1   Background

Coastal fish monitoring has a long tradition in the Baltic Sea, dating back to the 1960s in some areas (HELCOM 2012, HELCOM 2018abc). Today, monitoring of coastal fish is undertaken in all HELCOM Contracting Parties (Annex 1), either as routine monitoring programme or as project-based surveys. The HELCOM expert network for coastal fish has coordinated the monitoring and assessments of coastal fish in the Baltic Sea since 2003. Over the years, the network has existed on a project basis under the acronyms HELCOM FISH, HELCOM FISH PRO, HELCOM FISH PRO II and HELCOM FISH PRO III, with the current project period lasting until 2023 (http://www.helcom.fi/helcom-at-work/projects/fish-pro).

Regional attention to the monitoring and status assessment of different ecosystem components of the Baltic Sea has increased since the 2000s, with the implementation of the Baltic Sea Action Plan (BSAP, HELCOM 2007) and the Marine Strategy Framework Directive (MSFD, Anon. 2008), where coastal fish comprise an important segment of the assessments. For the implementation of the BSAP and MSFD, indicators to assess the status of coastal fish communities were agreed on by HELCOM countries for use in coastal fish status assessments in the Baltic Sea (HELCOM 2013).

The last update of the HELCOM guideline for coastal fish monitoring was published in 2015. The current (2019) revision is made in order to harmonize HELCOM monitoring guidelines among ecosystem components, and to incorporate recent changes and updates to the coastal fish monitoing program. This document describes the methods and gears used, and variables monitored to study coastal fish communities in the HELCOM area. Specific information is summarized in annexes. National monitoring procedures are still being developed by several Contracting Parties to fulfill requirements stemming from other legal obligations (e.g. the MSFD). Therefore, regular revisions of the HELCOM guidelines are necessary in order to update and align these guidelines with evolving monitoring needs.

1.1   Introduction

Coastal fish, the fish assemblages in relatively near-shore and shallow (<20 m depth) coastal areas, are important for the Baltic Sea ecosystems and highly valued socio-economically and culturally (HELCOM 2018c). Fish are central in the Baltic Sea food-web and hence have a key role in linking different processes. As such, the status of coastal fish conveys information on the general status of coastal ecosystems in the Baltic Sea (HELCOM 2007, 2018c, Anon. 2008).

Coastal fish communities in the Baltic Sea generally harbour a mixture of species with a marine and freshwater origin (HELCOM 2012, Olsson et al. 2012a). In the western parts of the Baltic Sea (The Sound and Kattegat), however, the relatively higher salinity renders a much lower share of freshwater species. Coastal resident fish species in the eastern and northern parts of the Baltic Sea are typically demersal species of a freshwater origin. They mainly reside locally in shallow coastal areas, seldom migrate long distances, and are rather tightly bound to their preferred habitat (Laikre et al. 2005, Olsson et al. 2011, 2012ab, Wennerström et al. 2017, Östman et al. 2017a). Other coastal species, however, are more mobile and migrate between the coast and open sea depending on the season and location of important feeding and spawning areas.

Due to the mixture of species representing different origin and environmental preferences, there is typically a certain variation over the year in the species structure of fish in coastal areas (Olsson et al. 2012a; Mustamäki et al. 2015, 2016). Species with a freshwater origin, such as perch (*Perca fluviatilis*) and fishes from the carp family (Cyprinidae) prefer higher water temperatures and predominate in many areas during the warmer period of the year (HELCOM 2012). Due to a mixture of species representing different origin and

environmental preferences, there is typically a certain variation over the year in the species structure of fish communities in coastal areas (Olsson et al. 2012a; Mustamäki et al 2015, 2016) as fish migrate seasonally between coastal areas and off-shore or fresh water areas. During early spring, late fall and winter, the share of species with a marine origin usually increases, such as herring (*Clupea harengus*) and cod (*Gadus morhua*), as well as that of other species preferring cooler waters, such as whitefish (*Coregonus maraena*; Olsson et al. 2012b). There is also variation between the more sheltered parts of the coastal zone and the more open and exposed parts (Mustamäki et al. 2015, HELCOM 2018abc). Species of a freshwater origin generally dominate in the most shallow and sheltered areas and closer to land, whereas marine and migratory fish species are more common in open coastal areas and further out in the archipelago. In the more saline western Baltic Sea, a temperature-related pattern is seen within the group of marine species, with those preferring higher water temperatures dominating in more sheltered parts and during the summer, and species preferring cooler waters being more abundant during fall, winter and spring as well as in more exposed areas (HELCOM 2018abc).

1.2   Purpose and aims

Coastal fish communities are influenced by a plethora of impacting variables, including human-induced pressures related to overexploitation, climate change, eutrophication, contaminants, habitat degradation, effects of trophic interactions and competition with non-indigeneous species (HELCOM 2018c). Although there is a general understanding on the influence of these pressures, little is known about their relative importance and local patterns. Because of the locality of the fish communities, variability between locations regarding which variables are the most important may also be expected.

The aim of the current monitoring strategy is to monitor overall changes in coastal fish communities in relation to local and regional changes in the environment, and to support an indicator-based assessment of the status of coastal fish, reflecting potential effects of pressures such as climate, eutrophication, habitat degredation, trophic interactions and fishing. In relation to the effects of climate change, species of freshwater origin generally respond positively to increased water temperatures and decreased salinity levels, whereas marine species and those sensitive to higher water temperatures tend to respond negatively (Olsson et al. 2012a). The abundance of cyprinids in the coastal zone is considered to be indicative of coastal eutrophication in the Baltic Sea, whereas the abundance of coastal piscivores is considered to also reflect coastal fishing pressure (Bergström et al. 2016ab, Bergström et al. In press, HELCOM 2018c). To that end, in being in the center of the food web, all coastal fish species are impacted by trophic interactions and other changes in the ecosystem structure and function as well.

2   Monitoring methods

2.1   Monitoring features

Coastal fish monitoring in the Baltic Sea is generally designed to follow interannual changes in the key characteristics of the coastal fish assemblage, including species structure as well as age- and size structure. The information is useful for the indicator-based assessment of status as well as for estimating population growth and reproduction.

The data can readily be obtained from fisheries independent surveys. If fisheries independent data is not available, data for assessment of coastal fish may be obtained with other methods such as commercial catches or by citizen science.

The common monitoring strategy in fisheries independent surveys is to monitor changes over time (years) at fixed stations, and to follow the relative abundance of different segments of the coastal fish community in

each monitoring area (Thoresson 1996; Neuman et al. 1999). Monitoring is generally performed using passive gears, such as gillnets or fyke nets, but active gears as trawls are used in some areas. The monitoring areas are often reference areas in which the level of direct pressure from human activities is comparably small, and the aim of the monitoring is to reflect large-scale changes in the Baltic marine environment, such as the results of climate change and eutrophication.

Data on commercial catches can be collected from the officially reported caches (national databases and/or EU-MAP (EU 2016/1251)), at least for selected species and indicators. Fisheries dependent monitoring typically samples a narrower spectrum of the coastal fish community. The abundance estimates are biased towards larger fish, focal species within the fishery, and to those species typically targeted by the type of gear used (Olsson et al. 2015). When fishing effort data is available, catch per unit of effort (CPUE) is a more reliable indicator of changes in fish stocks than total catches. Preferably, changes in discards and landings should also be taken into account. However, the commercial catches may provide a rough indication on changes in the fish stocks in cases where the effort is moderately stable over the sampled years and areas.

Data can also be collected by citizen science based methods, such as the recreational fishermen survey carried out in Denmark (Støttrup et al. 2018). The Danish recreational fisheries survey is conducted using standard gear, standardized stations and conduct regular monitoring (Støttrup et al. 2018).

The focal species for monitoring are generally coastal resident species. However, most fishing methods do catch several species. The absolute density of a species or population can generally not be measured, and the focus is rather on changes in the relative CPUE per species and hence in the species composition. For fisheries independent data, a standardized effort is a part of the monitoring method. This is also true for the Danish recreational fisheries survey (Støttrup et al. 2018). For the commercial fisheries dependent data, the reliability of the effort information is highly variable in different countries or lacking in some countries. The good quality of effort data is a prerequisite for using the commercial catch data for monitoring purposes.

When establishing new coastal fish monitoring programs, it is advisable to base it on the monitoring guidelines presented here. In addition, consulting relevant experts of regional monitoring and assessment is recommended to support coherence in how the data are collected. Any new monitoring program should be designed to ensure that the data obtained will be as comparable as possible to the data from the already existing monitoring areas. As a first priority, it is advisable to base the monitoring on Nordic coastal multi-mesh gillnets (also called "Nordic nets") using the recommended sampling strategy described below. This gear is currently used in Finland, Germany, Poland, Latvia and Sweden in their more recently established coastal fish monitoring programs or projects, and the application of same standard in many areas enhances the possibilities for making temporal and geographical comparisons (Bergström et al., 2016b). The Nordic coastal multi-mesh gillnets were first taken into use in Sweden, beginning in 2001 (Appelberg et al. 2003, Söderberg 2006), with the aim to provide a higher spatial represenativity for each area, to sample a wider range of the targeted fish communities, and to improve the precision of the monitoring.

Abiotic ambient factors play an important role for the behaviour and metabolism of fish. The activity level of fish may be influenced, for example, by temperature, wind conditions, currents, salinity and water transparency (Bergström et al. 2016a; Östman et al. 2017b). Furthermore, survival during the first year of life is both directly and indirectly linked to temperature, for instance via food uptake and growth. Consequently, it is essential to include information on water temperature in the monitoring. Other important abiotic variables should also preferably be registered.

In all types of monitoring programs, it should be considered that not all existing coastal fish species and sizes are equally sampled in different studies and with different gears (HELCOM 2012). For example, those gillnet surveys taking place in August – with the exception of higher saline areas in the Western Baltic –

predominantly catch demersal and benthopelagic species of a freshwater origin preferring relatively warmer water temperatures. Frequently occurring species are perch (*Perca fluviatilis*), roach (*Rutilus rutilus*), and ruffe (*Gymnocephalus cernua*). Respectively, gillnet surveys later in autumn catch higher numbers of marine species, including flounder (*Platichtys flesus*) and cod (*Gadus morhua*). The abundance of freshwater species within the coastal fish assemblages may also be influenced by the amount of riverine runoff. Irrespective of season, passive gears like gillnets typically sample indivuduals within a certain size range representitavely, and species with eel-like body forms (eelpout, *Zoarces viviparus*) and sedentary behaviour (as for example pike, *Esox lucius*) are generally not representatively sampled in the nets.

2.2   Time and area

The Baltic Sea coastal fish monitoring programs are summarized in Annex 2. The fisheries independent surveys are mainly carried out during late summer, but some surveys are carried out during spring and autumn, or even year around. Catches of coastal commercial fisheries cover a whole calendar year. Citizen science data is collected from April to November (or even year-round if possible).

2.3   Monitoring procedure

2.3.1   Monitoring strategies

The Baltic Sea coastal fish monitoring uses both fisheries independent and fisheries dependent monitoring strategies (Annex 2).

2.3.2   Sampling methods and equipments

All monitoring is conducted with the same method each year. Several different gears are, or have been, used in the coastal fish monitoring in the Baltic Sea region. See Annex 2 for an overview of the gears used in each monitoring area and Annex 3 for a description of the gears and gear-specific methods. For new fisheries independent monitoring, the Nordic coastal multi-mesh gillnet is the recommended gillnet gear (Annex 3).

2.3.3   Sample handling and analysis

All fish are determined to species and their length and weight are measured directly in connection to the fish monitoring (Annex 4). Environmental parameters are measured directly in connection to the fish monitoring (Annex 4).

The raw data are used for calculating catch per unit of effort (CPUE), which is used as the basic unit in the data analysis and indicator-based assessments. The indicators are calculated as the summed CPUE of all species/fish included in the concerned indicator, and the results are presented as an average value for each year of all sampling stations in each monitoring area (HELCOM 2018abc). The core indicators currently used in status assessment are **Abundance of coastal fish key functional groups** (CPUE of cyprinids/mesopredators and CPUE of piscivores) and **Abundance of key coastal fish species** (CPUE of perch, cod or flounder) (HELCOM 2018ab).

2.4   Data analysis

Data anlysis is conducted in order to evaluate whether or not the core indicators indicate good environmental status (HELCOM 2018abc). In the analysis, either a baseline approach or a trend-based approach is used dependending on time-series length. The baseline approach is used if the dataseries covers at leat 15 years and if the part of the dataset which is used to determine the baseline does not display a linear trend within itself. In other cases, the trend-based approach is used. A detailed description of the core indicator assessment is provided in HELCOM 2018abc.

3   Data reporting and storage

The raw data from the monitoring are stored in national databases following country-specific routines for quality assurance and storage. **Raw data for the fisheries independent methods** are stored in national databases as the number of fish within each species and length class separately for each gear and fishing station, together with other supporting parameters (listed in Annex 3). **Raw data for the Finnish commercial catch data** is stored in the database of the Official Fisheries Statistics of Finland (Natural Resources Institute Finland (Luke)). **Raw data for the Danish citizen science data** is stored in a database as the number of fish within each species and length class separately for each gear, fishing station and fishing event.

Since 2017, indicator results are stored in a regionally share database hosted at the HELCOM Secretariat. Each country calculates indicator values for their monitoring areas using the raw data from fish monitoring. Yearly indicator data and values are uploaded during the first half of the coming year to the HELCOM database for coastal fish core indicators, COOL (bio.helcom.fi/coastalfish). For carrying out status assessments, indicator data series are extracted from the COOL database, and the assessment undertaken by the lead country (Sweden) according to the assessment protocol outlined in HELCOM 2018abc.

4   Quality control

4.1   Quality control of methods

The quality of the raw data collected within the different coastal fish monitoring programs is assured on a national level in alignment with the here presented guidelines.

4.2   Quality control of data and reporting

Each Contracting Party has their own quality assurance system within which all raw data used for common assessments of coastal fish community status has been considered. The regional data represented calculated indicator values in accordance with this guidline and with HELCOM 2018ab, and is reported to the COOL database, hosted by HELCOM (bio.helcom.fi/coastalfish).

5   Contacts and references

5.1   Contact persons, the HELCOM FISH PRO III expert network on coastal fish

Jens Olsson, Lena Bergström, Noora Mustamäki and Rahmat Naddafi – Department of Aquatic Resources, Swedish University of Agricultural Sciences SLU, Sweden.

Mikko Olin, Antti Lappalainen and Outi Heikinheimo – Natural Resources Institute Finland (LUKE).

Kaj Ådjers – Provincial Government of Åland Islands, Finland.

Lauri Saks and Roland Svirgsden – Estonian Marine Institutde, University of Tartu, Estonia.

Laura Briekmane and Didzis Ustups, Institute of Food Safety, Animal Health and Environment "BIOR", Latvia.

Linas Lozys, Justas Dainys and Egle Jakubaviciute, Nature Research Center, Vilnius, Lithuania.

Adam Lejk and Łukasz Dziemian, National Marine Fisheries Research Institute, Gdynia, Poland.

Marina Carstens and Claudia Starke, Ministry of Agriculture and the Environment, Mecklenburk Vorpommern, Germany

Josianne Støttrup and Elliot John Brown, National Institute of Aquatic Resources, Technical University of Denmark, Denmark.

Sergey Shibaev, Kaliningrad State Technical Univeristy, Russia.

5.2   References

Anon. 2008. Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy. Official Journal of the European Communities, L164: 19-40.

Appelberg M, Holmqvist M and Forsgren G. 2003. An alternative strategy for coastal fish monitoring in the Baltic Sea. ICES CM 2003/R:03.

Bergström L, Bergström U, Olsson J and Carstensen J. 2016. Coastal fish indicators response to natural and anthropogenic drivers - variability at temporal and different spatial scales Long term changes in the status of coastal fish in the Baltic Sea. Estuarine, Coastal and Shelf Science, 183: 62–72.

Bergström L, Dainys J, Heikinheimo O, Jakubaviciute E, Kruze E, Lappalainen A, Lozys L, Minde A, Saks L, Svirgsden R, Ådjers K, Olsson J. 2016. Long term changes in the status of coastal fish in the Baltic Sea. Estuarine Coastal and Shelf Science, 2016: 74–84.

Bergström L, Karlsson M, Bergström U, Phil L, Kraufvelin P. In press. Relative impacts of fishing and eutrophication on coastal fish assessed by comparing a no-take area with an environmental gradient. Ambio, https://doi.org/10.1007/s13280-018-1133-9.

EU 2016/1251. Commission Implementing Decision (EU) 2016/1251 of 12 July 2016. Adopting a multiannual Union programe for collection, management and use of data in the fisheries and aquaculturesectors for the period 2017–2019.

HELCOM 2007. Baltic Sea Action Plan. HELCOM ministerial meeting. Krakow, Poland, 15 Nov 2007.

HELCOM 2012. Indicator-based assessment of coastal fish community status in the Baltic Sea 2005–2009. Baltic Sea Environment Proceedings No. 131.

HELCOM 2013. HELCOM core indicators: Final report of the HELCOM CORESET project. Baltic Sea Environment Proceedings No. 136.

HELCOM 2018a. Abundance of coastal fish key functional groups. HELCOM core indicator report. Online. 4 September 2018, http://www.helcom.fi/baltic-sea-trends/indicators/abundance-of-coastal-fish-key-functional-groups/. ISSN 2343-2543

HELCOM 2018b. Abundance of coastal fish key species. HELCOM core indicator report. Online. 4 September 2018, http://www.helcom.fi/baltic-sea-trends/indicators/abundance-of-key-coastal-fish-species. ISSN 2343-2543

HELCOM 2018c. Status of coastal fish communities in the Baltic Sea during 2011-2016 – the third thematic assessment. Baltic Sea Environment Proceedings 161. Online 27 November 2018, http://www.helcom.fi/Lists/Publications/Status-of-coastal-fish-2018-HELCOM-report.pdf

Laikre L, Palm S and Ryman N. 2005. Genetic population structure of fishes: implications for coastal zone management. Ambio, 34: 111–119.

Mustamäki N, Jokinen, H, Scheinin M, Bonsdorff E and Mattila J. 2015. Seasonal small-scale variation in distribution among depth zones in a coastal Baltic Sea assemblage. ICES Journal of Marine Science, 72: 2374–2384.

Mustamäki N, Jokinen, H, Scheinin M, Bonsdorff E and Mattila J. 2016. Seasonal shifts in the vertical distribution of fish in a shallow coastal area. ICES Journal of Marine Science, 73: Pages 2278–2287.

Neuman E, Sandström O and Thoresson G. 1999. Guidelines for coastal fish monitoring. National Board of Fisheries, Institute of Coastal Reseach.

Olsson J, Bergström L and Gårdmark A. 2012a. Abiotic drivers of coastal fish community change during four decades in the Baltic Sea. ICES Journal of Marine Science, 69: 961–970.

Olsson J, Lingman A and Bergström U. 2015. Using catch statistics from the small scale coastal Baltic fishery for status assessment of coastal fish. Aqua reports 2015:13. Swedish University of Agricultural Sciences.

Olsson J, Mo K, Florin A-B, Aho T and Ryman N. 2011. Genetic population structure of perch, Perca fluviatilis L, along the Swedish coast of the Baltic Sea. Journal of Fish Biology, 79: 122–137.

Olsson J, Mo K, Florin A-B, Aho T and Ryman N. 2012b. Genetic structure of whitefish (*Coregonus maraena*) in the Baltic Sea. Estuarine, Coastal and Shelf Science, 97: 104–113.

Östman Ö, Lingman A, Bergström L and Olsson J. 2017a. Temporal development and spatial scale of coastal fish indicators in reference sites in coastal ecosystems: hydroclimate and anthropogenic drivers. Journal of Applied Ecology, 54: 557–566.

Östman Ö, Olsson J, Dannewitz J, Palm S and Florin A-B. 2017b. Inferring spatial structure from population genetics and spatial synchrony in population growth of Baltic Sea fishes: implications for management. Fish and Fisheries, 18: 324–339.

Söderberg K. 2006. Provfiske i Östersjöns kustområden – Djupstratifierat provfiske med Nordiska kustöversiktsnät. (Test fishing in the coastal areas of the Baltic Sea – Depth statified test fishing with Nordic coastal multi-mesh gillnets). In Swedish.

Støttrup JG, Kokkalis A, Brown EJ, Olsen J, Kærulf Andersen S, Pedersen EM. 2018. Harvesting geo-spatial data on coastal fish assemblages through coordinated citizen science. Fisheries Research, 208: 86–96.

Thoresson G. 1996. Guidelines for coastal fish monitoring. Swedish Board of Fisheries Kustrapport 1996:2.

Wennerström L, Olsson J, Ryman N and Laikre N. 2017. Temporally stable, weak genetic structuring in brackish water northern pike (*Esox lucius*) in the Baltic Sea indicates a contrasting divergence pattern relative to freshwater populations. Canadian Journal of Fisheries and Aquatic Sciences, 74: 562–571.

5.3 Additional literature

Artificial reef project Mecklenburg-Vorpommern, Germany: reports (in German) see https://www.riff-nienhagen.de/forschungsberichte.shtml

Kraufvelin P, Pekcan-Hekim Z, Bergström U, Florin A-B, Lehikoinen A, Mattila J and Olsson J. 2016. Essential fish habitats (EFH): Conclusions from a workshop on the importance, mapping, monitoring, threats and conservation of coastal EFH in the Baltic Sea. TemaNord 2016:539. Nordic Council of Ministers 2016. ISSN 0908-6692. https://www.norden.org/en/publication/essential-fish-habitats-efh

Annex 1

Map of coastal fish monitoring areas in the Baltic Sea.

See Annex 2 for the names of the monitoring areas.
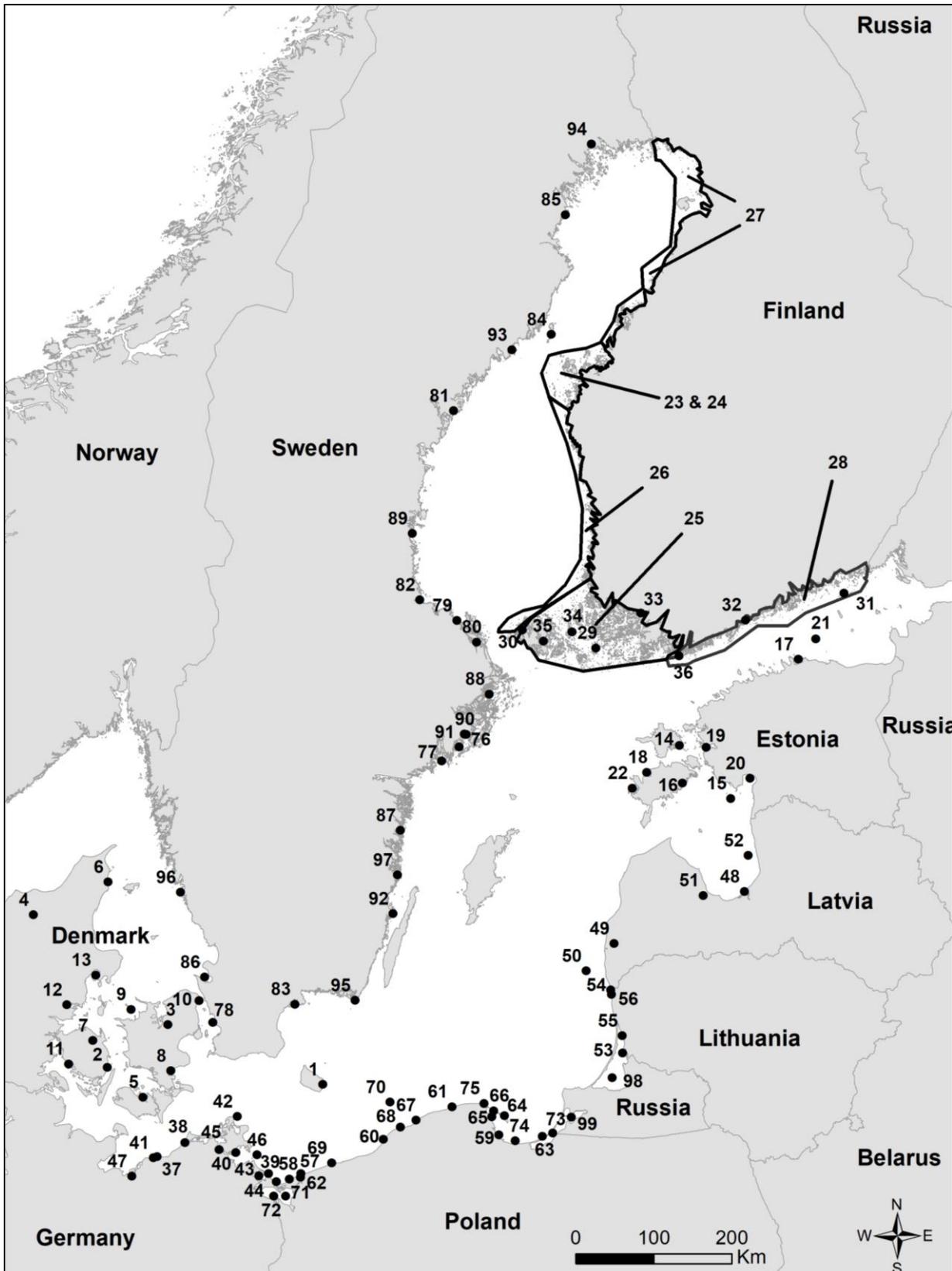
Annex 2

Baltic Sea coastal fish monitoring programs

Table, part 1 of 5, Denmark. Overview the coastal fish monitoring in the Baltic Sea. Number of the monitoring area on the map (Nr. figure 1), the country, type of monitoring (Type: fisheries independent, fisheries dependent and citizen science), station/area of monitoring, time period (all years when monitoring has been conducted), month (all months when monitoring has been conducted; Month: 1–12 / year around) and all gears used (Nordic = Nordic coastal multi-mesh gillnet. For monofilament gillnets, mesh size is presented in mm. See 2.3.2 for gear descriptions)

Nr.	COUNTRY	TYPE	STATION/AREA	TIME PERIOD	MONTH	GEAR
1	**Denmark**	Citizen science	Bornholm	2010–Present	4–11	Gillnet (65 mm), paired fyke net
2	**Denmark**	Citizen science	Great Belt	2005–Present	4–11	Gillnet (65 mm), paired fyke net
3	**Denmark**	Citizen science	Isefjord and Roskilde fjord	2005–Present	4–11	Gillnet (65 mm), paired fyke net
4	**Denmark**	Citizen science	Limfjord	2005–Present	4–11	Gillnet (65 mm), paired fyke net
5	**Denmark**	Citizen science	Lolland-Falster	2006–Present	4–11	Gillnet (65 mm), paired fyke net
6	**Denmark**	Citizen science	Northern Kattegat coast	2008–Present	4–11	Gillnet (65 mm), paired fyke net
7	**Denmark**	Citizen science	Odense Fjord	2005–Present	4–11	Gillnet (65 mm), paired fyke net
8	**Denmark**	Citizen science	Præstø Fjord	2005–Present	4–11	Gillnet (65 mm), paired fyke net
9	**Denmark**	Citizen science	Sejerø Bay	2006–Present	4–11	Gillnet (65 mm), paired fyke net
10	**Denmark**	Citizen science	Sound	2005–Present	4–11	Gillnet (65 mm), paired fyke net
11	**Denmark**	Citizen science	West and south of Funen	2005–Present	4–11	Gillnet (65 mm), paired fyke net
12	**Denmark**	Citizen science	Western Kattegat fjords	2005–Present	4–11	Gillnet (65 mm), paired fyke net
13	**Denmark**	Citizen science	Århus Bay	2005–Present	4–11	Gillnet (65 mm), paired fyke net

Table, part 2 of 5, Estonia and Finland. Overview the coastal fish monitoring in the Baltic Sea. Number of the monitoring area on the map (Nr. figure 1), the country, type of monitoring (Type: fisheries independent, fisheries dependent and citizen science), station/area of monitoring, time period (all years when monitoring has been conducted), month (all months when monitoring has been conducted; Month: 1–12 / year around) and all gears used (Nordic = Nordic coastal multi-mesh gillnet. For monofilament gillnets, mesh size is presented in mm. See 2.3.2 for gear descriptions)

Nr.	COUNTRY	TYPE	STATION/AREA	TIME PERIOD	MONTH	GEAR
14	**Estonia**	Fisheries independent	Hiiumaa	1991–Present	7–8	Net series Summer
15	**Estonia**	Fisheries independent	Kihnu Island	1997–Present	7	Net series Summer, fyke net
16	**Estonia**	Fisheries independent	Kõiguste	2005–Present	7	Net series Summer, fyke net
17	**Estonia**	Fisheries independent	Käsmu	1997–Present	8	Net series Summer, fyke net
18	**Estonia**	Fisheries independent	Küdema	1992–97, 2000–Present	10–11	Net series Autumn
19	**Estonia**	Fisheries independent	Matsalu	1993–Present	7	Net series Summer, fyke net
20	**Estonia**	Fisheries independent	Pärnu Bay	2001–Present	4–12	Bottom trawl, gillnet (16–60 mm)
21	**Estonia**	Fisheries independent	Vaindloo	1997–Present	8	Net series Summer
22	**Estonia**	Fisheries independent	Vilsandi	1993–Present	7	Net series Summer, fyke net
23	**Finland**	Fisheries dependent	ICES rectangle 23	1980–Present	Year around	Gillnet (36–60 mm)
24	**Finland**	Fisheries dependent	ICES rectangle 28	1980–Present	Year around	Gillnet (36–60 mm)
25	**Finland**	Fisheries dependent	ICES SD 29	1980–Present	Year around	Gillnet (36–60 mm)
26	**Finland**	Fisheries dependent	ICES SD 30	1980–Present	Year around	Gillnet (36–60 mm)
27	**Finland**	Fisheries dependent	ICES SD 31	1980–Present	Year around	Gillnet (36–60 mm)
28	**Finland**	Fisheries dependent	ICES SD 32	1980–Present	Year around	Gillnet (36–60 mm)
29	**Finland**	Fisheries independent	Brunskär	1991–Present	7–8	Coastal survey net, Nordic
30	**Finland**	Fisheries independent	Finbo, Åland Islands	1991–Present	8	Coastal survey net, Nordic
31	**Finland**	Fisheries independent	Haapasaaret	2003–2006	8	Nordic
32	**Finland**	Fisheries independent	Helsinki	2005–Present	8	Nordic
33	**Finland**	Fisheries independent	Kaitvesi	2005–2011	8	Nordic
34	**Finland**	Fisheries independent	Kumlinge, Åland Islands	2003–Present	8	Nordic
35	**Finland**	Fisheries independent	Lumparn, Åland Islands	1999–Present	10	Net series Autumn, Nordic
36	**Finland**	Fisheries independent	Tvärminne	2005–Present	8	Nordic

Table, part 3 of 5, Germany, Latvia and Lithuania. Overview the coastal fish monitoring in the Baltic Sea. Number of the monitoring area on the map (Nr. figure 1), the country, type of monitoring (Type: fisheries independent, fisheries dependent and citizen science), station/area of monitoring, time period (all years when monitoring has been conducted), month (all months when monitoring has been conducted; Month: 1–12 / year around) and the gears used (Nordic = Nordic coastal multi-mesh gillnet. For monofilament gillnets, mesh size is presented in mm. See 2.3.2 for gear descriptions)

Nr.	COUNTRY	TYPE	STATION/AREA	TIME PERIOD	MONTH	GEAR
37	**Germany**	Fisheries independent	Börgerende	2003–Present	Year around	Gillnet (55 & 60 mm), Nordic type German, Trammel net
38	**Germany**	Fisheries independent	Darß-Zingst Bodden chain	2008–Present	5–10	Fyke net enclosure system
39	**Germany**	Fisheries independent	East of Usedom Peninsula	2008–Present	5–10	Fyke net enclosure system
40	**Germany**	Fisheries independent	Greifswalder Bodden	2008–Present	5–10	Fyke net enclosure system
41	**Germany**	Fisheries independent	North of Kühlungsborn city	2008–Present	5–10	Fyke net enclosure system
42	**Germany**	Fisheries independent	Northeast of Ruegen Island	2008–Present	5–10	Fyke net enclosure system
43	**Germany**	Fisheries independent	Peene river / Achterwasser	2008–Present	5–10	Fyke net enclosure system
44	**Germany**	Fisheries independent	Stettin Lagoon	2008–Present	5–10	Fyke net enclosure system
45	**Germany**	Fisheries independent	Strelasund	2008–Present	5–10	Fyke net enclosure system
46	**Germany**	Fisheries independent	Usedom Island / Oder bank	1992–2016	9	Bottom trawl
47	**Germany**	Fisheries independent	Wismar Bight and Salzhaff	2008–Present	5–10	Fyke net enclosure system
48	**Latvia**	Fisheries independent	Daugavgriva	1995–Present	8	Net series Summer, Nordic
49	**Latvia**	Fisheries independent	Jūrkalne	1999–Present	8	Net series Summer, Nordic
50	**Latvia**	Fisheries independent	Liepaja	2005–Present	Year around	Net series Summer, Nordic
51	**Latvia**	Fisheries independent	Plienciems	2005–Present	Year around	Net series Summer, Nordic
52	**Latvia**	Fisheries independent	Salacgiva	2005–Present	Year around	Net series Summer, Nordic
53	**Lithuania**	Fisheries independent	Atmata	1993–Present	7	Net series Summer
54	**Lithuania**	Fisheries independent	Butinge	2000–Present	8	Net series Summer
55	**Lithuania**	Fisheries independent	Dreverna	1993–Present	7	Net series Summer
56	**Lithuania**	Fisheries independent	Monciskes	1993–Present	8	Net series Summer

Table, part 4 of 5, Poland. Overview the coastal fish monitoring in the Baltic Sea. Number of the monitoring area on the map (Nr. figure 1), the country, type of monitoring (Type: fisheries independent, fisheries dependent and citizen science), station/area of monitoring, time period (all years when monitoring has been conducted), month (all months when monitoring has been conducted; Month: 1–12 / year around) and all gears used (Nordic = Nordic coastal multi-mesh gillnet. For monofilament gillnets, mesh size is presented in mm. See 2.3.2 for gear descriptions)

Nr.	COUNTRY	TYPE	STATION/AREA	TIME PERIOD	MONTH	GEAR
57	**Poland**	Fisheries independent	Dziwna River mouth	2011, 2018	7–8	Bottom trawl
58	**Poland**	Fisheries independent	Dziwna – Świna	2011	9	Polish coastal multi-mesh gillnet
59	**Poland**	Fisheries independent	Inner Gulf of Gdańsk	2011, 2014–2015, 2018	7–8	Nordic
60	**Poland**	Fisheries independent	Jarosławiec – Sarbinowo	2011, 2015	7–9	Polish coastal multi-mesh gillnet, Nordic
61	**Poland**	Fisheries independent	Jastrzębia Góra – Rowy	2011	7–8	Polish coastal multi-mesh gillnet
62	**Poland**	Fisheries independent	Kamieński Lagoon	2011, 2018	7–8	Polish coastal survey net
63	**Poland**	Fisheries independent	Mierzeja Wiślana	2011	7–8	Polish coastal multi-mesh gillnet
64	**Poland**	Fisheries independent	Półwysep Hel	2011	7–8	Polish coastal multi-mesh gillnet
65	**Poland**	Fisheries independent	Puck Bay	2011, 2013, 2018	7–9	Polish coastal survey net, Nordic, Bottom trawl, Polish coastal multi-mesh gillnet
66	**Poland**	Fisheries independent	Puck Lagoon	2011, 2013–2018	7–9	Polish coastal survey net, Polish coastal multi-mesh gillnet
67	**Poland**	Fisheries independent	Rowy - Jarosławiec Wschód	2011	7–8	Polish coastal multi-mesh gillnet
68	**Poland**	Fisheries independent	Rowy - Jarosławiec Zachód	2011	7–8	Polish coastal multi-mesh gillnet
69	**Poland**	Fisheries independent	Sarbinowo – Dziwna	2011	7–8	Polish coastal multi-mesh gillnet
70	**Poland**	Fisheries independent	Słupsk Bank	2011	7–8	Polish coastal survey net
71	**Poland**	Fisheries independent	Świna River mouth	2011, 2018	7–8	Bottom trawl
72	**Poland**	Fisheries independent	Szczecin Lagoon	2011, 2014, 2015, 2018	7–9	Polish coastal multi-mesh gillnet, Nordic
73	**Poland**	Fisheries independent	Vistula Lagoon	2011, 2014–2018	7–9	Polish coastal multi-mesh gillnet, Nordic
74	**Poland**	Fisheries independent	Vistula River mouth	2011, 2014–2015, 2018	7–8	Bottom trawl
75	**Poland**	Fisheries independent	Władysławowo - Jastrzębia Góra	2011	7–8	Polish coastal multi-mesh gillnet

Table, part 5 of 5, Sweden and Russia. Overview the coastal fish monitoring in the Baltic Sea. Number of the monitoring area on the map (Nr. figure 1), the country, type of monitoring (Type: fisheries independent, fisheries dependent and citizen science), station/area of monitoring, time period (all years when monitoring has been conducted), month (all months when monitoring has been conducted; Month: 1–12 / year around) and all gears used (Nordic = Nordic coastal multi-mesh gillnet. For monofilament gillnets, mesh size is presented in mm. See 2.3.2 for gear descriptions)

Nr.	COUNTRY	TYPE	STATION/AREA	TIME PERIOD	MONTH	GEAR
76	**Sweden**	Fisheries independent	Askviken	2009–2016	8	Nordic
77	**Sweden**	Fisheries independent	Asköfjärden	2005–Present	8	Nordic
78	**Sweden**	Fisheries independent	Barsebäck	1999–Present	4, 8	Fyke net
79	**Sweden**	Fisheries independent	Forsmark	1987–Present	8	Coastal survey net, Nordic
80	**Sweden**	Fisheries independent	Galtfjärden	1995–Present	10	Net series Autumn, Nordic
81	**Sweden**	Fisheries independent	Gaviksfjärden	2004–Present	8	Nordic
82	**Sweden**	Fisheries independent	Gävlebukten	2011–Present	10–11	Nordic
83	**Sweden**	Fisheries independent	Hanöbukten	2012–Present	8	Nordic
84	**Sweden**	Fisheries independent	Holmön	1989–Present	8	Coastal survey net, Nordic
85	**Sweden**	Fisheries independent	Kinnbäcksfjärden	2004–Present	8	Nordic
86	**Sweden**	Fisheries independent	Kullen	2002–Present	8, 10	Fyke net
87	**Sweden**	Fisheries independent	Kvädöfjärden	1987–Present	8, 10	Net series Summer & Autumn, Nordic
88	**Sweden**	Fisheries independent	Lagnö	2002–Present	8	Nordic
89	**Sweden**	Fisheries independent	Långvindsfjärden	2002–Present	8	Nordic
90	**Sweden**	Fisheries independent	Lännåkersviken	2009–2016	8	Nordic
91	**Sweden**	Fisheries independent	Muskö	1992–Present	10	Net series Autumn
92	**Sweden**	Fisheries independent	Mönsterås	1995–Present	8	Net series Summer
93	**Sweden**	Fisheries independent	Norrbyn	2002–Present	8	Nordic
94	**Sweden**	Fisheries independent	Råneå	2002–Present	8	Nordic
95	**Sweden**	Fisheries independent	Torhamn	2002–Present	8	Nordic
96	**Sweden**	Fisheries independent	Vendelsö	1976–Present	4, 8	Fyke net
97	**Sweden**	Fisheries independent	Vinö	1995–Present	8	Net series Summer
98	**Russia**	Fisheries independent	Curonian Lagoon	1960–Present	5–11	Pelagic trawl, Bottom trawl
99	**Russia**	Fisheries independent	Vistula Lagoon	2005–Present	5–11	Pelagic trawl, Bottom trawl

Annex 3

Methods in Baltic Sea coastal fish monitoring

Sampling methods in Baltic Sea coastal fish monitoring

Gear types used in fisheries independent surveys

The **Nordic coastal multi-mesh gillnet**, also called Nordic net is the focal gear in the coastal fish monitoring program. The gear is used in Finland, Germany, Latvia, Poland and Sweden. A Nordic coastal multi-mesh gillnet consists of 1.8 m (6 feet) deep bottom gillnets with a length of 45 m. The lower net-rope (main line) is 10 % longer than the upper net-rope (=38.5 m). The gillnets are made up of nine parts, each 5 m long. These have different mesh sizes and are placed in the following order: 30, 15, 38, 10, 48, 12, 24, 60 and 19 mm (mesh bar). The gillnets are made of transparent monofilament nylon of 0.15 mm diameter in the seven smallest mesh sizes, 0.17 mm in mesh size 48 mm and 0.20 in mesh size 60 mm. The nets are bottom set. The upper net-rope has a buoyancy of 6 g/m and the lower net-rope weigh 22 g/m.

The **Nordic multi-mesh gillnet type German** is used in the artificial reef program in Mecklenburg-Vorpommern, Germany. It is a Nordic multi-mesh gillnet with a slightly different set up; this gillnet is 49 m long and 2 m deep with the mesh sizes of 6.5, 15, 20, 26, 35, 50 and 70 mm.

Net series of two types are used in Estonia, Finland, Lithuania and Sweden. Latvia used net series until 2016, whereafter only Nordic nest have been used. A net series consists of bottom set gillnets which are 1.8 m (6 feet) deep and made of spun green nylon and attached to each other. One gillnet consists of a 60 m long stretched net bundle which is attached to a 27 m net-rope (35 cm between floats, buoyancy 6 g/m) and a 33 m lower net-rope (weight 2.2 kg/100 m). The **net series type Summer** consists of four gillnets with mesh sizes of 17, 21.5, 25 and 30 mm. Yarn thickness is no. 110/2 for all mesh sizes except 33–50 mm (210/2), according to the Tex-system (e.g., 110/2 means 2 filaments each weighing 110 g per 10 000 m). In Estonia, Latvia and Lithuania additional mesh sizes are added to the gear in some areas. The **net series type Autumn** consists five gillnets with mesh sizes of 21.5, 30, 38, 50 and 60 mm. Yarn thickness is no. 210/3 for the mesh size 60 mm, no. 212/2 for the mesh sizes 50–38 mm and no. 110/2 for the other mesh sizes, according to the Tex-system (e.g., 110/2 means 2 filaments each weighing 110 g per 10 000 m).

Fyke nets are used in Estonia, Germany and Sweden. The **fyke nets** used in Estonia and Sweden are 55 cm high with a semi-circular opening and a leader or wing that is 5 m long. They are made of 17 mm mesh in the arm and 10 mm mesh in the crib of yarn quality no. 210/12 in twisted nylon. The **enclosure fyke net system** used in the German Baltic Sea coast of Mecklenburg-Vorpommern consists of boundary nets, leaders and fyke nets. A boundary net (height 1.8 m, length 100 m, mesh size 10 mm) has a fyke net in each corner. The net square encloses a fished area of 1 ha. In addition, 6 chains of eel traps (4 double-chamber fyke nets with an 8 m leader net) are placed inside the 100 m x 100 m net square. The leaders of the fyke nets are 3 m long and the fyke net contains chambers with the mesh sizes of 17, 14 and 11 mm (from the opening to the end of the fyke net). The gear was originally designed for eel monitoring (Ubl & Dorow 2015, Dorow et al. in press), aiming at quantitative estimates of eel abundance or biomass per area. The suitability of the enclosure approach for other fish species was also shown (Reckordt et al. 2012, Rothe et al. 2016).

Bottom trawls are used in Estonia, Germany, Poland and Russia. In Estonia, bottom trawl surveys have been carried out since 2009 in the Pärnu Bay. The bottom trawl (working depth 0.3 m from the bottom) is pulled with the speed of 3 knots for 30 minutes. The trawl mouth is 2 m high and 6 m wide, distance between doors is 20 m and maximum distance between the 8.2 m long trawl wings is 12 m. Mesh size is 60 mm (knot to knot), at the tip of the trawl wings, 45 mm at the trawl mouth and decreases gradually to 10 mm at the codend. In Germany, an eel-trawl was used between 2003 and 2011 in Pomeranian Bay. The total length (wing and bag) of the eel trawl is 16.6 m, the minimum mesh size in the codend is 14 mm, and the distance between the wings 10 m. From 2012 until recently, then the international standard bottom trawl TV3-520/40-10 has been used. In addition, a shrimp trawl is used to

catch smaller sized fish and larger invertebrates. The shrimp trawl has a dredge frame with an opening of 2 m, a minimum mesh size in the codend of 5 mm (from knot to knot). In Poland, four types of bottom trawls (with mesh bar lengths from 11 to 30 mm) were used during the pilot studies for the Polish coastal fish monitoring programme in 2011. From 2014, sampling is performed using a commercial fishery bottom trawl equipped with standardized 10 mm mesh bar length in the codend. The towing speed is 3.0 knots, and each haul is no shorter than 10 minutes. In Russia, for monitoring in Curonian and Vistula lagoons two types of bottom trawls are used: a 23 m long trawl with a mesh-size of 12 mm and a 15 m long trawl with a mesh-size of 5 mm. Trawling time is 30 minutes and speed 3 knots.

Pelagic trawls are used in Russia for monitoring in Curonian and Vistula lagoons. The pelagic trawl is 7 m long with a mouth of 4.5 m^2 and a mesh-size of 0.5 mm. Trawling time is 15 minutes and speed 3 knots.

Trammel nets are used in Germany. The two-panel trammel net is 50 m long with a height of 2 m, where the inner wall of net has a mesh-size of 60 mm and the outer wall 350 mm.

Monofilament gillnets are used in Germany (45 m long with a height of 2.4 m and a mesh size of 60 or 55 mm) and Estonia (mesh sizes of 16, 22, 25, 30, 38, 45, 48, 50 and 60 mm).

Some gear types are no longer used in coastal fish monitoring. *The coastal survey net* used to be widely utilized in fish monitoring in Finland and Sweden. A coastal survey net is 3 m deep (about 2.5 m in water), and consists of five parts, each 7 m long. These have different mesh sizes and are placed in the following order: 17, 22, 25, 33 and 50 mm (mesh bar). The upper net-rope is 35 m long and the lower net-rope (main line) is 38.5 m long. The nets are made of green monofilament nylon of 0.20 mm diameter in the two largest mesh sizes and 0.17 mm in the others. The upper net-rope is made of net-rope and the lower is plastic net-rope (weight = 3.2 kg/100 m). *The Polish coastal survey net* was used in Poand in 2011 and 2014. The gear consists of six 30 m long panels and one 10 m long panel. The total length of one gillnet is hence 190 m and the height in the water about 1.8 m. Each panel is made up of a single mesh size: 10 (10 m long), 17, 22, 25, 30, 40 and 50 (all 30 m long) mm. The floatline weighs 0.9 kg/100 m and the lower leadline 3.2 kg/100 m. The gillnet is made of green monofilament nylon of 0.12 to 0.20 mm diameter. *The Polish coastal multi-mesh gillnet* was used in Poland in 2011 and 2013. The gear consists of six 30 m long panels. The total length of one gillnet is hence 180 m and the height in the water is about 3.0 m. Each panel is made up of a single mesh size: 25, 30, 38, 45, 50 and 60 mm. The floatline weighs 0.9 kg/100 m and the lower leadline 3.2 kg/100 m. The gillnet is made of green monofilament nylon of 0.12 to 0.20 mm diameter.

Sampling methods in fisheries independent surveys

Nordic coastal multi-mesh gillnets The smallest geographical unit is a *station* at which one gillnet is placed. The sampling strategy is based on depth-stratified random sampling using up to 45 stations distributed in different depth intervals (Söderberg et al. 2006). A group of stations within the same depth interval (0–3 m, 3–6 m, 6–10 m or 10–20 m), forms a *section*. An *area* is a denominated geographical area within which there are a number of sections (depth intervals). The recommended number of stations is up to 45 but it may vary depending upon the morphometric characters of the area and the abundance of fish. One fishing effort is done at each station each year.

Net series and coastal survey nets The smallest geographical unit is a *station* at which a gear is placed. A group of neighbouring stations with similar conditions (depth, exposure, etc.) and similar influence of environmental disturbance forms a *section*. An *area* is a denominated geographical area within which there may be one or more sections. To select stations for trend monitoring a predesign study has to be made. In the predesign study, a large number of stations (>20) are visited once to provide a mapping of spatial variability. About 10 stations are then selected for a continued three-year evaluation period. Based on these experiences, the number of stations may be further reduced after performing statistical tests of homogeneity. Six stations per area is considered a minimum for monitoring of abundance trends with coastal survey nets or net series. Typically, three to six fishing efforts are conducted at each station yearly. All stations within a section are fished on the same day. If all sections cannot be fished on the same day, the fishing is continued in the remaining sections before returning to the first section. In

Estonia, fixed stations are used only in Hiiumaa, Kõiguste and Küdema. In all other areas, random sampling inside the section(s) is conducted. The number of stations in most areas is at least 30, except Vaindloo Island where six stations and Kõiguste where 22 stations are monitored. In Sweden and Finland (Åland Islands), the fishing effort was reduced from six nights to three nights from year 2006.

Fyke nets In Sweden are placed in pairs, joined leader to a crib, one pair per station, which is the smallest geographical unit. A group of neighbouring stations with similar external conditions (depth, exposure, assumed environmental disturbances, etc) forms a section. An area is a named geographical area within which there may be one or more sections. The recommended number of stations and the number of visits per station may vary depending upon the morphometric characters of the area and the abundance of fish. All stations within a section are fished on the same day. If all sections cannot be fished on the same day, the fishing is continued in the remaining sections before returning to the first section. In Estonia, a smallest geographical unit is a station at which two fyke nets are joined leader to leader. Several such stations may be joined together (e.g. 20 fyke nets joined leader to leader and crib to crib) and then this set is considered to be one station. At least 80 fyke net nights (e.g. 20 fyke nets for four nights) are fished per monitoring area annually. In Germany, nine areas are monitored with the enclosure fyke net system, and within each area, six randomly selected stations are fished per year (Frankowski 2015, Ubl & Dorow 2015).

Bottom trawl was used during the pilot studies for the Polish coastal fish monitoring programme in 2011 in the Gulf of Gdańsk, Puck Bay, Vistula River Mouth, Dziwna River Mouth and Świna River Mouth. Trawling in Poland is strictly limited to the areas of river mounths (Vistula River - three stations, Dziwna River - one station, and Świna River - three stations). Each station is fished twice (minimum 24 hours between hauls). The German bottom trawl survey covers a wider sea area from the near shore up to the offshore on the Oder Bank. Depending on the environmental conditions, 10 to 35 stations are covered per year. In Estonia, six fixed trawl transects are situated three to eight km from shore (water depth five to nine m) to cover the entire length of the Pärnu Bay.

In Germany, for the *Nordic coastal multi-mesh gillnets type German*, *monofilament gillnets and trammel nets* one visit per station was carried out eight to ten times per year, throughout the year, until 2016. From 2017 onwards, one visit per station is carried out quarterly.

Fishing techniques and exposure time in fisheries independent surveys

All gillnet gears are set lightly stretched from an anchored buoy to keep them at a fixed position during the fishing period. The direction of the gear should be constant when fishing in shallow water. Before the fishing is started, each station must be carefully documented with regard to the type of bottom substate and position (longitude, latitude). The gear should be checked for damage each time it is used. Occasional broken meshes are tolerated. In Germany, the nets are set during the mid day (10–11 am) and lifted 24 hours later. In other areas, all gillnet gears are set in the afternoon/evening and lifted in the morning the following day. Within each area the times for setting and lifting should vary as little as possible between fishing efforts. The time when the gears are set and collected can differ between monitoring occasions carried out during spring, summer and autumn due to the differences in day-length.

Fyke nets must be checked on land prior to fishing for damage and to ensure correct function. Ooccasional broken meshes are not tolerated. *The fyke nets* are set tightly stretched at right angles to the shore. Stones with buoys are attached with short lines to the inner leader and the outer crib. In Estonia, the fyke nets are emptied daily. In Sweden, the fyke nets are emptied daily between 7 and 10 A.M. and replaced immediately after being emptied. In Germany, the standard fishing time for the *enclosure fyke net fishing system* is 48 hours (Ubl & Dorow 2015).

Bottom trawl Trawling is conducted during day time. In Germany, a standard haul is 30 minutes for the eel and standard bottom trawl and 20 minutes for the shrimp trawl. In Poland, a haul is minimum 10 minutes depending on the local circumstances and abundance of fish caught.

Fishing period in fisheries independent surveys

All gillnet gears Fishing targeting the warmer season assemblages is done during the period from mid July to mid/end of August, within a 14-day period. Areas to be compared should be fished within as short time period as possible. In Estonia some areas (Kihnu, Vilsandi, Kõiguste) are fished during the first half of July and the area Pärnu is fished during the spring (May–June) and autumn (October–November). Fishing targeting the colder season assemblages is done during October, March or April. In Germany, until 2016 fishing was carried out in eight to ten surveys over the year. From 2017 onwards, one visit per station is carried out quarterly.

With the ***fyke nets***, fishing targeting the warmer season asseblages is done during a period from mid-July to August and fishing targeting the colder season assemblages is done during the period mid October to mid November, within a 14-day period for each area. Areas to be compared should be fished with as short time difference as possible. In Germany, ***fishing with the enclosure fyke net system*** is conducted from May to October at water temperatures above 10 °C. The 10 °C threshold has been chosen as the eel activity is decreasing at temperatures below 10°C (see Ubl & Dorow 2015).

Bottom trawl In Poland, bottom trawl sampling season is July 25th – August 31th. In Oder Bank, Germany, bottom trawling was conducted during September until 2016. In Estonia, bottom trawling is conducted in spring (April-June), summer (July-September) and autumn (October–December).

Fisheries dependent methods – commercial catches

For Finland, the commercial catch data is obtained from the the Official Fisheries Statistics of Finland (Natural Resources Institute Finland). The catch (biomass in kg) by species and gear, as well as efforts (number of nets and fishing nights) and fishing areas as ICES statistical rectangles (55 x 55 km grids) are via a logbook reported to national or regional fisheries administration. Since Finland lacks fisheries independent monitoring of coastal fish in many areas along the coastline, alternative CPUE data based on commercial gillnet fishing (36–60 mm bar length) are used as indices of the abundance of the target species. The method is most suitable for e.g. perch, pikeperch (*Sander lucioperca*), whitefish, but less useful for non-target fish species since they may be incompletely reported. Recently commercial exploitation of cyprinids (common bream (*Abramis brama*) and roach) has started in the coastal waters of Finland, which will enhance the use of CPUEs as abundance indices for these species as well.

Citizen science based monitoring – Recreational fishermen survey

This type of data collection is currently unique to Denmark. Recreational fishermen are contracted on a voluntary basis to carry out monitoring of coastal fish. The "Key-fishermen project" was initiated in 2002 with fyke nets and 2005 with gillnets. It is currently covering 18 areas along the Danish coast (Støttrup et al. 2012; Kristensen et al. 2014, Støttrup et al. 2017; Støttrup et al. 2018).

The gears utilised are ***gillnet*** (monofilament, mesh size: 65 mm, mesh depth: 8.5 kn, knot length: 2400 kn, floatline nr. 1.25, sinkline nr 1.5, mounted length: 39 m) and ***paired fyke net*** (80/7 with 8 m net between the two traps). Fishing with both gear types is conducted at fixed positions. The gears are set in the afternoon and lifted the following morning. Exposure time and effort are always registered.

In each area, up to nine stations are fished, and for each gear, the total catch is registered by species, numbers per species and length distribution. At each station, up to three samples are collected monthly from around April to November, in the beginning of each month. A temperature logger is attached to either the gillnet or the fyke net or permenantly fixed to a buoy anchored at the position.

Sample handling and analysis in Baltic Sea coastal fish monitoring

Environmental parameters are measured directly in connection to the fish monitoring. All fish are determined to species and their length and weight are measured directly in connection to the fish monitoring (Annex 4).

The raw data are used for calculating CPUE, which is used as the basic unit in the data analysis and indicator-based assessments. To support the indicator-based assessment, the CPUE is calculated separately for the groups of piscivores, the cyprinids/mesopredators and for the key species, which is either perch, cod or flounder depending on the area (HELCOM 2018abc).

For fishery independent methods, CPUE values are calculated as the number of fish per net and fishing night, separately for each station and species. In most cases, the number of nets and fishing nights is one and the CPUE is identical to the cath per station in the fishery. In order to only include species and size groups suited for quantitative sampling by method, individuals smaller than 12 cm (Nordic Coastal multimesh nets) or 14 cm (other net types) are excluded. Fyke net catch is expressed as catch per a pair of fyke nets for the Swedish data, and catch per one fyke net for the Estonian data. In the German enclosure fyke net approach, the catch is expressed as numbers per hectar. For the Russian trawling data, for each station, the CPUE is calculated for the catch, species composition, length, weigth, age, sex, and gonad maturity are recorded. The main final paramenter for assessment are fish community composition, stock number and biomass, year-class strength and recruitment.

For the Finnish commercial catch data, CPUE values are calculated as biomass of fish (kg) per gillnet and fishing day, separately for each fishing area for the whole fishing season.

For the Danish citizen science data, CPUE values are calculated as number of individuals of the species used in the indicator caught per gear (gillnet or a paired fyke net), and standardised to a twelve-hour (gillnet) or 24-hour (fyke net) fishing period. Only data from August and fish >14 cm were included in the analyses.

References

Dorow M, Schulz S, Frankowski J and Ubl C. In press. Using a telemetry study to assess the boundary net efficiency of enclosure system utilized for yellow eel density monitoring. Fisheries Management and Ecology.

Frankowski J. 2015. Umsetzung der Aalmanagementpläne in den Aaleinzugsgebieten Mecklenburg-Vorpommerns 2012-2015. Final report, 22 pages. In German.

Kristensen LD, Støttrup JG, Andersen SK and Degel H. 2014. Registrering af fangster i de danske kystområder med standardredskaber. Nøglefiskerrapport 2011-2013. DTU Aqua-rapport nr. 286-2014. Institut for Akvatiske Ressourcer, Danmarks Tekniske Universitet. In Danish with English summary.

Reckordt M, Ubl C, Dorow M and Möller P. 2012. Charakterisierung der bodennah lebenden Fischartengemeinschaft in den Küstengewässern von MV. Fischerei & Fischmarkt in Mecklenburg-Vorpommern 12(2): 26–34. In German.

Støttrup JG., Andersen SK., Kokkalis A., Christoffersen M., Olsen J., Pedersen EM. 2017. Registrering af fangster i de danske kystområder med standardredskaber. Nøglefiskerrapport 2014–2016. DTU Aqua-rapport nr. 320-2017. Institut for Akvatiske Ressourcer, Danmarks Tekniske Universitet. In Danish with English summary.

Støttrup JG, Kokkalis A, Brown EJ, Olsen J, Kærulf Andersen S, Pedersen EM. 2018. Harvesting geo-spatial data on coastal fish assemblages through coordinated citizen science. Fisheries Research, 208: 86–96.

Støttrup JG, Sparrevohn CR, Nicolajsen H, Kristensen L. 2012. Registrering af fangster i de danske kystområder med standardredskaber. Nøglefiskerrapporten for årene 2008-2010. DTU Aqua-rapport nr. 252-2012. Charlottenlund. Institut for Akvatiske Ressourcer, Danmarks Tekniske Universitet. In Danish with English summary.

Rothe U, Möller P and Dorow M. 2016. Ausbreitung der Schwarzmundgrundel (*Neogobius melanostomus*) in den Küstengewässern Vorpommerns. Fischer & Teichwirt 67: 173–175. In German.

Ubl C and Dorow M. 2015. A novel enclosure approach to assessing the yellow eel (*Anguilla anguilla*) density in non-tidal coastal waters. Fisheries Research 161: 57–63.

Annex 4

Parameters measured in Baltic Sea coastal fish monitoring

Table. Parameters measured during fishing. X = the parameter is measured in a currently ongoing monitoring program

MONITORING TYPE		Fisheries independent										Fisheries dependent	Citizen science	
GEAR TYPE		Gillnet							Fyke net			Gillnet	Gillnet	Fyke net
COUNTRY		Estonia	Finland	Germany	Latvia	Lithuania	Poland	Sweden	Estonia	Germany	Sweden	Finland	Denmark	Denmark
STATION parameters	Latitude and longitude	X	X	X	X	X	X	X	X	X	X	X	X	X
	Water depth	X	X	X	X	X	X	X	X	X	X		X	X
	Bottom type			X			X	X			X			
AMBIENT DATA parameters	Water depth	X	X	X	X	X	X	X	X	X	X	X****	X	
	Water temperature, surface	X	X	X	X	X	X	X	X	X	X	X****	X	
	Water temperature, bottom	X	X	X	X		X	X		X	X			X
	Wind direction	X	X	X	X	X	X	X	X	X	X		X	
	Wind velocity	X	X	X	X	X	X	X	X	X	X		X	
	Salinity		X	X	X	X	X	X		X	X	X****		
	Visibility (Secchi depth)	X	X	X			X	X	X	X	X	X****	X	
	Oxygen concentration			X	X							X****		
CATCH parameters	Species	X	X	X	X	X	X	X	X	X	X	X	X	X
	Length, 1 mm	X			X	X	X*		X*			X*	X*	
	Length, 5 mm						X*							
	Length, 1 cm		X	X			X	X		X	X			X
	Length, 2.5 cm		X**						X**		x**			
	Weight	X	X	X	X	X	X	X	X*	X	X	X	X*	
	Disease, external signs	X	X	X*	X		X	X	X	X	X		X	
	Stomach content	X*		X*			X***		X*				X*	
	Sex	X*	X*	X*		X*	X	X*	X*			X*	X*	

* Certain species only
** Until 2001 in Finland and Åland, until 2000 in Sweden
*** Stomach filling level (0–4 = empty–full)
**** Ambient data is not collected during commercial fishing, but derived from the Finnish Meteorological Institute and Finnish Environment Institute (SYKE)