Agenda Item 12.1 National Reporting

Reports from Parties

Information Document 12.1.i Rev.1

2013 Annual National Report Sweden

Action Requested

- Take note

Submitted by Sweden

NOTE:
DELEGATES ARE KINDLY REMINDED
TO BRING THEIR OWN COPIES OF DOCUMENTS TO THE MEETING

Secretariat’s Note

Upon request of Sweden the original document was replaced by this revised version, submitted after closure of the meeting.

2013 ASCOBANS Annual National Reports

Pre-filled with answers given in 2012 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.

The 7th Meeting of the Parties in 2012 agreed to move to online reporting with immediate effect. In order to benefit fully from the opportunities for synergies among CMS Family treaties afforded by this tool, Parties decided that a revised national report format be developed by a small working group assisted by the Secretariat for consideration by the Advisory Committee in preparation for the 8th Meeting of the Parties. While retaining the questions related only to ASCOBANS, it should align more closely to the format used in CMS, AEWA and EUROBATS.

General Information

Name of Party
› Sweden

Report submitted by

Name	Susanne Viker
Function	National expert
Organization	SwAM
Address	
Telephone/Fax	
Email	

Changes

Changes in Coordinating Authority or appointed Member of the Advisory Committee
› Susanne Viker at SwAM has replaced Sofia Brockmark

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
› AquaBiota Water Research, Ida Carlén, ida.carlen@aquabiota.se

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

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

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

› Swedish University of Agricultural Sciences (SLU), Sara Königson, sara.konigson@slu.se

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

› AquaBiota Water Research, Julia Carlström, julia.carlstrom@aquabiota.se

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).

› A Swedish fishing gear company Carapax has planned a project with funding for the next year to develop a full-scale cod pot fishing method. The project mainly focuses on how to improve the construction of the pot as well solutions for better handling of the pots on board. The outcome of this project may be of interest to evaluate in terms of bycatch reduction as well as consequences for the fisheries.

› 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.

You have attached the following documents to this answer.

Königson 2013 Development of alternative gear.pdf - article on arlernative fishing gear published in 2013. Describes efforts done by SLU.

Königson 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

› 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.

› 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.

1.3 Other relevant information

Other relevant information, including bycatch information from opportunistic sources
› In 2010 the SBF bought altogether nine camera systems to place on board fishing boats, to investigate discard as well as marine mammal and bird bycatch. Four of them were placed on trawlers and five on smaller fishing boats fishing with gillnets. A large effort was put into this project but only one fisherman was willing to participate in the project even if they were offered incentives for participating. These systems were later taken over by the SwAM whom is responsible for the task since July 2011.

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
› 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 "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.

› 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.

2.2 Ship Strike Incidents

Please list all known incidents and provide information separately for each

	Incident 1	**Incident 2**	**Incident 3**	**Incident 4**	**Incident 5**
Date					
Species					
Type of Injury					
Fatal Injury (Yes/No)					
Type of Vessel (length, tonnage, speed)					
Location (coordinates)					
More Information (name, email)					

2.3 Major Incidents

Major Incidents Affecting Significant Numbers of Cetaceans (two or more animals)

	Incident 1	**Incident 2**	**Incident 3**	**Incident 4**	**Incident 5**

Date					
Location					
Type of Incident					
Further Information					

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.

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

3.2 GIS Data

Please indicate where GIS data of the boundaries (and zoning, if applicable) can be obtained (contact email / website).
› None

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.

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)
› The Baltic Sea, up to Skanör/Måkläppen: Basically samples from all carcasses were collected, and if the carcass was not too rotten SMNH made a full autopsy. Skin, blubber, muscular tissue, kidney, liver, brain, lung, spleen, stomach, intestines teeth etc. are taken and stored deep frozen in SMNH's Environmental Specimen Bank (ESB).
Porpoises found in 2011 have autopsied by pathologists at The National Veterinary Institute (SVA) together with personnel from SMNH. All of the carcasses were from the Baltic Sea (including the Kattegat). In addition, eleven stranded porpoises were sampled by GNM. Samples (dorsal fin, blubber, lower jaw) were sent to ESB. Seven of the specimen originated from the Baltic Sea.
No report have been deliverd by SMNH in 2012.

› In 2013 there were 6 harbour porpoises reported, all from the Swedish west coast. They were all non-sexually mature. Three of them could be considered as by-catch (found on the beach with injuries from fishing nets + drowned)

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)		

5.7 Other Relevant Information

Please provide any other relevant information on post-mortem / stranding schemes
› None

Relevant New Legislation, Regulations and Guidelines

6.1 New Legislation, Regulations and Guidelines

Please provide any relevant information
› During 2010 SEPA started developing national guidelines for underwater noise and marine mammals. This responsibility for the guidelines has now shifted to the SwAM. A background report that SEPA commissioned by AquaBiota Water Research which has been received by the SwAM. The guidelines do not cover noise from vessels, but will be useful during constructions of windparks, pipelines, blastings, etc. SwAM has not approved the report in 2012.

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.

› 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.

› SAMBAH’s web site (www.sambah.org) gives general information about the project’s objectives, activities, methodologies etc.

› Harbor porpoise day 18 of may 2014 at "Naturum Kullaberg"

› 19 of may there was activities around

Possible difficulties encountered in implementing the Agreement

Difficulties in Implementing the Agreement

Please provide any relevant information
› None

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).

This alternative fishing gear, a combination of the large mesh trap and the pontoon fish chamber, has been a successful development of seal-safe alternative fishing gear (LUNNERYD et al. 2003). The traps are now used by 86 % of the Swedish salmon trap fishermen along the northern Baltic coast (HEMMINGSSON & LUNNERYD, 2007).

Pontoon traps are being developed for other fish species such as perch *(Perca fluviatilis)*, pike perch (*Sander lucioperca*) and herring *(Clupea harengus).* The development of a seal-safe herring pontoon trap began in 2009. The traps can be used when the herring aggregate in coastal areas. A problem with traps used for herring is the possibility of large catches of small herring. However, the traps can be made selective by releasing the undersized herring with the use of selection grids (LUNDIN et al., 2011).

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.

a. b. c.

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

from the same area as the experimental fishing. All licensed fishermen with a boat over 8 meters of length are obligated to report their daily catch and effort to the EU logbook. Extrapolating catch per pot from test fishing to the number of pots possible to use in a commercial pot fishery, preliminary results showed that in spring, pots caught less than gillnets (Figure 3). However, in fall, the monthly catch from pots increased and was comparable to the catch from the gillnet fisheries (Figure 3). There are many factors which can affect the pots temporal variation in the fishing efficiency. Pots are baited fishing gear and their catch per effort is affected by two factors - fish availability to the gear, such as fish distribution over time and space and the baited gears catchability (ENGÅS & LØKKEBORG, 1994; ARREQUI`N-SA`NCHES, 1996). The gears catchability is dependent on environmental variables effecting fish activity, feeding motivation and fish ability to detect, locate and consume baits (STONER, 2004).

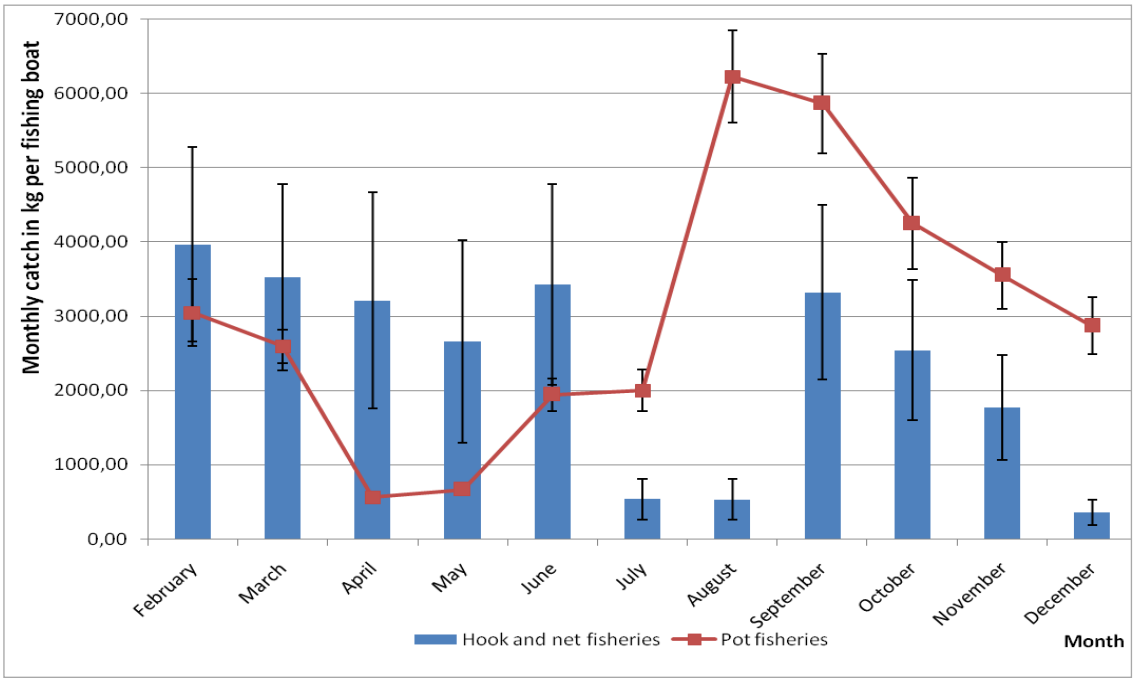

Figure 3: Extrapolating the catch per kg and month to a possible full-time cod pot fishery using 100 pots and comparing it to a full-time gillnet and hook fishery in the same area reported to the EU-logbook (from KÖNIGSON et al., 2010). In July and August, fishing with gillnets and hooks is not permitted.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

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

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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.

6 References

Arreguı´n-Sa´nchez, F. (1996): Catchability: a key parameter for fish stock assessment. Reviews in Fish Biology and Fisheries 6: 221–242.

Baltscheffsky, S. (1997): Seals in the Bothnian Sea: From endangered species to coastal nuisance. Enviro 23

Ben-Yami, M. (1988): Attracting fish with light. FAO, Rome, 72 pp.

Bryhn, A.C. Königson, S. Lunneryd, S.-G. & Bergenius, M. (2012): Visual stimuli affecting the catch efficiency of floating cod (*Gadus morhua*) pots in the Baltic Sea. Manuscript, Swedish Agricultural University, Department of Aquatic Resources.

Engås, A. & Løkkeborg, S. (1994): Abundance estimation using bottom gillnet and longline – the role of fish behaviour. In Fernö, A. & Olsen, S. (Ed.), Marine Fish Behaviour in Capture and Abundance. Oxford, Fishing News Books. 134–165 pp.

Fjälling, A. (2004): Assessment and reduction of the conflicts between commercial fisheries and grey seals (*Halichoerus grypus*) in Swedish waters. Licentiate Thesis. Institute of Technology, Linköping University.

Furevik, D. M. & Løkkeborg, S. (1994): Fishing trials in Norway for torsk (Brosme brosme) and cod (*Gadus morhua*) using baited commercial pots. Fisheries Research 19: 219-229.

Furevik, D.M. Humborstad, O.B. Jørgensen, T. Løkkeborg, S. (2008): Floated fish pot eliminates bycatch of red king crab and maintains target catch of cod. Fisheries Research 92: 23-27.

Havet (2011): Om miljötillståndet i svenska vatten. Ges ut av Naturvårdsverket och Havsmiljöinstitutet. www.havet.nu

Hemmingsson, M. & Lunneryd, S.G. (2007): Pushup-fällor i Sverige, Introduktionen av ett nytt sälsäkert fiskeredskap. (Push-up traps in Sweden, the introduction of a new seal-safe fishing gear). Finfo Fiskeriverket informerar 8 (in Swedish with English summary).

Hemmingsson , M. Fjälling, A. & Lunneryd, S-G. (2008): The pontoon trap: Description and function of a seal-safe trap-net. Fisheries Research 93: 357-359.

Hornborg, S. Nilsson, P. Valentinsson, D. & Ziegler, F. (2012): Integrated environmental assessment of fisheries management: Swedish *Nephrops* trawl fisheries evaluated using a life cycle approach. Marine Policy 34(6): 1193-1201

Jennings, S. Kaiser, M. J. & Reynolds, J. D. (2001): Marine Fisheries Ecology. Blackwell, Oxford, 417 pp.

Kauppinen, T. Siira A. & Suuronen P. (2005): Temporal and regional patterns in seal-induced catch and gear damage in the coastal trap-net fishery in the northern Baltic Sea: effect of netting material on damage. Fisheries Research 73: 99-109.

Kelleher, K. (2005): Discards in the world's marine fisheries: an update. FAO Fisheries Technical Paper No. 470. Food and Agriculture Organization of the United Nations, Rome, Italy.

Königson, S. Hemmingsson, M. Lunneryd, S-G. & Lundström, K. (2007): Seals and fyke nets: An investigation of the problem and its possible solution. Marine Biology Research 3: 29-36.

Königson, S. Lunneryd, S-G. & Ljunghager, F. (2010): Cod pots, an alternative fishing gear to nets and hooks? Presentation at the ICES annual conference 2010, Nantes, France

Königson, S. (2011) Seals and Fisheries - A Study of the Conflict and Some Possible Solutions. PhD dissertation, Gothenburg University, Gothenburg

Königson, S. Lövgren, J. Ovegård, M. & Lunneryd, S-G. (2012): Seal Exclusion Devices can prevent seal bycatches in a cod pot fishery without necessarily reducing the fishing power of the gear

Lundin, M. Calamnius, L., Hillström, L., and Lunneryd, S.G. (2011): Size selection of herring *(Clupea harengus membras)* in a pontoon trap equipped with a rigid grid. Fisheries Research 108: 81-87.

Lunneryd, S.G. (2001): Fish preference by harbour seal (*Phoca vitulina*), with implications for the control of damage to fishing gear. ICES Journal of Marine Science 58(4): 824-829.

Lunneryd, S. G. Westerberg, H & Wahlberg, M. (2002): Detection of leader net by whitefish *Coregonu lavaretus* during varying environmental conditions. Fisheries Research 54: 353–362.

Lunneryd, S.G. Fjälling, A. & Westerberg, H. (2003): A large-mesh salmon trap: a way of mitigating seal impact on a coastal fishery. ICES Journal of Marine Science 60: 1194-1199.

Lunneryd, S. G. & Fjälling, A. (2004): Lyckad introduktion av stormaskefällan och pushup fiskhuset. (A successful introduction of the large mesh trap and the pushup fish bag.)Yrkesfiskaren 13/14: 12-14

Løkkeborg, S. (1998): Feeding behaviour of cod, *Gadus morhua*: activity rhythm andchemically mediated food search. Animal Behaviour 56: 371–378.

Ovegård, M. Königson, S. Persson, A. & Lunneryd, S-G. (2011) Size selective capture of Atlantic cod (*Gadus morhua*) in floating pots. Fisheries Research 107: 239-244.

Stoner, A.W. (2004) Effects of environmental variables on fish feeding ecology: implications for the performance of baited fishing gear and stock assessment. Journal of Fish Biology 65: 1445–1471.

Suuronen, P. Chopin, F. Glass, C. Løkkeborg, S. Matsushita, Y. Queirolo, D. & Rihan, D. (2012): Low impact and fuel efficient fishing - looking beyond the horizon. Fisheries Research 119-120: 135-146.

Thomsen, B. Humborstad, O.-B. & Furevik, D. M. (2010): Fish pots: fish behavior, capture processes and conservation issues. In: He, P (Ed.), Behavior of Marine Fishes: Capture Processes and Conservation Challenges. Blackwell, Oxford, 143-158 pp..

Westerberg, H. Fjälling, A & Martinsson, A. (2000): Sälskador i det svenska fisket. (Seal damage in the Swedish fishery). Fiskeriverket Rapport 3:4–38.

Westerberg, H. Lunneryd, S-G. Fjälling, A. & Wahlberg, M. (2006): Reconciling Fisheries Activities with the Conservation of Seals throughout the Development of New Fishing Gear: A Case Study from the Baltic Fishery–Grey Seal Conflict. American Fisheries Society Symposium 587-598.

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).

This alternative fishing gear, a combination of the large mesh trap and the pontoon fish chamber, has been a successful development of seal-safe alternative fishing gear (LUNNERYD et al. 2003). The traps are now used by 86 % of the Swedish salmon trap fishermen along the northern Baltic coast (HEMMINGSSON & LUNNERYD, 2007).

Pontoon traps are being developed for other fish species such as perch *(Perca fluviatilis)*, pike perch (*Sander lucioperca*) and herring *(Clupea harengus).* The development of a seal-safe herring pontoon trap began in 2009. The traps can be used when the herring aggregate in coastal areas. A problem with traps used for herring is the possibility of large catches of small herring. However, the traps can be made selective by releasing the undersized herring with the use of selection grids (LUNDIN et al., 2011).

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.

a. b. c.

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

from the same area as the experimental fishing. All licensed fishermen with a boat over 8 meters of length are obligated to report their daily catch and effort to the EU logbook. Extrapolating catch per pot from test fishing to the number of pots possible to use in a commercial pot fishery, preliminary results showed that in spring, pots caught less than gillnets (Figure 3). However, in fall, the monthly catch from pots increased and was comparable to the catch from the gillnet fisheries (Figure 3). There are many factors which can affect the pots temporal variation in the fishing efficiency. Pots are baited fishing gear and their catch per effort is affected by two factors - fish availability to the gear, such as fish distribution over time and space and the baited gears catchability (ENGÅS & LØKKEBORG, 1994; ARREQUI`N-SA`NCHES, 1996). The gears catchability is dependent on environmental variables effecting fish activity, feeding motivation and fish ability to detect, locate and consume baits (STONER, 2004).

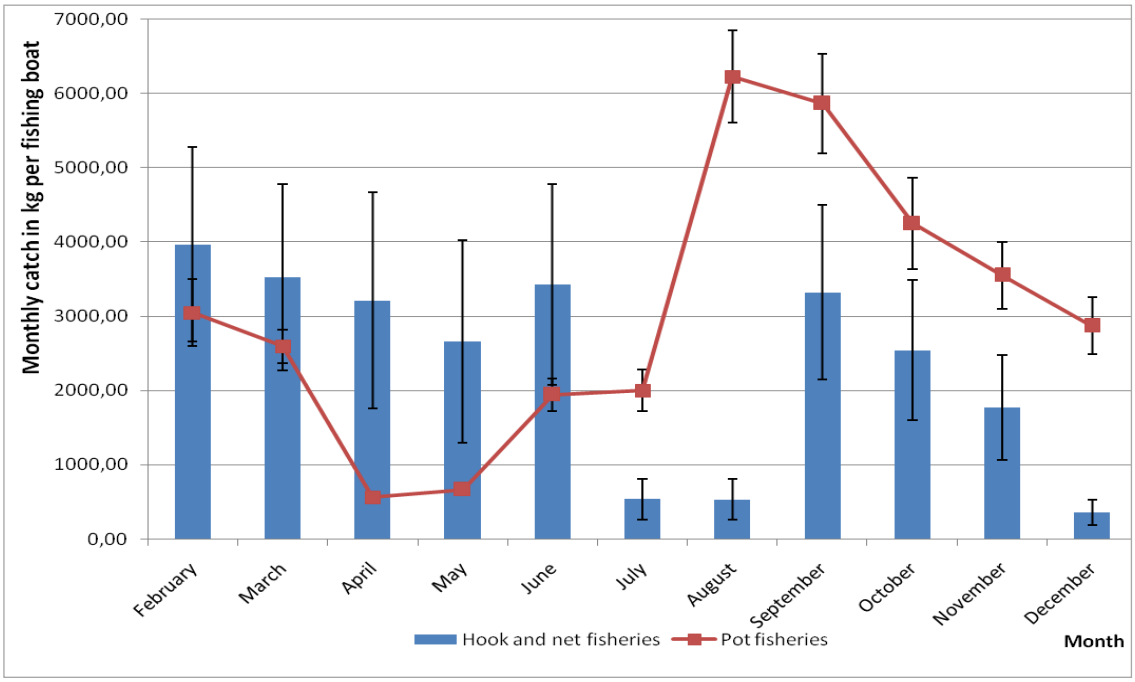

Figure 3: Extrapolating the catch per kg and month to a possible full-time cod pot fishery using 100 pots and comparing it to a full-time gillnet and hook fishery in the same area reported to the EU-logbook (from KÖNIGSON et al., 2010). In July and August, fishing with gillnets and hooks is not permitted. 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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6 References

Arreguı´n-Sa´nchez, F. (1996): Catchability: a key parameter for fish stock assessment. Reviews in Fish Biology and Fisheries 6: 221–242.

Baltscheffsky, S. (1997): Seals in the Bothnian Sea: From endangered species to coastal nuisance. Enviro 23

Ben-Yami, M. (1988): Attracting fish with light. FAO, Rome, 72 pp.

Bryhn, A.C. Königson, S. Lunneryd, S.-G. & Bergenius, M. (2012): Visual stimuli affecting the catch efficiency of floating cod (*Gadus morhua*) pots in the Baltic Sea. Manuscript, Swedish Agricultural University, Department of Aquatic Resources.

Engås, A. & Løkkeborg, S. (1994): Abundance estimation using bottom gillnet and longline – the role of fish behaviour. In Fernö, A. & Olsen, S. (Ed.), Marine Fish Behaviour in Capture and Abundance. Oxford, Fishing News Books. 134–165 pp.

Fjälling, A. (2004): Assessment and reduction of the conflicts between commercial fisheries and grey seals (*Halichoerus grypus*) in Swedish waters. Licentiate Thesis. Institute of Technology, Linköping University.

Furevik, D. M. & Løkkeborg, S. (1994): Fishing trials in Norway for torsk (Brosme brosme) and cod (*Gadus morhua*) using baited commercial pots. Fisheries Research 19: 219-229.

Furevik, D.M. Humborstad, O.B. Jørgensen, T. Løkkeborg, S. (2008): Floated fish pot eliminates bycatch of red king crab and maintains target catch of cod. Fisheries Research 92: 23-27.

Havet (2011): Om miljötillståndet i svenska vatten. Ges ut av Naturvårdsverket och Havsmiljöinstitutet. www.havet.nu

Hemmingsson, M. & Lunneryd, S.G. (2007): Pushup-fällor i Sverige, Introduktionen av ett nytt sälsäkert fiskeredskap. (Push-up traps in Sweden, the introduction of a new seal-safe fishing gear). Finfo Fiskeriverket informerar 8 (in Swedish with English summary).

Hemmingsson , M. Fjälling, A. & Lunneryd, S-G. (2008): The pontoon trap: Description and function of a seal-safe trap-net. Fisheries Research 93: 357-359.

Hornborg, S. Nilsson, P. Valentinsson, D. & Ziegler, F. (2012): Integrated environmental assessment of fisheries management: Swedish *Nephrops* trawl fisheries evaluated using a life cycle approach. Marine Policy 34(6): 1193-1201

Jennings, S. Kaiser, M. J. & Reynolds, J. D. (2001): Marine Fisheries Ecology. Blackwell, Oxford, 417 pp.

Kauppinen, T. Siira A. & Suuronen P. (2005): Temporal and regional patterns in seal-induced catch and gear damage in the coastal trap-net fishery in the northern Baltic Sea: effect of netting material on damage. Fisheries Research 73: 99-109.

Kelleher, K. (2005): Discards in the world's marine fisheries: an update. FAO Fisheries Technical Paper No. 470. Food and Agriculture Organization of the United Nations, Rome, Italy.

Königson, S. Hemmingsson, M. Lunneryd, S-G. & Lundström, K. (2007): Seals and fyke nets: An investigation of the problem and its possible solution. Marine Biology Research 3: 29-36.

Königson, S. Lunneryd, S-G. & Ljunghager, F. (2010): Cod pots, an alternative fishing gear to nets and hooks? Presentation at the ICES annual conference 2010, Nantes, France

Königson, S. (2011) Seals and Fisheries - A Study of the Conflict and Some Possible Solutions. PhD dissertation, Gothenburg University, Gothenburg

Königson, S. Lövgren, J. Ovegård, M. & Lunneryd, S-G. (2012): Seal Exclusion Devices can prevent seal bycatches in a cod pot fishery without necessarily reducing the fishing power of the gear

Lundin, M. Calamnius, L., Hillström, L., and Lunneryd, S.G. (2011): Size selection of herring *(Clupea harengus membras)* in a pontoon trap equipped with a rigid grid. Fisheries Research 108: 81-87.

Lunneryd, S.G. (2001): Fish preference by harbour seal (*Phoca vitulina*), with implications for the control of damage to fishing gear. ICES Journal of Marine Science 58(4): 824-829.

Lunneryd, S. G. Westerberg, H & Wahlberg, M. (2002): Detection of leader net by whitefish *Coregonu lavaretus* during varying environmental conditions. Fisheries Research 54: 353–362.

Lunneryd, S.G. Fjälling, A. & Westerberg, H. (2003): A large-mesh salmon trap: a way of mitigating seal impact on a coastal fishery. ICES Journal of Marine Science 60: 1194-1199.

Lunneryd, S. G. & Fjälling, A. (2004): Lyckad introduktion av stormaskefällan och pushup fiskhuset. (A successful introduction of the large mesh trap and the pushup fish bag.)Yrkesfiskaren 13/14: 12-14

Løkkeborg, S. (1998): Feeding behaviour of cod, *Gadus morhua*: activity rhythm andchemically mediated food search. Animal Behaviour 56: 371–378.

Ovegård, M. Königson, S. Persson, A. & Lunneryd, S-G. (2011) Size selective capture of Atlantic cod (*Gadus morhua*) in floating pots. Fisheries Research 107: 239-244.

Stoner, A.W. (2004) Effects of environmental variables on fish feeding ecology: implications for the performance of baited fishing gear and stock assessment. Journal of Fish Biology 65: 1445–1471.

Suuronen, P. Chopin, F. Glass, C. Løkkeborg, S. Matsushita, Y. Queirolo, D. & Rihan, D. (2012): Low impact and fuel efficient fishing - looking beyond the horizon. Fisheries Research 119-120: 135-146.

Thomsen, B. Humborstad, O.-B. & Furevik, D. M. (2010): Fish pots: fish behavior, capture processes and conservation issues. In: He, P (Ed.), Behavior of Marine Fishes: Capture Processes and Conservation Challenges. Blackwell, Oxford, 143-158 pp..

Westerberg, H. Fjälling, A & Martinsson, A. (2000): Sälskador i det svenska fisket. (Seal damage in the Swedish fishery). Fiskeriverket Rapport 3:4–38.

Westerberg, H. Lunneryd, S-G. Fjälling, A. & Wahlberg, M. (2006): Reconciling Fisheries Activities with the Conservation of Seals throughout the Development of New Fishing Gear: A Case Study from the Baltic Fishery–Grey Seal Conflict. American Fisheries Society Symposium 587-598.