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Background

HELCOM monitoring guidelines for coastal fish monitoring were last updated in 2015 (Guidelines for COASTAL FISH monitoring sampling methods of HELCOM).

The need to update and harmonize the HELCOM monitoring guidelines stems back from the second meeting of State and Conservation in 2015. That meeting discussed the review of the HELCOM COMBINE manual and the need to develop new monitoring guidelines and update existing ones. STATE & CONSERVATION 3-2015 agreed on using a new template for HELCOM monitoring guidelines for the harmonization of contents of all the different HELCOM monitoring guidelines.

FISH-PRO II 3-2016 agreed to use the new template when updating the monitoring guidelines for coastal fish in 2018.

The FISH-PRO II 5-2018 Meeting agreed that Sweden will lead the activity of updating the guideline and presenting the final draft at FISH-PRO III 1-2019. That meeting also agreed that the updated guideline would be published in 2019, after approval by STATE & CONSERVATION 10-2019.

During 2018, Sweden has led the activity of updating the guideline and produced the final draft for the FISH-PRO III 1-2019 February, annexed to this document.

Action requested

The Meeting is invited to review the draft guideline and agree on further tasks for the update work, with the view of sending the updated guidelines for approval to STATE & CONSERVATION 10-2019, and with the goal to publish the guideline during spring 2019.

Guidelines for coastal fish monitoring

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, except for Russia, 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 tables. 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). 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 areas 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 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 is considered to be indicative of coastal eutrophication in the Baltic Sea, whereas the abundance of piscivores is considered to reflect fishing pressure (Bergström et al. 2016ab, Bergström et al. In press, HELCOM 2018c).

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 be readily obtained from fisheries independent surveys. 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 area (Thoresson 1996; Neuman et al. 1999). Monitoring is generally performed using passive gears, such as gillnets, fyke nets or trap 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.

If fisheries independent data is not available, data for assessment of coastal fish may be obtained from fisheries dependent sources. 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, catches per unit of effort (CPUE) are 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 were the effort is moderately stable over the sampled years and areas. Data can also be collected from other surveys, such as the recreational fisheries 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 measure catch per unit of effort 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 sampled equally representatively (HELCOM 2012). For example, those gillnet surveys taking place in August sample predominantely 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 cernuus*). Respectively, gillned surveys later in autumn sample 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, the passive gears 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 them.

2.2 Time and area

The fisheries independent surveys are mainly carried out during late summer, but some surveys are carried out during spring and autumn, or even year round. Fisheries independent data series are currently limited in Finland and Germany, and lacking in Denmark. The Finnish data is therefore also derived from commercial catches, which cover a whole calendar year. The German information and data is derived from dedicated project work in the Mecklenburg-Vorpommern area. The Danish data is derived from recreational fishermen surveys and is collected from April to November.

2.3 Monitoring procedure

2.3.1 Monitoring strategies

The Baltic Sea coastal fish monitoring uses both fisheries independent and fisheries dependent monitoring strategies. The Baltic Sea coastal fish monitoring programs are summarized in Table 1.

Table 1. Overview the coastal fish monitoring in the Baltic Sea. Given is the country, station/area of monitoring, time period (years when the monitoring was conducted), type of monitoring (fisheries independent, commercial catches or recreational fishermen survey), time of monitoring (months 1–12 / year around) and type of gear used. Nordic = Nordic coastal multi-mesh gillnet

COUNTRY	STATION/AREA	TIME PERIOD	TYPE OF MONITORING	MONTH	GEAR
Denmark	Bornholm	2010–Present	Recreational fishermen survey	4–11	Gillnet (65 mm mesh size), single fyke net
Denmark	Great Belt	2005–Present	Recreational fishermen survey	4–11	Gillnet (65 mm mesh size), single fyke net
Denmark	Isefjord and Roskilde fjord	2005–Present	Recreational fishermen survey	4–11	Gillnet (65 mm mesh size), single fyke net
Denmark	Limfjord	2005–Present	Recreational fishermen survey	4–11	Gillnet (65 mm mesh size), single fyke net
Denmark	Lolland-Falster	2006–Present	Recreational fishermen survey	4–11	Gillnet (65 mm mesh size), single fyke net
Denmark	Northern Kattegat coast	2008–Present	Recreational fishermen survey	4–11	Gillnet (65 mm mesh size), single fyke net
Denmark	Odense Fjord	2005–Present	Recreational fishermen survey	4–11	Gillnet (65 mm mesh size), single fyke net
Denmark	Præstø Fjord	2005–Present	Recreational fishermen survey	4–11	Gillnet (65 mm mesh size), single fyke net
Denmark	Sejerø Bay	2006–Present	Recreational fishermen survey	4–11	Gillnet (65 mm mesh size), single fyke net
Denmark	Sound	2005–Present	Recreational fishermen survey	4–11	Gillnet (65 mm mesh size), single fyke net
Denmark	West and south of Funen	2005–Present	Recreational fishermen survey	4–11	Gillnet (65 mm mesh size), single fyke net
Denmark	Western Kattegat fjords	2005–Present	Recreational fishermen survey	4–11	Gillnet (65 mm mesh size), single fyke net
Denmark	Århus Bay	2005–Present	Recreational fishermen survey	4–11	Gillnet (65 mm mesh size), single fyke net
Estonia	Hiiuma	1991–Present	Fisheries independent	7–8	Net series Summer
Estonia	Kihnu Island	1997–Present	Fisheries independent	7	Net series Summer, single fyke net
Estonia	Kõiguste	2005–Present	Fisheries independent	7	Net series Summer, single fyke net
Estonia	Küdema	1992–97, 2000–Present	Fisheries independent	10–11	Net series Autumn
Estonia	Käsmu	1997–Present	Fisheries independent	8	Net series Summer, single fyke net
Estonia	Matsalu	1993–Present	Fisheries independent	7	Net series Summer, single fyke net
Estonia	Pärnu Bay	2009–Present	Fisheries independent	4–12	Bottom trawl
Estonia	Pärnu Bay	2005–Present	Fisheries independent	10	Gillnet (16–60 mm mesh size)
Estonia	Pärnu Bay	2001–Present	Fisheries independent	5–6	Gillnet (16–60 mm mesh size)
Estonia	Vaindloo	1997–Present	Fisheries independent	8	Net series Summer
Estonia	Vilsandi	1993–Present	Fisheries independent	7	Net series Summer, single fyke net
Finland	Coast of Finland	1980–Present	Commercial CPUE	Year around	Gillnet (36–60 mm mesh size)
Finland	Brunskär	1991–Present	Fisheries independent	7–8	Coastal survey net, Nordic
Finland	Finbo, Åland Islands	1991–Present	Fisheries independent	8	Coastal survey net, Nordic
Finland	Haapaasaret	2003–2006	Fisheries independent	8	Nordic
Finland	Helsinki	2005–Present	Fisheries independent	8	Nordic

COUNTRY	STATION/AREA	TIME PERIOD	TYPE OF MONITORING	MONTH	GEAR
Finland	Kaitvesi	2005–2011	Fisheries independent	8	Nordic
Finland	Kumlinge, Åland Islands	2003–Present	Fisheries independent	8	Nordic
Finland	Lumparn, Åland Islands	1999–Present	Fisheries independent	10	Net series Autumn, Nordic
Finland	Tvärminne	2005–Present	Fisheries independent	8	Nordic
Germany	Börgerende	2003–Present	Fisheries independent	Year around	Gillnet (55 & 60 mm mesh size), Nordic type German, Trammel net
Germany	Darß-Zingst Bodden chain	2008–Present	Fisheries independent	5–10	Fyke net enclosure system
Germany	East of Usedom Peninsula	2008–Present	Fisheries independent	5–10	Fyke net enclosure system
Germany	Greifswalder Bodden	2008–Present	Fisheries independent	5–10	Fyke net enclosure system
Germany	North of Kühlungsborn city	2008–Present	Fisheries independent	5–10	Fyke net enclosure system
Germany	Northeast of Ruegen Island	2008–Present	Fisheries independent	5–10	Fyke net enclosure system
Germany	Peene river / Achterwasser	2008–Present	Fisheries independent	5–10	Fyke net enclosure system
Germany	Stettin Lagoon	2008–Present	Fisheries independent	5–10	Fyke net enclosure system
Germany	Strelasund	2008–Present	Fisheries independent	5–10	Fyke net enclosure system
Germany	Usedom Island / Oder bank	1992–2016	Fisheries independent	9	Bottom trawl
Germany	Wismar Bight and Salzhaff	2008–Present	Fisheries independent	5–10	Fyke net enclosure system
Latvia	Daugavgriva	1995–Present	Fisheries independent	8	Net series Summer, Nordic
Latvia	Jūrkalne	1999–Present	Fisheries independent	8	Net series Summer, Nordic
Latvia	Liepaja	2005–Present	Fisheries independent	Year around	Net series Summer, Nordic
Latvia	Plienciems	2005–Present	Fisheries independent	Year around	Net series Summer, Nordic
Latvia	Salacgiva	2005–Present	Fisheries independent	Year around	Net series Summer, Nordic
Lithuania	Atmata	1993–Present	Fisheries independent	7	Net series Summer
Lithuania	Butinge	2000–Present	Fisheries independent	7	Net series Summer
Lithuania	Dreverna	1993–Present	Fisheries independent	8	Net series Summer
Lithuania	Monciskes	1993–Present	Fisheries independent	8	Net series Summer
Poland	Dziwna River mouth	2011, 2018	Fisheries independent	7–8	Bottom trawl
Poland	Kamieński Lagoon	2011, 2018	Fisheries independent	7–8	Polish coastal survey net
Poland	Polish coastal area	2011, 2015	Fisheries independent	7–8	Polish coastal survey net
Poland	Puck Bay	2011, 2013, 2018	Fisheries independent	7–9	Polish coastal survey net, Nordic, Bottom trawl, Polish coastal multi-mesh gillnet
Poland	Puck Lagoon	2011, 2013–2018	Fisheries independent	7–9	Polish coastal survey net, Polish coastal multi-mesh gillnet
Poland	Słupsk Bank	2011	Fisheries independent	7–8	Polish coastal survey net
Poland	Świna River mouth	2011, 2018	Fisheries independent	7–8	Bottom trawl
Poland	Szczecin Lagoon	2011, 2014, 2015, 2018	Fisheries independent	7–9	Nordic, Polish coastal multi-mesh gillnet
Poland	Vistula Lagoon	2011, 2014–2018	Fisheries independent	7–9	Nordic, Polish coastal multi-mesh net
Poland	Vistula River mouth	2011, 2014–2015, 2018	Fisheries independent	7–8	Bottom trawl
Sweden	Askviken	2009–2016	Fisheries independent	8	Nordic
Sweden	Asköfjärden	2005–Present	Fisheries independent	8	Nordic

COUNTRY	STATION/AREA	TIME PERIOD	TYPE OF MONITORING	MONTH	GEAR
Sweden	Barsebäck	1999–Present	Fisheries independent	4, 8	Fyke net
Sweden	Forsmark	1987–Present	Fisheries independent	8	Coastal survey net, Nordic
Sweden	Galtfjärden	1995–Present	Fisheries independent	10	Net series Autumn, Nordic
Sweden	Gaviksfjärden	2004–Present	Fisheries independent	8	Nordic
Sweden	Gävlebukten	2011–Present	Fisheries independent	10–11	Nordic
Sweden	Hanöbukten	2012–Present	Fisheries independent	8	Nordic
Sweden	Holmön	1989–Present	Fisheries independent	8	Coastal survey net, Nordic
Sweden	Kinnbäcksfjärden	2004–Present	Fisheries independent	8	Nordic
Sweden	Kullen, Skälderviken	2002–Present	Fisheries independent	4, 8	Single fyke net
Sweden	Kvädöfjärden	1987–Present	Fisheries independent	8, 10	Net series Summer & Autumn, Nordic
Sweden	Lagnö	2002–Present	Fisheries independent	8	Nordic
Sweden	Långvindsfjärden	2002–Present	Fisheries independent	8	Nordic
Sweden	Lännåkersviken	2009–2016	Fisheries independent	8	Nordic
Sweden	Muskö	1992–Present	Fisheries independent	10	Net series Autumn
Sweden	Mönsterås	1995–Present	Fisheries independent	8	Net series Summer
Sweden	Norrbyn	2002–Present	Fisheries independent	8	Nordic
Sweden	Råneå	2002–Present	Fisheries independent	8	Nordic
Sweden	Torhamn	2002–Present	Fisheries independent	8	Nordic
Sweden	Vallviksfjärden	2010–Present	Fisheries independent	10–11	Nordic
Sweden	Vendelsö	1976–Present	Fisheries independent	4, 8	Single fyke net
Sweden	Vinö	1995–Present	Fisheries independent	8	Net series Summer

2.3.2 Sampling methods and equipments

2.3.2.1 Fisheries independent methods

Several different gears are, or have been, used in the gathering of fisheries independent data for the coastal fish monitoring in the Baltic Sea area. For new monitoring, the Nordic coastal multi-mesh gillnet is the recommended gillnet gear. See Table 1 for an overview of the gears used.

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 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, Latvia, Lithuania and Sweden. 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 of two types are used in Estonia, Germany and Sweden. The ***single fyke net*** 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 Germany consists of boundary nets, leaders nets 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 designed for eel monitoring (Ubl & Dorow 2015, Dorow et al. in press).

Bottom trawls are used in Estonia, Germany and Poland. 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 evertebrates. 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.

Trammel nets are used in Germany. The two-panel trammel net is 50 m lomg with a heigt 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 used in fish monitoring in Finland and Sweden. The gear consists of 3 m (10 feet) deep gillnets. The height in the water is about 2.5 m and the length is 35 m. The lower net-rope (main line) is 10 % longer than the upper net-rope (=38.5 m). The gillnets are made up 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 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 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 and Estonia, the smallest geographical unit is a *station* at which two fyke nets, joined leader to crib, are placed. 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, at least 80 fyke 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 of 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 single 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, several single fyke nets are joined leader to leader and crib to crib. In Estonia, the fyke nets are emptied daily. In Sweden, the fyke nets are placed in pairs with leader to a crib. 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 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 ***single 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 was 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/May) and autumn (September–December).

Catch handling and registration in fisheries independent surveys

Environmental parameters are measured directly in connection to the fishing (table 3). All fish are determined to species and their length and weight are measured directly in connection to the fishing (Table 3).

Table 3. Parameters measured during fishing with gillnet gears (Nordic coastal multimesh gillnets, coastal survey nets, nat series summer& Autumn) and fyke nets. X = the parameter is measured in currently ongoing monitoring program

PARAMETER		GILLNET GEARS							FYKE NETS		
		Estonia	Finland	Germany	Latvia	Lithuania	Poland	Sweden	Estonia	Germany	Sweden
Station	Latitude and longitude	X	X	X	X	X	X	X	X	X	X
	Water depth	X	X	X	X	X	X	X	X	X	X
	Bottom type			X			X	X			X
	Disturbance						X	X		X	X
Ambient data	Water depth	X	X	X	X	X	X	X	X	X	X
	Water temperature, surface	X	X	X	X	X	X	X	X	X	X
	Water temperature, bottom	X	X	X	X		X	X		X	X
	Wind direction	X	X	X	X	X	X	X	X	X	X
	Wind velocity	X	X	X	X	X	X	X	X	X	X
	Salinity		X	X	X	X	X	X		X	X
	Visibility (Secchi depth)	X	X	X		X	X	X	X	X	X
	Oxygen concentration			X	X						
Catch	Species	X	X	X	X	X	X	X	X	X	X
	Length, 1 mm	X			X	X	X*		X*		
	Length, 5 mm						X*				
	Length, 1 cm		X	X			X	X		X	X
	Length, 2.5 cm		X**					X**			x**
	Weight	X	X	X	X	X	X	X	X*	X	X

	Diseases	X	X	X*	X	X	X	X	X	X	X
	Stomach content			X*			X***		X*		
	Sex			X*			X	X*	X*		

* Certain species only
** Until 2001 in Finland and Åland, until 2000 in Sweden
*** Stomach filling level (0–4 = empty–full)

2.3.2.2 Fisheries dependent methods

Recreational fishermen survey

This type of data collection is currently unique to Denmark. Recreational fishermen are contracted to carry out monitoring of coastal fish. The "Key-fishermen project" was initiated in 2005, and is currently covering 18 areas along the Danish coast. The Danish Recreational Fish Monitoring Programme is based on voluntary catch and registration by recreational fishermen (citizen science), based on catches at fixed stations along most of the Danish coastline (Støttrup et al. 2012; Kristensen et al. 2014, Støttrup et al. 2017; Støttrup et al. 2018).

The gears utilised are gillnets (monofilament, mesh size: 65 mm, mesh depth: 8.5 kn, knot 120 length: 2400 kn, floatline nr. 1.25, sinkline nr 1.5, mounted length: 39 m) or fyke nets (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.

Commercial catch data

For Finland, the commercial catch data is obtained from the the Official Fisheries Statistics of Finland (Natural Resources Institute Finland). The catch by species and gear, as well as efforts 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 data (catches per unit of effort) 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.

2.3.3 Sample handling and analysis

The raw data are used for calculating the catch per unit effort (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 and for the key species, which is either perch, cod or flounder depending on the area (HELCOM 2018abc).

For fishery independent methods, the catch per unit effort (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. In the German enclosure fyke net approach, the catch is expressed as numbers per hectar.

For fishery dependent methods, the catch per unit effort (CPUE) values are calculated for the ***commercial catch data*** as biomass of fish (kg) per gillnet and fishing day, separately for each fishing area for the whole fishing season. **For the recreational fisheries data**, the catch per unit effort (CPUE) values are calculated as number of individuals of the species used in the indicator caught per gear, and standardised to a twelve-hour fishing period. Only data from August and fish >14 cm were included in the analyses.

The indicators are calculated as the summed CPUE of all species included in the concerned indicator, and the results are presented as an average value for each year of all sampling stations in each area (HELCOM 2018abc). The core indicators currently used in status assessment are **Abundance of coastal fish key functional groups** (cyprinids and piscivores) and **Abundance of key coastal fish species** (perch, cod or flounder) (HELCOM 2018ab). For this purpose, the average CPUE values per each year and area are calculated for 1) All cyprinid species combined for the abundance of coastal fish key functional groups. 2) All piscivorous species combined for the abundance of coastal fish key functional groups. 3) Perch, cod or flounder depending on the area for the abundance of key coastal fish species.

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 lenght. 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 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 table 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 recreational fisheries 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 locations 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

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