Symposium on Biology and Management of Seals in the Baltic area

15 –18 February 2005
Helsinki

Riista- ja kalatalouden tutkimuslaitos

ISBN 951-776-105-8
ISSN 1238-3325

Preface

The present **Symposium on the Biology and Management of Seals in the Baltic Area** is part of the series of meetings which began in 1974 at Lidingö, Sweden, a good 30 years ago. Since then, symposia have been held in Haikko, Finland, in 1977, in Konstancin, Poland, in 1980, in Savonlinna, Finland, in 1984, in Nyköping, Sweden, in 1994, in Pärnu, Estonia, in 1999, and now, for the seventh time, in Helsinki. From the very beginning, a common opinion prevailed that issues concerning seals living around the Baltic Sea and in the two adjacent lakes deserved a meeting forum of their own, as many topics and circumstances are different from those applying to the oceans and oceanic seal populations.

The need for this Symposium has not disappeared, because the issue of seals in the Baltic area has received wide publicity due to large changes in the population numbers, which are increasingly linked with human activities. There is an urgent need to update our knowledge on the state of seal populations, research and management.

This Symposium was originally planned to take place in Russia, which had become more active in seal research and has important seal stocks in its territory. However, it was announced in the spring of 2004, that the plan to meet in Russia could not be arranged on the date that had been agreed. It was considered very important to stick to the timetable, however, so Finland took responsibility for organizing this Symposium. The Symposium has been arranged at very short notice, the first invitations were only delivered in late October 2004. We would like to thank all participants for contributing with such short warning.

The Finnish Game and Fisheries Research Institute is the main organizer of the Symposium, as has been the case for the two earlier Symposia arranged in Finland. The main organizers have discussed the meeting with a large number of colleagues, and we were aided at the later stages by the programme group, namely Olle Karlsson from Sweden, Ivar Jüssi from Estonia, Michail Verevkin from Russia and Antti Halkka from Finland. We want to express our warmest thanks for their help.

We consider this Symposium to be scientific, but we also wanted to give floor time to participants involved with on-going work as well as to hear reports on management issues. To our great pleasure, we will hear a greater number of contributions dealing with seal – man relations than in the earlier Symposia.

The abstract booklet is also available on the web at: www.rktl.fi.

Eero Helle, head of the organizing team

Symposium on Biology and Management of Seals in the Baltic area

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Programme

15.2.	10:00 -	Registration & accommodation
	13:15	Opening of the Symposium
		1st Session: Abundance and monitoring of seal numbers
	13:30	Numbers of grey seals counted in censuses in the Baltic Sea, 2000 – 2004 *Antti Halkka, Eero Helle, Björn Helander, Ivar Jüssi, Mart Jüssi, Olle Karlsson, Martti Soikkeli, Olavi Stenman and Mikhail Verevkin*
	14:00	Development of the Swedish Baltic grey seal stock 1990-2004 *Olle Karlsson and Björn Helander*
	14:30	Numbers and occurrence of grey seals in the Finnish sea area in the years 1970 – 2004 *Olavi Stenman, Antti Halkka, Eero Helle, Seppo Keränen, Jukka Nummelin, Martti Soikkeli, Torsten Stjernberg and Antti Tanskanen*
	15:00	Coffee
	15:30	The ringed seal in the Archipelago Sea, SW Finland: population size and survey techniques *Mika Miettinen, Antti Halkka, Jouko Högmander, Seppo Keränen, Anita Mäkinen, Mikael Nordström, Jukka Nummelin and Martti Soikkeli*
	16:00	Numbers and occurrence of ringed seals in the Gulf of Finland in the years 1997 – 2004 *Olavi Stenman, Michail Verevkin, Lilia Dmitrieva and Roustam Sagitov*
	16:30	Seal monitoring in Latvia: 1999-2004 *Evalds Urtans, Nikolajs Liskins and Valdis Pilats*
	17.00	Break
	17:10	Occurrence of seals in Poland in recent years *Iwona Kuklik and Krzysztof E. Skóra*
	17:40	Seals in the Lithuanian territorial waters *Arûnas Gruðas and Pavel Kulikov* *(see also Dinter et al.)*
16.2.		**1st Session continues**
	9:00	Analysis of spatially distributed photo-identification data to estimate the size of the Baltic grey seal population *Lex Hiby, Torkel Lundberg, Olle Karlsson, John Watkins, Mart Jüssi, Ivar Jüssi and Björn Helander*
	9:30	Spatial differences in the changes of population size of the Saimaa ringed seal *Tero Sipilä, Jouni T. Koskela and Tuomo S. Kokkonen*
	10:00	Extinction of Greenland seals in the Baltic as a result of holocene climatic variability: a study using historical knowledge and satellite SAR survey *Vladimir V. Melentyev*
	10:30	Break

16.2. **2nd Session: Behaviour and ecology**

11:00 Underwater behaviour of Saimaa ringed seals during the nursing season
Anni Rautio, Jorma Sorjonen, Ismo J. Holopainen, Heikki Hyvärinen, Juha Taskinen, Markku Viljanen and Mervi Kunnasranta

11:30 Ice as abiotic factor of ecology of grey seals in the Baltic: joint analysis of tagging and satellite SAR data
Vladimir V. Melentyev, Olle Karlsson and Mikael Sjöberg

12:00 Distribution of haul outs of Ladoga ringed seals on the islands of the Valaam Archipelago in summer
Elena Agafonova, Tero Sipilä, Maria Sokolovskaia, Vlada Shahnozarova, Mikhail Verevkin

12:30 Lunch

13:30 Food remains in the alimentary tracts of Baltic grey and ringed seals
Olavi Stenman and Outi Pöyhönen

13:50 Diet of grey seals in the Baltic Sea assessed from hard-part prey remains
Karl Lundström, Olle Hjerne, Karin Alexandersson and Olle Karlsson

14:10 Diet of the Ladoga ringed seal – a pilot study
Olavi Stenman, Outi Pöyhönen and Tero Sipilä

14:30 "It's not the seals that are threatened today, it's the coastal fishermen"
Sven Gunnar Lunneryd

14:50 By-catch of seals in Swedish commercial fisheries
Sven Gunnar Lunneryd and Sara Königson

15:10 Coffee

16.2. **3rd Session: Pathology, physiology, anatomy, toxins**

15:30 Pathology of seals from the Finnish coastal waters, lake Saimaa and lake Ladoga in the years 1982 – 2004
Bengt Westerling, Olavi Stenman and Eeva Rudbäck

16:00 Increased prevalence of intestinal ulcers in Baltic grey seals
Britt-Marie Bäcklin and Anders Bergman

16:30 Reproductive capacity of grey and ringed seal females in Finland
Eero Helle, Madeleine Nyman and Olavi Stenman

17:00 Health status of grey seals in Latvian coastal waters
Nikolajs Liskins and Valdis Pilats

(see also Dinter et al.)

17.2. **3rd Session continues**

9:00 Grey seals use vision rather than olfaction when they locate baited buoys representing fishing gear
Arne Fjälling, Jenny Kleiner and Magdalena Beszczynska

9:30 Magnetic resonance imaging in the study of the Saimaa ringed seal anatomy
Taina Usenius, Anne-Mari Mustonen, Jussi-Pekka Usenius, Heikki Hyvärinen, Tero Sipilä, Jouni T. Koskela and Petteri Nieminen

10:00 Break

10:15 Vertical chemical profile of seal blubber
Ursula Strandberg, Anne Käkelä, Christian Lydersen, Kit Kovacs, Tero Sipilä, Jouni Koskela, Otto Grahl-Nielsen, Heikki Hyvärinen and Reijo Käkelä

10:45 Contaminant burden, biomagnification and biomarkers in the Baltic seals
Madeleine Nyman, Heli Routti, Jaana Koistinen, Christina Bäckman and Eero Helle

11:15 Lunch

17.2. **4th Session: Interactions between seals and man**

12:30	Vendace as a resource for fishery and the Saimaa ringed seal. *Juha Jurvelius, Heikki Auvinen, Tero Sipilä and Jouni Koskela*
13:00	Grey seals and salmon set trap fisheries in the Baltic sea *Arne Fjälling*
13:30	Seal-fisheries interactions in lake Ladoga *Mikhail Verevkin and Tero Sipilä*
14:00	Mitigation of seal damages by improved fishing technology *Petri Suuronen, Antti Siira, Esa Lehtonen, Raimo Riikonen, Hannu Harjunpää and Tiina Kauppinen*
14:30	Coffee
15:00	The Voluntary Logbook for Seal & Bird Damages in the Swedish Coastal Fisheries *Susanne Tärnlund*
15:30	Commercial fishermen's conceptions about protection areas for seals *Pekka Salmi, Eila Seppänen and Anssi Ahvonen*
16:00	The losses in the Finnish aquaculture caused by seals in 2003 *Pentti Moilanen, Riitta Savolainen and Anssi Ahvonen*
16:30	Break
16:45	The influence of human disturbances on behaviour of Ladoga ringed seals on haul outs *Elena Agafonova, Tero Sipilä, Maria Sokolovskaia, Vlada Shahnozarova and Mikhail Verevkin*
17:15	Experience of application of satellite SAR for ice monitoring and prevention of mass destruction of seals resulted in ship traffic *Vladimir V. Melentyev and Vladimir I. Chernook*

18.2. **5th Session: Management**

9:00	Project "Grey seal in the Kvarken region" *Anita Storm*
9:30	Reports on managing seals in different countries
10:30	Break
10:45	Discussion on management continues
12:00	Closing of the Symposium

Distribution of haul outs of Ladoga ringed seals on the islands of the Valaam Archipelago in summer

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Ladoga ringed seal haul outs on the islands of the Valaam Archipelago were studied and number of animals was counted in the summers of the 2001-2004. In June through August, the haul outs and the number of seals on each was registered every 3-4 days. At the same time, meteorological data such as wind speed and direction, wave height and direction, air temperature and rainfall were collected.

In all three years of the study the highest number of days seals hauled out on islets and rocks off the shores of islands, and highest number of the seals on the haul outs were registered in June. On some days the number of the Ladoga ringed seal in the study area reached 600-650 animals. In June, and almost in every count, haul outs were registered on the islands of Zapadniy Sosnoviy and Vostochniy Sosnoviy, Krainiy, Lisiy and Krestoviy. In 2002 and 2003 haul outs of up to 100 animals were registered regularly on the islands of Bolshoi Baioniy and Lembos. In 2004 there were no haul outs on these islands due to the disturbance caused by the building activities at the Valaam Monastery on Lembos.

The probability of seal haul outs forming in July and August varied from year to year. In spite of several storms in 2004, haul outs of 10 to 400 animals were registered regularly on the shoreline stones of islands. The same was observed in August of 2001. The presence of seals in this area in July and August is probably closely associated with an abundance of fish, especialle whitefish. In 2001 and 2004, a sharp increase in the catch of whitefish by fishermen was registered. During seals count crowding flocks of seals, gulls and terns revealed 8-17 schools of whitefish in the waters of the archipelago. In July and August of 2003 there were few seals on the islands and islets, and in the surrounding waters. Only on three occasions more than 80 seals were observed, and the catch of whitefish in the Valaam archipelago was small.

The character of seal hauling out on the archipelago islands varies through the summer. In June the majority of animals (57-100%) haul out on the small islands, which are most distant from Valaam, such as Krainiy, Lisiy and Krestoviy, and on islets near them. On the islands Zapadniy Sosnoviy and Vostochniy Sosnoviy haul outs also are continously observed in June, but the number of seals on these haul outs is relatively small. In July and August the number hauling out on small islands exposed to storms typical for late summer. During storms, the haul outs are mostly formed on Sosnoviy island, which has suitable shores for seals hauling out protected from any wind direction.

The influence of human disturbances on behaviour of Ladoga ringed seals on haul outs

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In June of 2003 and 2004 the behaviour of Ladoga ringed seals was studied on Sosnoviy Island in the Valaam Archipelago. From 5 a.m. to 12 p.m. the number and distribution of seals on the haul out site on the beach were registered every 10 minutes. During these 10-minutes intervals all landings, departures and conflicts between the seals were registered. The reasons for departure and the process of re-formation of the haul out were described.

The number of seals on the haul outs is continuously changing, mostly due to small (1-10% or sometimes up to 30%) numbers of seals coming and going. The movements are usually caused by conflicts between seals, birds passing, sudden wave splashes etc. Mass departures are in 70% of cases caused by human disturbances, such as sounds of engines, ships passing, noise of helicopters, bells ringing, smoke etc. In these situations all seals escape to the water.

The time of re-formation of the haul outs and the behavior of the seals are quite different in cases of small movements and after mass departures. After small disturbances the seals return within 10-30 min, and the number of conflicts between intruders and hauling animals does not increase. After mass departures the process of re-formation of the haul outs is prolonged. In most cases it takes several hours for all the seals to return. Seals often hesitate on landing, and may go back into water several times before settling on the stones close to the shore.

During re-formation of the haul out after a mass departure there is a sharp increase in interrupted landing attempts accompanied with conflicts between the seals. Furthermore, alarm is signalled more often, and the number of seals reacting to these signals increases. In such situations mass repetition of alarm signals by the seals in the water is widespread, and seals on shore are prone to respond to the alarm signals.

Thus, we can conclude that human disturbance not only leads to a great drop in the number of seals hauling out, but also seriously influence their level of wariness and aggressiveness.

Increased prevalence of intestinal ulcers in Baltic grey seals

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A severe decrease in the number of Baltic seals was observed in the middle of the 1900s. At the end of the 1960s, the Baltic biota was found to be highly polluted by the organochlorines PCB and DDT. Pathological changes representing a disease complex in ringed and grey seals were described in the 1980s. In the 1970s PCB and DDT concentrations decreased, and in the middle of the 1980s an increase in numbers of grey seals was observed. The prevalence of most pathological changes belonging to a disease complex observed in the 1970s and 1980s in grey seals has decreased during the last 15 years but that of intestinal ulcers has increased. These are localised in the ileum, caecum and colon. The size of the ulcers vary from a few millimetres in diameter to extended ones occupying large parts of ileum and colon. Hookworms almost always occur, to a more or less extent, in or around affected areas. Lesions of a more deep nature are localised to the anterior part of the colon. In such cases, when the ulcerous process has reached the muscular tunic the serosal lining may show chronic inflammation with fibrinous or fibrous adherences between the intestinal portion and closely situated abdominal organs. Earlier and recent haemorrhages then are common in the affected area. At this stage perforation of the intestinal wall is common. This lesion is, next to drowning, the most common cause of death in Baltic grey seals examined at the Swedish Museum of Natural History. Death from colonic ulcer occurs at all ages but has not been observed in seals younger than oneyear. In the statistics, the prevalence of colonic ulcers of moderate and severe degree i.e. lesions exceeding 10 mm in diameters has been calculated. The prevalence of intestinal ulcers is similar in by-caught grey seals and in grey seals obtained by hunting. Furthermore, there is a geographical difference in prevalence of this lesionwithin the Baltic Sea. It is a significantly more common finding in the Gulf of Bothnia compared to that of the southern part of the Baltic Sea. According to the literature, only one case of intestinal ulcer in grey seals has been reported outside the Baltic Sea. The overall high prevalence seems to be unique for the Baltic population of grey seals.

Grey seals and salmon set trap fisheries in the Baltic Sea

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A database was built using detailed information on catches and seal-disturbance from contracted commercial fishermen in the northern Baltic Sea. A model was developed for the calculation of seal-induced losses in set traps for salmon. The model compared catches on consecutive days or day-pairs. It was found that the total losses in set traps were high: 61% of the potential catch in a trend-adjusted sample of paired data. A significant part of these losses was hidden, such as fish wholly removed from gear. The traditional method of assessing losses by counting fish remains was found to underestimate losses. The scaring effect of seal visits was not included. The model was also used for an analysis of the damage process. It was found that there were significant negative after-effects of seal visits on catch levels and that seal damage was correlated with rising catches. It was indicated that seals prefer smaller salmon to large when raiding traps. It was suggested that the traditional method of estimating losses by counting fish remains should be calibrated when used and that the new model with day-pairs should be tried in analyses of seal interference in other fishing operations.

Presented at the symposium

Report on the situation regarding seals on the German Baltic Sea coasts

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Population status

Grey and common seals had been breeding on the Baltic Sea coasts of Germany until roughly about 1900. Although species had not been distinguished in most reports of those times it can be assumed that grey seals were more common in the eastern part of Mecklenburg-Vorpommern state (and West-Poland) whereas common seals had a higher abundance in the western parts of Mecklenburg-Vorpommern and in Schleswig-Holstein state.

In those times bounties had been paid for killing seals as being declared fisheries enemies, although no species discrimination had been done in the respective statistics in most cases. Due to this campaign of seal eradication the last autochthonous seals vanished in the 1920s.

Grey seals (*Halichoerus grypus*): A pair of grey seals is living permanently in a coastal lagoon system (Darß-Zingster-Boddenkette) in Mecklenburg-Vorpommern since 1968. They had at least one pup (found dead in 1978). In the period 1951-2004 there had been reported observations of at least 137 grey seals on the coast of Mecklenburg-Vorpommern, mostly in the regions east of Rostock. In the last four years grey seals from Denmark, Sweden, and Poland tagged with satellite transmitters moved to the coasts of Mecklenburg-Vorpommern where they stayed from several days to several months.

Common seals (*Phoca vitulina*): Since 1991 also common seals occur more frequently mainly in the regions west of Rostock. In the period 1979-2004 at least 58 common seals have been observed only in Wismar-Bay and 4 new-born common seals were found: 2 on the island Greifswalder Oie in 1999 and 2001, and 2 in Wismar-Bay in 1992 and 2004. Also tagged common seals from Rødsand/Denmark showed to move into German waters, mostly into Mecklenburg-Bight.

Ringed seal (*Phoca hispida*): A single ringed seal has been reported repeatedly to stay in the area of the Stralsund from August 2004 until now.

The German Oceanographic Museum in Stralsund has been collecting information on occurrence, strandings, and by-catch of marine mammals in the waters of Mecklenburg-Vorpommern for many decades.

As part of the Environmental Monitoring Program investigations on pathology and health status are conducted in stranded or by-caught marine mammals. Between 1998 and 2003, a total of 12 grey seals and 27 common seals were found dead on the coasts of Mecklenburg-Vorpommern (in 2002: 7 of 11 found common seals were PDV-positive). On fresh carcasses *i.a.* from 6 grey seals and 3 common seals, a full necropsy was performed, including weighting and measuring the animals. Samples for further investigations, including histology, microbiology, parasitology, serology, toxicology, genetics, age determination, reproduction and stomach analyses were processed or preserved for future projects. Skeletons were macerated, fully investigated and stored at the German Oceanographic Museum.

During the PDV-Epidemic 2002, death seals were investigated by the State Veterinary Diagnostic Laboratory of Mecklenburg-Vorpommern. In August 2003, a full necropsy was made on fresh carcasses of 15 animals by the Research- and Technology Centre Westcoast (FTZ), Büsum.

The grey seals examined in the period 1998-2003 were adults up to 40 years. Some of the old animals showed leiomyomas, occlusion and stenosis of the uterus, loss of bone substance, fibrosis and multifocal calcification of the kidneys and the adrenal glands, heavy parasitic burdens, thrombosis and sclerosis of blood vessels and severe necrotic splenitis. Parasitological investigations revealed *Pseudoterranova decipiens* in the stomach, and *Corynosoma strumosum*, or *semerme* in the intestine. Potential pathogenic bacteria found were *Escherichia coli*, a- and b-hemolytic Streptococci and *Clostridium perfringens*. In addition, zoonotic bacteria *Erysipelothrix rhusiopathiae* could be cultivated. Besides the PDV epidemic 2002 in common seals, no epidemics caused by a specific bacterial or viral infection were found in Mecklenburg-Vorpommern (Harder et al. 2004).

Monitoring of the health status for seals in Schleswig-Holstein is performed since the first seal die-off in 1988/89. All dead seals are transported to the Research and Technology Center Westcoast (University of Kiel) for further investigations (as described before for animals from Mecklenburg-Vorpommern). Since 1996 in total 11 common, 5 grey, and 2 ringed seals were found on the Baltic Sea coast of Schleswig-Holstein. The animals were of various age and state of preservation. Pathological findings included gastroenteritis due to infection of kryptosporidia, suppurative myositis, and hepatitis, abscessation in the muscles and stomach wall with septicemia, bronchitis, and endometritis. One harbour seal found in 2002 died due to Phocine Distemper Virus. Morbillivirus infections were not found in any other year in Schleswig-Holstein.

References

Harder , K., Wolf, P., Siebert, U. and Benke, H. 2004: Monitoring of health status in marine mammals stranded on Baltic coast in Mecklenburg-Western Pomerania, Germany. – Poster at the Annual Conference of the European Cetacean Society (ECS), Kolmården 28.-31.03.2004.

Grey seals use vision rather than olfaction when they locate baited buoys representing fishing gear

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Mitigation methods for the seals-fisheries conflict must be based on a thorough knowledge of seal behaviour. It is thus important to clarify how seals locate fishing gear. A field trial in areas with high reported seal damage was performed during 2004 to test if seals use their visual or olfactory sense in this context. Experimental buoys were designed to represent fishing gear and to provide above-water sensory stimuli to seals. In the first trial, standard buoys were used to give visual cues: a/ dimension (three sizes, diameter 150 – 400 mm) and b/ colour (red, white). In the second trial, hollow vented buoys were used to give off olfactory cues when loaded with: a/ attractive material (freshly cut fish) and b/ repellent material (seal oil).

Suspended at 3 m dept below each experimental buoy, a bait (fresh herring) was available to approaching seals. All occasions of baits taken were recorded. The experimental buoys were set several hundred meters apart at a random pattern. They were checked, re-baited and relocated daily. Self-triggered cameras were occasionally attached to the buoy line for verification, i.e. to secure that baits were not taken by birds (cormorants, mergansers). Visual seal observations (binoculars) were made.

Baits were significantly more often taken from underneath large buoys than from small buoys and control buoys of diminutive size (40 mm) and appearance (grey). The relative frequency of taken baits generally increased with buoy size. Vision seems important for seals locating fishing gear.

Baits were taken equally often from underneath buoys with attractive smells, from buoys with repellent smells and from control buoys (without smell, ballasted). Olfaction did not seem important for seals locating the buoys representing fishing gear in this trial.

All pictures from self-triggered cameras depicted grey seals. There was no clear correlation between the number of visually observed seals and the frequency of taken baits.

Seals in the Lithuanian territorial waters

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The Lithuanian territorial waters and economic zone cover the water area of approximately 7000 km². In the Lithuanian territorial waters grey seals (*Halichoerus grypus*) and ringed seals (*Phoca hispida botnica*) dwell. Although Lithuanian coastal water extends to 100 km, only the Lithuanian Sea Museum observes and breeds seals. Due to the fact that the observations are made more on a voluntary basis than of scientific study, the results of the observations are not precise. There are no proper conditions for scientific study as we lack of financial funding and specialists.

Questioning of the residents of the Baltic coast about the seal population failed in 1990 because of passivity of the residents. Next year the public and the fishermen were addressed by the mass media and asked to inform about the spotted seals by phone. Starting in 1991 the first data have been collected.

The seals do not live permanently in the Lithuanian territorial waters, but rather visit together with migrant fish. Consequently, we do not have exact numbers of the animals. According to recent reports, the number of the seals neighboring our coastal area is increasing.

Mostly we spot live seals in spring. These are young seals of the same year that have not reached their sexual maturity yet, or seals aged 2 or 3 years. This is one of the reasons why seals do not give birth to their young on our seashores. Another reason is the intense human activity in the littoral zone and the beaches are not suited for breeding. Dead seals are usually found during summer months

Since 1991, 14 young seals born at the museum and raised to the age of one year have been set free in the Baltic Sea. All seals are marked. One of them was found dead on the coast of Denmark. One of them was observed near the Saaremaa Island. The examples evidence that our seals do not stay in the Lithuanian territorial waters but travel to the North.

During the period from 1914 to 2004, 36 dead seals were found on the Lithuanian seashore (34 grey seals and 2 ringed seals). The main determined causes of death of adult seals have been: mechanical (they are caught in fishing nets, are shot or get sepsis from contamination by fishing hooks) - 37%; exhaustion - 17%. In 46% of cases, the cause of death could not be determined.

The resources of most commercial fish have deteriorated due to environmental conditions and highly intensive fishing. Therefore the conflicts between seals and fishermen are fierce. Fishermen are not benevolent towards the seals - they use the cheapest fishing net, do not use deterrent measures, and claim the government for damages. The government is not concerned about the seals.

Numbers of grey seals counted in censuses in the Baltic Sea, 2000-2004

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Numbers of grey seals (*Halichoerus grypus*) have been censused annually in recent years in Estonia, Finland, Russia and Sweden, which cover almost entirely the present distribution of the species in the Baltic Sea. The censuses have been carried out by an unofficial group of researchers. We present here the annual census results achieved in the area of these countries in 2000-2004.

In constructing annual count results for the whole survey area, only censuses performed during an annually pre-agreed 2-week period at the shift of May-June were used, with minor exceptions, to minimize the possibility of double-counting in this rather limited sea area. In addition, counts from nearby areas between countries were checked carefully to avoid double-counting. In the census time grey seals are hauling out due to moult and may be counted in maximum numbers in the course of the year. In Finland aerial censuses aided by aerial photographs were used, whereas counts from boats and land were used in the other countries. The essential use of this haul-out figure is to monitor the population abundance, as the censuses are carried out with largely comparable methods in the course of years. Census results should be understood as relative indices of abundance, which are smaller than the real population size.

Following annual numbers of grey seals were counted in the censuses: 9,700 in 2000, 10,300 in 2001, 13,100 in 2002, 15,950 in 2003, and 17,640 in 2004. To demonstrate the distribution of grey seals by sea area the count for 2004 comprised the following numbers: Bothnian Bay and North Quark 1,330, Sea of Bothnia excluding Åland achipelago 870, waters around SW Finnish archipelago including Åland 7,735, Gulf of Finland 870, W Estonia 2,690, Swedish Baltic proper south of Gulf of Bothnia down to 58°N (northern tip of Gotland) 3,900, and Swedish Baltic proper south of 58°N, 245.

When interpreting the annual counts one has to bear in mind the possibility of double-counting, in spite of the common census period, because seals may move long distances in only a couple of days. On the other hand an error could emerge *vice versa:* seals may have escaped the censuses entirely due to movements.

The series of annual figures in 2000-2004 indicate a clear increasing trend in the population size of the Baltic grey seal. It should not be taken to express the true rate of increase, however, because an increase of such magnitude over the period of observation is biologically unrealistic in the grey seal, since it implies unrealistic fecundity/survival rates. Increase in census experience and efficiency, change in haul-out behaviour of seals, and - perhaps most important - chance, resulting from only few repeats of counts, are all factors that may have played a role in the observed increase in the numbers of seals.

Reproductive capacity of grey and ringed seal females in Finland

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Reproductive capacity and disorders in the Baltic seals have been studied in Finland since the 1970s. We present here preliminarily the most recent data on the grey seal from the years 2001-2004 and on the ringed seal from the years 1991-2004, and compare the results with the previous ones.

The grey seal material includes 149 specimens (age determined for 100 specimens, 49 being not yet age determined), and the ringed seal material 54 mature females. Grey seals have been hunted in the above period in Finland, and the bagged specimens have been utilized for the purpose of this study. The ringed seal has been protected throughout the above years, but a small number of specimens have been sampled in the Bothnian Bay for scientific purposes. Uteri were opened and studied for foetuses, placental scars, occlusions, stenoses, leiomyomas and other visible structures. Ovaries were studied for presence of *corpus luteum* and *corpus albicans*. Most of the specimens originate from spring, thus *c. luteum* indicates a recent ovulation (and ongoing pregnancy?), and *c. albicans* of certain size, delivery of a pup during the previous breeding season some 2-3 months earlier.

None of the mature grey seal females (n = 149) had stenoses, occlusions or leiomyomas in the uterine horns. Cysts connected to uterine horns or ovaries were found in five (3,4%) females with no effects on ovulation or pregnancy. 99% out of the 124 females had ovulated in the previous breeding season, based on the presence of healthy-looking *c. luteum*. Judged by the presence of *c. albicans*, 81% of the females (aged 3-37 years) had given birth in the previous breeding season. The respective percentage for females aged 3-8 years was 67.6 and for those aged 9-37 years, 86.8. In most cases *c. luteum* and *c. albicans* were located in the ovaries of opposite side, but in 16% of females they were situated in the same ovary.

The only macroscopic disorders found in the ringed seal females were uterine occlusions. In 1991-2004, 30% of the mature females from the Bothnian Bay were affected by occlusions. More recently, the percentage had dropped to little bit over 20% for the years 1995-2004.

In the 1980s and 1990s, leiomyomas and one case of uterine occlusion were found in the grey seal females, all in specimens over 30 years of age (Westerling et al. in this volume). The material may be biased in respect to diseases, however, as most affected specimens were found dead. The present grey seal material may be taken to be a random sample, as the animals were shot. Thus both the total absence of pathological uterine findings and the high frequency of deliveries indicate that the grey seal population is reproducing normally. On the contrary, the ringed seal in the Bothnian Bay is still suffering from uterine occlusions, although recovery has slowly taken place since the late 1970s.

Analysis of spatially distributed photo-identification data to estimate the size of the Baltic grey seal population

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With a growing grey seal population in the Baltic Sea and the introduction of culling as a way to mitigate seals/fisheries conflicts, there is need to estimate the size of the seal population for management regimes. Photo-id uses re-sightings of animals with distinctive markings as a method for studying population size as well as movement patterns and other population parameters. The technique is non-invasive and relatively inexpensive as compared to traditional tagging methods.

The size of the year 2000 summer population of grey seals in the Baltic Sea is estimated here using identification of individual seals from photographs taken over a period of six years. Photos were taken at haul-out sites within all major grey seal areas in the semi-closed Baltic Sea. The minimum number of different animals represented in the photo-id catalogue is 1671. To estimate local and total population sizes we used the estimator introduced by Darroch 1961 (Biometrika 48:241-60), which allows for spatial variation in sampling intensity. By summing over all release samples over the six years, paired with recapture samples restricted to the final year, we were able to allow for selectivity by pattern quality, mortality and loss of identification markings and the risk of failing to recognize some animals in the recapture samples. Patterns of movement over the six years were modeled on the assumption that during the summer individual preferences for haul-out areas remained constant from year to year.

The estimate for the total Baltic population is 15,631, with 95% confidence limits from 9592 to 19005. The estimate is based on a value for annual survival of identification markings of 0.9035, which was also estimated using the photo-id data. The estimate is subject to an unknown, but probably small, upward bias resulting from the risk of failure to identify all individuals in the photographs used for the analysis. An estimated minimum of 15950 seals were counted at moulting haul-outs in 2003 (Halkka et al. in this volume), which thus provides a lower bound on the population size in that year and, allowing for growth of the population, represents 80% of the photo-id point estimate.

Vendace as a resource for fishery and the Saimaa ringed seal

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In the Saimaa lake complex, the protected ringed seal *(Phoca hispida saimensis)* shares its habitat with commercially-fished vendace *(Coregonus albula)*. Vendace is the second most important species in Finnish fishery. To reduce the risk of sudden extinction, the aim is to double the number of seals by 2020. In anticipation of the discussion concerning commercial fishing and the protection of the ringed seal, we compared the amount of vendace consumed by the seal with fishermen's catches and vendace stock estimates in Lake Pihlajavesi.

Lake Pihlajavesi is a part of the Saimaa lake complex in Finland. Its water area is about 550 km². This lake is one of the most important habitats of the ringed seal. A 120 kHz split-beam echo-sounder was used in the abundance assessment survey (c. 300 km) of vendace stock in August-September 2001. Fish species and size were assessed by simultaneous exploratory trawling. Fishermen's catches were based on the daily records of the trawlers and published data. The estimate of the population size of the seal was based on lair and shoreline haul-out observations. The energy consumption of the seal was related to body mass and it was assumed that the seals consumed only vendace.

Lake Pihlajavesi was inhabited by 43 mature and 17 immature seals as well as 12 pups in 2001. During that year, trawlers fished about 200 tonnes vendace in the area. Vendace stock size was estimated at 660 tonnes in August-September 2001. Total vendace catch was about 250 tonnes, while seals consumed 68 tonnes. We estimated that during the whole year seals ate about 8 % of the vendace spawning stock biomass in the area while fishermen caught 30 % of it. In periods of low vendace density, it may be that seals consume a higher proportion of the stock and reduce the catch per unit of effort. However, our assumption that seals fed only on vendace should be considered as the “worst-case” scenario when considering the conflict between fisheries and the seal.

Development of the Swedish Baltic grey seal stock 1990-2004.

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Estimating growth rate of a natural population is fundamental for the understanding of any species and links various facets of population ecology. Understanding of population growth is a prerequisite to forecast future population trends. Therefore data on population growth and abundance are key factors for the management of any wildlife population.

Estimating population growth and describing population trends in the Swedish grey seal stock have been the main focus of the Swedish grey seal monitoring program established in 1989. The monitoring program is based on surveys (mostly counts from boat) of grey seals during peak moulting time in late May and early June. The methodology for counting grey seals has remained the same so the data should only to a minor extent be affected by any improvements in efficiency over the study period.

The mean annual growth rate for coastal sub-areas and for all areas combined is calculated as the log-linear growth rate from 1990-2004. Counts from two years, 1991 and 1993, have been excluded from the calculations for the Northern Baltic Coast, and hence also from the whole Swedish Baltic Coast, due to insufficient surveys.

The number of grey seals has increased in all areas but the growth rate was higher for the Northern Baltic stock and slightly lower for Southern Baltic stock. However, the differences in growth rate between areas was small and a plot of mean growth rates including confidence intervals makes it hard to discern any differences in growth rates between areas (Fig. 1).

To be able to give an adequate estimate of population growth time series should be of a sufficient length. To demonstrate this we calculated growth based on data-series of five years for the Swedish data 1990-2004. Based on data from only five years, growth varied between 1.4% and 16% over the period. The growth rate for the whole period 1990-2004 was close to 7.5%. This emphasizes the need to base any management decisions inferred from measurements of growth rate on time series of a sufficient length.

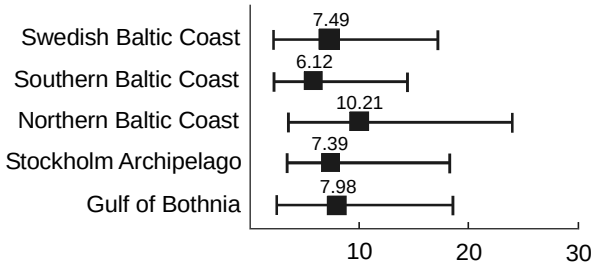

Fig. 1. Mean growth rate and 95% CI for the different areas along the Swedish Baltic Coast.

Occurrence of seals in Poland in recent years

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Data on seal occurrence and distribution along the Polish coast were collected during the years 2000-2004 and compared to the previous 5 years monitoring period 1995-1999. All data were collected based on voluntarily reports from opportunistic observers. 116 reports on sightings, strandings and bycatch have been collected on grey seals *(Halichoerus grypus)*, ringed seals *(Phoca hispida)* and common seals *(Phoca vitulina)*. The number is comparable to appropriate collected in previous 5 years (126 reports). The dominant species was grey seal (76 reports), additionally 10 ringed seals and 1 harbour seal were reported. 48% of reports concerned occasional sightings, 35% strandings and 17% bycatch. In comparison with 1995-1999 the number of bycatch reports has decreased from 24% to 17% and stranding reports increased (from 27% to 35%). Also a significant reduction in the bycatch reported from salmon semi-drift nets has been noticed from 11 individuals in 1995-1999 to 3 in 2000-2004 (from 37% to 15%).

Changes in seasonal distribution of both juvenile and adult grey seals have been noticed in the two reported periods. In 1995-1999 adults were observed in all months, most in winter – January and December (5 and 7) as well as in July (6). Juveniles were noticed from April till August with the maximum in April (8) and May (13). In 2000-2004 adult seals were not observed in winter from November to March, with an exception of one individual observed in December. Juveniles occurred from March to December with maximum in April (12 individuals).

The number of reports from the open sea coast has increased while the reports from the Gulf of Gdansk and particularly from the Puck Bay has decreased significantly from 18 in 1995-1999 to 3 in 2000-2004. Bycatch in coastal fishery has also decreased in recent years.

Health status of grey seals in Latvian coastal waters

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Assessment of the health conditions in the seal population is an essential task of the seal monitoring program carried out in Latvia since 1999. During the years 2001 – 2003, eight of the grey seals that perished in fishing gears in Latvian coastal waters and one founded alive at coast were investigated. By-caught animals were collected each of these years in the period from September 14 through November 17. The species, sex and weight of the seals were determined before dissection. The age was determined by slicing teeth to distinguish annual increment lines in tooth cement. Canines of the bottom jaw were used for definition of the age. To discover helminthes of the seals the standard examination technique of parasitology was used.

Six of nine seals were young, immature animals, at age from 0+ till 3+, whose physical development was not completed.

Eight of nine seal were infected with helminthes. Three species of parasites were found in the digestive tract: gastrointestinal nematodes *(Contracaecum osculatum)* and acanthocephalan worms (*Corynosoma semerme and C. strumosum)*. A high degree of helminthe infection was found for most of the animals. For example, one of the examined seals had up to 500 nematodes and up to 2500 acanthocephalan worms.

Gastrointestinal nematodes caused ulceration of the mucous membrane and submucosa due to penetration into the intestinal wall. Acanthocephalan worms caused severe haemorrhaging into the intestines, which results anemia. Damage of the thick gut and inflammation was observed in eight of nine animals as a result of activity of the parasites.

Absence of some teeth, injured mucous membrane of the mouth, and lesions of the skin were revealed during inspection as well.

Considerable changes of spleen tissues were found in female at age of 1-2 months. Unfortunately, post mortem changes in the spleen made histological interpretation difficult. But some of the signs (fistula in the mucous membrane of mouth, haemorrhage of eye) may suggest that it is syndrome of malign lymphoma of spleen.

Most of grey seals drowned in fishing gears can be classified as diseased animals. We may assume that such animals prefer more easily available food in fishing gears. Therefore it can be speculated that illness of seals may magnify an increasing conflict between grey seals and fishery, which has also developed during recent in Latvia.

Diet of grey seals in the Baltic Sea assessed from hard-part prey remains

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Gastrointestinal tract contents from 145 grey seals *(Halichoerus grypus)* collected between 2001 and 2004 in the Baltic Sea have been examined. The diet composition has been estimated by pooling the prey individuals over all seals as well as by calculating the seal weighted average. We have tried to compensate the data for biases introduced by erosion of otoliths, both by using additional hard-part structures other than otoliths, and species specific size and numerical correction factors. A total of 24 prey taxa were identified but only a few species contributed substantially to the diet. The diet composition is dependent on the prey number and diet composition estimation models used, but independently of estimation model herring *(Clupea harengus)* always dominates the diet, both by numbers and biomass. Besides herring in particular common whitefish *(Coregonus lavaretus)* and sprat *(Sprattus sprattus)* are relatively important prey, but cyprinids *(Cyprinidae)*, eelpout *(Zoarces viviparus)*, flounder *(Platichtys flesus)*, salmon *(Salmo salar)* and trout *(Salmo trutta)* also contribute significantly. Our results indicate dietary differences between the Gulf of Bothnia and the Baltic Proper, as well as a change in diet composition compared to the late 1960s.

“It’s not the seals that are threatened today, it’s the coastal fishermen”

Sven Gunnar Lunneryd

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Gear damage and catch losses due to seals have reached unacceptable levels within the Swedish inshore fisheries. These fisheries are suffering economic losses of over •5 million a year, which amounts to 15-20% of their total value. In 1994 the Seals & Fisheries Project was set up to work on mitigating this problem. This has been funded mainly by the Swedish Environmental Protection Agency and the National Board of Fisheries, with additional support from the Nordic Council of Ministers. Initially the project focused on the set trap fishery for salmonids in the Baltic. Trials lasting several years resulted in the development, with the co-operation of gear manufacturers, of completely seal-safe fishing gear, namely the ‘pushup’ fish chamber combined with large meshes in the rest of the trap.Today about a third of all set traps for salmonids in use in Sweden are of the pushup design. Damage and losses have not been entirely eliminated, but have been dramatically reduced.

Our work is now directed towards finding solutions for the seal-fisheries conflict as it affects the net fishery, which never could be solved by gear modifications. One idea is to convert this type of fishery to a set trap fishery, wherever possible, now that we know how to make such traps seal-safe. This process is going on already.

Other methods of tackling the problem have involved either scaring or enticing seals away, or concealing the catch and nets from view in some way:

– small submersed Acoustic Harassment Devices (AHD), which produce signals that are strong enough to induce pain and discomfort when the seals come too close.
– underwater buoying systems so that marker buoys are not visible on the sea surface.
– feeding seals with non-consumable fish in non-fishing areas in order to draw them away from commercially attractive fishing areas.

None of these techniques has been immediately successful, but each can have a positive effect in certain situations. Other ideas we are working with include creating large seal-free areas using more powerful AHDs. Finally, yet another strategy, known as conditioned taste aversion (CTA), which involves baiting fishing gear with powerful emetics in order to put the seals off, should be tested.

There will never be a single simple solution to the seals-fishery conflict. The fishing industry will have to use several different methods to reduce damage and losses, depending on the local situation. The introduction of seal-safe fishing methods may involve having to accept lower catches. It is also important to bear in mind that gear development is not necessarily sufficient on its own to solve the problem. Active management interventions such as reducing the seal population could be needed to decrease the conflict to a more acceptable level.

By-catch of seals in Swedish commercial fisheries

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A telephone survey was carried out in 2002 concerning by-catches of seals in the Swedish fishing industry. 220 randomly selected commercial fishermen were interviewed, all of which had given details of their fishing effort in their log-books. The sample corresponded to 16.6% of all Swedish fishing vessels in service. Two-thirds of these fishermen reported by-catches, with large variations in significance between different fishermen and different areas. In total a by-catch of 123 grey seals was reported in the Baltic Sea north latitude 56º, 10 ringed seals were reported from the northern Baltic Sea, 2 harbour seals from the central Baltic Sea and 73 harbour seals from the west coast. Most kinds of fishing gear were involved, but the majority of by-catches occurred in fixed gear set for salmon and eels and in flatfish and cod nets. By comparing the fishing efforts of our survey respondents with the total national fishing effort, we calculate that 462 (360-575, 95% c.f.) grey seals drowned in Swedish commercial fisheries during 2001, while the figures for ringed seals and harbour seals are 52 (34-70) and 416 (333-506) respectively. These figures are considered an under-estimate as they do not include part-time and non-commercial fishing, nor did our survey cover by-catches using fishing methods, which are known to have low by-catches. Despite the apparently high levels of by-catch of seals this cannot be considered a serious threat to Swedish seal populations, as all seal species have shown a growth in stocks in recent years.

Materials and methods

The basis of the study was a series of telephone interviews with commercial fishermen, backed up by material from the Swedish log-book system, which allow the recording of damage to fishing gear and catch caused by seals. It is also possible for fishermen to report any by-caught seals, though without asking for any details. However there is no requirement for fishermen to undertake this task and there is no direct incentive for them to do so.

The original selection process for the interviews was based on the 2001 log-book system, under which a total of 1 383 vessels were keeping log-books at some point during the year. Of these vessels 230 were randomly chosen own by 220 commercial fishermen. The interviews were conducted from March to August 2002, apart from some addition interviews which were completed in December.

The Swedish coastal waters were divided into four zones (Fig. 1):

The west coast (including Skagerrak, Kattegat and Öresund): east of longitude 10º002 E and north of latitude 55º202 N.

The southern Baltic Sea: south of latitude 56º002 N.

The central Baltic Sea: between latitudes 56º002 N and 60º002 N.

The North Baltic Sea: north latitude 60º002 N .

Within each area, the numbers of by-caught animals were calculated depending on type of fishing gear, fishing effort and number of reported by-caught seals.

Fishing effort (defined as amount of fishing gear multiplied by time in use) was derived from the log-book information. Estimates of total by-catch were made by dividing the numbers of by-caught animals reported by the interviewees' fishing effort and then multiplying that number with the total fishing effort in each area (Table 1).

The data was neither normally distributed nor transformable to normal because of the extremely skewed results, with the majority of fishermen recording a zero value while a few recorded catching several seals. Confidence limits for catches were therefore estimated by a bootstrap procedure. A visual basic macro was used in Excel to simulate data collection procedure with repeated re-sampling. As there was no statistical difference (t-test) in the fishing efforts for the different gear and areas between those who took part in the survey and the remaining fishermen, the same confidence interval was later extrapolated to the calculated total by-catch figures.

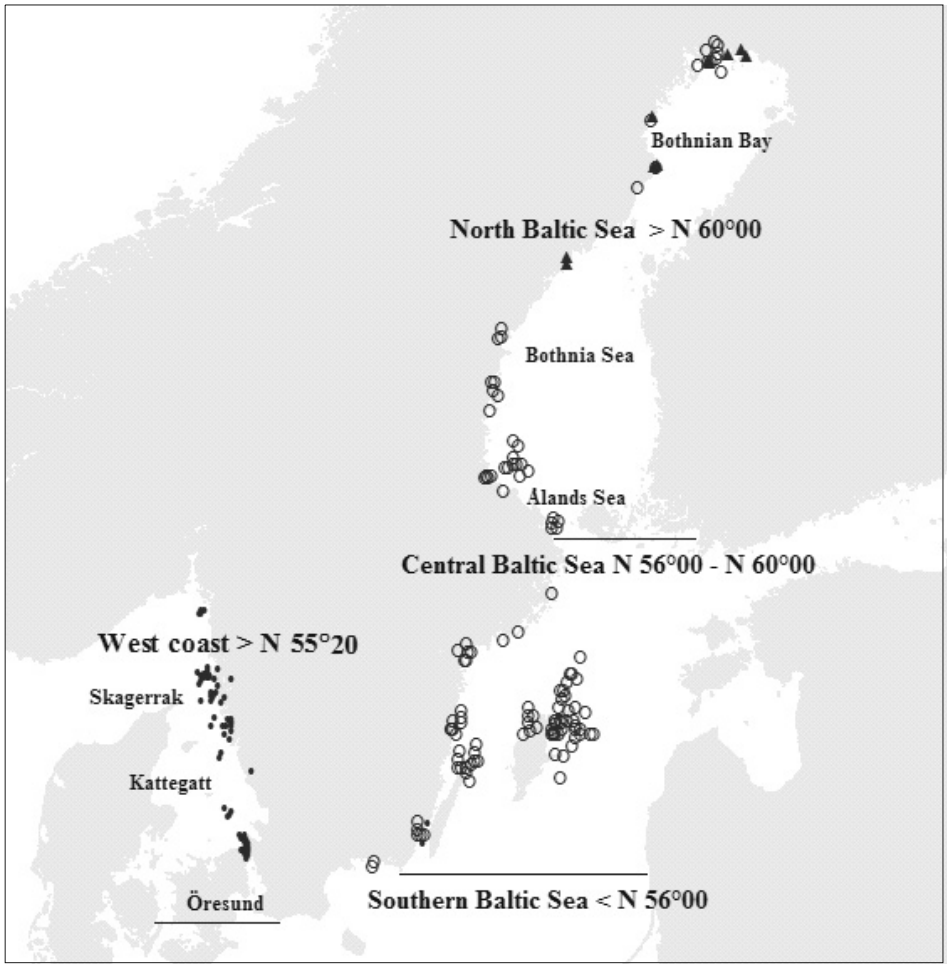

Fig. 1. The Swedish coastal waters is divided into four study areas. The black dots show the locations of harbour seal by-catch incidents. Open circles show the locations of grey seal by-catch incidents and triangles those of ringed seals. Locations supplied by the interviewees.

Table 1. Compilation of the survey material, including the numbers of seal deaths reported and the fishing effort. Fishing efforts for salmon traps, bottom-set nets and eel fyke nets are given in gear x d ays, for individual nets in km net x days and for trawls in hours with nets down. The confidence interval is derived from the bootstrap calculation.

Species/area/gear	*Seal deaths reported*	*Proportion of total fishing effort represented by survey sample (%)*	*Total fishing effort*	*Estimated total by-catch*	*95 % confidence interval*
***Grey seals** , Northern Baltic*					
Large salmon traps	*26*	*20*	*45 592*	*131*	
Whitefish nets	*2*	*20*	*5 831*	*10*	
Baltic herring trawls	*11*	*69*	*2 142*	*16*	
***Grey seals** , Central Baltic*					
Bottom-set nets	*16*	*35*	*28 372*	*46*	
Turbot nets	*42*	*33*	*10 268*	*128*	
Whitefish nets	*2*	*33*	*852*	*6*	
Cod nets	*19*	*19*	*78 615*	*98*	
Salmon nets	*5*	*19*	*9 699*	*27*	
Total				***462***	*360-575*
***Ringed seals** , north of 63°N*					
Large salmon traps	*8*	*20*	*32 175*	*40*	
Whitefish nets	*2*	*17*	*2 305*	*12*	
Total				***52***	*34-70*
***Harbour seals** , west coast*					
Eel fyke nets	*19*	*20*	*4 339 000*	*95*	
Trap nets	*19*	*66*	*1 222*	*29*	
Flatfish nets	*23*	*11*	*10 991*	*208*	
Crab nets	*6*	*55*	*1 655*	*11*	
Trawls (not including prawn nets)	*6*	*8*	*142 284*	*73*	
Total				***416***	*333-506*

Results

The telephone survey covered 16.6% of all fishing vessels operating from Sweden. A total of 208 by-caught seals were reported from all areas except the southern Baltic Sea.

The distribution of by-catch in relation to fishing vessels is highly skewed. A large majority (73%) of fishermen reported no by-catches at all, while a small number (3.5%) caught more than 5 seals.

Figure 1 shows the locations of the reported seal by-catch incidents within the four specified sea areas. The largest by-catches of grey seals occurred in the regions of the central Baltic Sea where most of the cod and turbot fishing is carried out.

No extrapolation of by-catches was done for harbour seals in the central Baltic because of the low numbers of by-caught seals reported. The main area for this population is thought to be between 56º N and 57º N along the coast of the Swedish mainland and out to 16º402 E, assuming a maximum range of 50 km from the haul-out sites. In this area, one commercial fisherman caught 2 harbour seals in a bottom net. 18 other fishing vessels from this area represented in the survey reported no harbour seal by-catches. The total number of fishing vessels active in the area, according to the log-books, was 66.

It was not possible to compile data on age and sex of by-caught seals. For grey seals, the species with the biggest weight variations, a third (40 animals) were thought to weigh over 90kg. One fisherman who reported five drowned seals said that the smallest of them weighed 117kg.

Discussion

We have many reasons to suspect that our final figures are an underestimation. We have only included in our extrapolations those fisheries in which by-catches were reported by the survey interviews. Some seals must have been by-caught in the southern Baltic, an area which is not included at all. Covering 16% of all fishermen, there is a chance that some low-level by-catches are not represented in the statistics presented in this study. Along the west coast that would primarily involve the herring, cod and mackerel fisheries. In the central Baltic, some seals must have been caught in trawls, and neither here nor in the northern Baltic are by-catches included in nets set for Baltic herring, perch, pike-perch, pike and flounders, nor in eel fyke nets.

In the central Baltic there is a semi-commercial part-time fishery on private waters (up to 300 m from land) which is not included in the log-book system at all and therefore is not in our estimates. The extent of this fishery is not known but in some counties it is believed to exceed the fishing effort applied by the registered inshore fishing vessels.

During 1997 a similar by-catch study was carried out investigating by-catches in the Baltic in 1996. From a reported by-catch of 176 grey seals, the total by-catch was estimated to 392 animals, 124 from the central Baltic Sea and 268 from the North Baltic Sea (Lunneryd & Westerberg 1997). Comparing this with the present study we see a geographical shift in by-catch incidents, with lower numbers in the northern part and an increase in the southern area. The greatest by-catch reduction has occurred in the fixed salmon trap fishery. The most significant reason for this is probably a reduction of fishing effort with this kind of gear.

Although the absolute number of by-caught grey seals has increased, the relative by-catch has probably decreased. In 1996 the estimated by-catch was 14% of the counted population of 2,800 individuals in Sweden. In 2001 4,475 seals were counted and the estimated by-catch under 10% (Helander 2002). Nevertheless the fact remains that despite the considerable losses due to by-catch, the overall grey seal population has continued to grow steadily at 6-7 % annually (Helander 2002), so by-catches at present levels cannot be considered to constitute a major threat to population growth.

Similarly in the case of ringed seals, it is unlikely that by-catch losses of 50 animals yearly would constitute any threat to the population. As regards to the harbour seal population, any losses due to by-catches are of marginal significance by comparison with the effects of the epizootic outbreaks which have threatened stocks several times over the last 15 years.

The contributor to this study has been Project Seal and Fishery (Swedish Environmental Protection Agency/National Board of Fisheries).

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Extinction of greenland seals in the Baltic as a result of holocene climatic variability: a study using historical knowledge and satellite SAR survey

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Eastern stock of greenland or harp seal *(Phoca groenlandica)* includes the White Sea and extinct population of the Baltic. Harp seals in the Baltic and surrounding areas have been harvested since the Neolith. However, a number of properties of its behavior ecology as well reasons of periodical reduction of the population, and extinction in extreme cases, are not well understood. The objective of our study is to investigate the variability of the marine environment as affected by large-scale climatic variability in the Holocene, and disclose the consequences of deglaciation of the Scandinavian ice sheet on evolution of inland water ecosystem and population dynamics. Particular focus is on the integrated use of historical knowledge and satellite SAR data for reconstruction of habitat and revealing plausible reasons for the decline of the harp seal in the Baltic.

A new analysis of fossil seal finds allows fixing the habitat of harp seals to separate regions in the southern Bothnia and Danish Straits. The line Vaasa-Umeå represented a northern limit of distribution. In our conclusion, this fact is a confirmation of exclusive dependence of reproduction migration of the extinct harp seal on algoristic type of ice and specific features of winter hydrology of the Pro-Baltic. These could be the same processes as were revealed in our previous comprehensive studies in the White Sea: intensive efferent ice drift in combination with strong external water exchange, presence of specific circulations – spiraling eddies and meandering fronts. Comparative studies of behavioural ecology of the White Sea population of our times allows us to suppose that two herds of harp seals existed in in the Pro-Baltic and that the major cause of their extinction was climate warming: decrease of ice content, changeover from a fresh water to a marine water body, and subsequently, to fresh again and then to brackish over the last 3000-4000 years. The ultimate cause for extinction was the complete change of the hydrological cycle which brought dominance of fast ice in the sea – a condition unacceptable for reproduction of harp seals. The examined scenario will be discussed as a topical for present-day modification of whelping migration and reduction of population number of ice form of seals in the Western Arctic.

Experience of application of satellite SAR for ice monitoring and prevention of mass destruction of seals resulted in ship traffic

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The greenland or harp seal *(Phoca groenlandica)* is the most numerous representative of the Pinnipedia in the Western Arctic. The species is an important component of the marine wild life and an economic base for the livelyhood of some people within its range. The drastic reduction of the greenland seal population is a result of several factors including mass destruction of both young and adult female seals due to heavy ship traffic. All three populations of greenland seal breed in restricted narrow ice zones in the White Sea, Newfoundland and Jan-Mayen regions. Unfortunately these areas are on intensively used round-the-year ship routes.

The goal of our study is to demonstrate the possibilities of satellite SAR data application for monitoring and protecting the ice fields suitable for seals. 35 ERS/RADARSAT/Envisat SAR images of the White Sea and adjacent ice areas were received in near-real time. Thematic interpretation of satellite SAR images was used in a frame of multi-level sub-satellite experiments to recognize seal breeding ice. It allows revealing those ice floes that are selected for whelping and have specific properties and radar signatures contrasting with surrounding ice areas. This type of ice is solid and strong: it is secure against breaking and can protect pups from fatal accidents due to moistening of un-moulted pre-natal fur and super-cooling. The discovered SAR contrasts were used for operational charting of ice. Examples of optimal planning of ship routing in the White Sea with recommended course for avoiding zones of mass accumulation of seals distributed to the icebreakers and cargo ships of the Murmamsk Shipping Company will be presented.

The examined scenario will be discussed as a topic for present-day application for securing ice fields suitable for seals in the Western Arctic and sub-Arctic. Ideas about spreading our experience of using satellite SAR data for the prevention similar situations for grey seals and ringed seals in the Baltic will be considered. A proposal for applying satellite SAR survey for organizing of eco-tourism in the White Sea as well as in the Baltic will be presented.

Ice as abiotic factor of ecology of grey seals in the Baltic: joint analysis of tagging and satellite SAR data

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Grey seals inhabit the North Atlantic and the Baltic Sea and are divided into three separate stocks. The western Atlantic stock in the western Atlantic from Labrador to New England with the largest colonies in Canada around Sable Island and the Gulf of St. Lawrence. The eastern Atlantic stock, from Iceland, UK, Holland, Norway and the Kola Peninsula (Anon 1994, Matishev 2000, Anon 1996, Vishnevskaya et al. 1990). The Baltic stock is separated from their Atlantic stocks, morphologically, genetically as well as ecologically by the timing of the breeding season (Ridgeway & Harrison 1990). Baltic grey seals are predominantly breeding on ice, but during mild winters pups are also born on land in the southern Baltic. Most pups are born in late February and early March, which coincides with maximum extent of ice coverage in the Baltic Sea. Ice features (Melentyev et al. 2004) have been shown to influence where seals choose to whelp. Therefore we attempt to link seal behavior assessed with Satellite Linked Time Depth Recorders (SLTDRs) with ice features assessed with satellite syntetic aperture radar (SAR) data.

Grey seal migrations have been studied only in general and most data from the Baltic has been collected during the ice free period. Only four seals have been equipped with SLTDRs during the winter. But all four seal showed a similar pattern when they left the breeding grounds, spending a lot of time at sea most likely to replenish energy stores after breeding. The only previous information about ice forms and grey seals in the Baltic is based on anecdotal information from seal hunters. But the combination of Satellite telemetry (Fedak et al. 1983, Lundqvist & Arnell 1996, Matishev 2000, Sjöberg 1999) and SAR data (Melentyev et al. 1998, Melentyev et al. 2001) have made it possible to study grey seals association to specific ice features. SAR have the advantage over other satellite images since it makes it possible to penetrate clouds and snow cover to be able to see also the subsurface structures, i.e ice features.

Even if the resolution of SAR data is not high enough to reveal the location of an individual grey seal, it enables us to study ice as an abiotic factor of the ecology of the species. SAR data has therefore the potential to unravel ice features suitable for seals, knowledge about such features might prove valuable in for example stratification of aerial surveys. The main objective of our studies is the thematic interpretation of satellite ERS/RADARSA SAR archieve and joint analysis of the results of satellite ice charting and tagging of grey seals that were performed in the Baltic during the winter seasons of 1995/96 and 1996/97.

According to Lunqvist & Arnell (1996) and Lundqvist & Asp (1997) the studied seasons are characterized as winters of different severity: 1996/1997 was classified a mild winter and 1995/96 was classified as a very severe winter. The specificity of ice conditions of this winter is associated with a large ice-coverage of the sea (262000 km²) and predominance of easterly winds. The thickness of the ice in the Gulf of Bothnia ranged from 50 to 70 cm, occasionally exceeding 100 cm. In contrast the winter 1996/97, was a mild winter with the

ice coverage of only 128000 km². Analysis of satellite images revealed repeated external drift of the ice to the southern part of the Baltic and unusually late beginning of ice melting (in contrary to the warm temperature background).

The time period of satellite tracking of the two females captured in 1996 was 53 and 40 days. The females were captured on March 17 and March 24, in the Gulf of Bothnia at the points with coordinate 62°58' N/19°21' E and 62°54' N/19°12' E (Karlsson 2003, Sjöberg 1999). In 1997 the post-breeding females were captured in the Gulf of Riga on March 14 and 20, correspondingly. They were captured on a rocky island Allirahu southward from Saarema Island (the tracking time, respectively, 54 and 59 days). The tracking data show that post-breeding females can move great distances: the tagged animals used for foraging a large part of the Gulf of Bothnia (66000 km^2) and the Gulf of Riga (51000 km^2). These areas are larger than used by seals during the pre-breeding period. The Allirahu females used the water areas in or close to the Gulf of Riga. The tracking data revealed that both these females first fed in the Gulf of Riga and subsequently, one of them moved to the strait between Hiuma Island and the mainland, where it remained during the entire tracking period. The other female left northward, first for the Åland region and subsequently to the Stockholm archipelago.

According to satellite data, the Gulf of Riga was nearly ice-free as early as on 16.03.97, except for a narrow ice belt connecting the islands Saarema and Hiuma. The thickness of the fast ice there ranged from 5-15 to 20-40 cm. Joint analysis of tagging data and satellite ice images revealed that both females did not leave far for the open sea, remaining within the boundary of ice edge and isotherm 2° Ñ.

Comparative assessments of satellite archive data relating to the different winter severity allows to reveal the scale of seasonal modification of the fast ice zone as well the drift ice zone. In cold winter, the parameters of ice remain fairly stable. But during the mild winters the ice condition are unfavorable for grey seals because the ice extent and ice concentration, as well as the hummocking of ice, are much modified especially when the ice massif is pressed to the fast ice zone. The predominance of the NW/W winds during such winters removes the ice massif from the Swedish shore, inducing rafting and ridging of the ice inside massif as well in the coastal zone in the eastern Bothnia. As result ice area suitable for post-breeding migration is restricted by ice edge zone.

The ice massif where the females were captured southward from Umea is classified as consolidated ice breccia with concentration of 9-10/10 tenths and thickness of 20-40 cm. According to satellite data that ice massif had numerous hummocks. The total extent of the consolidated ice zone was 50-60 km.

The joint analysis of the tagging date and satellite ERS/RADARSAT SAR surveys have suggest that the pattern of the distribution of grey seals in winter is a function of a number of external factors, including the ice origin, wind direction and winter hydrology. Post-breeding movements of the Baltic grey seal are associated with the certain type of ice and the appointed temperature of the sea surface (position of the isotherm + 2° Ñ). The time spent by seals on the shore and on the ice during the post-breeding migration is a function of thermal conditions. If the whelping occurs on the pack ice it proves successful only in case of correct assessment by the animal of ice solidity ensuring the prevention of the pup from overcooling.

The choice of the specific type of ice is also important for grey seals during the molting period (April-May), when adults need to protect themselves from contact with water. According to the satellite SAR data, ice suitable for molting is developed during the autumn-winter period under the effect of river runoff in various parts of the Bothnia at the sites of establishment of quasi-stationary spiral vortexes. The physics-mechanical distinction of these ice areas creates a specific radio physical property and specific contrasting SAR signatures of that ice types.

Acknowledgements

The presented satellite studies of grey seals in the Baltic Sea were supported by the Umea Marine Research Center (UMSC), Sweden.

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The ringed seal in the Archipelago Sea, SW Finland: population size and survey techniques

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The present population of the Baltic ringed seal *(Phoca hispida botnica)* is generally described to be found in three main areas: the Gulf of Bothnia (5510), the Gulf of Finland (150) and the Gulf of Riga (1400) (hauled out populations estimated by Härkönen et al. (1998) shown in parenthesis).

However, the status of the population in the Archipelago Sea has not been described since the 1950s. Based on hunting statistics it has been estimated that the Baltic population was between 190 000 and 220 000 in the early 20th century (Harding & Härkönen 1999). The population was obviously high even in the Archipelago Sea (including Åland), since c. 400 individuals were hunted annually in the 1920s and 1930s. During 1924, 1929 and 1930 more than 1000 ringed seals were killed.

After the II world war the situation has been somewhat uncertain. Göran Bergman (1956, 1958) concluded, that the population had declined in the 1930s to a status approaching extinction; he based this on own observations, hunting statistics, and information on bycaught seals. Between 1967–1975 718 ringed seals were caught in Åland and in 1969-1970 138 in the south part of the Archipelago Sea (excluding Åland) (Helle and Stenman 1990); these statistics indicate that a perhaps somewhat larger population existed again in the 1960's. When WWF collected data on bycaught seals in the Archipelago Sea in the end of the 1980's, 14 ringed seals were included (Helle and Stenman 1990).

Because the situation in the Archipelago Sea has been unclear and no earlier census has been carried out (Helle and Stenman 1990), WWF established a working group in 2002, the goal of which has been to survey and estimate the current population size in the Archipelago Sea.

Material and methods

The study was conducted in the Archipelago Sea within the municipalities of Dragsfjärd, Houtskär, Iniö, Korppoo, Kustavi, Nauvo, Rymättylä, Uusikaupunki and Västanfjärd (Fig. 1). The Åland Islands have not been included in this census. Before the monitoring started,

we interviewed c. 30 persons with insight to the area's wildlife about their ringed seal observations in recent decades. This way we were able to recognize areas with recent observations, but also areas were no observations had been made between the 1960s and 1990s. Based on this information, we concentrated our survey effort to the working area of the Archipelago National Park (Fig. 1). This area is 3 000 km² and it consists of c. 8000 islands, islets and skerries.

During 2002 to 2004 we surveyed ringed seals from a boat (5 m aluminium boat with an outboard motor). This method involves slow driving in island groups and searching for ringed seals with binoculars or from land by using a spotting scope (Zeiss 85 T*FL with 20-60x ocular). The method requires calm wind and rather good sight. These censuses were carried out from early May to late June (2002 and 2003) and late April to early May (2004). Occasionally observations were made also in autumn until November.

In spring 2004 we used an additional method, when surveys were made on the fast-ice during the last week before the ice broke. In 2004, this occurred in early April. We moved on the ice with a hovercraft, which enabled us to cross harsh ice and even open water. We stopped in 1-2 km intervals and searched for seals from the top of higher skerries with the help of a spotting scope. By this time there was no snow on the ice, so seals were easy to spot and identify. We estimated that a seal could be found from a distance of 5 km. Identification was made from shorter distances (up to 3 km). The ice conditions in 2004 were rather average (Finnish Institute for Marine Research, www.fimr.fi) and all but the southern edge of the Archipelago Sea was ice-covered. We censused c. 15 % of the total area of the Archipelago National Park. During these three years we have surveyed nearly the whole area of the Park, but not exactly the same areas each year.

Fig. 1. Study area in the Archipelago Sea. Area from were ringed seal observations were collected (black), area which has been surveyeded in 2002-2004 (Archipelago National Park) (grey) and three localities (Korppoo north (upper), Korppoo south (lower) and Nauvo (middle)) which have regular and stable ringed seal populations, and where the main part of the ringed seals observed in the survey have been found.

Results

The interviews gathered ca. 60 observations of ringed seals in the Archipelago Sea between 1983 and 2001. Furthermore, we were able to recognise areas were there apparently do not exist observations from the 1960 onwards. This kind of large ringed seal-free areas include the Kustavi area and the western archipelago of Hanko. Most seals were reported from Korppoo and Nauvo, and some observations had been made in Dragsfjärd, Houtskär and Iniö. The census effort was concentrated to the Archipelago National Park were most observations had been made. The whole area was not censused in one year only, but during all three years. Therefore the results will be presented together for all three years.

Open water surveys 2002-2004

Largest numbers of ringed seals were found on the same localities in all years. In Korppoo the seals inhabited in two separate areas (70-80 individuals) and in Nauvo (50-60 individuals) (Figure 1). One-two individuals were also found in Dragsfjärd each year. We found one pup and one juvenile in 2003 in Nauvo and one pup and one juvenile in Korppoo and one pup in Nauvo in 2004. In addition to these we have gathered information about one pup in Nauvo in 2002 and >5 pups in Nauvo and Korppoo between 1992 and 1999. After mid to late June ringed seals were not found on these traditional places, and returned again in late autumn (October-November). Numbers were considerably higher in 2004, with 50-60 in Nauvo and 70-80 in Korppoo, compared with 25-30 respectively 26-28 in 2003. Numbers were higher in 2004 also during the same survey period in May than in 2002 and 2003. Areas where ringed seals were found, were usually undisturbed groups of islands in the outer archipelago (no boat courses or settlement nearby), sometimes within restricted areas.

In 2003 and 2004 we also noted the behaviour of ringed seals. When a seal was first discovered in 2003, it was found on land in 80 % and in water in 20 % of the cases (n 114). 78 % of observations were made during afternoon or evening (12-24 p.m.), and only 22 % were made in the morning (00-12 a.m). During the open water survey in 2004, 26 % were found in the water (n 198) and 34 % were observed in the morning.

In three occasions we found fairly large numbers of ringed seals in the same herd which is interesting as the species is not generally considered to be gregarious. In late May 2003 a flock of 17 individuals was observed in the southern archipelago of Korppoo and on the 30.4. 2004 flocks of 20 and 9 individuals were found in Nauvo. A flock of 10 individuals was observed in Korppoo (north) in April 2004.

Fast-ice surveys 2004

During the ice-count in April 2004, we found 51 different individuals. We surveyed a large part of Dragsfjärd, Nauvo and a slightly smaller part of Korppoo north. The outer edge of the Archipelago Sea was ice-free. In Dragsfjärd we found 18 individuals, whereas in 2003, when the same area was censused during open water, we found one individual. In Nauvo we found 14 and in Korppoo 19 ringed seals, but they were on the same areas as during open water. One pup was found in Korppoo and two in Nauvo.

Discussion

Our results show that the ringed seal population in the Archipelago Sea is small, and it seems to be restricted to certain well defined localities. Ringed seals are usually found in the same areas and even from the same islands from year to year. The population size for the Archipelago National Park is now estimated by us to be roughly at the level of 150 individuals. Since the population size outside the National Park is small, this is also close to the estimate for the Archipelago Sea, excluding Åland. To get a comprehensive knowledge about the whole Archipelago Sea population, the survey should be extended to the Åland Islands in the future. The results indicate, that the Archipelago Sea ringed seal population should be considered as one of the main populations of the Baltic ringed seal as it is roughly of the size of the population of the Gulf of Finland (Härkönen et al. 1998). As the population is not restricted to the outermost islands, but is also found in the inner parts of the archipelago and is present in the breeding period, we think that the seals seen mostly belong to a genuine breeding population and do not originate from elsewhere.

In this survey we found only six pups. Therefore more effort is needed to reveal the reproductive status of the ringed seal population in the Archipelago Sea. Pups may be difficult to find, and therefore we can not declare anything about possible problems in reproduction, as found in the Bothnian Bay population (Härkönen et al. 1998).

By June, ringed seals leave the areas were they are found, and based on rather few observations, they return in October-November. For the conservation of the species it would be of great importance to know where they disperse during this time. Do they e.g. mix with ringed seals from other sub-populations? Perhaps an indication of this are the large (17 and 20) flocks that were observed in 2003 and 2004.

Possible threats, which needs to be taken into count in forthcoming studies and management plans, to the population in the Archipelago Sea include climate change, eutrophication, pollution and human disturbance. Ringed seals are highly dependent on fast ice and snow cover during reproduction, and therefore a warming of the climate may be a serious threat to all southern populations in the Baltic Sea (Meler et al. 2004).

Survey methods

Surveying ringed seals during open water is laborious and time-consuming. However, searching for seals with a spotting scope from many different islands and from different angles, and also during differrent times of the day will be likely to reveal whether an area has ringed seals or not. Open water surveys should be scheduled in early spring, since from June onwards individuals leave the Archipelago Sea. There seems to be a slightly higher probability of observing ringed seals in the evening than in the morning. A survey on fast-ice is more effective and enables the observer to cover larger areas than the open water method. In late winter, the snow has melted and seals lying on the ice are easy to spot. Theoretically, this method should also be more appropriate for finding pups.

Acknowledgements

Surveys were financially supported by Ålandsbanken, Environment Centre of Southwest Finland and Kastu senior high school. Finnish Forest and park Services assisted in practical arrangements.

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The losses in the Finnish aquaculture caused by seals in 2003

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In 2003 the total amount of fish produced for human consumption in Finland was about 12.5 million kilograms (Table 1). The value of fish farming is higher than the value of commercial fishing. Fish farming is concentrated to the coastal areas of the Baltic Sea, and 87 % (10.4 million kg in 2003) of the farmed fish comes from those areas. All the fish is farmed in net cages.

The statistics of the losses caused by seals was compiled for the first time in 2003. The information was collected at the same time as Finnish Game and Fisheries Research Institute collected production information from the fish farmers by a mail questionnaire (FGFRI 2004). The data was collected separately from each production unit. In Åland the data was received from the Provincial Government of Åland.

Excluding Åland the frame population consisted of 147 food fish farms. The overall response rate was 69%. Among the 101 respondents, the number of operating fish farms was 73 and 28 fish farms had closed or were not operating in 2003. The Provincial Government of Åland informed that there were 35 operating food fish farms in Åland in 2003.

Eight respondents didn't give the information of the losses caused by seals in their fish farm. Thus the partial non-response rate was 11% of the operating fish farms. The missing information was handled using hot-deck imputation. It means that the missing values were replaced with values randomly selected from the sample by strata.

Table 1. Food fish production (1000 kg ± 95% confidence interval, ungutted fish) in Finnish sea area in 2003.

Region	Fish production 1000 kg ± CI
Gulf of Finland	1136 ± 355
Archipelago Sea and coast of Satakunta	4323 ± 713
Åland	3843
Coast of Ostrobothnia and Bothnian Bay	1132 ± 239
Total	10434 ± 826

The total non-response was corrected using the same post-stratification as in calculation of the production estimates (FGFRI 2004). The basis for the post-stratification was the location of the fish farm, according to the regional distribution of fisheries units of the Employment and Economic Development Centres, and the facts of fish farm activity based on the Aquaculture Register.

In 2003 the total number of operating fish farms in seawater food fish production in the coastal Continental Finland was 119. On sixty farms (50.4%) seals had caused damages to the fish farming. In Åland 12 of 14 enterprises reported fish losses caused by seals. Damages often occurred in several farms of the same enterprise.

In the whole coastal sea area the total fish losses caused by seals were estimated to be 372000 kilograms (Table 2). The major losses consisted of killed or otherwise injured fish. In some areas seals ripped the net cages. The losses also included the fish escaped from the ripped cages. In Åland the quality of the damages was not reported but the fish losses caused by seals were bigger compared to the other Finnish sea areas. In different sea areas the fish losses caused by seals varied 2.3-4.5% of the total amount of fish produced for human consumption.

The value of the fish and cage losses caused by seals added up to 967 000 euros. The value of the losses consisted mainly of the fish damages. The proportion of the cage damages was relatively minor, about 34 000 euros (Table 3).

The data was collected in connection with the well-established statistical data collection, so the sampling design and its special features were well known. In the analysis of the data, we could benefit the methodological development work in the estimation of fish farming statistics in long term.

The coverage of the data was good, even though there is sometimes delay in updating the changes in the activity of the fish farms to the aquaculture register.

Table 2. The losses in food fish production (1000 kg ± 95% confidence interval, ungutted fish) caused by seals in the Finnish sea regions in 2003.

Region	Killed fish 1000 kg ± CI	Injured fish 1000 kg ± CI	Escaped fish 1000 kg ± CI	Total losses 1000 kg ± CI
Gulf of Finland	32 ± 16	19 ± 8	0 ± 0	51 ± 22
Archipelago Sea and coast of Satakunta	74 ± 34	10 ± 4	20 ± 13	104 ± 40
Åland	.. ..	.. ..	.. ..	182
Coast of Ostrobothnia and Bothnian Bay	10 ± 6	5 ± 3	20 ± 5	35 ± 9
Total	116 ± 38	34 ± 9	40 ± 14	372 ± 46

Table 3. The value of the fish and cage losses (1000• ± 95% confidence interval) caused by seals in the sea regions in 2003.

Region	Killed fish 1 000 € ± CI	Injured fish 1 000 € ± CI	Escaped fish 1 000 € ± CI	Cage damages 1 000 € ± CI	Total losses 1 000 € ± CI
Gulf of Finland	88 ± 40	20 ± 9	0 ± 0	0 ± 0	107 ± 39
Archipelago Sea and coast of Satakunta	214 ± 96	12 ± 5	52 ± 36	30 ± 22	309 ± 111
Åland	.. ..	.. ..	.. ..	.. ..	454
Coast of Ostrobothnia and Bothnian Bay	28 ± 16	7 ± 6	58 ± 15	4 ± 4	97 ± 25
Total	330 ± 106	39 ± 11	110 ± 39	34 ± 23	967 ± 120

The non-response rate was about 31 %, which is fairly low, if we compare it to business surveys in general. Despite the bias possibly caused by the non-response was corrected using post-stratification in the estimation.

The random error that occurs in the estimates, due to reply failure, has been described in the tables by the confidence interval of 95 %. For the total estimates the confidence intervals are relatively narrow. For example for the estimate of all losses the confidence interval was about ± 12%. The confidence intervals were only approximate values, because the increase of confidence intervals due to imputation of missing values was not considered.

The measuring error, which here means the difference between the real amount of losses and the losses declared by the respondents, is difficult to appraise. When examining the data, it can be noticed that the data is quite well in balance between respondents, even though some asked things were difficult to measure and were based more on judgment than on measuring.

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Contaminant burden, biomagnification and biomarkers in the Baltic seals

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The Baltic Sea has been one of the most polluted water areas in the world since the 1970s, resulting in a heavy contaminant load in the Baltic fauna. The major source of contaminants in the Baltic seals is most likely the diet. Baltic ringed and grey seals feed roughly at the same trophic level of the food web. However, there are differences in the contaminant burden between the seals. Especially Baltic ringed seals are still suffering from exceptionally high concentrations of persistent organic pollutants (POPs), such as PCBs and DDT compounds. The observed difference in contaminant pattern between ringed and grey seals could be partly due to species-specific food sources. Several pathological and biochemical changes observed in the Baltic seals correlate with the individual POP loads. A number of the observed biochemical changes in the seals have been proposed as possible biomarkers of the contaminant load in these species. However, as the vitamin A and E status of marine mammals also reflects the nutritional vitamin level, the diverging vitamin concentrations observed in these animals could be a reflection of the levels of these vitamins in their food sources. The aim of this study was to investigate the contaminant load in the Baltic seals and to evaluate the usefulness of potential exposure and effect biomarkers. POP and vitamin levels were also studied in seal prey species in order to investigate the bioaccumulation of these compounds to seals from their main food sources. Our results show that grey seals are ingesting more PCB compounds than ringed seals. This indicates that grey seals have either less capacity for metabolising these compounds, or that the metabolism is less efficient at lower levels of exposure. The biomagnification of DDT compounds was similar for both species. The higher level of DDT in ringed seals compared to the grey seals could thus be explained by the differences in their diets. Our results on vitamin bioaccumulation further support our previous hypothesis that the toxic effects of environmental contaminants could be causing the observed divergence in vitamin levels between the Baltic seals and the reference seal populations, and that vitamins are potential biomarkers for contaminant load and effect for the Baltic ringed and grey seal. However, as the vitamin A accumulation in seals is poorly known, more research should be conducted on the vitamin A dynamics in order to better understand the influence of contaminants on stored vitamin A.

Underwater behaviour of saimaa ringed seals during the nursing season

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The Saimaa ringed seal *(Phoca hispida saimensis)* is an endangered freshwater subspecies in Lake Saimaa, Finland. The current population estimation is about 250 seals. During the last decades human activities have constantly increased on Lake Saimaa and are expected to cause disturbance to the seals, especially during the breeding season. Here we studied the underwater behaviour, especially vocalization of Saimaa seals in April of three successive nursing seasons (2002-2004). Hydrophone and underwater video cameras were used to monitor the behaviour of the seals close to their lairs. In addition, the seal's reactions to occasional human activity like passing skiers and snowmobiles were recorded. The behaviour of four different females with pups was observed. This study indicates that the pups are vocally quite active in their nursing time. A total of 227 sounds made by pups were measured (Raven 1.1). The minimum frequency of the fundamental varied between 113 and 658 Hz and the maximum frequency between 255 and 1425 Hz. The call duration was from 160 to 3230 msec. The calls were classified into five types. Most of the calls were frequency modulated or flat, but often the harmonic structure was partly missing. Mostly the calls consisted of one-part only, but two- or three-part calls existed as well. The adult Saimaa seal has been supposed to be very quiet. However, a vocalization of an adult female was recorded in this study. This was a knocking sound series consisting of 2-10 knock elements per series. The higher frequency of a knock element was between 0.41 to 24 kHz. The sound duration of one knock ranged from 4 to 47 msec and the whole series duration from 130 to 820 msec. Similar sound type has been described earlier from the Ladoga ringed seals *(P. h. ladogensis)*. Until the breaking up of ice, the seals use actively both the lairs and the surrounding underwater shoreline habitat. The pups use their birth lairs until collapsing of the lair roof and may dig new caves actively by themselves. The behavioural activity patterns of the seals have a circadian rhythm. Although it seems that there may be a kind of habituation to disturbance in the seals' behaviour, the effects are difficult to estimate because of the small sample size. More research on the behaviour and effects of human caused disturbance on Saimaa seals is urgently needed.

Commercial fishermen's conceptions about protection areas for seals

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In 2001 seven protection areas for seals were founded on the sea areas of Finland. This brought increased fishing regulations to those areas. In connection with the acceptation of the reserves in the Parliament, there was a resolution, according which Ministry of the Environment, Ministry of Agriculture and Forestry and Game and Fisheries Research Institute have to, among other issues, estimate the effects of the seal protection areas on commercial fishing. In 2003 Finnish Game and Fisheries Research Institute made telephone interviews with commercial fishermen, who had fished near the conservation areas. In this presentation we study the answers of those interviews (see also Salmi et al. 2004).

The questionnaire in the interviews consisted of 12 structured and open-ended questions, dealing with fishing operations, distance of fishing from the protection areas, effects of the protection areas on fishing and on the number or behaviour of seals, problems caused by the seals and considerations about the governance related to the seal problem. The total sample of interviewees was 174, namely those commercial fishermen who had fished near the protection areas in 2001 (in the rectangles of 0.5 degree LAT * 0.5 degree LON, about 50 km* 50 km). The interviews were made with 145 fishermen, thus the response rate was 83%.

The material was classified in five areas: the Bothnian Bay (Möyly protection area, 46 interviews), Kvarken (Snipansgrund – Medelkalla, 11), the Bothnian Sea (Södra Sandbäck – Sandbäck, 15), the Archipelago Sea (Grimsörarna, Mastbådan, 33) and the Gulf of Finland (Sandkallan – Stora Kölhällen, Kallbådan, 40). In addition, a classification was made according to the distance of fishing from the protection area and continuance of the fishing livelihood: 1) those who fished near the protection area (n=32), 2) those who did not fish near the protection area (n=75) and 3) those who had stopped fishing after 2001 (n=38).

Fishermen in the Bothnian Sea fished most commonly near the protection area before the foundation of the areas. Gill net was the most popular gear used both near the protection area and at more distant waters (Fig. 1). Trawls were typically used near the protection

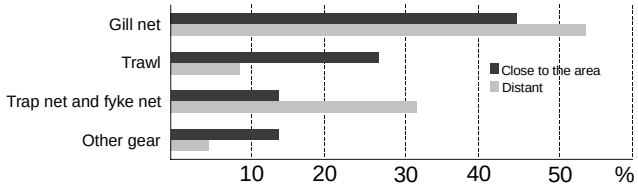

Fig. 1. The proportions of fishermen using different fishing methods before the foundation of seal protection areas, divided in those which were used nearer than 2 nautical miles from the protection area and those which were used within the distance of 2 nautical miles or further away from the reserves.

area and at more distant waters (Fig. 1). Trawls were typically used near the protection areas, whereas trap nets and fyke nets were more often used further away. The same fisherman may have fished using more than one fishing method.

Effects of the seal protection areas

Fishing restrictions connected with the establishment of the reserves have affected directly activities of only a few professional fishermen. The interviewees were asked "Have you been forced to reduce your fishing or change fishing areas due to fishing restrictions connected to the seal protection areas?" Seven (32%) out of those fishermen, who had fished nearer than 2 nautical miles from the protection area, answered 'yes'. The positive answers represented 5% of all interviewees. A general argument was that the seal problems had started earlier than 2001, not least in the areas chosen for the reserves, and thus fishermen had been forced to adjust their fishing behaviour already before the foundation of the areas.

Those who had been forced to change their fishing due to the restrictions were situated in the Bothnian Bay, the Bothnian Sea and the Gulf of Finland. Straight disadvantages of the fishing restrictions were catch reductions and the change of fishing methods and areas, which increased fishing costs. Also the composition of fish species in the catch had changed.

The telephone survey highlighted also more general problems that seals or the protection of them have caused to fishing. More than one half of the interviewed fishermen considered that the founding of the conservation areas has increased the number of seals and has had an effect on their behaviour and by that means also on the operational preconditions of commercial fishermen. Those who had fished near the seal protection areas more commonly considered that the areas have affected seal's behaviour. The seals have moved to the coastal areas, which makes fishing more difficult. Seals follow the fishermen to find an easy meal: they not only eat fish from the gear but damage fish and fishing gear and scare fish away from the fishing grounds. This deduces incomes and increases costs and work. Also changes in species composition and the marketability of the catch were named as problems.

Most (72%) of the interviewed fishermen who had continued fishing after 2001 answered positively to the question "Has the general increase in the seal population affected the fish stocks?" They commented that especially whitefish, Baltic salmon, Baltic herring, vendace and pikeperch stocks have been weakened due to the increase of the seal population. Trawl fishermen did not find seals as a problem for their livelihood, but they either did not back the conservation.

Solutions to the seal problems

When asked about how the fishermen had mitigated the seal problems in their activities, the most common means was changing the fishing methods (Fig. 2). Especially for those who had fished close to the protection area the change of fishing areas was typical. Making the fishing gear stronger or other development of the fishing gear was also popular. In addition to adding the fishing effort, the fishermen also increased guarding of the gear.

When inquired about how the seal problems should be mitigated in the future, the most typical answer was related to hunting seals in order to reduce the seal population and scare seals from the gear. Also a killing bounty was suggested. Fishermen also called for economic compensations for the losses and damages. They commented that only partial

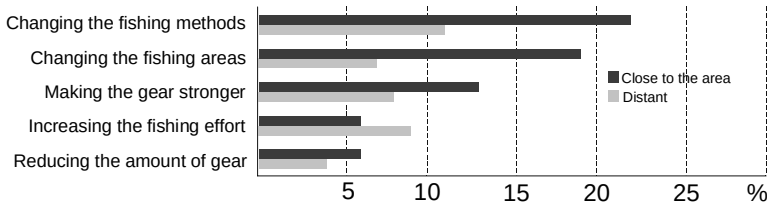

Fig. 2. How have you mitigated the seal problems in your own fishing activities? The bars indicate proportions of the alternatives chosen as the most important. The answers were divided in those fishermen who had fished nearer than 2 nautical miles from the protection area and those who had operated within the distance of 2 nautical miles or further away from the reserves.

only for fishermen receiving fishing revenues covering at least 30% of their total income.

The development of seal-proof fishing gear was mentioned rather seldom, mostly among the Bothnian Bay fishermen. Although development of seal-proof fishing gear was going on at the time of the interviews, the results were not widely seen as promising from the fisherman's perspective. Moreover, the development of gear has concentrated on trap nets and thus, as gill net is the most popular fishing gear among the Finnish commercial fishermen along the coast, the technical development does not solve the problem for most of the fishermen. A part of the interviewed fishermen, especially those in the Gulf of Finland, noticed that the seal problem is so severe that nothing can be done anymore and consequently they saw no future in commercial fishing.

When asked about who should be responsible for taking care of the seal problem, many fishermen especially among the fishermen in the Bothnian Bay suggested the State. The role of the State in the answers was connected to the organization and funding of seal hunting activities. Also the European union was mentioned as responsible institution. Another popular proposition, typically mentioned among the fishermen in the Kvarken area, was that the hunting organizations should take care of the seal problem. Also fishermen themselves, water owners, fish farmers and other local people were mentioned as groups responsible for actions.

Finally a question "How should the seal conservation areas and the connected regulations be developed in the future?" was stated. About one half of the informants held the reserves and fishing restrictions as pointless and suggested their removal. These perspectives were highlighted especially in the Gulf of Finland and in the Kvarken area. Transfer and reduction of the reserves were also brought up.

The problem between commercial fishing and the seal population along the Finnish coast is not a new one. In 1994 a total of 200 semi-structured interviews were made with commercial fishermen along the Finnish coast and 30 of these fishermen highlighted the seal problems (Jurvelius & Salmi 1995). Also in those interviews the fishermen preferred hunting of the seals and stressed the need for compensations of their losses. The problems were connected especially with drift net and line fishing for Baltic salmon and the coastal trap net fishing, mostly in the Gulf of Bothnia, eastern parts of the Gulf of Finland and in the Åland Sea. The problems in drift net fishing concentrated near the outer parts of the archipelagos. When comparing the results from the telephone interviews presented in this paper, it seems obvious that the seal problems have become more severe and relates to wider coastal areas and groups of fishermen than 10 years ago.

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Spatial differences in the changes of population size of the Saimaa ringed seal

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The subspecies of the ringed seal, Saimaa ringed seal *(Phoca hispida saimensis*), is endangered according IUCN's classification (IUCN 1996, Rassi et al. 2001). European Union legislation lays down that the Saimaa seal population needs to be strictly protected (Class 4a in Habitat Directive).

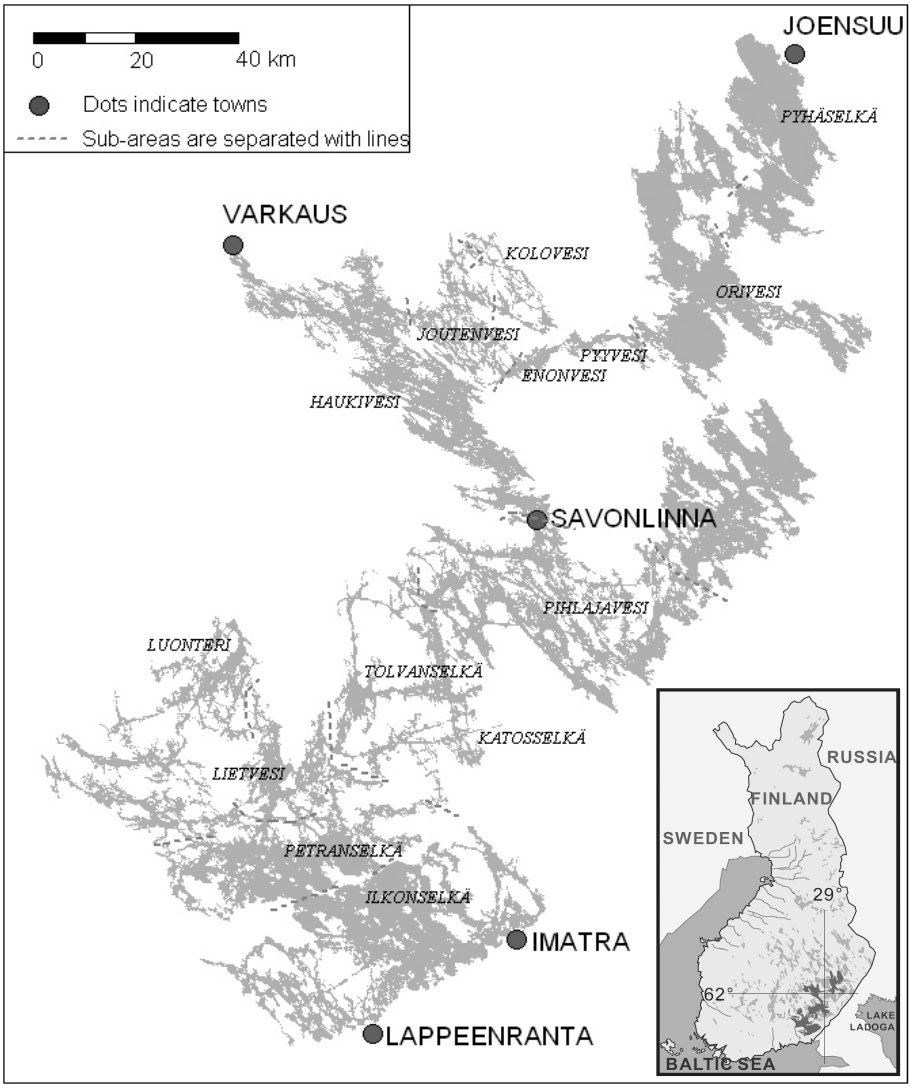

Fig. 1. Sub-areas of Lake Saimaa. © Metsähallitus 2005, © Maanmittauslaitos 1/MYY/05.

The total area of Lake Saimaa is 4 400 km^2 and it is a highly fragmented lake complex totalling 13 710 islands and islets. This habitat of the Saimaa seal is subdivided into smaller lakes, e.g. Kolovesi, Joutenvesi, Haukivesi and Pihlajavesi, which are separated from each other by narrow straits (Fig. 1). The subdivision of Lake Saimaa into sub-areas is based on the geomorphology of the lake and does not suggest separate subpopulations. These areas are thought to refer to different breeding or lairing occurrences (Sipilä 2003).

Unless protection measures are applied, the Saimaa ringed seal will face extinction due to abnormally high lair-mortality and the high mortality caused by seals getting tangled up in fishing gears. Protected areas with fishing restrictions and protection of lairing shorelines are necessary for the survival of Saimaa seal (e.g. Sipilä & Koskela 2000, Sipilä & Hyvärinen 1998).

During the period 1990 – 2004, a total of 209 seal carcasses were found, and 30% of them were too rotten to enable post mortem analyses to be done. The cause of death was determined from 146 carcasses. The most common causes of death were drowning (or suffocation) in fishing tackle (52.1%) and mortality of lanugo-coated pups (41.8%). Only 6.2% had died a “natural” death (lanugo-coated pups excluded), e.g. due to infections.

The bulk of the population is found in the central parts of Lake Saimaa in Lake Haukivesi and in Lake Pihlajavesi, where about 50% of individuals reside. Lakes Haukivesi and Pihlajavesi are both large water bodies (approx. 500 km^2) and at present together comprise more than 50% of the undisturbed breeding habitat of the ringed seal. The estimated population sizes vary a lot between sub-areas of Lake Saimaa (Table 1).

The minimum observed population of Saimaa ringed seal was approx. 190 seals in 1990 (Sipilä 2003). In 1990-2004, the mean annual population growth has been 2.6% per annum. The estimated changes in population size differ a lot between breeding areas (Table 1). It is very likely that the ringed seal will vanish from the northern parts of Lake Saimaa in the near future.

The fastest population growth of the population was observed in Lake Petranselkä. One explanation for this abnormally high growth is the immigration from the Lietvesi sub-area. There is an unexpected difference in the changes in population size between the two main breeding areas in Lake Haukivesi and Lake Pihlajavesi. Lake Haukivesi includes a

Table 1. Estimated numbers of Saimaa ringed seals in the early winter 1990, 1995, 2000, 2004 and mean annual growth in different sub-areas of Lake Saimaa. These figures do not include pups born in the estimation year.

	Population size				*Growth rate*
Sub-area	*1990*	*1995*	*2000*	*2004*	*1990–2004*
Pyhäselkä	*13*	*9*	*4*	*4*	*0.919*
Orivesi	*14*	*13*	*12*	*10*	*0.976*
Pyyvesi-Enonvesi	*7*	*7*	*17*	*15*	*1.056*
Kolovesi	*15*	*15*	*25*	*25*	*1.037*
Joutenvesi	*16*	*16*	*25*	*30*	*1.046*
Haukivesi	*48*	*49*	*53*	*55*	*1.010*
Pihlajavesi	*38*	*43*	*60*	*80*	*1.055*
Tolvanselkä-Katosselkä	*16*	*20*	*20*	*20*	*1.016*
Lietvesi	*15*	*10*	*9*	*10*	*0.971*
Luonteri	*2*	*2*	*2*	*2*	*1.000*
Petranselkä	*4*	*6*	*13*	*15*	*1.099*
Ilkonselkä	*4*	*4*	*3*	*3*	*0.980*
Total	*189*	*192*	*242*	*269*	*1.026*

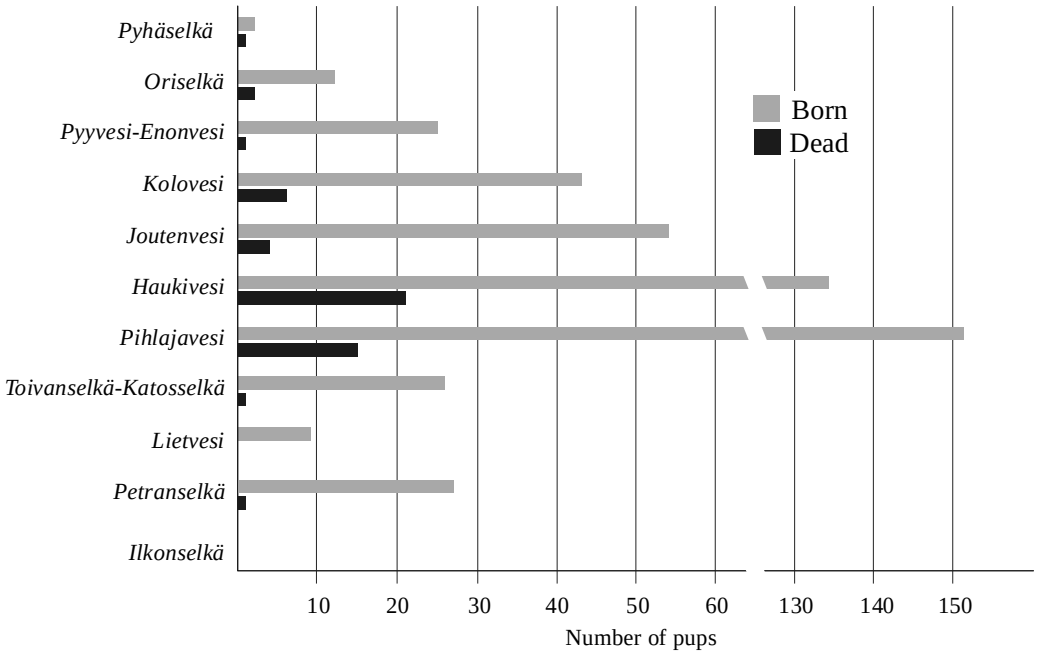

Fig. 2. The number of pups born and found dead in lairs in different sub-areas of Lake Saimaa in the years 1990-2004.

large national park, while Pihlajavesi has only a proposed protection area under the N2000 program. Another national park in Lake Saimaa is in Lake Kolovesi.

The number of newborn pups tallied in the period 1994-2004 was 485. Of these, 10.8% were found dead in lairs (Fig. 2.). The survey results for Lake Haukivesi in 1994-2004 were as follows: total of 134 pups, of which 15.7% had died in their lairs, and the corresponding figures for Lake Pihlajavesi were 151 and 9.9%. The figures suggest that at present Lake Pihlajavesi is a better breeding habitat for the Saimaa seal than Lake Haukivesi.

The above survey also showed that 23 seals had died after becoming entangled in fishing tackle, which is equivalent to 3.9% of the mean annual mortality in Lake Haukivesi. The corresponding figures for Lake Pihlajavesi were 12 and 1.8%. During the said period, Lake Haukivesi had about 20-30 km^2 more of its area under fishing restrictions from mid-April to the end of June than was the case with Lake Pihlajavesi.

It seems that at present the efficiency of protection is more or less in balance with the main threats facing the Saimaa seal in Lake Pihlajavesi, but a greater degree of protection may be needed in Lake Haukivesi.

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Food remains in the alimentary tracts of the Baltic grey and ringed seals

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The Baltic seals were considered mainly as noxious animals until the early 1970s. They were competitors with fishermen catching the same fishes. In addition, they robbed and destroyed fishing gears. After different procedures of seal protection, the need for better knowledge about the food of seals became obvious. The subject was studied first by Söderberg in Sweden (1975) and by Tormosov & Rezvov in the Soviet Union (1978). However, their studies did not concern the seals in the Finnish sea areas. Interest in the diet of these seals arose as the two species became totally protected in Finland, the grey seal *(Halichoerus grypus)* in the year 1982 and the ringed seal *(Phoca hispida botnica)* in the year 1986.

Material and methods

The Finnish Game and Fisheries Research Institute (FGFRI) has collected seals drowned in fishing gears or found dead ashore for pathologic research in the National Veterinary and Food Research Institute. The project started in the year 1986 and was supported economically by the WWF Finland.

In connection of this research the stomachs and intestines of the seals were preserved frozen for diet analysis. Before the autopsies the seals were weighted and measured. Their ages were determined according to layers in canine teeth cementum in FGFRI. These background data are in certain cases essential for evaluating the results of the diet analysis. In addition, the amount of parasites in different parts of the alimentary tracts was counted for the purpose of separate publication.

After the restart of the grey seal hunting, stomach and intestine samples were collected together with other samples from the autumn 2000 onwards. The condition for getting a hunting license was the delivering of all the samples asked for FGFRI.

The material from the years 1986-2004 is presented in Table 1. Collection of the material continues until the end of the hunting season (July 31, 2005).

The analysis of the content in stomachs and intestines is mainly based on searching and determining of otoliths. From the hard parts of the bony fishes the otoliths are most resistant against digestion and mechanical wearing (Härkönen 1986). In order to recognize the otoliths a reference material was collected from fishes living in the Finnish sea areas. The size of otoliths in relation to the weight and length of the reference fishes was determined (Raitaniemi et al. 2000).

Table 1. The material divided according to age classes, sexes and sea areas. (M/F/?= males/females/ indet. SWA=Southwestern Archipelago, GF=Gulf of Finland, GB=Gulf of Botnia). Causes of death: FDF=found dead in a fishing gear, FD=found dead, S=shot.

	1986-2004					
H.g.	**<1 v**	**1-5**	**6-15**	**>16**	**not yet det.**	**SUM**
SWA	**M/F/?**	**M/F/?**	**M/F/?**	**M/F/?**	**M/F/?**	**M/F/?**
-FDF	21/15/-	4/7/-	2/-/-	1/-/-	-/-/-	28/22/-
-FD	1/1/-	1/-/-	1/1/-	2/2/-	-/-/-	5/4/-
-S	1/2/7	2/7/11	-/1/2	-/1/1	6/1/10	9/12/31
GF	**M/F/?**	**M/F/?**	**M/F/?**	**M/F/?**	**M/F/?**	**M/F/?**
-FDF	42/28/-	2/2/-	1/-/-	-/1/-	-/-/-	45/31/-
-FD	5/3/1	-/-/-	-/1/-	2/1/-	-/-/-	7/5/1
-S	1/-/2	-/3/2	-/-/1	-/1/-	1/2/-	2/6/5
GB	**M/F/?**	**M/F/?**	**M/F/?**	**M/F/?**	**M/F/?**	**M/F/?**
-FDF	45/22/-	5/8/-	2/1/-	-/-/-	-/-/-	52/31/-
-FD	2/3/1	-/1/-	1/-/-	-/-/-	-/-/-	3/4/1
-S	7/8/21	11/26/15	9/70/15	2/20/5	6/37/5	35/161/61
						186/276/99

	1986-2004					
P.h.b.	**<1 v**	**1-5**	**6-15**	**>16**	**not yet det.**	**SUM**
SWA	**M/F/?**	**M/F/?**	**M/F/?**	**M/F/?**	**M/F/?**	**M/F/?**
-FDF	2/2/-	-/1/-	-/-/-	-/1/-	-/-/-	2/2/-
-FD	-/-/-	-/-/-	-/-/-	-/-/-	-/-/-	-/-/-
-S	-/-/-	-/-/-	-/-/-	-/-/-	-/-/-	-/-/-
GF	**M/F/?**	**M/F/?**	**M/F/?**	**M/F/?**	**M/F/?**	**M/F/?**
-FDF	33/18/2	3/1/-	0/1/-	0/1/-	-/-/-	36/21/2
-FD	8/9/-	1/2/-	-/2/-	-/-/-	-/-/-	9/13/-
-S	-/-/-	-/-/-	1/-/-	-/-/-	-/-/-	1/-/-
GB	**M/F/?**	**M/F/?**	**M/F/?**	**M/F/?**	**M/F/?**	**M/F/?**
-FDF	10/4/-	1/1/-	-/-/-	1/1/-	-/-/-	12/6/-
-FD	-/1/-	-/-/-	-/-/-	-/1/-	-/-/-	-/2/-
-S	-/-/-	1/2/-	4/6/-	4/3/-	-/-/-	9/11/-
						69/55/2

Results and conclusions

Because the collection of material is not yet finished, we now present such results and conclusions only which hardly change any more. For the same reason the statistical analysis of the results is being left for later presentation.

Both the grey and ringed seal are opportunists when it comes to the diet. They eat what is most easily found. This behaviour is more typical for the grey seal than for the ringed seal, which was also noticed by Söderberg (1975). Regardless of the age of the seals, both species use the herring *(Clupea harengus membras)* as the most common food species. For the ringed seal it is commonly typical to catch three-spined sticklebacks *(Gasterosteus aculeatus)*, as Tormosov & Rezvov (1978) had already revealed.

None of the 49 grey seals and 12 ringed seals, all less than one year of age, which had drowned in salmon nets, had eaten of the salmon. This supports a hypothesis that inexperienced young seals entangle and die in fishing nets during their search for small fishes, mussels and crustaceans on the bottom.

There are no statistically significant differences in the use of food between young males and females. On the other hand, the individuals drowned in fishing gears are more often males than females (Table 1).

Of the salmon fish species, highly pursued by men, the whitefish *(Coregonus lavaretus)* was the most common fish species in the diet. The salmon *(Salmo salar)* and the trout *(Salmo trutta)* were not very important; they were mostly found in the older seals.

Most of the grey seals hunted were shot on ice in the Bothnian Bay (Table 1). They had eaten herring almost exclusively. The following fish species in prevalence were the sprat *(Sprattus sprattus)*, the smelt *(Osmerus eperlanus)* and the whitefish. In the material of 198 grey seals from the years 2001-03 only seven had eaten salmon or trout. The stomachs of the grey seals shot were often nearly empty, but the analysis of the intestine still gave some results.

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Diet of the Ladoga seal – a pilot study

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In the Sortavala veterinary station autopsies were made on 27 Ladoga ringed seals *(Phoca hispida ladogensis)*, which had drowned in fishing gears in the northern part of the lake during the period 2000-03. The study was a part of a larger Finnish-Russian research project on the sub-species. From the seals studied several samples were taken, among them the stomachs and intestines for diet analyses to be done in the Finnish Game and Fisheries Research Institute. There is no scientific data available in the literature on the subject, though the item has been discussed in articles concerning the biology of the sub-species (e.g. Tormosov & Filatov 1979).

The method used for diet analyses was the same than described in an other article (by Stenman & Pöyhönen) in this volume. In the connection of the analyses also the amount of *Corynosoma*-parasites in different parts of the alimentary tracts were carefully counted for a separate publication. The ages of the seals were determined from the cementum layers of the canine teeth.

The most important fish species in the scanty material studied were the smelt *(Osmerus eperlanus)* and the vendance *(Coregonus albula)*. In addition, eight other fish species were found in the diet, among them the ruff *(Gymnocephalus cernuus)* as the commonest. Typical for the fishes found was their small size. Concequently, the number of smelt in four seals varied in the range 365-431 individuals.The bigger salmon fish species were seldom represented in the material. Crustaceans, in particularly *Gammaracanthus lacustris*, were quite common.

Unfortunately there were no exact data on the fishing gears used or the catching date of the seals. However we hope that the results of this pilot study will encourage our Russian colleagues to make new efforts for collection of a larger material.

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Numbers and occurrence of ringed seals in the Gulf of Finland in the years 1997-2004

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According to the latest scientific publication on the size and distribution of the Baltic ringed seal *(Phoca hispida botnica)* population, the number of hauling out individuals in the eastern Gulf of Finland was falling to the range 149-169 individuals in the years 1994-96 (Härkönen & al. 1998). The figures resulted from aerial surveys done over the Russian part of the gulf, the only area that was covered by ice suitable for reproducing during the census period.

The results were achieved by applying the strip census technique. However, a Mi-8 helicopter was used in the year 1994 and an An-2 aircraft in the years 1995-96. The logistic change could have an unknown influence on the results. In addition, it was not possible to carry out flights over the wide boundary zone between Finland and Russia. Therefore, an extrapolation of the results to cover the whole ice field was problematic. Whether the occurrence of ice only in Russia gather ringed seals also from the open sea in Estonia and Finland is not known.

Because of the difficulties in evaluating the results, it became unclear whether the ringed seal stock had recovered or not from the high mortality that occurred in the eastern Gulf of Finland in the late autumn 1991 (Westerling & Stenman 1992, Stenman & Westerling 1995).

Material and methods

Monitoring the occurrence of ringed seals in the Gulf of Finland is very difficult because of many wide border and military areas with restricted or prohibited access. Getting a flight permission requires lot of time or will not be received at all. In addition, the great differences between the years in the ice situation cause problems for evaluation of the results.

The amount of ringed seals hauling out on stones or skerries near the coast have been observed off the peninsula Kurgalsky in Russia during different periods of time in May-June and September-October in the years 1997-1999, 2001, and 2004. In the years 1995-1997 also motor or sailing boats have been used to search for new hauling out areas near the gulf islands.

It has not been possible to use this method in Finland, because the occurrence of ringed seals on such stones is at present very sporadic. On the other hand, in the springs 2001 and

2004 grey seal hunters have been able to observe how and in which numbers ringed seals gather on the last ice fields of the gulf, situated then in the national park near the border zone. Finnish Game and Fisheries Research Institute (FGFRI) have been informed about the observations.

FGFRI carried out aerial censuses in the Gulf of Finland over the Finnish sea area for the first time in March 30, 1999, and then over the Esthonian and Finnish sea areas in April 20-21, 2003. During the first flight the ice covered only the Finnish and Russian sea-areas, but during the next flights the ice situation was normal, the Gulf being totally covered. An upper wing Cessna 180 rigged out with skies was used. The flight altitude was 90 m, and the method also otherwise the same as the one used earlier in other gulfs of the Baltic Sea (Härkönen et al. 1989).

FGFRI has carried out aerial censuses also together with the Russian seal research group on April 21, 2002, and on April 7, 2004. The flights were done over the last ice fields in Russia, now using a double wing An-2. The flight altitude was 100 m, and the method modified for this aircraft but still based on census strips.

Results

Off the coast of the Kurgalsky peninsula a greatly varying number of ringed seals have been observed in the years 1997-2001 with the maximum figure 56 individuals. The figures show neither an increasing nor a decreasing trend. Also in the year 2004, the maximum was 56. Ringed seals have normally been observed in small groups or solitarily also near the gulf islands. During summer the ringed seals are presumed to dwell in the deepest waters of the gulf.

In the spring of 2001 the ice cover in the Gulf of Finland was formed late and was strongest in March. Later in the spring, the last ice field extended to northeast from Gogland up to the national park in the Finnish sea area. The Finnish grey seal hunters working here on April 24 observed ringed seals in five areas, about 300 individuals altogether. They also spotted lots of ringed seals on the Russian side of the border (Harri Piispa, lit. inf.). After an ice winter of the same type, in the spring 2004, April 16-18, the hunters again observed 63 ringed seals on the ice field along the boundary zone.

The first aerial survey was carried out on March 30, 1999, and it covered the Finnish sea area from the longitude of Helsinki to the eastern border, 127 km^2 in totally. If the scanty result of 13 observed ringed seals (among them 3 pups) is extrapolated to the whole pack ice field, a hauling-out number of 141 individuals for the Finnish sea area will be received. (Theoretically: If the result is extrapolated also to the Russian pack ice field, over which no flights were made, the hauling out number for the gulf would be about 340 individuals.)

The second aerial survey was carried out over the Russian sea area on April 21, 2002. It was delayed by problems concerning flight permission and bad weather. When the flight finally could be made, there was ice on about 200 km^2 off the Berezowyi archipelago outside Primorsk only. The census strips covered 25 % of the ice field. Together 41 ringed seals were observed on the strips, which makes in total 164 hauling out individuals.

The third aerial census was carried out in idealistic weather conditions on April 20-21, 2003. It covered the whole Finnish sea area from the longitude of Helsinki to the eastern border, as well as the middle part of the Esthonian sea area (Fig. 1). The flights took together five hours, but only two ringed seals were observed on the strips, both on the Finnish side. The result pointed out, that during a normal ice winter the ringed seals nowadays are really rare both in the Esthonian and the Finnish side of the Gulf of Finland.

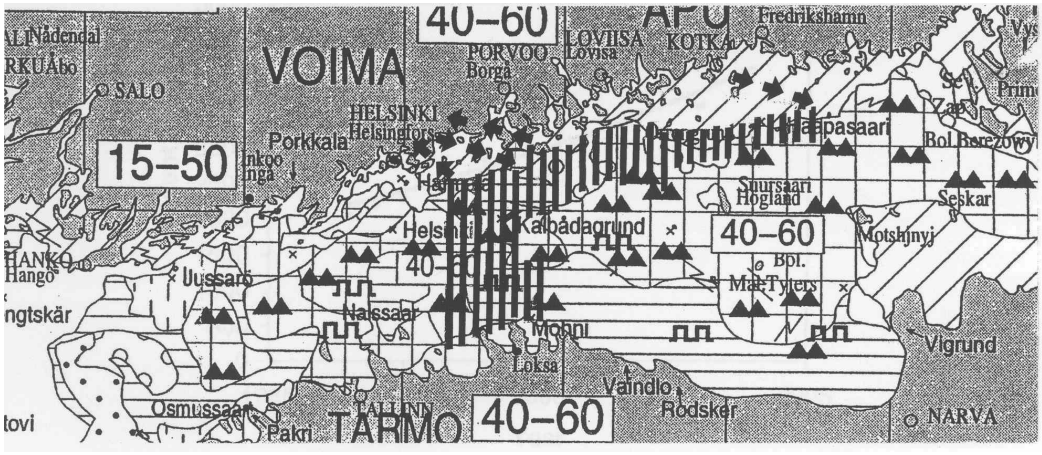

Fig. 1. The flight strips on April 20-21, 2003, over the eastern part of the Finnish sea area and the middle part of the Esthonian sea area in the Gulf of Finland. (Ice chart made by the Finnish Institute of Marine Research.)

Therefore, an attempt was immediately made to carry out a census flight also on the Russian side. Unfortunately, the flight permission was delayed until the start of a rainy period, and no fights could be made.

Even the fourth aerial census was delayed by flight permission difficulties and bad weather. Finally, the flight could be carried out on April 7, 2004, in good weather over the Russian sea area. It covered 170 km^2 of census strips, but surprisingly only three ringed seals were observed. The ice field was moving towards the boundary zone against Finland, and probably had already brought the ringed seals into an area prohibited for aircrafts. On the Finnish side, however, grey seal hunters later on saw many ringed seals.

Conclusions

Though the scanty and dispersed results do not give possibilities for statistical analyses, it is probable, that no more than a few hundred ringed seals really are left in the eastern Gulf of Finland. There is no indication that the local ringed seals are clearly recovering from the high mortality occurred among them in late autumn 1991. The obtaining of better results needs much more effective census work during the ice period in such a way that censuses can be made simultaneously on the Finnish and Russian sides. The importance of monitoring the numbers and occurrence of the ringed seals in the Gulf of Finland, is accentuated by the heavily increasing boat traffic.

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Numbers and occurrence of grey seals in the Finnish sea area in the years 1970-2004

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The documented information about numbers and occurrence of the grey seal *(Halichoerus grypus)* in the Finnish sea area was until the end of 1960s based mainly on bounty statistics, analysed for instance by Bergman (1956), Söderberg (1974) and Helle (1979). Combining of the statistics with the corresponding data in the Soviet and Swedish statistics has made it possible to examine retrospectively, how the size of the Baltic grey seal population has changed since the beginning of the 1900s (Harding & Härkönen 1999, Kokko et al. 1999). All the studies resulted in a general statement pointing out a drastic decrease in the amount of grey seals, roughly expressed from one hundred thousand to some thousand individuals in the Baltic. It is mere guesswork to judge, how big the Finnish part of the total amount was in the beginning of 1970s.

Material and methods

In the years 1970-71 the Finnish Game and Fisheries Research Institute (FGFRI) distributed an inquiry about the occurrence of grey seals to the coast guard stations of the country. The inquiry was repeated in the years 1978-79, 1981, and 1984-85, now concerning also the summer. Finally, an inquiry concerning only the summer, was sent in the years 1989 and 1996-97.

FGFRI started grey seal censuses in the summer 1974, following the recommendations of the first international symposium on the Baltic seals, in Lidingö, Sweden. During the first years the censuses covered only the eastern part of the Gulf of Finland. Later they were extended on some occasions also westwards to the Southwestern Archipelago (consisting of Åland and the Archipelago Sea), which is the most important distribution area of the species. The census method by boat in summer became much more efficient when the new WWF seal research group started to use it in 1986. The group – in which FGFRI was represented from the beginning until the autumn 2000 – was founded with significant economical support from Silja Line. In the Gulf of Bothnia, the censuses by boat were started in late 1990s, the North Quark being the most important study area.

The working group made lots of observations also on grey seals on ice fields in connection with a programme for tagging pups in 1986-93. The activity was possible, because the Coast Guard allowed the group onboard boats operating along the boundary zone. While the boats were resting inside an ice field, an opportunity was given to search for pups.

The ice fields with hauling out grey seals were observed in wider areas when a researcher had access to a coast guard helicopter on patrol flights over the Gulf of Finland. This has happened 27 times in 1975-97.

In 1994-2000 a researcher also had access to the coast guard aircraft in the turn of May-June. The patrol flights over the Gulf of Finland and Southwestern Archipelago were planned to pass by the islets on which grey seals normally haul out. The pilots also informed about their grey seal observations from patrol flights over the Gulf of Bothnia.

The most efficient method for monitoring the grey seal numbers has been the ordinary aerial censuses, carried out in 1974-2004. They have been made in the turn of May-June, during the moulting period of the species. In the northwestern part of Åland, also two Swedish islets very near the border have been observed, because they belong - in a bio-geographic sense – to the archipelago of Åland. The grey seal groups move across the boundary zone there, and it is impossible to determine which of the countries they belong to. Therefore, all the seals counted there have been included in the Finnish figure. The same problem exists in the North Quark, although not in a large scale. In addition, over these two areas the flights have been extended in some occasions to the nearest Swedish archipelago in order to be sure that the grey seal groups have been hauling out at the same time on both sides of the sea.

Since 1986 the groups of grey seals hauling out on islets have been photographed in order to count the number of individuals from slides (which can bee analysed carefully by projecting them on a paper for marking the individuals). During the same period of time in the Bothnian Bay, groups of grey seals have been searched also over the last ice fields, on which they tend to gather and haul out.

The total number of flights made in 1974-2004 is about sixty. It is clear that the technique has improved with the experience. For instance, there is sometimes a need for approaching a big and dense group so closely that the grey seals start to straighten up, which makes the group more open. Efforts have also been made to photograph over the group downwards as vertically as possible.

Results and conclusions

Only some results are given in this connection, due to the big diversity and unevenness of the material. The period of 35 years is divided in shorter parts according to the characteristics of the methods. By this means it is possible to get a more reliable view on the development of the numbers and occurrence of grey seals hauling out on islets in the Finnish sea areas.

In the period 1970-74 the protection of the grey seal was improved in the Soviet Union as well as in Sweden. In Finland however, the species was still considered a noxious animal, free to catch all the year round. The knowledge of its abundance and distribution was mainly based on observations made by the hunters who saw pups on floating ice fields. The bounties comprised hundreds of grey seals killed by men operating from vessels capable to move in ice. For instance in the spring 1973, when there was very little ice, some ice fields drifted from the Soviet Union, i.e. from an area where no hunting occurred any more. The number of pups solely exceeded 500. The situation was similar in the North Quark. The bounty statistics for the year comprise about 500 grey seals and indicate that the population encountered a serious disaster. Although no systematic seal surveys were

conducted along the Finnish coasts during this period, the existing data indicate that probably only some tens of grey seals were hauling out on islets in the Finnish sea areas, mainly in the Southwestern Archipelago.

In the period 1975-79 single individuals and small groups of grey seals were seen in late spring and during summer quite regularly on the outer islets of the Gulf of Finland and Southwestern Archipelago. This slight increase in numbers was influenced by the closing of the hunting season for the breeding time from the year 1975 onwards and by abolishing the bounty system in the following year. The protection measures were of significant importance, because also the spring 1975 was exceptionally mild. Because of the poor ice condition the grey seals had to breed on very limited areas in the North Quark, the Bothnian Bay and the Soviet part of the eastern Gulf of Finland. From this southern area about 550 pups and many adults were floating on ice to the Finnish side of the boundary zone. If only this figure is taken into account, the size of the Baltic grey seal population had to be at least several thousands in the late 1970s (about 4 000 according to Harding & Härkönen 1999). The ceasing of killing pups even in Finland after the year 1974 showed positive effects with a 4-5 years' time lag, so that the grey seal numbers were increasing because of the new reproductive groups.

In the period 1980-85 there was a considerable growth in numbers of grey seals hauling out on islets. This was confirmed by the surveys and from observations made by the coast guard stations. For instance in June 1983, three groups of about a hundred individuals in each were seen during a single flight in the Southwestern Archipelago, and a boat survey in the same area in the following year resulted in 400 individuals. In fact, the total number of grey seals hauling out in Finland reached the limit of half a thousand. The increase was probably also influenced by closing the hunting in the year 1982. The gradual prohibition of the hunting during the passed eight years in Finland had, however, a deciding effect on saving the population from an imminent collapse. Such a positive change can hardly be explained by the fact, that the heavy load of the pollutants in the Baltic started to come down from the late 1970s when it was at its highest (Olsson & al. 2000), in particularly because the results from the pathological studies show that the grey seal only exceptionally suffer from uterine occlusion (Helle et al., Westerling et al., in this volume).

In the period 1986-93 the boat and flight surveys in the Southwestern Archipelago were made much more efficient because of the activity of the new WWF seal research group. The total number of hauling out grey seals here exceeded 1 000 individuals. For instance in 1989 a single group consisted of 367 individuals, which was a record, and a boat survey in the northwest and northeast parts of the archipelago resulted in a total of 556 observed individuals. The end of killing seals in Sweden near fishing gears in 1986 could also have made grey seals less cautious and easier to observe. The project of pup tagging in 1990-93 showed that grey seals were reproducing in great numbers in the Bothnian Bay, though the observations of hauling out individuals on the Finnish islets in the North Quark still were scanty. Pups were found also in the Gulf of Finland, where the number of grey seals in summer increased to about 50 individuals.

In the period 1994-2004 the efficiency of the flight surveys improved as they were made with two aircrafts in Southern Finland and one in the Bothnian Bay. Particularly during the last years attempts were made to carry out the flights on a strict time schedule to minimise the risk of double counting in the Southwestern Archipelago. This even made it possible to compare the results and evaluate their reliability. At the same time schedule some flights were carried out over the Bothnian Bay in order to observe grey seals on the last ice fields partly covering both Finnish and Swedish sea areas. The highest number there has been so far about 1 800 individuals altogether. Later these grey seals probably moved mostly to the Swedish coast to complete the moult. Because of the simultaneous flights in the south and in the north, the theoretical possibility for double counting was avoided.

During the whole period of 1994-2004 the numbers of grey seals hauling out increased strongly. The total number for the whole country was about 1 500 in 1994 and passed the limit of 2 000 in 1998. In the following years the increase particularly in the Southwestern Archipelago was so strong that it also presupposes movements of grey seals from Estonia and Sweden to Finland. The concentration in the northeastern Åland is a good example. In 1999 the total number of 340 individuals for the whole area was considered very high, but in the years 2002 and 2004 the largest group here already consisted of more than 1 000 individuals.

The increase in numbers is well demonstrated by the figures for the whole country: about 3 000 individuals in 2000, about 5 000 individuals in 2002 and about 8 000 in 2004 (Halkka et al.,in this volume).

The amount of grey seals in Finland during the moulting period is mostly concentrated to the Åland islands, in three important areas: one in the south, one in the north west and one in the north east. The total number for Åland was about 6 000 individuals in 2004. In addition, there were about 1 700 individuals in the southern zone of the Archipelago Sea (where 440 pups were born on islets in 2004), about 500 individuals in the Gulf of Bothnia (mostly near Åland) and some 200-300 individuals in the Gulf of Finland.

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Project “Grey seal in the Kvarken region”

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Seals have traditionally been an important resource for the coastal populations of the Kvarken region. Cooperation of action and information exchange have been active for several hundreds of years. In 2001 a cross-border cooperation project “Grey seal in the Kvarken region” was initiated with financing from the EU structural fund through Interreg III A Kvarken MittSkandia.

Sealing has for various reasons been banned in the two countries between 10 and 30 years. Hunting has been reintroduced in a limited form in the two countries since the stocks have recovered. Efficient maintenance is now necessary if the increased seal stocks, hunting and utilization are to be well managed considering the different viewpoints. The project works at a regional level with knowledge about the situation, action to solve the conflict and comprising the viewpoint: grey seal – “from conflict to resource”.

In 2001 the grey seal project formulated the following common standpoint:

1. The grey seal stock in the Gulf of Bothnia is robust and increasing.

2. The coastal fishery is threatened by the increasing grey seal population.

3. The authorities should devise an administrative plan specifying the desirable level and measures to reach this goal.

4. As long as seals cause damage to the fishing industry, individual professional fishermen should be compensated for the damage.

5. Resources are needed for preventive measures against damage to fishery such as development of gear and methods.

6. When hunting is started, the grey seal is regarded as a taxable and renewable resource, and methods should be managed to hunt seals and utilize the quarry with best available practices. Seals and seal products should be part of the means of subsistence in the archipelago.

7. The necessity for protecting the grey seal is proportioned to the robustness of the stock.

The project consists of three main activity areas:

Joint action in the Kvarken region: Finding a common understanding in the Kvarken region of the importance of the seals from an ecological point of view, as a resource and as a problem in the region.

Seals and fishing: The goal is to reduce the damage caused by seals to fishery, for instance by developing gear, methods and means and in this way to mitigate the conflict between seal and fishery.

Utilizing the seal: The goal is to consider the grey seal as a renewable and taxable resource, which can be utilized in a sustainable way according to a plan of management and thus form part of subsistence.

Achievements include: Action plan for the Kvarken region; Bi-annual information booklets; Introduction of fishing gear from Sweden to Finland; Experience exchange meetings for fishermen and/or gear manufactors; Education package for hunting, utilisation and ice know-how; Sealskin collection for men; Gourmetfood of sealmeat.

The project achievements form the basis for future independent activities. Continuing promotion of ecologically safe maintenance of the existing seal stock will benefit the coastal population and create a framework for the usage of a valuable, renewable resource while ensuring that the ecological balance of the environment is preserved. Increased knowledge and awareness of seals as a resource.

The project goals are to promote ecologically safe maintenance of the existing seal stock for the benefit of the coastal population of the Kvarken Mittskandia area and to create a framework for the usage of a valuable, renewable resource while ensuring that the ecological balance of the environment is preserved. Increased knowledge and awareness of seals as a resource.

In Kvarken Mittskandia region we work with new utilisation techniques and product development in the project “Seals – our common resource”.

Vertical chemical profile of seal blubber

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Vertical chemical profile of seal blubber is determined by analysing different chemical gradients along the whole depth of blubber. The substances of interest include fatty acids which are influenced by the diet in addition to being species-specific and environmental markers like the concentrations of fat-soluble vitamins and persistent organic pollutants. Subsamples at intervals of 3 mm are taken from skin to muscle from frozen blubber. The fatty acids are analysed as methyl esters by gas chromatography. Vertical gradient curves are drawn for the relative amount of each fatty acid in the sample. The shapes of the observed vertical profiles depend on individual's dietary history, endogenous metabolism, current nutritional status and physicochemical properties of each fatty acid. This method, that gives new kind of ecological and environmental information will be validated by analysing the vertical chemical gradients of different individuals from freshwater and marine environments.

Mitigation of seal damages by improved fishing technology

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Since early 1990s, seal-induced catch damages have increased dramatically in the trap-net fishery of salmon and whitefish along the coast of the northern Baltic Sea. In the trials conducted in 2003-2004 in the Bothnian Sea (Merikarvia), five types of salmon trap-net modifications were tested in co-operation with commercial fishermen. These trials demonstrated that the fish bag of a trap-net can be modified to effectively protect the catch from seals. The Swedish pontoon bag (push-up bag) made of double Dyneema-netting was most effective design in preventing seal damages, and it was also a practical and efficient gear in salmon fishery. It is very likely that pontoon trap will become popular in Finland in the coming years. The double-netting folded-hoops trap that was tested first in 2004 showed encouraging results but this design needs some more development. More work is also needed to develop efficient seal-safe trap modifications for whitefish fishery.

It is notable that even when the fish bag is fully protected from seal attacks, the trap-net design still permits an efficient hunting by seals in other parts of the gear, particularly in the wings and middle chambers (funnels). In fact, when the fish bags of all trap-nets are fully protected, seals may start to focus their predation increasingly on the other parts of the gear. To prevent catch losses in those parts of the gear, further development is necessary. The use of proper netting material is crucial. In the traditional traps, a substantial share of salmon catch is captured in the meshes of middle chambers that are made of conventional twisted nylon (PA) twine. In traps where the middle chambers are made of stiff PE-twine, the proportion of salmon caught is significantly smaller. Moreover, seal-induced gear-damages are negligible. Clearly, stiff and thick netting should be used in the chambers and wings to prevent the meshing of fish. The use of large-mesh netting in the wings and certain parts of chambers is another potential solution to prevent the meshing of fish. In such a trap, these parts are made of a mesh size which allows most fish to escape through the meshes when chased by seal. With salmon this strategy may be efficient but with whitefish it may be more difficult to find an optimal mesh size.

When the behaviour of fish and seals in a modified trapnet has been observed with an underwater video camera, salmon and some whitefish were seen entering through the wire-grid into the fish bag. However, sudden gear movements caused by high waves appeared to disturb and delay the fish from entering the fish bag through the grid. Those few underwater observations that have been made of adult seal in the funnel of a modified trapnet have shown that seal may stay substantial time periods in exploring the wire-grid but after while they are turning around. They thus remain outside the fish bag due to the grid. No observations, however, have been made of young seals (pups). They apparently

can squeeze through a markedly small wire gap. More work is still needed to develop an underwater observation system that enables simultaneous recordings from 3-4 cameras and the documentation of seal and fish behaviour in various critical parts of the trapnet (e.g. middle chambers and funnels).

The voluntary logbook for seal- & bird-induced damage in Swedish coastal fisheries

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Since 1996, the EU Fisheries Logbook, which is mandatory for fishing boats of 10 metres length or more, has contained a request that as well as fish catches, seal-induced damage should be reported. Since 1998, the opportunity to supply this information has also been available for smaller boats in the national Coastal Fisheries Journal. However, since it is optional to fill in information about seal disturbance and many fishermen do not in fact bother with this, the data collected in this way is not sufficient to properly monitor the distribution of seal-induced damage in Swedish coastal fisheries. In addition, only a monthly summary of each fisherman's catch is reported in the Coastal Journal, which makes the information difficult to use. Finally, up until 2004 it was not mandatory for fishermen operating in private waters to report their catches into the official catch statistics at all.

A supplementary system for monitoring the extent of the conflict between both seal and bird populations and the fisheries along the Swedish coast is therefore essential. For this reason, at the beginning of the 1990s the 'Seals & Fisheries' Project of the National Board of Fisheries implemented a new system, now known as the 'Voluntary Logbook for seal- & bird-induced damage in Swedish coastal fisheries', whereby collaborating fishermen keep a detailed daily log of fish catches, by-caught seals and seal disturbance both to fish and fishing gear.

Until 2003 the logging system focused on seal-fishery interactions in the salmonid fisheries in the Gulf of Bothnia, but it also included some records from the Baltic proper and the Swedish west coast. In 2004, the system was extended to collect more detailed information about by-caught birds and bird disturbance. Some fishermen also use it to record fish by-catches (discards). The geographic focus has also been extended and today the Voluntary Logbook samples more or less all of the various coastal fisheries along the Swedish coast.

In 2004 over 5,000 fishing records were noted by some 60 fishermen. Since 1993, in total nearly 38,000 records have been collected and the information has found a number of uses, for example in assessing financial losses in the coastal fisheries due to seal damage, and in the evaluation of the newly introduced 'Push-up trap', an advanced seal-safe trap net, and by-catch of seals. So far some 130 different fishermen fishing with 30 different types of fishing gear have participated in the Voluntary Logbook system at one time or another. As a compensation for the time the extra paperwork takes and also as an encouragement to continue the recording, a small payment is distributed each year to participating fishermen. To ensure that the information is properly recorded, all fishermen are contacted personally on a regular basis, and in some cases their work is checked up on

by personal observations. These days the Voluntary Logbook scheme is administered by the Seal group of the Institute of Coastal Research.

The presentation will describe the Swedish Voluntary Logbook for Seal- and Bird-induced Damage in the past, present and future.

More specifically, preliminary results of seal disturbance from 2004 in the gill-net and long-line fishery for cod in Sweden will be presented. The Voluntary Logbook randomly sampled fishermen representing 3 % of the Swedish gill-net fishery for cod in 2004 and according to the information recorded, widespread seal disturbance occur in this fishery. Seal-induced damage to fish or fishing gear in the gill-net fishery was noted in 34 % of the fishing records in the Voluntary Logbook, in comparison with the official catch statistics where less than 4 % of the fishing records had a note of seal disturbance. Also, the weight proportion of the seal damaged cod to the total catch in the Voluntary Logbook was 10 times higher than it was in the official statistics. Thus, to get a more accurate picture of seal-induced damage in Swedish coastal fisheries, it is necessary to collect additional information to supplement the official statistics.

Seal monitoring in Latvia: 1999-2004

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The monitoring of seals has been carried out in Latvia since 1999 as a part of a State financed monitoring program. It includes the tabulation of dead and living seals in the sea, on the shore and in fishing gears, as well as the determination of species, age and health conditions of the seals found dead. The direct survey on the shore is carried out in several coastal areas - Baltic Sea Protected Areas. Data on seal by-catch are collected from logbooks of more than 30 respondents acting along the whole Latvian seacoast as local contributors. It is part of data collection scheme for coastal fisheries introduced by Latvian Fisheries Research Institute in 1994. The questionnaire and information from other sources, including the media, were used to collect additional data for the whole coast of Latvia. The first quantitative data on damage caused by seals to salmon and cod catch were collected in 2002 and 2003.

The number of seals found dead on the shore between 1999 and 2004 varied annually from 1 to 15 per 100 km of surveyed coast. The total number of seals reported as found dead on the Latvian coast varied from 6 to 51 per year. Of 60 animals identified, 55 were grey, and only 5 were ringed seals. 80% of all identified Grey Seals were immature animals. Furthermore, adults have been recorded only in more recent years.

The number of by-caught seals recorded in logbooks varied each year from 14 to 32. If the results are extrapolated to the whole Latvian coastal fishery using data on fishing efforts, the by-catch estimates were 200 - 400 animals each year. Most of by-caught animals are also reported as Grey Seals. The bulk of by-caught seals are recorded in spring, primarily in April and May. Another period of seal appearance is autumn, mainly October. In most cases by-caught seals are reported from the Riga Gulf.

Results obtained by post-mortem examinations of 9 by-caught Grey Seals during 2001 - 2003 will be presented in a separate report in this volume.

Examination of seal damages to fish catch revealed insignificant losses in cod fishery, whereas 66% of salmon caught during the spawning migrations in coastal waters appeared to be damaged.

Magnetic resonance imaging in the study of the Saimaa ringed seal anatomy

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Saimaa ringed seal *(Phoca hispida saimensis)* is a rare subspecies of about 270 individuals endemic to lake Saimaa in Finland. Magnetic resonance imaging (MRI) is a modern method based on strong magnetic field. It is capable to distinguish normal anatomy and pathological changes. The aim of this study was to create a practical application of MRI to study post-mortem morphology of the Saimaa ringed seal, to describe its normal macroscopic MRI anatomy and to gather information from aspects not readily accessible in routine autopsy.

Material and methods

In this study we imaged with the permission of the Finnish Ministry of Agriculture and Forestry a female Saimaa ringed seal cadaver found dead in a fishing net on February 16th 2002 in Lake Pihlajavesi (part of the Lake Saimaa system, 686360:359760). Because of ice-cold water no signs of remarkable autolysis were found. The seal weighted 40 kg and was estimated to be one year old. The examination was performed in a 1.5T strong magnetic field where radio wave frequency energy is transmitted to tissue. The received signal results from water molecules, which are influenced by their environment. MRI was performed in Jyväskylä, Finland using a General Electric 1.5Tesla CV/i human magnetic resonance imaging equipment (Milwaukee, USA) owned by Magnetic Resonance Imaging of Central Finland. The seal was placed into the equipment in a ventral and cranial position. A head coil was used for the head region and a body coil for the rest of the seal. Both T1 and T2 MR-contrasts in axial, coronal and sagittal planes were obtained. In the axial plane the slices were 4.5 mm thick with a 0.5 mm interslice gap in the head region and 8.0 mm thick with a 2.0 mm gap for the rest of the body. For comparison the cadaver was refrozen after the study and cut into slices and photographed.

Results

A 4-5 cm thick layer of blubber covered the whole carcass being thinner only in the head region and in the extremities. The whole volume of the carcass was 37137 cm3 integrated graphically from axial T2 images and the volume of the blubber 18 526 cm3 or 49.9 % of body volume.

The grey and white matters of the brain were clearly distinguished from one another. The cerebral cortex was densely convoluted and the gyri and sulci were detected as well corpus callosum, pituitary gland and the ventricles (Fig. 1). The volume of the brain was 188 cm3 or 0.5% of body volume. The auditory canal was long (7 cm) and had multiple curves. The acoustic bullae with the senses of hearing and equilibrium had large volumes. The tympanic cavity was large and covered by a light tissue in T2 images. In the inner ear cavity the cochlea could be visualized in both sides. In the eye region could be seen the iris, a round lens, the front chamber and the optic nerve.

In the abdominal and thoracic region all main organs were identified (Fig. 2 and 3) including the oesophagus, the trachea and main bronchi, the lungs, the heart, the liver, the pancreas, the kidneys, the urinary bladder, the ventricle, the intestines, the rectum and the vagina. Uterus was minor because of immaturity. The main parts of the skeletall and muscular system were also identified.

Several characteristics of diving response were detected. In the larynx the soft epiglottis still covered the trachea tightly. The arteries were narrow while the venous system was more obvious. In the abdomen most voluminous structures were the dilated venous sinuses and vena cava posterior which were full of coagulated and non-coagulated blood. The same mass continued in the vena cava posterior through abdominal sphincter to the mediastinum and to the right side of the heart. The right ventricle and the chamber were extremely stretched compared to the left side of the heart.

Discussion

The main advantages of MRI are the excellent capacity to distinguish tissues and tissue margins and the possibility to observe structures without intervention. It can be performed fast and easily and it enables the studying of both alive and dead tissue. The detection limit of MRI is approximately 0.1 cm compared to the 0.5 cm of macroscopic dissections.

The examples from the brain and the inner ear region demonstrate the ability of this method to distinguish tissue margins. The tympanic cavity was covered by a highly vascularized tissue, the corpus cavernosum. This tissue probably regulates the volume of the cavity in different pressure condition.

The musculature was strong and symmetric. The strongest muscles in the paraspinal area are for swimming and in the ventral and proximal sides of the upper extremities due to the need to haul up.

As the seal descends into water, blood from superficial tissues and non-vital organs enters the inner regions of the body and is stored in the hepatic sinus and vena cava posterior. Flow into the thoracic portion of the inferior caval vein and to the right side of the heart is prevented by a sphincter system at the level of the diaphragm. In this case the pressure exerted on the circulatory system was, however, transmitted until to the right atrium and to the right ventricle evidenced by their expanded volume. This could partly be due to the lethal entanglement, but the great capability and elasticity of the right cardiac walls indicate

that they have evolved to withstand this expansion. Inside the spinal canal two large veins with multiple anastomosis controlled the intracranial pressure. The post mortem preservation of these findings show that the seal suffocated and did not drown.

Fig.1. Sagittal T2 image from Saimaa ringed seals head. Oe = olfactory epithelium, E = eye, Oc = oral cavity, Nc = nasal cavity, To = tongue, Vc = vocal cords, Ce = cerebrum, Cc = corpus callosum, Cr = cerebellum, Pg = pituitary gland, Ds = dorsum sellae, P = pons, Mo = medulla oblongata, Cm = cervical medulla, Cs = cervical spine, Bl = blubber

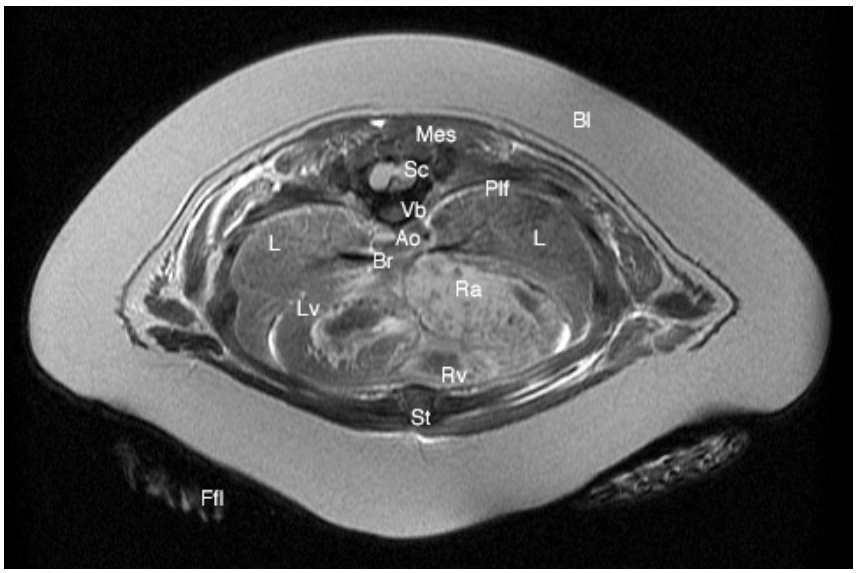

Fig. 2. Axial T2 image from Saimaa ringed seals thorax. The hearts right side is filled by coagulated blood. Bl = blubber, Mes = musculus erector spinae, Sc = spinal canal, Vb = vertebral body, Plf = pleural fluid, Ao = aorta, L = lung, Br = bronchus, Lv = left ventricle, Ra = right atrium, Rv = right ventricle, St = sternum, Ffl = front flipper.

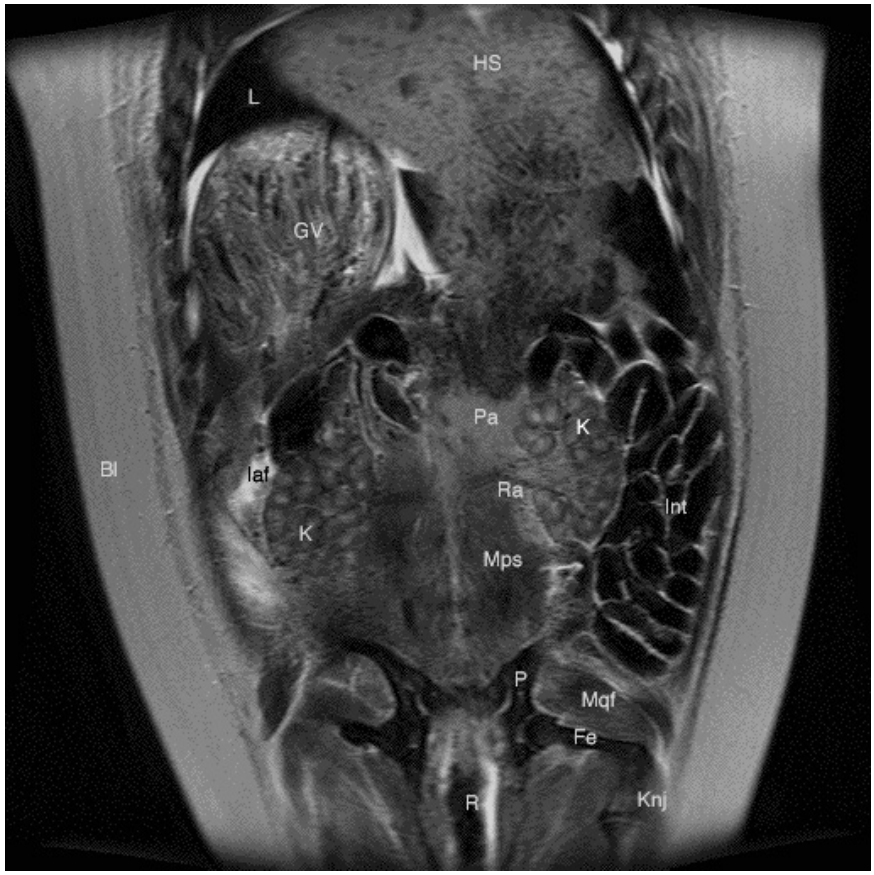

Fig. 3. Coronal T2 image from Saimaa ringed seals abdomen. HS = hepatic sinus, L = liver, GV = gastric ventricle, Pa = pancreas, Bl = blubber, Iaf = intra abdominal fluid, Ra = renal arteries, K = kidney, Mps = musculus psoas, Int = intestinum, P = bony pelvis, Mqf = musculus quadriceps femori, Fe = femur, R = rectum, Knj = knee joint.

Seal-fisheries interactions in Lake Ladoga

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The Ladoga ringed seal (*Phoca hispida ladogensis*) is a post-glacial relic, as are two other subspecies, the Baltic ringed seal *(P. h. botnica*) and the Saimaa ringed seal (*P. h. saimensis*).

In the Red data books of Russia and the Leningrad region it is classified as status 3 (Least Concern) and in the IUCN classification as Vulnerable. The Population size at the beginning of the 20th century was about 20 000 seals **(**Chapski 1932) and in mid 1970's ca 3500-4700 seals according to Antoniuk (1975). According to recent studies, the current seal population in Lake Ladoga is estimated to be some 3000 to 5000. The distribution area has also diminished, since the1990's seals were not observed in the most southernmost part of the lake which is the Bay of Petrokrepoct.

During 1924-39 bounties were paid on 15336 seals from northern Lake Ladoga (Jääskeläinen 1942). Statistics from 1950 to 1974 suggest that 500 to 1000 seal were shot by fishermen annually; e.g. the collective farm of Kalinin obtained a quota of 200-300 ring seals every year and the mean harvest by fishermen of seals was annually approx. 500. The state also encouraged amateur and sports hunters to kill seals. The total harvest in 1950-1974 can be roughly estimated at some 10 000 - 20 000 seals. The official bagging of ring seals was terminated in 1975 and nowadays the ringed seal is protected by law.

There is no reliable statistic of seals caught in fishing tackle. Rough estimates are that late into the Soviet era during the 1980's around 200-400 seals died due to fishing tackle (e.g. Sipilä et al. 1996). We interviewed 36 fishing crew leaders, mainly fishing ship captains, from southern Lake Ladoga and 17 from northern Lake Ladoga. From the southern part of the lake 30 crew leaders informed us that at least one seal was involved in a bycatch and correspondingly in the northern part of the lake only three. According to the crew leaders at least 351 seals had been tangled up in fishing tackle during 2003 (Table 1), while official statistics from the same year are only 60 bycatches in Lake Ladoga.

During the open water period there were 450 km in total of fishing nets in daily use on the lake. Unfortunately there is no reliable estimate of the amount of economical loss to fishermen caused by seals. The conflict of seal-fisheries interactions displays in the damage caused to fishery by seals. According to the fishermen the seal-fisheries interactions are in competition for fish. We feel that this is more connected with the decrease in fish numbers in Lake Ladoga, but it is not connected with the the number of ringed seals.

The figures from 2003 suggest that at present the mortality rate of seals in fishing tackle is most likely the main cause of death to seals in Lake Ladoga as it is also in Lake Saimaa.

Table 1. Ladoga seals mortality in fishing tackle in 2003 according to interviews of fishermen.

Fishing plant	Seals caught
Shilsselburg	133
Novaiy Ladoga	152
Olantes-Vilitsa	50
Valaam	9
Pitkäranta	No data
Sortavala	No data
Lahdenpohja	No data
Priozerks	7
Total	351

When fishing in Lake Ladoga increases, there might also be stronger interactions between seals and fisheries. Fishing probably will pose a serious threat to the seal population in the long run (Sipilä at el. 2002). Generally better estimation of mortality of Ladoga seals, especially to fishing tackle, is needed for management of the Ladoga seal population.

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Pathology of seals from the Finnish coastal waters, Lake Saimaa and Lake Ladoga in the years 1982-2004

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Amongst the investigation results concerning Baltic seals, phenomena like uterine occlusions (Helle & al. 1976), hypertrophy of the adrenal cortex and certain jaw bone defects (Bergman & Olsson 1986) have received great attention. Connections between these changes and the content of environmental pollutants in seals have been searched for by correlation analysis. Fragmentation of the sample material according to time and geographical distribution, as to sex and age groups in relation to numerous toxic compounds, have to a large extent complicated the reaching of reliable conclusions. For instance the supposed causal connection between uterine occlusions and the PCB-content has been strongly doubted (Addison 1989).

In our investigations, because of the above mentioned difficulties, we have left aside all speculations on connections between pathological changes and pollutants, and concentrated on the presentation of our observations, even though we have secured thousands of tissue samples for chemical analysis. The abundant results of these analyses have been presented e.g. on meetings of Nordic game pathologists and veterinary symposia, where attention also was called to the said difficulties (Westerling & Stenman 1992; Stenman, Westerling & Ekman, unpubl.).

Material and methods

The material consists of 304 grey seals *(Halichoerus grypus)*, 156 Baltic ringed seals *(Phoca hispida botnica)*, 66 Saimaa seals *(P.h. saimensis)* and 30 Ladoga seals *(P.h. ladogensis)*. From the two first mentioned 22 and 169 separate tissue samples respectively were examined. Besides, a few diagnoses were recorded from cadavers unsuitable for proper autopsy; i.e. 37 grey seals, 33 Baltic ringed seals and 9 Saimaa seals. The number of 156 Baltic ringed seals includes the 12 specimens investigated in connection with the high mortality in the species which occurred in the fall of 1991 in the eastern Gulf of Finland (Westerling & Stenman 1992, Stenman & Westerling 1995).

The autopsies on the Baltic seals were principally done at the National Veterinary and Food Research Institute (NVFRI) in Helsinki, on the Saimaa seals at the Joensuu University and the Ladoga seals in Sortavala veterinary station in Russia. At the autopsies, tissue samples were taken for chemical analysis and when needed for bacteriological and

histological investigations. The stomachs and intestinal tracts were delivered to the Finnish Game and Fisheries Research Institute (FGFRI) for diet analysis and parasite count. All histological slides were prepared at the Pathological Department of NVFRI, and age determination according to layers in canine teeth cementum at the FGFRI.

The material was mainly collected by FGFRI, the bureau of Åland environmental administration, Finnish Forest and Park Service and in Sortavala by a local fishermen organisation. The collecting was economically supported partly by WWF Finland.

Results

Due to the collecting system a large part of the material represents seals drowned in various kinds of fishing gear, the fate of young individuals in particular. In the whole material 271 grey seals, 123 Baltic ringed seals, 33 Saimaa seals and all the 30 Ladoga seals were judged to have lost their lives of physical causes brought about by man. Furthermore, 5 grey seals, 16 Baltic ringed seals, 7 Saimaa seals and 1 Ladoga seal probably had drowned, which was indicated by the autopsy picture, even if this could not be confirmed by anamnetic information. Alltogether this part of the material, however, gives certain information as to ailments occurring in the seal population.

The natural causes of death, illustrated by the rest of the material, show a large variety of ailments and diseases from the perinatal period up to high age. Certain differences in disease patterns and incidence between the taxons seem to occur. Where the grey seal is concerned, the occurrence of perforating colitis, malignant lymphoma and a high frequency of paradentotic bone lesions, the last mentioned even in otherwise healthy aninmals are worth mentioning. In the Baltic ringed seals 3 cases of intestinal torsion *(Volvulus mesenterialis jejuni)* were recorded, one case in the Saimaa seal, and 2 cases in the grey seal.

Outwearing of denture seem to be a problem in some old Baltic ringed seals, but without the above mentioned cheek bone lesions. In three Baltic ringed seals with outworn denture the emaciation was accompanied by hydronephrosis due to renal calculi, arteriosclerosis and chronic nephrosis respectively. In both the Baltic species emaciation and pneumonia due to beta-hemolytic streptococci were recorded in pups, some of them obviously orphans.

Except for the lymphomas mentioned above, only one case of malignant neoplasm was found, a cholesteatome-like tumor in the mediastinum of a 40 years old grey seal female caught in a trawl. A variety of less severe ailments were also observed in speciments caught in fishing gear, lacking regard to species. Two cases of congenital anomaly were found, a sub-aortal defect in a grey seal pup and a defective ureter leading to unilateral hydronephrosis in another.

The uterine state of 25 grey seals, 37 Baltic ringed seals emanating almost exclusively from the southern coast of Finland (Fig. 1), 7 Saimaa seals and 5 Ladoga seals, all in mature age, was examined. The uteri of the Baltic ringed seals aged 3-15 years were macroscopically normal. Amongst the older 16 specimens 5 cases of bilateral and 2 cases of unilateral occlusions were found. A bilateral uterine occlusion was found in a grey seal 33 years old, of a definitely other character than those found in ringed seals. All grey seals over 36 years old had various numbers of leiomyomas of various sizes in the uterine wall.

In connection with the investigation concerning food particles in stomachs and intestines of grey seals hunted on ice or skerries (see Stenman and Pöyhönen in this volume), leiomyomas were also found in the intestinal wall of a few individuals out of 106 specimens subjected to macroscopic pathological study.

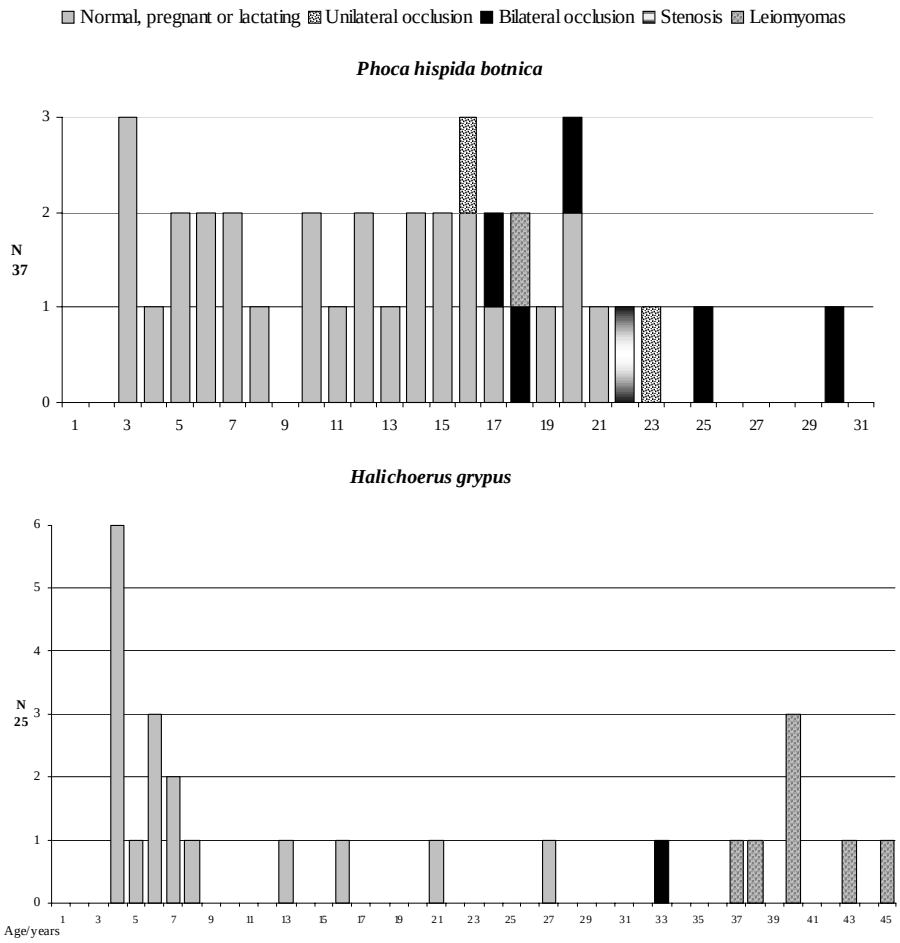

Figure 1. Uteri from mature females, mostly found dead in fishing gears or on land 1982-2004.

The incidence of heartworms *(Dipetalonema spirocauda)* was as high as 19% in 111 Baltic ringed seals under one year of age from the southern coast areas, the incidence being highest in the eastern parts, but was found in only one specimen out of 13 from the Bothnian waters. In three individuals the parasite was judged to have caused the death of its host. The highest number of worms counted in the right chamber and pulmonary artery was 113. Heartworms were not found in any ringed seal over 3 years of age, and in none out of 325 grey seals investigated. No heartworms were found in the Saimaa seals, but in two of the Ladoga seals.

Gastrointestinal nematods *(Contracaecum osculatum)* were found in almost all the grey seals, in some cases in high numbers. The acanthocephalan worms *(Corynosoma strumosum & semerme)* might constitute a significant health factor in individual seals. Both species were present in all the seal groups, in practically every individual over 2 months of age, as a rule in numbers increasing with age of the host. Their density was highest in the colon and the aboral part of the small intestine, the total number reaching in some cases several thousands. (Stenman & Pöyhönen, unpubl.).

The infestation rate of lungworms *(Parafilaroides sp.)* was high in all the populations, except for the Saimaa seal, where only 3 cases were recorded. A number of other more or less sporadically occurring parasites like lice, cestodes and trematodes were also recorded.

Conclusions

The survey revealed a wide variety of ailments and diseases in a frequency comparable to that which is met with in our terrestrial mammals. One distinct difference was obvious though. Old senile individuals are very rarely found in populations of wild animals with natural predatory enemies in their habitat. Because of the few recorded cases of actual disease, the material is insufficient for a statistical study of disease versus results of the chemical tissue analyses made on the animals reported on here. As a matter of fact, disease and death are natural elements of life.

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Management of the seal populations in the Baltic area

This summary gives information about certain actions in management of the seal populations in the different Baltic countries in the Baltic area. It has been compiled according to the national contributions on the item (by Ivar Jüssi/ Estonia; Eero Helle and Olavi Stenman/ The Mainland Finland, Tommy Blomberg/ Åland, the autonomic part of the country, and Tero Sipilä/ Lake Saimaa; Harald Benke, Wolfgang Dinter, Klaus Harder and Ursula Siebert/ Germany; Valdis Pilats/ Latvia; Arûnas Gruðas and Pavel Kulikov/ Lithuania; Iwona Kuklik and Krzysztof E. Skóra/ Poland; Vladimir I. Chernook, Vladimir V. Melentiev and Roustam Sagitov/ Russia, and Nikolai Medvedev, Tero Sipilä and Mikhail V. Verevkin/ Lake Ladoga; Britt-Marie Bäcklin, Björn Helander, Olle Karlsson, Sven Gunnar Lunneryd and Ivar Sundvisson/ Sweden. Under each of the chapters the countries are dealt with in alphabetic order. Monitoring and research have not been included in this compilation any more; they become apparent e.g. in the abstrcts of this collection.

Full protection

The seals are fully protected with exception of the grey seal in Finland and in Sweden. However, the decree gives a hunting period (1st September - 15th October and 16th April -31st May) since 1st August, 1996, for the Baltic ringed seal in the Mainland Finland, but so far no licenses have been admitted by the Ministry of Agriculture and Forestry. In the Finnish Red List both the grey and ringed seal are classified as NT (Near Threatened) and in the Swedish list the ringed seal as NT.

According to Estonian Red List (1998) Baltic ringed seal is classified as VU (vulnerable) and grey seal as CD (Care Demanding). Both species are under the II protection category (fully protected) in Estonian Nature Protection Law.

Grey seals are fully protected pursuant to the national species protection act (1999) and not covered by the national hunting law of the Federal Republic of Germany at all.

The protection status of harbour seal in the Baltic is classified under the Swedish Red List as a genetically distinct, small (about 700 specimens) subpopulation, and EN (Endangered).

Current conservative management of seals in Polish waters is a consequence of the high conservation status of all Baltic seal species given by international conventions and agreements (HELCOM Recommendation 9/1, Bonn Convention (App. II), Bern Convention APP. III), Habitat Directive (APP. II and V), IUCN Red List 2000). The seals have been protected by law since 1984. Until present day a recolonisation of historical habitats by grey seals have not been observed. The recent regulation of the Ministry of Environment (Dz.Ust. 220 / 2237, 28.09.2004) has given the highest conservation priority to the grey seal and recommended its active protection.

The protection status of Saimaa ringed seal has been pronounced by the following orders: 1) IUCN Red Data Book (1996), EN, 2) National Red Data Book (2000), EN, 3) Habitat Directive (Council Directive 92/43/EEC, 4a, 4) Federal Register (1993), EN and threatened.

The protection status of Ladoga ringed seal has been pronounced by the following orders: 1) IUCN Red Data Book (1996), VU, 2) Red Data Book of Russian Federation (2001), 3) Red Data Book of Leningrad Region (2002), LC (Least Concerned), 4) Red Data Book of Karelian Republic (1995), R (Rare).

Hunting

Estonia and Latvia. The hunting ban was introduced in 1975 and 1980 for the grey seal and the Baltic ringed seal, respectively. Both species are on the national lists of particularly protected species since 1987. The hunting law does not cover the seals. However, in Latvia pursuant to the law on protection of species and biotopes (issued 16 March 2000) it is possible to obtain a licence to take seals if the necessity for it can be justified.

Finland. Hunters have to apply for licenses of grey seal hunting both in the Mainland Finland and in Åland. Hunting should be carried out particularly in areas where damages caused by seals to fisheries are noticeable. In addition, 5-10 Baltic ringed seal have been sampled yearly in the Bothnian Bay for scientific purpose to monitor the health and reproduction statuses.

Germany. The possibility to hunt grey seal was terminated in 1955 by the former German Democratic Republik. Hunting of the harbour seal on the Baltic coasts has not been an issue after the 2. world-war on the German Baltic Sea coasts in general. Presently the quota on common seals is zero in all coastal states. Additionally, the potential hunting season on common seals covering 1.5 months (Sept. 15 to Oct 31) had been closed completely in Schleswig-Holstein state since 1985.

Sweden. Since 2001 a “protective grey seal hunting” (in order to mitigate damages on fish catches and gears) is introduced in specified areas in the northern and central parts of the Swedish Baltic waters.

Hunting period

Finland. The common hunting year in the Mainland Finland starts 1st August and ends 31st July. The period for grey seal hunting has been made longer as follows. 1) Since 1st August, 1996: 1st September - 15th October and 16th April - 31st May. 2) Since 1st August 2000: 16th April - 15th October. 3) Since 1st August 2004: 16th April - 31st December.

In Åland the period was latest from 20th April, 2004, to 31st January, 2005. However, hunting is not allowed inside Natura-2000 areas during 1st May - 1st August, neither year around in the three most important grey seal areas.

Sweden. Since 2001 the period for grey seal hunting has been 16th April - 31st December after a yearly decision of the Swedish Environmental Protection Agency.

Catch

Finland. During the last three hunting periods the grey seal quota has been enlarged in the Mainland Finland as follows: 230>395>490 (for the ongoing period). However, the problem has been to fulfil the quotas. According to the statistics of the Hunters’ Central Organization the catches for the two first periods mentioned were only 128 and 135 specimens shot.

Table 1. The grey seal hunt in Finland from 2001 to 2004 separately for mainland Finland and Åland.

	Mainland Finland		Åland		Total		
	Quota	Seals shot	Quota	Seals shot	Quota	Seals shot	Percent
2001	100	60	89	54	189	114	60
2002	180	92	156	95	336	187	56
2003	230	128	171	82	401	210	52
2004	395	135	232		627	135	22
Total	905	415	648	231	1553	646	42

In Åland the tendency has been similar (Table 1). Here licenses have been granted also to fishing farms for eliminating grey seals specialized in taking parts of fishes through the net.

Sweden. In the years 2001-2004 the grey seal quota per county adding has been about 150 specimens per year. Each county has a quota of a maximum number of seals to be taken. Each seal shot should be reported the same day and the hunters must check what quota is available before they start the hunt. Hunting is only allowed in areas that the counties have defined as conflict areas, and not in nature reserves. The hunt should be organised in such a way that the shot seals can be landed. To minimize injuries, hunting is only allowed from land, ice or boat moored to the ice edge. In addition, tens of personal licenses for fishermen have been given, including also some licenses for harbour seal hunting on the west coast of the country. During the years 2001-2004 altogether 296 grey seal have been shot (Table 2).

Seal sanctuaries and protection measures

Estonia. Five grey seal and ringed seal regular haul outs are within the borders of existing National Parks and Nature protected areas. Protection regime of these protected areas satisfy the needs for seal protection. Three seal sanctuaries are in preparation. Action plan for protection of grey seal population is in force since 2001. Similar plan for ringed seals was prepared and submitted to Ministry of Environment early 2005.

Finland. Seven areas situated in the outer archipelago of the Mainland Finland were protected for grey seal on a decree basis 9th August, 2001. The decree became valid 15th September, 2001. Of the areas two are in the Gulf of Finland, two in the southern Archipelago Sea, one in the southern Bothnian Sea, one in the North Quark, and one in the northern Bothnian Bay. The areas surface altogether about 19 000 hectares. The final regulations

Table 2. The grey seal hunt in Sweden from 2001 to 2004, divided in two parts. The southern area consists of the counties of Stockholm, Södermanland and Östergötland. The northern part consists of the counties of Norrbotten, Västerbotten, Västernorrland, Gävleborg and Uppsala (according to Ivar Sundvisson and Sven Gunnar Lunneryd).

	Baltic N 58.10 - N 60		North Baltic		Total		
	Quota	Seals shot	Quota	Seals shot	Quota	Seals shot	Percent
2001	12	6	138	51	150	57	38
2002	20	8	130	71	150	79	53
2003	48	6	122	73	170	79	46
2004	48	11	122	70	170	81	48
Total	128	31	512	265	640	296	46

will be made in late 2006 according to the results of studies on: 1) the escape distance of seals towards approaching boats; 2) effects of the areas upon fishing in nearby archipelagos.

In Åland the only area for grey seal protection was established in 1998. It is situated in the southern archipelago and surfaces 670 hectares.

In the Lake Saimaa there are following special measures to protect Saimaa ringed seal: 1) protection of lairing shorelines, e.g. in the national parks; 2) regional restrictions of fishing and forbidden fishing methods; 3) temporary fishing restrictions on breeding areas 15th April - 30th June; 4) regulation of water level.

Germany. There are numerous reserves under different management regimes along the German Baltic coast comprising sand spits, remote beaches, and small sand banks. However, none has been declared specifically as seal sanctuary so far although it could be done i.a. under the FloraFaunaHabitat(FFH)-regime as soon as seal colonies would establish.

Latvia. No protected areas are or will be established for seals due to absence of suitable haul-outs.

Poland. Data on the occurrence and bycatch have been collected as well as studies carried out on the biology, ecology and health of the seals in Polish waters in Hel Marine Station of University of Gdansk, the national coordinating centre of the marine mammals investigations. The centre of breeding and rehabilitation of grey seal has been established as a part of thr activity of Hel Marine Station to regulation of the Ministry of Environment (Dz.Ust. 220 / 2237, 28.09.2004).

All animals born or rescued in the centre have been released to the wild in the aim of reestablishment of residential colony at the coast of Southern Baltic. Most of the released animals are equipped with satellite transmitters to monitor their migration. They are also tagged with microchips (TROVAN system) and have freeze branded marks on one side of the body.

The need of ensuring the selas their historical habitats at the coast of Southern Baltic has been taken into account within the Polish marinen protected areas dedicated to NATURA 2000 (e.g. PLH-220034 /Puck Bay/ and two national parks – Wolinski and Sowinski).

Moreover the grey seal breeding programme has been supported with the education and information projects. They are very important tools in creating a pro-nature awareness of the society.

Russia. In the Lake Ladoga there are protected haul-out shorelines for Ladoga ringed seal herds in the Valaam Nature Park. Recommendations have been made to protect lairing shorelines and to limit fishing in the northern part of the lake. In the Gulf of Finland, there is a protected breeding region for ringed seals on the “Berezovge islands protected territorial”. Recommendation has been made to protect haul-out shorelines close to the “Kurzalsky protected territorial”.

Sweden. From the mid-1970s up to 1987, seal sanctuaries were established in 23 areas distributed in nine coastal counties on the Swedish Baltic coast, and in 12 areas distributed in three coastal counties on the Swedish West coast. Sanctuaries have been subject to some revisions since, but remain largely the same.

Three sanctuaries on the southern Baltic coast are mainly for harbour seal and one is for both harbour and grey seal; the rest is for grey seal. On the West coast all sanctuaries are designed for harbour seal. The sanctuaries are exclusively haul-outs for grey seal and combined breeding areas and haul-outs for harbour seal. There is no sanctuary for ringed seal in Sweden. The addition, a sanctuary was established at one breeding site for grey seal on the Baltic coast in 2001.

Sanctuaries for grey seal on the Baltic coast at present cover a total of 23,780 ha, out of which ca 120 ha land and the rest water.

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