2015 ASCOBANS Annual National Reports

This questionnaire has been pre-filled with answers given in 2014 National Report - **please update!**

This format for the ASCOBANS Annual National Reports was endorsed by the 6th Meeting of the Parties in 2009. Reports are due to be submitted to the Secretariat by 31 March of each year.

Parties are requested to use this report to provide **new** information on measures taken or actions towards meeting the objectives of the Conservation and Management Plan and the Resolutions of the Meeting of the Parties.

General Information

Name of Party
› Sweden

Report prepared by

This should indicate the name and affiliation of the lead person for filling in the report.

Name	Susanne Viker
Function	National expert
Organization	SwAM
Address	Box 11930, S 404 39 Göteborg
Telephone/Fax	+46730897967
Email	susanne.viker@havochvatten.se

Coordinating Authority and National Coordinator

Please confirm the Coordinating Authority responsible for the national implementation of the Agreement, and give the name and contact details of the officially appointed National Coordinator (Focal Point).
› Susanne Viker at SwAM

List of National Institutions

List of national authorities, organizations, research centres and rescue centres active in the field of study and conservation of cetaceans, including contact details
› Swedish University of Agricultural Sciences (SLU), Sara Königson, sara.konigson@slu.se

› Swedish Defence Research Agency (FOI), Peter Sigray, peter.sigray@foi.se

› Swedish Museum of Natural History (SMNH), Julia Carlström, julia.carlstrom@nrm.se

› Swedish Museum of Natural History (SMNH), Anna Roos, anna.roos@nrm.se

› Göteborg Natural History Museum (GNM), Anders Nilsson, anders.nilsson@gnm.se

› Kolmårdens Wildlife Park, Mats Amundin, mats.amundin@kolmarden.com

Habitat Conservation and Management

Fisheries Interactions

Direct Interaction with Fisheries

1.1 Investigations of methods to reduce bycatch

› Studies investigating alternative fishing gear such as cod pots and traps for species like pike-perch and herring have been carried out by the Department of Aquatic Resources, the Swedish University of Agriculture Science. Since July 2011 this research is conducted by the Department of Aquatic Resources of the Swedish University of Agricultural Sciences (SLU).
The Department of Aquatic Resources, the Swedish University of Agriculture Science has carried out a project to try and find out why cod pots do work and catch cod in certain areas and do not work in other areas. Parameters as prey in the area, current, state of the fish might impact.

› In the Swedish small-scale and coastal fisheries, alternative fishing gear has been, and is still being, developed. The main reason for the development is the seal inflicted damages to fishing gear and catch that threaten an economically viable gillnet fishery. Studies investigating alternative fishing gear such as cod pots and traps for species like pike-perch and herring have been carried out by the Department of Aquatic Resources, the Swedish University of Agriculture Science. Since July 2011 this research is conducted by the Department of Aquatic Resources of the Swedish University of Agricultural Sciences (SLU).
Traps and pots are types of fishing gear where it is possible to protect the catch from seals. In traps and pots, the catch can be gathered in closed compartments which in turn can be designed using a solid construction and a strong material which ensures a seal-safe fishing gear. Despite several years effort there is still some work to do before there is some commercial alternative as pot or traps for many commercial fish species. However, a pot or trap fishery could also result in a high bycatch of seals or other species such as certain cetaceans or bird species. In order to prevent bycatches, especially of seals that are attracted to the catch inside the pot, pot entrances were equipped with seal exclusion devices (SEDs) of various sizes and shapes. A field study was conducted to investigate what effect different types of SEDs had on the bycatch of seals as well as on the pots' catchability. Results from the trials show that it is possible to decrease bycatches of seals to low levels without reducing fishing effi-ciency. (Königson et al., 2015). The development of cod pots are also progressing. Königson et al., (2015b) investigates cod pots as an economically viable alternative to gillnets in the southern Baltic Sea. The seal/fisheries conflict is still increasing in the Baltic and spreading further south. This leads to an increased need to develop alternative fishing gears in areas around the Baltic. Since 2014 Sweden and Denmark have been cooperating in developing cod pots as an alternative to the gillnet cod fisheries in the southern Baltic. Recent years’ research in this area has focused on trying to find out what parameters affect the catch for baited fishing gear in different areas. The behaviour of the species targeted in alternative fishing gears is also a major focus area to identify what characteristics in the fishing gear affect the fish behaviour and thereby the efficiency of the gear.
In the Swedish small-scale coastal fisheries, alternative fishing gear has been, and is still being, developed. Studies investigating alternative fishing gear such as cod pots and traps for species like pike-perch and herring have been carried out by the Department of Aquatic Resources, the Swedish University of Agriculture Science. Since July 2011 this research is conducted by the Department of Aquatic Resources of the Swedish University of Agricultural Sciences (SLU).
Traps and pots are types of fishing gear where it is possible to protect the catch from seals. fisheries in Northern Baltic and Pontoon traps for fishing salmon, white fish, trout and vendace are now used in commercial fisheries.
The main reason for the fishing gear development is the seal inflicted damages to fishing gear and catch which threatens an economically viable gillnet fishery. Traps and pots are types of fishing gear where it is possible to protect the catch from seals. In traps and pots, the catch can be gathered in closed compartments which in turn can be designed using a solid construction and a strong material which ensures a seal-safe fishing gear. However, a pot or trap fishery could also result in a high bycatch of seals or other protected species such as certain cetaceans or bird species. In order to prevent bycatches, especially of seals that are attracted to the catch inside the pot, pot entrances can be equipped with seal exclusion devices (SEDs) without this affecting the pots catch efficiency. The development of cod pots is still in progress. Since 2014 Sweden and Denmark have been cooperating in developing cod pots as an alternative to the gillnet cod fisheries in the southern Baltic. Recent years’ research in this area has focused on trying to find out what parameters affect the catch rates for baited fishing gear in different areas. The behaviour of the species targeted in alternative fishing gears is also a major focus area to identify what characteristics in the fishing gear affect the fish behaviour and thereby the efficiency of the gear.

You have attached the following documents to this answer.

Ascobans_rapportering_20150827SK_Just_SV.docx - Alternative fishing gear short report Sweden 2014
K_nigson_2013_Development_of_alternative_gear.pdf - article on arlernative fishing gear published in 2013. Describes

efforts done by SLU.
K_nigson_2013_Development_of_alternative_gear.pdf - Report to the Proceedings of the conference: Progress of marine conservation in Europe. It describes why and how Sweden are developing alternative fishing gear.

1.2 Implementation of methods to reduce bycatch

› Fishermen in the south of the Kattegat have been offered pingers for free and been successfully using them in the gillnet fisheries for flatfish. Six fishers have been using pingers since March 2011.

› During 2012, only one fisher, Kattegatt, was required to use pinger according to EC Regulation 812/2004.

› At the Swedish south coast development and testing of new gear has been conducted. The South Coast Fishing Area (Sydkustens fiskeområde) operates experimental fishing project with seal-proof cod cages in collaboration with local fishermen and scientists at SLU. The goal of the South Coast Fishing Area is to develop future coastal fishing industries by initiating and supporting projects and greater integration between fish nutrition and other nutrition in the region. The business is collaboration between the municipalities of Sölvesborg, Kristianstad, Simrishamn and Ystad. In 2013 this project started collaborating with the Department of Aquatic Resources, the Swedish University of Agriculture Science to get a more scientific approach on the project. Several different models of pots have been tried out and the results are promising. The pots fish around 2 to 7,7 kg cod per emptying.

1.4 Report under EC Regulation 812/2004

Please provide the link to your country's report under EC Regulation 812/2004.
› See Appendix 1.
http://ices.dk/sites/pub/Publication%20Reports/Expert%20Group%20Report/acom/2013/WKBYC/wkbyc_2013.pdf#search=wgbyc
Report from the Working Group on Bycatch.

Reduction of Disturbance

2.1 Anthropogenic Noise

Please reference and briefly summarise any studies undertaken
› FOI has published the report "Skydd av marint liv vid användning av aktiv sonar" (Protection of marine life in conncetion with the use of active sonar; FOI-R--3716--SE, ISSN 1650-1942). It deals with generating knowhow on the effect of such noise and how to minimize these effects.

› TIn the field of the European Marine Strategy Framework Directive, SwAM has participated in the EU Working for Good Environmental Status (GES WG), to develop the indicators for descriptor 11 (energy and noise).

› FOI has published the report “Ambient Underwater Noise Levels at Norra Midsjöbanken during Construction of the Nord Stream Pipeline” which was funded by the Swedish Environment Protection Agency, SEPA, together with Nord Stream AG. It presents results from measurements of noise during the construction of the North Stream pipeline, which passes about 4 km off Norra Midsjöbanken which is a Nature 2000 area. Measures included trenching activities as well as the ambient noise including shipping noise.

› FOI has published the report "Akustiska miljöeffekter av svenska marinens aktiva sonarsystem" (Acoustic environmental effects of the Swedish Navy's active sonar systems; FOI-R--3504--SE, ISSN 1650-1942). it presents a summary of existing systems, the frequencies used and their relation to the audiogram of marine mammals residing Swedisch waters. It also gives risk distances for behavioural effects as well as temporary and permanent hearing threshold shifts.

› FOI has published the report "Säker användning av militära sonarsystem - nationella handlingsregler och svensk lag" (Safe use of military sonar systems - national handling rules and Swedish law; FOI-R--3656--SE, ISSN 1650-1942). It presents guidelines on how to plan and implement military exercises where active sonar is included.

› The 4th Naval warfare flotilla, part of the Swedish Armed Forces, has produced the "Maringeografisk biologikalender" (the Marine geographic biology calender), a planning tool for the Swedish Navy, with the aim at minimizing the negative effects of military activities on the marine ecosystems. It is presented as an ArcGIS-based map, on which layers with the distribution in time and space of different factors, e.g. protected areas, biological databases for fish, birds, seals, etc., can be shown. It is still under development, and e.g. the SAMBAH harbour porpoise distribution maps will be included when available.

› (Does FOI provide information on the updated version of the Armed Forces’ “Maringeografisk biologikalender”? They have not so far but a link to their web-page is attached.)
There should be some updated information on the continued underwater noise monitoring at Norra Midsjöbanken and Hönö from FOI.

To this, information should be added on that in conjunction with the underwater noise monitoring, acoustic monitoring of harbor porpoises has been carried out by attaching a C-POD to the noise rig. The C-POD data collection has been carried out in cooperation between FOI and AqB (Julia Carlström). No C-POD analyses have yet been carried out due to lack of funding.

You have attached the following Web links/URLs to this answer.

Marinbiologisk kalender

2.4 Pollution and Hazardous Substances

Please report on main types of pollution and hazardous substances (including source, location and observed effects on cetaceans). Please provide information on any new measures taken to reduce pollution likely to have an impact.
› The Swedish Museum of Natural History (SMNH) is carrying out a 3-year study on several contaminants in harbour porpoises from Swedish waters. The study was finished in 2012 and a report of the results should have been delivered to SwAM, but the report has been delayed.

› The report was delivered during 2015 and can be found attached.
In Swedish only.

› Porpoises from Swedish waters, from four areas (Skagerrak, Kattegat, Öresund and the Baltic) have been analyzed for a number of environmental contaminants: metals, chlorinated and brominated compounds, tennorganic compounds and perflourinated chemicals (including PFOS). Between 22 and 27 animals were analyzed, and a report was presented to SwAM in 2015 (in Swedish). Also, a poster of some of the results was presented at the 29th Conference of the European Cetacean Society, 23rd to 25th March 2015.
The poster is attached.

You have attached the following documents to this answer.

Tumlare_rapport_2015.pdf - Report contaminant concentrations and health status for harbour porpoise in Swedish waters. In Swedish.
Malta_2015.pdf - Abstract from conference in Malta 2015. Contamminant concentrations for harbour porpoise in Swedish waters

2.5 Other Forms of Disturbance

Please provide any other relevant information, e.g. relating to recreational activities affecting cetaceans.

› None

Marine Protected Areas

Marine Protected Areas for Small Cetaceans

3.1 Relevant Information

Please provide any relevant information on measures taken to identify, implement and manage protected areas for cetaceans, including MPAs designated under the Habitats Directive and MPAs planned or established within the framework of OSPAR or HELCOM.
› The protection of marine areas is an important measure in ensuring that Sweden reaches its national environmental objectives. This action is also key in fulfilling the requirements put forth by a number of EU directives and international conventions.
Today, 6.3 percent of Sweden’s marine waters are designated as protected areas. Included are marine nature reserves, marine habitat areas within the Natura 2000 network, and Sweden’s marine national park Kosterhavet.
To ensure biodiversity in these areas, conservation goals are needed. According to goals established by the Swedish government to address biodiversity, 10 percent of the country’s marine waters are to be protected by 2020, an increase of 570,000 hectares from today.

› In a report to the Swedish government, the Swedish Agency for Marine and Water Management, SwAM, has

suggested the need for fishing regulations as a first-step measure in reaching conservations goals in the country’s marine protected areas.

› Partially as Action C5 of the SAMBAH project (www.sambah.org) and partially commissioned by SwAM, AqB has identified high density areas for harbor porpoises in Swedish waters. The identification of high density areas has been based on published kernel densities of satellite tagged animals in Danish waters (Sveegaard et al., 2011, Mar Mamm Sci) and preliminary predictions of probability of detections from the SAMBAH project. The results have been published in a report (Carlström & Carlén, 2015, AqB report 2015:02, in Swedish). The identified high density areas serve as a basis for the County Administrative Board in their currently ongoing work of proposing Natura 2000 sites for harbor porpoises in Swedish waters. The deadline for proposals of Natura 2000 sites are June 15, 2016.

3.2 GIS Data

Please indicate where GIS data of the boundaries (and zoning, if applicable) can be obtained (contact email / website).
› GIS layers presented in the report on high density areas of harbor porpoises in Swedish waters (Carlström & Carlén, 2015, AqB report 2015:02, in Swedish) can be obtained by contacting Julia Carlström (NRM) or Ida Carlén (CCB). These include identified high density areas of harbor porpoises as well as a number of anthropogenic threats, such as selected gillnet fisheries, AIS traffic, marine constructions, military activities, and also various types of existing marine protected areas.

Surveys and Research

4.1 Abundance, Distribution, Population Structure

Overview of Research on Abundance, Distribution and Population Structure

› A LIFE+ Nature application for the SAMBAH project was approved and the Grant Agreement was signed in November 2009 by the Kolmården Wildlife Park as the Coordinating Beneficiary. This project is running over five years (January 2010 – September 2015), and aims at producing an estimate of the total abundance and distribution of harbour porpoises in the Baltic Sea. The project is based upon data from passive acoustic porpoise echolocation loggers (CPODs) deployed from 1 May 2011 to 30 April 2013 at approximately 300 positions at 5-80m in the Baltic Sea. All EU countries around the Baltic Sea participate in the project; Germany with separate funding.
Three types of experiments have been carried out for calculation of the CPOD detection function; (1), all partners have carried out playback trials emitting artificial harbour porpoise clicks at 0-300m from the CPODs in conjunction with their servicings, (2) the German Oceanographic Museum has lead an experiment in which a three-dimensional array has been deployed from a boat, drifting in an area where CPODs have been deployed and porpoises have been present, and (3) the Danish team has deployed CPODs on a line outside pound nets with porpoises trapped inside. In addition to these experiments, the Danish team has deployed acoustic tags on harbour porpoises to obtain data on their click rate. These data sets will be used as input to state of the art population density statistics, and subsequently allow for habitat modelling carried out by AquaBiota Water Research, Stockholm.
In 2013 the CPOD data collection and all experiments on supplementary data have been finished. The CPOD data has been quality controlled and a database for future storage of the data has been designed. Due to the delay in the CPOD data collection (originally planned from January 2010 to December 2012) the project end date has been extended from December 2014 to September 2015. All analyses will be finalized in 2014 and the public end-of-project conference will be held at Kolmården Wildlife Park on 8-9 December 2014.

› The SAMBAH end-of-project conference was held on 8-9 December 2014 at Kolmarden Wildlife Park. Here, the final results of SAMBAH were presented, including abundance estimates and distribution maps of harbour porpoises in the Baltic Sea, and the use of the results in management were discussed.
On 9-10 December there was a national workshop dedicated to Swedish marine environment managing bodies.
Please visit www.sambah.org for more information.

You have attached the following documents to this answer.

SAMBAH-news-2014-08.pdf - SAMBAH news August 2014

4.2 Technological Developments

New Technological Developments

› SLU have conducted behavioural studies on cods at the entrance of cod pots. The goal is to produce useful results to develop more catch efficient cod pots. This work has continued in cooperation with a project on cod pots by the South Baltic Flag.

Use of Bycatches and Strandings

Post-Mortem Research Schemes

5.1 Contact Details

Contact details of research institutions and focal point
› Anna Roos, Department of Contaminant research, Swedish Museum of Natural History, PO Box 50007, SE-104 05 Stockholm. anna.roos@nrm.se

5.2 Methodology

Methodology used (reference, e.g. publication, protocol)

› Using a common protocol made for cetaceans.

5.3 Samples

Collection of samples (type, preservation method)
› 12 porpoises that were found between March-October 2015 were collected for necropsy and sampling for the Environmental Specimen Bank. Two were from the Skagerrak, four from the Kattegat, 4 from Öresund and two from the Baltic. All were found on beaches and at least one of them was bycaught in a fishing geer.

5.4 Database

Database (number of data sets by species, years covered, software used, online access)
› The SMNH has a database of porpoise samples from 1972 until today, and consist of more than 700 specimens.
Software: MySQL. No online access yet.
Data include: species, location, cause of death, blubber thickness (several places), length, weight, weight of several organs etc.
The SMNH also has a database on reported live (and dead) animals, all published on line at www.nrm.se/tumlare.

5.5 Additional Information

Additional information (e.g. website addresses, intellectual property rights, possibility of a central database)
› The SMNH host a web page where the public can report sightings of live porpoises: www.nrm.se/tumlare.

Activities and Results

5.6 Necropsies

Number of necropsies carried out in the reporting period

	Number	Recorded cause of death
Phocoena phocoena		
Tursiops truncatus		
Delphinus delphis		
Stenella coeruleoalba		
Grampus griseus		
Globicephala melas		
Globicephala macrorhynchus		

Lagenorhynchus albirostris		
Lagenorhynchus acutus		
Orcinus orca		
Hyperoodon ampullatus		
Mesoplodon bidens		
Kogia breviceps		
Other (please specify under number)		
Other (please specify under number)		
Other (please specify under number)		
Other (please specify under number)		
Other (please specify under number)		
Other (please specify under number)		

Public Awareness and Education

7.1 Public Awareness and Education

Please report on any public awareness and education activities to implement or promote the Agreement to the general public and to fishermen.
› Harbor porpoise day in may 2015 at "Naturum Kullaberg"
You can see harbour porpoises from land and from boat and hear their "clicks".
Link is provided, but only in Swedish.(Information about Kullaberg in general also available in english)

› A project called "Rappen" is an app where you can report harbour porpoise and som other species (some alian species with special focus). It is a pilot-study with focus on public awareness. Web link attached. In Swedish

› The Kolmården Wildlife Park, in the dolphinarium, has a one-day program “Närkontakt Delfin” (Dolphin Close Encounters), available on demand to pre-booked groups. It offers an in-depth lecture on dolphin biology in general and also gives updated information on the dire situation of the Baltic harbour porpoise. A special SAMBAH exhibition is presented to all visitors to the Lagoona, one of the public display areas of the Dolphinarium. In addition the staff of Kolmarden has given lectures on SAMBAH for special tour groups at the dolphinarium and during conferences. The main dolphin show, called LIFE. presents a strong message about the grave effects of pollution on the marine eco systems.

› There are two different websites and database systems for reporting of harbour porpoises and cetacean in general: one is the web site of SMNH accessible for the public to report live harbour porpoises, the other is the Species Gateway (Artportalen).
The report form of SMNH's web site is relatively simple which make it relatively easy for almost anyone to complete a report (www.nrm.se/tumlare). Statistics from 2012 have not been compiled but in 2011 at least 177 reports were submitted. Most of the reports came from the Swedish west coast. All reports are quality controlled before being published on the web. The web page also includes photos, and a couple of very interesting films of porpoises playing around a small boat. Data from the SMNH’s database have not been submitted to the HELCOM/ASCOBANS Harbour porpoise database and map service. However, SwAM have asked SMNH to complete that.
Species Gateway (Artportalen) is an independent site by the Swedish Species Information Centre at the SLU for collecting sightings of species (www.artportalen.se/default.asp). The site is open to anyone who wishes to contribute their data and is more detailed in data, relative to that one of the SMNH. It also demands relatively more of the observer to be complete the report, than in the SMNH’s database. Beside the option to report cetaceans in the reporting system for mammals, Amphibians and Reptiles, there are reporting systems for all organism groups. The data can be used by anyone – the general public, scientists, organisations and authorities. All observations are published first and are verified later by authorized persons within the organisations.
Data of the two databases are not directly exchangeable but information to some extent has been transferred to the SMNH. Booth reporting databases has been developed by support from SEPA. However, the authorities should consider which of the organizations that will have national responsibility for receiving reports. Therefore SwAM initiated a meeting regarding this in 2012, which was held in 2013. Both parties agreed to make a joint interface and the data should be stored in a way to make it easier to execute statistical reports from.

You have attached the following Web links/URLs to this answer.

Harbour porpoise day at Kullaberg Sweden - Announcment on web page about harbour porpoise day at Kullaberg
Rappen - reporting harbour porpoise and alien species - Pilot study in public awareness and more

Possible difficulties encountered in implementing the Agreement

Difficulties in Implementing the Agreement

Please provide any relevant information

› None

Fisheries Interactions

Direct Interaction with Fisheries

1.1 Investigations of methods to reduce bycatch

Studies investigating alternative fishing gear such as cod pots and traps for species like cod, pike-perch and herring have been carried out by the Department of Aquatic Resources, the Swedish University of Agriculture Science.

SLU in cooperation with DTU Aqua in Denmark started a project developing cod pots in Southern Baltic. The purpose of the project is to develop the cod pots, make them more effective, and to investigate if the fishery can be economic reliable.

South Baltic Flag an organization funded by EU, in collaboration with Swedish Agriculture University (SLU) finished their project involving cod pots and their effectivity as well as practicality. The goal of the South Coast Fishing Area is to develop future coastal fishing industries by initiating and supporting projects and greater integration between fish nutrition and other nutrition in the region. The project was carried out in close collaboration with fishermen. Many different pots were tried and the project showed that cod pots in the future can be effective and viable fishery. One of the fishermen designed a large bottom standing cod pot with four entrances. The pot gave on average 7,7 kg per pot.

Figure 1. Bottom standing cod pot with four entrances.

The Department of Aquatic Resources, the Swedish University of Agriculture Science investigated what parameters do affect the cod pots catchability. Parameters taken into regards were current velocity and direction, topography, season and soaktime. Different stimuli to attract cods to the pots was also investigated. Light is a stimuli that can increase the pots catchability significantly.

A project developing a new concept trying to catch cod in the southern Baltic started out in 2014. The project was carried out by the SLU. Two pontoon traps adjusted to catch cod were developed and one of them in use in 2014. The traps can be effective and the project continued in 2015.

Bryhn, A. C., Königson, S. J., Lunneryd, S. G., and Bergenius, M. A. J. 2014. Green lamps as visual stimuli affect the catch efficiency of floating cod (*Gadus morhua*) pots in the Baltic Sea. Fisheries Research, 157: 187-192. DOI 10.1016/j.fishres.2014.04.012

Königson, S. J., Fredriksson, R. E., Lunneryd, S-G., Strömberg, P., and Bergström, U. M. 2015 Cod pots in a Baltic fishery: are they efficient and what affects their efficiency? – ICES Journal of Marine Science, doi: 10.1093/icesjms/fsu230.

Lundin, M., Calamnius, L., Lunneryd, S. G., and Magnhagen, C. 2014. The efficiency of selection grids in perch pontoon traps. Fish. Res., 162: 58-63. doi:10.1016/j.fishres. 2014.09.017

Burfiske I Östersjön-Nytt I Östersjön. Sydkustens fiskeområde i samarbete med SLU. Report written in swedish.

Development of Alternative Fishing Gear in the Swedish Small-scale Coastal Fisheries

SARA KÖNIGSON AND SVEN-GUNNAR LUNNERYD

Institute of Coastal Research, Swedish University of Agricultural Sciences, Sweden

1 Why do we need alternative fishing gear?

In the Swedish small-scale and coastal fisheries, alternative fishing gear has been, and is still being, developed. The main reason for the development is the seal inflicted damages to fishing gear and catch. Seals can cause damage by tearing holes in the fishing gear which shortens the livelihood of the fishing gear and in trap fisheries cause the catch to escape. Seals also consume or damage the catch caught in the fishing gear. There are three species of seals along the Swedish coast; the grey seal (*Halichoerus grypus*), the ringed seal *(Phoca hispida)* and the harbour seal (*Phoca vitulina*). All populations have increased in numbers. Grey seals are increasing by 7 to 8%, ringed seals by 4,5% and Harbour seals on the west coast by 12% (HAVET, 2011). The seals-fisheries conflict in the Baltic has escalated concurrently with the population increase (BALTSCHEFFSKY, 1997; KAUPPINEN et al., 2005; WESTERBERG et al., 2000; LUNNERYD, 2001; FJÄLLING, 2004). The fisheries which are subjected to the seal-fisheries conflict to the greatest extent is the small-scale and coastal fisheries. Coastal fisheries are widely scattered along the Swedish coastline and they are of great importance to the local population in many villages. In addition to facing damage caused by seals, these fisheries tend to suffer from diminishing fish stocks and structural problems such as difficulties distributing the catch. There is a need to develop alternative fishing gear in order to decrease the seal fisheries conflict. Traps and pots are fishing gear where it is possible to protect the catch from seals. In traps and pots, the catch can be gathered in closed departments which in turn can be designed using a solid construction and a strong material which ensures a seal-safe fishing gear.

Nevertheless, there are many other reasons why we need alternative fishing methods. The environmental impact of alternative fishing gear such as traps and pots is considered less severe compared to traditional fishing methods. In comparison to trawls and other active fishing gear, alternative gears such as pots cause limited harm to the marine environment (JENNINGS et al., 2001; THOMSEN et al., 2010). SUURONEN et al., (2012) included pots in the compilation of LIFE (Low Impact and Fuel Efficient) fishing gear due to their low energy use, effective species selectivity and low gear construction costs. Another advantage with pots is that these can be designed to capture cod above a certain length limit (KÖNIGSON, 2011; OVEGÅRD et al., 2011)

as well as decreasing the bycatch of marine mammals and birds. There is a need to broaden the perspectives regarding fisheries management for every kind of fisheries, e. g., with life cycle assessment methods which evaluate the environmental impacts of products using a broad and systematic approach (HORNBORG et al., 2012).

Another equally important reason for considering alternative fishing gear is that the small-scale coastal fisheries suffer from low profitability and scant addition of young fishers, needs a positive development. Coastal or small scale fishery is often carried out by single fishers who make daily fishing trips and return every night to harbour. These fisheries could supply a local market with high quality fish and low transportation costs. However, in Sweden, Baltic fishers get a low price for the fish (on average less than 1.5 euro per kg cod) and the fish is often exported to central Europe as there are no other distribution channels. A positive development such as using alternative fishing gear could include ecolabelling fish or marketing the fish as locally caught which in turn could hopefully give the fishers a higher catch value and a higher income.

2 How do we develop alternative fishing gear?

The seal-fisheries conflict, the environmental impact, practical handling of alternative fishing gear and, last but not at least, the catch efficiency of the alternative fishing gear must be taken into regard when developing alternative fishing. Our first priority has been to study the fishing efficiency of alternative fishing gear and whether catch from alternative fishing gear is comparable to traditional fishing gear. This work not only includes comparing the fishing efficiency but also studying which variables can affect the catch and how we can increase the fishing efficiency of alternative gear by for example modifying the gear or by using stimuli to attract fish.

The next priority is the environmental impact, such as increasing size selectivity of the fishing gear as well as decreasing the bycatch of marine mammals and birds. Pots and traps can effectively limit the catch of undersized fish by using selection panels (OVEGÅRD et al., 2011; LUNDIN et al., 2011). Decreasing the fuel costs and the extent of ghost fishing by lost gear are also factors which need to be taken into regard. By having an opening in the pot which is secured with degradable thread material as for example cotton, the opening will open after a couple of months and thereby create an escape for fish trapped inside the pot. Pots and traps also demand less fuel compared to gill nets which are normally set during one day and retrieved the following day. Pots and traps can be left in the water and emptied when the weather allows it or when there is an accentuated demand of fresh fish.

The last part of the work has been to actually develop a seal-safe fishing gear. This can be done by gathering the fish in a closed and solid compartment where seals cannot

access the catch. Making it hard for seals to access the catch will consequently minimize the reward for the seal and thereby decrease its motivation to raid fishing gear for food (KÖNIGSON et al., 2007). Handling and practicality of the fishing gear also needed to be taken into account.

Most important in the development of alternative fishing gear was the cooperation between fishers, manufactures and scientists. The following two chapters will describe two alternative fishing gears developed to decrease the seal-fisheries conflict in the Baltic.

3 Trap net fisheries in northern Baltic

Salmon (*Salmo salar,*) trout (*Salmo trutta*) and whitefish (*Coregonus laveratus*) traps are included in the gear category subject to the largest economic damage due to seals in the Swedish fishery and in this category, developing alternative fishing gear as a mitigation method has been highly prioritized (WESTERBERG et al., 2006). The trap net fishery in the Baltic is, in many respects, a model fishery - being selective, energy saving and harmless to the benthic environment. The trap nets used in the fisheries are huge constructions that comprise a leader arm, a trap (gathering compartments) and a fish chamber where the fish finally gather (Figure 1). The trap nets are often placed close to river mouths with the traps leader arm set perpendicular to the shore line. The fisheries are carried out with small boats normally operated by one single person. Salmon, trout, and whitefish follow the leader arm into the trap and finally get caught in the fish chamber.

A solution was found by redesigning the whole trap in such a way that it became a hindrance to the seals' fishing efforts, instead of assisting seals. The fish chamber was constructed with an outer protecting net. The outer net needed to be under tension to prevent seals from reaching the fish, and to accomplish this, the fish-bag had to be stiff. This led to a special arrangement for emptying the bag. Inflatable pontoons were mounted under the bag, lifting the fish chamber up to the surface with the help of an air compressor. Handling this new construction proved to be very labor saving and took less time than handling the original fish chamber. The opening into the fish chamber has a frame made of stainless steel with a width of 40 cm and a wire in the middle of the frame in order to prevent seals from entering the fish chamber. The trap connected to the pontoon fish chamber was designed without any narrow corners. The stretched mesh size of 400 mm allows the fish but not the seal to swim through the meshes during a chase inside the trap. Traditional traps have sharp corners and are made in a polyethylene material with a mesh size of 200 mm. These traps guide or lead the fish into the fish chamber where the fish gather. Lunneryd et al. (2002) showed that the mesh size can be large without losing the guiding properties. However, data showed

that there was a loss of salmon through the large meshes in the experimental trap which was independent from seal disturbance. In a following study, detailed damage records of 5,400 emptyings of conventional and large mesh traps with pontoon fish chambers were kept. The result showed that the catch of salmon and trout was 50% higher and that the number of incidents with damaged fish and gear decreased by 80% compared with conventional salmon traps (LUNNERYD & FJÄLLING, 2004).

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Figure 1: The pontoon' trap, here seen on its way up to be emptied, consists of a fish chamber connected to a large mesh trap.

4 Cod pot fisheries in central Baltic

Another example of an alternative fishing gear which is under development is the cod pot. At this point, at least three models of the seal-safe cod pots have been produced by three fishing gear manufacturers (Figure 2). Two different two-chambered pots as well as one chambered pots are produced and the different models are currently being tried out by commercial fishers in the south Baltic. To meet the requirements of being a seal-safe gear, the construction needs to be rigid and made in a strong material. Therefore, the models are either collapsible or possible to stack on each other.

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Figure 2: Three of the seal-safe models being developed in collaboration with fishing gear manufacturers, fisheries scientists and fishers. Model a and b are collapsible made in a material with a meshsize of around 30 mm mesh to mesh. Model c can be stacked on each other and has a mesh size of 45 mm. Model a has only one chamber, model b and c are two-chambered with an entrance chamber and a fish holding chamber. The two-chambered models are the most efficient pots compared to pots with only one chamber and an open entrance.

The first focus in developing cod pots has been to study whether pots have a potential as a commercial fishing gear in comparison to gillnet and hook fisheries in the central Baltic. To evaluate this, experimental fishing trials with two-chambered floating pots (described by OVEGÅRD et al., 2011; FUREVIK et al., 2008), were conducted in the southern Baltic Sea in 2009 and 2010. Trials were carried out in collaboration with local fishermen conducting a full-time fishery and using up to 100 pots. The pots were set in strings with up to 8 pots connected on a bottomline and a distance of 50 meter between pots. Results from experimental fishing trials showed that in the area where the experimental fishing was conducted cod pots had an economical potential as an alternative fishing gear compared to gillnets and hooks in the central Baltic (OVEGÅRD et al., 2011; KÖNIGSON et al., 2010). The catch in pots from the experimental fishing was compared to the catch from gillnet and hook fisheries reported to the EU logbook

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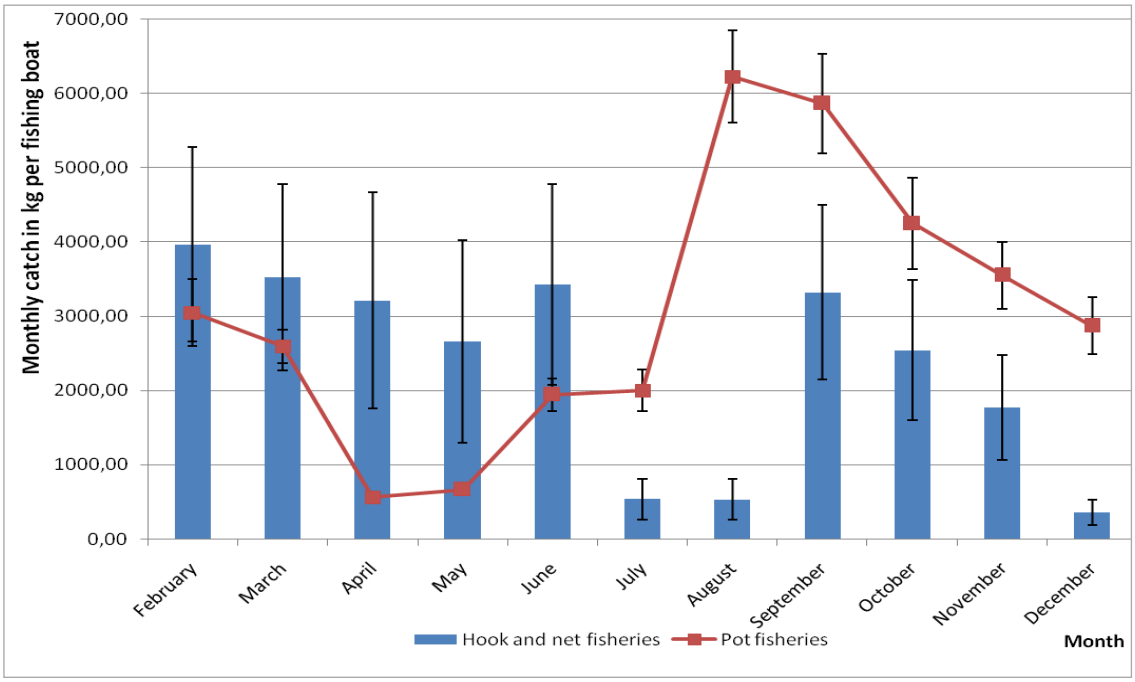

Figure 3: Extrapolating the catch per kg and month to a possible full-time cod pot fishery using 100 pots and comparing it to a full-time gillnet and hook fishery in the same area reported to the EU-logbook (from KÖNIGSON et al., 2010). In July and August, fishing with gillnets and hooks is not permitted. Therefore catches were small during this period.

Compared to other fishing gear, such as for example gillnets which can cover long distances, the general catch efficiency of pots is low (SUURONEN et al., 2012) and therefore there is a need to increase the fishing efficiency of the pots. High fishing efficiency of pots is usually maintained by attracting fish to the fishing grounds using bait (FUREVIK & LØKKEBORG, 1994; LØKKEBORG, 1998), but fishing efficiency could be improved further with other methods such as visual stimuli. Artificial light is a

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The subsequent focus in the development work was to study and if possible decrease the negative environmental impact of cod pots. A problem that needed to be solved regarding the pot fisheries was the high discard rates of undersized fish. Approximately 45–60% of the cod caught in the commercially available floating pot consists of fish below legal minimum landing size (FUREVIK et al., 2008). High discard rates of caught and thereby possible fatally injured fish are not only a threat to the productivity of the stock; they are also a highly time-consuming problem for the fishermen (KELLEHER, 2005). Therefore, the effect on the size of cod captured in floating pots when modified with a selection panel of different mesh sizes was studied (OVEGÅRD et al., 2011). By comparing the proportion of catch from pots with selection panels to the total catch (pots with and without selection panels) at each length interval we received information on which mesh size or other kind of panel would be optimal for a certain length of fish. Using a selection panel with a square mesh of 45 mm, the absolute majority of fish below 38 cm (which is the minimum legal landing size on fish caught in the Baltic Sea) escaped from the pot. Results also showed that pots are not only size selective but also species selective, only the target species cod was caught in the pots. This is most likely because they are floating above the bottom preventing bottom-dwelling species such as flatfish to enter the pot.

However, the bycatch of marine mammals such as seals is a problem in the pot fisheries (KÖNIGSON et al.). Seals, in contrast to harbor porpoises, actively explore traps and pots for food and thereby risk getting caught in the fishing gear. One way of preventing seals from getting caught in pots is to stop them entering the pot with the aid of a Seal Exclusion Device (SED). Trials with the pontoon trap used in salmon fisheries in the Northern Baltic have shown that large grey seals could not enter the trap when an SED, in this case in the form of a rigid metal frame with a wire set in the middle of the frame, was placed in the entrance of the trap (HEMMINGSSON et al., 2008). The entrance of the pot was strengthened with a metal frame and the size of the entrance was reduced to prevent seals from forcing their way in. Results showed that SEDs decreased the bycatch of seals however depending on the size and shape of the SED the catch of cod was also affected (KÖNIGSON et al.). A square metal frame decreased the catch of cod while an oval frame increased the catch instead. However, results from this study did not give any clear indications as to which characteristics a

SED should have to maximize its fishing efficiency in terms of SED variation in shape, size and dimension of the steel bar of the frame.

5 Challenges and future work

There is a need for alternative fishing gear in many fisheries along the Baltic coast due to many of the reasons mentioned in this report. When developing alternative fishing gears an overarching recommendation is the need for researchers to fully understand and work together with the subjected fishery. This usually requires collaborations between scientists, industry, and fishery managers.

Fishing gear, which catchability is dependent on the behavior of the target species such as for example pots, do most likely have different requisites in different areas. A fishing gear used in a certain area might not work for the same target species in another area due to abiotic factors which affects the species behavior. This is important to take into consideration when evaluating alternative fishing gears that potentially can be used in an area. Therefore, when developing alternative fishing gear, studies on the behavior of target fish species in relation to fishing gear characteristics as well as the surrounding abiotic factors are crucial. This knowledge can help determine what fishing gear characteristics are needed to develop alternative fishing gear for different target species.

We will most likely not be able to continue fishing the way we are used to in the future. For example we need to reduce the fuel consumption as well as the bycatch of non-target species and we need to increase the size selectivity of the fishing gear. However if we want to work towards a sustainable fishery then alternative fishing gear might be the solution in many fisheries. I believe there is a need to start thinking outside the book when developing fishing gear. We need to look at new fishing possibilities and taking the behavior of the target species into consideration might be a way forward. Developing fishing gear is challenging as well as time consuming, however hopefully the results will take us towards a sustainable fishery. The large-meshed push-up trap is an excellent example of a newly developed fishing gear taking the behavior of fish into consideration and thereafter having a successful implementation in the subjected fishery.

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Development of Alternative Fishing Gear in the Swedish Small-scale Coastal Fisheries

SARA KÖNIGSON AND SVEN-GUNNAR LUNNERYD

Institute of Coastal Research, Swedish University of Agricultural Sciences, Sweden

1 Why do we need alternative fishing gear?

In the Swedish small-scale and coastal fisheries, alternative fishing gear has been, and is still being, developed. The main reason for the development is the seal inflicted damages to fishing gear and catch. Seals can cause damage by tearing holes in the fishing gear which shortens the livelihood of the fishing gear and in trap fisheries cause the catch to escape. Seals also consume or damage the catch caught in the fishing gear. There are three species of seals along the Swedish coast; the grey seal (*Halichoerus grypus*), the ringed seal *(Phoca hispida)* and the harbour seal (*Phoca vitulina*). All populations have increased in numbers. Grey seals are increasing by 7 to 8%, ringed seals by 4,5% and Harbour seals on the west coast by 12% (HAVET, 2011). The seals-fisheries conflict in the Baltic has escalated concurrently with the population increase (BALTSCHEFFSKY, 1997; KAUPPINEN et al., 2005; WESTERBERG et al., 2000; LUNNERYD, 2001; FJÄLLING, 2004). The fisheries which are subjected to the seal-fisheries conflict to the greatest extent is the small-scale and coastal fisheries. Coastal fisheries are widely scattered along the Swedish coastline and they are of great importance to the local population in many villages. In addition to facing damage caused by seals, these fisheries tend to suffer from diminishing fish stocks and structural problems such as difficulties distributing the catch. There is a need to develop alternative fishing gear in order to decrease the seal fisheries conflict. Traps and pots are fishing gear where it is possible to protect the catch from seals. In traps and pots, the catch can be gathered in closed departments which in turn can be designed using a solid construction and a strong material which ensures a seal-safe fishing gear.

Nevertheless, there are many other reasons why we need alternative fishing methods. The environmental impact of alternative fishing gear such as traps and pots is considered less severe compared to traditional fishing methods. In comparison to trawls and other active fishing gear, alternative gears such as pots cause limited harm to the marine environment (JENNINGS et al., 2001; THOMSEN et al., 2010). SUURONEN et al., (2012) included pots in the compilation of LIFE (Low Impact and Fuel Efficient) fishing gear due to their low energy use, effective species selectivity and low gear construction costs. Another advantage with pots is that these can be designed to capture cod above a certain length limit (KÖNIGSON, 2011; OVEGÅRD et al., 2011)

as well as decreasing the bycatch of marine mammals and birds. There is a need to broaden the perspectives regarding fisheries management for every kind of fisheries, e. g., with life cycle assessment methods which evaluate the environmental impacts of products using a broad and systematic approach (HORNBORG et al., 2012).

Another equally important reason for considering alternative fishing gear is that the small-scale coastal fisheries suffer from low profitability and scant addition of young fishers, needs a positive development. Coastal or small scale fishery is often carried out by single fishers who make daily fishing trips and return every night to harbour. These fisheries could supply a local market with high quality fish and low transportation costs. However, in Sweden, Baltic fishers get a low price for the fish (on average less than 1.5 euro per kg cod) and the fish is often exported to central Europe as there are no other distribution channels. A positive development such as using alternative fishing gear could include ecolabelling fish or marketing the fish as locally caught which in turn could hopefully give the fishers a higher catch value and a higher income.

2 How do we develop alternative fishing gear?

The seal-fisheries conflict, the environmental impact, practical handling of alternative fishing gear and, last but not at least, the catch efficiency of the alternative fishing gear must be taken into regard when developing alternative fishing. Our first priority has been to study the fishing efficiency of alternative fishing gear and whether catch from alternative fishing gear is comparable to traditional fishing gear. This work not only includes comparing the fishing efficiency but also studying which variables can affect the catch and how we can increase the fishing efficiency of alternative gear by for example modifying the gear or by using stimuli to attract fish.

The next priority is the environmental impact, such as increasing size selectivity of the fishing gear as well as decreasing the bycatch of marine mammals and birds. Pots and traps can effectively limit the catch of undersized fish by using selection panels (OVEGÅRD et al., 2011; LUNDIN et al., 2011). Decreasing the fuel costs and the extent of ghost fishing by lost gear are also factors which need to be taken into regard. By having an opening in the pot which is secured with degradable thread material as for example cotton, the opening will open after a couple of months and thereby create an escape for fish trapped inside the pot. Pots and traps also demand less fuel compared to gill nets which are normally set during one day and retrieved the following day. Pots and traps can be left in the water and emptied when the weather allows it or when there is an accentuated demand of fresh fish.

The last part of the work has been to actually develop a seal-safe fishing gear. This can be done by gathering the fish in a closed and solid compartment where seals cannot

access the catch. Making it hard for seals to access the catch will consequently minimize the reward for the seal and thereby decrease its motivation to raid fishing gear for food (KÖNIGSON et al., 2007). Handling and practicality of the fishing gear also needed to be taken into account.

Most important in the development of alternative fishing gear was the cooperation between fishers, manufactures and scientists. The following two chapters will describe two alternative fishing gears developed to decrease the seal-fisheries conflict in the Baltic.

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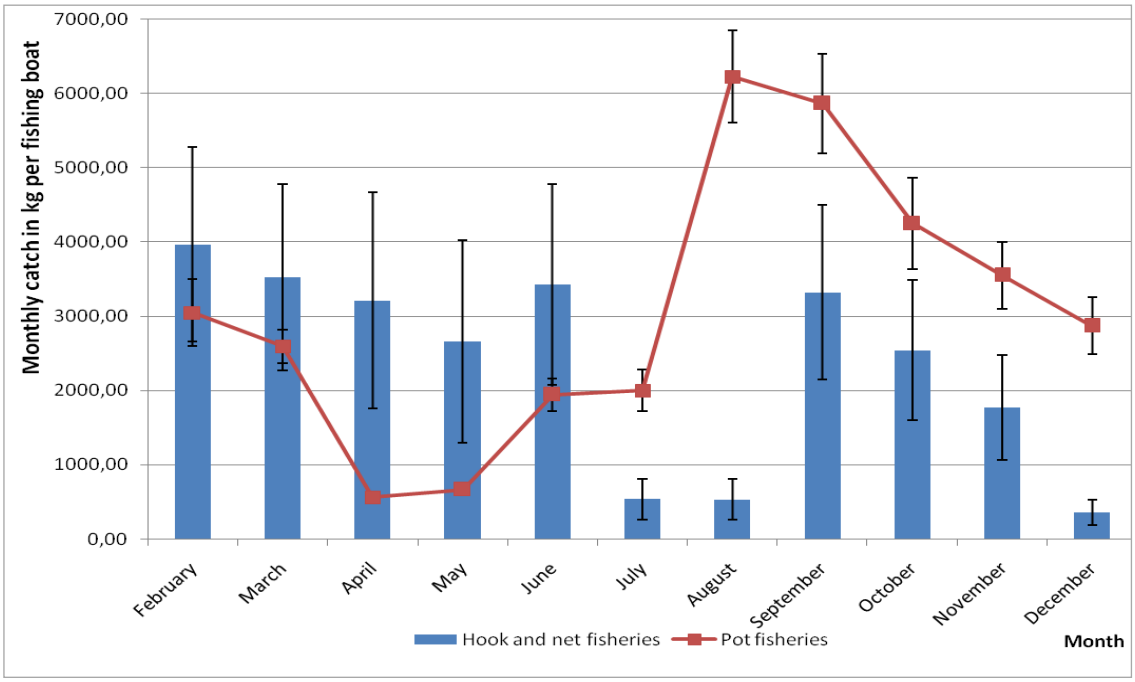

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Compared to other fishing gear, such as for example gillnets which can cover long distances, the general catch efficiency of pots is low (SUURONEN et al., 2012) and therefore there is a need to increase the fishing efficiency of the pots. High fishing efficiency of pots is usually maintained by attracting fish to the fishing grounds using bait (FUREVIK & LØKKEBORG, 1994; LØKKEBORG, 1998), but fishing efficiency could be improved further with other methods such as visual stimuli. Artificial light is a

stimulus which can be used to attract or affect fish in order to increase catch efficiency (BEN-YAMI, 1988). A study was carried out to investigate Atlantic cod behaviour when confronted by visual stimuli in floating cod pots and to determine whether it is possible to increase the pots catch efficiency when using a steady green light inside pots. Preliminary results showed that the catch increased significantly in pots with a green lamp inside (BRYHN et al., manuscript).

The subsequent focus in the development work was to study and if possible decrease the negative environmental impact of cod pots. A problem that needed to be solved regarding the pot fisheries was the high discard rates of undersized fish. Approximately 45–60% of the cod caught in the commercially available floating pot consists of fish below legal minimum landing size (FUREVIK et al., 2008). High discard rates of caught and thereby possible fatally injured fish are not only a threat to the productivity of the stock; they are also a highly time-consuming problem for the fishermen (KELLEHER, 2005). Therefore, the effect on the size of cod captured in floating pots when modified with a selection panel of different mesh sizes was studied (OVEGÅRD et al., 2011). By comparing the proportion of catch from pots with selection panels to the total catch (pots with and without selection panels) at each length interval we received information on which mesh size or other kind of panel would be optimal for a certain length of fish. Using a selection panel with a square mesh of 45 mm, the absolute majority of fish below 38 cm (which is the minimum legal landing size on fish caught in the Baltic Sea) escaped from the pot. Results also showed that pots are not only size selective but also species selective, only the target species cod was caught in the pots. This is most likely because they are floating above the bottom preventing bottom-dwelling species such as flatfish to enter the pot.

However, the bycatch of marine mammals such as seals is a problem in the pot fisheries (KÖNIGSON et al.). Seals, in contrast to harbor porpoises, actively explore traps and pots for food and thereby risk getting caught in the fishing gear. One way of preventing seals from getting caught in pots is to stop them entering the pot with the aid of a Seal Exclusion Device (SED). Trials with the pontoon trap used in salmon fisheries in the Northern Baltic have shown that large grey seals could not enter the trap when an SED, in this case in the form of a rigid metal frame with a wire set in the middle of the frame, was placed in the entrance of the trap (HEMMINGSSON et al., 2008). The entrance of the pot was strengthened with a metal frame and the size of the entrance was reduced to prevent seals from forcing their way in. Results showed that SEDs decreased the bycatch of seals however depending on the size and shape of the SED the catch of cod was also affected (KÖNIGSON et al.). A square metal frame decreased the catch of cod while an oval frame increased the catch instead. However, results from this study did not give any clear indications as to which characteristics a

SED should have to maximize its fishing efficiency in terms of SED variation in shape, size and dimension of the steel bar of the frame.

5 Challenges and future work

There is a need for alternative fishing gear in many fisheries along the Baltic coast due to many of the reasons mentioned in this report. When developing alternative fishing gears an overarching recommendation is the need for researchers to fully understand and work together with the subjected fishery. This usually requires collaborations between scientists, industry, and fishery managers.

Fishing gear, which catchability is dependent on the behavior of the target species such as for example pots, do most likely have different requisites in different areas. A fishing gear used in a certain area might not work for the same target species in another area due to abiotic factors which affects the species behavior. This is important to take into consideration when evaluating alternative fishing gears that potentially can be used in an area. Therefore, when developing alternative fishing gear, studies on the behavior of target fish species in relation to fishing gear characteristics as well as the surrounding abiotic factors are crucial. This knowledge can help determine what fishing gear characteristics are needed to develop alternative fishing gear for different target species.

We will most likely not be able to continue fishing the way we are used to in the future. For example we need to reduce the fuel consumption as well as the bycatch of non-target species and we need to increase the size selectivity of the fishing gear. However if we want to work towards a sustainable fishery then alternative fishing gear might be the solution in many fisheries. I believe there is a need to start thinking outside the book when developing fishing gear. We need to look at new fishing possibilities and taking the behavior of the target species into consideration might be a way forward. Developing fishing gear is challenging as well as time consuming, however hopefully the results will take us towards a sustainable fishery. The large-meshed push-up trap is an excellent example of a newly developed fishing gear taking the behavior of fish into consideration and thereafter having a successful implementation in the subjected fishery.

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Naturhistoriska riksmuseet

NATUR VÅRDS VERKET
SWEDISH ENVIRONMENTAL PROTECTION AGENCY

NATIONAL ENVIRONMENTAL MONITORING COMMISSIONED BY THE SWEDISH EPA

Tumlare i svenska vatten

- Miljögiftsbelastning och hälsostatus

Anna Roos

Rapport till Naturvårdsverket

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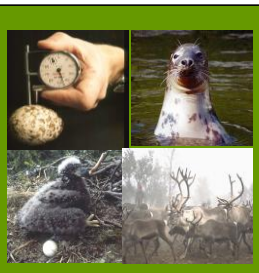
Enheten för miljöforskning och övervakning

Naturhistoriska riksmuseet
Box 50007

104 05 Stockholm



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1. Inledning

1.1 Biologi

Tumlaren tillhör de minsta tandvalarna och hör till familjen *Phocoenidae.* I denna familj finns totalt sex arter. Den vanliga tumlaren, den art som finns i Svenska vatten (*Phocoena phocoena),* förekommer i kalla och tempererade vatten i Norra Stilla Havet, Nordatlanten och Svarta Havet. Tumlaren är den vanligast förekommande valen i Nordsjön och den enda arten som förekommer regelbundet i Östersjön.

Tumlaren har en spolformad kropp som är gråsvart på ryggen, ljusare grå sidor och en vit mage. Ryggfenan är låg och triangelformad och nosen är trubbig. Vuxna tumlare är oftast mindre än 1.8 m och väger mellan 45 till 70 kg. Nyfödda kalvar är ca 70 till 90 cm och väger runt 5 kg.

Tumlaren blir könsmogen vid 3-4 års ålder och honorna kan därefter föda en kalv varje eller vartannat år, vanligtvis under första halvan av sommaren. Honan är dräktig i 10-11 månader och ger di till sin kalv i 8-12 månader, men kalven börjar äta fisk också från 3-4 månaders ålder. En tumlare kan leva upp till 24 år men lever sällan längre än 12 år. Tumlare lever inte i stora grupper, vanligtvis är det bara hona/or och kalv/ar eller en liten grupp på upp till åtta individer som förekommer i grupp. Men ibland ses stora antal tumlare tillsammans, det är då flera smågrupper som födosöker på samma ställe.

Tumlaren i Svenska vatten äter mest sill och skarpsill, men också olika torskfiskar, smörbultar och pirål [1]. Storleksordningen på fisken kan variera mellan 10-30 cm, beroende på bl.a. geografiskt område och ålder på tumlaren.

Tumlaren fridlystes i Sverige år 1973, men har ännu inte återhämtat sig i Östersjön. Den är klassad som sårbar på IUCNs rödlista. Den tillhör lagparagrafen Statens Vilt, och fynd av döda tumlare bör rapporteras till myndigheterna. Insamling av tumlare för olika forskningsprojekt har medfört att Naturhistoriska riksmuseet fått in prover av djur eller hela djur för obduktion och provtagning av olika organ till museets miljöprovbank. I denna rapport har data sammanställs på djur som inkommit till museet mellan 1972 och 2013. Ett drygt tjugotal har inom åtgärdsprogrammet analyserats med avseende på klorerade, bromerade och fluorerade organiska miljögifter samt tennorganiska ämnen och tungmetaller.

1.2. Mål med studien

Målet med denna studie är att få information om miljögiftsbelastningen i tumlare från svenska vatten. Några miljögiftsanalyser på tumlare från svenska vatten har inte gjorts på många år, och flera av de ämnen som vi ingår i studien har inte analyserats i tumlare från svenska vatten någonsin. Eftersom tumlaren födosöker högt upp i den marina näringskedjan är det av stort intresse att analysera tumlare med avseende på persistenta miljögifter och för att övervaka belastningen av dessa ämnen.

2. Tumlare i Naturhistoriska riksmuseets samlingar

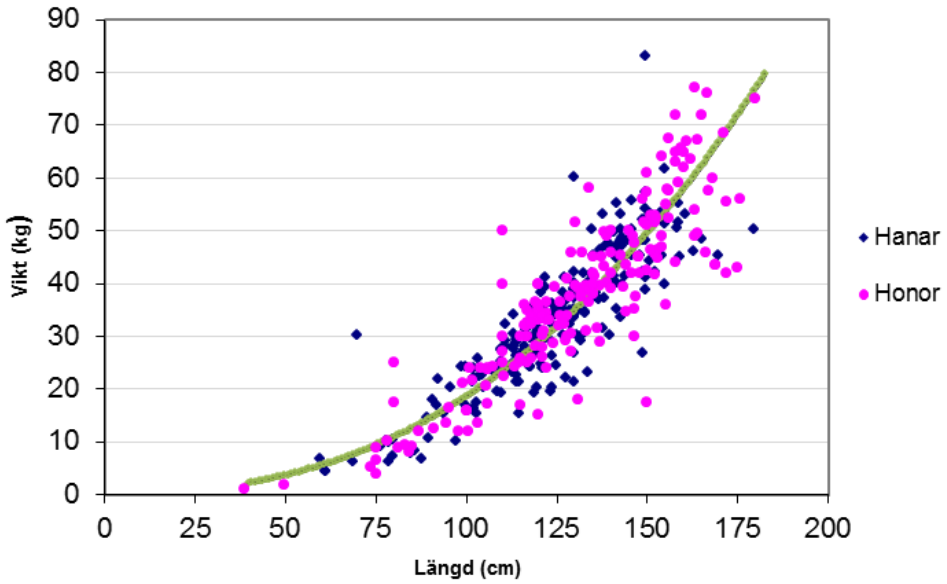
2.1 Antal tumlare i museets miljöprovbank, åldersindelning, kön

De flesta tumlare som återfinns och rapporteras från Östersjön skickas till Naturhistoriska riksmuseet (NRM) för provtagning och obduktion. Det rör sig om ytterst få djur, framför allt från södra Östersjön, och flera av dem kan ha kommit in till Östersjön med vattenströmmar efter att de har dött. I de flesta fall är dessvärre dessa djur kraftigt förruttnade varför en ordenlig obduktion är svår att genomföra. I vissa fall har endast skallen skickats in till museet. Tumlaren tillhör visserligen lagparagrafen om Statens Vilt, men alla hela tumlare funna döda på Svenska västkusten skickas inte regelbundet in till NRM på grund av bristande ekonomi. Naturhistoriska museet i Göteborg samlar in hela djur eller tar prover av dem i mån av tid och skickar dessa djur/prover med uppgifter om längd, vikt, kön etc till NRM. I vissa fall har man inte kunnat väga tumlaren (då den legat på en svårtillgänglig plats) och därför saknas en del data om vikt och i vissa fall saknas även uppgift om längd och kön. Göteborgs Naturhistoriska museum samlar även in hela djur som de skickar till NRM eller SVA för obduktion. Även Havets Hus i Lysekil har varit behjälpliga, liksom Kristinebergs Marina Forskningsstation.

I riksmuseets miljöprovbank finns prover från 230 hanar, insamlade mellan 1972 och 2013 med känd längd och vikt. Den längsta hanen var 180 cm lång och vägde 50 kg, och kom från Kattegatt. Den tyngsta hanen vägde 83 kg och var 150 cm lång, också den från Kattegatt.

I miljöprovbanken finns också 187 honor med känd vikt och längd, insamlade mellan 1977 och 2013. Det var ingen skillnad i storlek mellan könen i detta material (Figur 1). Den längsta honan var 180 cm och vägde 75 kg och kom från Öresund. Den tyngsta honan vägde 77,1 kg och var 163 cm lång och kom från Kattegatt.

Det förelåg inte heller någon skillnad i proportion mellan längd och vikt hos könen i tumlarena (variansanalys, $p<0,14$) och därför presenteras könen i samma diagram (Figur 1).

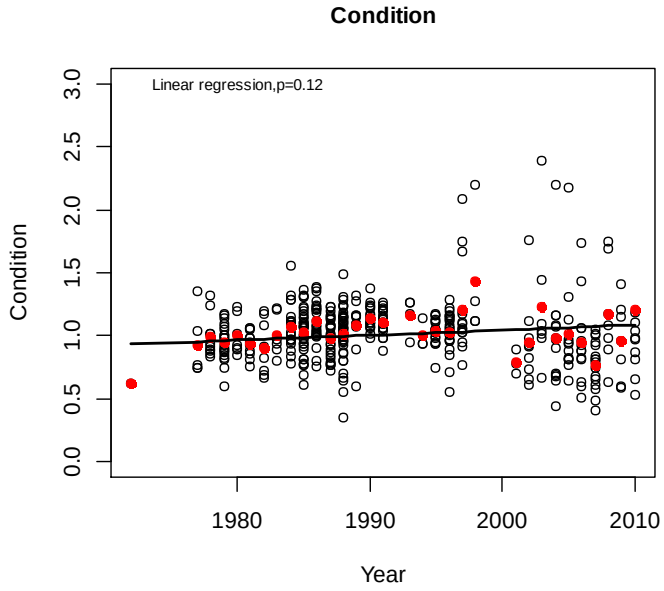


*Figur 1. Förhållande mellan längd och vikt hos tumlare som inkommit till Naturhistoriska riksmuseet mellan 1972-2013 (n=418). Rosa cirklar är honor och blå cirklar är hanar. Längd/viktrelationen är bestämd utifrån en regression av log(vikt) mot log(längd) (vikt=0,00023*längd ^{2,45}).*

2.2. Dödsorsaker, späcktjocklek

De flesta tumlare som obducerats har drunknat i fiskeredskap. Det gäller även de som återfinns döda på stranden. Obduktion kan påvisa att djuret drunknat/kvävts, men det beror på hur pass färsk kroppen är. Alla tumlare i miljöprovbanken har inte obducerats, utan många har skickats in i delar.

Eftersom man noterat en minskning av späcktjockleken hos gråsäl i Östersjön på senare år så är det av intresse att se om detsamma kan ses hos tumlare. Vid en beräkning av kroppsindex (body condition index, BCI) av samtliga tumlare i NRMs databas med känd längd och vikt (n=443) så framgår det att BCI inte har förändrats över tid de senaste dryga fyra decennierna (1972-2013). Det var ingen skillnad i späcktjocklek under året och därför ingår alla tumlare med känd längd och vikt i analysen (Figur 2).



Figur 2. Konditionsindex hos samtliga tumlare i riksmuseets miljöprovbank som har känd längd och vikt. Både hanar och honor ingår i analysen, som visar att konditionsindex inte har förändrats över tid. Fyllda röda cirklar indikerar medelvärdet för året.

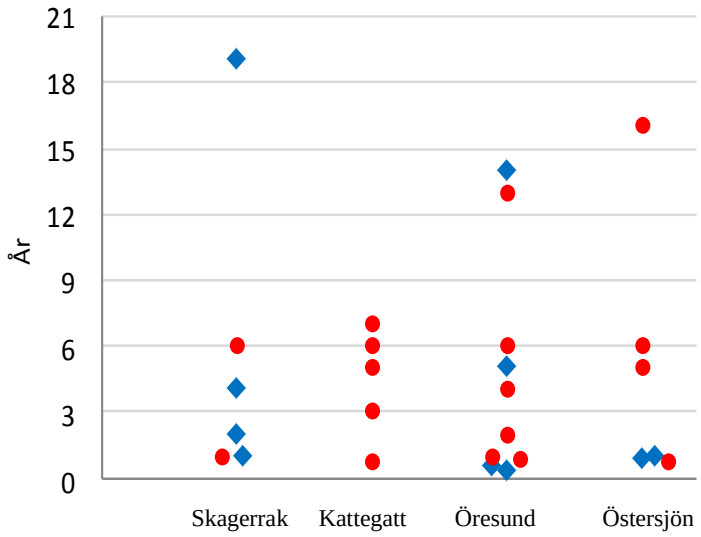
2.3. Maginnehåll

Maginnehållet från 31 tumlare insamlade under 2010-2012 har analyserats. Framför allt återfanns rester av torsk, sill, skarpsill, vitling, tobis, stubbar/bultar och bläckfisk i magarna. Tolv av magarna var helt tomma.

2.4 Tumlare analyserade för miljögifter

Inom ramen för Åtgärdsprogrammet har 27 tumlareprover analyserats med avseende på en rad olika miljögifter. Djuren kom från fyra olika områden: Skagerack, Kattegatt, Öresund samt

Östersjön, insamlade mellan 2005 och 2012 (se Bilaga 1). Tumlarna som ingår i gruppen från Östersjön, kommer från de södra, svenska delarna av Östersjön. Medelåldern på tumlarna från Skagerrak var 2,8 år, Kattegatt 6,7 år, Öresund: 4,7 år och Östersjön 5 år (Figur 3). Grupperna var inte statistiskt skilda åt åldersmässigt (p=0,66, Anova). Det äldsta djuret i studien var en hane på 19 år från Kattegatt, näst äldst var en hona om 16 år från Östersjön.



Figur 3. Ålder på de tumlare som har analyserats med avseende på miljögifter inom denna studie. Blå rektanglar representerar hanar och röda cirklar representerar honor.

ACES, Stockholms universitet har analyserat klorerade och bromerade ämnen i späck samt perflourerade ämnen i lever. Lunds universitet har anlyserat tungmetaller i lever, och Eurofins har analyserat tennorganiska ämnen i lever. Christina Lockyer, Age Dynamics, har åldersbestämt djuren med hjälp av tandsnitt.

2.5. Statistik

För att eftersträva normalfördelning har koncentrationerna av miljögifter logaritmerats innan statistisk analys. I de fall där endast ett fåtal koncentrationer legat under detektionsgränsen har detektionsgränsen för respektive analys dividerats med roten ur två för att kunna inkludera även dessa data i de statistiska analyserna [2]. I de fall där merparten av halterna ligger under detektionsgränsen så har ingen statistik genomförts. $P<0,05$ har använts som gräns för statistisk signifikans, och p=0,05-0,10 som tendens.

Varje ämne för sig testats med Single Factor ANOVA individuellt för att se om det är skillnad i halt mellan områdena. Principal Component Analys (PCA) har används för att se om mönstret i de olika ämnesgrupperna skiljer sig åt mellan de olika områdena.

Preliminära diagram av logaritmen av koncentrationen mot kvadratroten av åldern visade att förutsättning om linjäritet för regressionsanalysen var uppfylld. Relationen mellan miljögift och ålder kunde därefter analyseras med hjälp av linjär regression.

3. Analysresultat

3.1. Tungmetaller och spårämnen

Följande ämnen har analyserats i lever från 27 tumlare: Arsenik, kobolt, kadmium, koppar, krom, järn, kvicksilver, nickel, bly, antimon, selen, tenn, uran och zink. Halterna redovisas i µg/g våtvikt (vv). En PCA (Principal Component Analysis) av samtliga tungmetaller visade att mönstret i metallkoncentrationerna inte skiljde sig mellan områdena (Bilaga 2). Nedan gås samtliga metaller igenom mer i detalj.

3.1.1. Kvicksilver, selen, kadmium och bly

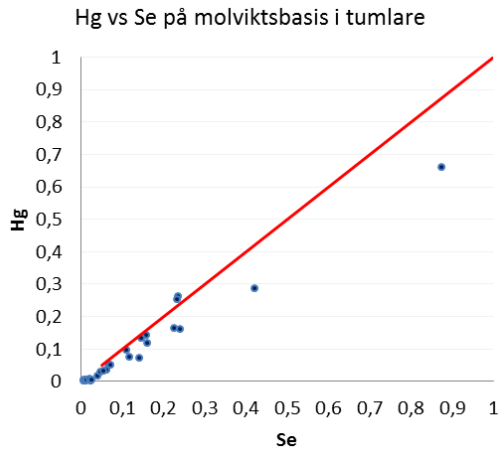
Halterna av kvicksilver i tumlarelever låg mellan 0,4 och 132 µg/g vv. Halten av selen låg mellan 0,6 och 69 µg/g vv. (Tabell 1). Det var ingen statistisk skillnad i halter mellan de fyra områdena ($p<0,36$ Anova), men det fanns en tendens till högre halter i tumlare från Kattegatt.

	min-max	Medel	SD
Hg	0,38-132	20	34
Se	0,63-69	10	17
Cd	0,0002-0,3	0,08	0,07
Pb	0,0001-0,06	0,01	0,01

Tabell 1. Kvicksilver, selen, kadmium och bly (µg/g vv) i lever från 27 tumlare (Min, max, medel och standardavvikelse.

Koncentrationen av Hg och Se berodde på åldern av djuret. Halterna var högre ju äldre djuret var ($p<0,001$), Bilaga 3. De högsta halterna av Hg och Se hade en 16-årig hona från Östersjön (132 resp 69 µg/g vv), och näst högsta halter hade en 7-årig hona från Kattegatt (57 resp 33 µg/g vv).

Det fanns en stark korrelation mellan kvicksilver och selen. I samtliga tumlare med undantag av två var halterna av selen på molviktsbasis något högre än kvicksilver, vilket betyder att det fanns ett litet överskott av selen. I två fall överskred kvoten mellan Hg och Se 1, det var i en 14 årig hane från Öresund (51 µg/g Hg vs 18,5 µg/g Se) och en 5 årig hane från samma område (52 µg/g Hg vs 18,7 µg/g Se) och det tyder på att dessa två hade ett överskott av Hg jämfört med Se – övriga tumlare hade ett överskott av selen som därmed kan vara tillgängligt för andra funktioner (Figur 4).



Figur 4. Koncentrationen av Hg vs Se på molviktsbasis. Röd linje indikerar ett 1:1 förhållande. Två av tumlarna låg över denna linje och flera låg nära.

Generellt var halterna av både kadmium och bly låga i tumlarena, och det var ingen statistisk signifikant skillnad i halt mellan områdena ($p<0,47$ resp 0,84 ANOVA). Högsta halten av Cd (0,27 µg/g vv) hade en 7-årig hona från Skagerrak, och den högsta halten Pb (0,06 µg/g vv) hade en 16-årig hona från Östersjön (Tabell 1 samt Bilaga 3). Koncentrationen av både Cd och Pb ökade med ökad ålder ($p=0,0009$ resp 0,0011) (Bilaga 3).

3.1.2. Aluminium, arsenik, kobolt, krom, koppar, järn, nickel, antimon, tenn, uran och zink

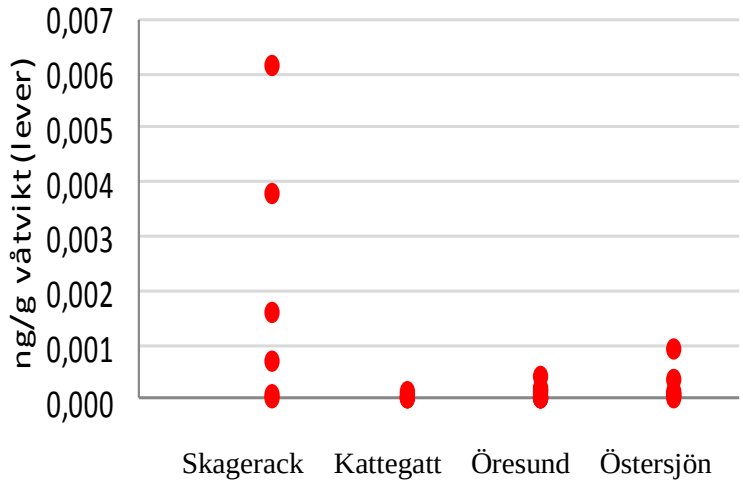
Aluminium (Al), Arsenik (As), Kobolt (Co), krom (Cr), koppar (Cu), järn (Fe), nickel (Ni), antimon (Sb), tenn (Sn), uran (U) och zink (Zn) analyserades i tumlarelever, se Tabell 2. Halterna redovisas i µg/g vv.

	min-max	medel	SD
Al	0,06-4,3	0,9	0,9
As	0,13-1,6	0,47	0,3
Co	0,0-0,01	0,01	0,0
Cr	0,00-0,6	0,1	0,1
Cu	1,5-34	9,3	6,7
Fe	45-630	340	150
Ni	0,00-1,1	0,17	0,27
Sb	0,00-0,004	0,001	0,001
Sn	0,02-0,5	0,14	0,11
U	0,00-0,01	0	0
Zn	24-220	67	49

Tabell 2. Koncentrationer av aluminium, arsenik, kobolt, krom, koppar, järn, nickel, tenn, antimon, uran och zink (µg/g vv) i lever från 27 tumlare (Min, max, medel och standardavvikelse).

Halterna av aluminium, arsenik, kobolt, krom och koppar visade ingen skillnad mellan områdena ($p<0,46$, 0,80, 0,79 resp 0,94, ANOVA). Detsamma gäller för järn ($p<0,37$), nickel ($p<0,77$), antimon ($p<0,25$), tenn ($p<0,81$) och zink ($p<0,17$). Uran låg under detektionsgränsen i sju av tumlarna och uppmättes i låga halter i övriga djur. Halterna av uran låg under detektionsgränsen i en av sex tumlare från Skagerrak, en av fem från Kattegatt, fyra av tio från Öresund samt en av sex från Östersjön. Halterna av uran var högst i tumlare från

Skagerrak. De två tumlare med högst halt uran kom bägge från Skagerrak (0,004 resp 0,006 ng/g vv, se Figur 5).



Figur 5. Uran i tumlare från Skagerack, Kattegatt, Öresund och Östersjön (ng/g vv, i lever.)

Koncentrationen av Cr och Cu minskade i tumlare med stigande ålder (p=0,001 resp 0,036), och Sn ökade med stigande ålder (p<0,003) till skillnad från övriga ämnen som inte ändras med åldern (p-värden mellan 0,17 och 0,90, se Bilaga 4).

3.2. Klorerade och bromerade ämnen

Späck från 25 tumlare samt två mjölkprover har analyserats inom detta projekt: sju konjener av PCB (CB nr 28, 52, 101, 118, 153, 138+163 och 180), *p,p'*-DDT och dess nedbrytningsprodukter *p,p'*-DDD och *p,p'*-DDE, HCB, a-HCH, b-HCH och lindan. Dessutom analyserades sex bromerade ämnen som ingår i brandskyddsmedel: BDE-47, -99, -100, -153, -154 samt HBCDD. En PCA av samtliga ämnen visade att mönstret i koncentrationerna inte skiljde sig mellan områdena (Bilaga 5). Nedan gås samtliga ämnen igenom mer i detalj.

3.2.4. Klorerade ämnen

Det förelåg ingen skillnad i halter mellan områdena för dessa ämnen (p-värden mellan p=0,64-0,75, ANOVA). Några av ämnena var mycket låga i tumlarna: CB-28, lindan, α-HCH och β-HCH låg i nästan samtliga fall under detektionsgränsen och därför har de inte behandlats statistiskt.

Halterna av sPCB (i detta fall summan av CB101+118+153+138+163+180) låg mellan 1000 och 38 000 ng/g fettvikt. Se Tabell 3 för min, max och standardavvikelse för de olika kongenerna. Den högsta halten hade det äldsta djuret i studien, en 19-årig hane från Skagerrack år 2011. Lägst hade en 7-årig hona från Kattegatt år 2007. CB-153 stod för hälften av sPCB (49%), och därefter kom CB-138+163 (30%). Minst andel stod CB-52 och -101 för (4%). Halterna av flera kongener var högre i äldre djur, mest tydligt hos hanar.

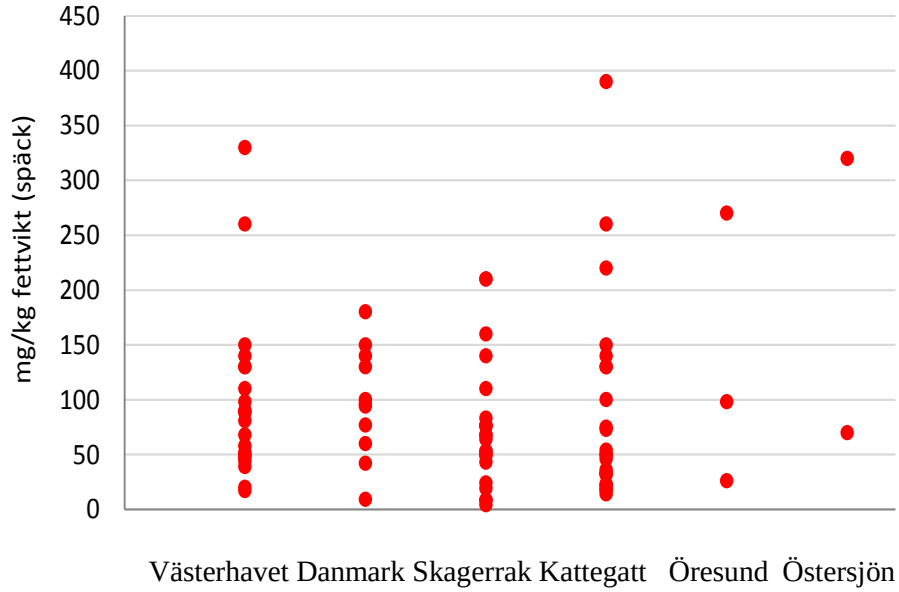
p,p'-DDT fanns i mätbara halter i 22 av 25 tumlare, i halter mellan 120-1700 ng/g fv. Mellan 0-17% av sDDT (*p,p'*-DDT+ *p,p'*-DDE+ *p,p'*-DDD) utgjordes av *p,p'*-DDT. Halterna av

sDDT låg mellan 570-12 700 ng/g fv. Den högsta halten sDDT hade den 19-årige hanen från Skagerack 2011, och näst högst hade en årsunge från Östersjön 2007. Lägst hade en 7-årig hane från Kattegatt (2007) och en årsunge från Östersund 2010. Varken HCB, *p,p'*-DDE eller *p,p'*-DDT ändrades med ökad ålder, men *p,p'*-DDD var nästan signifikant ($p<0,06$).

	min-max	medel	SD
CB-28	ud		
CB-52	36-994	216	206
CB-101	52-599	247	115
CB-118	90-3460	441	655
CB-153	442-21115	2992	3994
CB-138+163	288-12553	1838	2356
CB-118	100-4050	514	757
p,p'-DDD	420-7944	2385	1664
p,p'-DDE	92-2995	632	570
p,p'-DDT	61-1716	348	355
HCB	1,6-2,7	2,1	0,3

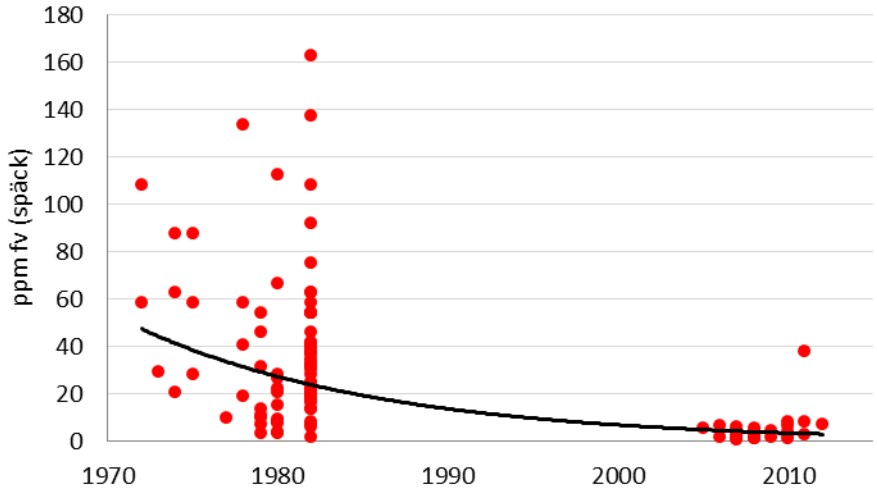
Tabell 3. Min, max, medel och standardavvikelse för klorerade ämnen i tumlare (späck, ng/g fettvikt). Ud= under detektionsgränsen.

Tidigare har späck från 85 tumlare insamlade 1972-1983 analyserats med avseende på sPCB och sDDT. Tumlarna kom från 6 områden: Västerhavet, Jylland/Danmark, Skagerrak, Kattegatt, Öresund samt Östersjön. Inte heller då förelåg någon skillnad i halt mellan områdena (Figur 6). Analyserna genomfördes på en s.k. packad kolonn, som inte separerar de olika CB-kongenerna [3]. Den analysmetod som används efter 1992 baseras på en gaskolonn GC och separerar de individuella kongenerna mycket bättre [4]. sPCB analyserad på packad kolonn redovisar summan av topp 3 samt 7-14 (varje topp inkluderar flera kongener). För att sammanföra gamla analysresultat med nya så bör man analysera åtminstone 10 djur med bägge analysmetoderna för att se om de korrelerar. Så har inte skett för tumlare, men väl för några andra arter, bland annat gråsäl i Östersjön. Summan av de största kongenerna analyserade på packad kollon (sPCB)/2,4 visade sig motsvara summan av CB-138+153+180 analyserade på kapillär kolonn [5] i gråsäl.



Figur 6. sPCB analyserade i ett tidigare projekt, i 85 tumlare från 1974-1983 (mg/kg fettvikt, späck)

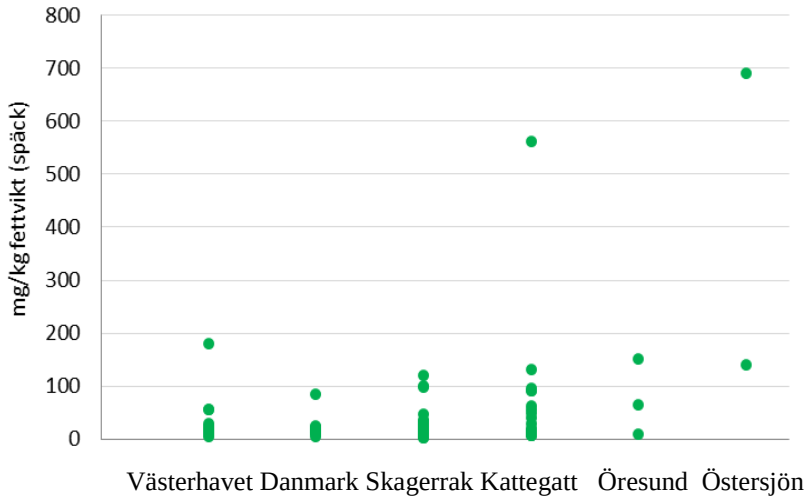
För att se hur halterna av sPCB ser ut över tid så gjordes en regression på loggade värden över tid, baserat på äldre ej publicerat material (sPCB/2,4) och resultaten från denna studie sCB-138, 153 + 180). Halterna visade på en minskande trend, med 6,9% årligen ($p<0,001$), se Figur 7. Denna trend får ses som ytterst preliminär, eftersom den inkluderar tumlare från olika områden och ålder samt två analysmetoder. Dock är minskningshalten liknande vad som ses för andra djur så den är säkerligen inte alltför långt ifrån sanningen.



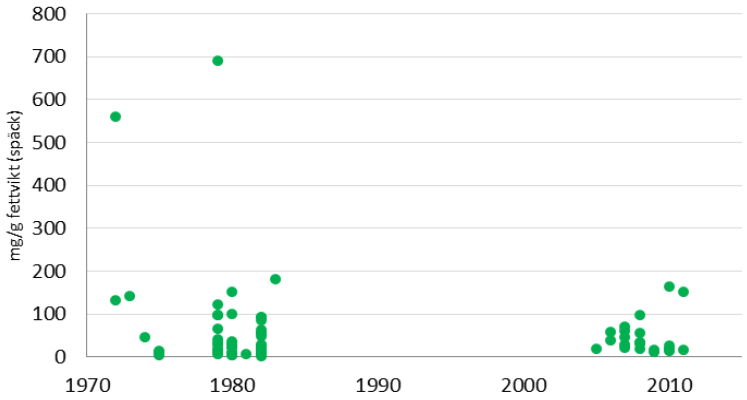
Figur 7. sPCB i 110 tumlare (späck) insamlade mellan 1972 och 2012. Resultaten från 1974-1983 baseras på packad kolonn GC och senare data på kapillärkolonn GC.För att få jämförbara resultat har sPCB på packad kolonn delats med 2,4 och resultaten från senare tid består av summan av CB-138+153+180.

Tumlare från 6 områden har analyserats med avseende för sDDT tidigare, samma djur som analyserats för sPCB (Figur 8).

Analysmetoden för DDT har precis som för PCB ändrats efter 1992, men här tyder data från gråsäl på att det inte är någon skillnad mellan analysmetoderna (packad vs kapillärkolonn) och därför lades data från 1972-1983 ihop med data från denna studie. Här visar det sig att sDDT inte har förändrats över tid. (Figur 9).



Figur 8. sDDT analyserade i tumlare insamlade mellan 1974-1983 (mg/kg fettvikt.) från Danmark (Västerhavet och "Jylland/Danmark"), Skagerrak, Kattegatt, Öresund och Östersjön.



Figur 9. Halterna av sDDT (mg/kg fettvikt) har inte minskat signifikant över tid i tumlare.

Inom studien analyserades mjölk från en lakterande hona samt späck från henne med avseende på klorerade och bromerade ämnen. Även späck från en diande kalv analyserades samt ren mjölk som fanns i dess mage. Kvoten för de olika kongenerna visar att halten av *p,p'*-DDE, *p,p'*-DDT och flera av PCB-erna var ungefär dubbelt så hög i mjölken som i honans späck. I kalven visade det sig att den hade ca dubbelt så hög halt av ffa *p,p'*-DDE, *p,p'*-DDT, CB-118 och CB-153 som i mjölken. (Tabell 4). Det visar att en stor överföring av dessa fettlösliga ämnen sker från mamma till kalv.

	DDE	DDT	CB-28	CB-52	CB-118	CB-153	CB-(138+163)	CB-180
Kvot mjölk/späck (hona)	2,07	2,59	2,79	1,30	1,42	1,47	1,83	1,94
Kvot späck/mjölk (kalv)	2,24	2,49	1,20	1,19	2,23	1,91	1,44	1,48

Tabell 4. Kvoten av olika klorerade kongener i mjölk resp späck av en lakterande hona, samt i kalven jämfört med mjölk den hade i magen.

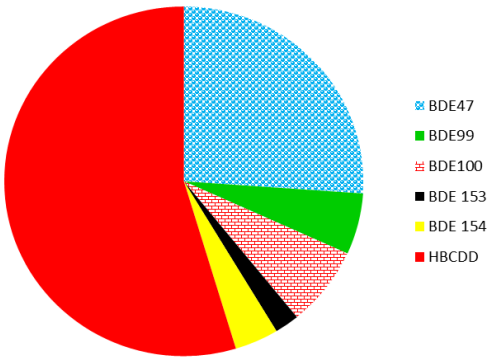
3.3 Bromerade ämnen

Det förelåg ingen skillnad i halt mellan områdena (p-värden mellan p<0,45-0,72, ANOVA), se Tabell 5. Koncentrationen BDE-154 ökade signifikant med ökad ålder (p=0,010), och HBCDD nästan signifikant (p=0,052). I övrigt fanns inga samband mellan BDE och ålder (p=0,44-0,99).

	BDE-47	BDE-99	BDE-100	BDE-153	BDE-154	HBCDD
min-max	33-315	5-74	9-102	1,0-30	3-42	54-507
medel	106	23	30	9	16	222
SD	63	17	21	8	11	118

Tabell 5. Bromerade ämnen i tumlare (späck). Min, max, medel och standardavvikelse. Halterna visas på fettviktsbasis, ng/g.

BDE-47 stod för ca en fjärdedel av sPBDE + HBCDD i tumlare i denna studie (se Figur 10). Högst halt av BDE-47 hade en årsunge från Östersjön (315 ng/g fv), och näst högst halt hade en tvååring från Skagerack. Lägst halt (33 resp 36 ng/g fv) hade en 5-årig hona från Östersjön, och en 7-årig hona från Kattegatt. Halten av HBCDD utgjorde drygt hälften av de bromerade ämnena (Figur 10). Högst halt HBCDD hade en 19-årig hane från Skagerack (507 ng/g fv).



Figur 10. Medelvärden för de olika bromerade kongenerna i tumlare. BDE-47 står för ca hälften av alla kongener.

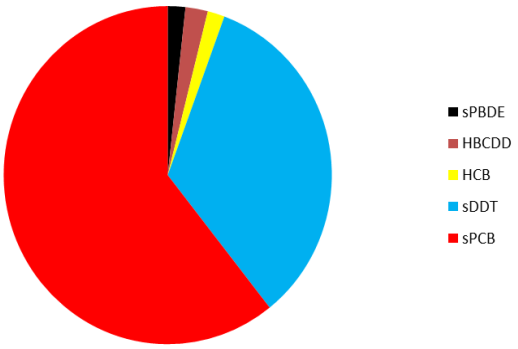
Späck och mjölk från en lakterande hona analyserades även för bromerade ämnen, liksom späck från en diande kalv samt ren mjölk som fanns i dess mage. Kvoten för de olika bromerade kongenerna visar att halterna var lägre i mjölk jämfört med honan, till skillnad från

de klorerade ämnena. Men, i likhet med de klorerade så var även bromerade ämnen högre i kalven jämfört med mjölken i dess mage. (Tabell 6).

	BDE-47	BDE-99	BDE-100	BDE-153	BDE-154	HBCDD
Kvot mjölk/späck (hona)	0,77	0,50	0,62	0,47	0,59	0,36
Kvot späck/mjölk (kalv)	2,21	1,99	1,79	1,27	1,09	2,01

Tabell 6. Kvoten av olika bromerade kongener i mjölk resp späcket av den lakterande honan, samt i kalven jämfört med mjölk den hade i magen.

Fortfarande utgör sPCB (61%) och därefter sDDT (34%) de högsta halterna av de fettlösliga ämnena i tumlare trots att de har varit förbjudna i över fyra årtionden. Cirkeldiagrammet nedan visar medelhalterna för sPBDE, HBCD, HCB, sDDT och sPCB (Figur 11).



Figur 11. Cirkeldiagram med medianhalterna av sPBDE (BDE-47, -99, -100 och -153), HBCDD, HCH, sDDT (p,p'-DDT, p,p'-DDE, p,p'-DDD) och sPCB (CB-52, -101, -118, -153, -138, -163, -180).

3.4 Perflourerade ämnen

Inom åtgärdsprogrammet har lever från 24 tumlare analyserats med avseende på 15 perflourinerade ämnen: perfluorerade karboxylsyrorna PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUnDA, PFDoDA, PFTrDA, PFTeDA, PFPeDA, PFBS samt de perfluorerade sulfonsyrorna PFHxS, PFOS, PFDS och FOSA. Av dessa låg PFHxA, PFHpA och PFBS under detektionsgränsen i samtliga prover (0,1 ng/g vv) och PFHpA under detektionsgränsen (0,08) i alla utom fyra prov. I elva tumlare låg halten av PFOA under detektionsgränsen, (0,3 ng/g vv, se Tabell 7). En PCA av samtliga ämnen visade att mönstret i koncentrationerna inte skiljde sig mellan områdena (Bilaga 6).

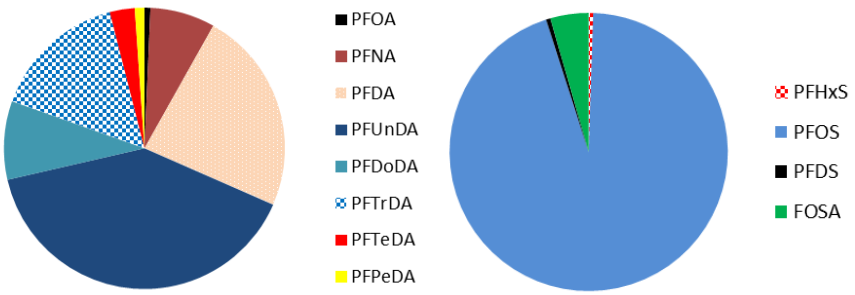
Det förelåg ingen skillnad i halter mellan områdena ($p<0,53$-$0,95$, ANOVA). PFOS var det ämne som visade på de allra högsta koncentrationerna. Det stod för drygt 90 % av halten perfluorerade sulfonsyrorna.

Bland de perfluorerade karboxylsyrorna stod PFDA, PFUnDA och PFTrDA för den största andelen (ca 80%) (Figur 12). Högst halt av PFUnDA och PFTrDA hade en årsunge från Öresund, tätt följt av en 4-årig hona från Skagerrak. Lägst halt av PFUnDA hade två 5-6 åriga honor från Kattegatt och Skagerrak. Lägst halt av PFTrDA hade en 19-årig hane från Skagerrak.

	PFOA	PFNA	PFDA	PFUnDA	PFDoDA	PFTrDA	PFTeDA	PFPeDA	PFHxS	PFOS	PFDS	FOSA
min-max	0,1-1,6	0,5-34	2,8-78	5,6-88	1,4-19	2,7-25	0,5-4,8	0,2-1,7	0,1-11	58-1440	0,3-11	1,7-93
medel	1	5	16	28	6	11	2	0,8	1,3	340	1,9	16
SD	0	7	16	22	5	7	1	0,40	2,3	340	2,3	24

Tabell 7. Perflourerade ämnen i tumlare (lever, ng/g vv). Min och maxvärde redovisas, samt medelvärde och standardavvikelse (SD).

Flera av ämnena var starkt korrelerade till varandra. Halterna av PFOS uppgick till 1440 ng/g vv, med ett medelvärde på 340 ng/g vv (Tabell 7). Högst halt av PFOS hade årsungen från Öresund, tätt följt av en 4-årig hona från Skagerrak, d.v.s. de tumlare som hade de högsta halterna av karboxylater. Lägst halt hade en femårig hona från Östersjön, och en sexårig hona från Skagerrak.



Figur 12. Medelhalter av de olika karboxylaterna (vänster) och sulfonaterna (höger) i tumlarelever.

Flera av ämnena visade på signifikant minskande halter med ökad ålder: PFDoDA ($p<0,03$), PFTrDA ($p<0,03$), PFTeDA ($p<0,04$) och PFHxS ($p<0,04$). PFUnDA och PFDS visade på nästan signifikant minskning med ökad ålder ($p<0,08$ resp 0,10). Ingen trend sågs för övriga ämnen ($p=0,12$-$0,44$, se Bilaga 7 och 8).

3.6 Tennorganiska ämnen

Inom åtgärdsprogrammet har lever från 22 tumlare analyserats med avseende för flera tennorganiska substanser: Tributyltenn (TBT), Dibutyltenn (DBT), Monobutyltenn (MBT), Monooktyltenn (MOT), Dioktyltenn (DOT), Trifenyltenn (TPhT) samt Tricyklohexyltenn (TCHT). Halterna redovisas i ng/g vv. (Tabell 8).

	TBT	DBT	MBT	summa TBT+DBT+MBT)	TPhT
min-max	u.d.-166	6,4-346	u.d.-29	13,5-541	1,3-166
medel	35	89	8,9	133	35
SD	38	93	7,6	131	38

Tabell 8. Halter av tennorganiska ämnen i tumlare (lever). Min-max, medelvärde samt standardavvikelse. Halterna visas i ng/g våtvikt.

MOT, DOT och TCHT låg under detektionsgränsen i samtliga prover. Det förelåg ingen skillnad i halt mellan de fyra områdena för de övriga ämnena (ANOVA, p=0,28-0,92). DBT återfanns i de högsta halterna, och därefter TBT och sedan MBT. I sex tumlare låg halterna av MBT under detektionsgränsen och i tre av tumlarna låg halten TBT under detektionsgränsen. Kvoten TBT/summa (TBT, DBT och MBT) låg i medeltal på 0,3 (0,1-0,7).

Koncentrationen av MBT ökade med stigande ålder (p=0,02) och en stark trend sågs för TBT och DBT (p=0,053 och p=0,084, se Bilaga 9). PThT ändrades inte med ökad ålder (p=0,27).

4. Sammanfattning/diskussion

Denna rapport redovisar data om ett stort antal miljögifter i tumlare från de senaste åren (2006-2012). De flesta ämnena som analyserats är mycket stabila (persistenta) och giftiga. En del av dem är naturligt förekommande (t.ex. metaller) men som dessutom sprids med människans hjälp. Flera av dem är fettlösliga (de klorerade och bromerade ämnena) och återfinns framför allt i fettrika organ som t.ex. späck. Andra beter sig annorlunda, de perflourerade ämnena och de tennorganiska ämnena binds till proteiner och blodrika organ, och därför har dessa ämnen analyserats i lever. Eftersom metallerna framför allt binds till lever och njure har även dessa ämnen analyserats i lever.

Tumlarna kom från fyra olika områden: Skagerrak, Kattegatt, Öresund och Östersjön. De flesta tumlare som inkommit till NRM är från Öresund; och endast ett fåtal djur från Östersjön har påträffats döda de senaste åren. Medelåldern för tumlare från de olika områdena var ungefär densamma. Äldst var en 19-årig hane från Skagerrak, och han visade sig ha de högsta halterna av klorerade och bromerade ämnen, men också lägst av flera av de perflourerade ämnena.

Det var ingen geografisk skillnad mellan områdena för något av de analyserade ämnena. Huvudsyftet med studien var att få en baslinje över nivåerna av miljögifter i tumlare.

Man kan inte utesluta, utan snarare förvänta sig, synergistiska effekter av olika miljögifter, s.k. cocktaileffekter. Flera av gifterna förmodas ha liknande negativa effekter på djurens hälsa. Det finns inga säkra tröskelhalter för när ett visst miljögift ger en negativ effekt på tumlare, men djurförsök på laboratoriedjur kan ge viss information även om det naturligtvis inte går att ”översätta” resultaten rakt av.

4.1 Metaller och spårämnen

Studier på tumlare har visat på ett samband mellan höga halter av flera metaller och lägre motståndskraft mot sjukdomar och ökad förekomst av parasiter och lunginflammation [6, 7].

Den högsta halten kvicksilver i denna studie låg över det värde som kan ge skador hos marina däggdjur (i.e. 100-400 µg/g vv, [8]), och ytterligare tre djur låg nära värdet. Medelhalten av kvicksilver i denna studie var högre än halterna i tumlare från Nordsjön [9] och Svarta Havet [10] men liknande halterna hos tumlare i Nederländska vatten och i Irländska sjön [9]. Två av tumlarna hade högre halt kvicksilver jämfört med selen på molviktbasis, vilket indikerar ett överskott av kvicksilver och kanske selenbrist, som i sig kan ge negativa effekter. I en europeisk studie där 102 tumlare undersöktes fann man att alla utom 7 individer (93%) hade ett överskott av selen i förhållande till kvicksilver [3]. I studien, som analyserade både lever och njure, fann man att kvoten Hg/Se på molarbasis låg mellan 0,16 och 1,27. De sju djur i

studien som hade en kvot över 1 kom från fyra olika områden (norra och södra Nordsjön, nordvästra Skotland och Irländska sjön). De flesta av dem (73%) hade en kvot understigande 0,8. Det är liknande vad som redovisas i denna studie: kvoten Hg/Se på molviktsbasis mellan låg 0,08-1,1. Merparten av tumlarna i denna rapport hade en kvot under 0,8 (81%).

Halterna av kadmium och bly var mycket låga. Kadmiumhalterna låg långt under effektnivåer i marina däggdjur, där tröskelvärdet för leverskada för marina däggdjur misstänks ligga på 200 µg/g vv [11].

Zink är viktig för immunsystemet, och förhöjda halter av zink i lever hos tumlare har associerats med nedsatt hälsa och lunginflammation [12]. Halter över 100 µg/g vv har föreslagits vara förhöjda [13] och tre tumlare i denna studie hade halter över denna ”tröskel” (en 6-åring och en 1-åring från Öresund och en 2-åring från Skagerack). Dödsorsaken hos två av dem är okänd, den ena samlades in i samband med en epizooti 2007 då knubbsäl och tumlare hade förhöjda dödstal i en okänd lungsjukdom [14]. Tyvärr var ingen av dem obducerade.

4.2 Klorerade och bromerade substanser

Olika laboratorieförsök på mink t.ex. visar på en försämrad reproduktion och ungöverlevnad vid mellan 2000 och 65 000 ng PCB/g fett [15-18].

I en studie från England och Wales visade att tumlare som dött en traumatisk död (framför allt bifångst) var friskare och hade lägre halter av PCB (i snitt 14 000 ng/g fv) än de som dött i infektionssjukdomar (som hade i snitt 31 000 ng/g fv PCB), och de hade dessutom fler parasiter [19]. Skillnaden i halt kunde inte relateras till ålder eller kön. Förhöjda halter av PCBs var också associerade med nedsatt immunförsvar hos tumlare i Storbritannien [20]. Experimentella studier på knubbsäl i Holland visade att sälarna hade försämrad reproduktion vid 25 000 ng/g fv i blodet [21, 22]. Andra studier på mink visar att de får försämrad reproduktion vid 12 500 ng/g fv [23] resp 40 000-60 000 ng/g fv PCB och minskad valpvikt vid 2400 ng/g fv PCB [18]. Kannan med flera har rapporterat en tröskelnivå på 17 000 ng/ för effekter av sPCB på reproduktionen hos akvatiska däggdjur [24].

I denna studie låg halterna av sPCB mellan 1000-38 000 ng/g fv (summan av kongenerna CB-101, 118, 138,163 och 180, medeltal 5000 ng/g fv), dvs ofta något lägre halter än vad som ger reproduktionsskador hos flera akvatiska däggdjur. Summa-PCB beräknas dock på lite olika sätt så studierna är inte helt jämförbara. Hanar visade på en ökning i halt med ökad ålder för de klorerade ämnena, men ett sådant mönster sågs inte hos honorna. Det är välkänt att fettlösliga klorerade substanser följer med mjölken under laktationen, och därmed avgiftas honan och det sågs också i det mamma-mjölkprov som också analyserades inom studien där mjölken från en lakterande hona hade dubbelt så höga halter som i hennes späck. Trots att materialet är mycket litet i denna studie så framkommer det tydligt. De bromerade ämnena visade däremot inte på någon tydligt samband med åldern, endast BDE-154 ökade signifikant med ökad ålder och HBCDD nästan signifikant. I mjölkprovet var halterna av dessa ämnen lägre än i den lakterande honans späck.

I en tidigare studie av tumlare från Svenska vatten framkom att det var högre halter av både PCBs och DDTs och PCDD/F i tumlare från Östersjön [25] men det kunde inte påvisas i detta material. Det kan dock bero på att det var få Östersjötumlare i studien och de kom från södra och sydvästra delarna av Svenska Östersjökusten, och dessa djur har säkerligen inte uppehållit

sig i Östersjön så länge, samt att materialet i denna studie inte är så stort. Halterna av PCB i den tidigare studien var baserad enbart på hanar och med djur som påträffats längre in i Östersjön.

Det verkar som om sPCB har minskat över tid, när resultat från 1972-1983 lades ihop med resultat från denna studie. Däremot visade sDDT inte på någon minskning, något som inte var förväntat och kan inte förklaras. Men två olika analysmetoder har använts för att beräkna sPCB och sDDT och för att få säkrare resultat borde de två analysmetoderna först jämföras med att t.ex. tio tumlare analyseras med båda metoderna för att se om metoderna är jämförbara.

Halterna av BDE-47 var ca 30 gånger högre i tumlare jämfört med sill och strömming från Svenska vatten och 5-10 gånger högre än i sillgrissleägg från Stora Karlsö [26]. Halten av HBCDD var ungefär lika hög som summan av de övriga BDE i tumlarena. Det är ett liknande mönster som hos gråsäl i Östersjön, men inte i utter (där ligger oftast HBCDD under detektionsgränsen). Halterna av HBCDD var liknande eller högre i tumlare från denna studie än i vuxna gråsälshanar från Östersjön (ej publicerat mtrl) och ca 20 gånger högre än sill och strömming från svenska vatten och liknande eller högre än i sillgrissleägg från Stora Karlsö.

Medianhalten av HBCDD i denna studie (200 ng/g fv) är i ungefär samma storleksordning som i tumlare från Spanien, men lägre än i tumlare från Skottland (medianer för olika områden: 800-5100 ng/g fv), Irland (1200 ng/g fv), Holland, Belgium och Frankrike (1100 ng/g fv) [27].

Intressant att notera att fortfarande än i dag 4 decennier efter förbuden av PCB och DDT så är halterna av avlägset mycket högre jämfört med PBDE och HBCDD.

4.3 Tennorganiska ämnen

Halterna av TBT och DBT i tumlare i denna studie var något lägre än i tumlare från Danmark och betydligt högre än i knubbsäl från Danmark [28]. Kvoten TBT/summa (TBT, DBT och MBT) låg i medeltal på 0,3 (0,1-0,7). Med andra ord utgör TBT (som är ursprungssubstansen) ca 30% av summan av TBT och metaboliterna DBT och MBT. Det ger en indikation om hur långt nerbrytningen har gått. I tumlare från Danmark var kvoten lägre, ca 20% [28]. I en studie från Svarta havet (1997) låg motsvarande kvot på 0,15 i tumlare. Halterna av TBT i denna studie ligger högre än den från Svarta Havet, medan halterna av DBT och MBT ligger lägre [29]. Trots det ligger halterna av TBT, DBT och MBT under de tröskelvärden som har associerats med leverskador och minskad immunförsvar hos labbråttor [30].

4.4. Perflourerade ämnen

Halterna av PFDA är jämförbara med vad som rapporterats från gråsäl från Östersjön [31], men PFUnDA och PFTrDA ligger högre i tumlare än i gråsäl.

PFOS stod för drygt 90 % av halten perfluorerade sulfonsyrorna, ett mönster som är liknande vad som setts i arter som t.ex. svenska uttrar och gråsälar [31, 32] samt tumlare i danska vatten [33]. Halterna av PFOS uppgick till 1440 ng/g vv, med ett medelvärde på 340 ng/g vv. Det är liknande vad som rapporterats för gråsäl i Östersjön [31] men lägre än i svenska uttrar

[32], minst fem gånger högre än i vikare från Grönland, och ungefär likvärdigt eller något högre än i isbjörn [34].

5. Tack till:

Göteborgs Naturhistoriska museum: Stort Tack till Anders Nilsson och Friederike Johansson mfl som hjälpt till och samlat in döda tumlare. Tack även till alla privatpersoner som också hjälper till och skickar in tumlare och rapporter om levande tumlare. Även Havets Hus och Kristinebergs Marinbiologiska Laboratorium har hjälpt till att ta hand om döda tumlare.

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Bilaga 1.

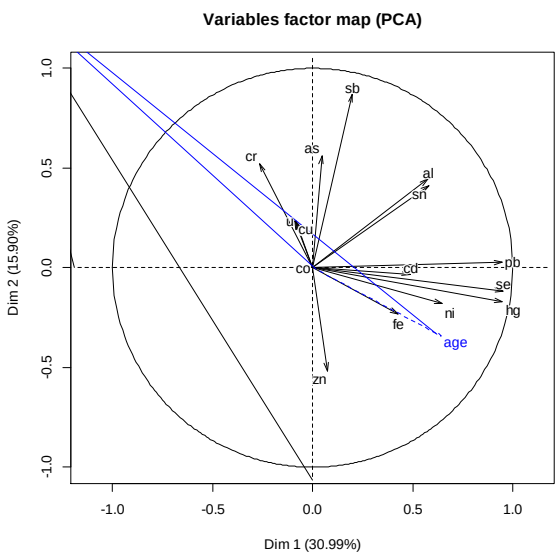
Tumlare analyserade inom ÅTG.

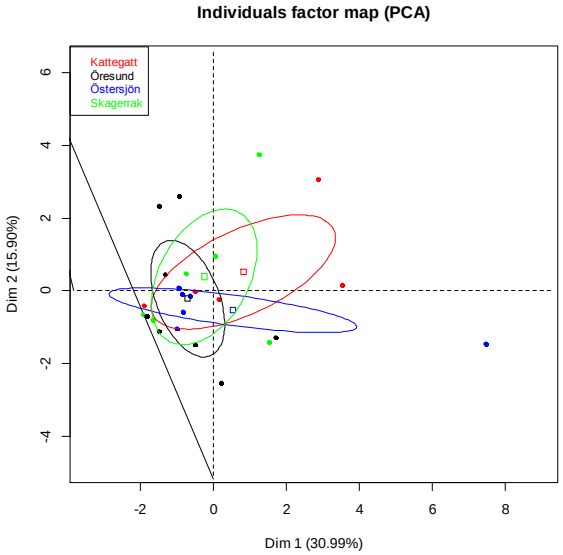
Nummer	År	Lokal	Område	Ålder	Kön	Längd	Vikt	Dödsorsak
A2004/05183	2006	Skagerrak	Skagerrak	4	Hane	135,5	40,6	Bifångst
A2007/05369	2007	13 sjömil V Marstrand	Skagerrak	6	Hona	158	44,1	Bifångst (trål)
A2005/05132	2005	Saltö, Ängklåvbukten	Skagerrak	2	Hane	121,5	23,8	Trol bifångst
C2007/08063	2006	Skogsskär, Saltöfjorden, Lysekil	Skagerrak	1	Hane	109,5	24	Trol bifångst
C2008/08899	2008	Bovallastrand	Skagerrak	1	Hona	113,5	24,3	Okänd
C2010/10096	2010	Halland	Kattegatt	6	Hona	156	52,4	Bifångst
C2012/00009	2011	Gottskär, norra änden av Utholmen	Kattegatt	19	Hane	154,5	45	Okänd
C2010/10098	2010	Varberg	Kattegatt	3	Hona	144	43	Trol bifångst
C2007/07615	2007	Falkenberg	Kattegatt	7	Hona	185		Okänd
C2010/10097	2010	Väröbacka, Ringhals	Kattegatt	0+	Hona	118	32,3	Trol bifångst
C2009/04448	2009	V om Vrångö	Kattegatt	5	Hona	159,5	65,7	Okänd
C2009/07366	2009	Öresund, Malmö, Ribersborg	Öresund	13	Hona		43,5	Bifångst
C2010/05196	2010	Rå Vallar	Öresund	<1	Hane	104,5	22,3	Trol bifångst
C2010/05197	2010	Rå Vallar	Öresund	Kalv	Hane	89,5	14,4	Trol bifångst
C2007/07619	2007	Örby, Helsingborg	Öresund	6	Hona	172	42	Okänd
C2007/07622	2007	Rydebäck, Helsingborg	Öresund	2	Hona	135	40	Okänd
C2008/00004	2008	Helsingborg	Öresund	1	Hona	121		Okänd
C2008/00005	2008	Helsingborg	Öresund	<1	Hona	126		Okänd
C2012/00002	2011	Bunkeflo strand	Öresund	5	Hane	136		Trol bifångst
C2012/00006	2012	Nyhamnsläge, Höganäs kommun, Strandbaden	Öresund	4	Hona	145		Okänd
C2012/00007	2011	Höganäs kommun, Strandbaden, Nyhamnsläge	Öresund	14	Hane	150	39	Trol bifångst
A2006/05226	2006	Hanöbukten, Åhus	Östersjön	6	Hona	151	46,5	Bifångst, drivgarn lax
A2008/05140	2007	Trelleborg	Östersjön	>1	Hane	140		Okänd
C2008/00017	2008	Höllviken	Östersjön	<1	Hane	123,5	19,4	Okänd
C2008/08865	2008	Ön Gråen utanför Landskrona	Östersjön	>1	Hona	115	30	Okänd
C2008/09130	2008	Sv om Falsterbo fyr	Östersjön	5	Hona	153		Okänd
C2012/00004	2011	Öst om Smygehamn	Östersjön	16	Hona	169	43,6	Okänd

Bilaga 2.

PCA över metallhalter i tumlare.

Vänster: Pricipalkomponent biplot som visar metallernas korrelation till med de två första pricipalkomponenterna. Pilernas längd anger korrelationens storlek. Pilar som pekar åt samma riktning visar att de är positivt korrelerade med varandra medan pilar som går i motsatt riktning är negativt korrelerade med varandra. De pilar som är vinklerätt mot varandra är ej korrelerade med varandra.
Höger: Pricipalkomponent 1 mot principalkomonent 2 för de individuella djuren. Elipserna representerar 95% av konfidenintervallet för centret för de fyra olika områdena och kuberna visar centrum. Elipserna överlappar varandra och är det ingen skillnad i halt mellan områdena.

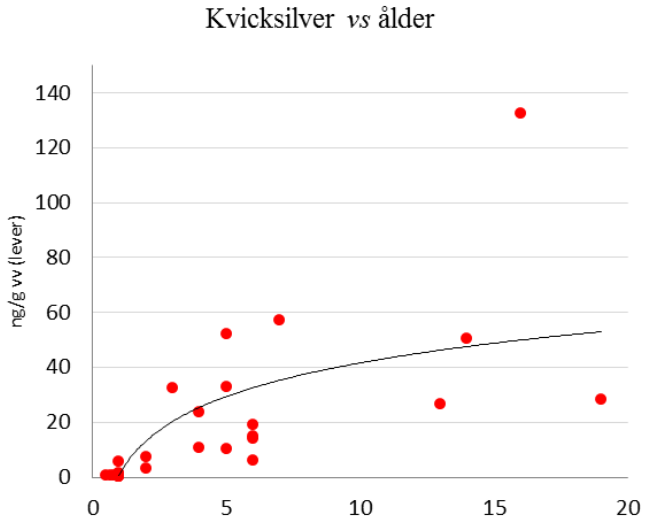


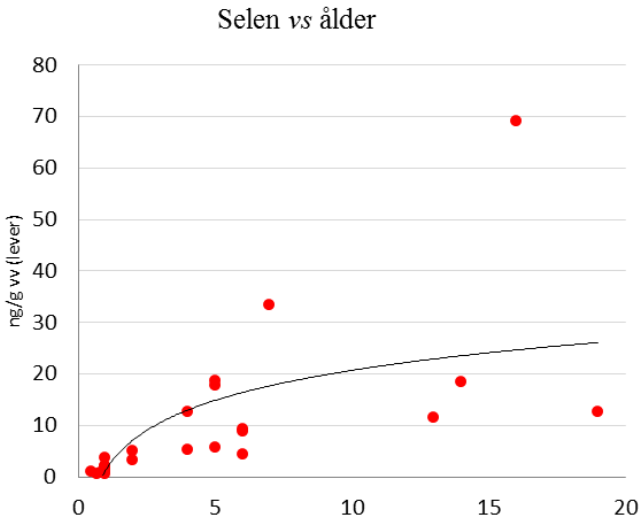


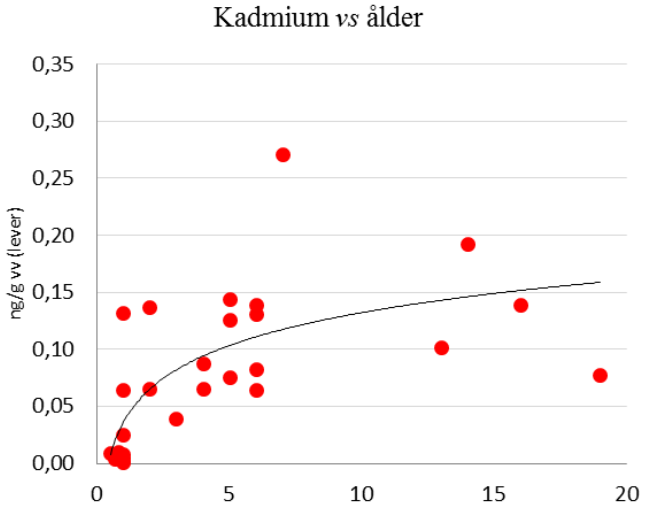
Bilaga 3.

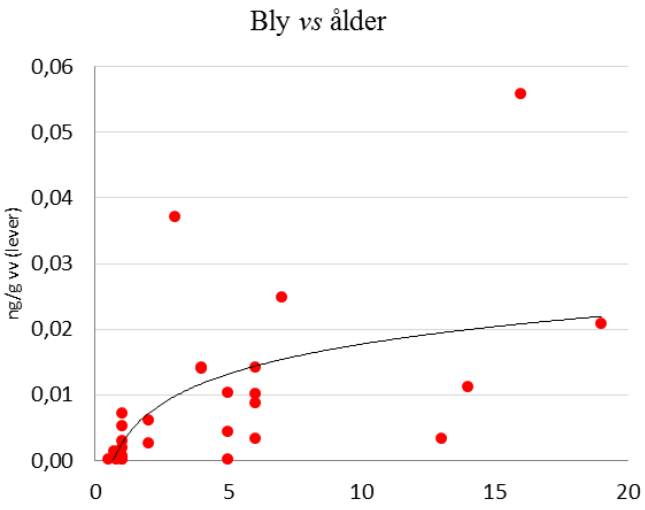
Kvicksilver, selen, kadmium samt bly vs ålder i tumlare.

Samtliga fyra ämnen ökar signifikant i halt med ökad ålder på djuret (ng/g våtvikt i lever).





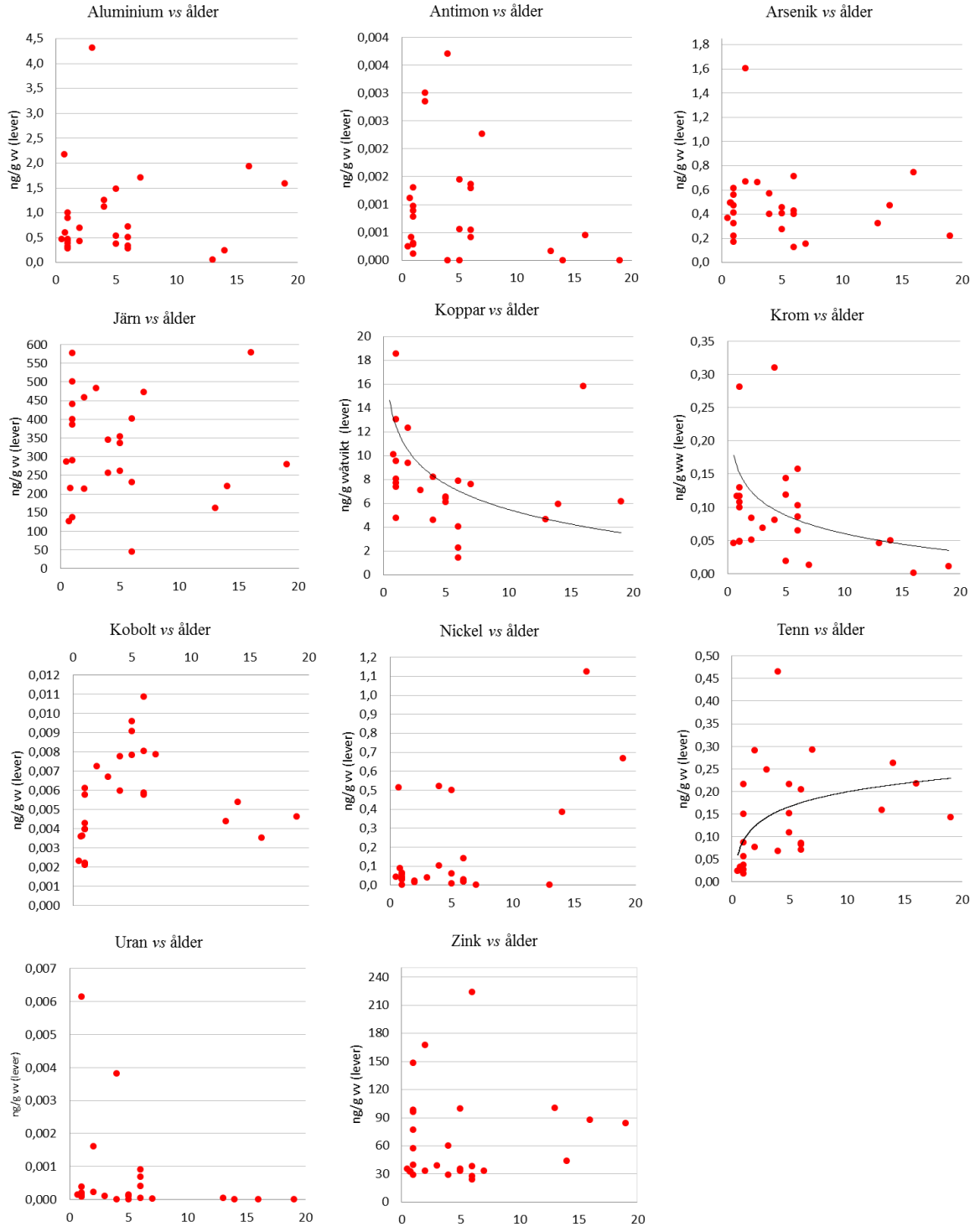




Bilaga 4.

Aluminium, antimon, arsenik, järn, koppar, krom, kobolt, nickel, tenn, uran och zink vs ålder i tumlare.

Tre ämnen förändras signifikant i halt med ökad ålder på djuret och linjen som är utritad för dessa är logaritmisk (ng/g våtvikt i lever).

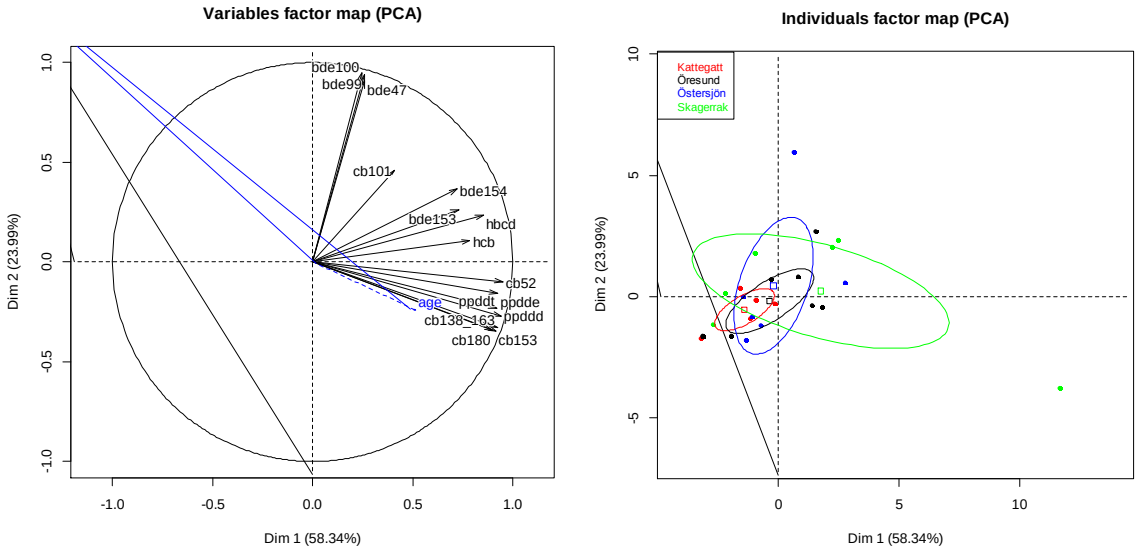


Bilaga 5.

PCA över klorerade och bromerade ämnen.

Vänster: Pricipalkomponent biplot som visar klorerade och bromerade korrelation till med de två första pricipalkomponenterna. Pilernas längd anger korrelationens storlek. Pilar som pekar åt samma riktning visar att de är positivt korrelerade med varandra medan pilar som går i motsatt riktning är negativt korrelerade med varandra. De pilar som är vinklerätt mot varandra är ej korrelerade med varandra. De bromerade ämnena är således inte korrelerade med de klorerade ämnerna.

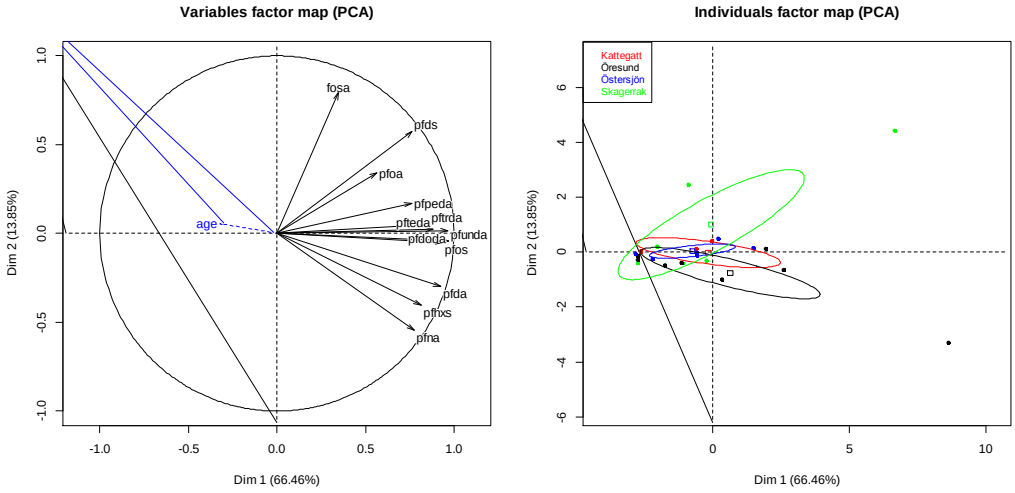
Höger: Pricipalkomponent 1 mot principalkomonent 2 för de individuella djuren. Elipserna representerar 95% av konfidenintervallet för centret för de fyra olika områdena och kuberna visar centrum. Elipserna överlappar varandra och är det ingen skillnad i halt mellan områderna.



Bilaga 6.

PCA över perfluorerade ämnen

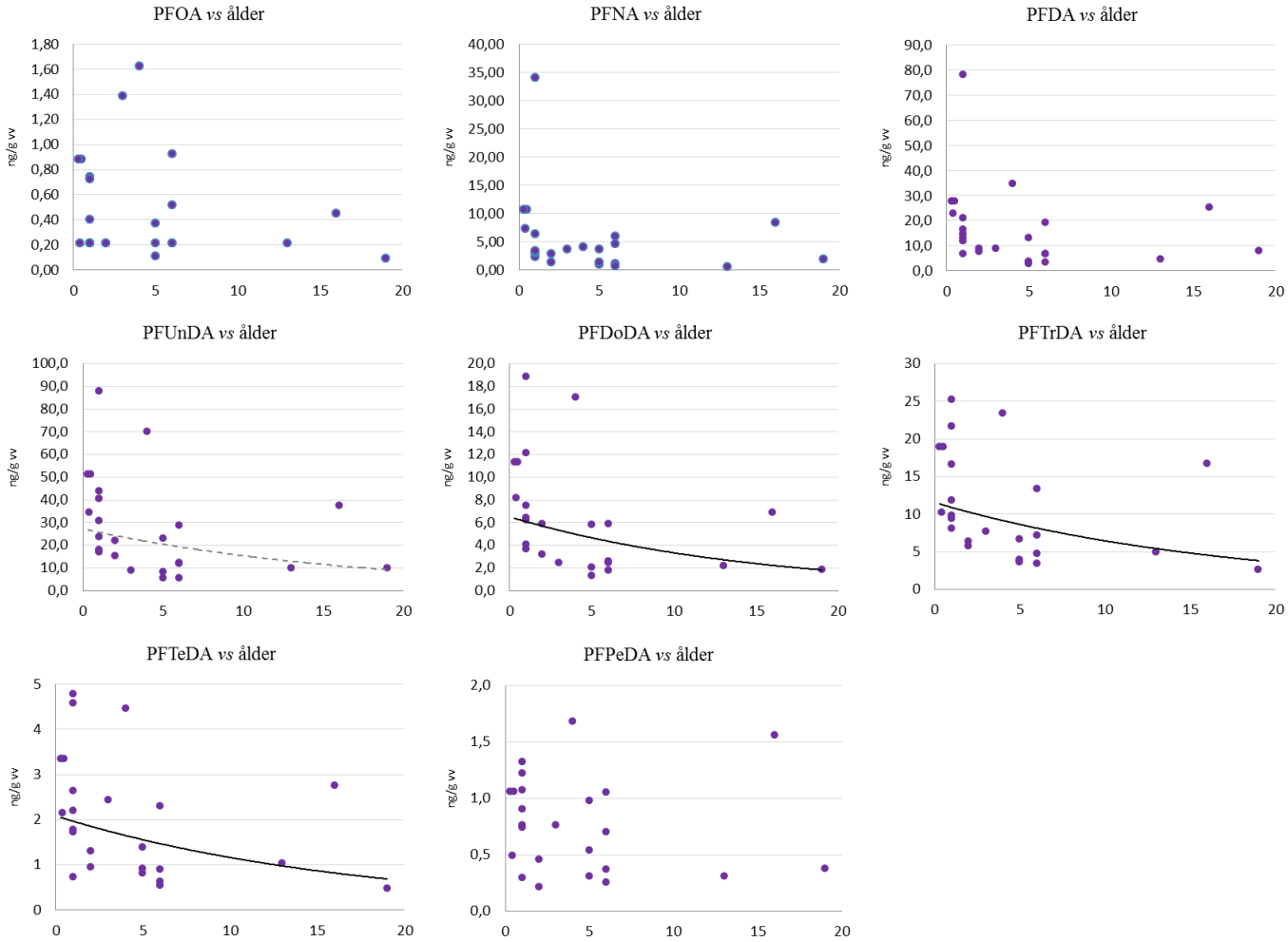
Vänster: Pricipalkomponent biplot som visar metallernas korrelation till med de två första pricipalkomponenterna. Pilernas längd anger korrelationens storlek. Pilar som pekar åt samma riktning visar att de är positivt korrelerade med varandra medan pilar som går i motsatt riktning är negativt korrelerade med varandra. De pilar som är vinklerätt mot varandra är ej korrelerade med varandra.
Höger: Pricipalkomponent 1 mot principalkomonent 2 för de individuella djuren. Elipserna representerar 95% av konfidenintervallet för centret för de fyra olika områdena och kuberna visar centrum. Elipserna överlappar varandra och är det ingen skillnad i halt mellan områdena.



Bilaga 7.

Halt av perfluorerade karboxylsyrorna vs ålder i tumlare.

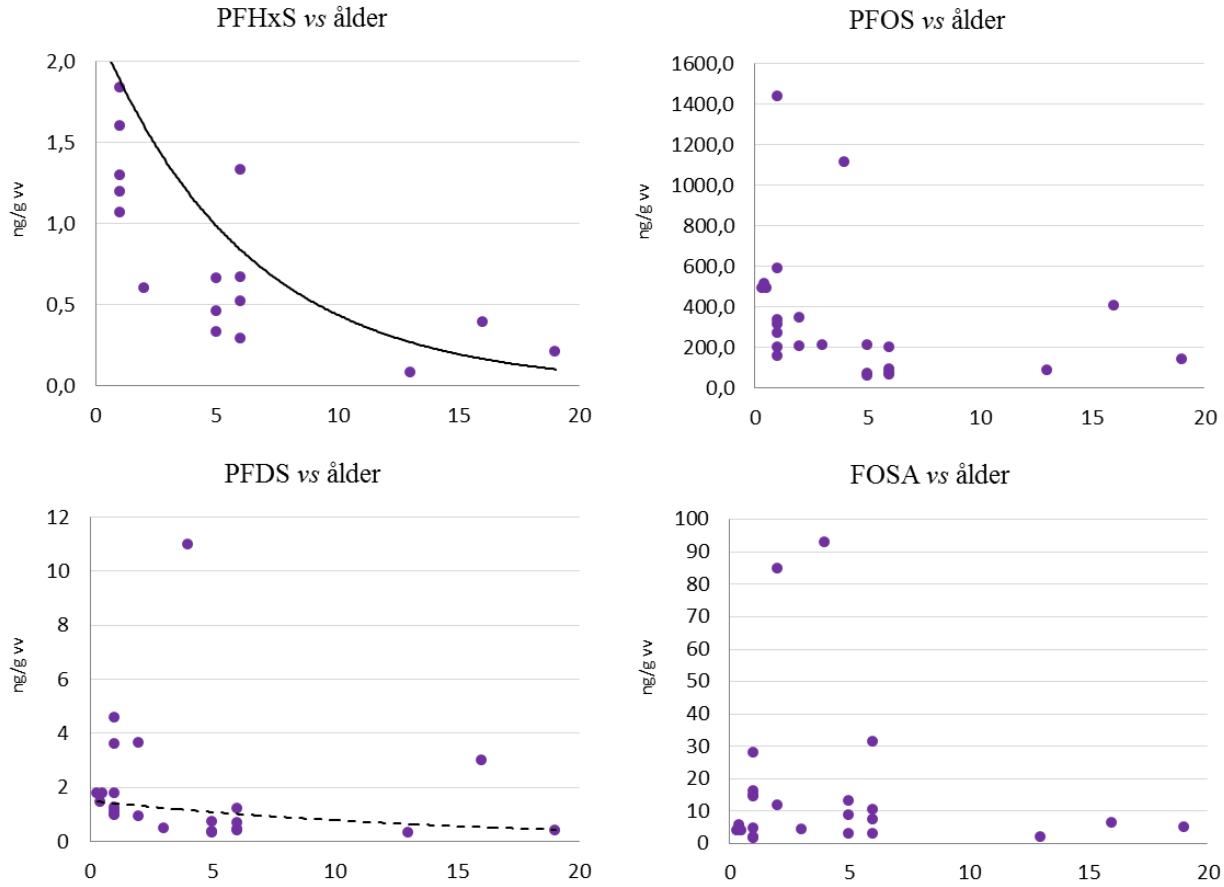
Heldragen linje är ritad då signifikant förändring med ålder förelåg, streckad linje visar en trend som inte är statistiskt signifikant. Fyra av ämnena visade inte på någon förändring med ökad ålder.



Bilaga 8.

Halt av perfluorerade sulfonsyror vs ålder i tumlare.

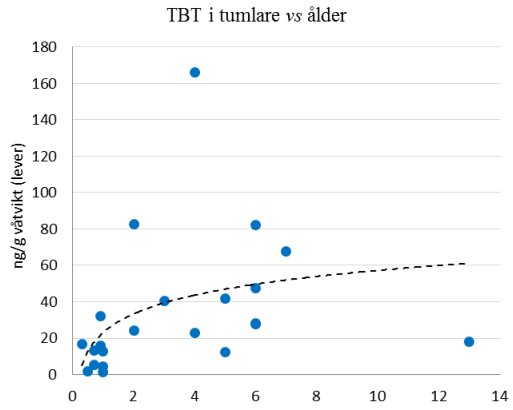
Heldragen linje är ritad då signifikant förändring med ålder förelåg.

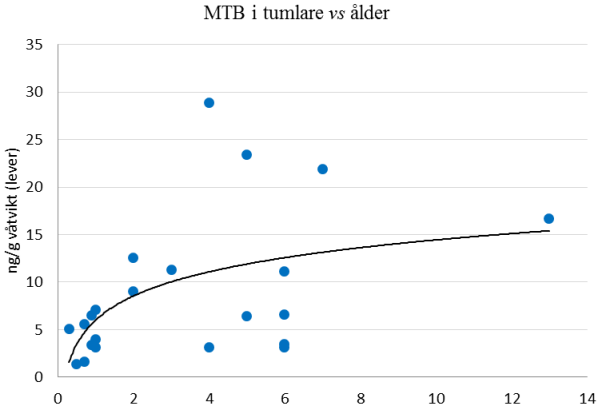


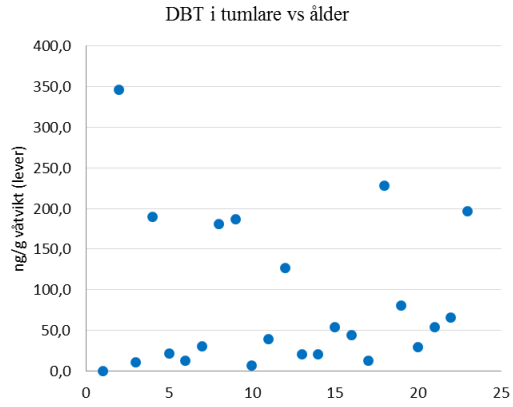
Bilaga 9.

Tennorganiska ämnen i tumlare vs ålder.

Heldragen linje är ritad då signifikant förändring med ålder förelåg, streckad linje visar en trend som inte är statistiskt signifikant. Fyra av ämnena visade inte på någon förändring med ökad ålder.







STR-POLL-01

Cause of death and contaminant concentrations (metals and organotin compounds) for harbour porpoises from Swedish waters.

Anna M. Roos[1], and Aleksija Neimanis[1,2]
anna.roos@nrm.se
[1]Department of Environmental Research, Swedish Museum of Natural History, PO Box 50007, SE-104 05 Stockholm, Sweden
[2]Department of Pathology and Wildlife Diseases, National Veterinary Institute, 751 89 Uppsala, Sweden

Background

The harbour porpoise (*Phocoena phocoena*) is highly threatened in the Baltic Sea, but is not uncommon along the western coast of Sweden. In this study we collected 44 porpoise carcasses from 2008-2013 to investigate health and/or contaminant burden in animals from Swedish waters. Carcasses were examined by necropsy, and sampled for contaminant analysis. Contaminant analysis was performed on a subset of animals (n =22-27), including tennorganic compounds (TBTs), chlorinated chemicals (PCB, DDT etc), brominated flame retardants (PBDE), perflourinated chemicals (PFCAs) as well as metals (Al, As, Cd, Co, Cr, Cu, Fe, Ni, Pb, Sb, Sn and U). Contaminant data were compared among four regions: The Skagerrak, The Kattegat and Öresund along the Swedish west coast, as well as from the southern Baltic Sea. In this substudy we present some of the data form TBTs and metals.

Results necropsy

24 females and 20 males were necropsied. 11 of them were calves, 19 immature, 12 mature and 2 unknown. Cause of death included fishery interaction (10, Figure 1), emaciation (8, Figure 2), blunt trauma (2), infectious disease (2, *e.g.* Figure 3) and other (3). Although a definitive cause of death could not be determined for 19 animals, 11 of these were in good nutritional condition without evidence of underlying disease or definitive line marks from fishing gear and therefore fishery interaction could not be excluded.

Figure 1. Probable net marks of the dorsal fin.

Figure 2. An emaciated young of the year.

Figure 3. Pericarditis caused by Staphylococcus aureus.

Results contaminant concentrations

22-27 porpoises between 0-19 years old were inclued in this part of the study. The porpoises were divided into four areas. Mean age was similar for all four areas (3-6 years old). All data was log transformed before statistical analysis, in order to meet assumptions of normal distribution.

- No contaminant concentrations differed significantly between the four regions (ANOVA, p=0,17-0,94) apart from uranium (p=0,05). Uranium was found in low concentrations in all but 7 porpoises, and somewhat elevated concentrations in porpoises from Skagerrak (Figure 4).

- The highest individual concentration of Hg was 57,3 µg/g wet weight, which is higher than concentrations found in adult grey seals (*Halochoerus grypus*) from the Baltic Sea. Two specimens had higher concentrations of Hg compared to Se based on molar weight, indicating an excess of Hg, or Se deficiency (Figure 5). Pb, Cd, Hg, Se, Sn increase with increasing age, but were found in fairly low concentrations. Cu and Cr decreased with increasing age and other metals did not change with age.

- Only mono-, di- and tributyltin were found in measurable concentrations in most samples. Dibutyltin (DBT) was found in highest concentrations (6,4-346 ng/g wet weight), followed by tributyltin (TBT, 1,3-17 ng/g wet weight). Monobutyltin (MBT) increased significantly with increasing age (Figure 6), and TBT and DBT showed a strong tendency of increasing concentrations with increasing age. TBT (the original compound used for antifouling vessels) was approximately 30% of the sum of (TBT+DBT+MBT).

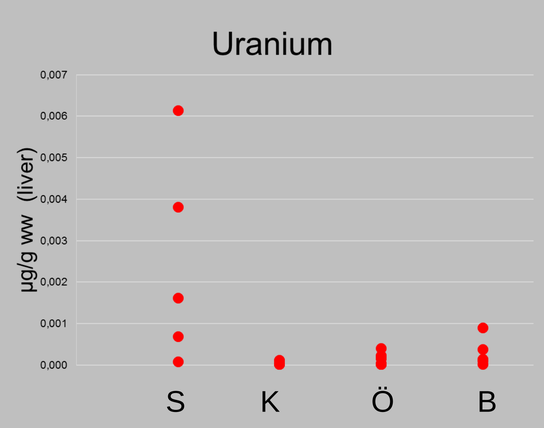


Figure 4. Uranium in porpoises from Western Sweden: Skagerrak (S), Kattegat (K) and Öresund (Ö) as well as from the Baltic (n=27).

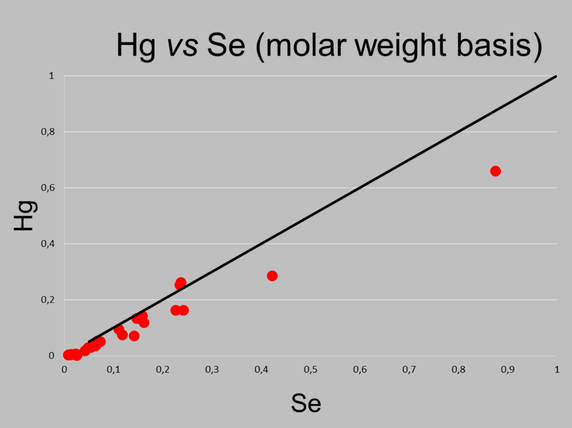
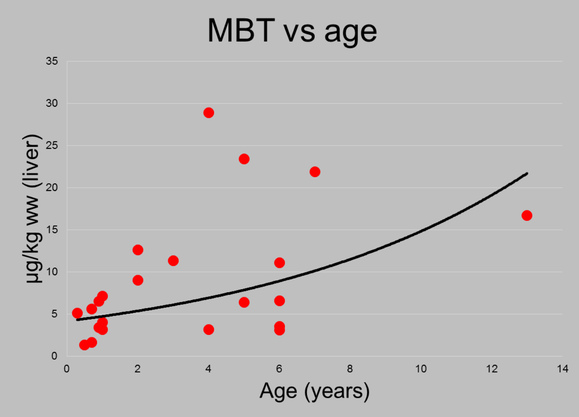


Figure 5. Hg vs Se on molar basis in liver from porpoises. The black line represents a 1:1 ratio. (n=27)

Figure 6 (right). Monobutyltin (MBT) increases in concentrations with increasing age (n=22).



Acnowledgement

This study was funded by the Swedish EPA.
Background photo was taken by Fredrik Aronsson.

Naturhistoriska riksmuseet

SVA NATIONAL VETERINARY INSTITUTE

SAMBAH NEWS

August 2014

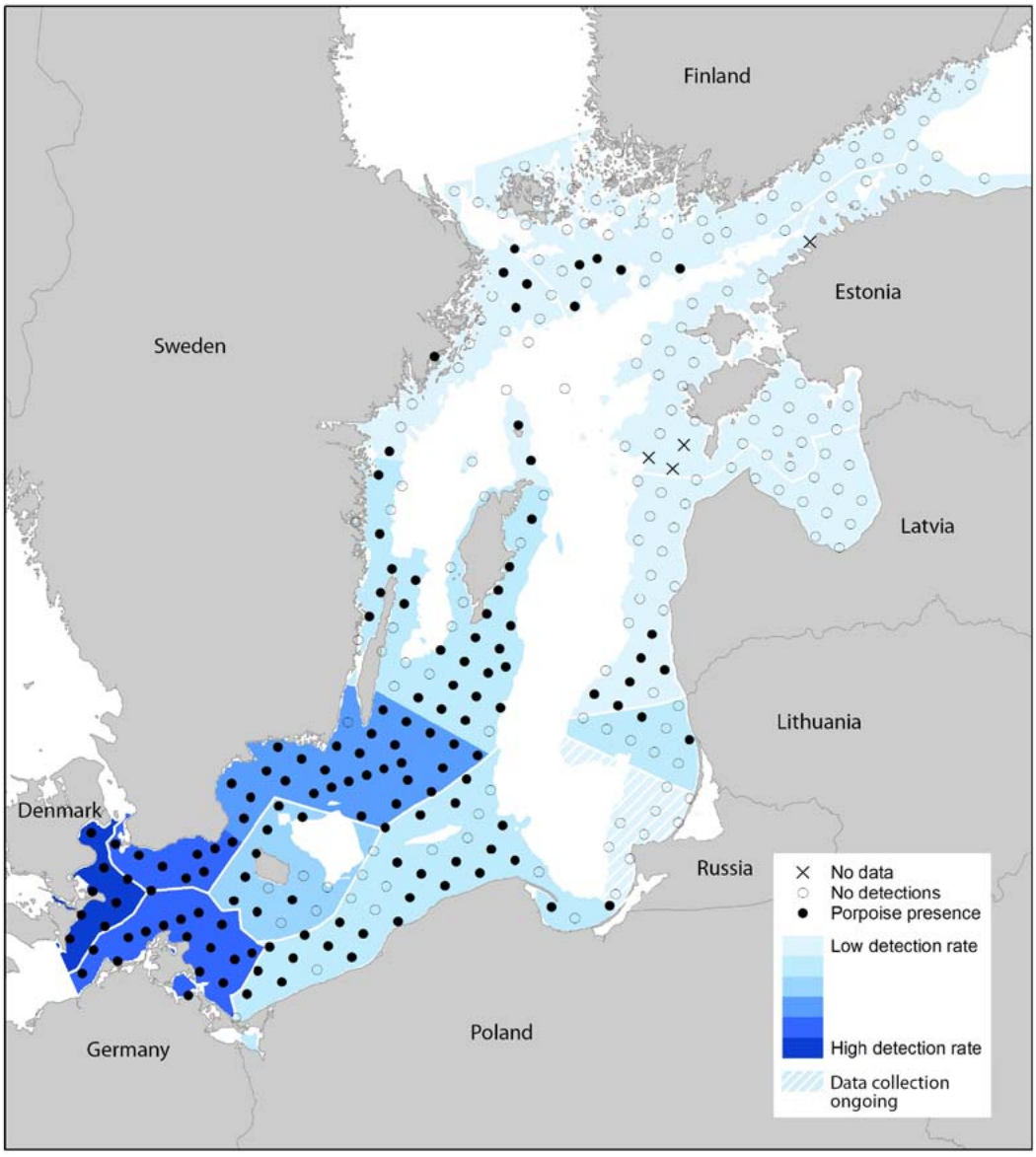
SAMBAH is an international LIFE+ funded project involving all EU countries around the Baltic Sea, with the ultimate goal to secure the conservation of the Baltic Sea Harbour porpoise.

SAMBAH current status

After completing the project field work in the summer of 2013, much time and effort have been devoted to securing the CPOD data quality. The CPOD system includes sophisticated algorithms to extract true porpoise click trains from the data. A special version of this algorithm, adapted to Baltic conditions, has been developed and validated. Also the metadata, including for example time of deployment, time of retrieval, geographical position etc has been meticulously checked.

Of the total possible 608 years of data, SAMBAH managed to recover 68%, corresponding to 413 years of data, a recovery rate that we are very pleased with. Needless to say, this is the largest passive acoustic monitoring data set in the world collected to date.

As expected the number of click detections was highest in the South/ South-West of the Baltic and became more rare to the North and East. Relative densities were slightly higher than expected along the Swedish coast of eastern Skåne and Blekinge, and there was a relatively high number of detections in the waters that include the shallow banks South of Öland and Gotland.



SAMBAH positions with at least one detection during the two-year field period are shown as black dots in the map.

The COSAMM array experiment and SAMBAH density analyses

In 2012 and 2013, the German Oceanographic Museum led the COSAMM hydrophone array study with the aim to evaluate different Passive Acoustic Monitoring instruments by acoustically tracking porpoises underwater in the vicinity of a matrix of CPODs. The distance of clicking porpoises in relation to the CPOD registrations could be determined, which allowed for the calculation of the detection function describing the probability of porpoises being detected at a given distance from the CPOD; a vital input into the porpoise density calculations in SAMBAH.

COSAMM field team performing playbacks to the deployed grid of C-PODs.

After the initial post-processing all data was transferred for further analysis to the Centre for Research into Ecological & Environmental Modeling at the University of St Andrews, Scotland. Here the click detections are translated into population density and abundance. The outcome of this analysis is expected in the near future.

Progress meetings and workshops

There is a tradition of arranging the SAMBAH spring progress meeting in connection with the annual European Cetacean Society conference. In 2013 this was held on April 7 in Setubal, Portugal, and in 2014 it was on April 5 in Liège, Belgium. In addition, the Finnish SAMBAH crew hosted a progress meeting on October 22-23, 2013, on the island of Seili at the Archipelago Research Station belonging to Turku University. At these meetings all participants got a chance to present and discuss the current status of the project and to make plans for the pending work. Different aspects of data analyses were also discussed.

On April 15, 2013, a SAMBAH stakeholder workshop was arranged in Gothenburg. The aim was to discuss the future use of SAMBAH data in the management of the Baltic Sea, and how SAMBAH's findings might affect users of the marine environment, e.g. professional fishermen, constructors of offshore windmill parks, etc. Important participants also came from NGO's engaged in the Baltic Sea. The workshop was successful and we hope to continue this effort in the future.

Participants at the SAMBAH progress meeting in Seili, Finland, Oct 2013.

The stakeholder workshop was arranged back-to-back with the ASCOBANS Jastarnia group meeting, taking place in Gothenburg on April 16-18, 2013. SAMBAH was represented on this meeting and reported on the positive outcome of the stakeholder workshop and the general project progress. In 2014 the Jastarnia Group meeting was held on April 1-3 in Bonn, and SAMBAH was again given the chance to present the current status of the project. SAMBAH will be a major input for the realization of the Jastarnia Plan for the conservation of the Baltic harbor porpoise, hence the great interest in the group to hear about the project progress.

SAMBAH project time extended

Due to the initial delay caused by the severe winter in 2010-2011, all subsequent actions were also delayed. In 2013 it became clear that the project end date had to be postponed, and the European Commission granted SAMBAH an extension until the 30th of September 2015. The extra time will allow us to focus on data analysis during 2014 and leave administrational matters for 2015.

SAMBAH conference 8-9 December 2014

The SAMBAH end-of-project conference will be held on 8-9 December 2014 at Kolmarden Wildlife Park. Here, the final results of SAMBAH will be presented, including abundance estimates and distribution maps of harbour porpoises in the Baltic Sea, and the use of the results in management will be discussed. Please visit **www.conference.sambah.org** for more details and booking information.

On 9-10 December there will be a national workshop dedicated to Swedish marine environment managing bodies. Other national workshops may be organized by the respective SAMBAH teams.