Advisory Committee on Ecosystems

ICES CM 2003/ACE:03
Ref. E,G

REPORT OF THE

Working Group on Marine Mammal Ecology

Hel, Poland
25–29 March 2003

International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

Palægade 2–4 DK–1261 Copenhagen K Denmark

TABLE OF CONTENTS

Section			Page

TABLE OF CONTENTS

Section	Page

TABLE OF CONTENTS

Section **Page**

1 Introduction

1.1 Participation

The Working Group on Marine Mammal Ecology (WGMME) met at the Hel Marine Station, Hel, Poland from 25–29 March 2003. See Annex 1 for the list of participants.

The Working Group members were welcomed by Krzysztof Skóra and Iwona Kuklik. The Working Group reviewed the Terms of Reference and a schedule of work was adopted.

1.2 Terms of Reference

A set of terms of reference for the newly named Working Group (CM 2002/2ACE03) was agreed at the 89th Statutory Meeting of ICES. The Working Group on Marine Mammal Ecology will meet in Hel, Poland from 25–29 March 2003 to:

a) develop further the response to the European Commission standing request regarding fisheries that have a significant impact on small cetaceans and other marine mammals:
   i) review any new information on population sizes, by-catches or mitigation measures and suggest relevant advice,
b) in response to a request from HELCOM [HELCOM 2003/6]:
   i) develop a monitoring programme for estimation of the abundance of seals and other marine mammal populations in the Baltic Sea,
   ii) provide advice on harmonisation and synchronisation of monitoring and estimating procedures for marine mammal populations across the Baltic region,
c) evaluate the populations of seals and harbour porpoise in the Baltic marine area, including the size of the populations, distribution, migration, reproductive capacity, effects of contaminants and health status, and additional mortality owing to interactions with commercial fisheries (by-catch, intentional killing) [HELCOM 2003/2];
d) for the EcoQOs relating to (1) seal population trends in the North Sea, and (2) by-catch in the North Sea of harbour porpoises [OSPAR 2003/3.1]:
   i) develop draft guidelines (taking into account MON 01/9/1, Annex 6), including monitoring protocols and assessment methods, for evaluating the status of, and compliance with, those EcoQOs;
   ii) for EcoQO (1), propose a list of species to be covered by this EcoQO;
   iii) for both EcoQOs, provide current levels and other reference levels as can be justified scientifically, on an appropriate geographical basis, to be used as baselines against which progress can be measured;
   iv) reconstruct the historic trajectory of these metrics and determine their historic performance (hit, miss or false alarm) relative to the objective being measured, as a basis for evaluating their relationship to management; and
   v) provide the basis for advice on what management measures could be taken to help meet the EcoQOs;
e) commence development, on the basis of the criteria for sound EcoQOs established by ICES in 2001, of related metrics, objectives and reference levels for the EcoQOs relating to the utilisation of North Sea breeding sites of seals [OSPAR 2003/3.2];
f) commence development, on the basis of the criteria for sound EcoQOs established by ICES in 2001, of related metrics, objectives and reference levels for the EcoQOs relating to (b) presence and extent of threatened and declining species in the North Sea [OSPAR 2003/3.3]. In this respect,

i) for EcoQ element (b), consider the marine mammal species and the habitats on the Draft OSPAR list of threatened and declining species for their relevance and usefulness as a basis for EcoQOs for the North Sea;

ii) where possible and appropriate, reconstruct the historic trajectory of the metrics and determine their historic performance (hit, miss or false alarm) relative to the objective being measured, as a basis for deciding their relationship to management.

g) further develop EcoQs for marine mammals in the North Sea including current, reference, and suggested target levels. Developments could include preparing estimates of the maximum rates of increase and suggested limits for anthropogenic removals of harbour porpoises, other small cetaceans, and seals based on review of simulations and risk analysis incorporating life history parameters;

h) review preliminary findings from the 2002 seal epizootic event in the North Sea and Kattegat and review the role of such events in population regulation;

i) review census techniques for seals, and statistical analysis of resulting data (including correction factors);

j) review the effects of interspecific competition, particularly population effects of habitat exclusion, on expanding grey and harbour seal populations;

k) devise a process to construct in 2004 a time-series of:

iii) marine mammal abundance in the North Sea by quarter and year since 1963;

iv) marine mammal consumption rates and dietary composition by species and size class for selected periods by quarter and year.

l) prepare a case for a WGMME Workshop on Marine Mammal Health in relation to Habitat Quality.

The WGMME will report by 11 April 2003 for the attention of ACE, and the Marine Habitat and Living Resources Committees.

In addition, a late term of reference was added in relation to the OSPAR list of threatened and declining species

m) provide an assessment of the data on which the justification of the marine mammals in the OSPAR Priority List of Threatened and Endangered Species and Habitats has been based; this assessment should be to ensure that the data used for producing the justification are sufficiently reliable and adequate to serve as a basis for conclusions that the marine mammals concerned can be identified, consistently with the Texel-Faial criteria, as requiring action in accordance with the OSPAR Strategy on the Protection and Conservation of the Ecosystems and Biological Diversity of the Maritime Area.

1.3 Justification of Terms of Reference

a) This is further work in relation to a European Commission request for an increase in ICES efforts to provide information and advice in relation to the by-catch of marine mammals in commercial fisheries and means to decrease such by-catches.

b) and c) Requests from the Helsinki Commission for 2003.

d), e), f), g) and m) Requests from the OSPAR Commission for 2003. TOR f) is further work in relation to an OSPAR request for recommendations for appropriate Ecological Quality Objectives for North Sea marine mammals, and the preparation of provisional estimates for the current, reference, and target levels for the proposed EcoQO indices.

h) The scale of this epizootic was unknown in September 2002. Previous epizootic events have caused population crashes as well as considerable public concern.

i) There has been some standardisation of seal census techniques, but a further review would help in delivering reports on, e.g., EcoQOs in European waters, or trends in populations in the ICES area.

j) There is considerable interest in many quarters as to the carrying capacity of the marine environment for seals. A review of worldwide harbour and grey seal population growth rates and a determination of carrying capacity for these species would be useful.

k) This information is required by WGMSNS in order to provide a more accurate run of the multispecies model of the North Sea.

l) There is a need to interpret marine mammal health in relation to marine mammal habitats, as identified in the past by WGMMHA, WGMMPH and in the current OSPAR request.

WGMME will report by 11 April 2003 for the attention of the ACE and the Living Resources Committee.

1.4 Acknowledgements

WGMME thanks Alicja Makowska, Administrative Manager, Krzysztof Skóra and Iwona Kuklik of Hel Marine Station for their excellent hospitality and support to the meeting. We also thank Callan Duck (UK) and for providing information on SMRU seal census techniques; Rune Dietz (DK) for providing reports on the 2002 seal epizootic and satellite tagging of harbour and grey seals in the Baltic; and Janet Pawlak (ICES) for providing background documents on EcoQOs.

The Chair also acknowledges the diligence and commitment of the participants, which ensured that the extensive Terms of Reference for this meeting were addressed.

2 New information on by-catch of cetaceans

2.1 Introduction

Information on cetacean by-catches in European waters was reviewed in 2002 by the Working Group on Marine Mammal Population Dynamics and Habitats (WGMMPH) (ICES CM 2002a) and also by two meetings of the Subgroup on Fisheries and Environment (SGFEN) of the Scientific, Technical and Economic Committee for Fisheries (STECF) (CEC, 2002a, 2002b). There has been little new information since the second of these two SGFEN meetings.

2.2 Gillnets

The most recent estimates for by-catch of harbour porpoises (*Phocoena phocoena*) in Danish gillnet fisheries were provided by Vinther and Larsen (2002) and are summarised in last year's ACE report (ICES, 2002b). Estimates for UK gillnet fisheries were presented in the report of the first SGFEN meeting (CEC, 2002a) and are also summarised in last year's ACE report. There are still no estimates of by-catch for any extant Norwegian gillnet fisheries, though there is now a limited marine mammal by-catch observer scheme on vessels greater than 21 m working north of 62°N. German records of by-catch are limited to opportunistically obtained records. For Schleswig Holstein there was one recorded by-catch and for Mecklenberg and Pre-Pomerania there were three recorded by-catches in 2002 (Benke, pers comm.). Information on Dutch by-catches is limited to inferences from strandings and was summarised by ICES last year.

By-catches of harbour porpoises in the Baltic have been reviewed by ASCOBANS (2000) and are also considered in Section 4.7.5. The only new information relates to Polish by-catches that are described by Kuklik and Skóra (2000). They report 45 dead harbour porpoises that were returned to port by fishermen over a period of ten years, with nearly half of these from Puck Bay (Figure 4.12) and 40% in semi-drift net fisheries for salmonids. A further third of the by-catch was in set-nets for cod (Table 4.8).

Estimates of by-catch for Irish gillnet fisheries are limited to those for the now-terminated albacore driftnet fishery and those for the Irish hake gillnet fishery in the Celtic Sea (Treganza *et al*., 1997; Rogan and Mackey, 1999). Tregenza and Collet 1998 also provide an estimate of around 200 common dolphins (*Delphinus delphis*) taken annually in the Celtic Sea hake gillnet fishery (UK and Ireland). Current levels of this interaction are unknown. There are as yet no estimates of by-catch for UK and Irish gillnet and tangle net fisheries in the Celtic Sea other than for the hake fishery.

There are no estimates of by-catch in gillnet fisheries for France, Spain or Portugal, though some observations have been made in all three countries. Some of these were summarised in CEC (2002a) and CEC (2002b). Further observations have been made by AZTI (Fisheries and Food Technological Institute) in gillnet fisheries in the Spanish Basque Country. Observers on board commercial fishing vessels collected data in the period 1998–2001 in several surveys.

These included discard and other survey types, during which marine mammal by-catch data were also collected. So far only the number of dolphins has been recorded, and there has been no species identification. Observations have been carried out on board the artisanal gillnet Basque fleet (with tangle and trammel nets) working on depths less than 150 m, in the Basque Country shelf. Despite scattered sightings of dolphins made during some of the trips, no cetacean by-catches were recorded in 14 tangle net hauls between 1998 and 2001 and 34 trammel net hauls between 1999 and 2000.

2.3 Pelagic and other trawl fisheries

There are no reliable estimates of by-catch for pelagic trawl fisheries, though observations have been made and by-catch rates have been established for several fisheries.

Kuklik and Skóra (2003) refer to a single record of a harbour porpoise by-caught in a herring trawl in the Baltic. There have been some limited discard observations in other pelagic trawl fisheries in the Baltic but no records of porpoise by-catch are known.

Information on the by-catch of common dolphins, striped dolphins (*Stenella coeruleoalba*), white-sided dolphins (*Lagenorhynchus acutus*) and long-finned pilot whales (*Globicephala macrorhynchus*) in the Irish pelagic trawl fishery for albacore was summarized in last year's ACE report. Observations in several other pelagic trawl fisheries were reported by Morizur *et al*. (1999) and were also summarized in the SGFEN review (CEC 2002a). Cetacean by-catches were reported in pelagic trawl fisheries for albacore, bass and hake in ICES Sub-area VIII (common dolphins and bottlenose dolphins (*Tursiops truncatus*), and for mackerel and horse mackerel south and west of Ireland. There is an ongoing observer programme in the UK monitoring cetacean by-catch rates in pelagic trawl fisheries. In 2001, 53 common dolphins were recorded from 12 of 116 observed tows in the pelagic pair trawl fishery for bass in the English Channel, while in 2002 the numbers were 8 common dolphins recorded in 2 hauls among 66 observed tows (Northridge, pers comm.). There have been no observed cetacean by-catches in other UK pelagic trawl fisheries.

It is worth recalling here the fact that hundreds of dead common and striped dolphins have been washed ashore in the early part of every year in southern England and the Biscay coast of France for more than 15 years. Many of these animals show clear evidence of having died in fishing operations. Pelagic trawl fisheries have been blamed for these deaths, but the limited extent of observer coverage in the many fisheries operating in this region makes it impossible to attribute these mortalities to specific fisheries with any degree of certainty. Clearly if these mortalities are to be reduced, independent observations will first need to be made among all the fisheries operating in this area at this time of year to identify the source of all of these by-catch mortalities.

Basque trawl fisheries in the Bay of Biscay (Divisions VIIIa,b,c,d) have been monitored by observers over the period 1997 to 2001, again in several fishery-related surveys rather than in a dedicated cetacean by-catch monitoring survey. Although there are several trawl metiers in the Basque fleet, observations have mostly been made in just three: the "Baka" bottom trawl, targeting mixed species (in Divisions VIIIa,b,d), the bottom pair trawl working with VHVO (very high vertical opening) nets, targeting hake in Divisions VIIIa,b,d, and the bottom pair trawl working with VHVO nets, targeting mainly blue whiting and other pelagic species in Division VIIIc along the edge of the shelf of the Basque Country. The number of hauls observed and numbers of dolphins recorded are summarized in Table 2.3.1.

Table 2.3.1 Observations of marine mammals on board of different bottom trawl metiers in the Basque Country trawl fleet in the period 1996–2001.

Fishing gear	ICES Division	Days fishing	Hauls observed	Dolphin by-catch
VHVO BT*	VIIIabd	69	207	3
VHVO BT	VIIIc	55	187	0
Baka	VIIIabd	8	48	0
VHVO BT	VIIIabd	28	43	5
VHVO BT	VIIIc	4	5	0
Baka	VIIIabd	7	29	0
VHVO BT	VIIIabd	34	39	4
Baka	VIIIabd	106	488	0
VHVO BT	VIIIc	17	52	0
VHVO BT	VIIIabd	61	128	12
Baka	VIIIabd	110	282	0
VHVO BT	VIIIc	2	7	0
VHVO BT	VIIIabd	101	167	0
VHVO BT	VII**	38	76	0

* Very High Vertical Opening Bottom Trawl.
** This ICES Sub-area is out of the Bay of Biscay.

Again, no species identifications are available, but this information will be collected in future. The by-catches observed in these trawl fisheries show considerable variability between years and months. No clear patterns of by-catch have been identified, and thus these data have not been used to extrapolate to the total by-catch for the whole fleet. The species composition is also unknown, and as in many other places, there is a lack of information on the population size of any of the candidate species in the Bay of Biscay, making it difficult to assess whether or not the observed levels of by-catch are likely to represent a risk to any populations here.

2.4 Other fisheries

AZTI has also sampled longline and purse seine effort. Longlining was widely used in the past, but its use is now in decline in Spain. Observations were made in Divisions VIIIa,b,c,d on vessels targeting mainly hake between 1998 and 2001. A total of 45 days and 45 hauls were observed with no marine mammal by-catch recorded.

Spanish purse seine vessels targeting tuna in the Indian and Central-Eastern Atlantic Oceans have also been observed. In a programme funded by the ship owners, 63 observers were placed on board 63 purse seiners, 23 in the Central-Eastern Atlantic and 40 in the Indian Ocean in 1998 and 1999. There were 2459 days at sea observed in the Indian Ocean and 3113 days at sea observed in the Atlantic without any marine mammal by-catch.

There have been a few recorded incidents of minke whales becoming drowned in trap lines in lobster/crab fisheries. These were summarized by the IWC in 2001 (IWC, 2002) and include 3 records in 2000 and 1 in 2001 for the UK, and 1 for Spain in 2000.

2.5 Mitigation measures

2.5.1 Possible limitations on use of gear: time/area closures

There has been no new work on time/area closures with respect to limiting cetacean by-catch.

2.5.2 Use of pingers in gillnets

The use of pingers has been mandated by domestic Danish regulations in North Sea cod wreck net fisheries between August and October. The UK has recently launched a consultation document with a proposed national by-catch reduction strategy that will entail using pingers on all nets of more than 220 mm (stretched mesh) in ICES Divisions IVb and IVc, as well as on offshore cod wreck nets, and on all gillnets and tangle nets fished outside of 6 n.m. in ICES Divisions VIIe,f,g,h,j (DEFRA, 2003).

In Sweden pingers have been deployed in the salmon driftnet fishery in a feasibility study to examine their handling characteristics and any potential disruption of fishing activity (H. Westerberg, pers. comm.).

The technical specifications of the pingers currently available were reviewed by SGFEN (CEC, 2002).

2.5.3 Acoustic deterrents in pelagic trawl fisheries

BIM (2003) conducted trials during the summer of 2002 in the Irish pelagic pair trawl fishery for albacore using acoustic deterrent devices. A paired trial using standard pingers in one net and a control net without pingers was inconclusive. A paired trial using a remotely triggered louder acoustic deterrent seemed promising, but further work is needed.

2.5.4 Exclusion devices

Work on the development of a dolphin exclusion grid for use in the bass pelagic pair trawl fishery continues in the UK. Two trials have been conducted, in 2002 and 2003, largely aimed at addressing fish loss; the report of the most recent trial has not yet been completed.

2.6 References

ASCOBANS, 2000. Fourth annual compilation of national reports. ASCOBANS Secretariat, Bonn.

BIM. 2003. Bord Iascaigh Marah 2002 Annual Review. Irish Sea Fisheries Board, Dun Laoghaire, Ireland. p.16.

CEC. 2002a. Incidental catches of small cetaceans. Report of the meeting of the Subgroup on Fishery and the Environment (SGFEN) of the Scientific, Technical and Economic Committee for Fisheries (STECF), Brussels, 10–14 December 2001. SEC (2002) 376.

CEC. 2002b. Incidental catches of small cetaceans. Report of the second meeting of the Subgroup on Fishery and the Environment (SGFEN) of the Scientific, Technical and Economic Committee for Fisheries (STECF), Brussels, 11–14 June 2002. SEC (2002) 1134.

DEFRA. 2003. UK small cetacean bycatch response strategy – consultation document. Department for Environment, Food and Rural Affairs, Bristol.

ICES. 2002a. Report of the Working Group on Marine Mammal Population Dynamics and Habitats. ICES CM 2002/ACE:02. 21pp.

ICES. 2002b. Report of the ICES Advisory Committee on Ecosystems, 2002. ICES Cooperative Research Report, 254: 2–17.

IWC. 2002. Annex O: Summary of information from progress reports. Journal of Cetacean Research and Management, V. 4 Supplement April 2002.

Kuklik, I., and Skóra, K.E. 2000 (in press). Bycatch as a potential threat for harbour porpoise (*Phocoena phocoena* L.) in the Polish Baltic Waters. NAMMCO Scientific Publications.

Morizur, Y., Berrow, S.D., Tregenza, N.J.C., Couperus, A.S., and Pouvreau, S. 1999. Incidental catches of marine-mammals in pelagic trawl fisheries of the Northeast Atlantic. Fisheries Research, 41: 297–307.

Rogan, E., and Mackey, M.J. 1999. Cetacean by-catch in a driftnet fishery for Albacore tuna in the Celtic Sea. European Research on Cetaceans Astracts, 13: 135.

Tregenza, N.J.C., Berrow, S.D., Hammond, P.S., and Leaper, R. 1997. Harbour porpoise (*Phocoena phocoena*) bycatch in set gillnets in the Celtic Sea. ICES Journal of Marine Science, 54: 896–904.

Tregenza, N.J.C. and Collet, A. 1998. Common dolphin (*Delphinus delphis*) bycatch in pelagic trawl and other fisheries in the northeast Atlantic. Reports of the International Whaling Commission, 48: 453–459.

Vinther, M. and Larsen, F. 2002. Updated estimates of harbour porpoise by-catch in the Danish bottom set gillnet fishery. Paper presented to the Scientific Committee of the International Whaling Commission, Shimonoseki, May 2002, SC/54/SM31. 13pp.

3 Information on cetacean populations: abundance and distribution

Existing small cetacean abundance estimates were summarised by ACE (ICES, 2002) and by SGFEN (CEC, 2002). Although abundance estimates have been made for the North Sea and part of the Celtic Sea (in 1994), and for a few other small areas, it is clear that for most other parts of the ICES region and for most species there are as yet no satisfactory abundance estimates. There have been no new estimates of cetacean abundance anywhere in this region since 2002.

Clearly it is not possible to assess the impact of any by-catch without knowing anything about the abundance of the animals concerned. A planning committee is currently drawing up a proposal to repeat the SCANS survey of 1994 (Hammond *et al.*, 2002) over a wider area, and WGMME expressed its hope that this will finally provide some abundance estimates against which by-catch estimates can be measured.

Berggren *et al*. (2002) reported on a joint sighting and acoustic survey of the Baltic Sea, with just one acoustic and one visual detection of a porpoise in 2210 km and 377 km of trackline surveyed by the two methods, respectively.

Scheidat *et al.* (2003) conducted aerial surveys in May to August 2002 to examine the distribution of harbour porpoises in German North Sea and Baltic waters. In the North Sea densities were highest in the northeastern part of the survey area, closest to the Danish border, while in the Baltic highest densities were recorded east of the Island of Rügen, close to the Polish border.

References

Berggren, P., Brown, S., Gillespie, D., Kuklik, I., Lewis, T., Matthews, J., McLanaghan, R., Moscrop, A. and Tregenza, N. 2002. Passive acoustic and visual survey of harbour porpoises (*Phocoena phocoena*) in Polish coastal waters confirms endangered status of Baltic population. Paper at 16th annual European Cetacean Society Conference, Liege, 7–11 April 2002.

CEC. 2002. Incidental catches of small cetaceans. Report of the meeting of the Subgroup on Fishery and the Environment (SGFEN) of the Scientific, Technical and Economic Committee for fisheries (STECF), Brussels, 10–14 December 2001. SEC (2002) 376.

Hammond, P.S., Berggren, P., Benke, H., Borchers, D.L., Collet, A., Heide-Jørgensen, M.P., Heimlich, S., Hiby, A.R., Leopold, M.F., and Øien, N. 2002. Abundance of the harbour porpoise and other cetaceans in the North Sea and adjacent waters. Journal of Applied Ecology, 39: 361–376.

ICES. 2002. Report of the Advisory Committee on Ecosystems, 2002. ICES cooperative Research Report, 254: 4.

Scheidat, M., Kock, K.-H., and Siebert, U. 2003. Summer distribution of harbour porpoise (*Phocoena phocoena*) in the German North and Baltic Seas. Working paper presented at the 2003 ASCOBANS meeting. 13 pp.

4 Recommendations

WGMME noted that advice on cetacean by-catch has been sought from several quarters in the past few years, and that many of the same fundamental problems have been repeatedly highlighted. WGMME considers that:

- Abundance estimates are required for small cetaceans throughout EU waters. WGMME recognises that a steering group has been convened to draw up a proposal for a major sightings survey in 2004/2005 and urges EU support for this initiative.

- By-catch rate estimates are still lacking for many important fisheries. These include Norwegian gillnet fisheries and many pelagic trawl fisheries. WGMME notes that by-catch monitoring is required by EU member states (and Norway) under the Habitats Directive, and will also be required for certain fisheries under the Bergen Declaration to address the EcoQO for the by-catch of harbour porpoises in the North Sea.

- Recognising that this lack of action in implementing observer schemes is at least in some part due to the lack of any clearly defined methodology and an absence of any criteria to define sampling levels or strategies, the

WGMME suggests that consideration be given to holding a workshop to address these issues. As an adjunct to this process, WGMME again (?) stresses that the lack of readily available estimates of the numbers of fishing boats and fishing effort in the relevant fisheries at a European level also hinders the development of adequate monitoring strategies and prevents the estimation of total by-catch removals. WGMME therefore recommends that this should be addressed by some central collation of fishing effort statistics at a European level.

- WGMME endorses previous recommendations by SGFEN (2002) that further work should be conducted to address concerns about possible population-level effects of the widespread deployment of pingers.

- WGMME recommends that work on new mitigation methods should be given a high priority.

- WGMME recommends that where pingers or other mitigation measures are implemented in fisheries, monitoring should continue at a level sufficient to ensure that management objectives continue to be met by the implementation of the mitigation plan.

- WGMME also recommends that the EU develop some institutional framework for addressing by-catch determination and mitigation, including the development of management objectives, issues which at present are being addressed solely at a national level and with little evident coordination.

5 Development of a monitoring programme for Baltic marine mammals

5.1 Seals

5.1.1 Introduction

The application of risk analysis for grey seals and of power analyses for harbour seals have proven to be powerful tools to clarify the power of monitoring programmes to detect changes. Therefore, it is important to carry out risk and power analyses for different monitoring schemes. Risk analyses have been conducted for grey seals. The growing population of grey seals has led to increased fishery interactions and subsequent demands for the re-introduction of hunting. A demographic analysis and a risk assessment of the population have shown how the risk of quasi-extinction by overexploitation can be reduced. Although hunting increases the risk of quasi-extinction, the risk can be significantly reduced by the choice of a cautious hunting regime. The best hunting regimes allow no hunting below a "security level" in population size. Obviously, to implement such a hunting regime, knowledge of the population size and growth rate are required. With the current survey methodology, it would take more than 9 years to detect a 5% change in annual rate of increase. A hunt exceeding 300 females increases the risk for quasi-extinction substantially, but also the age and sex composition of killed animals influences the "cost of the hunt", and thereby the risk for quasi-extinction (Harding *et al.*, 2003).

5.1.2 Grey seals

5.1.2.1 Currently used methodology

Abundance has been estimated in the Baltic Sea using photo-identification mark-recapture methodology (Hiby *et al.*, 2001, 2003). Trends in relative abundance have been monitored using direct counts of moulting animals (Jüssi and Jüssi, 2001; Helander and Karlsson, 2002).

5.1.2.2 Proposed monitoring programme

The standard aerial survey methodology used for grey seal surveys during the pupping season (Duck, 2002) is less suitable in the Baltic since pupping occurs on both land and ice. The proportion of seals pupping on land and on ice varies depending on ice conditions. Ice breeders are distributed over vast unstable areas which are difficult to survey. However, the standard method of monitoring numbers of pups born would be feasible in years when ice coverage is limited and a majority of pups are born on land. In contrast to Atlantic populations, Baltic grey seals change land-breeding sites frequently. For estimates of pup production and mortality rates, ground counts involving assessment of moulting stages are necessary. Therefore, WGMME proposes three methods for monitoring grey seals in the Baltic: 1) photo-identification to derive population estimates, 2) counts during the peak moulting season to study population trends, and 3) pup counts under conditions when a majority of pups are born on land.

Photo-identification should be carried out at least once every second year. To be useful, it is important that the project is coordinated and implemented on a permanent basis for the whole Baltic region. The ideal situation is that the work is performed by a small number of teams to ensure consistency in data collection. However, photo-identification is less suitable to detect changes in abundance early on, since the process to derive the estimates is slow. Therefore internationally coordinated counts during the peak moulting season are proposed to derive trends in abundance and to be able to detect changes in trends. It is also important that the survey design is coordinated internationally to ensure consistency in data collection, including environmental covariates that may affect the number of seals hauled-out. A periodic international workshop is needed to ensure that photo-identification methodology will be standardized and subsequently deployed in all countries involved.

5.1.3 Harbour seals

5.1.3.1 Currently used methodology

A minimum of three aerial surveys during the peak moulting season in the end of August are used for estimates of trends in the entire area of distribution (Härkönen *et al*. 2002). At specific monitoring sites, ground counts of pups are conducted for estimating changes in reproductive capacity (Härkönen *et al*., 2002).

5.1.3.2 Proposed monitoring programme

Power analyses have shown that it will take seven years to detect a 5% change in annual rate of increase, when using three replicate flights. Thus, annual replicate surveys of seals in the entire area are required to make it possible to detect changes in trends within a reasonable time. Monitoring carried out at long time intervals reduces the possibilities to evaluate the effects of catastrophic events. Furthermore, more frequent surveys increase the likelihood to detect annual variations in rates of increase. Given a choice between annual replicated flights or longer intervals and single annual flights, the WGMME recommends the former.

5.1.4 Ringed seals

5.1.4.1 Currently used methodology

For estimates of distribution and abundance on ice, a strip survey technique has been used as described by Härkönen and Heide-J¢rgensen (1990) and Härkönen and Lunneryd (1992). In this method, strips are placed in a systematic manner to evenly cover the study area. The surveyed strips extended to 400 m to either side of the aircraft, flying at an altitude of 90 m. Observations of seals were noted at two-minute intervals, which permits positioning of observations within segments (Härkönen and Lunneryd, 1992). When seal density is calculated for each segment, detailed mapping of ringed seal distribution is possible. The method has been implemented in all surveys in the Bothnian Bay from 1988–2002, and in 1996, also in surveys in the Gulf of Riga and the Gulf of Finland. In surveys before 1996 (see below) different or modified methods were used in the latter two areas due to logistic problems and changing ice conditions.

In earlier surveys a low-winged single-engined aircraft was flown at an altitude of about 30 m over the ice where conditions were judged to be most suitable for seals. The distance and angle to each sighted seal were measured and recorded and strip width was calculated retrospectively based on these measurements (Helle, 1980). The length of the strip was calculated from air speed of the aircraft.

Lair counts and monitoring of mortality are used to assess population size in Lake Saimaa. In Lake Ladoga there is no regular monitoring, but considering the biology of the species, both lair counts and aerial surveys have been developed for the region.

5.1.4.2 Proposed monitoring programme

The WGMME proposes the use of the strip survey technique according to Härkönen and Heide-J¢rgensen (1990) and Härkönen and Lunneryd (1992) described above, since the results are less affected by subjective factors. The method is also suitable for preparing detailed ringed seal distribution maps.

For Lake Saimaa, continuation of annual lair counts and mortality monitoring is recommended, while in Lake Ladoga application of both ringed seal survey methods should be employed according to alternative breeding behaviour of the seals.

5.2 Harbour porpoises

5.2.1 Currently used methodology

The standard method for estimating abundance of cetaceans is the line-transect distance sampling methodology described in detail in Buckland *et al*. (1993). These surveys can be conducted using either aircraft or ships and need to include some calculation of correction factors (g(0)). A minimum number of sightings is needed to estimate the effective strip width. Therefore a problem in using line-transect in areas of very low density such as the Baltic Proper is the difficulty in getting a sufficient number of sightings to obtain a reliable abundance estimate with an acceptable confidence interval.

5.2.2 New methodology

The development of new methods of analysing line transect data, such as modelling used by Hedley (1999), can be used to estimate population sizes. This can also be applied to old data which could be re-analysed.

Also, the development of additional methods for areas of low density is urgently needed. One approach is to use acoustic methods to detect porpoises. Towed hydrophone click detectors have been used in surveys in the Baltic Sea (Gillespie *et al*., 2002), but no abundance estimates have been derived from these methods. Acoustics have been used together with visual surveys for sperm whales to estimate abundance (Barlow, 1999). The planned SCANS II survey for 2005 should incorporate the development and use of click detectors and provide data to calibrate this methodology with the line-transect distance sampling results.

The use of stationary hydrophones such as PODs (porpoise detectors) can be used to monitor small areas. They are especially useful in areas of low density of porpoises.

5.2.3 Proposed monitoring programme

Because of the different populations and their very different status within the larger Baltic Sea area, the two populations are treated separately.

5.2.3.1 Harbour porpoises in the Kattegat/Skagerrak/Belt Sea area

To estimate abundance of harbour porpoises standard line-transect distance sampling, either by plane, or by boat, should be used. A large-scale aerial and/or shipbased line-transect distance sampling survey should be conducted annually (ideally), or at least every 3 years. Detailed surveys will probably provide smaller confidence intervals for the population sizes. The more frequently a survey is conducted, the higher the probability to detect changes in trends in population size.

5.2.3.2 Harbour porpoises in the Baltic Proper

Due to the low density of porpoises in the Baltic Proper, standard line-transect methodology is not applicable. Furthermore, very little information on current distribution of porpoises in the Baltic Proper is available. To obtain information on abundance, the following step-wise process is proposed:

1) Review information on historical and current distribution of harbour porpoises in the Baltic Proper, including strandings, by-catches and sightings.
2) Develop an automated harbour porpoise click detector that can be deployed from various platforms of opportunity.
3) Find appropriate platforms of opportunity from which the acoustic detectors will be deployed. This could, for example, include ferries or research vessels.
4) Use stationary click detectors (POD – porpoise detectors) in sites chosen based on information provided through step 1 in order to confirm presence or absence of porpoises in particular areas.

5) Deploy satellite tags on harbour porpoises of the Baltic Proper to get information on the movement of these animals in the Baltic Sea. A suitable area for this project could the area around Hel where it is possible to deploy Pound nets to catch animals.
6) Analyse the data collected from step 1 to step 5 in terms of occurrence and distribution of harbour porpoises, including seasonal changes.
7) Use the available data to determine the best temporal and spatial scale for conducting a dedicated line-transect survey to determine abundance in a substratum of the Baltic Proper, using combined visual and acoustic shipboard methodology.

5.3 Provide advice on harmonisation and synchronisation of methods

5.3.1 Seals

Workshops are held annually to ensure compatibility of methods and analyses of grey seal abundance. Training of field personnel should include evaluations of observer variability.

5.3.2 By-catch estimation

The knowledge about marine mammal by-catches in the Baltic is very limited. The recent available data are reviewed for each species in Section 6 and summarised in Table 5.3.2.1.

Table 5.3.2.1. Estimates of yearly by-catch in parts of the Baltic and Kattegat for the year 2001 (a ten year mean for the Polish data was used).

Species	Animals/year	Method	Comment
Ringed seal	120	Interview	SE+FI
Grey seal	590	Interview	SE+EST+PO
Harbour seal, Kalmarsund	2	Reported	SE
Harbour seal, Kattegat	325	Interview	SE
Harbour porpoise, Baltic	4.5	Reported	PO, 10 years
Harbour porpoise, Kattegat	2	Reported	SE

Independent observer schemes have so far been used in the Baltic only for estimating discards, and the coverage has been much too low to allow any realistic assessment of marine mammal by-catches. Obviously observers are the best method for by-catch monitoring, but there are several reasons why it is difficult in Baltic fisheries:

- The high-risk gears both for seals and porpoises are driftnets and bottom-set gillnets. These gear types have a very high frequency in the Baltic Proper, where the bulk of the grey seal incidental catches occur in the northern half and where harbour porpoise abundance is highest in the southern half. This means that the observer effort has to cover most of the Baltic.
- The gillnet fleet is large and dominated by boats less than 12 m.
- Statistics for fishing activities are very poor or non-existing as boats <12 m in most countries do not have to keep a fishing logbook. Data on the overall effort are necessary for estimating by-catch even with good observer data.
- There are limits for total net length in the salmon driftnet and the cod gillnet fisheries, which means that the range of effort/boat is limited. This means that coverage of a large fraction of the fishing effort requires many observers.

In spite of this, it is important to get reliable information on harbour porpoise by-catch. The steps 1 to 7 in Section 5.2.3.2 should be used to find areas in which harbour porpoises are present. To focus and optimise an independent observer programme, an assessment should be made of the distribution, seasonal variation and amount of fishing effort in the fisheries that have a high potential for by-catch according to available data (salmonid surface nets, large-mesh bottom-set gillnets). Interviews in a sample of Baltic fishing ports can supply otherwise unavailable data about the small-scale fisheries, and possible concentrations of harbor porpoise by-catch. With this background, an observer programme can be designed that maximises the information with limited resources.

Several schemes for direct reporting by the fishermen are used. Reporting by-catch in the fishing logbook is mandatory in several Baltic countries. Intercomparison between logbook data and interviews show large underreporting, however.

There is no automated observation system in operational use, but different possibilities have been discussed. Onboard video monitoring of the fishing operations, with some additional data to estimate total fishing effort, is the most common. As with human observers, there are large logistical problems to apply automated systems in the small-boat Baltic fishery where it will be difficult to find place even for a video. In addition there are the problems with tampering with the instruments and the effort that has to be put into monitoring the recordings.

For seals the information about by-catch is less sensitive and alternative methods like interviews are possible. A recent study was made for the Swedish fishery (Lunneryd *et al*., 2003). This fishery has the advantage of having effort statistics for all boats down to 5 m, which allow a relatively detailed extrapolation of interview data for gear type and area. Table 5.3.2 provides a summary of the results, including spatial distribution of gear types involved in seal by-catch.

Table 5.3.2. The incidental catches of seals in the Swedish fishery in 2001 by gear type and area. The units of effort are: for traps – number of gear*day; eel fykes – 1000*number of gear*day, km of net*day and trawl number of gear*hours. Confidence intervals are calculated by bootstrap iterations.

	Number reported in interviews	Interviews part of total effort	Effort	Estimation of total number seals
Grey seal Baltic north of 60º N				
Salmon trap	26	20%	45,592	131
Whitefish net	2	20%	5,831	10
Herring trawl	11	69%	2,142	16
Sum	**39**			**157**
Grey seal Baltic 56ºN–60º N				
Eel trap	16	35%	28,372	46
Turbot net	42	33%	10,268	128
Whitefish net	2	33%	852	6
Cod net	19	19%	78,615	98
Salmon driftnet	5	19%	9,699	27
Sum	**84**			**305**
Total grey seal	**123**			**462**
95 % confidence interval				247–749
Ringed seal Baltic north of 63ºN				
Salmon trap	8	20%	32,175	40
Whitefish net	2	17%	2,305	12
Sum	**10**			**52**
95 % confidence interval				11–102
Harbour seal Eastern Baltic				
Eel trap	2			-
Harbour seal West coast and the Sound				
Eel fyke net	19	20%	4,339	95
Eel trap	19	66%	1,222	29
Flatfish and lumpsucker net	23	11%	10,991	208
Crab net	6	55%	1,655	11
Trawl	6	8%	142,284	73
Sum	**73**			**416**
95 % confidence interval				190–692

5.3.3 Harbour porpoises

Aerial and shipboard surveys using line-transect distance sampling methodology should be standardized to assure comparable results.

To make the data collection and analyses from stationary click detectors comparable between countries an international workshop should be conducted.

5.4 References

Barlow, J.1999. Trackline detection probability for long diving whales. Marine Mammal Survey and Assessment Methods (eds G.W. Garner, S.C. Amstrup, J.L. Laake, B.F.J. Manly, L.L. McDonald & D.G. Robertson), pp. 209–221. A.A. Balkema, Rotterdam, the Netherlands.

Buckland, S.T., Anderson, D.R., Burnham, K.P., and Laake, J. 1993. Distance Sampling: Estimating Abundance of Biological Populations. Chapman & Hall, London, UK.

CEC. 2002. Report of the Subgroup on Fishery and Environment (SFGEN), Scientific, Technical and Economic Committee for Fisheries (STECF), Incidental Catches of Small Cetaceans, Brussels 10–14 December 2001. SEC (2002) 376, 83 pp.

Duck, C. 2002. Pup production in the British grey seal population. Annex II in Scientific advice on matters relating to British seal populations. 2002. Available through: http://smru.st-and.ac.uk

Gillespie, D., Brown, S., Lewis, T., Matthews, J., McLanaghan, R., and Moscrop, A. 2002. Preliminary results on the relative abundance of harbour porpoises (*Phocoena phocoena*) from acoustic and visual surveys in German, Danish, Swedish and Polish waters during summer 2002. IFAW preliminary Report (unpublished). *Song of the Whale* Research Team, International Fund for Animal Welfare, 87–90 Albert Embankment, London SE1 7UD, UK. 10 pp.

Harding, K., Härkönen, T. and Helander, B. 2003. Ecological risk analysis of the Baltic gray seal population (*Halichoerus grypus*). Working paper presented to this meeting of WGMME, available from T. Härkönen (see Annex 1).

Härkönen. T., Harding, K., and Heide-Jørgensen, M-P. 2002. Rates of increase in age-structured populations: a lesson from the European harbour seals. Canadian Journal of Zoology, 80: 1498–1510.

Härkönen, T., and Heide- Jørgensen, M.-P. 1990. Density and distribution of the ringed seal in the Bothnian Bay. Holarctic Ecology, 13: 122–129.

Härkönen, T., and Lunneryd, S. G. 1992. Estimating abundance of ringed seals in the Bothnian Bay. Ambio, 21: 497–503.

Hedley, S. L., Buckland, S. T., and Borchers, D. L. 1999. Spatial modelling from line transect data. Journal of Cetacean Research and Management 1, 255: 64.

Helander, B., and O. Karlsson. 2002. Inventering av gråsæl vid svenska Östersjoökusten 2001.

Helle, E. 1980. Lowered reproductive capacity in female ringed seals (*Pusa hispida*) in the Bothnian Bay, northern Baltic Sea, with special reference to uterine occlusions. Annals Zoologica Fennica, 17: 147–158.

Hiby, L., Lundberg, T., Karlsson, O., and Helander, B. 2001. An estimate of the size of the Baltic grey seal population based on photo-id data. Report to project "Seals and fisheries" Länstyrelsen I Västernorrlands Län and Naturvardsverket. 29-11-2001.

Hiby, L., Lundberg, T., Karlsson, O., Watkins, J., and Helander, B. 2003. An estimate of the size of the Baltic grey seal population based on photo-id data. Working paper presented at this meeting of WGMME, available from O. Karlsson (see Annex 1).

Jüssi, I., and Jüssi, M. 2001. Action plan for grey seals in Estonia 2001–2005. Eesti ulukid/Estonian Game 7. 88 pp.

Lunneryd, S.-G., Königson, S., and Westerberg, H. 2003. Bycatch of seals in the Swedish fishery in 2001. Working paper to this meeting of WGMME, available from H. Westerberg (see Annex 1).

6 Status of populations of seals and harbour porpoise in the Baltic Marine Area

6.1 Baltic ringed seal (*Phoca hispida botnica*)

6.1.1 Distribution and migration

Baltic ringed seals are found in three main areas in modern times (Reeves, 1998): the Bothnian Bay (Figure 6.1.1.1), Gulf of Finland (Figure 6.1.1.2) and Gulf of Riga (Figure 6.1.1.3). About 70% of the total population is found in the north, 25% in the Gulf of Riga and 5 % in the Gulf of Finland. The winter distribution of the species is largely determined by the occurrence of dense pack ice and fast ice. The main breeding areas are found in the central northern part of the Bothnian Bay (Härkönen and Lunneryd, 1992), the eastern part of the Gulf of Finland, and in the Gulf of Riga (Härkönen *et al.,* 1998). Outside these areas, low numbers of ringed seals are found in the Bothnian Sea (Härkönen and Heide-J¢rgensen, 1990; Härkönen *et al*., 2003) and in the southwestern archipelago of Finland (Helle and Stenman, 1990).

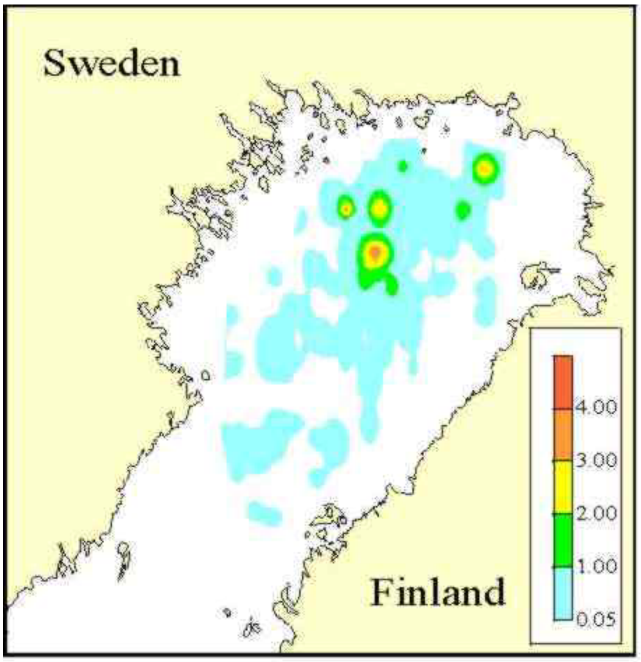


Figure 6.1.1.1. Late winter distribution of ringed seals in the Bay of Bothnia (Härkönen *et al*., 1998)

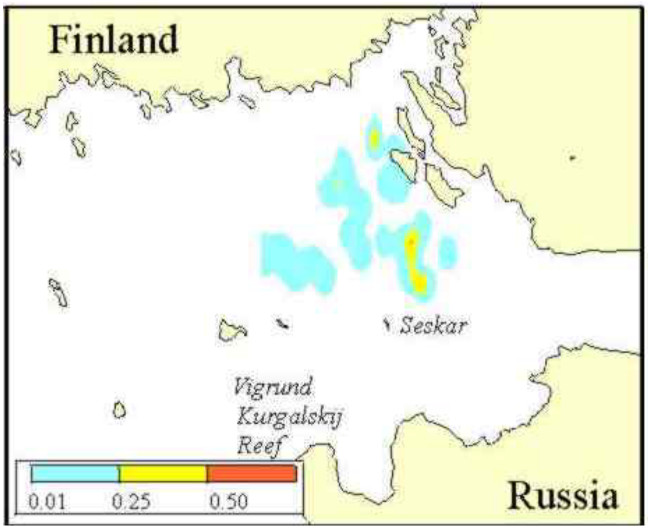


Figure 6.1.1.2. Distribution of ringed seals breeding in the Gulf of Finland (Härkönen *et al.*, 1998).

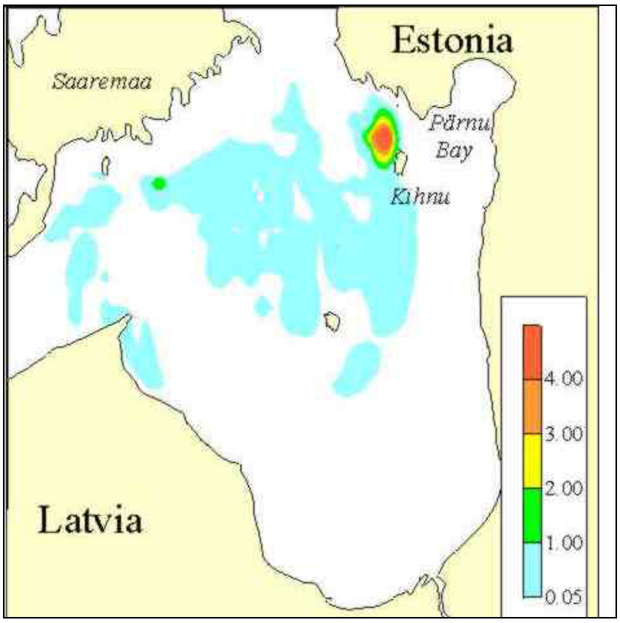


Figure 6.1.1.3. Distribution of ringed seals breeding in the Gulf of Riga (Härkönen *et al.*, 1998).

6.1.1.1 Distribution during the ice-free period

Limited information is available on distribution during the period spring to autumn, since ringed seals in the Bothnian Bay, the most intensively studied area, do not haul out in large numbers during the ice-free period and there have been no at-sea surveys. In contrast, the species does haul out in the Russian part of the Gulf of Finland. Several haul-out sites were found on islands, islets and rocks during boat surveys in spring and summer 1993–1996. The largest numbers of ringed seals, in groups of up to 80 individuals, were observed at the Kurgalskij Reef and Vigrund Island along the south-eastern coast of the Gulf during late May, early June and in August.

Several groups, comprising up to a few tens of animals, haul out on rocks around the islands of Hiiumaa and Saaremaa on the Estonian west coast. There is evidence of seasonal changes in the haul-out pattern of these seals, as the highest numbers are observed in early spring and late autumn (Härkönen *et al*., 1998).

6.1.1.2 Late winter distribution

In the Bothnian Bay and in the Gulf of Finland, the largest numbers of ringed seals are hauled out on ice during the moulting period in April to May (e.g., Helle, 1980a). The highest numbers on ice in the Gulf of Riga occur by mid-April as ice conditions deteriorate two weeks earlier than in the Gulf of Finland.

The late winter distribution of Baltic ringed seals is based on results from the 1996 survey, when all three areas were surveyed using the same method (Härkönen *et al*. 1998). The distribution in the Bothnian Bay was similar in all years from 1988–1996, with the largest concentrations of seals found in the central northern drift ice. This pattern was similar when ice fields extended south of the Quark archipelago in 1988, indicating that seal distribution in this area is not directly correlated to the size of ice fields.

In the Gulf of Finland, the highest densities were found in the east with very low densities elsewhere. This pattern of distribution was found also in 1993–1995, most probably a consequence of the distribution of suitable seal ice. The westernmost part of the Gulf could not be surveyed due to military restrictions, however a survey in Estonian parts of the Gulf on 18 April 1996 found low numbers of ringed seals in the area.

The whole of the Gulf of Riga was covered by ice in 1996, but ringed seal distribution was strongly concentrated in the northeastern section. The highest concentrations were found around Kihnu Island (a traditional seal hunting area) close to Pärnu Bay and along cracks at the fast ice edge in the northeast.

6.1.1.3 Movements

Ringed seals in the Baltic are relatively sedentary.

Nineteen adult ringed seals of both sexes were equipped with satellite transmitters, of which five were deployed in the Bothnian Bay, ten in Estonian coastal waters, and four in the Gulf of Finland. Data from the Bothnian Bay covered the period from November to March, and during this period the the movements of ringed seals were restricted to the ice-covered areas in the north. None of the five seals moved out from the Bothnian Bay. A more complete data set from Estonian coastal waters covering the period from May to March indicated a similar behaviour, but also permitted a more detailed analysis. In late May the seals left the shallow areas in the Moonsund Archipelago and most "at-sea locations" during June and July were over deeper waters in the Gulf of Riga, but also at the mouth of the Gulf of Finland. Animals occurred west of Hiiumaa and Saaremaa Islands in summer. In September and October all seals moved towards the main coastline. In December and January, all seals moved to the northern parts of the Gulf of Riga, a behaviour correlated to ice formation. In February, the Moonsund is covered by fast ice and none of the seals remained in the area. The four seals in the Gulf of Finland showed similar patterns, and none left the Gulf during the ice-free period.

Estonian seals spend the winter in the northern parts of the Gulf of Riga and move northwards to the Moonsund Archipelago at the break-up of the fast ice in April (Härkönen *et al.*, 1998). At the same time, catches of herring in the Moonsund increase and peak in early May. In June and July herring abandon the shallow areas and move to the deeper waters of the Gulf of Riga and off the Estonian west coast, a pattern also followed by the seals.

6.1.2 Population size

6.1.2.1 Historical population size

The Baltic ringed seal has been heavily exploited during the past century and bounty statistics provide information on past population sizes (Bergman, 1956). Modelling based on numbers of killed ringed seals show that 190,000 to 220,000 ringed seals occurred in the Baltic up to the first decade of the 20th century (Harding and Härkönen 1999).

The traditional methods used for hunting seals before the 20th century (stalking, clubbing, netting and harpoon (Bergman, 1956)) were less efficient for catching solitary ringed seals compared with group-forming grey seals. The ringed seal population needed to be large to make hunting this species worthwhile. During the last decades of the 19th century, ringed seals were hunted even less than in earlier decades due to low seal oil prices, and consequently, the ringed seal population could not have been severely depleted at the beginning of the 20th century. This likely scenario was used in modelling to establish an "original" population level, by adjusting the net reproductive rate to values that gave a stable development during the last decade of the 19th century and during the first decade of the 20th (Harding and Härkönen, 1999).

With the introduction of bounties in 1903 in Sweden and 1909 in Finland and the use of modern rifles, the situation changed. Stalking of ringed seals became more profitable, and the intensive hunting during the 1910s reduced the population to about half of the original size. The decline in the population continued in the 1920s, but at a considerably lower rate. As a consequence of favourable weather conditions, but also because of economic reasons, hunting pressure increased again in the 1930s, which resulted in a new dramatic drop in ringed seal numbers up to 1939, when about 23,000 to 27,000 seals remained (Figure 6.2.1.1.1).

During the following 25 years (1940–1965), the population appears to have been stable, but a new decline occurred in the mid-1960s as a result of increased hunting pressure in Finland and Estonia (Figure 6.2.1.1.1). Although catches decreased after 1969, the population continued to decline until 1975 as a consequence of lowered net reproductive rates after 1965. In the mid-1970s the population was considerably below 5000 animals.

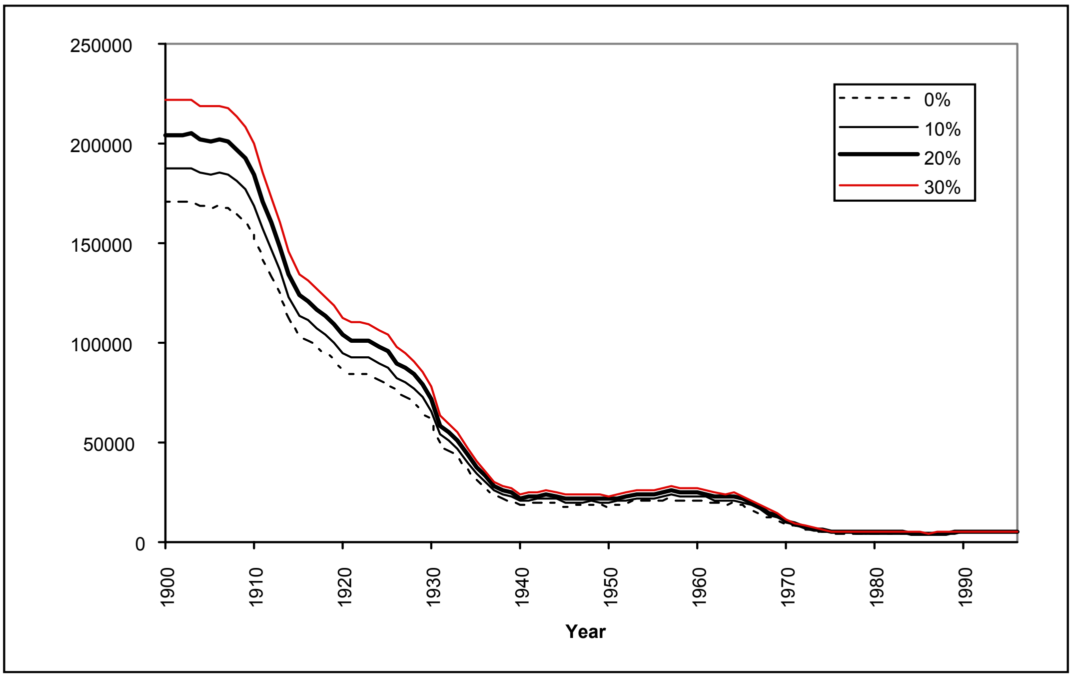


Figure 6.2.1.1.1. Projection of past population sizes of ringed seals in the Baltic (Harding and Härkönen, 1999). Ranges given for 0% to 30% hunting losses.

6.1.2.2 Current population in the Bay of Bothnia

The first surveys in the area, conducted in 1975 and in 1978, provided estimates of about 3000 ringed seals in the area for both years (Helle, 1980a). Surveys in 1984 and 1987 indicated a decreasing trend in local population up to the mid-1980s (Helle, 1990). From 1988 to 2002, a new series of surveys was carried out in the Bothnian Bay, using a survey method with fixed strip width and systematically placed strips (Härkönen and Heide-Jorgensen 1990, Härkönen and Lunneryd, 1992; Härkönen *et al.*, 1998, 2003). The population increased at about 5% per year over this period (Figure 6.1.2.2.1) to an estimated hauled-out population in 2002 of 4498.

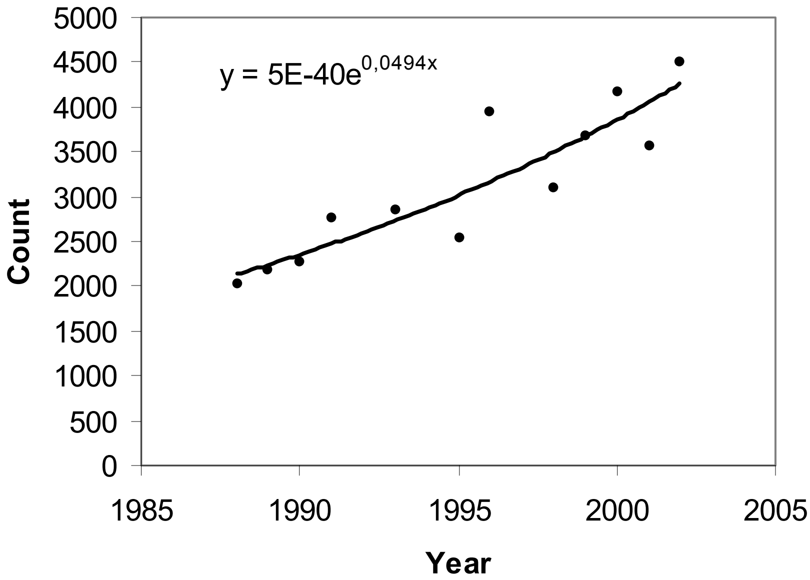


Figure 6.1.2.2.1. Counts of hauled-out ringed seals in Bothnian Bay 1998–2002 (Härkönen *et al.*, 1998, 2003).

6.1.2.3 Current population in the Gulf of Finland

The first estimate of ringed seal population size for the Soviet area of the Gulf of Finland, based on counts in 1970, was of 5000 individuals (Rezvov, 1975). However, only very limited information was supplied on survey methods and the location of the area counted. An estimate of 8,200 ringed seals in Soviet waters in the Gulf of Finland was made in 1973 (Tormosov and Rezvov, 1978). This is also difficult to evaluate as no information is available on survey methods. A further estimate was made of 2100 ringed seals for the Gulf of Finland based on surveys in 1979 (Tormosov *et al.*, unpublished). This estimate was an extrapolation over several steps, but the primary data show that the observed number of ringed seals in strips was 65. As the survey fraction was 8.8%, the resulting estimate should have been 793 hauled-out ringed seals for the Gulf of Finland. Härkönen *et al.* (1998) could not evaluate this result in more detail as further information on location of strips, variance, etc., is lacking. However, it gives a strong indication that ringed seal numbers were considerably lower than reported earlier.

With the exception of the Härkönen *et al.* (1998, 2003) reviews of the study of Tormosov *et al.* (unpublished), there is no useful information on earlier population size in the Gulf of Finland, and the published assessments are probably gross over-estimates. Early estimates cannot therefore be used for evaluations of past trends.

Aerial surveys using strip transect methods were undertaken from 1992 to 1996. These gave estimates of this population of between 92 and 169 (Table 6.1.2.3.1). Sampling fractions for the surveys of 1992 and 1993 are not available, and thus the estimates are unreliable. A variant of the strip census method was used in 1994 and 1995 (Härkönen *et al.*, 1998, 2003), and the population assessments can be used only as indications of population size. In 1996 the total ice-covered area was 2688 km^2, but only 60% (1613 km^2) could be covered by the range of strips due to military regulations. Thus, if the mean seal density in strips west of 28°20'E at 0.053 seals/km^2 is applied to the remaining ice-covered area (1075 km^2), a calculated number of 57 seals results for that area. Therefore, the estimate for the whole ice-covered area would be 149.

Table 6.1.2.3.1. Survey results of hauled-out ringed seals in the Gulf of Finland in 1992–1996 (Härkönen *et al*., 1998, 2003).

Year	Date	Ice area (km^2)	Seal density ($seals/km^2$)	SD	Count	Sampling Fraction %	Population estimate, Russia	±CI 95%
1992		-			89			
1993		-			40	<30	150	
1994	30/4	-			61	36	169	
1995	15/4	-			54	32	169	
1996	5/5	1613	0.057	0.135	22	24	92*	41

6.1.2.4 Current population in the Gulf of Riga and the Estonian west coast

Notes in literature (Greve, 1909) and statistics of seal hunting (Anon., 1939) indicate that in earlier times ringed seals were numerous in the area. However, earlier data cannot be relied upon as a basis for estimates of abundance or distribution. Surveys were made also in April 1994 and 1996 (Table 6.1.2.4.1).

Table 6.1.2.4.1. Survey results of hauled-out ringed seals in the Gulf of Riga on 14–21 April 1994 and on 15–17 April 1996 (Härkönen *et al.*, 1998). The estimate for 1994 is approximate because transect width could not be calculated exactly and due to changing ice conditions during surveys.

Year	Ice area (km^2)	Seal density ($seals/km^2$)	SD	Count	Sampling fraction %	Population estimate	±CI 95%
1994	1000–4000	-	-	450	unknown	(680)	
1996	9945	0.142	0.526	228	16.2	1407	590

6.1.3 Reproductive capacity

Population surveys in the Gulf of Bothnia show a 5% annual increase in population which is roughly 50% of the intrinsic rate of increase of ringed seals breeding in the Arctic. Population models suggest that pregnancy rates should be about 0.65 to yield the measured rate of population increase. The pregnancy rate of Arctic ringed seals is 0.90 (e.g., Smith, 1987). Although limited information is available from the Gulf of Finland, it is suggested that impaired reproduction also occurs in the area (Westerling and Stenman, 1992).

6.1.4 Effect of contaminants and health status

In the autumn of 1991, a high mortality was observed among ringed seals in the Russian part of the Gulf of Finland. About 150 dead seals drifted ashore both in Russia and in Finland, and there was speculation that natural or man-made neurotoxins were involved (Westerling and Stenman, 1992). Between two and seven corpses of adult ringed seals were found annually between 1992 and 1996 (Westerling and Stenman, 1992).

Pathological changes in reproductive tracts observed in the 1980s (Helle, 1980b) still persist in the ringed seal population but at lower frequencies (Mattson and Helle, 1995; E. Helle, pers. comm.). Physiological studies using CYP1A as a marker show that Baltic ringed seals are affected by persistent organic pollutants (Nyman *et al*., 2001).

6.1.5 Interactions with commercial fisheries and intentional killing

By-catches of ringed seals in the Swedish and Finnish fishery were estimated to amount to about 50 and 70 individuals, respectively, in 2001 (Lunneryd *et al*., 2003; E. Helle, pers. comm.). The majority of those are drowned in salmon and whitefish traps. By-catch information is not available from other areas, but is likely to occur. There is no intentional killing apart from the scientific sampling in some recent years (up to 10 mature females per year to study reproductive state) in the Gulf of Bothnia. A small number of ringed seals are shot by mistake under licences issued for the grey seal hunt in Finland and Sweden.

6.1.6 Recommendations

The number of vessels engaged in Baltic fisheries is unknown. WGMME recommends that a study be initiated to estimate the number of fishing vessels, and estimate fishing effort in key metiers (salmon and whitefish traps) in the Baltic.

6.2 Saimaa ringed seal (*Phoca hispida saimensis*)

6.2.1 Distribution

Based on literature, interviews of old fisherman and farmers and unpublished field notes from 1966–1973 made by Koivisto and Paasikunnas (1973), Sipilä (1994) estimated that the range of the Saimaa ringed seal covered about 90–95% of the surface area of Lake Saimaa at the start of the 20th century. Towards the end of the 20th century the range was about 30–40% (Sipilä 1994). There was no notable reduction in the area of distribution during 1980s and 1990s. Plainly this seal is not migratory.

6.2.2 Population size and trends

Modelling of earlier population sizes is based on hunting statistics, and suggests that the number of Saimaa ringed seals was between 100 and 1300 seals in the 1890s (Kokko *et al*., 1999). The highest density of 0.88–1.12 km^2 is at present in Lake Kolovesi. The population size at Lake Saimaa in pristine state was assumed to be at least 2000–2500 seals (Hyvärinen and Sipilä, 1992). Extrapolating, based on Lake Kolovesi, gives a potential total population size to Lake Saimaa of about 3800–4900 seals. The size of the Lake Saimaa seal stock decreased substantially in the mid-1950s (Kokko *et al*., 1999). In the late 1960s the population decreased further, probably as a result of changes in the habitat, new fishing methods and environmental toxins such as mercury (Marttinen, 1946; Sipilä, 1981; Becker, 1984; Sipilä, 1990; Sipilä *et al*., 1990). Counts in the1980s were most likely underestimates, due to insufficient coverage (Helle *et al.* 1981, Sipilä 1983, Sipilä *et al*. 1990). The first estimate based on systematically collected data was made in 1990 (Table 6.2.2.1, Figure 6.2.2.1). The highest density of seals, and about 50% of the population, is now found in the central parts of the Lake Saimaa (Lake Haukivesi and Lake Pihlajavesi).

In the late 1990s, the seal stock increased by about 50 animals (Table 6.2.2.1, Figure 6.2.2.1), corresponding to an annual growth rate of about 4%. The improved accuracy in the late 1990s in the lair counting method can explain 25% of the observed rate of increase in the late 1990s. The present annual growth rate is substantially lower than the possible maximum rate of increase for ringed seal populations of 10% (Reeves, 1998), but substantially higher than the 1% estimated for the period 1977–1995.

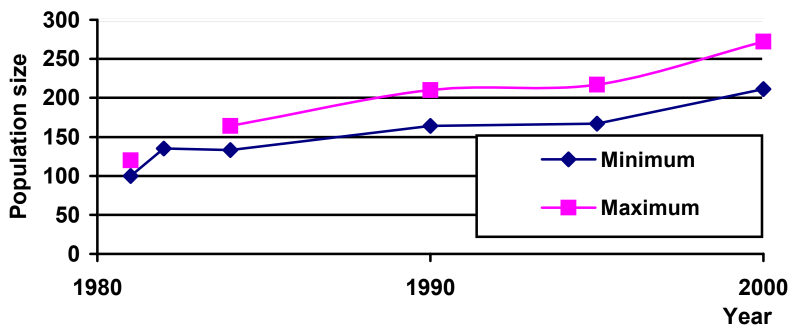


Figure 6.2.2.1. Maximum and minimum estimates for the Saimaa ringed seal population size from 1982–2000 (Sipilä, 1992, updated information).

Table 6.2.2.1. Estimated numbers of Saimaa ringed seals in the early winters of 1984, 1990, 1995, and 2000 in different parts of the Lake. These figures do not include pups born in the year of count (Sipilä, 1992, updated information.).

Area	1984	1990	1995	2000
Pyhäselkä	13	13	8–10	3–5
Orivesi	9–10	13–15	11–15	10–14
Pyy- and Enonvesi	6–7	5–8	6–8	15–18
Joutenvesi	8–10	13–18	13–18	20–30
Kolovesi	5–6	13–16	13–16	22–28
Haukivesi	32–37	41–55	44–54	48–58
Pihlajavesi	14–19	35–40	40–46	55–65
Tolvanselkä.- Katosselkä	4–5	13–19	15–25	16–24
Lietvesi	8–9	13–16	8–12	7–10
Luonteri	1–2	2	2	2
Petranselkä	9–12	3–4	4–7	11–15
Ilkonselkä	4	4	3–4	2–3
Lake Saimaa	113–134	164–210	167–217	211–272

6.2.3 Reproductive capacity

The pregnancy rate in the Saimaa ringed seal population was about 70% from the early 1980s to 1991. For later periods it varied between 75% and 83%. The mean pregnancy rate also varied in different areas of Lake Saimaa during the study period. In Lake Lietvesi the estimate was 58%, while it was 80% in Lake Kolovesi. Numbers of pups in relation to total numbers of seals was about 15% in the early 1980s, 17% in 1990, 21% in 1995 and 24% in 2000 (Figure 6.2.3.1).

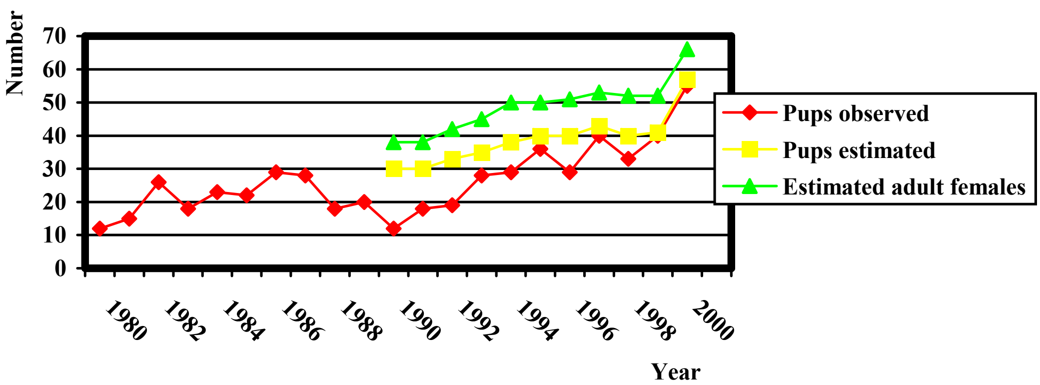


Figure 6.2.3.1. Numbers of Saimaa ringed seal pups observed and estimated and mature females, 1980–2000 (Sipilä, 2003).

6.2.4 Effect of contaminants and health status

6.2.4.1 Mercury

From studies of ringed seals in other areas, it is known that mercury loads in the environment severely influence many life history features. Very high concentrations of mercury in Saimaa ringed seal tissues were found in the1960s (Helminen *et al.*, 1968; Henriksson *et al.*, 1969). A substantial reduction was found in mercury levels in adult seal tissues from the early 1980s to the first half of the 1990s (Hyvärinen *et al.*, 1998). By contrast, mercury concentrations in liver and muscle tissues of seals less than one month of age, as well as in lanugo hair of pups did not show notable changes over the period 1981–1995 (Hyvärinen *et al.*, 1998).

There is a clear positive correlation between seal age and mercury concentration, and the mean accumulation rate of mercury in liver was 11 mg yr^{-1}. About 80% of total mercury burdens is found in the liver in adults seals, whereas, the rest is found in muscle tissue.

6.2.4.2 Organochlorines

In the Bothnian Bay high concentrations of organochlorines correlated with the observed decrease in birth rate of ringed seals (Helle, 1980b, 1985; Helle *et al.*, 1976). Concentrations of PCBs and DDT are relatively low in Lake Saimaa and the burdens of organochlorines have not been shown to affect the reproduction of Saimaa ringed seals (Helle, 1985; Helle *et al.* 1983, 1985; Kostamo *et al.*, 2000).

6.2.5 Interactions with commercial fisheries and intentional killing

A total of 182 carcasses were collected between 1977–2000. The most common causes of death of ringed seals in Lake Saimaa were drowning (or suffocation) in fishing gear (53.3%), and lair mortality (39.0 %). Only 5.5 % died a “natural death” (lanugo-coated pups excluded), for instance caused by infections (Figure 6.2.5.1).

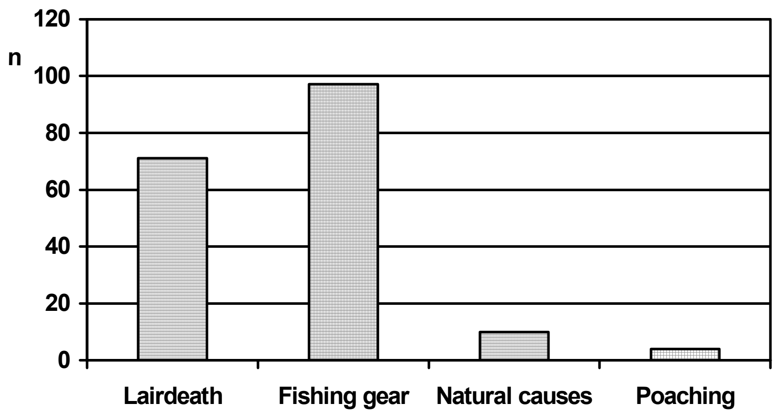


Figure 6.2.5.1. Main causes of death of the Saimaa ringed seal 1977–2000. “Lair-death” includes premature birth, still-birth and accidental death in the lair, “fishing gear” includes also deaths from suffocation without direct evidence of contact with fishing gear. “Natural causes” do not include lanugo-coated pups found dead (Sipilä *et al.*, 1999, 2002a; Sipilä and Koskela, 2003).

The survival rate of weaned pups up to the age of two years is about 10% higher in the fishing restriction areas than in areas without restrictions. The fishing restrictions were primarily established in areas where intensive net fishing had been carried out. In the early 1980s, 40% of pups born in protected areas were drowned in fishing gear compared with an equivalent figure of more than 60% in the era before fishing restrictions.

There is no record of intentional killing since the mid-1980s.

6.3 Ladoga ringed seal (*Phoca hispida ladogensis*)

6.3.1 Distribution

The species is distributed throughout Lake Ladoga with the exception of the southernmost part. Breeding distribution is related to the ice conditions in the northern part of the lake. During cold winters when the whole lake is frozen, about 60% of the population lives in the southern part of the lake. The northern part of the lake does not freeze during mild winters, and approximately 80% of the population can be found in the southern parts of the Ladoga under such conditions (Antoniuk, 1975; Filatov, 1990). Probably, a part of the population stays in the northernmost part of the lake and breeds on the ice that forms in the coastal archipelago. Aerial surveys in 1994 revealed that the seals prefer closed and compact ice to open ice.

In the ice-free period, main haul-out places for the species are in the Valaam archipelago and the Western archipelago.

6.3.2 Population size

6.3.2.1 Historical population size

Numbers of Ladoga ringed seals decreased by about 50–75% during the 19th century as a consequence of hunting (Chapskii, 1932; Jääskeläinen, 1942; Sipilä *et al.*, 1996, 2002b; Sipilä and Hyvärinen, 1998).

6.3.2.2 Current population estimates and trends

According to recent studies the current seal population in Lake Ladoga is estimated at about 5000 individuals (Medvedev *et al*., 1996), and although the estimates of the population vary widely, the population is thought to have remained stable over the past 30 years.

6.3.3 Reproductive capacity

The reproductive capacity of the species is not known.

6.3.4 Effect of contaminants and health status

There is no information on contaminants in these seals.

In August 2001, skin lesions resembling seal pox were observed in about 40% of seals in the Valaam Archipelago. Similar symptoms were also seen in the following summer, but there is no evidence of increased mortality or changes in behaviour of the affected seals.

6.3.5 Interactions with commercial fisheries and intentional killing

Current by-catches are unknown and it is known that some seals are killed illegally.

6.3.6 Recommendations

The number of vessels engaged in fisheries in Lake Ladoga is unknown. WGMME recommends that a study be initiated to estimate the number of fishing vessels and fishing effort in key metiers, and by-catch in Lake Ladoga.

6.4 Harbour seal (*Phoca vitulina*) (Kalmarsund stock)

There are two genetically separate harbour seal stocks in the Baltic Sea area (Figure 6.4.1). One is now confined to the Kalmarsund area in Sweden (and was described by Stanley *et al.* (1996) as the East Baltic stock), while another stock extends into the southwestern Baltic from the Kattegat (known as the West Baltic stock by Stanley *et al*., 1996). These stocks are treated separately in this report. The Kalmarsund stock numbers substantially less than the southwestern Baltic and Kattegat stock. Despite not being affected by the 2002 phocine distemper virus (PDV) epizootic, the Kalmarsund stock remains of greater management concern than the southwestern Baltic and Kattegat stock.

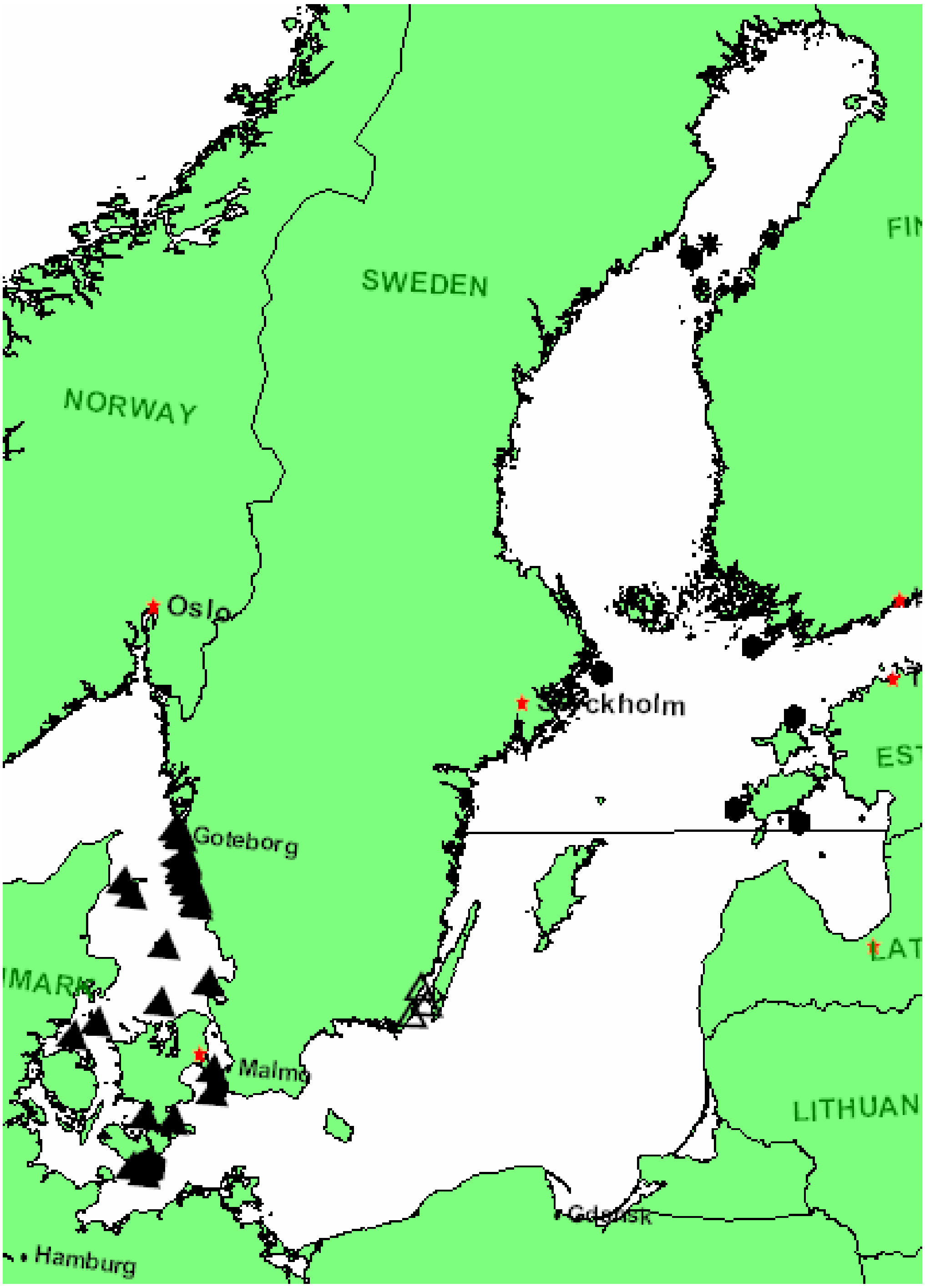


Figure 6.4.1. Seal breeding sites in the Baltic and Kattegat. Grey seals: filled circles (asterisks indicate breeding on ice). Harbour seals (Kalmarsund population): open triangles. Harbour seals (SW Baltic and Kattegat): filled triangles.

6.4.1 Distribution

During the Stone Age, the seals were distributed in the southern Baltic, south of a line north of Gotland (Sweden) to north of Saaremaa (Estonia). The present distribution is more restricted as compared with both archaeological data and hunting statistics. Harbour seals have disappeared from the southern part of Gotland, where reproducing animals were observed in the 1980s, and also from the east coast of Öland and the northern part of the Kalmarsund. The present distribution is limited to three localities in the Kalmarsund region in Sweden.

6.4.2 Population size

6.4.2.1 Historical population size

The maximum abundance over the past 8000 years occurred just prior to 1905, followed by a decline up to 1960 (Figure 6.4.2.1.1). Harbour seal numbers reached a minimum from 1960 to 1985, after which seal numbers increased. Although numbers of seals are indicated to have been lower in earlier history compared with the latter half of the 19th century, another peak in abundance occurred 4000 to 1800 years ago (Härkönen and Harding, 2003).

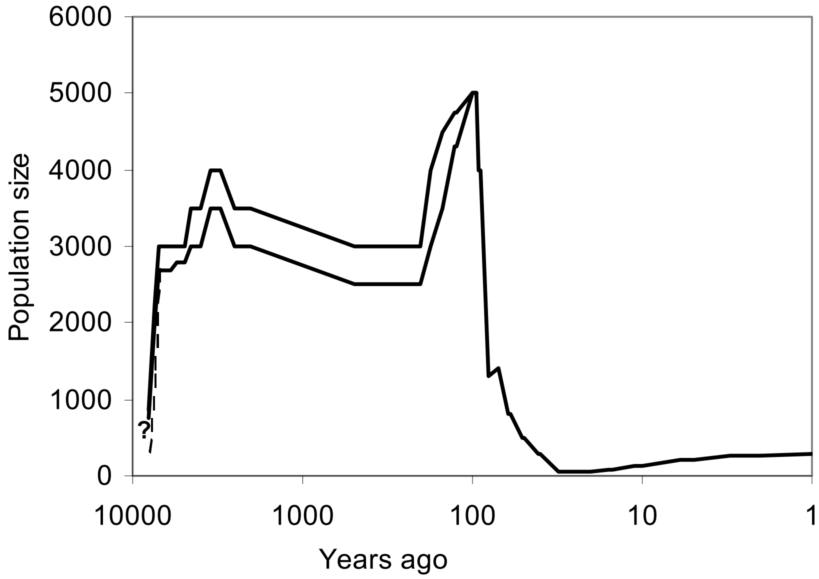


Figure 6.4.2.1.1. Model of population trends of harbour seals in the Baltic from 8000 years ago, when it was founded, up to the present. The maximum abundance is indicated to have occurred just prior to 1905, followed by a decline up to 1960. A severe bottleneck occurred during the period 1960 to 1985, after which seal numbers increased. Although numbers of seals are indicated to have been lower in earlier history compared with the latter half of the 19th century, an additional maximum abundance occurred 4000 to 1800 years ago (Härkönen and Harding, 2003).

6.4.2.2 Current population estimates and trends

Results from the first surveys along the Swedish coast in the mid-1970s found about 50 seals (Figure 6.4.2.2.1). An increase to 377 harbour seals had occurred by 2002, which corresponds to an annual rate of increase at 9%. There is a suggestion that the rate of increase may have slowed during the 1990s. This population was not affected by the PDV epizootics in 1988 or 2002 (Härkönen, pers. comm.).

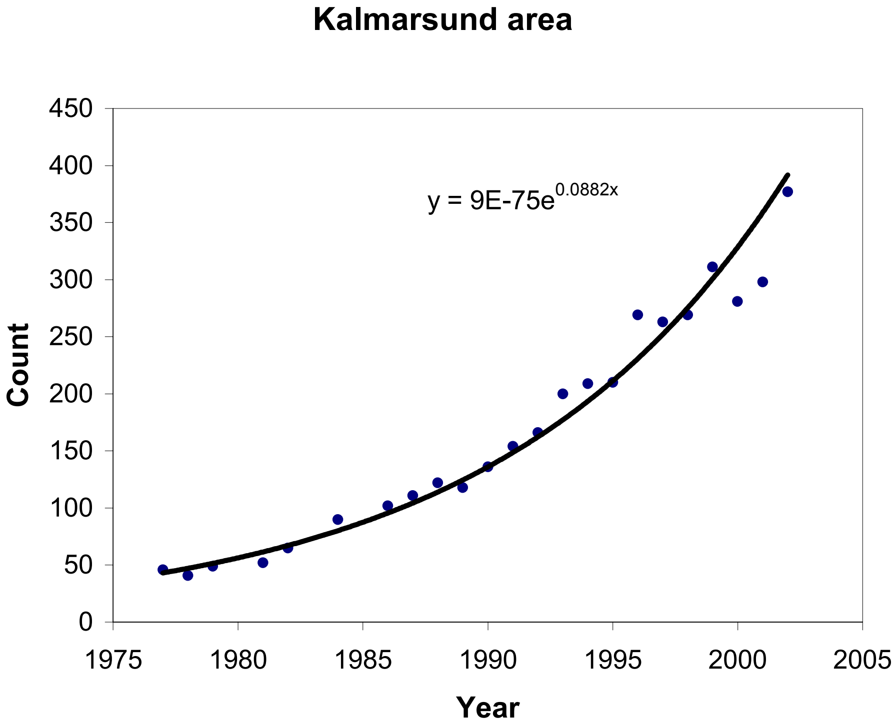


Figure 6.4.2.2.1. Counts of harbour seals in the Kalmarsund stock. The mean annual rate of increase was 9% in the period 1977–2002 (Härkönen and Harding, 2003).

6.4.3 Reproductive capacity

For the period 1990 to 2002 the number of pups as a percentage of total counted population size shows a decreasing trend (P<0.003) (Figure 6.4.3.1).

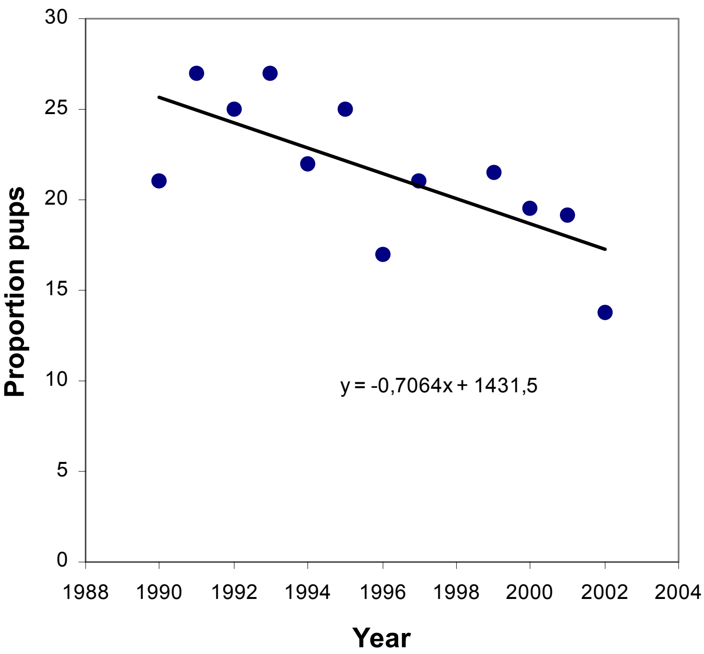


Figure 6.4.3.1. Proportions of pups in the harbour seal population in Kalmarsund. Pups were counted in June, while total population sizes were counted during moult in August (Härkönen and Harding, 2003).

6.4.4 Effect of contaminants and health status

Organochlorines had negative effects on the reproductive capacity of both ringed seals and grey seals from the 1960s to the 1980s (Helle, 1986; Bergman and Olsson, 1986; Bergman, 1999). Such effects are also suggested for harbour seals in the period 1977–1989 (Härkönen *et al*., 2002). There is no current information on health status and contaminants in this population.

6.4.5 Interactions with commercial fisheries and intentional killing

Eel pound nets close to the major haulout-site caused high by-catches in the past, but are are now closed down. This has reduced the fishery mortality. Two individuals are known to have drowned in eel fyke nets in 2001, but there is no recent estimate of total by-catch. There is no intentional killing of these seals.

6.5 Harbour seal (*Phoca vitulina*) (southwestern Baltic and the Kattegat stock)

6.5.1 Distribution

The species is distributed in all suitable sandbanks and islands of the southwestern Baltic and Kattegat. There are no seasonal changes in distribution.

6.5.2 Population size

6.5.2.1 Historical population size

Population dynamics prior to the 1988 seal epizootic are described in Heide-Jørgensen and Härkönen (1988). About 56% of harbour seals in the area died in the 1988 seal epizootic. After the 1988 epizootic, the population grew from approximately 5000 to more than 10,000 seals just prior to the 2002 epizootic, when again more than half of the population died. In the southwestern Baltic itself, the first surveys started in 1990 when 224 seals were counted. In 1998 numbers had increased to 315, which corresponds to a 4.8% annual rate of increase. In 2002 this population was hit by the PDV epizootic, and reduced by 50%.

6.5.2.2 Current population estimates

Current population size estimates and trends cannot be estimated before additional censuses scheduled for August 2003.

6.5.3 Reproductive capacity

The low rate of population increase in the area, compared to the Skagerrak, prior to the last epizootic is an indication of reduced reproductive capacity (Härkönen *et al*., 2002).

6.5.4 Effect of contaminants and health status

During the seal epizootic in 1988 more than 1000 lower jaws were collected in the Kattegat, Skagerrak and the Baltic. Subsequent analyses revealed a high prevalence of alveolar exostosis, not found at all in reference material collected from 1850–1930. Similar changes in Baltic grey seals were thought to be indicative of organochlorine pollution (Mortensen *et al*., 1992; Härkönen *et al*., 2002).

6.5.5 Interactions with commercial fisheries and intentional killing

By-catches of harbour seals amounted to about 300 individuals in the Swedish fishery on the west coast in 2001 (Lunneryd *et al.*, 2003) A high proportion of the by-catch is in lumpsucker and flatfish bottom-set gillnets. No information on by-catch is available from Denmark. In 2002, licences for a total of 6 animals were issued in Sweden to kill harbour seals and 3 were shot, and 3 licences were issued for 14 animals (but only 5 were shot) in Denmark in the same period.

6.5.6 Recommendations

The by-catch in Danish and German fisheries requires study and estimation. The latter will require a greater knowledge of the effort in relevant fisheries, such as those for lumpsucker and flatfish in bottom-set gillnets

6.6 Grey seal (*Halichoerus grypus*)

6.6.1 Distribution

In the Baltic, the grey seal is migratory and distribution varies between seasons. During the breeding season, the distribution of the species is dependent on ice conditions in the central Baltic and the main breeding areas can be found from 57°N up to the ice edge. The largest concentrations of grey seals outside the breeding season are found in the northern Baltic. Studies of long-distance movements show that some individuals move throughout the Baltic during the ice-free period. Grey seals do not breed at present on the southern coast of the Baltic.

6.6.2 Population size

6.6.2.1 Historical population size

At the beginning of the 20th century the minimum population size was about 100,000 individuals (Harding and Härkönen, 1999).

6.6.2.1 Current population estimates and trends

Total population size has been estimated using a capture-recapture method based on photo-ID (Hiby *et al*., 2001, 2003). The estimate for the year 2000 was 12,053 (95% CI 8,073–14,051). Assessments of population trends are based on coordinated counts during the peak of the moulting season. So far only counts on the Swedish coast provide a sufficiently long time-series for trend analysis. Here the mean annual population increase for the period 1990 to 2002 was 7.8%. The intrinsic rate of increase for east Atlantic grey seals was found to be about 10% (Harding *et al*., 2003).

6.6.3 Reproductive capacity

Pathological studies (Bergman, 1999) and population trends suggest that the reproductive capacity of the species has improved since the 1970s. Pregnancy rates in the material collected over the period 1985–1996 were 60% (Bergman, 1999). This improving trend has probably continued since 1996.

6.6.4 Effect of contaminants and health status

The general health status of grey seals in the Baltic has improved, but colonic ulcers caused by hookworm have increased in frequency and renal lesions persist. Colonic ulcers are the second most important cause of death after incidental catching and hunting (Bergman, 1999).

6.6.5 Interactions with commercial fisheries and intentional killing

In Estonia, 150 seals were estimated to have been by-caught in commercial fisheries in 2001, based on fishermen interviews (I. Jüssi, pers. comm.). In Poland, seven seal corpses were delivered to the Hel marine station in 2001 (K. Skóra and I. Kuklik, pers. comm.). An interview survey of the Swedish fishery gives an estimated total by-catch of 430 grey seals in 2001 (Lunneryd *et al*., 2003). Approximately 2/3 of this is in the Baltic Proper, where most of the fishing activity is located. About half of the by-catches occur in bottom-set gillnets for turbot and cod. In the Gulf of Bothnia the majority of incidental catches are in salmon traps. A similar estimate of grey seal by-catches was made in 1996 (Lunneryd and Westerberg, 1997). Compared to this, the number of by-catches has increased slightly, but the relative proportion of by-caught animals has decreased from approximately 14% of the counted population in Swedish waters to less than 10%. The reason for this is probably a change in fishing practice as an adaptation to increasing seal interaction. There are no recent data on by-caught grey seals from other Baltic countries.

The yearly hunting quota for 2002–2003 totals 430 grey seals for the Baltic Sea area (Sweden 200, Finland 230). In addition, permits to hunt grey seals are issued in Åland as mitigation to the seal-fisheries conflicts. No upper limit is set for those permits and 156 permits were granted in 2002–2003. Thus, the total allowable take by legal hunting adds up to 586 grey seals. The actual number of seals that were reported killed has been much less than half of the allowable catch, but hunting losses are unknown.

To mitigate fishery interactions, Finland has established seven nature preserves, mainly for grey seals, some for ringed seals also, in the Baltic Sea where fishing is banned (Sipilä, 2003).

At least 35 grey seal pups were illegally killed in one grey seal breeding colony at the Estonian coast in the spring of 2002.

6.6.6 Conclusions

A simple model was constructed to study whether combinations of observed data on population size, rate of increase and size of by-catches are realistic for the Baltic grey seal population. Assuming a theoretical size of the initial population at 10,000 and an annual rate of 800 by-caught individuals, rates of population increase were modelled under conditions where the catch was according to the stable age distribution, where 33% were pups, and finally where 66% were pups. We found that the data are realistic if 66% or more of the by-catch is of pups of the year (Figure 6.6.6.1).

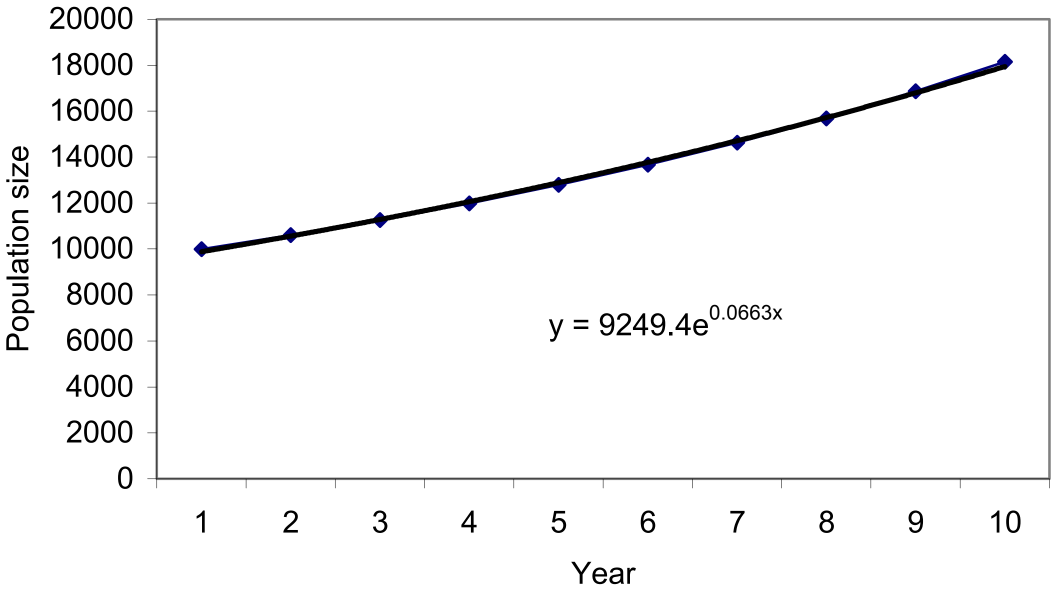


Figure 6.6.6.1. Modelled population growth of grey seals under the scenario where the initial population size is 10,000, the maximum rate of increase is 1.10 and the annual by-catch is 800 individuals, where pups of the year comprise 2/3 or more of the by-catch.

6.6.7 Recommendations

The WGMME reviewed the status of grey seals in the Baltic and is concerned that the population is about 15% of pristine levels. The prevalence of colonic ulcers has increased and is the second most important cause of death after by-catches. Furthermore, the WGMME notes that renal lesions and bone lesions persist in the population, which is why the Baltic grey seal population cannot be regarded to have a normal health status. The WGMME is concerned that by-catches plus the quotas given for intentional killing approach 10% of the population size. The WGMME is further concerned that no upper limit is set for the hunting quota in Åland. In a nearly unanimous decision, the WGMME therefore notes that the present intentional killing of grey seals in the Baltic is in conflict with the intent of international agreements and recommendations.

In a nearly unanimous decision, the WGMME recommends that if intentional killing of grey seals occurs it should:

i) be based on the precautionary principle (Mangel *et al*., 1996; HELCOM, 2001);

ii) be internationally coordinated to ensure that total catches do not exceed critical levels;

iii) be based on ecological risk analysis to find the least detrimental hunting regimes (Harding *et al*., 2003; Jeffries *et al*., 2003);

iv) not occur in conflict with international agreements and recommendations (HELCOM Rec. 9/1 1988; Habitats Directive; Bonn Convention).

6.7 Harbour porpoise *Phocoena phocoena*

6.7.1 Distribution

The relative abundance of harbour porpoises in the Baltic decreases from west to east from the Belt Seas towards the Baltic Proper (Hammond *et al.*, 2002; Berggren *et al.*, 2002; Gillespie *et al.*, 2003). Occurrence in the eastern Baltic is occasionally reported (Karalius, pers. comm.; ASCOBANS, 2002)

6.7.2 Migration and stock identity

Several studies of morphology, genetics and contaminant loads indicate that harbour porpoises in the Baltic Sea are distinct from animals in the Skagerrak-Kattegat areas (Börjesson and Berggren, 1997; Wang and Berggren, 1997; Berggren *et al.*, 1999). Population-level differences have been found between porpoises from the Belt Seas and the North Sea (Kinze, 1985; Andersen, 1993), between the Kiel-Mecklenburg Bights and the North Sea (Tiedeman *et al.*, 1996; Huggenberger, 1997), and between the Skagerrak–Kattegat areas and the west coast of Norway (Wang and Berggren, 1997). Further, porpoises in the Kiel–Mecklenburg Bights and the Baltic Sea are distinct on genetic and morphological grounds (Tiedeman *et al.*, 1996; Huggenberger, 1997; Huggenberger *et al.*, 2002). There are indications of seasonal migrations of porpoises between Danish inner waters and the North Sea (Teilmann *et al.*, 2003).

In summary, two populations of harbour porpoise are considered to live in the area: one in the Baltic Proper and one in the eastern part of the Skagerrak, Kattegat, Belt Sea, Kiel Bight and Mecklenburg Bight to the Darss sill in the east.

6.7.3 Population size

6.7.3.1 Historical population size

Available information indicates declining abundances but former population levels are not known.

6.7.3.2 Current population estimates and trends

The abundance of harbour porpoises in the Baltic Sea was estimated during a line-transect aerial survey in July 1995 (Hiby and Lovell, 1996). The survey used the standard methodology (both in track line design and to generate abundance estimates), aircraft and observers as used by Hammond *et al.* (2002). The survey covered a 43,000 km^2 area (corresponding to ICES Sub-divisions 24 and 25, but excluding a 22 km-wide corridor along the Polish coast) and yielded an estimate of 599 animals (Table 6.7.3.2.1). The abundance estimate for the Baltic Sea was based on sightings of only three groups, each containing a single animal. Although the 15 hours of tracklines surveyed gave enough coverage of the survey area to allow for the calculation of an abundance estimate, this was inevitably accompanied by a large confidence interval. The same crew also covered the Kiel and Mecklenburg Bight area in July 1995 and the resultant estimate was 817 animals (Hiby and Lovell, 1996). A ship-based line-transect survey of Polish coastal waters in 2001 saw only one harbour porpoise, thus rejecting the idea that these waters hold a large population of harbour porpoises (Berggren *et al.*, 2002.). Abundance estimates for other species are not available for this region.

Table 6.7.3.2.1. Abundance estimates for harbour porpoises in the Baltic Sea, Belt Seas, Kiel and Mecklenburg Bights, Kattegat and Skagerrak.

Year of estimate	ICES Area	Abundance estimate	95% Confidence limits	Method	Reference
1994	IIIa + b	36,046	20,276–64,083	Ship-based	Hammond *et al.,* 2002
	IIIc	588	(CV 0.48)		
1995	24+25	599	200 – 3300	Aerial survey, line transect	Hiby and Lovell, 1996
	K&M Bights	817	300 – 2400		

An aerial survey of German and some southern Danish waters was undertaken from May to August 2002 (Figure 6.7.3.2.1). This survey found the highest relative abundance of porpoises in the Pomeranian Bight between the island of Rügen and the Polish border (Scheidat *et al.*, 2003). The maximum group sizes in this area were ten animals. Repeated flights in August, September, December, February and March in the same area did not find a single porpoise (M. Scheidat, pers. comm.). This demonstrated that overall density of porpoises was lower between the island of Rügen and the Polish border than indicated through the surveys in May and July.

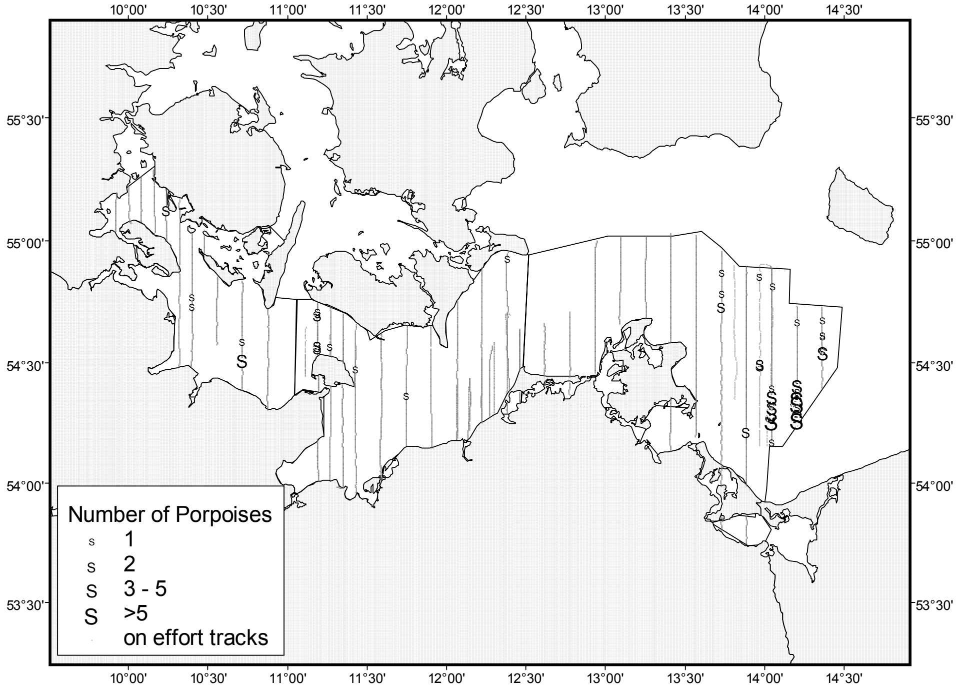


Figure 6.7.3.2.1. German aerial surveys in the Baltic (May to August 2002) (Scheidat *et al*., 2003).

No information is available for assessing any trend in abundance. Two aerial surveys have been conducted in the Baltic Sea in 2002 from Germany and Sweden, but the data have not yet been published. Another large-scale abundance survey is planned for 2005.

6.7.4 Reproductive capacity

There is no new information available.

6.7.5 Effect of contaminants and health status

A large number of different lesions and pathological changes are reported from the Baltic Sea. Typical autopsy findings are heavy attack from parasites in lung, liver, stomach, intestines and middle-ear cavities, skin lesions and pneumonia. Other findings are liver fibrosis, arthrosis, and abscesses in muscles, lungs and other organs (Siebert *et al*., 1999; Clausen and Andersen, 1988). Animals from the Baltic also had 41% to 254% higher mean levels of PCDD/Fs and PCBs than corresponding samples from the Kattegat and Skagerrak (Berggren *et al*., 1999; Bruhn *et al*., 1999).

6.7.6 Interaction with commercial fisheries (by-catch, intentional killing)

Incidental mortality in fishing gear represents the most significant threat to porpoise populations (Teilmann and Lowry, 1996; ASCOBANS, 2002). By-catch is known to occur in different types of fisheries but no reliable estimates are available for any large part of the Baltic, including the Kattegat (Koschinski, 2002).

As in other areas, harbour porpoises are believed to be subject to incidental takes in gillnet fisheries. Atlantic salmon driftnet fisheries were suggested to have taken substantial numbers of harbour porpoises in the past (Ropelewski, 1957; Lindroth, 1962). There have been very few studies in the Baltic to the east of the island of Rügen. No by-catches were reported by a Danish observer programme (350 km.days of net observed (less than 0.5% of total net days in this fishery)) between 1992 and 1998 (Vinther, 1999) or in more recent years (F. Larsen, pers. comm.). Berggren (1994) used reports from Swedish fishermen to estimate a minimum catch of about 5 harbour porpoises/year in the early 1990s. Most of these were taken in salmonid driftnets or cod gillnets. The scale of the fishery has declined over the past twenty years, so it is likely that the harbour porpoise by-catch has declined also. The Swedish turbot fishery has not reported a substantial by-catch (Berggren, 1994). A total of six nights were spent at sea by an observer on salmon driftnet vessels; no by-catch was recorded by this observer, but one was reported from a non-observed vessel (Harwood *et al*., 1999).

In a study of distribution of by-catch in Polish waters, Kuklik and Skóra (2003) report that 45 dead harbour porpoises from by-catch were reported to Hel Marine station over ten years, with nearly half of these from Puck Bay (Figure 6.7.6.1) and 40% in semi-driftnet fisheries for salmonids. A further third of the by-catch was in set-nets for cod (Table 6.7.6.1). Two by-catches were reported from Finland between 1986–1999 (ASCOBANS, 2000). In other countries' fisheries catching in the Baltic Proper, there is either no information (Lithuania) or no by-catch reported or believed to occur (Germany, Russia, Latvia, Estonia).

No by-catch was reported by the Danish fishery observer programme (193 km.days observed (less than 0.5% of total net days in this fishery)) in the Belt Seas between 1992 and 1998 (Vinther, 1999). Based on interviews with fishermen, K.-H. Kock (pers. comm.) estimated a catch of about 3–5 harbour porpoises per year in German fisheries in this area.

Studies on by-catch of harbour porpoises in set-net fisheries were conducted on the Swedish cod and pollack fisheries in the Kattegat in 1996–1997 (Harwood *et al.*, 1999). A total of 7441 net km.hrs was observed over three seasons of the year in two ICES rectangles on the Skagerrak/Kattegat boundary. A total of 12 porpoises were seen as by-catch, while a further 13 animals were reported as by-catch on unobserved vessels fishing in the same rectangles. Based on these figures, these authors extrapolated a catch of 105 animals per 10,000 net km.hrs in the Skagerrak/Kattegat combined. The Swedish fisheries targeting cod and pollack decreased by 59% between 1997 and 2000 due to the reduction in the stock size of cod. The overall effort in Swedish set-net fisheries decreased by 45 % during this period (data from the Swedish National Board of Fisheries). Vinther (1999) reported observations of 329 net km.days between 1995 and 1998 on Danish set-net fisheries in the Kattegat and Skagerrak. A total of five porpoises were observed as by-catch in one ICES rectangle; four of these were caught in the lumpfish fishery. This equates to 15 animals bycaught per 1000 net km.days.

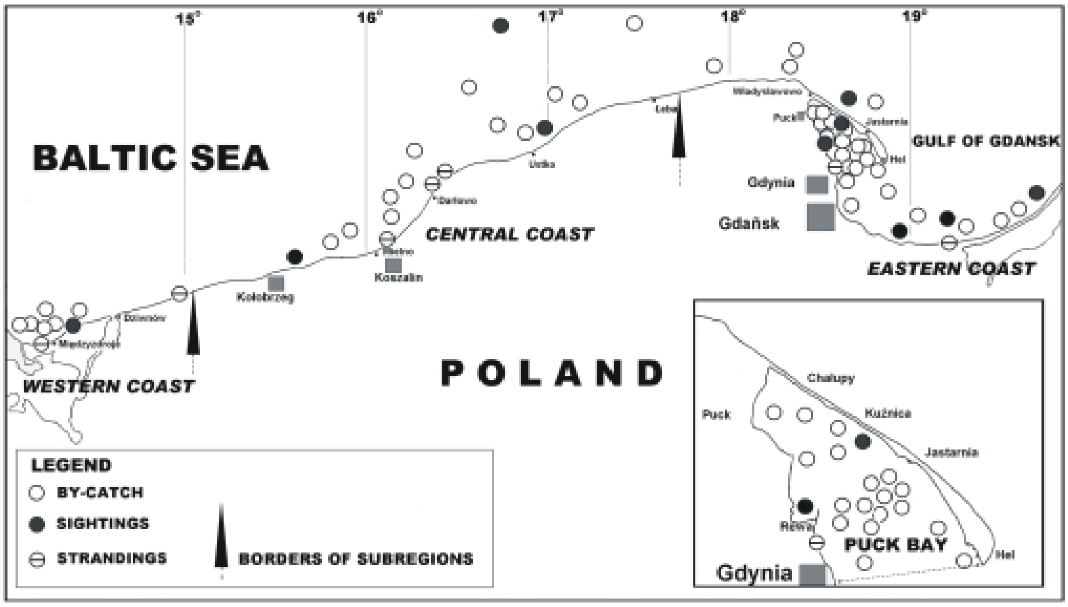


Figure 6.7.6.1. Places where harbour porpoises were sighted, bycaught and washed ashore on the Polish coast between 1990–1999 (Kuklik and Skóra, 2003).

Table 6.7.6.1. By-catch of harbour porpoises in different types of fishing nets in 1990–1999 in Poland (Kuklik and Skóra, 2003).

Year	**Total amount of by-caught animals**	**Type of nets**					
		Semi-drift nets (salmon)	**Bottom set gillnets**		**Herring gillnets**	**Herring trawl Nets**	**Other Set nets**
			Cod	**Others**			
1990	1	1					
1991	7	3	1	2			1
1992	5		1	2			2
1993	7	4	1	2			
1994	3	1	1		1		
1995	5	4				1	
1996	10	4	5	1			
1997	2	1	1				
1998	3		3				
1999	2		2				
Total	45	18	15	7	1	1	3
%	100	40.0	33.3	15.5	2.2	2.2	6.8

6.7.7 Recommendations

The number of harbour porpoises in the Baltic Proper is a small fraction of their former abundance. Their status has been reviewed extensively, and although the causes of their decline are unclear, by-catch in fisheries will be inhibiting any possible recovery. Ways of reducing this by-catch have been reviewed, and working with stakeholders (including fishermen) a recovery plan (ASCOBANS, 2002) has been drawn up. Key recommendations of this plan include:

1) Fishermen and their representatives need to be closely involved in any implementation process for by-catch reduction.
2) Measures should be taken by the Baltic Range States to reduce the fishing effort of driftnet and bottom-set gillnet fisheries in the Baltic.
3) Change fishing methods away from gear known to be associated with high porpoise by-catch (i.e., driftnets and bottom-set gillnets) and towards alternative gear that is considered less harmful.
4) Trials of fish traps, fish pots, and longlines should be initiated immediately, with the long-term goal of replacing gillnets in the cod fishery, particularly in areas where porpoises are known or expected to occur frequently.
5) Serious consideration should be given to replacing driftnets in areas where porpoise by-catch is known or likely to occur.
6) A study is needed to compile data on fishing effort in the Baltic.
7) Pinger use should be made mandatory in specific high-risk areas and fisheries, on a short-term basis (2–3 years).

WGMME supports all of these recommendations, and other parts of the recovery plan.

6.8 Summary table

Table 6.8.1 summarises in a convenient format the status of seals and harbour porpoise in the Baltic.

Table 6.8.1. Summary of the status of seals and harbour porpoise in the Baltic.

	Baltic ringed seal	**Saimaa seal**	**Ladoga seal**	**Grey seal**	**Kalmarsund harbour seal**	**SW Baltic harbour seal**	**Harbour porpoise**
Distribution	Resident in 3 separate regions	Fragmented, 60% of lake area	90 % of lake area	Northern and central Baltic proper, some structure	Kalmarsund, resident	To west of 13°E	Southern Baltic Proper, Belt seas, Kattegat
Population size in year 1900	200,000	<1,300	10,000	100,000	5,000	10,000	Unknown
Current population estimate	9,000 [1]	240–250	5,000	13,000	580[2]	4,500	36,046[3] 588[4] 599[5] 817[6]
Population trend	+5% GoB; unknown in GoR, GoF	+3–4%	Unknown	+ 7.8% SE, other areas unknown	+9%	−53% (epizootic loss)	Unknown
Reproductive rate	0.65	0.80	Unknown	>0.60	>0.85	Unknown	Unknown
Health status	Sterility, renal lesions	Normal	Skin lesions	Colonic ulcers, renal, bone lesions	Unknown	Bone lesions, skin lesions	Many lesions and parasites
By-catch (per year)	120 FIN, SE	10	Several tens	460 SE, 150 EST, c10 POL, other countries unknown	Unknown	300	10s Baltic proper, 100s in Belt Sea/ Kattegat
Intentional killing	0	0	Tens poached	Quota 586, less than 50% taken. 35 pups poached in EST	0	30 DK, 6 SE	0

Key:
GoB – Gulf of Bothnia; GoF – Gulf of Finland; GoR – Gulf of Riga; DK – Denmark; SE – Sweden; FIN – Finland; EST Estonia.
[1]Estimated from basking population of 5,400 individuals in 1996; [2]Estimated from basking population of 2,000 in 1994; [3]ICES Divisions IIIa,b; [4]ICES Divisions IIIc; [5]Baltic Sea Sub-divisions 24 and 25; [6]Kiel and Mecklenburg Bight.

6.9 References

Andersen, L. W. 1993. The population structure of the harbour porpoise, *Phocoena phocoena*, in Danish waters and part of the North Atlantic. Marine Biology, 116: 1–7.

Anon. 1939. Eesti statistika 1931–1939, Vol. 17. Tallinn (Estonian Statistics, in Estonian)

Antoniuk, A. A. 1975. Estimation of the population size of the ringed seal in Lake Ladoga. Zoolichesckii Zhurnal, 54: 1371–1377.

ASCOBANS. 2000. Fourth annual compilation of national reports. ASCOBANS Secretariat, Bonn.

ASCOBANS. 2002. ASCOBANS Recovery plan for Baltic harbour porpoises (Jastarnia plan). Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas, Bonn.

Becker, P. 1984. Uhanalaisuuden syyt. pp.109–118 in: Becker, P. (ed.) Saimaannorppa, Saimaannorppa. Suomen Luonnonsuojelun Tuki Oy, Helsinki. 109–118 pp.

Bergman, A. 1999. Health condition of the Baltic grey seal (*Halichoerus grypus*) during two decades. Gynaeological health improvement but increased prevalence of colonic ulcers. APMIS 107: 270–282.

Bergman, A., and Olsson, M. 1986. Pathology of Baltic grey seal and ringed seal females with special reference to adrenocortical hyperplasia: is environmental pollution the cause of a widely distributed disease syndrome? Finnish Game Research, 44: 47–62.

Bergman, G. 1956. Sälbeståndet vid våra kuster. Nordenskiöld-samfundets tidskrift, 16: 50–65.

Berggren, P. 1994. By-catches of the harbour porpoise (*Phocoena phocoena*) in the Swedish Skagerrak, Kattegat and Baltic waters, 1973–93. Report of the International Whaling Commission. Special Issue, 15: 211–216.

Berggren, P. Brown, S., Gillespie, D., Kuklik, I., Lewis, T., Matthews, J., McLanaghan, R., Moscrop, A., and Tregenza, N. 2002. Passive acoustic and visual survey of harbour porpoises (*Phocoena phocoena*) in Polish coastal waters confirms endangered status of Baltic population. Paper at 16th annual European Cetacean Society Conference, Liege, 7–11 April 2002.

Berggren, P., Ishaq, R., Zebür, Y., Näf, C., Bandh, C., and Broman, D. 1999. Patterns and levels of organochlorine contaminants (DDTs, PCBs, non-ortho PCBs and PCDD/Fs) in male harbour porpoises (*Phocoena phocoena*) from the Baltic Sea, the Kattegat-Skagerrak Seas and the west coast of Norway. Marine Pollution Bulletin, 12: 1070–1084.

Börjesson, P., and Berggren, P. 1997. Morphometric comparisons of skulls of harbour popoises (*Phocoena phocoena*) from the Baltic, Kattegat and Skagerrak seas. Canadian Journal of Zoology, 75: 280–287

Bruhn, R., Kannan, N., Petrick, G., Schulz-Bull, D. E., and Duinker, J. C. 1999. Persistent chlorinated organic contaminants in harbour porpoises from North Sea, the Baltic Sea and Arctic waters. Science of the Total Environment, 237/238: 351–361.

Chapskii, K. K. 1932. Ladozhski tiulen i vozmozhnost ego promysla. Report of the Fisheries Research Institute of Leningrad, 13: 147–157.

Clausen, B., and Andersen, S. H. 1988. Evaluation of bycatch and health status of the harbour porpoise (*Phocoena phocoena*) in Danish waters. Danish Review of Game Biology, 13: 1–20.

Filatov, I. E. 1990. Ladozhkaja kolchataja nerpa. pp. 57–64 in Sokolov V. E. and Janshin, A. L. (eds.) Redkie izthezajushie vidy mlekopitajushih SSSR. Nauka. Moskva.

Gillespie, D., Berggren, P., Brown, S., Kuklik, I., Lacey, C., Lewis, T., Matthews, J., McLanaghan, R., Moscrop, A., and Tregenza, N. 2003. The relative abundance of harbour porpoises (*Phocoena phocoena*) from acoustic and visual surveys in German, Danish, Swedish and Polish waters during 2001 and 2002. Working paper presented at the 2003 ASCOBANS meeting, 7 pp.

Greve, K. 1909. Säugtiere Kur-Liv-Estlands. Riga. 184 pp.

Hammond, P.S., Berggren, P., Benke, H., Borchers, D.L., Collet, A., Heide-Jørgensen, M.P., Heimlich, S., Hiby, A.R., Leopold, M.F., and Øien, N. 2002. Abundance of the harbour porpoise and other cetaceans in the North Sea and adjacent waters. Journal of Applied Ecology, 39: 361–376.

Harding, K., and Härkönen, T. 1999. Development in the Baltic grey seal (*Halichoerus grypus*) and ringed seal (*Phoca hispida*) populations during the 20th century. Ambio, 28: 619–627.

Harding, K., Härkönen, T. and Helander, B. 2003. Ecological risk analysis of the Baltic gray seal population (*Halichoerus grypus*). Working paper presented to this meeting of WGMME, available from T. Härkönen (see Annex 1).

Härkönen, T., and Harding, K. C. 2003. Historical and present status of the harbour seals in the Baltic proper. Working paper presented to this meeting of WGMME, available from T. Härkönen (see Annex 1).

Härkönen. T., Harding, K. and Heide-Jørgensen, M-P. 2002. Rates of increase in age-structured populations: a lesson from the European harbour seals. Canadian Journal of Zoology, 80: 1498–1510.

Härkönen, T., and Heide- Jørgensen, M.-P. 1990. Density and distribution of the ringed seal in the Bothnian Bay. Holarctic Ecology, 13: 122–129.

Härkönen, T. and Lunneryd, S. G. 1992. Estimating abundance of ringed seals in the Bothnian Bay. Ambio, 21: 497–503.

Härkönen, T., Jüssi, M., Jüssi, I., Stenman, O., and Sagitov, R. 2003. Status of the Baltic ringed seal (*Phoca hispida botnica*). Working paper presented to this meeting of WGMME, available from T. Härkönen (see Annex 1).

Härkönen, T., Stenman, O., Jüssi, M., Jüssi, I., Sagitov, R., and Verevkin, M. 1998. Population size and distribution of the Baltic ringed seal (*Phoca hispida botnica*). pp. 167–180 in Lydersen, C. and Heide- Jørgensen, M.-P. Ringed seals (*Phoca hispida*) in the North Atlantic. NAMMCO Scientific Publications, Vol. 1.

Harwood, J., Andersen, L.W., Berggren, P., Carlström, J., Kinze, C.C., McGlade, J., Metuzals, K., Larsen, F., Lockyer, C.H., Northridge, S., Rogan, E., Walton, M., and Vinther, M. 1999. Assessment and reduction of the by-catch of small cetaceans (BY-CARE). Final report to the European Commission on FAIR-CT05-0523.

Heide-Jørgensen, M.-P., and Härkönen, T. 1988. Rebuilding seal stocks in the Kattegat-Skagerrak. Marine Mammal Science, 4: 231–246.

HELCOM. 2001. Conservation and management of seal population in the Baltic. Action Plan for the implementation of the HELCOM Project on Seals. November 2001.

Helle, E. 1980a. Aerial census of ringed seals *Pusa hispida* basking on the ice of the Bothnian Bay, Baltic. Holarctic Ecology, 3: 183–189.

Helle, E. 1980b. Lowered reproductive capacity in female ringed seals (*Pusa hispida*) in the Bothnian Bay, northern Baltic Sea, with special reference to uterine occlusions. Annals Zoologica Fennica, 17: 147–158.

Helle, E. 1985. Ympäristömyrkyt ja Suomen hylkeet. Suomen Riista, 32: 5–21.

Helle, E. 1986. The decrease in the ringed seal population of the Gulf of Bothnia in 1975–84. Finnish Game Research, 44: 28–32.

Helle, E 1990. Norppakannan kehitus Perämerellä 1980-luvulla. Suomen Riista, 36: 31–36.

Helle, E., Hyvärinen, H., Pyysalo, H. and Wickström, K. 1983. Levels of organochlorine compounds in an inland seal population in eastern Finland. Marine Pollution Bulletin, 14: 256–260.

Helle, E., Hyvärinen, H. and Sipilä, T. 1981. Yhdestoista hetki saimaanhylkeen suojelussa. Suomen Luonto, 40: 423–425. (Summary: The Saimaa ringed seal - Symbol of successful nature protection measures, or a bitter defeat?)

Helle, E., Hyvärinen, H. and Stenman, O. 1985. PCB and DDT levels in the Baltic and Saimaa seal populations. Finnish Game Research, 44: 63–68.

Helle, E., Olsson, M. and Jensen, S. 1976. PCB levels correlated with pathological changes in seal uteri. Ambio, 5: 5–6.

Helle, E., and Stenman, O. 1990. (Baltic seal populations in 1986–1990) (in Finnish or Swedish with English summary). Maailman Luonnon Säätiön WWF Suomen Rahaston Raportteja 1. 76 pp.

Helminen, M., Karppanen, E. and Koivisto, I. 1968. Saimaannorpan elohopeapitoisuudesta 1967. Suomen Eläinlääkärilehti, 74: 87–89.

Henriksson, K., Karppanen, E., and Helminen, M. 1969. Mercury in inland and marine seals. Nordisk hygienisk tidskrift, 50: 54–59.

Hiby, L. and Lovell, P. 1996. Baltic/North Sea aerial surveys – final report. (Unpublished). 11pp.

Hiby, L., Lundberg, T., Karlsson, O., and Helander, B. 2001. An estimate of the size of the Baltic grey seal population based on photo-id data. Report to project "Seals and fisheries" Länstyrelsen I Västernorrlands Län and Naturvårdsverket. 29-11-2001.

Hiby, L., Lundberg, T., Karlsson, O., Watkins, J., and Helander, B. 2003. An estimate of the size of the Baltic grey seal population based on photo-id data. Working paper presented to this meeting of WGMME, available from O. Karlsson (see Annex 1).

Huggenberger, S. 1997. Schweinswale (*Phocoena phocoena* L.) der deutschen Nord- und Ostsee. Diplomarbeit der Universitat zu Köln (in German).

Huggenberger, S., Benke, H., and Kinze, C. C. 2002. Geographical variation in harbour porpoise (*Phocoena phocoena*) skulls: support for a separate non-migratory population in the Baltic Proper. Ophelia, 56: 1–12.

Hyvärinen, H., and Sipilä, T. 1992. Saimaannorppa, *Phoca hispida saimensis*. pp 68–71 in Elo, U. (ed.) Maailman Uhanalaiset Eläimet, Suomi, Weiling+Göös, Vantaa.

Hyvärinen, H., Sipilä, T., Kunnasranta, M., and Koskela, J. 1998. Mercury pollution and the Saimaa ringed seal **(***Phoca hispida saimensis)*. Marine Pollution Bulletin, 36: 76–81.

ICES. 2000. Joint report of the Working Group on Marine Mammal Habitats and the Working Group on Marine Mammal Population Dynamics and Trophic Interactions. ICES CM 2000 E:02/G:05. 32 pp.

Jääskeläinen, V. 1942. Laatokka kalavetenä. pp. 38–45 in: Näsi, V. and Ovaska, E. (eds.) Laatokan mainingit. Laatokan ja sen rannikon elämää sanoin ja kuvin. Otava. Helsinki.

Jeffries, S. Huber, H., Calambokidis, J., and Laake, J. 2003. Journal of Wildlife Management, 67: 207–219.

Kinze, C. C. 1985. Intraspecific variation in Baltic and North Sea harbour porpoise (*Phocoena phocoena* (L., 1758)). Videnskabelige Meddelelser Dansk Naturhistorisk Forening. 146: 63–74.

Koivisto, I., and Paasikunnas, Y. 1973. Julkaisemattomia kenttämuistiinpanoja ja karttoja vuosilta 1966–73. (In Finnish, unpublished field notes with maps, years 1966–73.)

Kokko, H., Helle, E., Lindstrom, J., Ranta, E., Sipilä, T. and Courchamp, F. 1999. Backcasting population sizes of ringed and grey seals in the Baltic and Lake Saimaa during the 20th century. Annals Zooligica Fennica, 36: 65–75

Koschinski, S. 2002. Current knowledge on harbour porpoise (*Phocoena phocoena*) in the Baltic Sea. Ophelia, 55: 167–197.

Kostamo, A., Medvedev, N., Pellinen, J., and Kukkonen, J. 2000. Analysis of organochlorine compounds and extractable organic halogen in three subspecies of ringed seal in Northeast Europe. Environmental Toxicology and Chemistry, 194: 848–854.

Kuklik, I., and Skóra, K.E. 2003 (in press). Bycatch as a potential threat for harbour porpoise (*Phocoena phocoena* L.) in the Polish Baltic Waters. NAMMCO Scientific Publications

Lindroth, A. 1962. Baltic salmon fluctuations 2: porpoise and salmon. Report of the Institute of Freshwater Research, Drottningholm, 44: 105–112

Lunneryd, S. G., and Westerberg, H. 1997. By-catch of and gear damages by grey seal (*Halichoerus grypus*) in Swedish waters. ICES CM 1997/Q:11. 10 pp.

Lunneryd, S-G., S. Königson and Westerberg, H. 2003. Bycatch of seals in the Swedish fishery in 2001. Working paper to this meeting of WGMME, available from H. Westerberg (see Annex 1).

Mangel, M., Talbot, L.M., Mefee, G.K., Agardy, M.T., Alverson, D.L., Barlow, J., Botkin, D.B., Budowski, G., Clark, T., Cooke, J., Crozier, R.H.P., Dayton, I.K., Elder, D.L., Fowler, C.W., Funtowicz, S., Giske, J., Hofman, R.J., Holt, S.J., Kellert, S.R., Kimball, L.A., Ludwig, D., Magnusson, K., Malayang III, B.S., Mann, C., Norse, E.A., Northridge, S.P., Perrin, W.F., Perrings, C., Peterman, R.M., Rabb, G.B., Regier, H.A., Reynolds III, J.E., Sherman, K., Sissenwine, M.P., Smith, T.D. , Starfield, A., Taylor, R.J., Tillman, M.F., Toft, C., Twiss, Jr., J.R., Wilen, J., and Young, T.P. 1996. Principles for the conservation of wild living resources. Ecological Applications, 6: 338–362.

Marttinen, A. 1946. Mikä on Saimaan hylkeen kohtalo. Metsästys ja kalastus 1946: 116–118.

Mattson, M., and Helle, E. 1995. Reproductive recovery and PCBs in Baltic seal populations. Eleventh Biennial Conference on the Biology of Marine Mammals 14–18 December 1995, Orlando, Florida, U.S.A. Abstracts. p. 74.

Medvedev, N., Sipilä, T., Hyvärinen, H., and Kunnasranta, M. 1996. Proposals for the protection of the Ladoga seal. In: V. Simile, M. Viljanen and T. Sepukhina, eds. Proceedings of the second international Lake Ladoga Symposium 1996. Univ of Joensuu publications of Karelian Institute No. 117. Joensuu. 302 pp.

Mortensen, P., Bergman, A., Bignert, A., Hansen., H.J., Härkönen, T., and Olsson., M. 1992. Prevalence of skull lesions in harbour seals *Phoca vitulina* in Swedish and Danish museum collections during 1835–1988. Ambio, 21: 520–524.

Nyman, M., Raunio, H., Taavistainen, P., and Pelkonen, O. 2001. Caracterization of xenobiotic metabolizing cytochrome P450 (CYP) forms in ringed and grey seals from the Baltic Sea and reference sites. Comparative Biochemistry and Physiology. Part C. Toxicology and pharmacology, 128: 99–112

Reeves, R. R. 1998. Distribution, abudance and biology of the ringed seals (*Phoca hispida*): an overview. pp 9–45 in Heide-Jørgensen, M.-P. and Lydersen, C. (eds.) Ringed seals in the North Atlantic. NAMMCO Scientific Publication 1.

Rezvov, G. 1975. On the distribution of pupping ringed seals in the Gulf of Finland and its dependence on the severity of winters. Marine Mammals, Kiev, 2: 73–74. (In Russian).

Ropelewski, A. 1957. The common porpoise (*Phocoena phocoena* L.) as a by-catch in Polish Baltic fisheries. Prace Morskiego Instytutu Rybackiego, 9: 427–437. (in Polish)

Scheidat, M., Kock, K.-H., and Siebert, U. 2003.Summer distribution of harbour porpoise (*Phocoena phocoena*) in the German North and Baltic Sea. Working paper presented at the 2003 ASCOBANS meeting. 13pp.

Siebert, U., Joiris, C., Holsbeek, L., Benke, H., Failing, K., Frese, K. and Petzinger, E. 1999. Potential relation between mercury concentrations and necropsy findings in cetaceans from German waters of North and Baltic Seas. Marine Pollution Bulletin, 38: 285–295.

Sipilä, T. 1981 Saimaanhylkeen suku sammuu. Pohjois-Karjalan Luonto, 11(1): 21–23.

Sipilä, T. 1983. Saimaanhyljetutkimus, tutkimusraportti 1981–1982. Laudatur – Erikoistyö, Joensuun korkeakoulu, Biologian laitos. 68 pp.

Sipilä, T. 1990. Lair structure and breeding habitat of the Saimaa ringed seal (*Phoca hispida saimensis*). Finnish Game Research, 47: 11–20.

Sipilä, T. 1991. Saimaanhyljealueiden suojelutavoitteet. WWF Suomen Rahaston Raportti No. 5. WWF, Helsinki. 82 pp. (English summary: Proposals for protection of Saimaa ringed seal breeding areas.)

Sipilä, T. 1992. Saimaannorpan (*Phoca hispida saimensis* Nordq.) pesintä-, populaatio- ja suojelubiologiasta. Lisensiaatintutkielma, Biologian laitos, Joensuun yliopisto. 45 pp.

Sipilä, T. 1994. Saimaannorppa, alkuperäinen savolainen. pp 91–94 in: Tahvanainen, P. (ed.) Ympäristön tila Mikkelin läänissä. Vesi- ja ympäristöhallitus, Helsinki. (in Finnish)

Sipilä, T. 2003. Conservation biology of Saimaa ringed seal (*Phoca hispida saimensis*). Section of PhD thesis, available from T. Sipilä (see Annex 1).

Sipilä, T. 2003. Nature protection areas for seals in Baltic Sea, Finalnd. Working paper presented to this meeting of WGMME, available from T. Sipilä (see Annex 1).

Sipilä, T. Helle, E., and Hyvärinen, H. 1990. Distribution, population size, and reproductivity of the Saimaa ringed seal (*Phoca hispida saimensis* Nordq.) in Finland 1980–84. Finnish Game Research, 47: 3–10.

Sipilä, T. and Hyvärinen, H. 1998. Status and biology of Saimaa (*Phoca hispida saimensis*) and Ladoga (*Phoca hispida ladogensis*) ringed seals. *In* Heide-Jørgensen, M.-P. and Lydersen, C. (eds.) Ringed seals in the North Atlantic. NAMMCO Scientific Publication, 1: 83–99.

Sipilä, T., Hyvärinen, H. and Medvedev, N. 1996. The Ladoga seal (*Phoca hispida ladogensis* Nordq.). Hydrobiologia, 322: 192–198.

Sipilä, T., and J. Koskela. 2003. Mortality of Sjaimaa seal 1994–2002. Working paper presented to this meeting of WGMME, available from T. Sipilä (see Annex 1).

Sipilä, T., Koskela, J. T. and Hyvärinen, H. 1999. Mortality of the Saimaa seal (*Phoca hispida saimensis*). Pp 174 in Abstracts 13th Biennial Conference on Biology of Marine Mammals, Wailea, HI, 28 Nov–28 Dec. The Society for Marine Mammalology.

Sipilä, T., Koskela, J. T., and Hyvärinen, H. 2002a. Mortality in the Saimaa ringed seal (*Phoca hispida saimensis*) population. Unpublished manuscript, available from T. Sipilä (see Annex 1).

Sipilä, T., Medvedev, N., Kunnasranta, M., Bogdanov, V., and Hyvärinen, H. 2002b. Present status and recommended conservation actions for the Ladoga seal (*Phoca hispida ladogensis*) population. WWF Suomen Rahaston Raportti No. 15. WWF, Helsinki. 30 pp.

Smith, T.G. 1987. The ringed seal, *Phoca hispida*, of the Canadian Western Arctic. Canadian Bulletin of Fisheries and Aquatic Science, 216. 81pp.

Stanley, H.F., Casey, S., Carnahan, J.M., Goodman, S., Harwood, J., and Wayne, R.K. 1996. Worldwide patterns of mitochondrial DNA differentiation in the harbour seal (*Phoca vitulina*). Molecular Biology and Evolution, 13: 368–382.

Stenman, O., and Westerling, B. 1995. Status of the seal population in the eastern Gulf of Finland, and a possible role for the UNESCO BFU in assisting the International Baltic Research Programme. BFU Research Bulletin March 1995: 21–22.

Teilmann, J., Dietz, R., Larsen, F., Desportes, G. and Geertsen, B. 2003. Seasonal migrations and population structure of harbour porpoises (*Phocoena phocoena*) in the North Sea and Inner Danish waters based on satellite telemetry. ECS Conference, Las Palmas de Gran Canaria, March, 2003. Abstract.

Teilmann, J., and. Lowry, N. 1996. Status of the harbour porpoise (*Phocoena phocoena*) in Danish waters. Report of the International Whaling Commission, 46: 619–625.

Tiedeman, R., Harder, J., Gmeiner, C., and Haase, E. 1996. Mitochondrial DNA patterns of harbour porpoises (*Phocoena phocoena*) from the North and Baltic Sea. Zeitschrift für Säugetierkunde, 61: 104–111.

Tormosov, D.D., and Rezvov G.V. 1978. Information on the distribution, number and feeding habits of ringed and grey seals in the Gulfs of Finland and Riga in the Baltic Sea. Finnish Game Research, 37: 14–17.

Tormosov *et al*. unpublished field notes available to: Härkönen, T., Stenman, O., Jüssi, M., Jüssi,, I, Sagitov, R. and Verevkin, M. 1998. Population size and distribution of the Baltic ringed seal (*Phoca hispida botnica*). pp. 167–180 in Lydersen, C. and Heide- Jørgensen, M.-P. Ringed seals (*Phoca hispida*) in the North Atlantic. NAMMCO Scientific Publications, Vol. 1

Vinther, M. 1999. Bycatches of harbour porpoises (*Phocoena phocoena* L.) in Danish set-net fisheries. Journal of Cetacean Research and Management, 1: 123–135.

Wang, J.Y., and Berggren, P. 1997. Mitochondrial DNA analysis of harbour porpoises (*Phocoena phocoena*) in the Baltic Sea, the Kattegat-Skagerrak Seas and off the west coast of Norway. Marine Biology, 127: 531–537

Westerling, B. and Stenman, O. 1992. Hälsotillståndet hos sälbestånden i Östersjön. Veterinären och den yttre miljön. Nordisk kommitte för veterinärvetenskapligt samarbete 7:e symposiet 1–2 oktober 1992, Wik, Uppsala. 77–83. (In Swedish).

7 EcoQO for seal population trends in the North Sea

7.1 Introduction

One of the EcoQOs adopted in the Bergen Declaration related to the trends in seal populations in the North Sea. Under this EcoQO, no seal population in the North Sea will decline more than 10% over less than ten years. OSPAR has requested further advice in order to ensure a scientifically sound implementation of this EcoQO. The species covered by this EcoQO are grey seals and harbour seals. The request covers four areas:

1) Develop draft guidelines, including monitoring protocols and assessment methods, for evaluating the status of, and compliance with, this EcoQO;
2) Provide current levels, on an appropriate geographical basis, to be used as baselines against which progress can be measured;
3) Reconstruct the historic trajectory of the EcoQ metric and determine its historic performance (hit, miss or false alarm) relative to this EcoQO, as a basis for deciding its relationship to management;
4) Provide the basis for advice on what management measures could be taken to help meet this EcoQO.

A strong assumption behind this EcoQO is that in the absence of major mortality incidents, real population declines of greater than 5 % per annum would be unusual in seal populations at or below carrying capacity levels and these declines would be detected reliably in surveys of either adults or newborn pups. It also assumes that observed declines between years are real. On a short-term scale, seal population size may not be the parameter most sensitive to environmental change. Due to the longevity and delayed maturity of seals, several years are usually needed before changes in their reproduction or immature survival rates affect their breeding numbers. Substantial increases in adult mortality would have a more immediate effect. Nevertheless, rates of change in population sizes are reasonably good indicators of important changes in seal populations, where density-dependent effects may easily reduce the usability of other population parameters such as absolute size.

The number of births is a sensitive parameter responding more rapidly than total population size to changes in habitat conditions such as food availability. Pup/adult ratio is probably an indicator that will rapidly pick up impaired production in harbour seal populations where populations are surveyed during breeding and moulting seasons.

7.2 Draft guidelines

Without the individual scientists responsible for running or managing the major monitoring programme for seals in the North Sea (especially from the UK), it is impossible to develop draft guidelines for this EcoQO. Monitoring protocols for seals in the Baltic are discussed in Section 5. Monitoring protocols for marine mammals involve tradeoffs between cost, resourcing, appropriate spatio-temporal survey coverage, and the appropriate survey technique, which is affected by animals' behaviour, and current population status. Initial discussions on the development of this EcoQO (ICES, 2001) identified the value of this EcoQO specifically because most nations in the OSPAR area have appropriate monitoring programmes in place. A meeting organised by NAMMCO to improve abundance estimation of grey seals will be held in Iceland in April 2003.

7.3 Current levels

As not all surveys after the 2002 epizootic have been completed, population estimates for harbour seals in 2002 are not available. Abundance estimates will be available for the next meeting of WGMME in 2004.

The most recent estimates of grey seal abundance in the North Sea that were available to WGMME are presented in Table 7.3.1.

Table 7.3.1. Current estimates of abundance of grey seals in North Sea waters.

Region	Year	Estimate of abundance
UK	2001	70,000
Germany	1998	100
The Netherlands		
Others?		

7.4 Historic trends

Data are available on the abundance of harbour seals through most of the North Sea and for grey seals in UK waters and in the Schleswig-Holstein Wadden Sea. These are discussed below. Time-series of abundances are not available for either species for all parts of the North Sea. This is a weakness of the EcoQO.

No definition for a "false alarm" has been given to the Working Group, so we proposed a working definition for use with this EcoQO. This was that a false alarm occurred when the estimate of seal abundance between two consecutive years decreased by at least 10%, but that the time-series for the years immediately following suggested that the observed "decline" in the year in question was a sampling artefact.

Table 7.4.1 and Figure 7.4.1 show data for grey seals in UK waters for 1960–2001 (Duck, 2002). If these data can be considered "historic", they indicate that there are seven occasions when estimates of pup production fell by over 10% between consecutive years over this period (Figure 7.4.1). British grey seal populations generally increased over the period for which data are available, so a reduction in pup production between consecutive years of 10% was considered a false alarm. Figure 7.4.2 shows the change in estimates of pup production between years for which data are available. WGMME did not have access to the confidence intervals associated with the data points for this time-series. Therefore, we were unable to determine whether these false alarms would remain if the uncertainty associated with each point estimate for each year was included in the calculation.

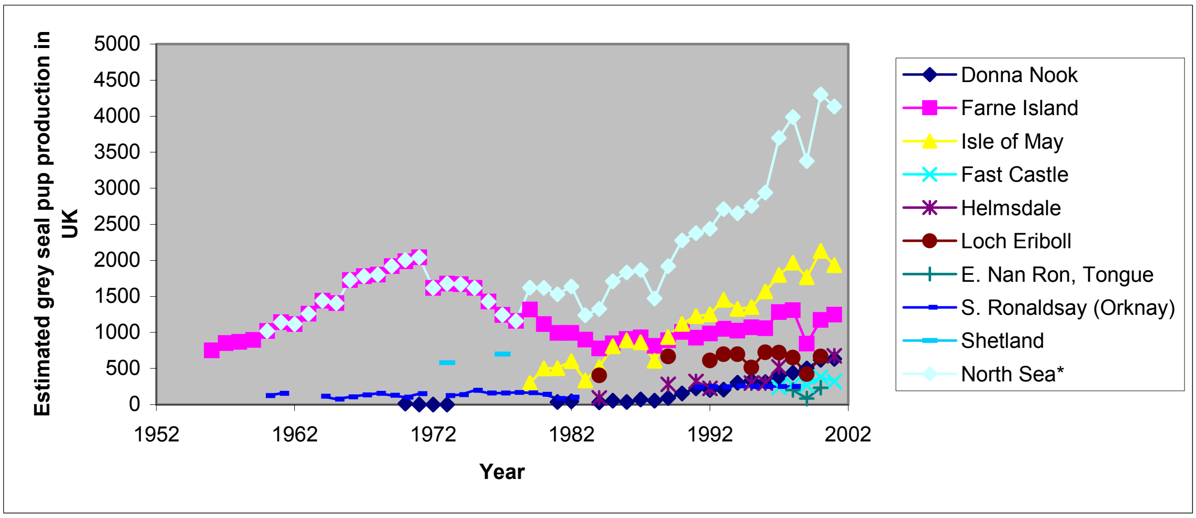


Figure 7.4.1. Time-series of estimates of grey seal pup production at major UK breeding sites in the North Sea, except Helmsdale, Orkney and Shetland (extracted from Duck, 2002).

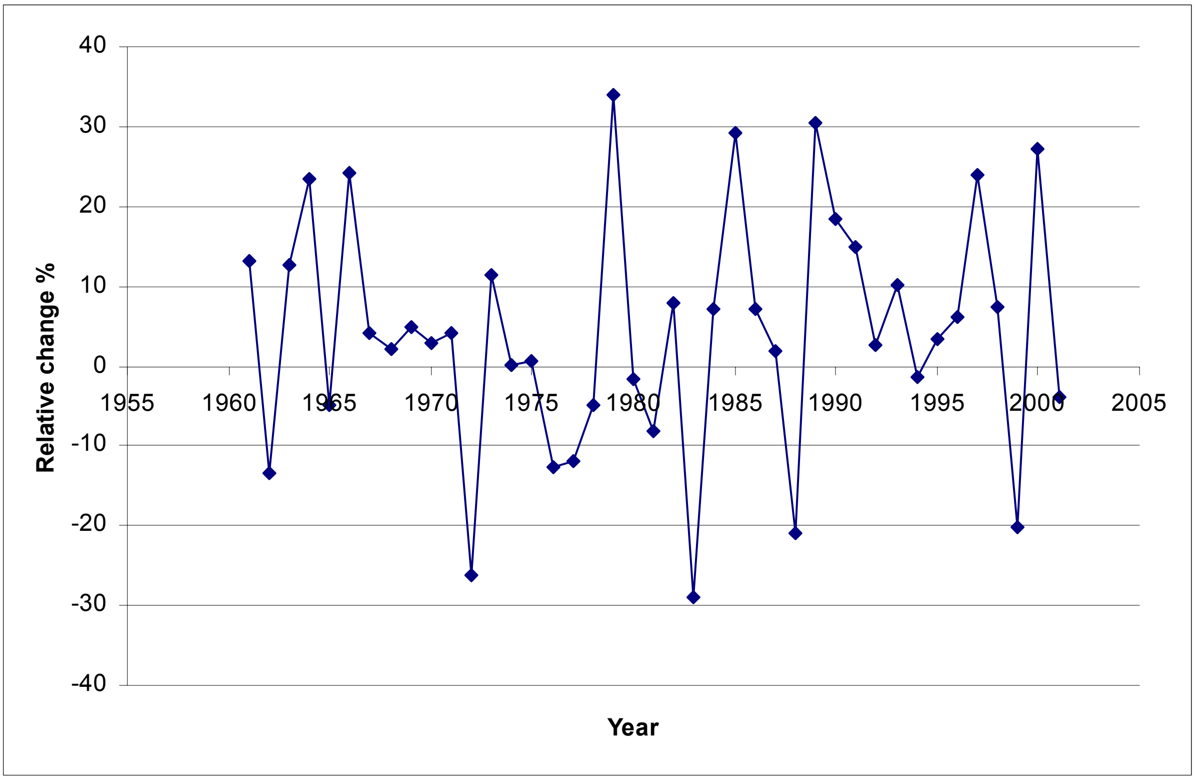


Figure 7.4.2. Time-series of annual changes in estimates of grey seal pup production at major UK breeding sites in the North Sea, except Helmsdale, Orkney and Shetland (extracted from Duck, 2002).

Table 7.4.1. Time-series of estimates of grey seal pup production at major UK breeding sites in the North Sea, except Helmsdale, Orkney and Shetland (Table 1 in Annex II of Scientific advice on matters related to the management of seal populations 2002. SCOS 02/2).

Year	North Sea
1960	1020
1961	1141
1962	1118
1963	1259
1964	1439
1965	1404
1966	1728
1967	1779
1968	1800
1969	1919
1970	2002
1971	2042
1972	1617
1973	1678
1974	1668
1975	1617
1976	1426
1977	1243
1978	1162
1979	1620
1980	1617
1981	1531
1982	1637
1983	1238
1984	1325
1985	1711
1986	1834
1987	1867
1988	1474
1989	1922
1990	2278
1991	2375
1992	2437
1993	2710
1994	2652
1995	2757
1996	2938
1997	3698
1998	3989
1999	3380
2000	4303
2001	4134

Figure 7.4.3 shows data for harbour seals in the Danish Strait and Skagerrak for 1988–1998 (from Härkönen *et al.*, 2002). If these data can be considered "historic", they indicate one occasion when estimates of abundance fell by over 10% between consecutive years over this period. These harbour seal populations generally increased over the period for which data are available, so this observed reduction between consecutive years of 10% was considered a false alarm. Figure 7.4.4 shows the change in estimates of pup production between years for which data are available. WGMME did not have access to the confidence intervals associated with the data points for this time-series. Therefore, we were unable to determine if this false alarm would remain if the uncertainty associated with each point estimate for each year was included in the calculation.

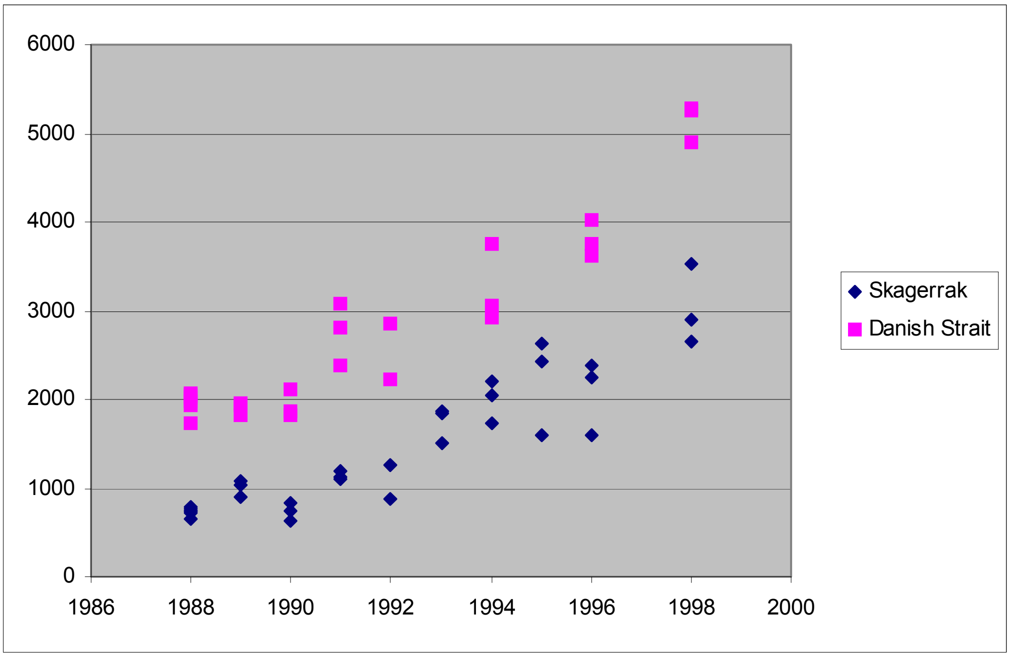


Figure 7.4.3. Estimates of harbour seal abundance from the Danish Strait and Skagerrak, 1988–1998. Extracted from Härkönen *et al.* (2002).

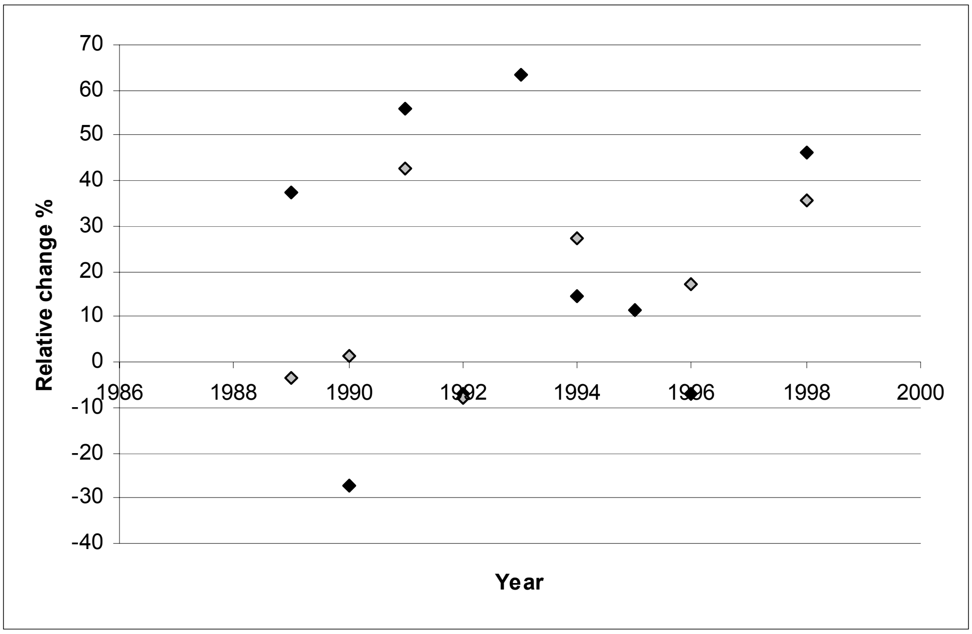


Figure 7.4.4. Time-series of annual changes in harbour seal abundance from the Danish Strait and Skagerrak, 1988–1998. Extracted from Härkönen *et al.* (2002).

Table 7.4.2 shows data for grey seals in the Schleswig-Holstein Wadden Sea waters for 1989–2000. If these data can be considered "historic", they indicate that there would be neither hits, misses nor false alarms for these animals.

Table 7.4.2. Time-series of the recorded numbers of grey seals in the Schleswig-Holstein Wadden Sea. Extracted from http://www.waddensea-secretariat.org.

Breeding season	**Counted live pups; Number of births**	**Dead pups**	**Adults counted during the breeding season**	**Adults counted in spring**
1988/89	9	0	16	26
1989/90	3	1	20	51
1990/91	7	1	10	47
1991/92	6	1	13	57
1992/93	10	1	28	54
1993/94	7	3	12	56
1994/95	5	2	7	88
1995/96	11	3	17	53
1996/97	11	4	14	73
1997/98	9	0	18	100
1998/99	11	2	19	-
1999/2000	13	3	?	?

Table 7.4.3 shows the indices of abundance of harbour seals at the Wash, UK, for 1988–2001 (Duck and Thompson, 2002). If these data can be considered "historic", they indicate that a hit would have occurred correctly in response to the phocine distemper virus epizootic of 1988. This "hit" did indeed occur and generated an appropriate response (research into the causes of the epizootic was conducted). Table 7.4.4 shows the indices of abundance of harbour seals in the German Wadden Sea, 1975–2001. If these data can be considered "historic", they indicate that a hit would have occurred correctly in response to the phocine distemper virus epizootic of 1988. This "hit" did indeed occur and generated an appropriate response (research into the causes of the epizootic was conducted).

Evaluating the relative importance of hits, misses and false alarms requires a tradeoff between Type I and Type II errors. This is an area of interaction between science and policy. Clearly it is not the responsibility of the Working Group to decide policy, so further interaction with policy makers is required to develop this area of EcoQOs. It is not clear from the request what consideration should be given to tradeoffs between these errors.

Table 7.4.3. Counts of harbour seals in The Wash, UK. Data from Duck (pers. comm.) and Annex III of Scientific advice on matters related to the management of seal populations 2002. SCOS 02/2.

Year	Count
1968	1468
1969	1722
1969	1473
1970	1662
1972	1632
1978	2186
1978	2176
1980	2191
1988	3087
1989	1531
1990	1532
1991	1226
1992	1724
1993	1759
1994	2277
1995	2266
1996	2151
1997	2561
1998	2367
1999	2320
2000	2528
2001	3194

Table 7.4.4. Time-series of counts of harbour seals from the German Wadden Sea (Abt pers. comm. to Scheidat).

Year	**Neider Sachsen**	**Schleswig Holstein**	**Wadden Sea Total**
1975	1049	1749	3492
1976	1163	1682	3526
1977	1140	1741	3622
1978	1228	1712	3620
1979	1109	1856	3745
1980	1298	2025	4410
1981	1441	2200	4672
1982	1543		5247
1983	1777		5851
1984	1936	3300	6249
1985	2062		6878
1986	2272		7740
1987	2400	3986	8790
1988	2508	4124	9800
1989	1401	1685	4355
1990	1620	1930	5005
1991	1924	2304	5921
1992	2255	2792	6988
1993	2482	3269	8107
1994	3111	3266	8916
1995	3214	3745	9761
1996	3529	4537	11013
1997	4319	5003	12927
1998	4588	5568	14446
1999	4809	6134	15244
2000	5233	6700	17008
2001	6223	7534	19387
2002	6481	7876	20975

7.5 Management measures

The management strategies for marine mammals applied by most nations in the OSPAR area are oriented towards maintaining or increasing marine mammal populations, so current management strategies are generally appropriate. A "hit" for this EcoQO triggers further research. The history of the effect of phocine distemper virus on harbour seal populations in European waters suggests that substantial reductions in seal numbers within the space of several months will trigger research in most countries. However, the comprehensiveness of these research programmes varies substantially between countries, from no research at all to detailed studies. It is certain that, despite signing the Bergen Declaration prior to the seal epizootic of 2002, no country initiated research on the basis that the EcoQO was triggered.

Recent changes to Norwegian management of grey and harbour seals in Norwegian waters appear aimed at achieving substantial reductions in the populations of these animals. This includes seals in the Norwegian sector of the North Sea. If these aims are achieved, i.e., hunters fill available seal quotas, this management strategy will trigger this EcoQO. The management measure required to reverse this is simply to return to the protocols used prior to 2003 for setting quotas.

However, the revised quotas established by the Norwegian government demonstrate a failure in the process of implementation of accepted pilot EcoQOs. There are only two EcoQOs adopted by the Bergen Declaration that deal specifically with marine mammals. The Norwegian government, a signatory to the Bergen Declaration, then instituted a management approach, the aim of which is clearly not to achieve the objective of the EcoQO. WGMME noted that development indicates that the essentials of national responsibility under the Bergen Declaration appear not to have been communicated to relevant line managers, in at least one country. WGMME was left pondering whether nations are taking EcoQOs seriously.

7.6 References

Duck, C. 2002. Pup production in the British grey seal population. Annex II in Scientific advice on matters relating to British seal populations. 2002. Available through: http://smru.st-and.ac.uk

Duck C., and Thompson D. 2002. The status of British common seal populations. Annex III in Scientific advice on matters relating to British seal populations. 2002. Available through: http://smru.st-and.ac.uk

Härkönen. T., Harding, K. and Heide-Jørgensen, M-P. 2002. Rates of increase in age-structured populations: a lesson from the European harbour seals. Canadian Journal of Zoology, 80: 1498–1510.

ICES, 2001. Report of the Working Group on Marine Mammal Population Dynamics and Habitats. ICES CM 2001/ACE:01.

8 EcoQO for the by-catch of harbour porpoise in the North Sea

8.1 Introduction

One of the EcoQOs adopted in the Bergen Declaration related to the by-catch in the North Sea of harbour porpoises. Under this EcoQO, annual by-catch levels should be reduced to levels below 1.7 % of the best population estimate. OSPAR has requested further advice in order to ensure a scientifically sound implementation of this EcoQO. The request covers four areas:

1) develop draft guidelines, including monitoring protocols and assessment methods, for evaluating the status of, and compliance with, this EcoQO;
2) provide current levels, on an appropriate geographical basis, to be used as baselines against which progress can be measured;
3) reconstruct the historic trajectory of the EcoQ metric and determine its historic performance (hit, miss or false alarm) relative to the EcoQO, as a basis for deciding its relationship to management;
4) provide the basis for advice on what management measures could be taken to help meet the EcoQO.

These are very large tasks to complete, and perhaps might be more properly contracted out for drafting, but a start on the work has been carried out below. Fortunately there has been considerable previous consideration of some of the technical issues and we have drawn extensively on this body of work.

8.2 Draft guidelines

Three main pieces of information are required to assess by-catch rates of harbour porpoises in the North Sea: population abundance estimate and structure, and the scale and geographic distribution of the by-catch.

There has been one estimate of harbour porpoise abundance in the North Sea. This was made in 1994 under the SCANS project (Hammond *et al*., 2002). The line-transect methods used in that survey were the best available at that time. A second abundance survey is planned (but not yet funded) for 2004–2005 that will use the same line-transect techniques as in 1994. Techniques have advanced though in scaling from transect data to abundance estimate, primarily through the use of GIS and post-hoc sampling (e.g., Hedley 2000). These techniques are still being refined. It is likely that the 1994 survey data will be revisited to compare with the new survey.

The population structure of the harbour porpoise in the North Sea is not well known, however there is likely to be some structuring (Tolley *et al*., 1999). Genetic studies indicate differences between porpoises in the northwestern North Sea and the southern North Sea, and between them and those on the Celtic Shelf (western channel – part of the North Sea in the current context). There is likely to be further subdivision of the population in the waters surrounding Jutland. Studies though are at present inconclusive and it is likely that any “population boundaries” that exist will not be fixed in space or time. In the absence of these population boundaries, a precautionary approach has been taken by, e.g., ASCOBANS and subdivision has been assumed. ASCOBANS has used the most relevant sampling areas of SCANS (Figure 8.2.1) to compare with by-catch rates in order to estimate population impacts.

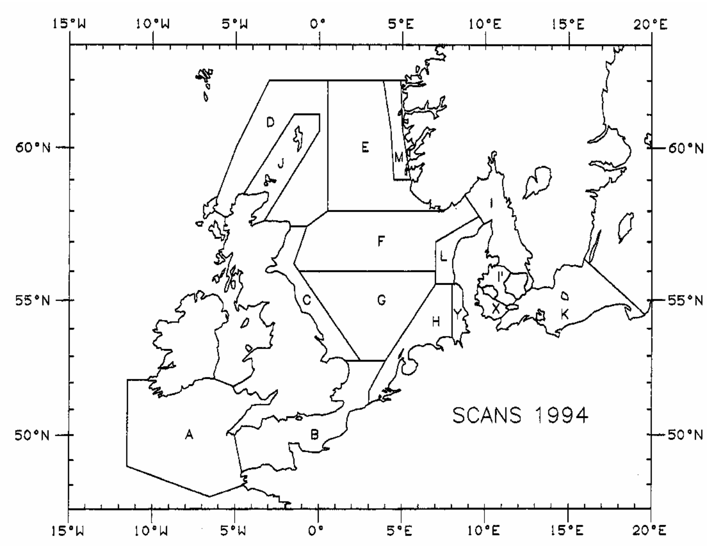


Figure 8.2.1. The North Sea with the relevant SCANS 1994 survey blocks for estimating abundance of small cetaceans (from Hammond *et al.,* 2002).

Northridge (1996) reviewed methods to assess by-catch of cetaceans. The recommendations of this report have been followed for most by-catch estimations in the North Sea in recent years, and we suggest that these methods continue to be followed. In summary, the only method to acquire reliable data for the majority of the fishing fleets is through the use of independent on-board observers. It is difficult, but not impossible, to estimate by-catch in fisheries conducted from smaller vessels. A major issue is that of scaling from on-board observations to fleet scale. In the North Sea, reasonable estimates exist for most fisheries relevant to harbour porpoise by-catch, with the notable exception of any way of estimating by-catch within the Norwegian small boat fisheries; even the scale of these fisheries remains completely unknown. By-catch will need to be estimated, preferably using effort information, within each of the major relevant fisheries of the North Sea and individual methods will need to be derived from the above guidance for each fishery.

8.3 Current levels

8.3.1 Driftnets

The UK has several small driftnet fisheries. Observations have been made on two of these (with relatively low proportionate effort) and no by-catch has been observed (S. Northridge, pers. comm.). By-catch of harbour porpoises in a Norwegian driftnet fishery for salmon was examined in 1988. A financial reward was offered to fishermen to return porpoises to port for post mortem examinations. Catch rates were among the highest ever recorded for a marine mammal in a net fishery, at around 0.65–1.47 porpoises/km.hour of fishing effort (Bjørge and Øien, 1995). This fishery was closed after the 1998 fishing season, mainly for reasons of salmon conservation.

8.3.2 Set nets

Vinther and Larsen (2002) extrapolated by-catch in Danish bottom-set fisheries in the North Sea. These extrapolations were based on a formula that includes effort (days at sea) and figures varied between 4000 and 7300 per year between 1987 and 2001 (Table 8.3.2.1). This extrapolation method indicates a higher by-catch than previously thought. The estimates may be further refined prior to formal publication of the paper.

Table 8.3.2.1. Estimates of harbour porpoise by-catch by fishery and season (quarter of year) for Danish bottom-set gillnet fishing in the North Sea (Vinther and Larsen, 2002).

Fishery	Season	1987	1988	1989	1990	1991	1992	1993	1994
Cod, wreck	1,2 and 4	97	99	89	104	102	117	116	123
	3	276	405	383	173	291	386	606	555
Cod, other	1 and 3	1410	1342	1217	919	1076	1307	1603	1578
	2 and 4	236	323	294	401	386	443	428	456
Hake	All	119	160	212	268	405	541	697	493
Turbot	2 and 3	2719	3229	2547	3067	3033	2577	2245	2534
Plaice	All	465	380	231	260	1018	1172	1014	1627
Sole	All	0	0	0	0	0	0	0	0
All	All	5322	5938	4973	5191	6312	6543	6709	7366

Fishery	Season	1995	1996	1997	1998	1999	2000	2001	Mean
Cod, wreck	1,2 and 4	117	121	130	148	126	106	67	111
	3	568	475	587	738	511	570*	405*	462
Cod, other	1 and 3	1546	1472	1514	1943	1705	1420	950	1400
	2 and 4	435	445	538	565	411	413	261	402
Hake	All	381	189	119	142	217	181	158	285
Turbot	2 and 3	2366	1999	1402	1034	737	985	1144	2108
Plaice	All	1325	1292	1018	636	521	475	903	822
Sole	All	0	0	0	0	0	0	0	0
All	All	6737	5991	5308	5206	4227	4149	3887	5591

* By-catch in this fishery is overestimated, as the effect of the use of pingers has not been taken into account.

Larsen *et al.* (2002) demonstrated a complete elimination of observed by-catch in the Danish North Sea wreck gillnet fishery in the third quarter of the year due to the deployment of pingers. By-catch estimates in Table 8.3.2.1 were made without considering the numbers of animals likely to have been saved by the use of pingers. Assuming 100% effectiveness, these would have amounted to 570 animals in 2000 and 405 animals in 2001. Larsen *et al*. (2002) also noted the unmonitored use of pingers by an unknown number of fishermen using gears other than cod wreck nets in the Danish North Sea set-net sector.

Harbour porpoise by-catch has been estimated for UK fisheries for cod, sole, skate and turbot in the North Sea (Table 8.3.2.2) for the period 1995–1999. The by-catch halved during this period as fishing effort (measured in days at sea) declined. By-catch estimates were based on observed by-catch per day at sea within metier, on the assumption that mean effort per day at sea among sampled vessels was an unbiased estimate of mean effort per day at sea for the entire metier.

Table 8.3.2.2. Estimates of harbour porpoise by-catch in the North Sea (CEC, 2002a). These estimates are for cod, sole, skate and turbot set-net fisheries and are derived from individual estimates for each of the fisheries in each area.

Year	North Sea	95 % confidence interval
1995	818	674–1233
1996	624	500–959
1997	627	513–957
1998	490	383–769
1999	436	351–684

Swedish gillnet fisheries for cod in a part of the Skagerrak were monitored during 1995/1996. From this study it was estimated that 53 porpoises per year were being taken at that time from a single ICES rectangle (Carlstrom and Berggren, 1996). Swedish gillnet fisheries in the Kattegat and Skagerrak also target flounder, crabs, dogfish, pollack, sole, turbot and herring. Overall catches by set nets have declined greatly in recent years (Figure 8.3.2.1).

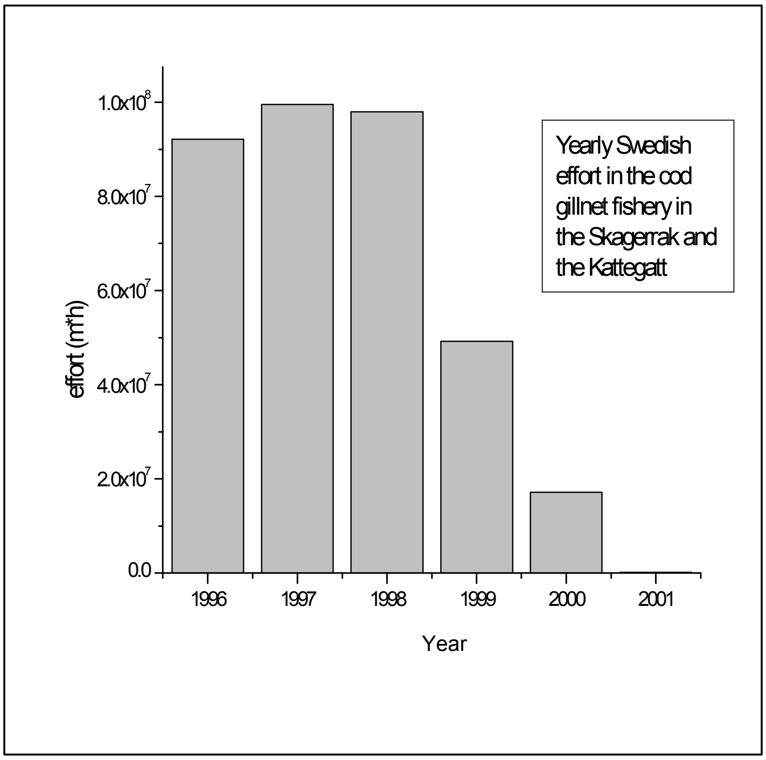


Figure 8.3.2.1. Yearly Swedish effort in the cod gillnet fishery in the Skagerrak and Kattegat, 1996–2001 (Anon., 2003).

There is no programme established to monitor cetacean by-catch in Norwegian set-net fisheries and neither is there is any information on fishing effort that might be used to provide an estimate of by-catch. However, there are a number of harbour porpoises taken per year in coastal gillnet fisheries (carcasses are periodically collected for biological studies). This by-catch may be substantial. The scale of harbour porpoise by-catch in the Norwegian offshore gillnet fisheries is unknown.

No by-catch of harbour porpoises has been observed in German set-net fisheries (Kock, 1997), though a project started in 2002 to investigate possible by-catch (K.-H. Kock, pers. comm.). There do not appear to be any adequate data on

German gillnet fishing effort in the North Sea. On the basis of evidence from stranded corpses, Kock and Benke (1995) reported 23 known by-catches from German waters between 1987 and 1995, mostly from around the Island of Sylt.

No information is available on harbour porpoise by-catch in the Dutch, Belgian or French fisheries. There is a low level of fishing effort by Dutch and Belgian gillnetters, with no records of marine mammal by-catch from these few vessels. About four Dutch vessels are reported to be working gillnets on a regular basis, and a few others on an irregular basis. Effort data are lacking.

8.3.3 Summary

By-catch levels within the North Sea of harbour porpoises appear to be variable by population, but it appears that the highest by-catch level is that of harbour porpoises within the central and southern North Sea. In the combined Danish fisheries alone, the extrapolated by-catch was about 4,000 individuals in 2000. In the recent past, this figure has been as high as 8,000 per year. In addition to this, UK fisheries in the same area took in the order of 800 individuals in 1995, and 440 individuals in 1999. Total fishery by-catch cannot be evaluated because other fisheries (in particular Norwegian fisheries) operating in the same harbour porpoise abundance area are not yet monitored for by-catch. The above decline (between 1994 and 2000) in by-catch levels of Danish and UK fisheries was as a result of reduced fishing efforts. It is likely that this trend has continued with the major decline in the cod stocks.

8.4 Historic trends in by-catch

These are unknown, and cannot be reconstructed. In theory, estimates might be made on the basis of fishing effort, but such information is also not available except in years from 1990 onwards (see Section 8.3). It would not be possible to assess by-catch rates, as there is no information at present on trends in abundance of harbour porpoise.

8.5 Management measures

By-catch can only be reduced by implementing fishery management measures. Read (2000) reviewed potential mitigation measures for reducing by-catches of small cetaceans in ASCOBANS waters, drawing on experience from by-catch reduction plans in the U.S. The report advised that, without unbiased data on the pattern and variation of by-catches from independent observer programmes, it is not possible develop or evaluate by-catch reduction plans, and recommended case-specific approaches for the development of such plans. It underlined the need for clear objectives for by-catch reduction plans and pointed to possible conflicts between fishery management and management of marine mammal populations. It stressed the importance of including all stakeholders, and referred to the experience of practical fishing operations represented by participating fishermen.

Hammond, P.S., Berggren, P., Benke, H., Borchers, D.L., Collet, A., Heide-Jørgensen, M.P., Heimlich, S., Hiby, A.R., Leopold, M.F., and Øien, N. 2002. Abundance of the harbour porpoise and other cetaceans in the North Sea and adjacent waters. Journal of Applied Ecology, 39: 361–376.

Bergen Declaration collect the raw data needed for this EcoQO. Until nations collect appropriate data, this EcoQO can never be implemented properly.

CEC (2002a, 2000b) reviewed all appropriate fisheries management measures and WGMME commends these reports as good reviews.

8.6 References

Anon. 2003. Effekter av drivgarnsfisket och förslag om bifångstminskande åtgärder. National Board of Fisheries, report to the Government 2003-02-23.

Bjørge, A., and Øien, N. 1995. Distribution and abundance of harbour porpoise *Phocoena phocoena* in Norwegian waters. Reports of the International Whaling Commission, Special Issue Series, 16: 89–98.

Carlstrom, J., and Berggren, P. 1996. Bycatch estimates of harbour porpoises (*Phocoena phocoena*) in the Swedish Skagerrak Sea obtained from independent observer data. Paper SC/48/SM25 presented to the IWC Scientific Committee, 1996.

CEC. 2002a. Incidental catches of small cetaceans. Report of the meeting of the Subgroup on Fishery and the Environment (SGFEN) of the Scientific, Technical and Economic Committee for Fisheries (STECF), Brussels, 10–14 December 2001. SEC (2002) 376.

CEC. 2002b. Incidental catches of small cetaceans. Report of the second meeting of the Subgroup on Fishery and the Environment (SGFEN) of the Scientific, Technical and Economic Committee for fisheries (STECF), Brussels, 11–14 June 2002. SEC (2002) 1134.
Hammond, P.S., Berggren, P., Benke, H., Borchers, D.L., Collet, A., Heide-Jørgensen, M.P., Heimlich, S., Hiby, A.R., Leopold, M.F., and Øien, N. 2002. Abundance of the harbour porpoise and other cetaceans in the North Sea and adjacent waters. Journal of Applied Ecology, 39: 361–376.
Hedley, S.L. 2000. Modelling heterogeneity in cetacean surveys. Thesis submitted for the degree of doctor of philosophy in the School of Mathematics and Statistics, University of St Andrews. August, 2000. 132 pp.
Kock, K.-H. 1997. The by-catch of small cetaceans in the German fisheries in the North Sea and the Baltic in 1996 – preliminary results. Paper SC/49/SM21 (International Whaling Commission).
Kock, K.-H., and Benke, H. 1995. On the by-catch of harbour porpoise (*Phocoena phocoena*) in German fisheries in the Baltic and the North Seas. ICES CM 1995/N:21.
Larsen, F., Eigaard, O.R., and Tougaard, J. 2002b. Reduction of harbour porpoise bycatch in the North Sea by high-density gillnets. Paper presented to the Scientific Committee of the International Whaling Commission, Shimonoseki, May 2002, SC/54/SM30. 12 pp.
Northridge, S.P. 1996. A review of marine mammal by-catch observer schemes with recommendations for best practice. JNCC Report No. 219, Aberdeen, UK.
Read, A.J. 2000. Potential mitigation measures for reducing the by-catches of small cetaceans in ASCOBANS waters. Report to ASCOBANS, December 2000. Duke University, North Carolina. 34 pp. + appendices.
Tolley, K.A., Rosel, P.E., Walton, M., Bjørge, A., and Øien, N. 1999. Genetic population structure of harbour porpoise (*Phocoena phocoena*) in the North Sea and Norwegian waters. Journal of Cetacean Research and Management, 1(3): 265–274
Vinther, M. 1999. Bycatches of harbour porpoises (*Phocoena phocoena* L.) in Danish set-net fisheries. Journal of Cetacean Research and Management, 1: 123–135.
Vinther, M., and Larsen, F. 2002. Updated estimates of harbour porpoise by-catch in the Danish bottom set gillnet fishery. Paper presented to the Scientific Committee of the International Whaling Commission, Shimonoseki, May 2002, SC/54/SM31. 13 pp.

9 EcoQO for seal breeding sites in the North Sea

9.1 Introduction

If habitat quality deteriorates within a species' geographical range, change or reduction in the species distribution may be observed before any impact may be detected in population size. With the fidelity for natal sites documented in harbour and grey seals, abandoning breeding sites should be a strong indicator of habitat degradation (or massive depletion of a population). Maintaining the current levels, no sites would be abandoned. If any breeding sites were abandoned, the EcoQO triggers management action to determine the causes and to act. In its previous incarnation as WGMMPH in 2001 (ICES, 2001), WGMME did not have the information available to determine the number of known, regularly occurring, breeding sites of seals in the North Sea.

The aim of this EcoQO is to reduce the continuous data on seal breeding sites (number of pups born) to binary data (presence/absence of pups). The presence or absence of seals at breeding sites should be easily detectable with cost-effective survey methods. Mostly this will involve working from standard surveys, but other data are likely to be needed also, particularly from breeding sites that are not surveyed regularly.

Harbour seals can move their breeding areas over relatively small spatial scales. Within the Orkney archipelago, harbour seals appear to have been displaced from one relatively small area, although the breeding population on the archipelago has remained relatively constant over the period of this displacement (Thompson *et al.*, 2001). We assume that managers would not find this level of displacement a suitable trigger for management action. Therefore, we assume that in order for this EcoQO to be of management utility, defining the appropriate spatial and temporal scales for application of this EcoQO is required. Presence/absence at breeding sites would therefore be particularly useful as an Ecological Quality Objective, as the long time-series of data in many areas throughout the North Sea are particularly useful for both evaluating the usefulness of breeding sites as an EcoQO and for identifying appropriate scales of breeding areas.

Available data comprise counts of breeding areas along the UK North Sea coast since the 1960s, in the Skagerrak and Kattegat since 1979, and in the Wadden Sea since 1970. Thompson and colleagues (e.g., Thompson *et al.*, 1997, 2001) suggested that individual bays or archipelagos are probably appropriate. In some places (e.g., Anholt), there is only one area that could possibly be used by seals for breeding. Ensuring that a breeding "site" is selected at the appropriate spatial scale needs further testing using existing survey data. In some places (e.g., the Orkney Islands), individual islands or skerries are probably an inappropriate spatial scale, but in other places (e.g., Anholt) an individual island is appropriate. Figure 19.1 shows known breeding areas of harbour seals in the North Sea, while Figure 19.2 shows known breeding areas for grey seals in the North Sea.

The following steps are required to develop this EcoQO:

1) Collate the available data on existing places where seals breed in the North Sea, with information provided at the finest spatial scale possible.
2) Collate what time-series exist on these sites, and on the recent establishment or loss of other seal breeding sites in the North Sea.
3) From 1 and 2, model the relationship between recording breeding sites at different spatial and temporal scales for detecting the likelihood for a hit, miss or false alarm from existing data.
4) Provide a suite of possibilities for implementation of this EcoQO at different spatial scales, including the likelihood of hits, misses and false alarms, for each implementation.
5) Develop guidelines for establishing a monitoring programme that is capable of monitoring this EcoQO at all scales listed in Step 4, or ensure that existing monitoring programmes can achieve this. Some minor modification of existing programmes may be required.

WGMME suggests developing a suite of possibilities for implementing this EcoQO in order to explain explicitly the tradeoffs between Type I and Type II errors that are implicit in the request to assess the likelihood of hits, misses and false alarms. As management aims for monitoring programmes should be explicit, not implicit (Yoccoz *et al.*, 2001), managers can then decide which one of the suite of probabilities that they find acceptable for application.

9.2 Recommendations

1) A spatial analyst must work with available data to develop the suite of implementation possibilities.
2) The results of these analyses should be presented at the next meeting of WGMME in order to develop plans of actions that should be associated with when this EcoQO is triggered.

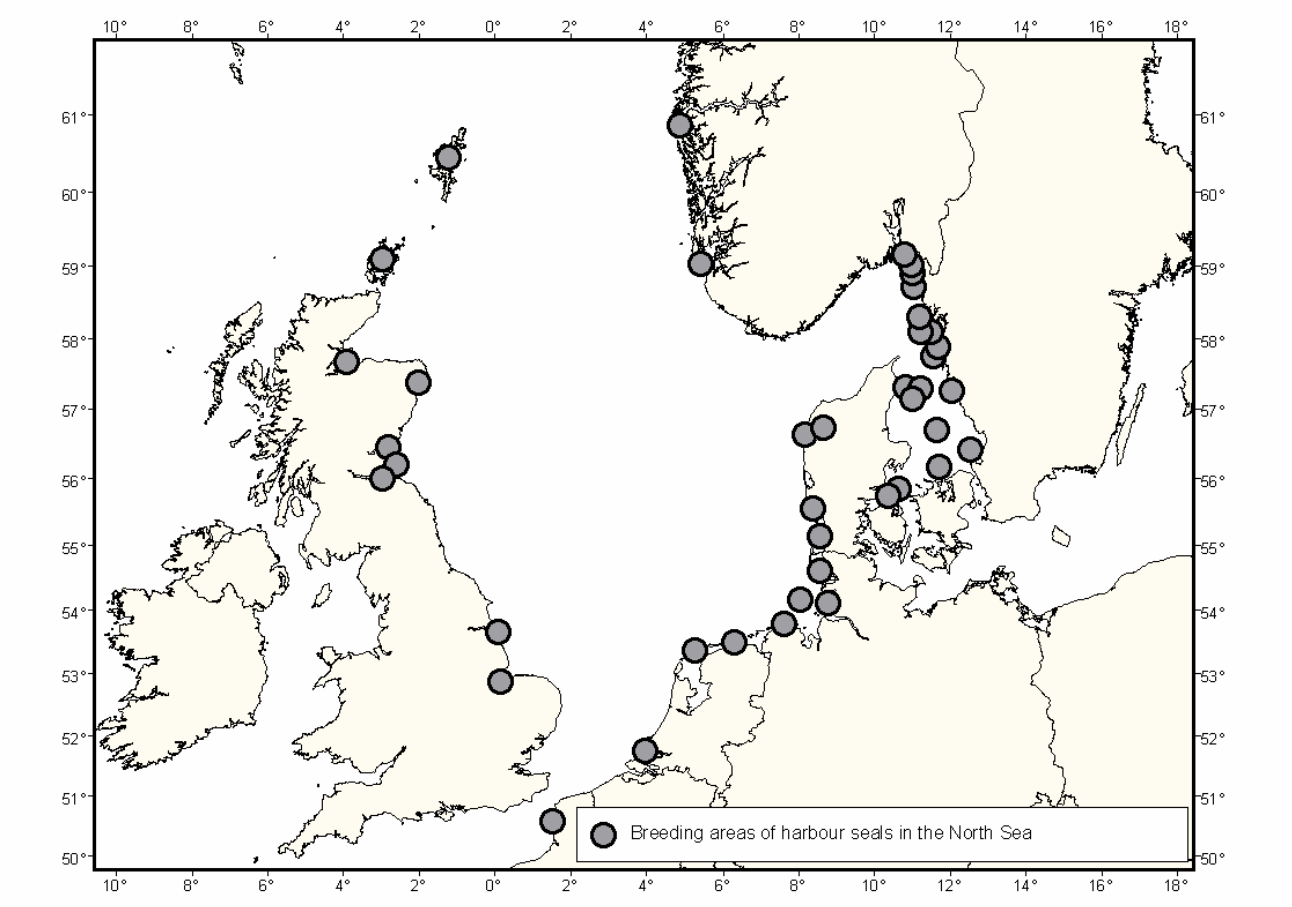


Figure 19.1. Locations of known breeding areas of harbour seals in the North Sea.

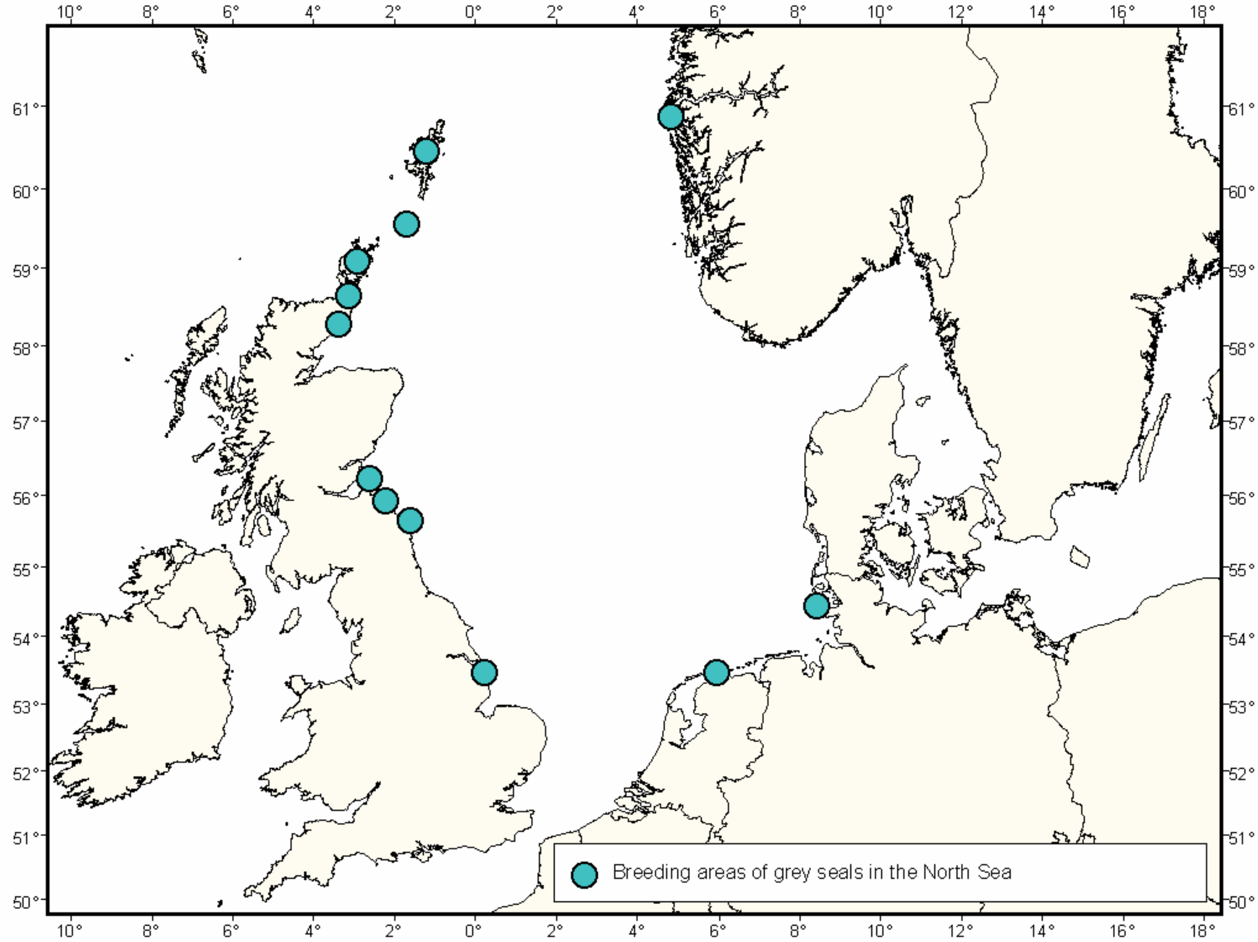


Figure 19.2. Locations of known breeding areas of grey seals in the North Sea.

9.3 References

ICES. 2001. Report of the Working Group on Marine Mammal Population Dynamics and Habitats. ICES CM 2001/ACE:01.

Thompson, P.M., Tollitt, D.J., Wood, D., Corpe, H.M., Hammond, P.S., and Mackay, A. 1997. Estimating harbour seal abundance and status in an estuarine environment in north-east Scotland. Journal of Applied Ecology, 34: 43–52.

Thompson, P.M., van Parijs, S., and Kovacs, K.M. 2001. Local declines in the abundance in harbour seals: implications for the design and monitoring of protected areas. Journal of Applied Ecology, 38: 117–125.

Yoccoz, N.G. Nichols, J.D., and Boulinier, T. 2001. Monitoring of biological diversity in space and time. Trends in Ecology and Evolution, 16: 446–453.

10 Further consideration of the EcoQO for threatened and declining marine mammal species in the North Sea

10.1 Introduction

Four species of marine mammals were proposed by the 2003 meeting of OSPAR's Biodiversity Committee for adoption onto OSPAR's list of threatened and declining species at the summer 2003 OSPAR Ministerial meeting. These were blue whale (*Balaenoptera musculus*), bowhead whale (*Balaena mysticetus*), northern (North Atlantic) right whale (*Eubalaena glacialis*) and harbour porpoise (*Phocena phocena*). In 2002, ICES recommended a series of steps to be followed to determine which species on the proposed OSPAR list would be suitable for robust and effective EcoQOs in the North Sea (ICES, 2002). Of the species on the proposed OSPAR list, only the harbour porpoise breeds in the North Sea, with the remainder occurring as vagrant non-breeders. We tested this species using the ICES steps:

Step 1 – Establish whether the species occurs in the Greater North Sea (OSPAR Region II).

Step 2 – Establish whether the status of the species can be quantified accurately.

Step 3 – Establish why the species is threatened or declining.

Step 4 – Establish whether trends in population status can be detected reliably on time frames relevant to management (perhaps over five years).

The status of harbour porpoise is known in the North Sea only from a single abundance estimate made in 1994. The estimate for the North Sea was 385,086 with a CV of about 0.15. The financial cost of achieving this estimate was high and there have been no further surveys since 1994, but another survey is now being planned. As noted by ICES (2001), no EcoQO relative to harbour porpoise population size was suggested owing to a lack of time-series of abundance estimates. In addition, power analysis indicated that only a 50 % decline of the population could be detected at the 5 % level using the CV obtained by the 1994 SCANS survey and with the current survey schedule of every ten years.

As has been reviewed elsewhere, the greatest threat to harbour porpoises in the North Sea is from by-catch in bottom-set fishing nets. An EcoQO has been agreed to limit this threat.

10.2 Recommendation

We would concur with previous advice from ICES that objectives for threatened and declining species are not very appropriate as EcoQOs (ICES, 2002), primarily in the case of harbour porpoise population size due to the difficulty and cost in accurately tracking population levels. In addition, the EcoQO for by-catch of this species addresses the major threat to its status in the North Sea. This does not mean that harbour porpoises do not require conservation. WGMME supports strongly the need to fully implement existing conservation plans.

10.3 References

ICES. 2001. Report of the Working Group on Marine Mammal Population Dynamics and Habitats. ICES CM 2001/ACE:01.

ICES. 2002. Report of the ICES Advisory Committee on Ecosystems, 2002. ICES Cooperative Research Report, 254: 68–71.

11 The 2002 seal epizootic event

11.1 Introduction

In 2002, an unusually large number of dead seals were found on the island of Anholt in the Kattegat. Post-mortem analysis of recovered carcasses demonstrated the presence of phocine distemper virus (PDV), genetically very similar to the strain of PDV responsible for the outbreak of 1988 (Jensen *et al.*, 2002). The mortality rate approached or exceeded 50% in areas affected in the beginning of the summer, whereas populations infected later showed lower mortality rates (Harding *et al.*, 2002). Details of the number of dead harbour seals and grey seals recorded to the end of December 2002 by area are presented in Table 11.1.1 (from Reineking, 2002) and Figure 11.1.1 (from Reijnders, 2003).

Some background from the 1988 epizootic event of immediate relevance to the 2002 epizootic event includes:

- There is evidence indicating that harp seals moving into southern waters in response to prey collapses in the Barents Sea in 1986/1987 introduced the virus into harbour seals.
- In 1988, the rate of dispersal of the epizootic was related to the distance between harbour seal colonies, rather than colony size.
- In 1988, approximately 56% of the estimated population of affected harbour seals died in the Kattegat-Skagerrak and the Wadden Sea, whereas mortality rates varied between 30% and 50% in UK waters.

The aim of this aspect of the meeting was to review preliminary findings from the 2002 seal epizootic event in the North Sea and Kattegat and review the role of such events in population regulation.

11.2 Preliminary findings of the 2002 seal epizootic event

Preliminary findings demonstrate some aspects of the 2002 epizootic that are clearly of interest. As in 1988 the outbreak started in the Kattegat. Mass mortalities were first recorded on exactly the same island, Anholt, as the first mass mortalities in the 1988 epizootic. Unlike 1988, a second centre of infections appears to have begun in the Netherlands in June.

Initial results suggest that approximately 30–50% of the estimated population(s) of harbour seals in European waters perished during the epizootic. The total number of carcasses recovered was just over 23,000. Including an estimate of seals that died but were not recovered, over 30,000 seals are likely to have died in 2002. Surveys to estimate abundance of harbour seals in 2003 will be completed after August. Following this, more reliable estimates of mortality caused by the epizootic event will be available.

When compared with the outbreak of the epizootic in 1988, scientists were far better prepared to collect data that will allow an assessment of the impact of this epizootic on harbour seal populations. Age structure of dead animals can be determined from approximately 3000 jaws collected in the Kattegat-Skagerrak area, 1300 from the Netherlands and approximately 250 jaws each from the UK and Germany. Reproductive tracts from approximately 1000 females, and 1200 samples for ecotoxicological analyses were collected from the Kattegat-Skagerrak area. Samples for genetic analyses were collected also, with an intention to relate the MHC variability, messenger RNA activity and ecotoxicological burden with health status of affected animals. Although samples have been collected, funds are required to carry out all the analyses proposed. Funding is being sought from external sources to achieve this.

11.2.1 Vectors and spread

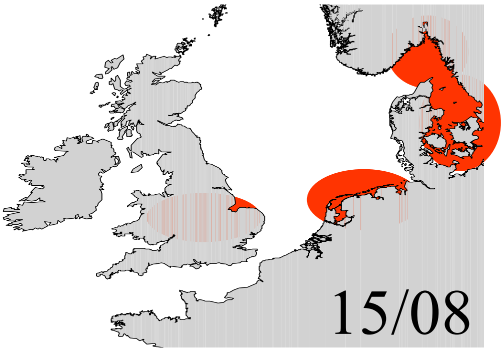
It is unlikely that harp seals were the vectors for the virus this time. Suggested vectors include grey seals, American mink, and red fox. Serological studies are under way to assess the likelihood of each of these species. Modelling from the previous epizootic suggests that PDV is so contagious that it cannot be maintained in the relatively small population of harbour seals existing in European waters. PDV could be maintained in the harp seal or ringed seal populations in the European Arctic. Other possible vectors (humans, birds) were discussed. Whether European grey seal populations are sufficiently large to maintain PDV is unknown and has not been modelled. There was a difference between the spread of infection and the spread of mass mortality. Reasons underlying this difference are unclear at this time.

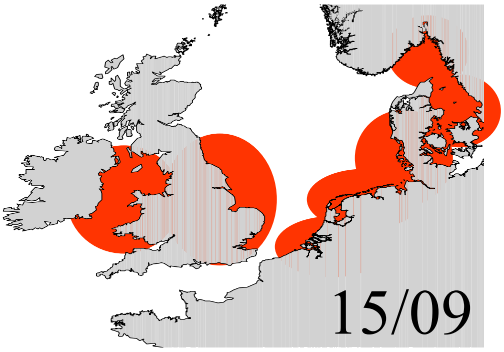
11.3 Review of the role of these events in population regulation

The longer-term consequences of epizootics in European harbour seal populations have been explored in a recent paper (Harding *et al*., 2002). Immunity played no substantial role in the dynamics of the 2002 epizootic. A stochastic model explored the relationship between mortality, recurrent epizootics and the long-term growth, fluctuation and persistence of populations. Given the period between the first and second epizootics, life history parameters of harbour seals, and known anthropogenic mortality, epizootics recurring with the same frequency are unlikely to drive European harbour seal populations to extinction. However, recurrent PDV epizootics of the same observed frequency and severity as those seen to date will reduce the long-term stochastic growth rate of harbour seals by approximately 50%. At the observed epizootic frequency, the risk for reduction to 10% of initial population size increased from a negligible 0.001 to a substantial risk of 0.18. Marine wildlife managers need to ensure that estimates of acceptable anthropogenic mortality take this into account.

Figure 11.1.1. Spread of the PDV epizootic in harbour seals in European waters in 2002. Red shading indicates areas where infected seals were observed on the date given. From Reijnders (2003).

Figure 11.1.1. Continued.





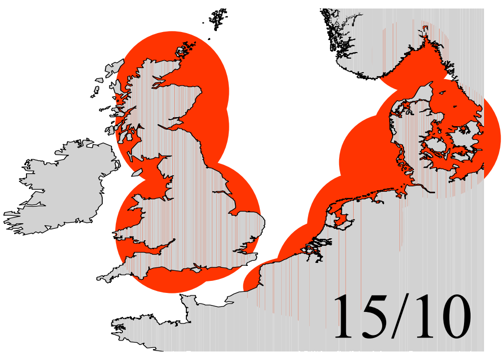


Table 11.1.1. Progression of the PDV epizootic in European harbour seals in 2002 (taken from Reineking (2002).

	First date of occurrence of unusual mortality	**Seal Report no. 43 (21.10.2002)** **Number of dead common and grey seals (until date)**	**Seal Report no. 44 (06.12.2002)** **Number of dead seals (until date)**	
			Common and grey seal	**Grey seal**
Wadden Sea				
Netherlands: - Wadden Sea - Noord- + Zuid-Holland, Zeeland	16 June 2002	 2,187 (19.11.02) 54 (19.11.02)	2,244 (22.11.02) epizootic over	2
Lower Saxony	17 July 2002	3,851 (18.11.02)	3,851 (18.11.02) epizootic over	19
Hamburg	21 August 2002	261 (29.10.02)	261 (29.10.02) epizootic over	-
Schleswig-Holstein	26 August 2002	3,338 (14.11.02)	3,338 (14.11.02) epizootic over	-
Denmark	30 August 2002	931 (19.11.02)	962 (05.12.02) epizootic over	1
Wadden Sea Total		**about 10,360**	**about 10,656**	**22**
Helgoland	11 August 2002	**270** (30.10.02)	**270** (30.10.02) epizootic over	-
Kattegat/Skagerrak				
Danish Kattegat	07 May 2002	2,044 (19.11.02) epizootic over	2,049 (05.12.02) epizootic over	-
Swedish Kattegat / Skagerrak	30 May 2002	about 4,000 (06.09.02) epizootic over	about 4,000 epizootic over	?
Norwegian Skagerrak	22 June 2002	878 (23.09.02) epizootic over	878 epizootic over	?
Kattegat/Skagerrak Total		**about 6.915**	**about 6.927**	
DK- Limfjord	about 18.09.2002	**380** (19.11.02)	**365** (05.12.02) epizootic over	-
Baltic Sea				
Danish Baltic Sea: Falster, Møn, South-Lolland, incl. Øresund	about 13.09.2002	**93** (19.11.02)	**95** (05.12.02) epizootic over	-
German Baltic Sea coast Mecklenburg-Western Pomerania	30 August 2002	**11** (07.10.02)	**11** no dead seal found since 07.10.02	-
Belgium/France	31.07.02 (France) /18.08.02 (Belgium)	**22** no dead seal found since 08.11.02	**22** no dead seal found since 08.11.02	-
United Kingdom England, Scotland, Wales, Northern Ireland	14 August 2002	3,285 (20.11.02)	3,544 (04.12.02)	at least 540
Republic of Ireland	21.09.2002	**113** (31.10.02) data from November not yet available	**158** (01.12.02)	at least 41
All Areas TOTAL		**about 21,720**	**about 22,050**	

11.4 References

Harding, J.C., Härkönen, T. and Caswell, H. 2002. The 2002 European seal plague: epidemiology and population consequences. Ecology Letters, 5: 727–732.

Jensen, T., van de Bildt, M., Dietz, H.H., Andersøn T.H., Hammer, A.S., Kuiken, T., and Osterhaus, A. (2002). Another phocine distempter outbreak in Europe. Science, 297: 209.

Reijnders, P.J.H. 2003. Newsletter of the Wadden Sea Secretariat. Available at http:// www.waddensea-secretariat.org.

Reineking, B. 2002. Information on Dead Seals in the Kattegat/Skagerrak Area, the Wadden Sea and the North Sea in 2002. No. 44, dated 6 December 2002. Information compiled by Common Wadden Sea Secretariat, and available at http://www.waddensea-secretariat.org.

12 Census methods

12.1 Introduction

WGMME reviewed census techniques for land-breeding phocid seals, and statistical analysis of resulting data (including correction factors). The review relied on both published and non-published material from the greater North Atlantic and northwest Pacific Oceans. The review identified a general similarity in harbour seal survey techniques, but large differences in statistical analysis of survey data. In contrast, grey seal surveys conducted in Atlantic Canada and the United Kingdom are designed to count pups, whereas in the Baltic Sea counts are conducted during the molt, therefore exclude pups.

12.2 Harbour seals

The standard methodology for estimating harbour seal population size is via fixed-wing, occasionally helicopters, aerial surveys of haul-out sites during the pupping or molting periods when a larger fraction of seals are hauled out (Gilbert and Wynne 1988; Heide-Jørgensen and Härkönen, 1988; Thompson and Harwood 1990; Stobo and Fowler 1994; Gilbert and Guldager 1998; Reijnders *et al.* 1997; Frost *et al.* 1999; Huber *et al.* 2001; Jeffries *et al.* 2003). Within these survey periods knowledge of pupping and molting phenology are required to ensure that survey timing captures the peak cycles (Thompson and Rothery 1987; Kovacs *et al.* 1990; Huber *et al.* 2001; Daniel *et al.* 2003; Jemison and Kelly 2003). Further, daily survey counts are normally made 2 h either side of low tide, particularly mid-day, when more animals are expected to be out of the water (Schneider and Payne 1983; Steward 1984; Watts 1996). These counts only provide minimum population estimates, therefore a variety of survey and analytical techniques have been employed to improve counts and reduce variability. Radio telemetry (Thompson *et al.* 1997; Ries *et al.* 1998; Huber *et al.* 2001; Jefferies *et al.* 2003) has been used to obtain a correction factor for the fraction of seals not hauled-out during survey operations. But, correction factors are likely to be biased since haul-out patterns are variable among age and sex groups, and over environmental conditions (Thompson *et al.* 1989, 1997; Huber *et al.* 2001; Härkönen and Harding 2001; Härkönen *et al*. 2002; Boveng *et al.* 2003). Distinct survey correction factors are not applicable to other geographic regions due to differences in harbour seal habitat use, haul-out behaviour, environmental variables and habitat type.

Replicate counts within a survey region, with and without telemetry, have also been used to obtain more precise population estimates. And, periodic replicate surveys have been used to examine trends (Pitcher, 1990; Frost *et al.*, 1999; Jeffries *et al.*, 2003) Further, modeling the effects of environmental variables (i.e., tide height, weather, wind direction, temperature, etc) have been used to obtain improved uncorrected counts and correction factors, and therefore population estimates (Frost *et al.* 1999; Boveng *et al.* 2003).

In the UK, two aerial survey methods are used by SMRU to survey harbour seals in Britain. On the east coast, where seals haul ashore on sandbanks (The Wash and surrounds, Firth of Tay and Moray Firth) counts are made using large format vertical photography. On sandbanks, seals are easily seen and this form of conventional photography is very cost effective.

The remainder of the Scottish coast (including the northern and western islands) is surveyed by helicopter equipped with a thermal imaging camera. Here, seals haul ashore on rocks or seaweed-covered rocks and can be very well camouflaged and difficult to detect. The thermal imager can locate groups of harbour seals at 3 km distance, occasionally further. This technique allows rapid and synoptic surveying of extensive stretches of complex coasts. The helicopter operates at a height of approximately 200–300 m and approximately 500 m offshore. At this distance seals are not disturbed from their haul-out sites. If they are, a count can usually be obtained from the thermal "footprints" remaining on the rock.

The thermal image is displayed on a black and white monitor and groups are counted directly, in real time, from this monitor. A second, colour, monitor displays the view from a Hi8 Camcorder mounted in parallel with the thermal imager. This is used to help differentiate between harbour and grey seals. The species can also be distinguished using their thermal profile (body shape and group structure) and directly, using binoculars. A copy of the thermal image is made on a VHS recorder.

The survey programme is as follows: East England (The Wash and surrounds): 2 annual surveys carried out during August; Scotland: Approximately 1 survey every 5 years. However, many areas have been surveyed more frequently than this (e.g., Firth of Tay, Moray Firth, Mull, Lismore, NW Skye).

In addition, Scottish Natural Heritage has commissioned breeding season surveys of most sites prior to selection as candidate Special Areas of Conservation for harbour seals.

Two replicate aerial surveys are conducted along the coasts of Sweden, Denmark and Norway (Kattegat, Skagerrak, and Limfjord) during the molting period (Härkönen *et al.*, 2002). Periodic pup counts are made from boats in the Swedish portion of the Skagerrak (Härkönen and Heide-Jørgensen, 1990; Härkönen *et al.*, 1999) Along the west coast of Norway, north of 59^0N, aerial surveys are conducted every 5^{th} year during the molting period. In the Walden Sea, a minimum of two aerial surveys are conducted during peak pupping and molting periods (Reijnders *et al.*, 1997).

Since 1981, periodic aerial surveys have been conducted in USA Atlantic waters along the coast of Maine during the pupping season (Gilbert and Guldager 1998). In most surveys only a small fraction of the survey region was replicated. In 2001, two replicate surveys (three in high density sites) were flown, and the first ever correction factor was obtained using radio-tagged animals (Gilbert *et al.,* in review).

Coast-wide harbour seal abundance surveys have not been conducted in Atlantic Canada waters. However, several seasonal aerial surveys have been conducted in the Bay of Fundy and off southwest Nova Scotia (Stobo and Fowler 1994; Jacobs and Terhune 2000).

In the non-UK surveys, hauled-out seals were counted visually or from reading photographs taken with 35 mm cameras, 70–300 mm telephoto lens, and high-speed color slide film.

12.3 Grey seals

In the Baltic region, grey seal surveys are conducted annually during the molting period (Jüssi and Jüssi, 2001; Helander and Karlsson, 2002). Surveys along the Swedish and Estonian coasts are conducted by small boat or land, and rely mostly on volunteers along the Swedish coast (Jüssi and Jüssi 2001; Helander and Karlsson 2002). In Finland surveys are made from fixed-wing aircraft and seals are counted from photographs. These counts provide data for analyses of trends, but are less suitable for estimates of population abundance. Since 1995, photo-identification techniques have also been employed to estimate the size of the Baltic grey seal population (Hiby *et al*. 2001). Photographs are taken of "well-patterned" seals (mostly adult females) during summer, following the annual molt (Karlsson *et al*. 2003). To allow for the effect of selection of well-marked seals by the photographer on the population size, marking qualities were recorded in two ways. The proportion of well-, medium- and bad-patterned seals were scored for a large number of seals at the haul-out during each session. Secondly the photographer allocated into the same categories, a sample of the seals actually photographed in the field. The photograph scores were included in the database so that when photographs were selected to form the release samples the proportion of seals in those samples that were in each of the three categories could be determined.

In the UK, a series of aerial surveys, using large format vertical photography, are conducted through the course of the breeding season. Individual breeding colonies are photographed between 4 and 7 times annually at approximately 10–12 day intervals (Duck 2002). Pups are counted on a microfiche reader which magnifies the image by 22 times and are categorised as being either "whitecoat" or "fully moulted". Surveys are at a height of 365 m (1,200 feet) giving a swath width of approximately 300 m x 200 m. The film has a very high resolution – you can see individual strands of fence wire, for example.

A mathematical model is used to estimate the total pup production for each colony given the observed number of white-coated and moulted pups through the course of the breeding season (Duck 2002). These estimates are calculated with corresponding confidence intervals (Duck 2002).

The total grey seal population size is estimated using a second model. This model assumes that the British grey seal population is a single entity and uses the combined total pup production for all annually monitored breeding colonies (Duck 2002).

In Norway counts are conducted primarily from small boats, occasionally using small aircraft, along sections of the coast (Barents Sea to Norwegian Sea) during the pupping and molting periods (Haug *et al.*, 1994). The entire region is covered over a three year period, and counts may include one-year old and older animals (Haug *et al.*, 1994). A multiplier in the range suggested by Harwood and Prime (1978) is used to estimate the total population.

In the Netherlands, grey seals are counted annually in connection with aerial harbour seal surveys in June. Grey seal pup (whitecoats) and adult counts are also conducted on breeding colonies in the Dutch Walden Sea, between February and April (Reijnders 2003).

Grey seal counts in the German portion of the Walden Sea are conducted during the summer surveys for harbour seals. During the breeding season counts are also made on Helgoland (Reijnders 2003).

In Atlantic Canada, counts are conducted during the entire pupping season, and total pup production is estimated using mark-recapture methods (Zwanenburg and Bowen 1990; Stobo and Zwaneburg 1990; Hammill *et al*. 1998). The total number of grey seals is estimated by applying a scaling factor to the pup counts.

12.4 Recommendation: Seal Census Methods

WGMME recommends that conveners of the 2004 ICES Workshop on Census Techniques for Phocid Seals invite specialists from both the North Atlantic and Northwest Pacific regions.

Justification: Phocid seal survey methods, data collection and analytical techniques vary greatly within and between the North Atlantic and Northwest Pacific regions. A compilation of these procedures into a single document will provide a valuable reference on seal census techniques.

12.5 References

Boveng, P. L., Bengston, J. L., Withrow, D. E., Cesarone, J. C., Simpkins, M. A., Frost, K. J., and Burns, J. J.. 2003. The abundance of harbor seals in the Gulf of Alaska. Marine Mammal Science 19: 111–127.

Daniel, R. G., Jemison, L. A., Pendleton, G. W., and Crowley, S. M. 2003. Molting phenology of harbor seals on Tugidak Island, Alaska. Marine Mammal Science 19: 128–140.

Duck, C. 2002. Pup production in the British grey seal population. Annex II in Scientific advice on matters relating to British seal populations. 2002. Available through: http://smru.st-and.ac.uk

Frost, K. J., Lowry, L. F., and Ver Hoef, J. M. 1999. Monitoring the trend of harbor seals in Prince William Sound, Alaska, after the *Exxon Valdez* oil spill. Marine Mammal Science 15: 494–506.

Gilbert, J. R. and Guldager, N. 1998. Status of harbor and gray seal populations in northern New England. NMFS/NER Cooperative Agreement 14-16-009-1557. Woods Hole, Massachusetts. Available from NOAA Fisheries, NEFSC, 166 Water St., Woods Hole, Massachusetts, USA 02543.

Gilbert, J. R. and Wynne, K. M. 1988. Status of harbor and gray seal populations in northern New England. Final report under NMFS/NER Cooperative Agreement 14-16-009-1557, Woods Hole, Massachusetts. Available from NOAA Fisheries, NEFSC, 166 Water St., Woods Hole, Massachusetts, USA 02543.

Hammill, M. O., Stenson, G. B., Myers, R. A., and Stobo, W. T. 1998. Pup production and population trends of the grey seal (*Halichoerus grypus*) in the Gulf of St. Lawrence. Canadian Journal of Fisheries and Aquatic Sciences, 55: 423–430.

Härkönen. T., and Harding, K. 2001. Spatial structure of harbour seal populations and the implications thereof. Canadian Journal of Zoology, 79: 2115–2127.

Härkönen. T., Harding, K., and Heide-Jørgensen, M-P. 2002. Rates of increase in age-structured populations: a lesson from the European harbour seals. Canadian Journal of Zoology, 80: 1498–1510.

Härkönen. T., Harding, K., and S. G. Lunneryd. 1999. Age- and sex-specific behavior in harbour seals *Phoca vitulina* leads to biased estimates of vital population parameters. Journal of Applied Ecology, 36: 825–841.

Härkönen, T., and Heide-Jørgensen, M.-P. 1990. Density and distribution of the ringed seal in the Bothnian Bay. Holarctic Ecology, 13: 122–129.

Harwood, J., and J. H. Prime. 1978. Some factors affecting the size of British grey seal populations. Journal of Applied Ecology 15: 401–411.

Haug, T., Henriksen, G. Kondakov, A., Mishin, V., Nilssen, K. T., and Rρv, V. 1994. The status of grey seals *Halichoerus grypus* in north Norway and on the Murman Coast, Russia. Biological Conservation 70: 59–67.

Heide-Jørgensen, M.-P., and Härkönen, T. 1988. Rebuilding seal stocks in the Kattegat-Skagerrak. Marine Mammal Science, 4: 231–246.

Helander, B., and O. Karlsson. 2002. Inventering av gråsæl vid svenska Östersjö kusten.

Hiby, L., Lundberg, T., Karlsson, O., and Helander, B. 2001. An estimate of the size of the Baltic grey seal population based on photo-id data. Report to project "Seals and fisheries" Länstyrelsen I Västernorrlands. Län and Naturvårdsverket.

Huber, H. R., Jeffries, S. J., Brown, R. F., DeLong, R. L., and VanBlaricom, G.. 2001. Correcting aerial survey counts of harbor seals (*Phoca vitulina richardsi*) in Washington and Oregon. Marine Mammal Science 17:276–293.

Jacobs, S. R. and J. M. Terhune. 2000. Harbor seal (*Phoca vitulina*) numbers along the New Brunswick coast of the Bay of Fundy in autumn in relation to aquaculture. Northeastern Naturalist, 7: 289–296.

Jeffries, S., H. Huber, J. Calambokidis, and J. Laake. 2003. Journal of Wildlife Management, 67: 208–219.

Jemison, L. A., and B. P. Kelly. 2003. Pupping phenology and demography of harbor seals (*Phoca vitulina richardsi*) on Tugidak Island, Alaska. Marine Mammal Science 17: 585–600.

Jüssi, I., and M. Jüssi. 2001. Action plan for grey seals in Estonia 2001–2005. Eesti ulukid/Estonain Game7. 88 pp.

Karlsson, O., Hixby, L., Lundberg, T., Jüssi, M., Jüssi, I., and Helander, B. 2003. Photo-identification, site fidelity and movement of grey seals (*Halichoerus grypus*) in the Baltic Sea. *In* Population structure, movements and site fidelity of grey seals in the Baltic Sea, pp 72–82. Ph.D. thesis Department of Zoology, Stockholm University.

Kovacs, K. M., Jonas, K. M., and Welke, S. E. 1990. Sex and age segregation by *Phoca vitulina* concolor at haul out sites during the breeding season in the Passamaquoddy Bay region, New Brunswick. Marine Mammal Science 6: 204–214.

Pitcher, K. W. 1990. Major decline in number of harbor seals, *Phoca vitulina richardsi*, on Tugidak Island, Gulf of Alaska. Marine Mammal Science 6: 121–134.

Reijnders, P.J.H. 2003. Newsletter of the Wadden Sea Secretariat. Available at http://www.waddensea-secretariat.org

Reijnders, P. J. H., Ries, E. H., Tougaard, S., Nρrgaard, N., Heidemann, G., Schwartz, J., Vareshi, E., and Traut, I. M. 1997. Population development of harbor seals *Phoca vitulina* in the Wadden Sea after the 1988 virus epizootic. Journal of Sea Research 38: 161–168.

Ries, E. H., A. R. Hiby, and P. J. H. Reijnders. 1998. Maximum likelihood population size estimation of harbour seals in the Dutch Wadden Sea based on a mark-recapture experiment. Journal of Applied Ecology 35:332–339.

Schneider, D. C., and P. M. Payne. 1989. Factors affecting haul-out of harbor seals at a site in southeastern Massachusetts. Journal of Mammalogy 64: 5187–520.

Steward, B. S. 1984. Diurnal hauling patterns of harbor seals at San Miguel Island, California. Journal of Wildlife Management 48: 1459–1461.

Stobo, W. T. and G. M. Fowler. 1994. Aerial surveys of seals in the Bay of Fundy and off southwest Nova Scotia. Canadian Technical Report of Fisheries and Aquatic Sciences 1943.

Stobo, W. T. and Zwanenburg, K. C. T. 1990. Grey seal (*Halichoerus grypus*) pup production on Sable Island and estimates of recent production in the northwest Atlantic. *In* W. D. Bowen (ed.), Population biology of sealworm (*Pseudoterranova decipiens*) in relation to its intermediate and seal hosts. Canadian Bulletin of Fishies and Aquatic Sciences 222: 171–184:

Thompson, P.M., and Harwood, J. 1990. Methods for estimating the population size of common seals, *Phoca vitulina*. Journal of Applied Ecology, 27: 924–938.

Thompson, P.M., Fedak, M.A., McConnell, B.J., and Nicholas, K.S. 1989. Seasonal and sex-related variation in the activity patterns of common seals (*Phoca vitulina*). Journal of Applied Ecology 26: 521–535.

Thompson, P. and Rothery, P.. 1987. Age and sex differences in the timing of the moult in the common seal, *Phoca vitulina*. Journal of Zoology, London 212: 597–603.

Thompson, P. M., Tollit, D. J., Wood, D., and Corpe, H. M. 1997. Estimating harbour seal abundance and status in an estuarine habitat in north-east Scotland. Journal of Applied Ecology, 34: 43–52.

Thompson, P.M., Tollitt, D.J., Wood, D., Corpe, H.M., Hammond, P.S., and Mackay, A.1997. Estimating harbour seal abundance and status in an estuarine environment in north-east Scotland. Journal of Applied Ecology, 34: 43–52.

Watts, P. 1996. The diel hauling-out cycle of harbour seals in an open marine environment: Correlates and constraints. Journal of Zoology, London 240: 175–200.

Zwanenberg, K. C. T., and Bowen, W. D. 1990. Population trends of the grey seal (*Halichoerus grypus*) in eastern Canada. Pgs. 185–197. *In* W. D. Bowen (Ed.), Population biology of sealworm (*Pseudoterranova decipiens*) in relation to its intermediate and seal hosts. Canadian Bulletin of Fishies and Aquatic Sciences 222.

13 Review interspecific competition between harbour and grey seals

WGMME determined that information on this TOR was insufficient for a meaningful discussion, therefore it was not considered at the meeting.

14 A process to construct a time-series of marine mammal abundance, diet, and consumption rates for the North Seal since 1963

14.1 Introduction

ICES Working Group on the Multispecies Model of the North Sea (WGMSNS) intends to carry out a run of the multispecies model during 2004–2005. The model requires a time-series of marine mammal abundance by quarter and year from 1963 to 2003. There is no subdivision of the North Seal within the model. The model also requires marine mammal consumption rates and dietary composition by species and size class by quarter and year. There is very little information on these features, collected by quarter and year, so the process we propose should provide the best possible information for these parameters, using extrapolation from existing data.

14.1.1 Marine mammal abundance: background

In an ideal world, the abundance of cetaceans would be calculated from densities observed at sea throughout the year. However, there has been only one estimate of cetacean abundance in the North Sea, that of SCANS in 1994 (Hammond *et al*. 2002). A further survey is planned in 2004 or 2005.

Seal abundance estimates in the North Sea are based on pup counts (grey seal) or haul-out counts during the moulting period (harbour seal). These counts can both be scaled to give a total population estimate. Grey seal counts have been made annually since the 1960s in the largest colonies in the UK (that comprise a great majority of the North Sea population), thus it is probably possible to derive total population estimates. Harbour seal counts in the Wadden Sea started in 1975, but counts around the UK started later and have not been annual. It would though be possible to make good estimates at intervals and to extrapolate to the intervening years.

14.1.2 Marine mammal abundance, proposed time-series process

Trends in annual abundance (moulting season for harbour seals, pupping season for grey seals) will be estimated for both species of seal. There is no evidence of great changes in abundance between seasons, though a “typical” year might be modelled on the basis of the greatest number in any one year being immediately after pupping, declining to the adult and immature only population immediately prior to pupping.

It will not be possible to describe trends in cetacean numbers, so a single abundance figure will have to be used throughout the period.

14.1.3 Marine mammal dietary composition and food consumption rates: background

There is very little information on the foods of the principal cetacean species occurring in the North Sea; what little there is can be found in published literature.

The diets of grey seals were examined in UK colonies/haul-outs in 1985 on a quarterly basis (Hammond *et al*. 1994a, 1994b). A further study was carried out on the east coast of Scotland in the mid-1990s (Hall 1999). Large-scale dietary surveys are presently being repeated as part of a doctoral study. Harbour seal diet has been studied on a year-round basis by Pierce *et al*. (1991) and Tollitt and Thompson (1996) in the Moray Firth in northeast Scotland. Hall *et al.* (1998) and Brown *et al*. (2001), respectively, conducted seasonal studies harbour seal diet in the Wash and the Shetlands. Studies in the Wadden Sea have been carried out by Reijnders (1992). Blubber fatty acids have been used to detect inter-annual variations in the diet of grey seals (Walton and Pomeroy 2003) on one Scottish North Sea colony.

Innes *et al.* (1987) reviewed studies of feeding rates of seals and whales held in captivity for a minimum of five days.

14.1.4 Marine mammal dietary composition and food consumption rates: proposed time-series process

A literature review will also be undertaken to check or draw up assumptions for North Sea wide diet, food consumption rates and food utilisation efficiencies for each of the common species of marine mammal. Dietary studies using pseudo-replication will be avoided. It is unclear if the energy content of foods will be needed as input to the North Sea multi-species model or whether this also should be reviewed by WGMME. Advice on the overall format of information requested from WGMME will be sought prior to the 2004 meeting of the group.

14.2 References

Brown, E. G., G. J. Pierce, J. R. G. Hislop, M. Begona Santos. 2001. Interannual variation in the summer diets of harbour seals *Phoca vitulina* at Mousa, Shetland (UK). Journal of the Marine Biological Association of the United Kingdom, 81: 325–337.

Hall, A. J. 1999. The diet of grey seals using faecal analysis. Final report of European Commission Project 95/78 of DG XIV. Effects of large-scale industrial fisheries on non-target species (ELIFONTS). St Andrews University, St Andrews.

Hall, A.J., Watkins, J., and Hammond, P. S. 1998. Seasonal variation in the diet of harbour seals in the south-western North Sea. Marine Ecology Progress Series, 170: 269–281.

Hammond, P.S., Berggren, P., Benke, H., Borchers, D.L., Collet, A., Heide-Jørgensen, M.P., Heimlich, S., Hiby, A.R., Leopold, M.F., and Øien, N. 2002. Abundance of the harbour porpoise and other cetaceans in the North Sea and adjacent waters. Journal of Applied Ecology, 39: 361–376.

Hammond, P.S., Hall, A.J., and Prime, J.H. 1994a. The diet of grey seals around Orkney and other island and mainland sites in north-eastern Scotland. Journal of Applied Ecology, 31: 340–350.

Hammond, P. S., A. J. Hall, and J. H. Prime. 1994a. The diet of grey seals around Inner and Outer Hebrides. Journal of Applied Ecology, 31: 737–746.

Innes, S. D. M. Lavigne, W. M. Earle, and K. M. Dovacs. 1987. Feeding rates of seals and whales. Journal of Animal Ecology, 56: 115–130.

Pierce, G. J., P. M. Thompson, A. Miller, J. S. W. Diack, D. Miller, P. R. Boyle. 1991. Seasonal variation in the diet of common seals (*Phoca vitulina*) in the Moray Firth area of Scotland. Journal of Zoology (London), 223:641–652.

Prime, J. H. and P. S. Hammond. 1990. The diet of grey seals from the southwestern North Sea assessed from analyses of hard parts found in faeces. Journal of Applied Ecology, 27: 435–447.

Reijnders, P.J.H. 1992. Retrospective population analysis and related future management perspectives for the harbour seal *Phoca vitulina* in the Wadden Sea. Proc. Int. Wadden Sea Symp., 7, Ameland, 1990. Netherlands Inst. Sea Res. Publ. Sev., 20: 193–197.

Tollit, D. J. and P. M. Thompson. 1996. Seasonal and between-year variations in diet of harbour seals in the Moray Firth, Scotland. Canadian Journal of Zoology, 74: 1110–1121.

Walton, M. and P. Pomeroy. 2003. Use of blubber fatty acid profiles to detect inter-annual variations in the diet of grey seals *Halichoerus grypus*. Marine Ecology Progress Series, 248: 257–266.

15 Prepare a case for a WGMME Workshop on marine mammal health in relation to habitat quality

WGMME noted that worldwide marine mammal health and habitat quality are important scientific issues and support a workshop held under the auspices of ICES. There were no specialists on these topics at the meeting, therefore WGMME recommended that the Chair contact former members of the dissolved Working Group on Marine Mammal Habitats regarding this issue.

16 Future work of the WGMME and recommendations

16.1 Future work of the WGMME

It is likely that the demand for advice from ICES client commissions and others on marine mammal issues will continue and will grow in future years. This WG should continue to be parented by the ICES Advisory Committee on Ecosystems.

16.2 Recommendation for Future Meeting

WGMME (Chair: Gordon T. Waring, USA) agreed that the best dates for the next annual meeting will be 3–4 days in mid-March 2004 at the AZTI Fisheries and Food Technological Institute, Pasajes (Guipuzcoa), Spain:

WGMME recommended that activities for the 2004 meeting include:

a) a review of the usefulness of marine protected areas to marine mammals,

b) review the scientific and management basis for seal removal programmes in the North Atlantic, including:

i) are monitoring programmes adequate to assess the population impacts;

ii) are the monitoring programmes on the expected social/economic/biological benefits sufficient to determine if benefits are being realized?

17 References

Andersen, L.W. 1993. The population structure of the harbour porpoise, *Phocoena phocoena*, in Danish waters and part of the North Atlantic. Marine Biology, 116: 1–7.

Anon. 1939. Eesti statistika 1931–1939, Vol. 17. Tallinn (Estonian Statistics, in Estonian)

Anon. 2002. Scientific advice on matters relating to the management of seal populations: 2002. Special Committee on Seals (SCOS), available at http://………..

Anon. 2003. Effekter av drivgarnsfisket och förslag om bifångstminskande åtgärder. National Board of Fisheries, report to the Government 2003-02-23.

Antoniuk, A.A. 1975. Estimation of the population size of the ringed seal in Lake Ladoga. Zoolichesckii Zhurnal, 54: 1371–1377.

ASCOBANS, 2000. Fourth annual compilation of national reports. ASCOBANS Secretariat, Bonn.

ASCOBANS. 2002. ASCOBANS Recovery plan for Baltic harbour porpoises (Jastarnia plan). Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas, Bonn.

Barlow, J.1999. Trackline detection probability for long diving whales. Marine Mammal Survey and Assessment Methods (eds G.W. Garner, S.C. Amstrup, J.L. Laake, B.F.J. Manly, L.L. McDonald & D.G. Robertson), pp. 209–221. A.A. Balkema, Rotterdam, the Netherlands.

Becker, P. 1984. Uhanalaisuuden syyt. pp.109–118 in: Becker, P. (ed.) Saimaannorppa,, Saimaannorppa. Suomen Luonnonsuojelun Tuki Oy, Helsinki. pp. 109–118.

Bergman, A. 1999. Health condition of the Baltic grey seal *(Halichoerus grypus)* during two decades. Gynaeological health improvement but increased prevalence of colonic ulcers. APMIS 107: 270–282.

Bergman, A., and Olsson, M. 1986. Pathology of Baltic grey seal and ringed seal females with special reference to adrenocortical hyperplasia: is environmental pollution the cause of a widely distributed disease syndrome? Finnish Game Research, 44: 47–62.

Bergman et al 1992

Bergman, G. 1956. Sälbeståndet vid våra kuster. Nordenskiöld-samfundets tidskrift, 16: 50–65.

Berggren, P 1994: By-catches of the harbour porpoise (*Phocoena phocoena*) in the Swedish Skagerrak, Kattegat and Baltic waters, 1973–93. Report of the International Whaling Commission. Special Issue, 15: 211–6.

Berggren, P. 2001

Berggren, P., Ishaq, R., Zebür, Y., Näf, C., Bandh, C., and Broman, D. 1999. Patterns and levels of organochlorine contaminants (DDTs, PCBs, non-ortho PCBs and PCDD/Fs) in male harbour porpoises (*Phocoena phocoena*) from the Baltic Sea, the Kattegat-Skagerrak Seas and the west coast of Norway. Marine Pollution Bulletin, 12: 1070–1084.

Bjørge, A., and Øien, N. 1995. Distribution and abundance of harbour porpoise *Phocoena phocoena* in Norwegian waters. Reports of the International Whaling Commission, Special Issue Series, 16: 89–98.

Börjesson, P., and Berggren, P. 1997. Morphometric comparisons of skulls of harbour popoises (*Phocoena phocoena*) from the Baltic, Kattegat and Skagerrak seas. Canadian Journal of Zoology, 75: 280–287

Boveng, P.L., Bengston, J.L., Withrow, D.E., Cesarone, J.C., Simpkins, M.A., Frost, K.J., and Burns, J.J. 2003. The abundance of harbor seals in the Gulf of Alaska. Marine Mammal Science, 19: 111–127.

Bruhn, R., Kannan, N., Petrick, G., Schulz-Bull, D.E., and Duinker, J.C. 1999. Persistent chlorinated organic contaminants in harbour porpoises from North Sea, the Baltic Sea and Arctic waters. Science of the Total Environment, 237/238: 351–361.

Buckland, S.T., Anderson, D.R., Burnham, K.P., and Laake, J. 1993. Distance Sampling: Estimating Abundance of Biological Populations. Chapman and Hall, London, UK.

Carlstrom, J., and Berggren, P. 1996. Bycatch estimates of harbour porpoises (*Phocoena phocoena*) in the Swedish Skagerrak Sea obtained from independent observer data. Paper SC/48/SM25 presented to the IWC Scientific Committee, 1996.

Chapskii, K.K. 1932. Ladozhski tiulen i vozmozhnost ego promysla. Report of the Fisheries Research Institute of Leningrad, 13: 147–157.

Clausen, B., and Andersen, S.H. 1988. Evaluation of bycatch and health status of the harbour porpoise (*Phocoena phocoena*) in Danish waters. Danish Review of Game Biology, 13: 1–20.

Daniel, R.G., Jemison, L.A., Pendleton, G.W., and Crowley, S.M. 2003. Molting phenology of harbor seals on Tugidak Island, Alaska. Marine Mammal Science, 19: 128–140.

Duck, C. 2002. Pup production in the British grey seal population. Annex II in Scientific advice on matters relating to British seal populations. 2002. Available through: http://smru.st-and.ac.uk.

Duck, C., and Thompson, D. 2002. The status of British common seal populations. Annex III in Scientific advice on matters relating to British seal populations. 2002. Available through: http://smru.st-and.ac.uk.

Filatov, I.E. 1990. Ladozhkaja kolchataja nerpa. pp. 57–64 in Sokolov V. E. and Janshin, A. L. (eds.) Redkie izthezajushie vidy mlekopitajushih SSSR. Nauka. Moskva.

Frost, K.J., Lowry, L.F., and Ver Hoef, J.M. 1999. Monitoring the trend of harbor seals in Prince William Sound, Alaska, after the "Exxon Valdez" oil spill. Marine Mammal Science, 15: 494–506.

Gilbert, J.R., and Guldager, N. 1998. Status of harbor and gray seal populations in northern New England. NMFS/NER Cooperative Agreement 14-16-009-1557., Woods Hole, Massachusetts. Available from NOAA Fisheries, NEFSC, 166 Water St., Woods Hole, Massachusetts, USA 02543.

Gilbert, J.R., and Wynne, K.M. 1988. Status of harbor and gray seal populations in northern New England. Final report under NMFS/NER Cooperative Agreement 14-16-009-1557, Woods Hole, Massachusetts. Available from NOAA Fisheries, NEFSC, 166 Water St., Woods Hole, Massachusetts, USA 02543.

Gillespie, D., Berggren, P., Brown, S., Kuklik, I., Lacey, C., Lewis, T., Matthews, J., McLanaghan, R., Moscrop, A., and Tregenza, N. 2003. The relative abundance of harbour porpoises (*Phocoena phocoena*) from acoustic and visual surveys in German, Danish, Swedish and Polish waters during 2001 and 2002. Working paper presented at the 2003 ASCOBANS meeting, 7 pp.

Gillespie, D., Brown, S., Lewis, T., Matthews, J., McLanaghan, R., and Moscrop, A. 2002. Preliminary results on the relative abundance of harbour porpoises (*Phocoena phocoena*) from acoustic and visual surveys in German, Danish, Swedish and Polish waters during summer 2002. IFAW preliminary Report (unpublished). Song of the Whale Research Team, International Fund for Animal Welfare, 87–90 Albert Embankment, London SE1 7UD, UK. 10 pp.

Greve, K. 1909 SÄugtiere Kur-Liv-Estlands.-Riga 184 pp.

Hammond, P.S., Berggren, P., Benke, H., Borchers, D.L., Collet, A., Heide-Jørgensen, M.P., Heimlich, S., Hiby, A.R., Leopold, M.F., and Øien, N. 2002. Abundance of the harbour porpoise and other cetaceans in the North Sea and adjacent waters. Journal of Applied Ecology, 39: 361–376.

Harding, K. and Härkönen, T. 1999 .Development in the Baltic grey seal (*Halichoerus grypus*) and ringed seal (*Phoca hispida*) populations during the 20th century. Ambio, 28: 619–627.

Harding, J.C., Härkönen, T., and Caswell, H. 2002. The 2002 European seal plague: epidemiology and population consequences. Ecology Letters, 5: 727–732.

Härkönen, T., Harding, K., and Heide-Jørgensen, M-P. 2002. Rates of increase in age-structured populations: a lesson from the European harbour seals. Canadian Journal of Zoology, 80: 1498–1510.

Härkönen, T., and Heide- Jørgensen, M.-P. 1990. Density and distribution of the ringed seal in the Bothnian Bay. Holarctic Ecology, 13: 122–129.

Härkönen, T., and Lunneryd, S.G. 1992. Estimating abundance of ringed seals in the Bothnian Bay. Ambio, 21: 497–503.

Härkönen, T., Stenman, O., Jüssi, M., Jüssi, I., Sagitov, R., and Verevkin, M. 1998. Population size and distribution of the Baltic ringed seal (*Phoca hispida botnica*). pp. 167–180 in Lydersen, C. and Heide- Jørgensen, M.-P. Ringed seals (*Phoca hispida*) in the North Atlantic. NAMMCO Scientific Publications, Vol. 1.
Hammill, M.O., Stenson, G.B., Myers, R.A., and Stobo, W.T. 1998. Pup production and population trends of the grey seal (Halichoerus grypus) in the Gulf of St. Lawrence. Canadian Journal of Fisheries and Aquatic Sciences, 55: 423–430.
Harwood, J., Andersen, L.W., Berggren, P., Carlström, J., Kinze, C.C., McGlade, J., Metuzals, K., Larsen, F., Lockyer, C.H., Northridge, S., Rogan, E., Walton, M., and Vinther, M. 1999. Assessment and reduction of the by-catch of small cetaceans (BY-CARE). Final report to the European Commission on FAIR-CT05-0523.
Harwood, J., and Prime, J. H. 1978. Some factors affecting the size of British grey seal populations. Journal of Applied Ecology, 15: 401–411.
Haug, T., Henriksen, G., Kondakov, A., Mishin, V., Nilssen, K.T., and Rρv, N. 1994. The status of grey seals *Halichoerus grypus* in north Norway and on the Murman Coast, Russia. Biological Conservation, 70: 59–67.
Hedley, S.L. 2000. Modelling heterogeneity in cetacean surveys. Thesis submitted for the degree of doctor of philosophy in the School of Mathematics and Statistics, University of St Andrews. August, 2000. 132 pp.
Hedley, S.L., Buckland, S.T., and Borchers, D.L. 1999. Spatial modelling from line transect data. Journal of Cetacean Research and Management, 1: 255:64.
Heide-Jørgensen, M.-P., and Härkönen, T. 1988. Rebuilding seal stocks in the Kattegat-Skagerrak. Marine Mammal Science, 4: 231–246.
Helander, B., and Karlsson, O. 2002. Inventering av grΔs≅l vid svenska _stersj kusten 2001. Naturhistoriska Rimsmusett, Stockholm, Sweden. S≅linformation 2002:1 (In Swedish).
HELCOM. 2001. Conservation and management of seal population in the Baltic. Action Plan for the implementation of the HELCOM Project on Seals. November 2001.
Helle, E. 1980a. Aerial census of ringed seals *Pusa hispida* basking on the ice of the Bothnian Bay, Baltic. Holarctic Ecology, 3: 183–189.
Helle, E. 1980b. Lowered reproductive capacity in female ringed seals (*Pusa hispida*) in the Bothnian Bay, northern Baltic Sea, with special reference to uterine occlusions. Annals Zoologica Fennica, 17: 147–158.
Helle, E. 1985. Ympäristömyrkyt ja Suomen hylkeet. Suomen Riista, 32: 5–21.
Helle, E. 1986. The decrease in the ringed seal population of the Gulf of Bothnia in 1975–84. Finnish Game Research, 44: 28–32.
Helle, E. 1990. Norppakannan kehitus PerÄmerellÄ 1980-luvulla. Suomen Riista, 36: 31–36.
Helle, E., Hyvärinen, H., Pyysalo, H., and Wickström, K. 1983. Levels of organochlorine compounds in an inland seal population in eastern Finland. Marine Pollution Bulletin, 14: 256–260.
Helle, E., Hyvärinen, H., and Sipilä, T. 1981. Yhdestoista hetki saimaanhylkeen suojelussa. Suomen Luonto, 40: 423–425. (Summary: The Saimaa ringed seal - Symbol of successful nature protection measures, or a bitter defeat?)
Helle, E., Hyvärinen, H., and Stenman, O. 1985. PCB and DDT levels in the Baltic and Saimaa seal populations. Finnish Game Research, 44: 63–68.
Helle, E., Olsson, M., and Jensen, S. 1976. PCB levels correlated with pathological changes in seal uteri. Ambio, 5: 5–6.
Helle, E., and Stenman, O. 1990. (Baltic seal populations in 1986–1990) (in Finnish or Swedish with English summary). Maailman Luonnon SÄÄtiön WWF Suomen Rahaston Raportteja 1. 76 pp.
Helminen, M., Karppanen, E., and Koivisto, I. 1968. Saimaannorpan elohopeapitoisuudesta 1967. Suomen Eläinlääkärilehti, 74: 87–89.
Henriksson, K., Karppanen, E., and Helminen, M. 1969. Mercury in inland and marine seals. Nordisk hygienisk tidskrift, 50: 54–59.
Hiby, L., and Lovell, P. 1996. Baltic/North Sea aerial surveys – final report. (Unpublished). 11 pp.
Hiby, L., Lundberg, T., Karlsson, O., and Helander, B. 2001. An estimate of the size of the Baltic grey seal population based on photo-id data. Report to project "Seals and fisheries" Lanstyrelsen I Vasternorrlands Lan and Naturvardsverket. 29-11-2001.
Huber, H.R., Jeffries, S.J., Brown, R.F., DeLong, R.L., and VanBlaricom, G. 2001. Correcting aerial survey counts of harbor seals (*Phoca vitulina richardsi*) in Washington and Oregon. Marine Mammal Science, 17: 276–293.
Huggenberger, S. 1997. Schweinswale (*Phocoena phocoena* L.) der deutschen Nord- und Ostsee. Diplomarbeit der Universitat zu Köln (in German).
Huggenberger, S., Benke, H., and Kinze, C.C. 2002. Geographical variation in harbour porpoise (*Phocoena phocoena*) skulls: support for a separate non-migratory population in the Baltic Proper. Ophelia, 56: 1–12.
Hyvärinen, H., and Sipilä, T. 1992. Saimaannorppa, *Phoca hispida saimensis*. pp 68–71 in Elo, U. (ed.) Maailman Uhanalaiset Eläimet, Suomi, Weiling+Göös, Vantaa.
Hyvärinen, H., Sipilä, T., Kunnasranta, M., and Koskela, J. 1998. Mercury pollution and the Saimaa ringed seal **(***Phoca hispida saimensis)*. Marine Pollution Bulletin, 36: 76–81.
ICES. 2000. Joint report of the Working Group on Marine Mammal Habitats and the Working Group on Marine Mammal Population Dynamics and Trophic Interactions. ICES CM 2000 E:02/G:05. 32 pp.:

ICES, 2001. Report of the Working Group on Marine Mammal Population Dynamics and Habitats. ICES CM 2001/ACE:01.

ICES 2001. ICES CM 2001/ACE:01. Report of the Working Group on Marine Mammal Population Dynamics and Habitats.

ICES, 2002. Report of the ICES Advisory Committee on Ecosystems, 2002. ICES Cooperative Research Report No. 254. 129 pp.

Jacobs, S. R., and Terhune, J. M. 2000. Harbor seal (*Phoca vitulina*) numbers along the New Brunswick coast of the Bay of Fundy in autumn in relation to aquaculture. Northeastern Naturalist, 7: 289–296.

Jääskeläinen, V. 1942. Laatokka kalavetenä. pp. 38–45. *In*: Näsi, V. and Ovaska, E. (eds.) Laatokan mainingit. Laatokan ja sen rannikon elämää sanoin ja kuvin. Otava. Helsinki.

Jeffries, S., Huber, H., Calambokidis, J., and Laake, J. 2003. Journal of Wildlife Management, 67: 208–219.

Jemison, L.A., and Kelly, B. P. 2003. Pupping phenology and demography of harbor seals (*Phoca vitulina richardsi*) on Tugidak Island, Alaska. Marine Mammal Science, 17: 585–600.

Jensen, T., van de Bildt, M., Dietz, H.H., Andersøn T.H., Hammer, A.S., Kuiken, T., and Osterhaus, A. 2002. Another phocine distempter outbreak in Europe. Science, 297:209.

Jηssi, I., and Jηssi, M. 2001. Action plan for grey seals in Estonia 2001–2005. Eesti ulukid/Estonain Game7. 88 pp.

Kinze, C.C. 1985. Intraspecific variation in Baltic and North Sea harbour porpoise (*Phocoena phocoena* (L., 1758)). Videnskabelige Meddelelser Dansk Naturhistorisk Forening, 146: 63–74.

Kock, K.-H. 1997. The by-catch of small cetaceans in the German fisheries in the North Sea and the Baltic in 1996 – preliminary results. Paper SC/49/SM21 (International Whaling Commission).

Kock, K.-H., and Benke, H. 1995. On the by-catch of harbour porpoise (*Phocoena phocoena*) in German fisheries in the Baltic and the North Seas. ICES CM 1995/N:21.

Koivisto, I., and Paasikunnas, Y. 1973. Julkaisemattomia kenttämuistiinpanoja ja karttoja vuosilta 1966–73. (In Finnish, unpublished field notes with maps, years 1966–73.)

Kokko, H., Helle, E., Lindstrom, J., Ranta, E., Sipilä, T., and Courchamp, F. 1999. Backcasting population sizes of ringed and grey seals in the Baltic and Lake Saimaa during the 20th century. Annals Zooligica Fennica, 36: 65–75.

Koschinski, S. 2002. Current knowledge on harbour porpoise (*Phocoena phocoena*) in the Baltic Sea. Ophelia, 55: 167–197.

Kostamo, A., Medvedev, N., Pellinen, J.,H., and Kukkonen, J. 2000. Analysis of organochlorine compounds and extractable organic halogen in three subspecies of ringed seal in Northeast Europe. Environmental Toxicology and Chemistry, 194: 848–854.

Kovacs, K.M., Jonas, K.M., and Welke, S.E. 1990. Sex and age segregation by *Phoca vitulina* concolor at haul out sites during the breeding season in the Passamaquoddy Bay region, New Brunswick. Marine Mammal Science, 6: 204–214.

Kuklik, I., and Skóra, K.E. 2003 (in press). By-catch as a potential threat for harbour porpoise (*Phocoena phocoena* L.) in the Polish Baltic Waters. NAMMCO Scientific Publications.

Larsen, F., Eigaard, O.R., and Tougaard, J. 2002b. Reduction of harbour porpoise bycatch in the North Sea by high-density gillnets. Paper presented to the Scientific Committee of the International Whaling Commission, Shimonoseki, May 2002, SC/54/SM30. 12 pp.

Lindroth, A. 1962. Baltic salmon fluctuations 2: porpoise and salmon. Report of the Institute of Freshwater Research, Drottningholm, 44: 105–112.

Lunneryd, S.G., and Westerberg, H. 1997. By-catch of and gear damages by grey seal (*Halichoerus grypus*) in Swedish waters. ICES CM:1997/Q11. 10 pp.

Mangel, M., Talbot, L.M., Mefee, G.K., Agardy, M.T., Alverson, D.L., Barlow, J., Botkin, D.B., Budowski, G., Clark, T., Cooke, J., Crozier, R.H.P., Dayton, I.K., Elder, D.L., Fowler, C.W., Funtowicz, S., Giske, J., Hofman, R.J., Holt, S.J., Kellert, S.R., Kimball, L.A., Ludwig, D., Magnusson, K., Malayang III, B.S., Mann, C., Norse, E.A., Northridge, S.P., Perrin, W.F., Perrings, C., Peterman, R.M., Rabb, G.B., Regier, H.A., Reynolds III, J.E., Sherman, K., Sissenwine, M.P., Smith, T.D. , Starfield, A., Taylor, R.J., Tillman, M.F., Toft, C., Twiss, Jr., J.R., Wilen, J., and Young, T.P. 1996. Principles for the conservation of wild living resources. Ecological Applications, 6: 338–362.

Marttinen, A. 1946. Mikä on Saimaan hylkeen kohtalo. Metsästys ja kalastus 1946: 116–118.

Mattson, M., and Helle, E. 1995. Reproductive recovery and PCBs in Baltic seal populations. Eleventh Biennial Conference on the Biology of Marine Mammals 14–18 December 1995, Orlando, Florida, U.S.A. Abstracts. p. 74.

Medvedev, N., Sipilä, T., Hyvärinen, H., and Kunnasranta, M. 1996. Proposals for the protection of the Ladoga seal. In: V. Simile, M. Viljanen and T. Sepukhina, eds. Proceedings of the second international Lake Ladoga Symposium 1996. Univ of Joensuu publications of Karelian Institute No. 117. Joensuu. 302 pp.

Morizur, Y., Berrow, S. D., Tregenza, N.J.C., Couperus, A.S., and Pouvreau, S. 1999. Incidental catches of marine-mammals in pelagic trawl fisheries of the Northeast Atlantic. Fisheries Research, 41:297–307.

Mortensen, P., Bergman, A., Bignert, A., Hansen., H.J., Härkönen, T., and Olsson., M. 1992. Prevalence of skull lesions in harbour seals *Phoca vitulina* in Swedish and Danish museum collections during 1835–1988. Ambio, 21: 520–524.

Northridge, S.P. 1996: A review of marine mammal by-catch observer schemes with recommendations for best practice. JNCC Report No. 219, Aberdeen, UK.

Nyman, M., Raunio, H., Taavistainen, P., and Pelkonen, O. 2001Caracterization of xenobiotic metabolizing cytochrome P450 (CYP) forms in ringed and grey seals from the Baltic Sea and reference sites. Comparative Biochemistry and Physiology. Part C. Toxicology and pharmacology, 128: 99–112.

Pitcher, K.W. 1990. Major decline in number of harbor seals, *Phoca vitulina richardsi*, on Tugidak Island, Gulf of Alaska. Marine Mammal Science, 6: 121–134.

Read, A.J. 2000. Potential mitigation measures for reducing the by-catches of small cetaceans in ASCOBANS waters. Report to ASCOBANS, December 2000. Duke University, North Carolina. 34pp. + appendices.

Reeves, R.R. 1998. Distribution, abudance and biology of the ringed seals (*Phoca hispida*): an overview. pp 9–45. *In* Heide-Jørgensen, M.-P. and Lydersen, C. (eds.) Ringed seals in the North Atlantic. NAMMCO Scientific Publication 1.

Reijnders. P.J.H. 2003. Newsletter of the Waddensea Secretariat. Available at http://www.waddensea-secretariat.org.

Reijnders, P.J.H., Ries, E. H, Tougaard, S., Nρrgaard, N., Heidemann, G., Schwartz, J., Vareshi, E., and Traut, I. M. 1997. Population development of harbor seals *Phoca vitulina* in the Wadden Sea after the 1988 virus epizootic. Journal Sea Research, 38: 161–168.

Reineking, B. 2002. Information on Dead Seals in the Kattegat/Skagerrak Area, the Wadden Sea and the North Sea in 2002. No. 44, dated 6 December 2002. Information compiled by Common Wadden Sea Secretariat, and available at http://www.waddensea-secretariat.org.

Rezvov, G. 1975. On the distribution of pupping ringed seals in the Gulf of Finland and its dependence on the severity of winters. Marine Mammals, Kiev, 2: 73–74. (In Russian).

Ries, E.H., Hiby, A.R., and Reijnders, P.J.H. 1998. Maximum likelihood population size estimation of harbour seals in the Dutch Wadden Sea based on a mark-recapture experiment. Journal of Applied Ecology, 35: 332–339.

Rogan, E., and Mackey, M. J. 1999. Cetacean by-catch in a driftnet fishery for Albacore tuna in the Celtic Sea. European Research on Cetaceans Astracts, 13: 135.

Ropelewski, A. 1957. The common porpoise (*Phocaena phocaena* L.) as a by-catch in Polish Baltic fisheries. Prace Morskiego Instytutu Rybackiego, 9: 427–437. (in Polish).

Scheidat, M., Kock, K.-H., and Siebert, U. 2003.Summer distribution of harbour porpoise (*Phocoena phocoena*) in the German North and Baltic Sea. Working paper presented at the 2003 ASCOBANS meeting. 13 pp.

SGFEN. 2002a. Incidental catches of small cetaceans. Report of the meeting of the subgroup on fishery and the environment (SGFEN) of the Scientific, Technical and Economic Committee for fisheries (STECF), Brussels, 10–14 December 2001. SEC (2002) 376.

SGFEN. 2002b. Incidental catches of small cetaceans. Report of the second meeting of the subgroup on fishery and the environment (SGFEN) of the Scientific, Technical and Economic Committee for fisheries (STECF), Brussels, 11–14 June 2002. SEC (2002) 1134.

Siebert, U., Joiris, C., Holsbeek, L., Benke, H., Failing, K., Frese, K., and Petzinger, E. 1999. Potential relation between mercury concentrations and necropsy findings in cetaceans from German waters of North and Baltic Seas. Marine Pollution Bulletin, 38: 285–295.

Sipilä, T. 1981 Saimaanhylkeen suku sammuu. Pohjois-Karjalan Luonto 11(1): 21–23.

Sipilä, T. 1983. Saimaanhyljetutkimus, tutkimusraportti 1981–1982. Laudatur – Erikoistyö, Joensuun korkeakoulu, Biologian laitos. 68 pp.

Sipilä, T. 1990. Lair structure and breeding habitat of the Saimaa ringed seal. (*Phoca hispida saimensis*) Finnish Game Research, 47: 11–20.

Sipilä, T. 1991. Saimaanhyljealueiden suojelutavoitteet. WWF Suomen Rahaston Raportti No. 5. WWF, Helsinki. 82 pp.(English summary: Proposals for protection of Saimaa ringed seal breeding areas).

Sipilä, T. 1992. Saimaannorpan (*Phoca hispida saimensis* Nordq.) pesintä-, populaatio- ja suojelubiologiasta. Lisensiaatintutkielma, Biologian laitos, Joensuun yliopisto. 45 pp.

Sipilä, T. 1994. Saimaannorppa, alkuperäinen savolainen. pp 91–94 in: Tahvanainen, P. (ed.) Ympäristön tila Mikkelin läänissä. Vesi- ja ympäristöhallitus, Helsinki. (in Finnish).

Sipilä, T. 2003. Conservation biology of Saimaa ringed seal (Phoca hispida saimensis). Section of PhD thesis.

Sipilä, T. Helle, E., and Hyvärinen, H. 1990. Distribution population size, and reproductivity of the Saimaa ringed seal (*Phoca hispida saimensis* Nordq.) in Finland 1980–84. Finnish Game Research, 47: 3–10.

Sipilä, T., and Hyvärinen, H. 1998. Status and biology of Saimaa (*Phoca hispida saimensis*) and Ladoga (*Phocahispida ladogensis*) ringed seals. *In* Heide-Jørgensen, M.-P. and Lydersen, C. (eds.) Ringed seals in the North Atlantic. NAMMCO Scientific Publication, 1: 83–99.

Sipilä, T., Hyvärinen, H., and Medvedev, N. 1996. The Ladoga seal (*Phoca hispida ladogensis* Nordq.). Hydrobiologia, 322: 192–198.

Sipilä, T., Koskela, J. T., and Hyvärinen, H. 1999. Mortality of the Saimaa seal (*Phoca hispida saimensis*). Pp 174 in Abstracts 13th Biennnial Conference on Biology of Marine Mammals, Wailea, HI, 28 Nov–28 Dec. The Society for Marine Mammalogy.

Sipilä, T., Koskela, J. T. and Hyvärinen, H. 2002a. Mortality in the Saimaa ringed seal (*Phoca hispida saimensis*) population. Unpublished manuscript, available from T. Sipilä (see Annex 1).

Sipilä, T., Medvedev, N., Kunnasranta, M., Bogdanov, V., and Hyvärinen, H. 2002b. Present status and recommended conservation actions for the Ladoga seal (*Phoca hispida ladogensis*) population.WWF Suomen Rahaston Raportti No. 15. WWF, Helsinki. 30 pp.

Smith, T.G. 1987. The ringed seal, *Phoca hispida*, of the Canadian Western Arctic. Canadian Bulletin of Fisheries and Aquatic Science 216: 81 pp.

Stanley, H.F., Casey, S., Carnahan, J.M., Goodman, S., Harwood, J., and Wayne, R.K. 1996. Worldwide patterns of mitochondrial DNA differentiation in the harbour seal (*Phoca vitulina*). Molecular Biology and Evolution, 13: 368–382.

Stenman, O., and Westerling, B. 1995: Status of the seal population in the eastern Gulf of Finland, and a possible role for the UNESCO BFU in assisting the International Baltic Research Programme. BFU Research Bulletin March 1995: 21–22.

Steward, B.S. 1984. Diurnal hauling patterns of harbor seals at San Miguel Island, California. Journal of Wildlife Management, 48: 1459–1461.

Stobo, W. T., and Fowler, G. M. 1994. Aerial surveys of seals in the Bay of Fundy and off southwest Nova Scotia. Canadian Technical Report of Fisheries and Aquatic Sciences 1943.

Stobo, W.T., and Zwanenburg, K.C.T. 1990. Grey seal (Halichoerus grypus) pup production on Sable Island and estimates of recent production in the northwest Atlantic. *In* W. D. Bowen (ed.), Population biology of sealworm (*Pseudoterranova decipiens*) in relation to its intermediate and seal hosts. Canadian Bulletin of Fishies and Aquatic Sciences, 222: 171–184.

Teilmann, J., Dietz, R., Larsen, F., Desportes, G., and Geertsen, B. 2003. Seasonal migrations and population structure of harbour porpoises (*Phocoena phocoena*) in the North Sea and Inner Danish waters based on satellite telemetry. ECS Conference, Las Palmas de Gran Canaria, March, 2003. Abstract.

Teilmann, J., and. Lowry, N. 1996. Status of the harbour porpoise (*Phocoena phocoena*) in Danish waters. Report of the International Whaling Commission, 46: 619–625.

Thompson, P.M., and Harwood, J. 1990. Methods for estimating the population size of common seals, *Phoca vitulina*. Journal of Applied Ecology, 27: 924–938.

Thompson, P.M., Fedak, M.A., McConnell, B.J., and Nicholas, K.S. 1989. Seasonal and sex-related variation in the activity patterns of common seals (*Phoca vitulina*). Journal of Applied Ecology, 26: 521–535.

Thompson, P., and Rothery, P. 1987. Age and sex differences in the timing of the moult in the common seal, *Phoca vitulina*. Journal of Zoology, London 212: 597–603.

Thompson, P.M., Tollit, D.J., Wood, D., and Corpe, H.M. 1997. Estimating harbour seal abundance and status in an estuarine habitat in north-east Scotland. Journal of Applied Ecology, 34: 43–52.

Thompson, P.M., Tollitt, D.J., Wood, D., Corpe, H.M., Hammond, P.S., and Mackay, A.1997. Estimating harbour seal abundance and status in an estuarine environment in north-east Scotland. Journal of Applied Ecology, 34: 43–52.

Thompson, P.M., van Parijs, S., and Kovacs, K.M. 2001. Local declines in the abundance in harbour seals: implications for the design and monitoring of protected areas. Journal of Applied Ecology, 38: 117–125.

Tiedemann, R., Harder, J., Gmeiner, C., and Haase, E. 1996. Mitochondrial DNA patterns of harbour porpoises (*Phocoena phocoena*) from the North and the Baltic Sea. Zeitschrift für Säugetierkunde, 61: 104–111.

Tolley, K.A., Rosel, P.E., Walton, M., Bjørge, A., and Øien, N. 1999. Genetic population structure of harbour porpoise (*Phocoena phocoena*) in the North Sea and Norwegian waters. Journal of Cetacean Research and Management, 1(3): 265–274

Tormosov, D. D., and Rezvov, G.V. 1978. Information on the distribution, number and feeding habits of ringed and grey seals in the Gulfs of Finland and Riga in the Baltic Sea. Finnish Game Research, 37: 14–17.

Tormosov *et al*. unpublished field notes available to: Härkönen, T., Stenman, O., Jüssi, M., Jüssi,, I, Sagitov, R. and Verevkin, M. 1998. Population size and distribution of the Baltic ringed seal (*Phoca hispida botnica*). pp. 167–180 in Lydersen, C. and Heide- Jørgensen, M.-P. Ringed seals (*Phoca hispida*) in the North Atlantic. NAMMCO Scientific Publications, Vol. 1

Tregenza, N.J.C., Berrow, S.D., Hammond, P.S., and Leaper, R. 1997. Harbour porpoise (*Phocoena phocoena*) bycatch in set gillnets in the Celtic Sea. ICES Journal of Marine Science, 54: 896–904.

Tregenza, N.J.C., and Collet, A. 1998. Common dolphin (*Delphinus delphis*) bycatch in pelagic trawl and other fisheries in the northeast Atlantic. Reports of the International Whaling Commission, 48: 453–459.

Vinther, M. 1999. Bycatches of harbour porpoises (*Phocoena phocoena* L.) in Danish set-net fisheries. Journal of Cetacean Research and Management, 1: 123–135.

Vinther, M., and Larsen, F. 2002. Updated estimates of harbour porpoise by-catch in the Danish bottom set gillnet fishery. Paper presented to the Scientific Committee of the International Whaling Commission, Shimonoseki, May 2002, SC/54/SM31. 13 pp.

Wang, J.Y., and Berggren, P. 1997. Mitochondrial DNA analysis of harbour porpoises (*Phocoena phocoena*) in the Baltic Sea, the Kattegat-Skagerrak Seas and off the west coast of Norway. Marine Biology, 127: 531–537.

Watts, P. 1996. The diel hauling-out cycle of harbour seals in an open marine environment: Correlates and constraints. Journal of Zoology, London 240: 175–200.

Westerling, B., and Stenman, O. 1992. Hälsotillståndet hos sälbestånden i Östersjön. VeterinÄren och den yttre miljön. Nordisk kommitte för veterinärvetenskapligt samarbete 7:e symposiet 1–2 oktober 1992, Wik, Uppsala. 77–83. (In Swedish).

Yoccoz, N.G. 2001. Trends in Ecology and Evolution, 16: 446–453.

Zwanenberg, K.C.T., and Bowen, W.D. 1990. Population trends of the grey seal (*Halichoerus grypus*) in eastern Canada. Pgs. 185–197 *in* : W. D. Bowen (ed.), Population biology of sealworm (*Pseudoterranova decipiens*) in relation to its intermediate and seal hosts. Canadian Bulletin of Fishies and Aquatic Sciences, 222.

18 Annexes

Annex 1 List of participants

Name	Address	Telephone no.	Fax no.	E-mail
Luis Arregi	AZTI Fisheries and Food Technological Institute Txatxarramendi ugartea z/g 48395 Sukarrieta Spain	+34 94 602 9400	+34 94 687 0006	larregi@suk.azti.es
Peter Corkeron	Institute of Marine Research, Tromsø N-9291 Tromsø Norway	+47 77 62 9229	+47 77 62 9100	peter.corkeron@imr.no
Tero Härkönen	Naturhistoriska Riksmuseet Stocholm Box 50007 S-104 05 Stockholm Sweden	+46 303 226927	+46303221723	tero.karin.h@swipnet.se
Ivar Jüssi	Dept. of Nature Conservation Ministry of Environment Toompuiestee 24 Tallinn, Estonia, 15172	+372 50 28313	+3726262901	ijussi@online.ee
Mart Jüssi	Institute of Zoology & Hydrobiology University of Tartu Vanemuise 46 EE51014 Tartu, Estonia	+372 5053732	+3727375830	mart@elfond.ee
Olle Karlsson	Naturhistoriska Riksmuseet Stocholm Box 50007 S-104 05 Stockholm Sweden	+46 158 12907	No fax	pholidae@algonet.se
Iwona Kuklik	Hel Marine Station University of Gdansk P.O. Box 37, Morska 2 84-150 Hel Poland	+48 58 6751 316	+48 58 6750 420	oceik@univ.gda.pl
Finn Larsen	Danish Institute for Fisheries Research Department of Marine Fisheries Charlottenlund Castle DK-2920 Charlottenlund Denmark	+45 33 96 34 68	+45 33 96 33 33	fl@dfu.min.dk
Mette Mauritzen	Division of Resource Ecology Institute of Marine Research Postboks 1870 Nordnes 5817 Bergen Norway	+47 55 238608	+47 55 238617	mette.mauritzen@imr.no
Simon Northridge	Sea Mammal Research Unit Gatty Marine Lab University of St Andrews St Andrews KY16 8LB United Kingdom	+44 1334 462654	+44 1334 462632	spn1@st-andrews.ac.uk

Name	Address	Telephone no.	Fax no.	E-mail
Meike Scheidat	Forschungs- und Technologiezentrum Westküste (FTZ) Universität Kiel Hafentörn 25761 Büsum Germany	+49 4834 604118	+49 4834 604199	scheidat@ftz-west.uni-kiel.de
Tero Sipilä	Natural Heritage Services Finnish Forest and Park Service Akselinkatu 8 57130 Savonlinna Finland	+358 205 645912	+358 201 645901	tero.sipila@metsa.fi
Krzysztof Skóra	Hel Marine Station University of Gdansk P.O. Box 37, Morska 2 84-150 Hel Poland	+48 58 6751 836	+48 58 6750 420	skora@univ.gda.pl
Mark L. Tasker	Joint Nature Conservation Committee Dunnet House 7 Thistle Place Aberdeen AB10 1UZ United Kingdom	+44 1224 655701	+44 1224 621488	mark.tasker@jncc.gov.uk
Gordon T. Waring (Chair)	NOAA Fisheries, Northeast Fisheries Science Center 166 Water Street Woods Hole MA 02543 USA	+1 508 495 2311	+1 508 495 2258	gwaring@whsun1.wh.whoi.edu
Håkan Westerberg	National Board of Fisheries Box 423 SE 40126 Göteborg Sweden	+46317430333	+46317430444	hakan.westerberg@fiskeriverket.se