Abundance of fish key functional groups

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Contents

Key message

In the majority of the areas assessed in the northern and western part of the Baltic, the abundance of key functional groups in coastal fish communities indicates a development towards a deteriorating environmental state during the last fifteen years. The abundance of cyprinids in the Bothnian Bay, Bothnian Sea, Archipelago Sea and Gulf of Finland has generally increased, concurrent with a decrease in the abundance of piscivores in Archipelago Sea, Gulf of Finland, northern Gulf of Riga and western Baltic Proper.

In three of the more northern areas in the Gulf of Bothnia and in the eastern Baltic Proper there has been a positive development or no change of the abundance of key functional groups during the last fifteen years.

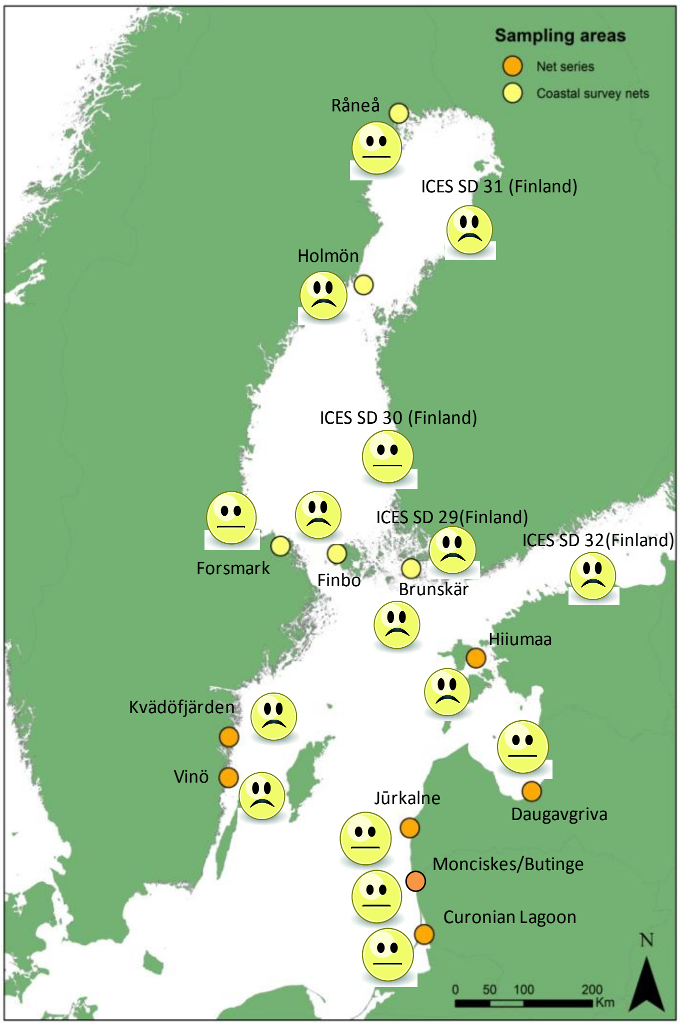

Figure 1. *Environmental status considering the combined abundances of cyprinids and piscivores in the HELCOM FISH PRO assessment areas between the period 1995-2011. A "happy smiley" denotes a development towards a favorable state, a "neutral smiley" no change, and a "sad smiley" a development towards a deteriorate state.*

Temporal development

Despite substantial interannual variation in many monitoring areas, there are divergent patterns across basins in the temporal development of the abundance of cyprinids. Generally, there has been an increase in cyprinids in the Gulf of Bothnia, whereas there has been no change or decreasing abundances in the Baltic Proper (Figure 2).

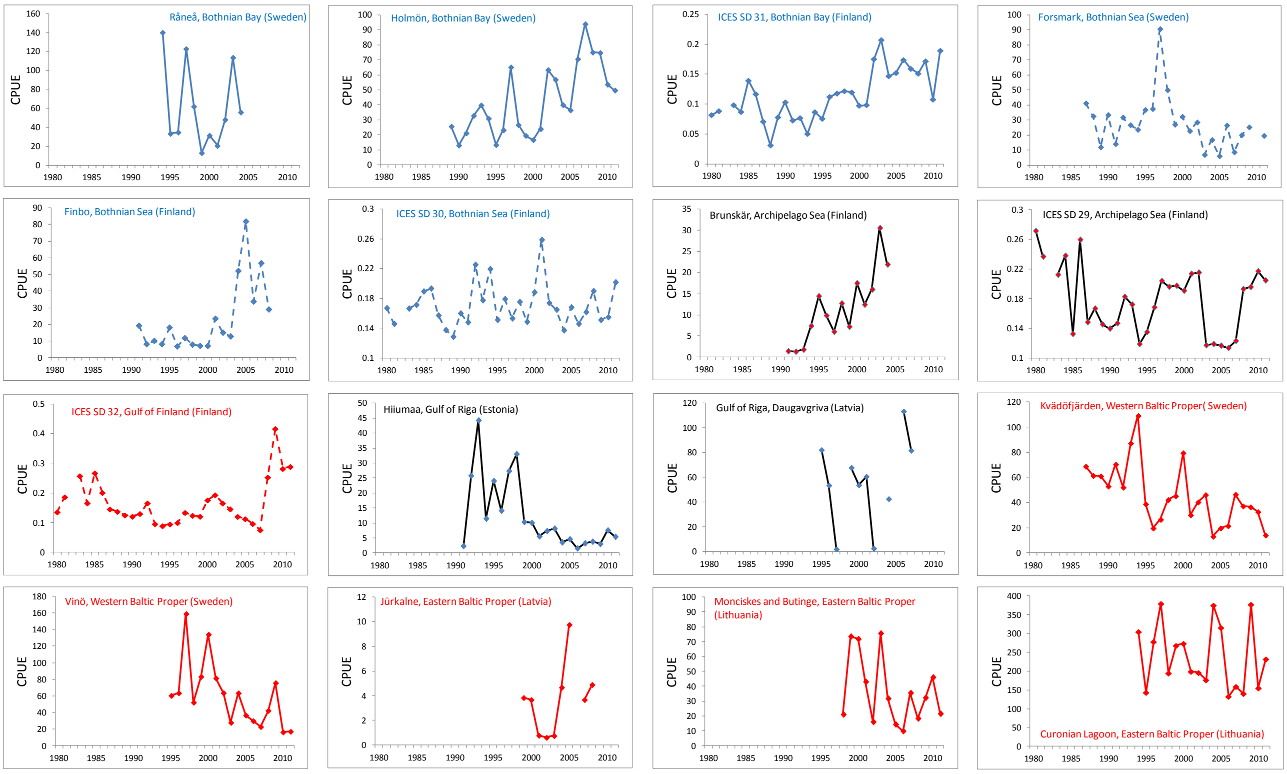

Figure 2. *The temporal development of the abundances of cyprinids in the HELCOM FISH PRO assessment areas. Bothnian Bay (blue solid line), Bothnian Sea (dotted blue line), Archipelago Sea (black solid line), Gulf of Finland (dotted red line), Gulf of Riga (dotted black line) and Baltic Proper (red line). For all areas except for ICES SD 29, 30, 31 and 32, CPUE denotes catch per unit effort (number of cyprinids per effort) from gillnet monitoring programs. For ICES SD 29-32 CPUE denotes catch per unit effort (kg per effort) of cyprinids (common bream and roach) from commercial gillnet fisheries.*

These patterns indicate a response to a rise in water temperatures and potentially also lowered salinity levels and increased nutrient levels in the Gulf of Bothnia (ICES, 2010; HELCOM, 2012; Olsson et al., 2012b). In the Baltic Proper, the level of eutrophication is comparably higher (HELCOM, 2009), and there has been a similar increase in water temperatures in the basin (Olsson et al, 2012b), concurrent with the decrease in cyprinids. Increased predation pressure from apex predators and piscivorous fish might though partly explain this pattern (Figure 3.

For the supporting metric, abundance of piscivores, there has been no change or an increase of the metric in the northern parts of the Baltic. In the Archipelago Sea, Gulf of Finland, northern Gulf of Riga and western Baltic Proper, however, sharp declines in the abundance of piscivores has occurred during recent years (Figure 3).

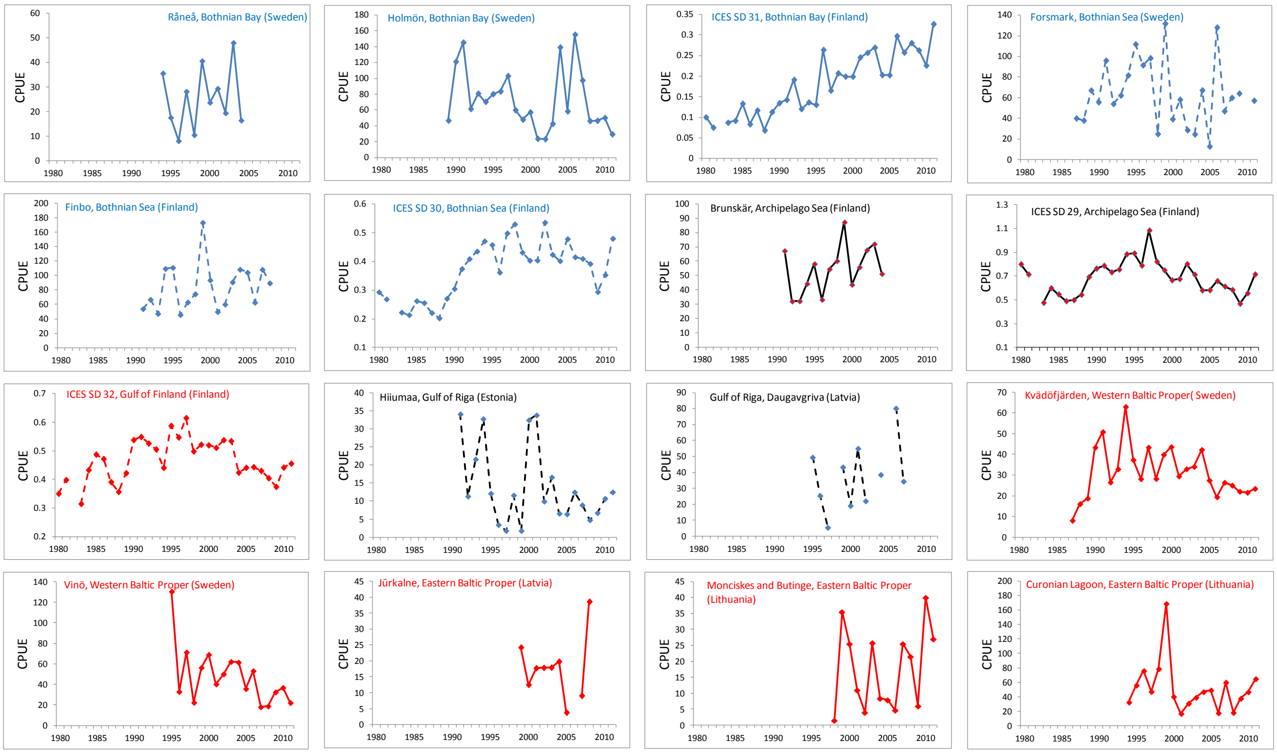

Figure 3. *The temporal development of the abundances of piscivores in the HELCOM FISH PRO assessment areas. Bothnian Bay (blue solid line), Bothnian Sea (dotted blue line), Archipelago Sea (black solid line), Gulf of Finland (dotted red line), Gulf of Riga (dotted black line) and Baltic Proper (red line). For all areas except for ICES SD 29, 30, 31 and 32, CPUE denotes catch per unit effort (number of piscivores per effort) from gillnet monitoring programs. For ICES SD 29-32 CPUE denotes catch per unit effort (kg per effort) of piscivores (perch, pikeperch and pike) from commercial gillnet fisheries.*

Variance in the Baltic Sea

Good environmental status was estimated on the basis of temporal trends of the time series data on the abundance of cyprinids in the assessment areas from 1995 and onwards. The assessment was supported by the abundance of piscivores during the very same time.

Considering the longest time-period available in the northern parts of the Gulf of Bothnia there has been no change in the abundance of cyprinids in Råneå (1994-2004) and an increase in Holmön (1989-2011, Figure 2). Along the Finnish coast of the Bothnian Bay, there has been an increase the abundance of roach and common bream in the commercial gillnet fishery since 1980. For the more southern parts of the basin, there has been a steady increase of cyprinid abundance in Finbo (1991-2008), whereas there has been no directional change in the abundance of cyprinids in Forsmark (1987-2011) and in catches from the commercial Finnish gillnet fishery in the Bothnian Sea (1980-2011, Figure 1).

In the Archipelago Sea there has been an increase in the abundance of cyprinids in Brunskär (1991-2004), but no change in the commercial Finnish gillnet fisheries in the Archipelago Sea and in the Gulf of Finland (1980-2011, Figure 2).

For the last fifteen years (1995-) where data is available for all areas, there has been no change (Råneå) or increase (Holmön and Finnish commercial gillnet fishery ICES SD 31) in the northern parts of the Gulf of Bothnia (Figure 2), and an increase in one of the southern areas (Finbo). In Forsmark, the last fifteen years has been characterized by a sharp decline in the abundance of cyprinids, caused by extraordinary high abundances in 1997 (Figure 2). In the commercial Finnish gillnet fishery in the Bothnian Sea the abundances has exhibited no directional change since 1995.

Since 1995, there has been an increase in the abundance of cyprinids in Brunskär, no change in the Finnish commercial gillnet fishery in the area (Archipelago Sea), but an increase in commercial gillnet fishery in the Gulf of Finland since 1995 (Figure 2).

The abundance of piscivores has exhibited no change in all areas except for Forsmark (increase), Archipelago Sea (commercial Finnish gillnet fishery, decrease) and Gulf of Finland (commercial Finnish gillnet fishery, decrease) during the last fifteen years (Figure 3).

In the Baltic Proper a somewhat different pattern is discernible (Figure 3). Considering the longest time-period available, there has been a decrease in two areas (Vinö [1995-2011] and Hiiumaa [1991-2011], Figure 3), whereas there has been no change in the abundance of cyprinids in the other five reference areas (Kvädöfjärden [1987-2011], Daugavgriva [1995-2007), Jūrkalne [1997-2008], Monciskes/Butinge [1998-2011] and Curonian Lagoon [1994-2011], Figure 2). In the two Latvian areas (Daugavgriva and Jūrkalne), however, the availability of data is limited due to lack of financial support for monitoring, and no sound assessment could hence be established. Worth noting is that the abundance of cyprinids are magnitudes higher in the Curonian Lagoon compared to the other areas assessed.

For the last fifteen years (1995-) where data to some extent is available for all areas, a similar pattern appears. A decrease in the abundance of cyprinids in one of the western areas (Vinö) and in the northern Gulf of Riga (Hiiumaa) area, and no change in the other areas (Figure 2).

With the exception of the two Swedish areas in the Baltic Proper (Vinö and Kvädöfjärden) and Hiiumaa (Estonia) in the Gulf of Riga, there has been no directional change in the abundance of piscivores in all areas during the last fifteen years (Figure 3). In Vinö, Kvädöfjärden and Hiiumaa, however, there has been a decrease in piscivores suggesting a general decrease in total fish production during recent years (Figure 3). As such the combined decrease in cyprinids and piscivores might signal a development towards a deteriorate state in these areas.

How the abuncance of key functional groups in coastal fish communities describe the environmental conditions in the Baltic Sea

Policy relevance

Coastal fish communities are of high socio-economical and ecological importance in Baltic Sea. Coastal fish is recognized as being important components of coastal food webs and ecosystems (reviewed in Eriksson et al., 2009), and despite that many of the species are not targeted by large-scale fisheries, they are important for the small-scale coastal fishery as well as for recreational fishing. Moreover many coastal fish species are rather local in their appearance (Saulamo and Neuman, 2005) and the temporal development of coastal fish communities might reflect the general environmental state in the monitoring area.

The abundance of cyprinids represents one metric of the CORE coastal fish indicator Abundance of fish key functional groups (HELCOM, 2012a). Other metrics representing this indicator could be the abundance of other functional groups as piscivores, and/or meso-predators, depending on the monitoring area. In this report we assess the development of the abundance of cyprinids in coastal fish communities in the Baltic, using the abundance of piscivores as a supporting metric. The functional group of cyprinids include carp fishes (family Cyprinidae), typically roach (Rutilus rutilus), bleak (Alburnus alburnus) and breams (Abramis sp.). The abundance of cyprinids is influenced by recruitment success and mortality rates, which in turn may be influenced by ecosystem changes and interactions within the coastal ecosystem. An increased abundance of carp fishes likely reflects eutrophication, a lowered salinity or increasing water temperatures in the area (Olsson et al., 2012), as well as piscivore decline (fish, mammals and birds; HELCOM, 2012b).

Piscivorous coastal fish such as perch (Perca fluviatilis), pikeperch (Sander lucioperca) and pike (Esox lucius) have important structuring roles in coastal ecosystems (Eriksson et al., 2009; 2011), and is highly valued species for both small-scale coastal fisheries and recreational fishing (Swedish Board of Fisheries, 2011). The abundance of piscivores is generally affected by the level of available resources, temperature, interactions within the coastal food web, fishing and predation by apex predators.

Changes in the long-term development of cyprinids and piscivores could hence reflect changes in the level of eutrophication, interactions in the coastal food web, the level of exploitation and natural predation, as well as effects of changes in water temperatures and salinity levels in coastal areas.

Factors impacting on coastal fish communities

The abundance of cyprinids in coastal fish communities is generally favored by eutrophication, increased water temperatures and low salinity levels (Härmä et al., 2008). Predation by apex predators (cormorant and seals) and other fish generally have a negative impact via top-down control on the abundance of cyprinids (Eriksson et al., 2009; Vetemaa et al., 2010). Other important factors regulating the abundance of cyprinids are the extent of available recruitment and juvenile habitat, and also the fishing pressure.

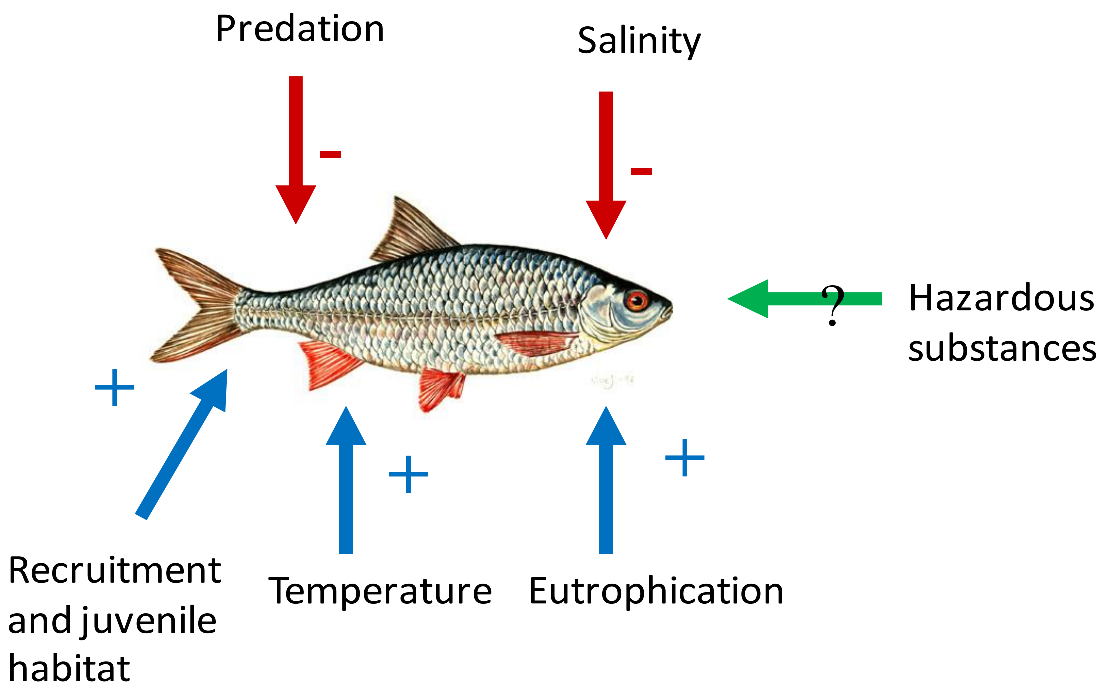

Figure 4. *A general and simplified framework of how pressures affect the abundance of cyprinids in coastal fish communities*.

Important factors regulating the abundance of piscivores are also multiple and includes climate, the level of production and predation by apex predators (Böhling et al. 1991; Linlokken et al., 2008; Olsson et al., 2012b). Also interactions within the coastal ecosystem and fishing pressure are important regulators for the abundance of piscivores in coastal fish communities (Eriksson et al., 2009; 2011). As for cyprinids, the extent of available recruitment and juvenile habitat is crucial for the development of the adult populations of piscivores (Sundblad et al., unpublished manuscript).

Technical data

Data source

Coastal fish monitoring using gill-nets is performed annually all over the Baltic Sea (Figure 5), coordinated within the HELCOM Fish PRO expert network. The network includes data from monitoring areas in Finland, Estonia, Latvia, Lithuania and Sweden. Coastal fish communities in the Baltic Sea areas of Russia, Poland, Germany and Denmark are to some extent monitored as well, but were not included in the present assessment. In Poland, fishery independent coastal fish monitoring was undertaken in 2011, but future funding of these programs are uncertain. In Germany, data are available from several monitoring sites along the German Western Baltic coast (Mecklenburg-Western Pomerania) since 2003 and 2008. In Denmark a coastal fish monitoring program was initiated in 2005. Data on gillnet catches from 2002 can, however, be extracted and put together with data from 2005 for some of the areas. For all these monitoring programs, the time-period monitored does not cover a sufficient number of years to be included in the current assessment report (Table 1). This is also true for many monitoring programs in Sweden and Finland. For several other monitoring programs, funding for an indicator based assessment of the status of the fish community is currently lacking (Estonia and Latvia), funding of future monitoring is uncertain (Poland) or the sampling program is at the moment inappropriate (i.e. some of the Lithuanian sites, see Table 1 for details). In future updates of this assessment, additional monitoring programs should be included providing that long-term funding is assured.

Responsible institutes for sampling are Finnish Game and Fisheries Research Institute (Finland), Estonian Marine Institute, University of Tartu (Estonia), BIOR Fish Resources Department (Latvia), Nature Research Center, Institute of Ecology (Lithuania), National Marine Fisheries Research Institute (Poland), Association Fish and Environment Mecklenburg-Vorpommern e.V. (Germany), Institute for Aquatic Resources, Institute for Aquatic Resources, DTU Aqua (Denmark), and Department of Aquatic Resources, SLU (Sweden). The funding for Latvian gill-net monitoring ceased in 2007, and no update of these time-series is therefore possible.

Data used for calculating coastal fish indicators should preferentially be fishery independent data such as gill-net or fyke net monitoring to allow comparisons across a Baltic wide scale. An alternative data source could be the data of catches and efforts of the commercial fishery, which nowadays is collected in all EU countries. The latter data sources should preferentially be used to enhance the spatial resolution of the regions assessed.

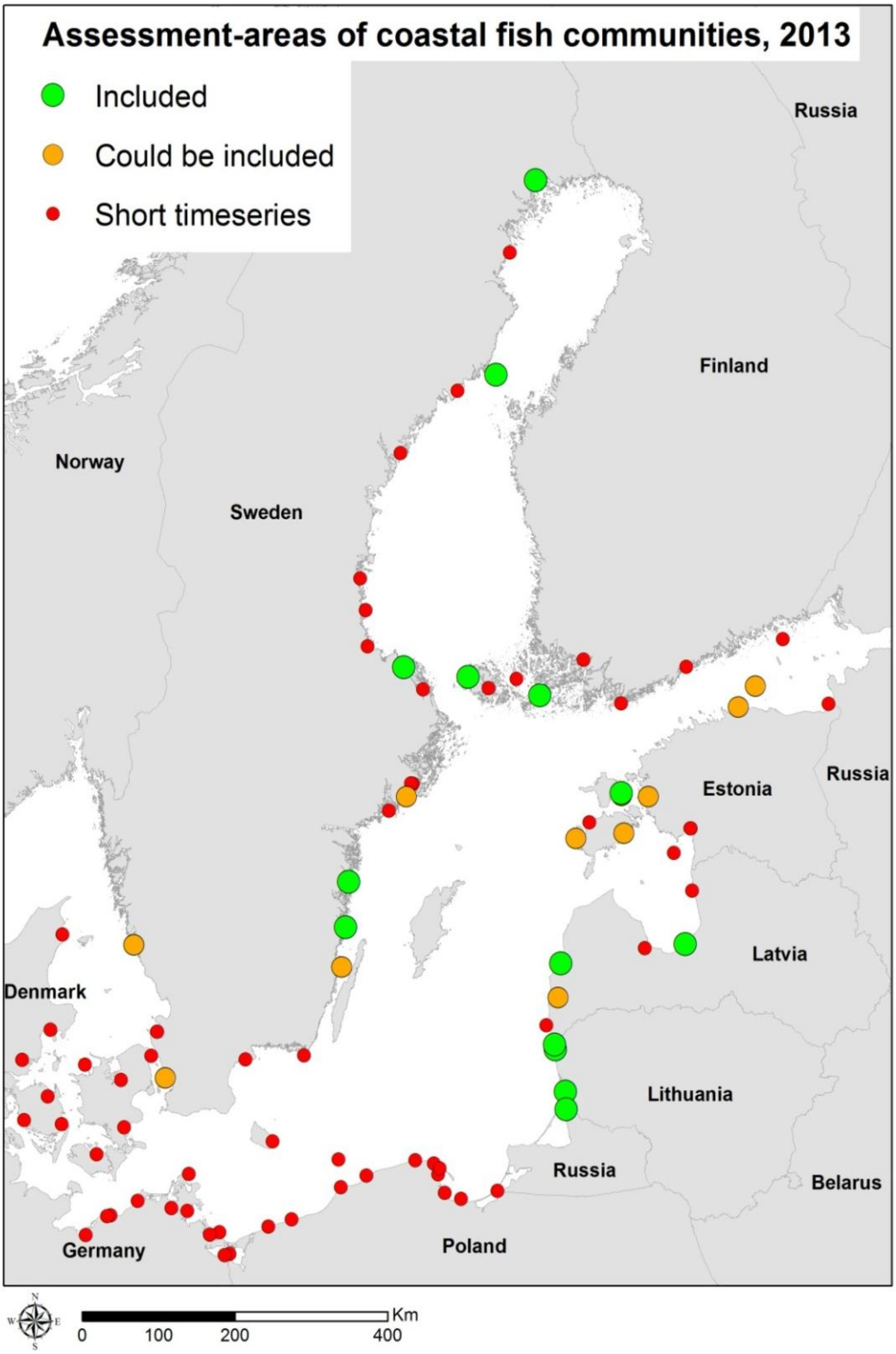

Figure 4. *Map of coastal fish monitoring programs in the Baltic Sea (HELCOM area) that is either included in the current assessment ("Included"), could be included in the current assessment ("Could be included") but are for various reason not included (see table 1 for reason), or are not included in the current assessment due to few years sampled ("Short time-series"). There are several additional monitoring programs/surveys for coastal fish in the Baltic, but they are currently not fulfilling the requirements to included in the current status assessments.*

Table 1. *Overview of coastal monitoring programs in the Baltic Sea. Information is given if the monitoring program is included in the current assessment or not, and an explanation for why the program is currently not included.*

Country	Station/Area	Start of data series	Included?	Could be included?	Comment
Estonia	Narva Bay	2007-	No	No	Short time-series, no funding
Estonia	Pärnu Bay	2009-	No	No	Short time-series, no funding
Estonia	Hiiuma	1991-	Yes	-	-
Estonia	Saarnaki	1992-	No	Yes	No funding
Estonia	Käsmu	1997-	No	Yes	No funding
Estonia	Vaindloo	1997-	No	Yes	No funding
Estonia	Kõiguste	2005-	No	No	Short time-series, no funding
Estonia	Kihnu Island	1997-	No	Yes	No funding
Estonia	Vilsandi	1993-	No	Yes	No funding
Estonia	Matsalu	1993-	No	Yes	No funding
Estonia	Pärnu Bay	2005-	No	No	Short time-series, no funding
Estonia	Pärnu Bay	2001-	No	No	Short time-series, no funding
Estonia	Küdema	1992-97, 2000-	No	No	Short time-series, no funding
Finland	Finbo	2002-	No	No	Short time-series
Finland	Finbo	1991-2008	Yes	No	No further monitoring
Finland	Brunskär	2002-	No	No	Short time-series
Finland	Brunskär	1991-2004	Yes	No	No further monitoring
Finland	Kumlinge	2003-	No	No	Short time-series
Finland	Hapaasaret	2003-2006	No	No	No further monitoring
Finland	Tvärminne	2005-	No	No	Short time-series
Finland	Helsinki	2005-	No	No	Short time-series
Finland	Kaitvesi	2005-	No	No	Short time-series
Finland	Kuivaniemi	1995-	No	No	Inapropriate sampling
Finland	Kalajoki	1979-	No	No	Inapropriate sampling
Finland	Helsinki	1995-	No	No	Inapropriate sampling
Finland	Ivarskärsfjärden	1999-2009	No	No	Inapropriate sampling
Finland	Lumparn	1999-	No	No	Inapropriate sampling
Finland	Lumparn	2010-	No	No	Short time-series
Germany	Börgerende	2003-	No	No	Short time-series
Germany	Wismar Bight and Salzhaff	2008-	No	No	Short time-series
Germany	North of Kühlungsborn city	2008-	No	No	Short time-series
Germany	Northeast of Ruegen Island	2008-	No	No	Short time-series
Germany	East of Usedom Peninsula	2008-	No	No	Short time-series
Germany	Darß-Zingst Bodden chain	2008-	No	No	Short time-series
Germany	Strelasund	2008-	No	No	Short time-series
Germany	Greifswalder Bodden	2008-	No	No	Short time-series
Germany	Peene river / Achterwasser	2008-	No	No	Short time-series
Germany	Stettin Lagoon (German part)	2008-	No	No	Short time-series

Country	Station/Area	Start of data series	Included?	Could be included?	Comment
Latvia	Daugavgr_va	1995-	Yes	-	Update not possible due to lack of funding
Latvia	J_rkalne	1999-	Yes	-	Update not possible due to lack of funding
Latvia	Salacgr_va	2005-	No	No	Short time-series
Latvia	Plie_ciems	2005-	No	No	Short time-series
Latvia	Liep_ja	2005-	No	No	Short time-series
Lithuania	Nemirseta	2009 / 2012 (every 3 years)	No	No	Inapropriate sampling
Lithuania	Uosto vartai	2009 / 2012 (every 3 years)	No	No	Inapropriate sampling
Lithuania	Ties Karkle	2009 / 2012 (every 3 years)	No	No	Inapropriate sampling
Lithuania	Monciskes	1993-	Yes	-	-
Lithuania	Butinge	2000-	Yes	-	-
Lithuania	Klaipedos sasiauris (Curonian lagoon)	2009 / 2012 (every 3 years)	No	No	Inapropriate sampling
Lithuania	Juodkrante (Curonian lagoon)	2009 / 2012 (every 3 years)	No	No	Inapropriate sampling
Lithuania	Nida (Curonian lagoon)	2009 / 2012 (every 3 years)	No	No	Inapropriate sampling
Lithuania	Pasienis (Curonian lagoon)	2009 / 2012 (every 3 years)	No	No	Inapropriate sampling
Lithuania	Dreverna (Curonian lagoon)	1993-	Yes	-	-
Lithuania	Atmata (Curonian lagoon)	1993-	Yes	-	-
Poland	Polish coastal area (open coast)	2011	No	No	Short time-series, no funding
Poland	Odra Lagoon	2011	No	No	Short time-series, no funding
Poland	Vistula Lagoon	2011	No	No	Short time-series, no funding
Poland	Puck Bay/extern	2011	No	No	Short time-series, no funding
Poland	Puck Bay/inner	2011	No	No	Short time-series, no funding
Poland	Vistula mouth	2011	No	No	Short time-series, no funding
Poland	Gulf of Gdańsk/coastal part	2011	No	No	Short time-series, no funding
Poland	Pomeranian Bay	2011	No	No	Short time-series, no funding
Poland	Słupsk Bank	2011	No	No	Short time-series, no funding
Sweden	Fjällbacka	1989-	No	No	Inapropriate sampling
Sweden	Råneå	2002-	No	No	Short time-series
Sweden	Råneå	1991-2006	Yes	-	-
Sweden	Kinnbäcksfjärden	2004-	No	No	Short time-series
Sweden	Holmön	2002-	No	No	Short time-series
Sweden	Holmön	1989-	Yes	-	-
Sweden	Norrbyn	2002-	No	No	Short time-series
Sweden	Gaviksfjärden	2004-	No	No	Short time-series
Sweden	Långvind	2002-	No	No	Short time-series
Sweden	Forsmark	2002-	No	No	Short time-series
Sweden	Forsmark	1989-	Yes	-	No long-term funding
Sweden	Lagnö	2002-	No	No	Short time-series
Sweden	Asköfjärden	2004-	No	No	Short time-series
Sweden	Kvädöfjärden	2001-	No	No	Short time-series
Sweden	Kvädöfjärden	1989-	Yes	-	-
Sweden	Vinö	1995-	Yes	-	-
Sweden	Torhamn	2002-	No	No	Short time-series
Sweden	Kullen, Skälderviken	2002-	No	No	Short time-series
Sweden	Stenungsund, Älgöfjorden	2002-	No	No	Inapropriate sampling
Sweden	Barsebäck	1999-	No	No	Indicators not yet fully developed
Sweden	Vendelsö	1976-	No	No	Indicators not yet fully developed
Sweden	Mönsterås	1995-	No	Yes	-
Sweden	Askviken	2009-	No	No	Short time-series
Sweden	Lännåkersviken	2009-	No	No	Short time-series
Sweden	Holmön	1989-	No	No	Inapropriate sampling
Sweden	Galtfjärden	2002-	No	No	Short time-series
Sweden	Muskö	1991-	No	No	Short time-series
Sweden	Kvädöfjärden	1989-	No	No	Inapropriate sampling
Sweden	Fjällbacka	1989-	No	No	Inapropriate sampling
Sweden	Fjällbacka	1989-	No	No	Inapropriate sampling
Sweden	Kullen, Skälderviken	2002-	No	No	Short time-series
Sweden	Stenungsund, Älgöfjorden	2002-	No	No	Inapropriate sampling
Sweden	Vendelsö	1976-	No	No	Indicators not yet fully developed
Sweden	Hanöbunkten	2012-	No	No	Short time-series
Sweden	Vallviksfjärden	2010-	No	No	Short time-series
Sweden	Gävlebukten	2011-	No	No	Short time-series

Country	Station/Area	Start of data series	Included?	Could be included?	Comment
Denmark	Limfjord	2005-	No	No	Short time-series
Denmark	Northern Kattegat coast	2008-	No	No	Short time-series
Denmark	Western Kattegat fjords	2005-	No	No	Short time-series
Denmark	Århus Bay	2005-	No	No	Short time-series
Denmark	Odense Fjord	2005-	No	No	Short time-series
Denmark	West and south of Funen	2005-	No	No	Short time-series
Denmark	Great Belt	2005-	No	No	Short time-series
Denmark	Sejerø Bay	2006-	No	No	Short time-series
Denmark	Isefjord and Roskilde fjord	2005-	No	No	Short time-series
Denmark	Sound	2005-	No	No	Short time-series
Denmark	Præstø Fjord	2005-	No	No	Short time-series
Denmark	Lolland-Falster	2006,2009,2010	No	No	Short time-series
Denmark	Bornholm	2010-	No	No	Short time-series

Description of data

Gillnet monitoring

The calculations are based on catch per unit effort data (CPUE) from annual averages of all sampling stations in each monitoring area. The coastal fish monitoring typically takes place in August and reflects trends in species that occur in coastal areas during the warm season of the year. As such mainly demersal and benthopelagic species with a temperature preference above 20˚C with a freshwater origin such as perch, roach, breams, bleak and ruffe (Gymnocephalus cernuus) are targeted (Thoresson, 1996; Neuman, 1974). The sampling programs do to some extent also catch marine species as cod (Gadus morhua), Baltic herring (Clupea harengus) and flounder (Platichthyes flesus), and those species of a freshwater origin with lower a lower temperature preference such as whitefish (Coregonus maraena) and smelt (Osmerus eperlanus).

Fishing is performed using survey nets using three different monitoring methods in the Baltic Sea. In the Baltic Proper, the longest time series data are from monitoring using Net series, and in the Bothnian Sea, Coastal survey nets are used. Monitoring using Nordic coastal multi-mesh nets was introduced in 2001 in Sweden, Finland and Poland. For details on the monitoring methods see Thoresson (1996) and HELCOM (2008). The data presented in this report is exclusively based on Net-series and Coastal survey nets. Additional monitoring programs are available for additional areas and countries, but the time-span of these programs is currently not long enough to be included in this assessment.

In Poland, a coastal fish monitoring program was established in 2011, but has since then not been continued. The monitoring program is focused on the warm season species community (in late summer) and executed using three different gears; Nordic coastal multi-mesh nets, Polish coastal survey nets and bottom trawl. The areas monitored were Odra (Szczecin) Lagoon (five stations), Polish coastal waters (Bornholm Basin, 12 stations), Polish coastal waters (Eastern Baltic Proper, four stations), Gulf of Gdańsk (22 stations) and Vistula lagoon (four stations).

In Germany, two coastal fish monitoring programs are currently running. In 2002 an artificial reef was established at 11-12 m water depth about 12 nm west of Rostock/ Warnemünde off the summer resort Nienhagen. The fish community at the reef and a reference area (since 2003) is monitored using uni-mesh gillnets and multi-mesh gillnets. Focal species is cod (Gadus morhua) and flounder. The other monitoring program was initiated in 2008 covering nine areas (six stations per area) along the coastline of Mecklenburg-Western Pomerania. The monitoring program is targeting eel (Anguilla anguilla) using a number of connected fyke-nets. Perch and flounder are caught in representative numbers in this monitoring program.

Commercial catch data

All commercial fishermen – including also “small-scale fishermen” using vessels under 10 meter long – are nowadays obliged to report their fishing activities in EU countries on daily or monthly basis. The catch by species and gear, as well as efforts and fishing areas as ICES statistical rectangles (55*55 km grids) are via a log-book reported to national or regional fisheries administration. In the Finnish coast, for example, the catch data has been collected in this form since 1980, and in 2010 over 1300 fishermen reported their catches. Among the several gear-types used in the Finnish log-book for small scale fishery, the gillnet (36-60 mm bar length) is likely the most suitable to provide data for fish abundance indexes.

Since Finland lacks fisheries independent monitoring of coastal fish in many areas along the coastline, alternative data based on commercial gillnet catches (36-60 mm bar length) was used for the Bothnian Bay (ICES SD 31), Bothnian Sea (ICES SD 30), Archipelago Sea (ICES SD 29) and Gulf of Finland (ICES SD 32). The data is effort-based in the form of kg/gillnet day.

Recreational catch data

In Denmark, data on coastal fish is collated by contracting recreational fishermen for catch registration ("Key-fishermen project"). There is voluntary registration of all fish caught using commercial gillnets and fyke nets on fixed monitoring stations monitored all year around (three times/month). The "Key-fishermen project" was initiated in 2005, and is currently covering 18 areas along the Danish coast. In some areas, data can be extended back to 2002.

Geographical coverage

For the longest time-series (Net series and Coastal survey nets) data are available for Sweden, Finland, Estonia, Latvia and Lithuania covering the Gulf of Bothnia and the northern and eastern parts of the Baltic Proper (Figure 1). In Sweden, Finland and Estonia the coasts are extensive and rather heterogeneous, and sampling programs only covers a part of the total stretch of coast.

Particularly in the northern parts of Finland (Gulf of Bothnia) and the southern parts of the Baltic Proper (Sweden), very little data from gill-net monitoring is available. In Sweden, Finland and Poland, the spatial coverage is increasing when considering the monitoring programs using Nordic coastal multi-mesh nets HELCOM (2012). These monitoring programs were initiated in the early – mid 2000s and are as such too short to be included in this assessment report. In Finland, effort based commercial catch statistics (CPUE) from the gillnet fishery are available along the whole coastline, and might in some areas act as a complement to the gillnet monitoring programs.

To summarize, the geographical coverage of the monitoring of coastal fish in the Baltic Sea covers the northern parts rather well, but in some areas there are substantial gaps. Given that coastal fish communities are typically local in their appearance and response to environmental and anthropogenic perturbations (Saulamo and Neuman, 2002; Olsson et al., 2011, 2012a), additional monitoring programs should be established and/or alternative data sources used in order to fully capture the current status of coastal fish communities along all parts of the Baltic coast. With this in mind, however, a recent study suggested that the temporal development of coastal fish communities in the Baltic during the last four decades to some extent have followed a similar development across basins (Olsson et al., 2012b). Moreover, during the last 15 years, where additional monitoring station can be considered, there has been an overall similar development of coastal fish communities in the existing gillnet monitoring programs in the Gulf of Bothnia (HELCOM, 2012). Coastal fish communities in gillnet monitoring programs in the Baltic Proper has followed a different development trajectory compared to those in the Gulf of Bothnia, but similar patterns are seen within the basin (HELCOM, 2012). In all, these studies together suggest that the general and basin specific development trajectories of fish community structure in coastal gillnet monitoring programs might be general also for areas currently not monitored, but that local and/or regional exceptions might exist (HELCOM, 2012). Worth considering, however, is that the current monitoring procedures of coastal fish in the Baltic Sea do not incorporate all features of the sampled communities (see the "Strengths and weaknesses" paragraph). Despite that the general development trajectories of coastal fish communities might overlap between regions, the absolute abundances and production of the communities likely differs across areas.

As such, targets and levels for sustainable long-term management of the systems and the levels for which reference states are defined, must be set within a smaller geographical context. Assessments could be performed on the level of HELCOM division of sub-basins, but this should be based on assessments of fish community status in the different water types within a sub-basin.

Temporal coverage

The longest gillnet monitoring time-series covers the last 24 years and were initiated in 1987. Many of the monitoring programs were, however, started later during the 1990s. During the last fifteen years (1995-), data are available for all areas, covering more than two times the generation time of the typical fish species assessed. As such, considering the development of an indicator over a time span of fifteen years should take into account potential influence on the outcome from for example strong year classes. In Finland, effort based commercial catch statistics (CPUE) from the gillnet fishery are available since 1980.

Data is missing for some years in the two Latvian areas (Daugavgriva and Jūrkalne), due to unreliable data caused by strong upwelling of cold water during monitoring. Financial support for gillnet monitoring in Latvia ceased in 2007, and updating of time-series and status classification is hence not possible.

For sampling programs using Nordic coastal multi-mesh nets data are available from the early and mid 2000s in Sweden and Finland. For Poland, the monitoring program was established in 2011.

Methodology of data analysis

Gillnet monitoring

The analyses were based on catch per unit effort data (CPUE) from annual averages of all sampling stations in each area. To only include species and size-groups suited for quantitative sampling by the method, individuals smaller than 12 cm (Nordic Coastal multimesh nets) or 14 cm (Net series, Coastal survey nets), and all small-bodied species (gobies, sticklebacks, butterfish), and species with eel-like body forms (taeniform, anguilliform or filiform shapes) were excluded from the analyses. The abundance of cyprinids was calculated as the CPUE of all carp fishes (family Cyprinidae), and the abundance of piscivores as the CPUE of all piscivorous fish species in the catch (species with a trophic level above 4 according to FishBase; see HELCOM 2012 for details). The temporal development of the indicators was assessed using linear regressions.

Commercial catch data

Analyses were based on catch per unit effort data (CPUE) in the form of kg/gillnet day, and each data point represents total annual catches per area. The gillnets used have mesh sizes between 36-60 mm (bar length) and hence target a somewhat different aspect of the fish community in the area. In addition, fishing is not performed at fixed stations and with a constant effort across years. As a result, the estimates from the gillnet monitoring programs and commercial catch data is not directly comparable, and only relative changes should be addressed across data sources. In this report the CPUE of cyprinids was calculated as the summed abundance (kg/gillnet day) of roach and common bream (Abramis brama). For piscivores the CPUE is based on the summed abundance (kg/gillnet day) of perch, pikeperch and pike in the catch. The temporal development of the indicators was assessed using linear regressions.

Subregional specificities of the indicator

Due to the inherent difference in environmental settings of the Baltic Sea with pronounced gradients in for example salinity and temperatures (Viopio 1981), the key functional group indicator might be based on different species in different areas. In general, the Cyprinid indicator should be based on the abundance of cyprinids in the northern parts and more in shore areas of the Baltic (Table 2). In more exposed and southern areas the abundance of mesopredators might be used as a complementary indicator. The spatial coverage of existing monitoring programs is generally good, with exceptions of some coastal areas (Table 2).

Table 2. *The spatial specificities per sub-basin of the Piscivore indicator for coastal fish community status. Given is what species the indicators should be based on, what sampling method that is recommended (GN = gill net, CCS = commercial catch statistics, FN = fyke net, EB = Eel baskets), what time in the year the monitoring should be carried out, current spatial coverage (High/Medium/Poor) and what complementary monitoring that is needed.*

Subbasin	Species	Survey method	Survey time	Spatial coverage	Complementary monitoirng
Bothnian Bay	Perch, pike and pikeperch	GN, CCS	GN-summer, CCS- all year	Medium	Catches in recreational fishing
Bothnian Sea	Perch, pike and pikeperch	GN, CCS	GN-summer, CCS- all year	Medium	Catches in recreational fishing
Åland Sea	Perch, pike and pikeperch	GN, CCS	GN-summer, CCS- all year	Medium	Catches in recreational fishing
Northern Baltic Proper	Perch, pike, pikeperch (inshore), cod (exposed)	GN	GN-summer, GN spring/fall (cod)	Medium	Catches in recreational fishing, monitoring for cod
Gulf of Finland	Perch, pike and pikeperch	GN, CCS	GN-summer, CCS- all year	Medium	Catches in recreational fishing
Gulf of Riga	Perch and pikeperch	GN	GN-summer	Medium	-
Western Gotland Basin	Perch, pike, pikeperch (inshore), cod (exposed)	GN	GN-summer, GN spring/fall (cod)	Medium	Monitoring for cod in Lithuania
Eastern Baltic Proper	Perch (in shore), cod (exposed Lithuania)	GN	GN-summer, GN spring/fall (cod)	Medium	Monitoring for cod
Gulf of Gdansk	Not specified yet	Not specified yet	Not specified yet	Not specified yet	Not specified yet
Bornholm Basin	Perch, pike, pikeperch (inshore), cod (exposed)	GN	GN-summer, GN spring/fall (cod)	Poor	Additional GN monitoirng needed
Arkona Basin	Perch	FN, EB	April-Sept (temp > 10 °C)	Good	-
The Sound	Cod	FN	FN-spring/fall	Medium (Swedish side)	Catches in recreational fishing
Mecklenburg Bight	Perch (in shore), perch and cod (exposed)	GN, FN, EB	In shore all year, Exposed April-Sept	Good	-
Kiel Bight	Cod	GN, FN	All year	Good	-
Little Belt	Cod	GN, FN	All year	Good	-
Great Belt	Cod	GN, FN	All year	Good	-
Kattegat	Cod	FN	FN-spring/fall	Medium (Swedish side)	Catches in recreational fishing

Table 3. *The spatial specificities per sub-basin of the Cyprinid indicator for coastal fish community status. Given is what species the indicators should be based on, what sampling method that is recommended (GN = gill net, CCS = commercial catch statistics, FN = fyke net, EB = Eel baskets), what time in the year the monitoring should be carried out, current spatial coverage (High/Medium/Poor) and what complementary monitoring that is needed.*

Subbasin	Species	Survey method	Survey time	Spatial coverage	Complementary monitoirng
Bothnian Bay	Cyprinids	GN	Summer	Medium	Data poor in Finland, data from CCS might be used
Bothnian Sea	Cyprinids	GN	Summer	Medium	Data poor in Finland, data from CCS might be used
Åland Sea	Cyprinids	GN	Summer	Medium	Data poor in Finland, data from CCS might be used
Northern Baltic Proper	Cyprinids (in shore), Mesopredators (exposed)	GN	Summer	Medium	-
Gulf of Finland	Cyprinids	GN	Summer	Medium	Data poor in Finland, data from CCS might be used
Gulf of Riga	Cyprinids	GN	Summer	Medium	-
Western Gotland Basin	Cyprinids (in shore), Mesopredators (exposed)	GN	Summer	Medium	Additional monitoring for mesopredators needed
Eastern Baltic Proper	Cyprinids	GN	Summer	Medium	-
Gulf of Gdansk	Not specified yet	Not specified yet	Not specified yet	Not specified yet	-
Bornholm Basin	Cyprinids (in shore), Mesopredators (exposed)	GN	Summer	Poor	Additional GN monitoirng needed
Arkona Basin	Cyprinids (in shore), Mesopredators (exposed)	FN, EB	April-Sept (temp > 10 °C)	Good	-
The Sound	Mesopredators	FN	FN-spring/fall	Medium (Swedish side)	-
Mecklenburg Bight	Cyprinids (in shore), Mesopredators (exposed)	GN, FN, EB	In shore all year, Exposed April-Sept	Good	-
Kiel Bight	Mesopredators	GN, FN	All year	Good	-
Little Belt	Mesopredators	GN, FN	All year	Good	-
Great Belt	Mesopredators	GN, FN	All year	Good	-
Kattegat	Mesopredators	FN	Summer	Medium (Swedish side)	-

Strengths and weaknesses of data

All contracting parties within the HELCOM FISH PRO expert network will use the same CORE indicators for assessing good environmental status for fish in their coastal waters using standardized monitoring procedures as basis for the assessments (see also the paragraph “data sources”; HELCOM 2008). The HELCOM FISH PRO expert network has annual meetings with the long-term goal to further develop harmonized indicators to assess coastal fish community status in the Baltic Sea. The indicators chosen for the current assessment are developed within the expert network and the procedure is documented in HELCOM (2012).

Due to the inherent environmental gradients in the Baltic Sea (Voipio, 1981), and the rather local appearance of coastal fish communities in their structure and response to environmental change, there are poor spatial and temporal coverage in some areas (Figure 1). Therefore, assessments in some of these areas have to be based on alternative data sources such as analyses of CPUE data from commercial fisheries or catch samples from the Data Collection Framework, or based on expert judgment. Furthermore, the levels of direct anthropogenic impact in the existing monitoring areas are low, future venues should also assess the response in more impacted areas.

Further development of the indicators should also include more robust analyses on their relation to important pressures, and the use of alternative data sources for indicator calculation.

With the upcoming revision of HELCOM monitoring programs, it is, however, crucial to stress that the current monitoring of coastal fish in the Baltic represents a minimum level of efforts, and serves as a very important first step for assessing the status of coastal fish communities. As stressed above, however, coastal fish communities are rather local in their appearance and response to environmental perturbations and human stress. The current monitoring therefore likely yields insights into the major and large-scale changes in coastal fish communities in the Baltic, but unique responses in some areas could nevertheless be anticipated. For future holistic assessments it is hence absolutely pivotal that the current extent of coastal fish monitoring in the Baltic is safe-guarded and financed. The monitoring in Latvia should, for example, receive future financial support, and monitoring in Lithuania and the other countries should be implemented on an annual basis to meet minimum criteria for statistical consistency of the data. In addition to this, additional monitoring programs in coastal areas that lack monitoring today, as for example along the German coast should be established.

Moreover, the current monitoring is designed to target coastal fish species preferring higher water temperatures and that dominates coastal areas in the warmer parts of the year, typically those with a freshwater origin (see above). Monitoring of species like whitefish, herring and cod that dominates coastal fish communities in the more exposed parts of the coast and during the colder parts of the year is, however, rather poorly represented. In order to fulfill the requirements of international directives as the Baltic Sea Action Plan and Marine Strategy Framework Directive, future monitoring of these species and components should hence be established.

Finally, in order to implement an ecosystem-based management and get a more holistic view of the processes impacting Baltic ecosystems, monitoring programs should ideally be coordinated in that monitoring of as many trophic levels and abiotic variables (including contaminants, toxins and physiology) as possible are performed in the very same region. For coastal fish, for example, information is accumulating that apex predators as birds and seals might have substantial impacts on fish communities and stocks in a severely disturbed ecosystem as the Baltic. At present, we have limited data on the development and impact on coastal fish communities from foremost local cormorant and other piscivorous bird populations. Moreover, there are data on seals, but we need additional information on their diets and expected effects on Baltic fish communities. In addition to this, the catches of coastal fish species is in many areas substantially higher in recreational fishing compared to that of the small-scale commercial coastal fishery. Data on catches in recreational fishing is, however, typically poor in spatial and temporal resolution, often also in the exact quantities. In order to fully understand the drivers of coastal fish community development, data on catches from recreational fishing is needed. If this kind of data could be effort-based, it might also serve as a compliment in estimating the abundance of coastal fish species that are target species in recreational fishing and underrepresented in gill-net monitoring programs.

Target values and classification methods

from the time series to be assessed. Thus, the definition of the GES boundary is site and sampling method specific, depending on local properties of the ecosystem such as topography and geographical position. The geographic scale of assessment is therefore within the region of the monitoring area. The baseline data set should cover a minimum number of years which is two times the generation time of the species most influential on the indicator, in order to account for the influence of strong year classes. For coastal fish, this is typically about ten years. The baseline data set should not display a linear trend within itself ($n>10$, $p>0.05$), in order to reflect a stable conditions and not a development towards a change in the environmental state. GES boundaries are defined as the indicator value at the Xth percentile of the median distribution of the baseline data set. The median distribution is computed by re-sampling (with replacement) from the baseline data set. In each repetition, the number of samples equals the number of years in the baseline data set. In order to improve precision, a smoothing parameter may be added in each repetition. The smoothing parameter is computed as the normal standard deviation of the re-sampled data set divided by the number of years re-sampled.

The following steps should be assessed:

1. For an indicator in which higher values represent better status (e.g. abundance of key species, abundance of piscivores) and the baseline data set represents GES, the median of the years to be assessed (n=5) should be above the 5th percentile of the median distribution of the baseline data set in order to reflect GES.
2. For an indicator in which higher values represent better status (e.g. abundance of key species, abundance of piscivores) and the baseline data set represents sub-GES, the median of the years to be assessed (n=5) should be above the 98th percentile of the median distribution of the baseline data set in order to reflect GES.
3. For an indicator in which values should be within an interval (i.e. not too low or too high) in order to represent GES (e.g. abundance of cyprinids) and the baseline data set represents GES, the median of the years to be assessed (n=5) should be within the 5th and 95th percentile of the median distribution of the baseline data set in order to represent GES.

1. If the requirements for defining a quantitative baseline conditions are not met (e.g. short time-series), trend based assessment should used. In this case, GES is defined based on the direction of the trend compared to the desired direction of the indicator over time.

1. For an indicator in which higher values represent better status (e.g. abundance of key species, abundance of piscivores) and the first years of the time-series assessed represents GES, the trend of the indicator over time should not be negative in order to represent GES. If the first years of the time-series assessed represent sub-GES, the trend in the indicator should be positive in order to represent GES.
2. For an indicator in which values should be within an interval (i.e. not too low or too high) in order to represent GES (e.g. abundance of cyprinids) and the first years of the time-series assessed represents GES, there should not be a trend in the indicator over time in order to represent GES. If the first years of the time-series assessed represent sub-GES, the trend in the indicator should be in direction towards GES conditions.

In the current assessment, status is due to time constraints derived from the temporal trends of the cyprinid and piscivore abundances from 1995 when data is available for all areas. Since the abundance of piscivores was considered as a supporting indicator, the “one-out-all-out” criterion was applied for the overall status assessment.

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