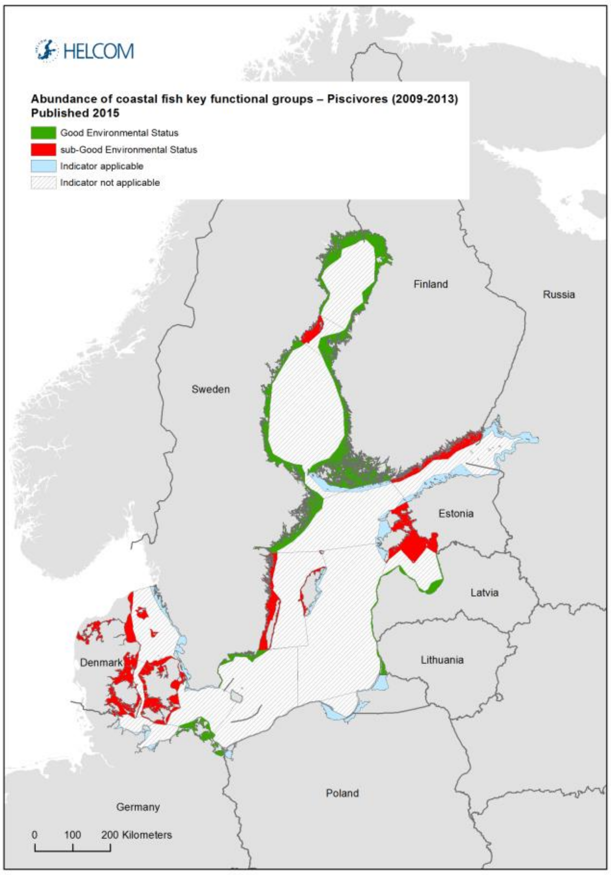
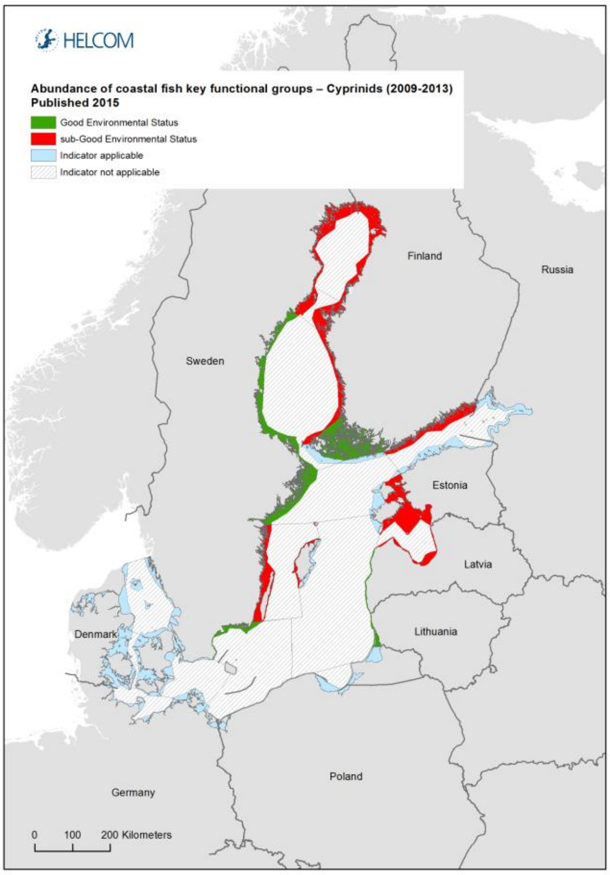
Abundance of coastal fish key functional groups

Key message





The status of functional groups of coastal fish in the Baltic Sea during the years 2009-2013 has been evaluated by assessing the status of piscivores (i.e. fish that feed on other fish) and cyprinids (i.e. fish that feed on e.g. benthic invertebrates). For piscivores GES is achieved in 27 of the in total 47 monitoring locations assessed, and for 15 of in total 24 assessment units. For cyprinids GES is only achieved in half of the in total 24 assessed locations, and for seven of 16 assessment units. In the locations classified as sub-GES, seven out of the in total 12 locations the abundance of cyprinids was at too high levels, and in four Swedish locations and in the only Estonian location the abundances appears to be too low.

As such, the environmental status as indicated by piscivores is slightly better compared to that of cyprinids. Generally the status of piscivores is better in more northern areas (Gulf of Bothnia) compared to more southern and western areas. For cyprinids, the only region characterized by GES is the Swedish coasts along the Bothnian Sea, Northern Baltic Proper and Bornholm basin, as well as the coast in the Archipelago Sea.

The level of confidence of the assessment differs across areas, and is higher in those areas having data dating back to the late 1990's. Data is lacking for more southern and western areas with respect to cyprinids.

Relevance of the core indicator

Coastal fish communities are of high socio-economic and ecological importance in the Baltic Sea, both for ecosystem functioning and for the recreational and small-scale coastal commercial fishery. As such, the state of functional groups of coastal fish generally reflects the ecological state in coastal ecosystems.

Changes in the long-term development of the abundance of functional groups coastal fish species mainly reflect effects of increased water temperature and eutrophication in coastal areas and/or changes in the level of anthropogenic exploitation or predation pressure.

Policy relevance of the core indicator

	BSAP Segment and Objective	MSFD Descriptors and Criteria
Primary link	Biodiversity • Natural Distribution and occurrence of plants and animals • Thriving and balanced communities of plants and animals	• D1 Biodiversity 1.6. Habitat condition (condition of typical species or communities, relative abundance and/or biomass, physical, hydrological and chemical conditions)
Secondary link	Hazardous substances • Healthy wildlife	D4 Food webs 4.3 Abundance/distribution of key trophic groups and species
Other relevant legislation: In some Contracting Parties potentially also EU Habitats Directive		

Cite this indicator

HELCOM [2015]. [Indicator name]**.** HELCOM core indicator report. Online. [Date Viewed], [Web link].

Indicator concept

Good Environmental Status

The quantitative boundaries for GES for coastal fish are based on location-specific baseline conditions, for time series covering >15 years. For shorter time series, a trend based approach (time series covering <15 years) is used. The approach used for different monitoring locations is compiled in Table 1.

The functional groups that the indicator is based on are piscivorous fish species and members of the cyprinid family (in areas where cyprinids do not naturally exist mesopredatory fish species could be used e.g. wrasses (*Labridae*), sticklebacks (*Gasterosteidae*) and gobies (*Gobiidae*)). Due to lack of data, only piscivorous fish and cyprinids are evaluated at present. Piscivorous fish coastal fish species are typically represented by perch (*Perca fluviatilis*), pike (*Esox Lucius*), pikeperch (*Sander lucioperca*) and burbot (*Lota lota*) at more in the less saline eastern and northern Baltic Sea (Sweden, Finland, Estonia, Latvia and Lithuania), and in sheltered coastal areas in Poland and Germany. In the more exposed coastal parts of the central Baltic Sea and in its western parts piscivores are typically represented by cod (*Gadus morhua*) and turbot (*Scophthalmus maximus*). A similar division could be done for members of the cyprinid family (*Cyprinidae*) e.g. roach (*Rutilus rutilus*) and breams (*Abramis sp.*) that are most abundant in the less saline eastern and northern Baltic Sea, and mesopredatory fish (sticklebacks, wrasses and gobies) that are representative for the more exposed coastal parts of the central Baltic Sea and in its western more saline region.

To evaluate Good Environmental Status (GES) for the key fish species of coastal fish communities in the Baltic Sea, estimates of the relative abundance and/or biomass of key coastal fish species as derived from fishery independent monitoring, recreational fishermen surveys and/or commercial catch statistics should be used. Since there are strong environmental gradients in the Baltic Sea, and since coastal fish communities and stocks are typically local in their appearance and respond mainly to area specific environmental conditions, the evaluation for coastal key fish species should be carried out on a relatively local scale, and the application of common Baltic wide boundary levels is not ecologically feasible. Coastal fish assessments should therefore be based on location specific boundaries for GES, derived from time series data.

The time period used to determine the baseline against which GES is compared should cover at least 10 years to extend over more than two times the generation time of the typical species represented in the indicator, to cater for natural variation in the indicator value due to for example strong and weak year classes. For the time period used to define the baseline to be relevant, it must be carefully selected to reflect time periods with stable environmental conditions, as stated within the MSFD (Anon 2008). Substantial turnover in ecosystem structure in the Baltic Sea have been apparent in the late 1980s leading to shifts in the baseline state (Möllmann et al 2009). For coastal fish communities, substantial shifts in community structure have been demonstrated in the late 1980s and early/mid 1990s (Olsson et al 2012). In some areas, there have been minor shifts in fish community structure also later (http://helcom.fi/baltic-sea-trends/environment-fact-sheets/biodiversity/temporal-development-of-baltic-coastal-fish-communities-and-key-species). The period used to define the baseline for coastal fish indicators hence spans over a ten-year-period beginning in the late 1990s. In the current evaluation data from 1998 and onwards has been included to cater for shifting baselines while including as much data as possible. The majority of the available time series of coastal fish community structure begin in the mid-1990s (HELCOM 2012). Using the baseline-approach this suggests a period of 1998 – 2008 for defining the baseline against which GES is evaluated and for the trend based approach data should date back to the early/mid 2000s to be included in the evaluation.

For the baseline approach the evaluation period should cover five years to cater for natural variability. In this indicator, status during the years 2009-2013 has been evaluated. GES is evaluated based on the deviation of the median value of the indicator during the assessment period in relation to the boundary level, as defined from the period used to define the baseline. For the trend-based approach, GES is evaluated based on the direction of the trend of the indicator over the time-period considered in relation to the desired direction of the indicator.

Anthropogenic pressures linked to the indicator

	General	**MSFD Annex III, Table 2**
Strong link	Several pressures, both natural and anthropogenic, acting in concert affect the state of key functional groups of coastal fish. These include climate, eutrophication, fishing, and exploitation and loss of essential habitats. To date, no analyses on the relative importance of these variables have been conducted.	Physical loss - sealing Physical damage -abrasion -selective extraction Inference with hydrological processes -significant changes in thermal regime -significant changes in salinity regime Nutrient and organic matter enrichment -inputs of fertilisers and other nitrogen and phosphorus-rich substances Biological disturbance -selective extraction of species, including incidental non-target catches
Weak link	There might also be effects of hazardous substances on the state of coastal fish key functional groups	Potentially also: Contamination by hazardous substances -introduction of synthetic compounds -introduction of non-synthetic substances and compounds

The state of key functional groups of coastal fish in the Baltic Sea is influenced by a multiple pressures including climate, eutrophication, fishing mortality and exploitation of essential habitats, but also by natural processes such as food-web interactions and predation from apex predators. The functional groups considered in the indicator are generally heavily affected by the impacts of a changing climate (Möllman et al. 2009; Olsson et al. 2012; Östman et al. submitted) including alterations in the food-web (Eriksson et al. 2009; 2011), the impact of increased water temperature and for cyprinids in particular also lowered salinity (Härmä et al. 2008).

Among pressures related to anthropogenic activities, exploitation of essential habitats (Sundblad et al 2014; Sundblad & Bergström 2014) impact both piscivores and cyprinids, whereas fishing generally mainly affects piscivores (Edgren 2005; Bergström et al 2007; Fenberg et al 2012; Florin et al 2013). Coastal piscivorous species, such as perch, pike and pikeperch, are targeted in the recreational fisheries sector and in many countries to a lesser extent by the small-scale commercial fisheries (Karlsson et al 2014), whereas cod is mainly exploited in the offshore commercial fisheries. The role of eutrophication in affecting the state of coastal fish communities does not appear to be of as large importance (Olsson et al. 2012), but the effect might increase with increasing latitude (Östman et al. submitted) and for some cyprinid species (Härmä et al. 2008).

Besides the above-mentioned pressures, natural interactions as predation pressure from apex predators, foremost cormorants (*Phalacrocorax carbo*), could at least locally impact the state of coastal fish communities (Vetemaa et al. 2010; Östman et al. 2012). In some areas the outtake of coastal fish by cormorants exceeds or is of a similar magnitude to that of the commercial fishery and recreational fishery (Östman et al. 2013). However, the magnitude of the effect of the cormorants on coastal fish species seems to vary between coastal areas (Lehikoinen et al. 2011). The state of groups of mesopredatory fish species such as wrasses, sticklebacks and gobies, and potentially also cyprinids, could be affected by the food-web structure in coastal areas and neighbouring ecosystems (Eriksson et al. 2011; Baden et al. 2012; Casini et al. 2012). Especially released predation pressure from declining stocks of piscivorous fish species might favour the increase in abundance of mesopredatory fish species.

Assessment protocol

Baseline approach

Coastal fish datasets must meet certain criteria in order for an evaluation of GES using the baseline-approach to be applied:

1. The data set used to determine the baseline should cover a minimum number of years, which should be two times the generation time of the species most influential to the indicator evaluation in order to account for the influence of strong year classes. For coastal fish, this is typically about ten years. In this case the base-line period span over the years 1998-2008.
2. The data set used to determine the baseline must not display a linear trend within itself ($n \geq 10$, $p > 0.05$), as the baseline for evaluation should optimally reflect the community structure at stable conditions and not a development towards a change in the environmental status.
3. Before evaluating GES, it should also be decided whether or not the period used to determine the baseline reflects a period of GES. This could be done either by using data dating back earlier than the start of the period used to determine the baseline, using additional information, or by expert judgment. For example, if data from time periods preceding the period used to define baseline have much higher indicator values, the baseline might represent sub-GES (in case of an indicator

where higher values are indicative of a good environmental status) or GES (in case of an indicator where higher values are indicative of an undesirable status).

Once the baseline status has been defined, the GES boundaries are defined as the value of the indicator at the X^{th} percentile of the median distribution of the data set used to determine baseline. The median distribution is computed by resampling (with replacement) from the data set used for determining the baseline. In each repetition, the number of samples equals the number of years in the data set used for determining the baseline status. 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. To evaluate GES during the assessment period the median value of the indicators during the assessment period is compared with the specific GES boundary (see also decision tree below):

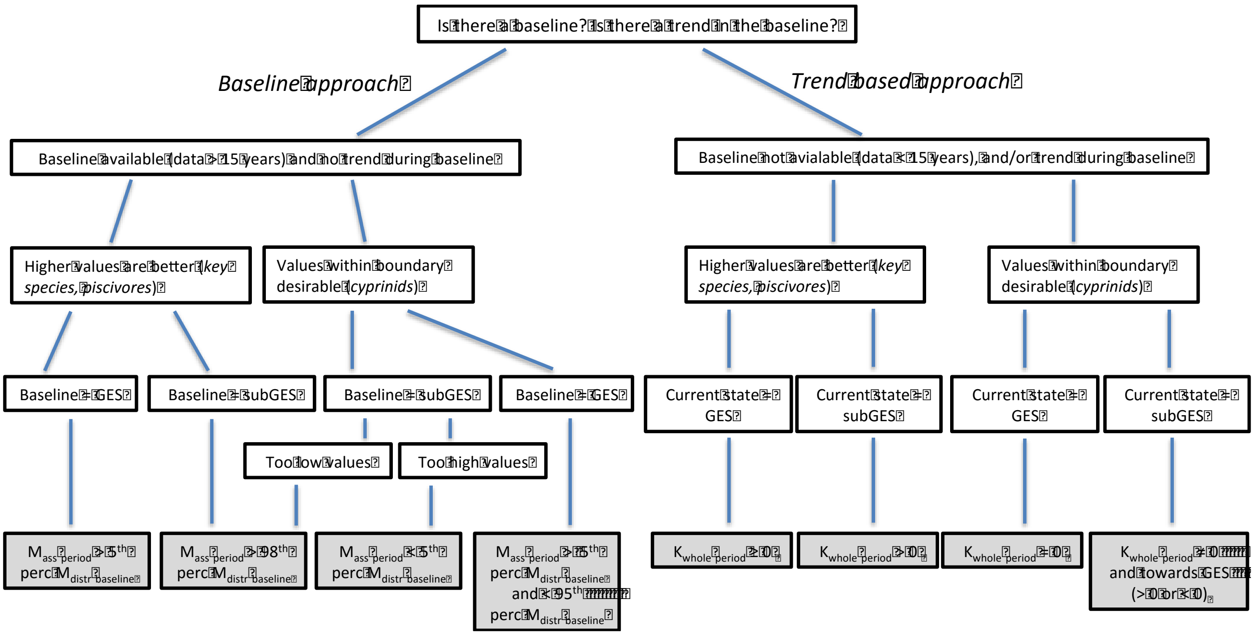
1. In situations where the baseline state reflects GES for piscivores, the median of the years to be assessed (n=5) should be above the 5^{th} percentile of the median distribution of the data set used to determine the baseline in order to reflect GES. For cyprinds and mesopredatory fish species, the median of the years to be assessed (n=5) should be above the 5^{th} percentile and below the 95^{th} percentile to reflect GES.
2. In situations where the baseline state reflects sub-GES for piscivores, the median of the years to be assessed (n=5) should be above the 98^{th} percentile of the median distribution of the data set used to determine the baseline in order to reflect GES. For cyprinds and mesopredatory fish species the median of the years to be assessed (n=5) should in order to reflect GES, be above the 98^{th} percentile if the status during the baseline is indicative of too low abundances, and below the 5^{th} percentile if the status during the base-line period is indicative of too high abundances.

Trend-based approach

If the requirements for defining quantitative baseline conditions are not met (e.g. short time series, or a linear development during the period used to determine the baseline), trend based evaluation should be used. In this case, GES is defined based on the direction of the trend compared to the desired direction of the indicator over time. In cases where a GES status is represented by the first years in the evaluated time series then the trend of the indicator over time should not be negative in order to represent GES for piscivores. For cyprinds and mesopredatory fish the trend of the indicator over time should not exhibited any direction to reflect 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 for piscivores, and in the desired direction to reflect GES for cyprinds and mesopredatory fish. The significance level for these trends should be $p < 0.1$.

Decision tree for GES evaluation using coastal fish community structure

In this tree the indicators abundance of key fish species is abbreviated as '*key species*', abundance of piscivores as '*piscivores'* and abundance of cyprinids as '*cyprinids*'. Baseline refers to the period 1998/1999 – 2008. $M_{ass\ period}$ refers to the median of the assessment period (2009-2013), perc = percentile, $M_{distr\ baseline}$ refers to the bootstrapped median distribution of the period used to determine the baseline, and K is referred to as the slope of the linear regression line over the whole time-period.



Status evaluation of coastal fish communities are representative for a rather small geographical scale due to the local appearance of typical coastal fish species. In this indicator evaluation the HELCOM assessment unit scale 3 'Open sub-basin and coastal waters' has been applied. The indicator is not assessed for the open sea sub-basins since the species in focus are coastal.

In assessment units with several monitoring data sets the summed status is determined as the status (GES or sub-GES) representing the majority of monitoring locations within the unit. If equal numbers had GES and sub-GES, the one-out-all-out procedure was applied.

Methodology of data analyses

Fishery independent monitoring

The analyses are 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 (other net types), 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. Abundance was calculated as the number of individuals of the species included in the indicator per unit effort (CPUE).

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 are not directly comparable, and only relative changes across data sources should be compared.

Relevance of the indicator

Policy Relevance

Coastal fish communities are of high socio-economic and ecological importance in the Baltic Sea. Coastal fish, especially piscivorous species, are recognized as being important components of coastal food webs and ecosystem functioning (reviewed in Eriksson et al. 2009, Olsson et al. 2012), 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 (Karlsson et al. 2014). Moreover, since many coastal fish species are rather local in their appearance (Saulamo & Neuman 2005; Laikre et al. 2005; Olsson et al. 2011), the temporal development of coastal fish communities might reflect the general environmental state in the monitoring locations. Coastal fish communities and stocks hence comprise important segments of international policies and directives as the MSFD, BSAP, and Habitats directive.

Role of key functional groups of coastal fish in the ecosystem

Piscivorous fish species in coastal ecosystems generally have a structuring role in the ecosystem. This is mainly mediated via top-down control on lower trophic levels in the food-web, and viable populations of piscivorous species are generally reflected by few eutrophication symptoms and balanced food-webs (Eriksson et al. 2011).

The abundance of piscivorous coastal fish (such as perch, pike, pikeperch and cod) is influenced by the recruitment success and mortality rates, which in turn might be influenced by ecosystem changes, interactions within the coastal ecosystem and abiotic perturbations. An increased abundance of piscivorous fish might reflect increasing water temperatures and moderate eutrophication (perch and pike), availability of recruitment habitats (all), low fishing pressure and predation pressure from apex predators (all), but also high eutrophication (pikeperch) as well as colder and more saline conditions (cod, Böhling et al., 1991; Edgren 2005; Bergström et al. 2007; Linlokken et al. 2008; HELCOM 2012; Olsson et al., 2012; Östman et al. 2012; Bergström et al. 2013; Östman et al. submitted). As for the majority of coastal piscivorous fish species, exploitation of recruitment areas has a negative impact on the development of perch populations (Sundblad et al. 2014; Sundblad & Bergström 2014).

Cyprinds and mesopredatory fish species typically represent lower trophic levels in being planktivores and benthivores. As such these groups of species are both impacted by bottom-up mechanisms as eutrophication (Härmä et al. 2008; Östman et al. in revision), but also by top-down regulation from piscivorous fish species (Eriksson et al. 2011; Baden et al. 2012; Casini et al. 2012) and apex predators (Östman et al. 2012). Hence, whereas abundant and strong populations of piscivorous coastal fish species are indicative for a functioning ecosystem in good environmental status, high abundances of cyprinids and mesopredators are often characterising systems in an undesirable environmental state.

Results and confidence

The current evaluation of GES using coastal fish is based on time series data dating back to 1998-2002 using a 'deviation from baseline approach' or a 'trend-based evaluation' depending on the time series coverage. Evaluations were carried out on the assessment unit scale 3 'Open sub-basin and coastal waters'. The status evaluation per monitoring location and assessment unit is summarized in Table 1. Only piscivores and cyprinids were evaluated in the indicator, due to a lack of data and fully developed indicators for mesopredators.

Piscivores

In more than half of the evaluated locations (27 out of the total 47 locations) GES is achieved. In a few assessment units there are differing environmental status evaluations form different monitoring programs in the same assessment unit (Table 1), likely reflecting the local appearance of coastal fish communities in the Baltic Sea. When summarizing over assessment units, GES is achieved in 15 out 24 assessed units. There are, however, some general patterns suggesting that the status depends on the geographic area and the species assessed. In the more northern and eastern areas where perch, pike and pikeperch represent the coastal piscivores, the status is generally good, whereas in more southern and western areas where cod and turbot are the dominating piscivorous species, status is worse.

In the northern most parts (Bothnian Bay and The Quark), the status is generally good (Table 1 and Figure 1). In most monitoring locations the relative abundance of perch, pike and pikeperch is high and stable or increasing. Only in one location, Norrbyn, the CPUE is decreasing over time.

In the Bothnian Sea, Åland Sea and Archipelago Sea, the relative abundances of piscivores is generally high and stable, but not increasing (Figure 1). In the only location where GES is not achieved, Gaviksfjärden, there is no temporal trend over the relatively short time-period covered, but the average abundance of piscivores is more than half of that in the other locations monitored with the same gear (Långvindsfjärden, Lagnö, Finbo and Kumlinge).

In the central part of the Baltic Sea (Northern Baltic Proper, Gulf of Finland, Gulf of Riga and Gotland Basin) there are differences across locations in the status, and GES is only achieved in four out of seven assessment units (Table 1). In the N Baltic Proper and Western part of the Gotland Basin GES is achieved, whereas in one of the Gulf of Riga monitoring stations (Hiiumaa), the Swedish locations in the Gotland Basin (Kvädöfjärden and Vinö), and in the Gulf of Finland all areas are characterized by sub-GES.

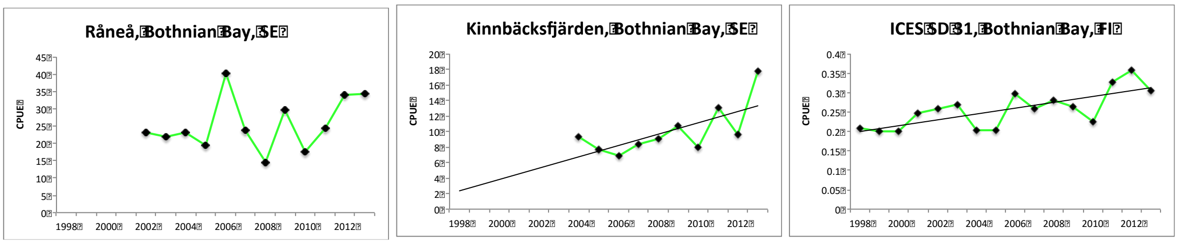
In the more southern parts, GES is achieved in the Swedish locations (Torhamn, Bornholm basin), and in general also in German coastal waters. In the remaining assessment units and monitoring locations mainly in the Danish waters where cod and turbot are the dominating piscivorous species GES is however not achieved (Table 1).

Table 1. Status assessment per monitoring location and assessment unit for piscivores.

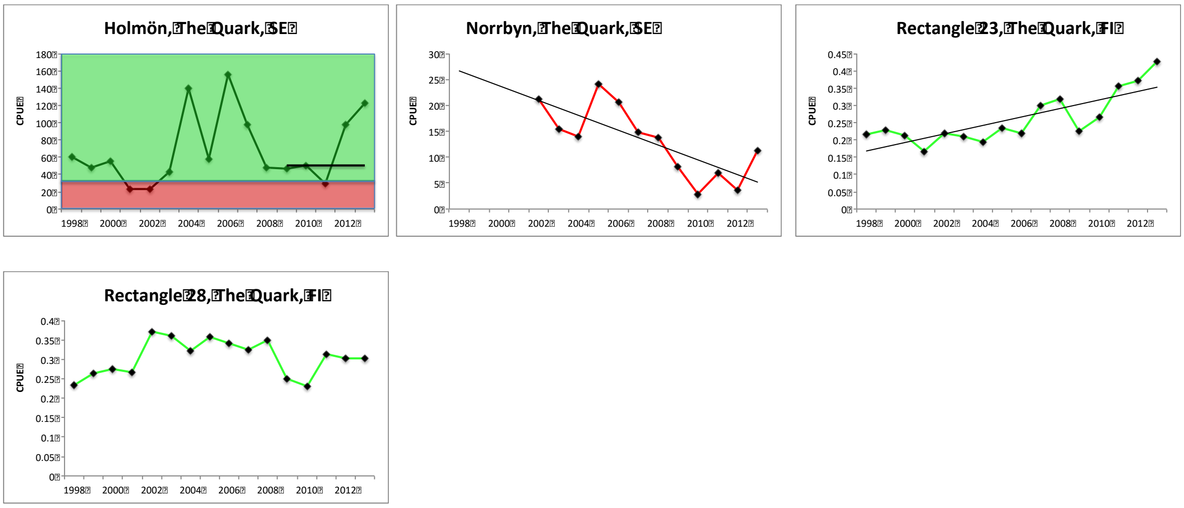
Subbasin	Country	Monitoirng area	Period	Coastal water type	Assessmen	Status
Bothnian Bay	Finland	ICES SD 31	1998-2013	Bothnian Bay Finnish Coastal waters	Baseline	GES
Bothnian Bay	Sweden	Råneå	2002-2013	Bothnian Bay Swedish Coastal waters	Trend	GES
Bothnian Bay	Sweden	Kinnbäcksfjärden	2004-2013	Bothnian Bay Swedish Coastal waters	Trend	GES
The Quark	Finland	Rectangle 23 & 28	1998-2013	The Quark Finnish Coastal waters	Baseline	GES
The Quark	Sweden	Holmön	1998-2013	The Quark Swedish Coastal waters	Baseline	GES
The Quark	Sweden	Norrbyn	2002-2013	The Quark Swedish Coastal waters	Trend	subGES
Bothnian Sea	Finland	ICES SD 30	1998-2013	Bothnian Sea Finnish Coastal waters	Baseline	GES
Bothnian Sea	Sweden	Gaviksfjärden	2004-2013	Bothnian Sea Swedish Coastal waters	Trend	subGES
Bothnian Sea	Sweden	Långvindsfjärden	2002-2013	Bothnian Sea Swedish Coastal waters	Trend	GES
Bothnian Sea	Sweden	Forsmark	1998-2013	Bothnian Sea Swedish Coastal waters	Baseline	GES
Åland Sea	Sweden	Lagnö	2002-2013	Åland Sea Swedish Coastal waters	Trend	GES
Archipelago Sea	Finland	ICES SD 29	1998-2013	Archipelago Sea Coastal waters	Baseline	GES
Archipelago Sea	Finland	Finbo	2002-2013	Archipelago Sea Coastal waters	Trend	GES
Archipelago Sea	Finland	Kumlinge	2003-2013	Archipelago Sea Coastal waters	Trend	GES
Northern Baltic Proper	Sweden	Askö	2005-2013	Northern Baltic Proper Swedish Coastal waters	Trend	GES
Gulf of Finland	Finland	ICES SD 32	1998-2013	Gulf of Finland Finnish Coastal waters	Baseline	subGES
Gulf of Riga	Estonia	Hiiumaa	1998-2013	Gulf of Riga Estonian Coastal waters	Baseline	subGES
Gulf of Riga	Latvia	Daugavgriva	1998-2007	Gulf of Riga Latvian Coastal waters	Trend	GES
Gotland basin	Sweden	Kvädöfjärden	1998-2013	Western Gotland Basin Swedish Coastal waters	Baseline	subGES
Gotland basin	Sweden	Vinö	1998-2013	Western Gotland Basin Swedish Coastal waters	Baseline	subGES
Gotland basin	Latvia	Jurkalne	1999-2007	Eastern Gotland Basin Latvian Coastal waters	Trend	GES
Gotland basin	Lithuania	Monciskes/Butinge	1998-2011	Eastern Gotland Basin Lithuanian Coastal waters	Trend	GES
Gotland basin	Lithuania	Curonian Lagoon	1998-2011	Eastern Gotland Basin Lithuanian Coastal waters	Trend	GES
Bornholm basin	Sweden	Torhamn	2002-2013	Bornholm Basin Swedish Coastal waters	Trend	GES
Bornholm basin	Germany	Pomeranian Bay, Outer	2003-2013	Bornholm Basin German Coastal waters	Trend	GES
Bornholm basin	Germany	Stettin Lagoon (German part)	2008-2013	Bornholm Basin German Coastal waters	Trend	GES
Bornholm basin	Germany	Peene river / Achterwasser	2009-2103	Bornholm Basin German Coastal waters	Trend	GES
Bornholm basin	Germany	East of Usedom Peninsula	2008-2013	Bornholm Basin German Coastal waters	Trend	subGES
Arkona basin	Germany	Greifswalder Bodden	2008-2013	Arkona Basin German Coastal waters	Trend	GES
Arkona basin	Germany	Strelasund	2009-2103	Arkona Basin German Coastal waters	Trend	GES
Arkona basin	Germany	Darß-Zingst Bodden chain	2008-2013	Arkona Basin German Coastal waters	Trend	GES
Arkona basin	Germany	Northeast of Ruegen Island	2008-2013	Arkona Basin German Coastal waters	Trend	GES
Arkona basin	Denmark	Præstø Fiord	2005-2012	Arkona Basin Danish Coastal waters	Trend	subGES
Arkona basin	Germany	North of Kühlungsborn city	2008-2013	Mecklenburg Bight German Coastal waters	Trend	GES
Arkona basin	Germany	Wismar Bight and Salzhaff	2008-2012	Mecklenburg Bight German Coastal waters	Trend	subGES
Arkona basin	Germany	Börgerende	2003-2013	Mecklenburg Bight German Coastal waters	Trend	GES
Arkona basin	Denmark	Area south of Zealand (Smålandsfarvandet)	2008-2013	Mecklenburg Bight Danish Coastal waters	Trend	subGES
Belt Sea	Denmark	Sejerø Bay	2005-2013	Belts Danish Coastal waters	Trend	subGES
Belt Sea	Denmark	Southern Little Belt and the archipelago	2005-2013	Belts Danish Coastal waters	Trend	subGES
Belt Sea	Denmark	Århus Bay	2005-2013	Belts Danish Coastal waters	Trend	subGES
Belt Sea	Denmark	Fiords of Eastern Jutland	2005-2013	Belts Danish Coastal waters	Trend	subGES
The Sound	Denmark	The Sound	2005-2013	The Sound Danish Coastal waters	Trend	subGES
Kattegat	Denmark	Isefjord and Roskilde Fjord	2005-2013	Kattegat Danish Coastal waters, including Limfjorden	Trend	subGES
Kattegat	Denmark	Northern Kattegat	2005-2013	Kattegat Danish Coastal waters, including Limfjorden	Trend	subGES
Kattegat	Denmark	Northern Limfjord	2005-2013	Kattegat Danish Coastal waters, including Limfjorden	Trend	subGES
Kattegat	Denmark	Hjarbæk Fjord	2005-2013	Kattegat Danish Coastal waters, including Limfjorden	Trend	subGES
Kattegat	Denmark	Venø Bay and Nissum Broad	2005-2013	Kattegat Danish Coastal waters, including Limfjorden	Trend	subGES

All evaluations are displayed per sub-basin for the monitoring locations in the panels of Figure 1 below. Green lines denote a GES evaluation outcome whereas a red line denotes a sub-GES evaluation outcome. In locations where the baseline approach is applied, the GES boundary is displayed as a green and a red field and the evaluation of GES/sub-GES is made for each point in time. The black lines indicate the median of the evaluated period.

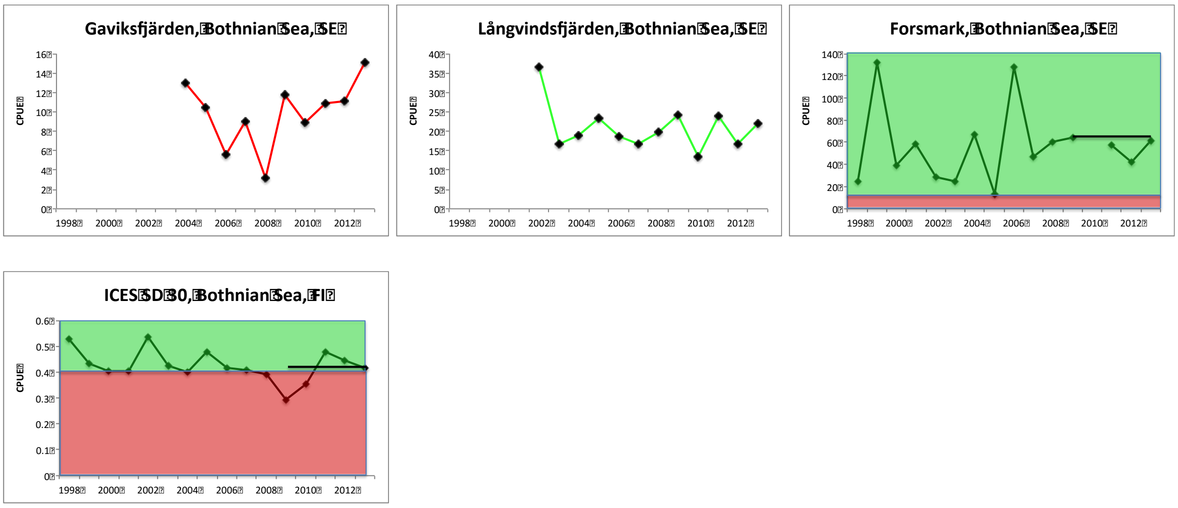
Bothnian Bay



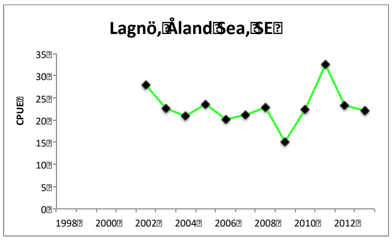
The Quark



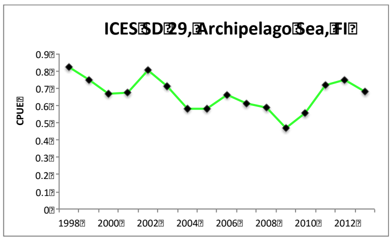
Bothnian Sea

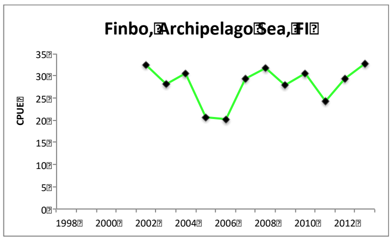


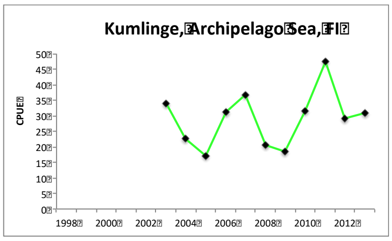
Åland Sea



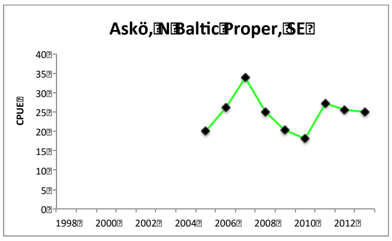
Archipelago Sea



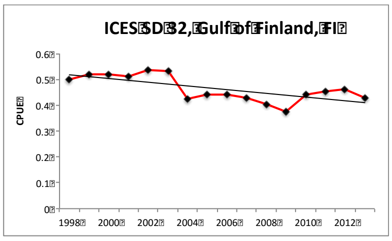




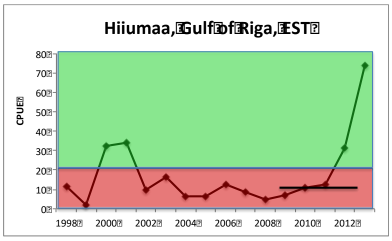
Northern Baltic Proper

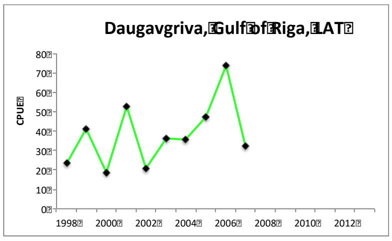


Gulf of Finland

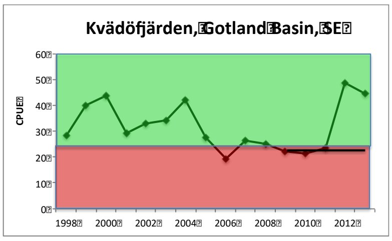


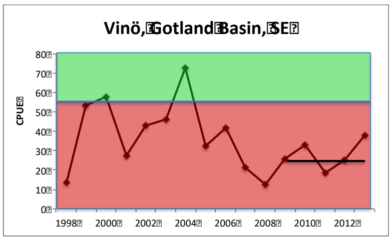
Gulf of Riga

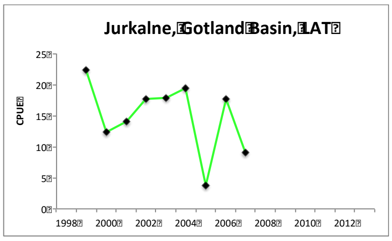


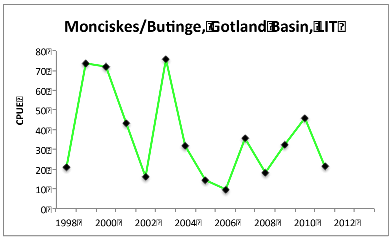


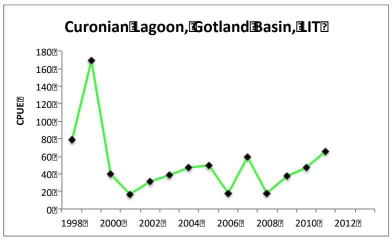
Gotland Basin



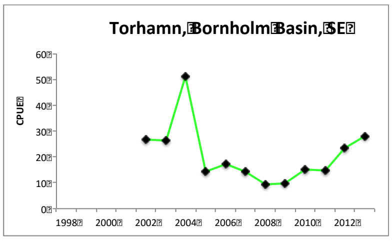


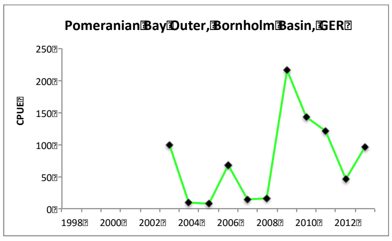


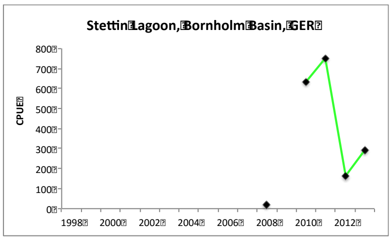


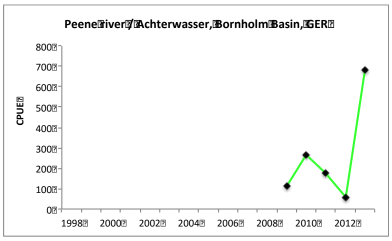


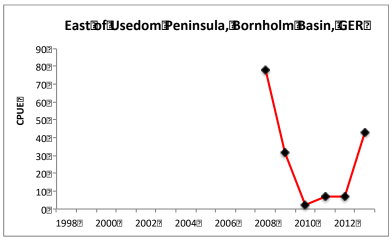
Bornholm Basin



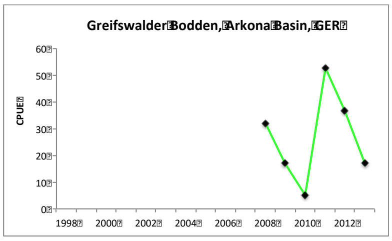


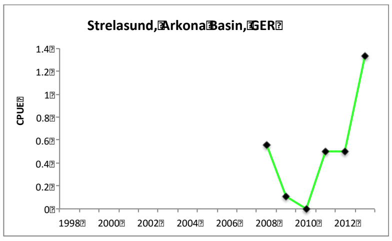


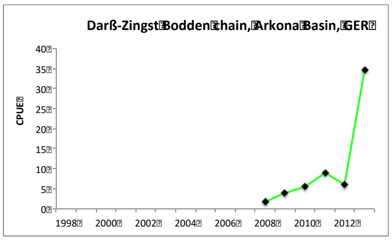


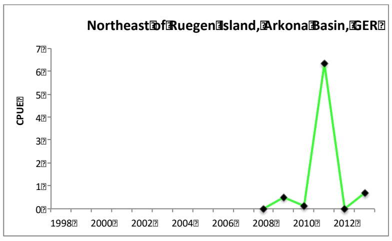


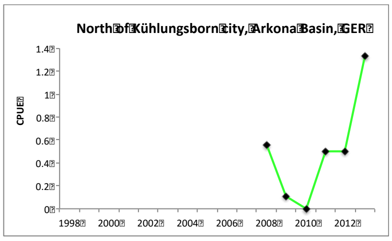
Arkona Basin

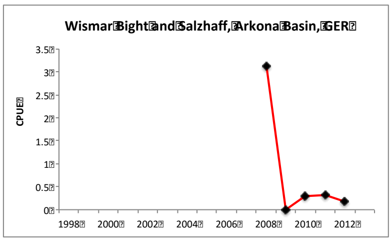


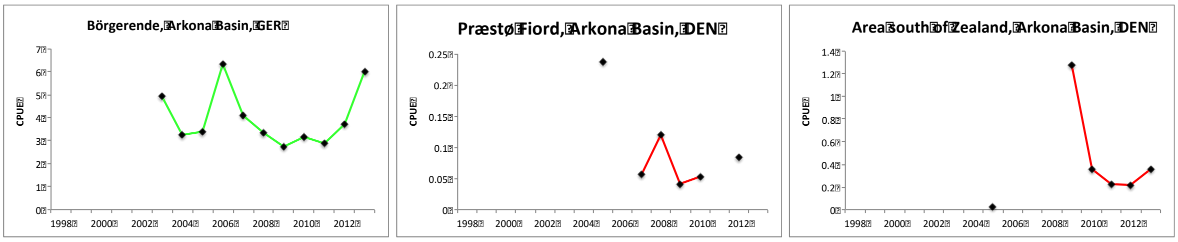




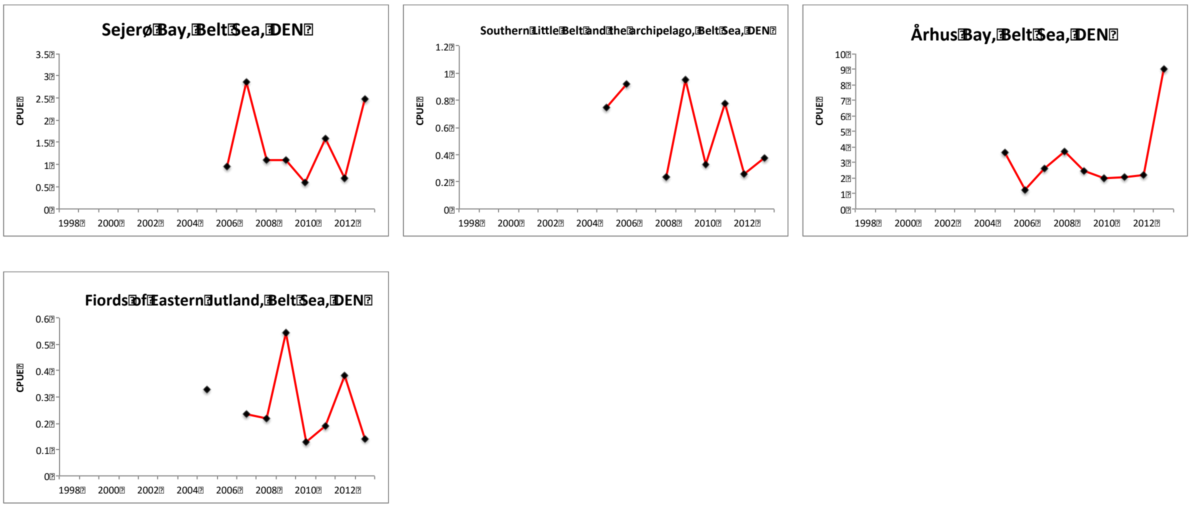




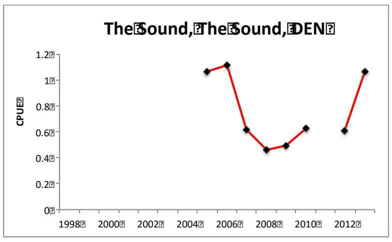




Belt Sea



The Sound



Kattegat

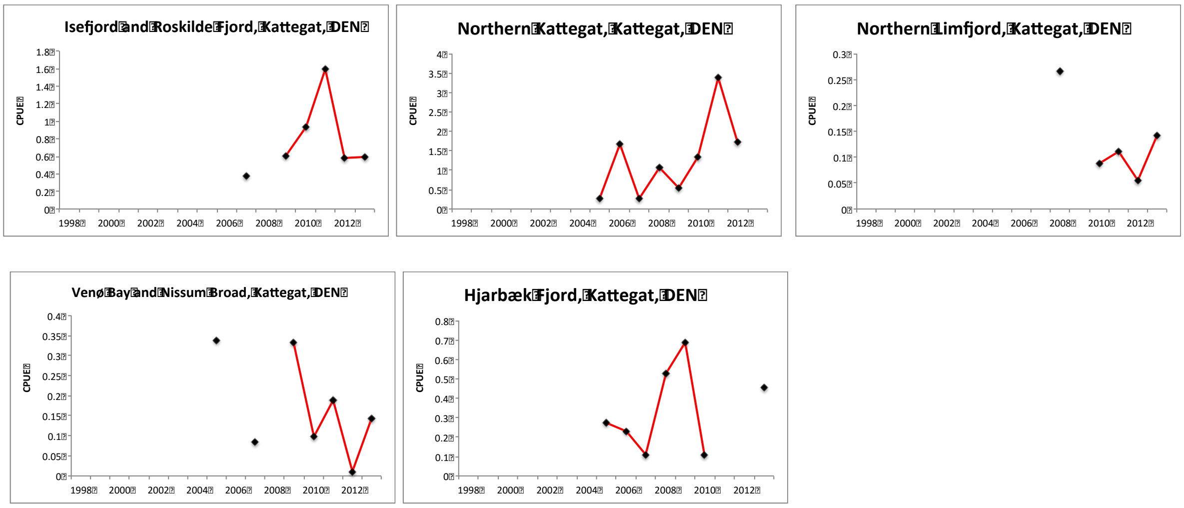


Figure 1. Temporal development of piscivorous coastal fish species per sub-basin in the different monitoring locations assessed. A green line denotes GES in locations with a trend-based assessment, and a red line denotes sub-GES. For

some locations a baseline approach is applied. Here the red field represents sub-GES conditions, the green field GES conditions, and the black line the median of the assessment period.

Cyprinids

The environmental status in the Baltic Sea assessed on the basis of the abundance of cyprinids is generally not good. In half of the assessed locations (12 out of in total 24 areas) GES is not achieved, and only in seven out of 16 assessment units GES is achieved. In the majority of the locations classified as sub-GES (7 out of 12), the abundance of cyprinids was at too high levels (GES high), however in four Swedish locations (in the Bothnian Bay and Gotland basin), and in the only Estonian location (Hiiumaa) the abundances appear to be too low to reflect GES (GES low) (Figure 2).

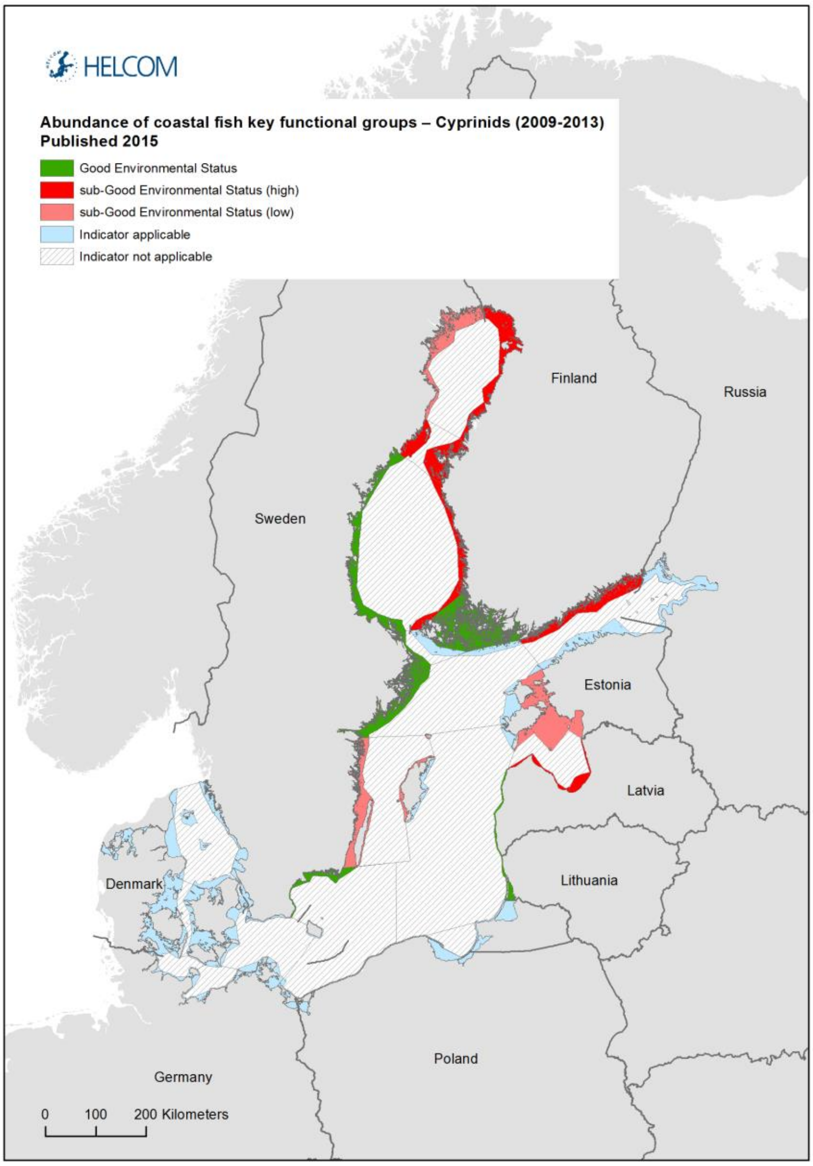


Figure 2. Spatial representation of the status evaluating, also detailing in if the sub-GES evaluation was due to cyprinid numbers having been considered too high or too low to reflect GES.

Since monitoring and/or fully developed indicators for mesopredatory fish are currently lacking, and evaluation was only carried out for cyprinids in the central and northern parts of the Baltic Sea. Here it appears that sub-GES is characterizing almost the whole Finnish coast with the exception of the Archipelago Sea area. Sub-GES also seems to characterize large parts of the coastline of Latvia and Lithuania. Along the Swedish coast GES is only achieved in the Bothnian Sea, Northern Baltic Proper and Bornholm basin.

In the northernmost parts (Bothnian Bay and The Quark), the status is generally not good (Table 2 and Figure 3). In all but two Swedish locations (Råneå and Kinnbäcksfjärden) the abundance if cyprinids is too high to achieve GES. In some of these locations, the abundance of cyprinids appears to increase over time.

In the Bothnian Sea, Åland Sea and Archipelago Sea, the relative abundance of cyprinids is generally stable along the Swedish coast and Archipelago Sea (indicating GES), whereas along the Finnish Bothnian Sea coast the abundance is too high (Figure 3).

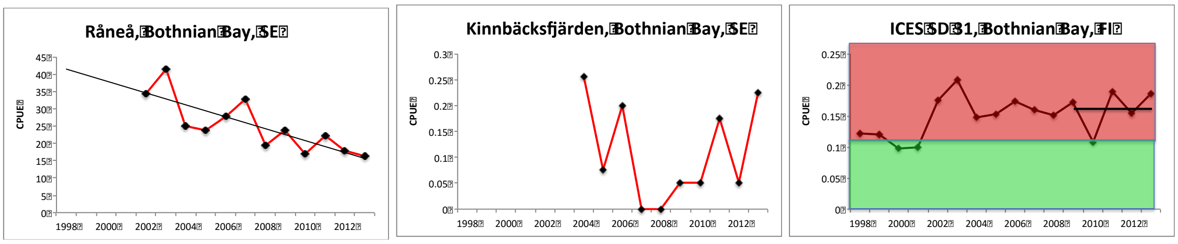
In the central part of the Baltic Sea (Northern Baltic Proper, Gulf of Finland, Gulf of Riga and Gotland Basin) the status of the evaluated fish communities with respect to cyprinids is overall not good. All but two of the eight locations in total (Jurkalne, Latvia and Monciskes/Butinge, Lithuania) are characterized by sub-GES (Table 3). In the southern most locations assessed (Torhamn, Bornholm basin) the environmental status of cyprinids is good.

Table 2. Status assessment per monitoring area and assessment unit for cyprinids.

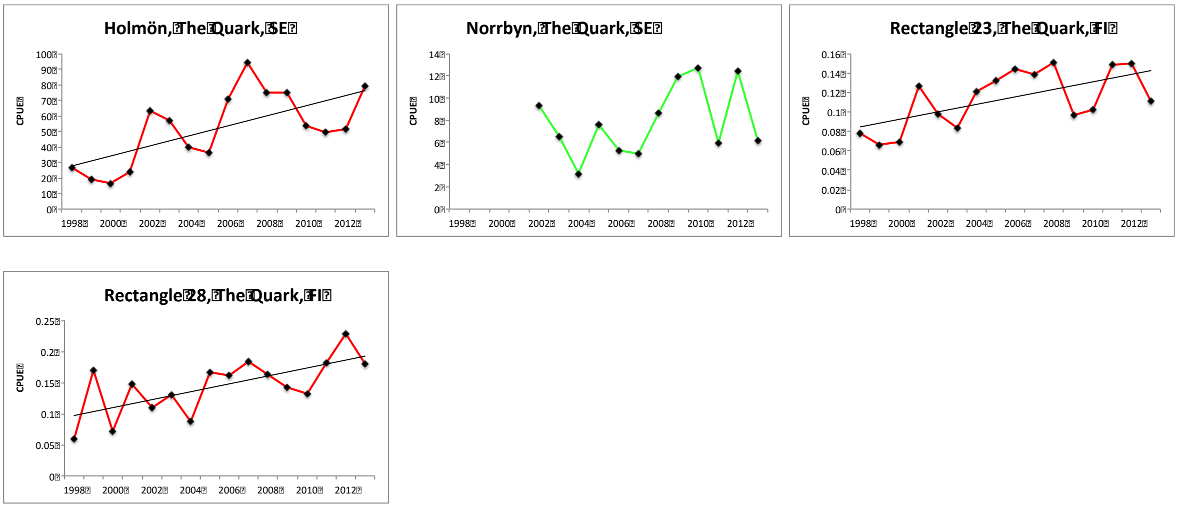
Subbasin	Country	Monitoirng area	Period	Coastal water type	Assessment method	Status	Comment
Bothnian Bay	Finland	ICES SD 31	1998-2013	Bothnian Bay Finnish Coastal waters	Baseline	subGES	High
Bothnian Bay	Sweden	Råneå	2002-2013	Bothnian Bay Swedish Coastal waters	Trend	subGES	Low
Bothnian Bay	Sweden	Kinnbäcksfjärden	2004-2013	Bothnian Bay Swedish Coastal waters	Trend	subGES	Low
The Quark	Finland	Rectangle 23 & 28	1998-2013	The Quark Finnish Coastal waters	Baseline	subGES	High
The Quark	Sweden	Holmön	1998-2013	The Quark Swedish Coastal waters	Baseline	subGES	High
The Quark	Sweden	Norrbyn	2002-2013	The Quark Swedish Coastal waters	Trend	GES	
Bothnian Sea	Finland	ICES SD 30	1998-2013	Bothnian Sea Finnish Coastal waters	Baseline	subGES	High
Bothnian Sea	Sweden	Gaviksfjärden	2004-2013	Bothnian Sea Swedish Coastal waters	Trend	GES	
Bothnian Sea	Sweden	Långvindsfjärden	2002-2013	Bothnian Sea Swedish Coastal waters	Trend	GES	
Bothnian Sea	Sweden	Forsmark	1998-2013	Bothnian Sea Swedish Coastal waters	Baseline	GES	
Åland Sea	Sweden	Lagnö	2002-2013	Åland Sea Swedish Coastal waters	Trend	GES	
Archipelago Sea	Finland	ICES SD 29	1998-2013	Archipelago Sea Coastal waters	Baseline	subGES	High
Archipelago Sea	Finland	Finbo	2002-2013	Archipelago Sea Coastal waters	Trend	GES	
Archipelago Sea	Finland	Kumlinge	2003-2013	Archipelago Sea Coastal waters	Trend	GES	
Northern Baltic Proper	Sweden	Askö	2005-2013	Northern Baltic Proper Swedish Coastal waters	Trend	GES	
Gulf of Finland	Finland	ICES SD 32	1998-2013	Gulf of Finland Finnish Coastal waters	Baseline	subGES	High
Gulf of Riga	Estonia	Hiiumaa	1998-2013	Gulf of Riga Estonian Coastal waters	Baseline	subGES	Low
Gulf of Riga	Latvia	Daugavgriva	1998-2007	Gulf of Riga Latvian Coastal waters	Trend	subGES	High
Gotland basin	Sweden	Kvädöfjärden	1998-2013	Western Gotland Basin Swedish Coastal waters	Baseline	subGES	Low
Gotland basin	Sweden	Vinö	1998-2013	Western Gotland Basin Swedish Coastal waters	Baseline	subGES	Low
Gotland basin	Latvia	Jurkalne	1999-2007	Eastern Gotland Basin Latvian Coastal waters	Trend	GES	
Gotland basin	Lithuania	Monciskes/Butinge	1998-2011	Eastern Gotland Basin Lithuanian Coastal waters	Trend	GES	
Gotland basin	Lithuania	Curonian Lagoon	1998-2011	Eastern Gotland Basin Lithuanian Coastal waters	Trend	GES	
Bornholm basin	Sweden	Torhamn	2002-2013	Bornholm Basin Swedish Coastal waters	Trend	GES	

All evaluations are displayed per sub-basin for the monitoring locations in the panels of Figure 1 below. Green lines denote a GES evaluation outcome whereas a red line denotes a sub-GES evaluation outcome. In locations where the baseline approach is applied, the GES boundary is displayed as a green and a red field and the evaluation of GES/sub-GES is made for each point in time. The black lines indicate the median of the evaluated period.

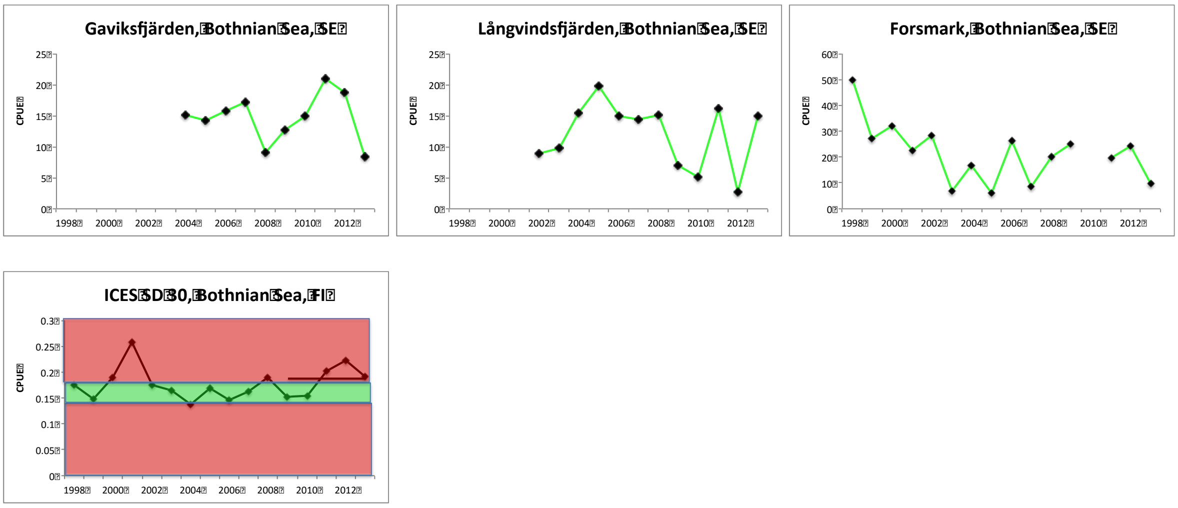
Bothnian Bay



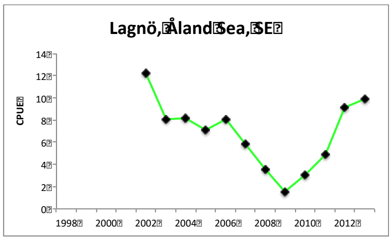
The Quark



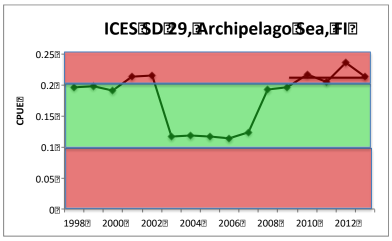
Bothnian Sea

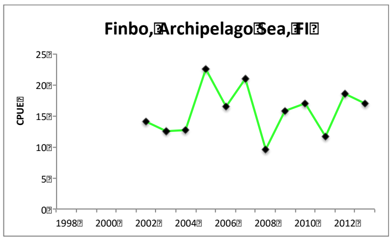


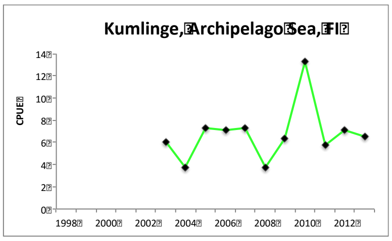
Åland Sea



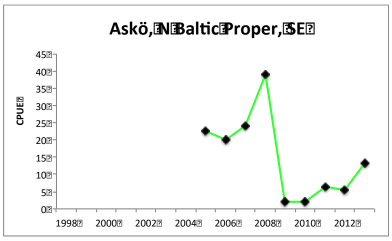
Archipelago Sea



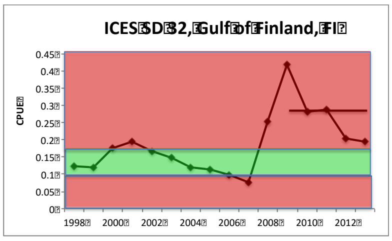




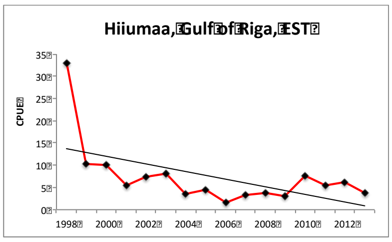
Northern Baltic Proper

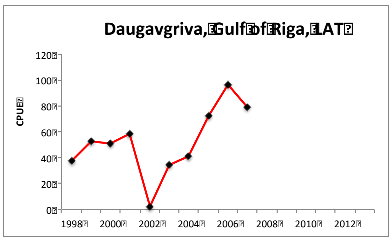


Gulf of Finland

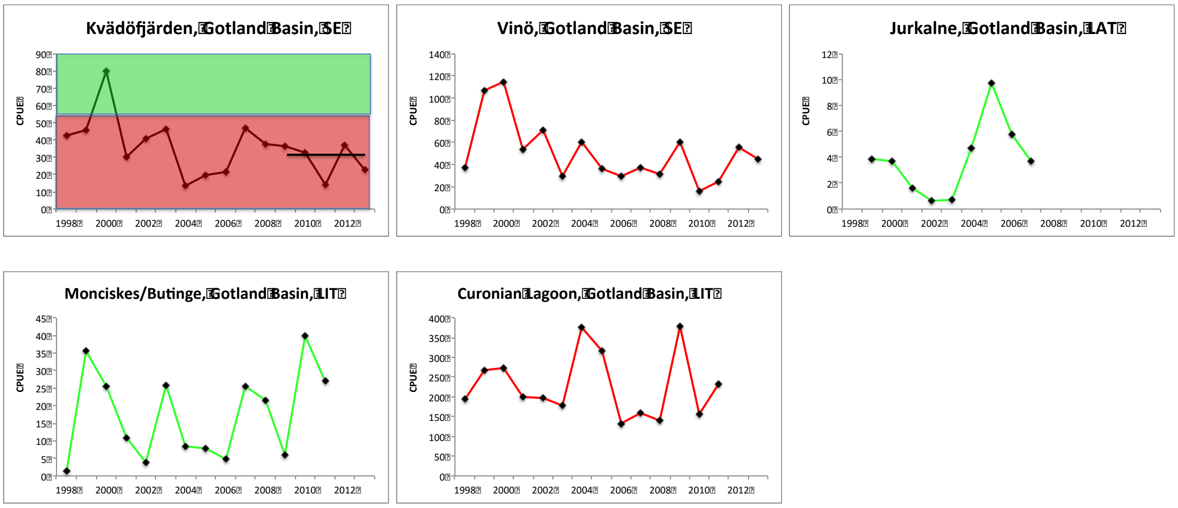


Gulf of Riga





Gotland Basin



Bornholm Basin

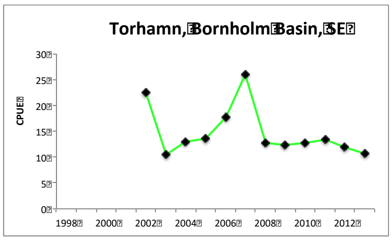


Figure 3. Temporal development of cyprinid coastal fish species per sub-basin in the different monitoring locations assessed. A green line denotes GES in locations with a trend-based assessment, and a red line denotes sub-GES. For some locations a baseline approach is applied. Here the red field represents sub-GES conditions, the green field GES conditions, and the black line the median of the assessment period.

Confidence of the indicator status evaluation

To date, no approach for rigorously determining the confidence of the status evaluation has been developed for coastal fish indicators. The confidence might, however, vary across assessment units, countries and monitoring programs. For example, the number of years of coastal fish monitoring underpinning the evaluation in different assessments units varies. Generally, however, in the locations where monitoring started before 1999, the confidence of the evaluation is higher, whereas for the locations with a shorter time-perspective the confidence is lower. Also, a low catch level of the target species (as in Denmark) might lower the confidence of the status evaluation.

Some assessment units cover relatively large coastal areas with few monitoring programs, making the evaluation of lower confidence. Also, due to the fact that coastal fish communities are typically more local in their appearance than the scale of assessment units applied in the indicator, there might be differing evaluations at different monitoring programs within an assessment unit yielding a lower confidence of environmental status. On the contrary, in those assessment units covering rather limited geographical area with several monitoring locations with the same status, the confidence is naturally higher.

As different gears and methods are used in different countries to monitor coastal fish, evaluations are not directly comparable across locations. However, each data point presented here represent an yearly average across several observations (numbers differs across monitoring programs), and since the evaluation of status within each location is based on reference conditions within that specific location and the specific gear used, the confounding effects from differences in methodology is not likely to form a substantial issue that would lower the overall confidence of the evaluation.

To improve confidence of the evaluation, longer time series are obviously needed in some monitoring locations, and some additional monitoring data. Also work is needed to develop a quantitative approach by which to determine the confidence of the evaluation, and principles for aggregating status evaluation across areas and indicators.

Monitoring requirements

Monitoring methodology

The HELCOM common monitoring on coastal fish is described on a general level in the HELCOM Monitoring Manual in the sub-programme: Coastal fish. Monitoring guidelines specifying the sampling strategy are adopted and published.

Description of optimal monitoring

There are spatial and temporal gaps in the current monitoring. In relation to the presence of natural environmental gradients across the Baltic Sea (Voipio, 1981), and the rather local appearance of coastal fish communities in their structure and response to environmental change, there is poor spatial coverage in some areas (Figure 3). Therefore, assessments in some of these areas have to be based on alternative data sources such as analyses of CPUE data from commercial fisheries (Olsson et al. 2015). Furthermore, the levels of direct anthropogenic impact in the existing monitoring areas are low, and future venues should also assess the status in more impacted areas (Östman et al in revision).

It is crucial to stress that the current monitoring of coastal fish in the Baltic Sea represents a minimum level of efforts, and serves as a first step for assessing the status of coastal fish communities. The current monitoring is likely yielding insights into the major and large-scale changes in coastal fish communities in the Baltic Sea, but unique and departing responses in some areas are possible.

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 dominate 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 fulfil 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.

Current monitoring

Coastal fish monitoring is rather wide-spread in the Baltic Sea (Figure 3), and does at present in some form cover 34 of in total 42 assessment units for the HELCOM assessment unit scale 3. For a more detailed description of the monitoring see above paragraphs and HELCOM (2015). For piscivores the current monitoring covers all the 34 assessment units (Figure 4), with a good spatial coverage. For cyprinids, the coverage of monitoring is poorer (26 out of 42 assessment units; Figure 4), partly due to the restricted occurrence of the species group (see above. The current assessment is based on data updated until 2013, but covers only 18 of the 42 assessment units for piscivores, due to either lack of monitoring and temporal coverage, lack of financial support to conduct the assessments, and a lack of operational indicators to assess the status (typically on the west coast of Sweden, units 39 and 41). For Cyprinids a status assessment are only performed in 24 areas representing 16 assessment units (Table 2). Currently no assessment for mesopredatory fish is conducted due to lack of data and indicators.

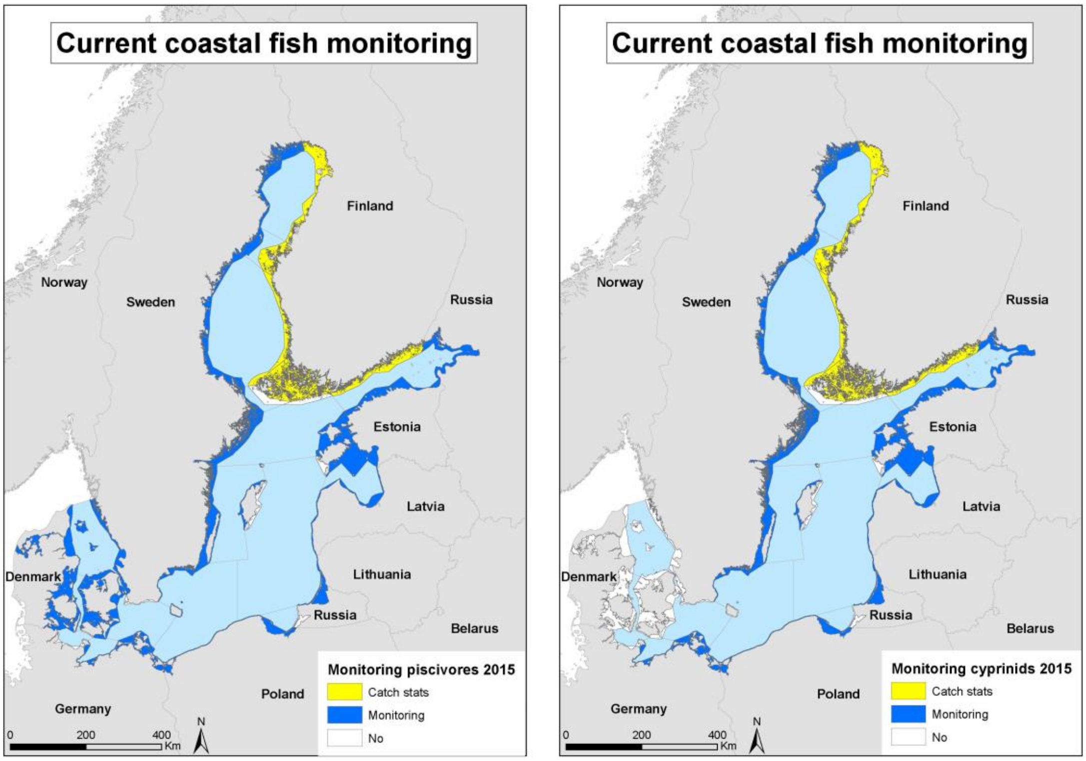


Figure 4. Coverage of HELCOM assessment unit scale 3 for current coastal fish monitoring of piscivores (left) and cyprinids (right). Catch stats = commercial catch statistics, Monitoring = fisheries independent monitoring, No = no current monitoring

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 3). 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, 2015). 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 was used instead of gillnet monitoring data.

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 state 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., 2012). 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 have followed a different development trajectory compared to those in the Gulf of Bothnia, but similar patterns are seen within the Gulf of Bothnia (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. 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 coastal fish communities and the levels for which reference states are defined for these, must be set within a relatively small geographical scale, at largest within the HELCOM assessment unit 3 as used in this assessment.

The longest gillnet monitoring time series included in this assessment covers the last 24 years and were initiated in 1987. Many of the monitoring programs were, however, started later during the 1990s. Since the late 1990s and early/mid 2000s data are available for the majority of areas, and the current assessment hence cover this period in time. In Finland, effort based commercial catch statistics (CPUE) from the gillnet fishery are available since 1980, but to enable comparisons of the assessments across areas, Finnish data were only included from 1998.

Since monitoring and assessments in Latvia ceased in 2007, no further indicator updates and status assessments can be undertaken. Also, in Lithuania monitoring is only undertaken every third year, so no further update since 2011 is available. In Estonia, coastal fish monitoring is undertaken at several locations (Figure 3), but the assessment has only been carried out in one location (Hiiumaa).

Description of data and up-dating

Metadata

Data are typically collected annually in August by national and regional monitoring programmes. Commercial catch statistics in Finland represent total annual catches. See HELCOM (2015) for details.

For future updates of this assessment, data should be collected on an annual basis.

A few time series of coastal fish monitoring began in the 1970s (Olsson et al. 2012), whereas other were started in the 1980s (HELCOM 2012). The majority of the available time series of coastal fish community structure were, however, initiated in the mid 1990's (HELCOM 2012). In Finland and Sweden a new coastal fish monitoring programme with a higher spatial resolution was established in the early 2000s (HELCOM 2012).

The raw data on which these assessments are based, are stored in national data bases and extracted for assessments. Each country has their routines for quality assurance of the stored data. No common data storage system hence currently exists for coastal fish CORE indicator data. Different options for developing a regional database for the coastal fish CORE indicators (i.e. not raw data) are currently being investigated. The aim is to clarify options for data-arrangements for the purposes of the core indicator during 2015.

Data source

Coastal fish monitoring using gill-nets is performed annually in all Baltic Sea countries, coordinated within the HELCOM Fish PRO II expert network. The network includes data from fisheries independent monitoring in Finland, Estonia, Latvia, Lithuania, Poland, Germany, Denmark and Sweden. Coastal fish communities in the Baltic Sea areas of Russia are to some extent monitored as well. In Poland, a fishery independent coastal fish monitoring programme was established in 2014 (see Figure 2) and since no time series data exist, data from Poland was hence not included in the current assessment. In Germany, data is derived from coastal fish monitoring within national projects as the artificial reef programme outside Rostock/ Warnemünde off the summer resort Nienhagen (since 2002), the eel monitoring programme along the coastline of Mecklenburg-Western Pomerania (since 2008), and the coastal trawl survey in the Pomeranian Bay by the University of Rostock (since 2003). None of these three projects have a long-term secured funding. In Denmark, there is no coastal fish monitoring program and the data provided relies on voluntary catch registration by recreational fishermen through the 'key-fishermen' project, without long-term secured funding (initiated in 2005). Since the monitoring programme in Finland has limited geographic coverage, the state of coastal fish communities in Finland is assessed using estimates of catch per unit effort (CPUE) from the small scaled coastal commercial fishery. Additional locations are monitored than the locations currently included in the assessment (HELCOM 2015), due to lack of national funding for carrying out status assessments in some countries.

Responsible institutes for sampling are Natural Resources Institute Finland (Luke) (Finland), Provincial Government of Åland Islands (Finland), Estonian Marine Institute, University of Tartu (Estonia), Institute of Food Safety, Animal Health and Environment "BIOR" (Latvia), Nature Research Center (Lithuania), National Marine Fisheries Research Institute, Gdynia (Poland), Association Fish and Environment Mecklenburg-

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