Baltic Sea Environment Proceedings No. 103 B

Changing Communities of Baltic Coastal Fish

Executive summary: Assessment of coastal fish in the Baltic Sea

Helsinki Commission

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Coastal fish – a combination of freshwater and marine species

Coastal fish communities are important components of Baltic Sea ecosystems. These communities consist of fish of various origins: marine species, freshwater species, migratory species, and glacial relicts. Representatives of these categories have different preferences for environmental conditions. For example, marine fish prefer more saline areas, freshwater fish prefer less saline areas, and glacial relicts are more abundant in cold-water layers in deeper areas. The composition of coastal fish communities varies in the different regions of the Baltic Sea in relation to the different habitat characteristics of these regions, with salinity, water temperature, and nutrient availability among the important factors. Other important factors include seabed type for bottom-dwelling fish, and algal and seagrass conditions in shallow waters for near-coastal species.

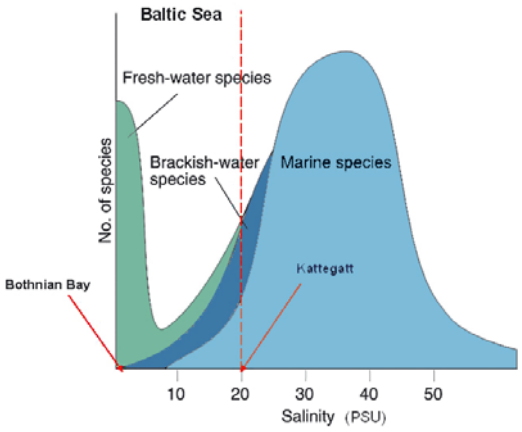


Figure 1.
The number of species as well as the number of individuals of marine species decreases with declining salinity. Freshwater species occur throughout the low-salinity areas in the Baltic as well as close to the coast and near river mouths in higher-salinity areas (>10 PSU). This diagram has been adapted from Remane, A. (1934) Die Brackwasserfauna. *Zoologischer Anzeiger (Supplement),* 7, 34–74.

In particular, the distribution of fish species in the Baltic Sea is strongly determined by salinity, which decreases towards the north and the east. Both the number of species and the number of individuals of marine species decrease with declining salinity. While

European perch *(Perca fluviatilis)*

The European perch is a very common fish which often occurs among aquatic vegetation but also along deeper bottoms. Perch have a clear daily rhythm: during the summer it feeds most actively in early morning and late evening whereas during winter it only has one active period during the day. Perch in coastal waters spend their nights alone along the sea floor but gather into schools in the morning.

Perch travel long distances to their feeding, wintering and spawning grounds. Perch use available food flexibly and depending on their size they feed on zooplankton, benthic organisms and/or other fish. They can live up to the age of 15 years.

Roach *(Rutilus rutilus)*

Roach is a very common fish in all coastal areas of the Baltic Sea. It usually occurs among vegetation in shallow coastal waters. During the day roaches move in schools, but at night they are solitary and stay close to the seafloor. Roaches feed mostly on mussels and clams, and juvenile roaches feed on zooplankton. During the summer however, they also feed on insects and aquatic plants that they grab from the water surface. Roaches can live to an age of 30 years.

Ruffe *(Gymnocephalus cernuus)*
Ruffe is a common fish and can be found in many different types of water. It occurs predominantly in darkish water along soft bottoms. Its main diet consists of insects and their larvae as well as molluscs but larger individuals may also eat small fish. In addition, it enjoys eating the fry of other fish species.

Common bream *(Abramis brama)*
Common bream occurs most commonly in vegetation rich bays with soft bottoms. It feeds on benthic organisms such as bivalves, clams, worms and larvae which it can suck up from a 10 cm depth in the sediment. During the winter, common bream moves to the outer edges of archipelagos where waters are deeper.

Common bream spawns in early summer on shallow vegetated bottoms. It spawns for the first time at an age of 6-9 years and can live to be up to 30 years old.

Zander or pikeperch *(Sander lucioperca)*
Zander prefer deep, murky but oxygen rich waters. It moves about in small schools or individually, spending

freshwater species occur throughout the low-salinity areas in the Baltic, in higher-salinity areas (>10 PSU) they appear close to the coast and near river mouths. Several marine species are found in the Baltic Sea; flounder is a marine species that is tolerant to lower salinities and thus occurs widely over the Baltic Sea, except in very low-salinity areas. Baltic herring is probably the most widespread fish species of marine origin in the Baltic Sea.

Pressures on coastal fish communities

Coastal fish communities are impacted by human activities, including fishing, runoff or discharges of nutrients, heavy metals, and toxic organic contaminants from agriculture, industry, or municipalities, the construction of structures affecting the habitat, and shipping (oil discharges, antifoulants, and transport of non-native species).

Nutrient enrichment causing eutrophication is a major factor influencing the composition and long-term development of the Baltic fish community, causing increased production of fish biomass and changes in fish community structure and function.

Predation by other marine biota also has an effect on coastal fish populations. There has been an increase in the populations of grey seals in the Baltic Sea since the late 1970s, after their population had reached the lowest level of the century. Grey seals mainly consume Baltic herring, but also a number of other species including common whitefish and European sprat. Seabirds, such as cormorants, also consume significant quantities of coastal fish. It is likely that the number of cormorants is now more numerous than ever before and is still increasing in the Baltic region.

Monitoring activities

In order to determine the potential effects of human activities on coastal fish communities, as well as the amelioration of effects

when measures have been taken against particular sources of human impact, a programme of annual monitoring of coastal fish in the Baltic Sea was initiated in the mid-1980s. The coastal fish monitoring programme is to be conducted according to a specific procedure in terms of the fishing gear and amount of fishing effort used, so that the results can be compared among the areas monitored. Fourteen areas are currently being monitored using three specific types of gillnets along the coasts of the Baltic Proper, the Gulf of Bothnia, the Gulf of Finland, and the Gulf of Riga, by Sweden, Finland, Estonia, Latvia, and Lithuania. Poland also participates at a fifteenth area along its coast, but employs a different type of sampling gear so the results are not comparable with those using gillnets. The "Co-ordination Organ for Baltic Reference Areas" (COBRA) coordinates this programme and maintains a database of the results. Fish in the coastal areas of Denmark, Germany, and Russia are also monitored, but results from these areas have not been included in this assessment.

Species and communities as indicators

The results of the coastal monitoring programme have shown that larger numbers (expressed as catch of individual fish per unit effort) of roach and other cyprinid fish species are caught in areas with less transparent water, indicative of eutrophic conditions. The largest catches of roach and other cyprinids in 2004 were in the Curonian lagoon, an area that has been subjected to a high nutrient load.

The coastal monitoring programme results have been analysed in relation to several indicators that have been proposed to describe the status and trends of coastal fish in the Baltic Sea. These indicators are: species richness, abundance, biomass, and the ratio between European perch and roach based on weight. Additional issues include whether there are species that are

winters in deep waters and moving to shallow areas in spring and early summer. During the summer, zander spends its days in deeper waters and moves to shallower areas to feed during darker hours. Juvenile zanders feed on zooplankton and crustaceans, but upon reaching a size of 5-15 cm they begin to prey on fish such as European smelt, roach, vendace, perch and herring. Zander can live to an age of 20 years.

Northern pike *(Esox lucius)*

Northern pike is typically found in shallow coastal lagoons although it can also be found in bladderwrack "forests" in outer archipelago areas. The pike is a fairly localised fish with each individual having its own feeding territory. It is a predatory fish that eats roach, herring, perch, viviparous blenny, three-spined stickleback, but also other pikes, water bird chicks and frogs. Pikes are most active during dawn and dusk.

Prussian carp *(Carassius gibelio)*

Prussian carp was originally introduced into Germany from Southeast Asia in the 16th century and has recently made its way into the Baltic Sea, where its distribution has expanded strongly in some areas. In several areas it is already the dominating species. Its abundance has increased so much that it has attained the status of a commercial fish species in the Curonian lagoon and the Gulf of Riga.

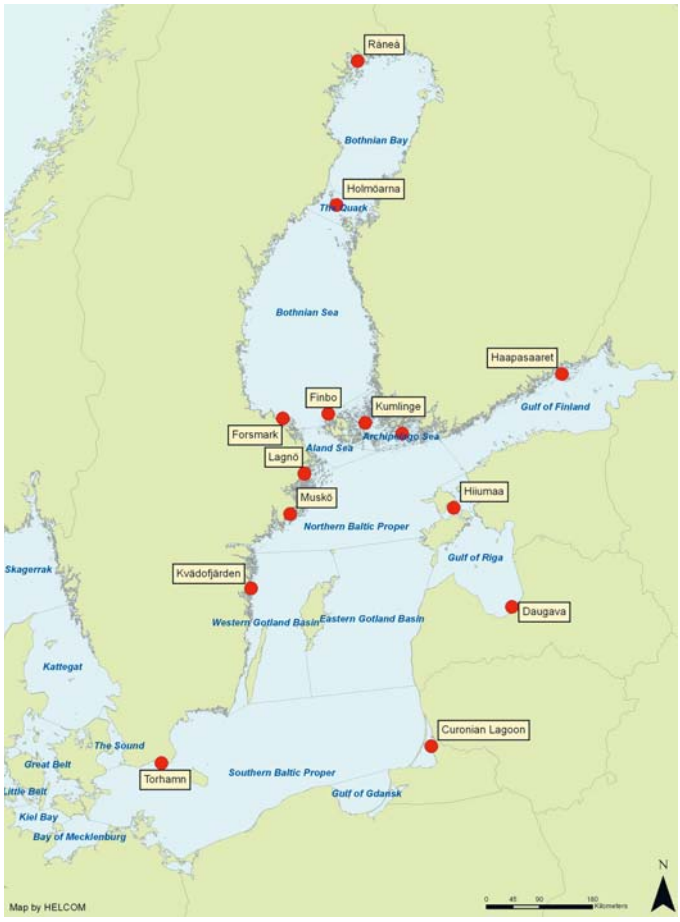


Figure 2.
Sampling locations for coastal fish monitoring under the COBRA programme, including the gear used and the first year of sampling.

Coastal fish monitoring in the Baltic Sea 2004		
Area	Gear	Start year
Råneå	Coastal survey nets	1994
Råneå	Nordic coastal nets	2002
Holmöarna	Coastal survey nets	1989
Holmöarna	Nordic coastal nets	2002
Forsmark	Coastal survey nets	1983
Forsmark	Nordic coastal nets	2001
Finbo	Coastal survey nets	1987
Finbo	Nordic coastal nets	2002
Kumlinge	Nordic coastal nets	2003
Brunskär	Coastal survey nets	1991
Brunskär	Nordic coastal nets	2002
Haapasaaret	Nordic coastal nets	2003
Lagnö	Nordic coastal nets	2002
Muskö	Net series	1991
Hiiumaa	Net series	1991
Kvädofjärden	Net series	1987
Kvädofjärden	Nordic coastal nets	2001
Daugava	Net series	1993
Torhamn	Nordic coastal nets	2002
Curonian lagoon	Net series	1991
Polish EEZ waters	Trawl	1996

threatened or declining and whether non-native species have established populations in the Baltic Sea.

Species richness is a measure of the number of species in a community; values obtained are sensitive to the amount of sampling effort and the type of gear employed. Five to thirteen freshwater species were found in the various sampling areas in 2004, distributed evenly throughout the Baltic. The most common of these species were European perch, roach, and ruffe, which were found in all areas monitored, sometimes in high densities. Considerable numbers of white bream, zander, Northern pike, and bleak were caught in most areas, and noticeable numbers of common bream, ide, rudd, common whitefish, and vimba were also caught in many areas. Few marine species were found in the Gulf of Bothnia or the Curonian lagoon, but Baltic herring was common in all areas except the Curonian lagoon. The second most common marine species was flounder, which was distributed throughout the Baltic Sea except in the more northerly areas of the Gulf of Bothnia.

European perch and roach are the dominant species in most of the areas investigated, and thus are key indicator species in assessing fish community structure and development in the Baltic Sea. Furthermore, European perch is an economically important species, while roach is mainly of environmental interest. Roach is of economical interest in the eastern countries of the Baltic Sea. Time series data on catches per unit effort of these two species in two areas in the archipelago between Sweden and Finland show significant increases in the catch of both species from 1987 to 2004. A simultaneous significant decrease in water transparency in one of these areas suggests that eutrophication may be a reason for the observed changes, particularly in relation to the increase in roach, as it is a member of the cyprinid family of species which tend to be more abundant in eutrophic Baltic waters.

However, in the Curonian lagoon and in four of the eight areas investigated in the Baltic Proper, the catch per unit effort of roach decreased significantly from 1991 to 2004. In the Curonian lagoon, this may be a result of heavy commercial exploitation of roach in the late 1990s.

The trophic level of a fish community reflects both the fish size structure and the position of fish in the food web, and thus the ecological role of the fish community. High values indicate that a large proportion of the species are at higher trophic levels of the food web, for example, that there is a large proportion of piscivorous fish (fish that prey on other fish) in the community. Low values indicate that the community is largely composed of plankton-feeding and benthos-feeding fish species. The trophic level reflects the various types of pressures on the fish community including fishing. As commercial fisheries often target piscivorous fish, low or decreasing abundances of piscivorous fish may indicate high fishing pressure, and this is also often reflected in a decrease in the trophic level of the fish community. In the results of coastal fish monitoring, areas with high abundances of piscivorous fish were similar to those of high trophic levels.

The trophic level of coastal fish communities was calculated for all areas monitored based on the weight of the catch per unit effort

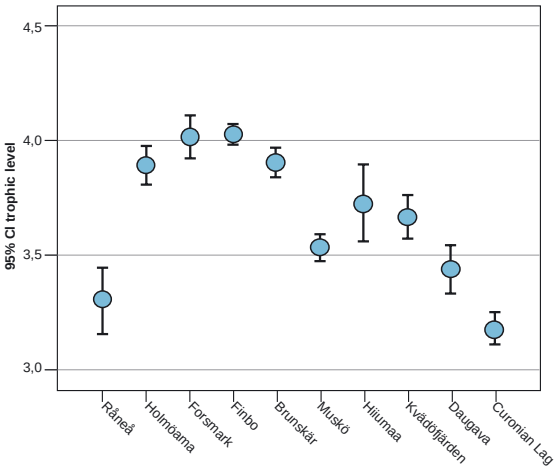


Figure 3.
Average trophic level of the fish communities in the areas monitored. The time series for the various areas ranges from 5 to 17 years.

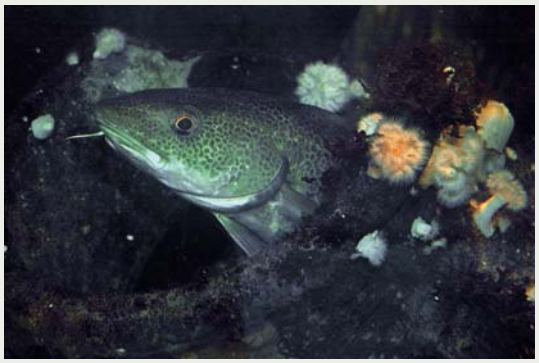
Round goby
(Neogobius melanostomus)

Round goby is native to the Caspian Sea, northern Black Sea, Sea of Azov, and their tributaries. They generally inhabit shallow areas of the sea and lower to middle reaches of rivers in brackish or fresh water, but have been known to overwinter in water as deep as 60m.

Round gobies are voracious feeders and consume a wide variety of benthic organisms. In its native habitat, the round goby poses no identifiable threat to the populations of any other species, most likely because it has co-evolved with other natives over time. Outside its native habitat however, round gobies actively compete with native species for limited food resources and nesting habitats. Their aggressive behavior, large size, and prolific reproduction have enabled round gobies to successfully displace or diminish other species. Not only do they out-compete most other benthic fish for food but they are also presumed predators on the eggs of other benthic fish, thus diminishing the populations of their competition at the same time that they are able to out-compete their rivals.

Common whitefish
(Coregonus lavaretus)

There are two kinds of common whitefish in the Baltic Sea - one which spends its whole life in the sea and the other which migrates to spawn in rivers like salmon and sea trout. The marine common whitefish are quite localised and general move perpendicular to the shoreline from the shallow coastal waters to deeper ones. As they like cold water, they tend to spend summers in the deeper waters of the outer archipelagos and during other times of the year closer to the shore. Whitefish eat small zooplankton and phytoplankton but adult individuals with sparer teeth also eat benthic organisms and fish fry.



Cod *(Gadus morhua)*

Cod is a widespread species in the Baltic Sea. It is a marine species, and therefore the amount of cod in the northern parts of the Baltic Sea depends on the success of spawning in southern areas of the Baltic. Cod live in deep cold waters close to the sea floor, though when it is dark they may also rise up closer to the surface. Cod are most active during dawn and dusk and feed on a large amount of herring and sprat as well as on many benthic organisms.

Cod spawn in the deep waters off the southern coast of Gotland, Bornholm Deep and the Gulf of Gdansk. The success of spawning is affected by water quality as their eggs will only float and survive in fairly salty and oxygen-rich water.

Cod is an important species for commercial fisheries, but stocks are dwindling due to fishing pressures and the degradation of the marine environment.

Flounder *(Platichthys flesus)*

Flounder occurs all over the Baltic Sea, although less frequently in the far reaches of the Gulf of Finland and the Bothnian Bay. Flounder is typically found on sandy bottoms where it covers itself with sand, but also occurs on rocky bottoms. Flounders spend winters in deeper waters away from the shore, and in late summer when surface waters are warm they also escape to cooler waters at depths of 10-30 metres. Flounders feed on invertebrates. They can also survive in fresh water and occasionally wander into rivers.

and adjusted by species-specific values for trophic level. The highest values of trophic level were found in the Northern Quark and in the archipelago regions of Sweden and Finland (see figure 3); these archipelago regions have also shown significant increasing trends in the abundance of piscivorous fish, where in 2001–2004 high abundances were found particularly of large European perch and also to a lesser extent of zander. The Kvädöfjärden areas have also shown a significant increase in trophic level over time, indicating an improved environmental situation. The lowest values of trophic level were observed in the northernmost area of the Bothnian Bay and in the eastern areas of the Baltic Proper (Daugava in the Gulf of Riga and the Curonian Lagoon). The low values in Daugava and the Curonian Lagoon may partly be explained by the high fishing pressure on piscivorous fish species in these areas.

In terms of fisheries, the coastal monitoring programme results in the West-Estonian Archipelago Sea reflect the drastic decline in the abundance of European perch in this area owing to overexploitation (see figure 4); Northern pike and zander are also over-exploited in this area. Similarly, the significant decrease in zander catch observed in the Daugava monitoring area of the Gulf of Riga is probably also related to the high fishing pressure.

Threatened fish species

There are a number of threatened species of fish in the Baltic Sea, several of which are either of local importance in the HELCOM area or of global importance. HELCOM has developed a high priority Red List of threatened and declining species, and a recent workshop has proposed the inclusion of 184 fish species on this list, of which 34 species are considered of high priority, 70 species of medium priority, and 80 species of low priority for conservation. The current coastal fish monitoring programme is able to monitor for only a small proportion of these species, as small-bodied species

(such as sticklebacks, gobies, and sandeels) and species living on hard substrates are not sampled. Thus, many threatened and declining fish species are not yet covered by this monitoring programme

Alien fish

There are a number of non-native fish species living in the Baltic Sea, many of which were introduced intentionally for the enhancement of commercial stocks in the second half of the 20th century. Few of these have been able to form self-sustaining populations in the Baltic Sea, and thus, in general, the ecological impact of alien species at the scale of the entire Baltic Sea is considered to be low. However, two non-native fish species have become of concern: the round goby and the Prussian carp. The round goby was first found in the Baltic Sea in 1990 in the Gulf of Gdansk, the result of unintentional introduction probably as a result of ships' ballast water. Now it has been found along the coasts from the north coast of Germany, the Gulf of Gdansk, various locations along the east coast of the Baltic Proper, the northeast Gulf of Riga, the Archipelago Sea, and the Gulf of Finland. A self-sustaining population has been established in the Gulf of Gdansk area. In this area, it is displacing several native demersal fish species owing to its competition for food, space, and spawning areas.

Future monitoring for assessing ecological status

An outcome of this first overall assessment of the results of the coastal fish monitoring programme will be a further development of this programme to integrate it with other coastal monitoring programmes to work towards an ecosystem approach to coastal zone assessment and management. This will include the development of the monitoring programme to provide a basis for estimating the ecological status of the coastal fish compartment and thus serve as a means for following progress in the achievement of management objectives

Salmon *(Salmo salar)*

Salmon is an open sea fish that migrates long distances from the remote reaches of the Bothnian Bay and the Gulf of Finland to the more central and southern parts of the Baltic Sea. At sea, salmon usually follow schools of herring and sprat but they also eat European smelt, three-spined sticklebacks and small sandeels. Salmon spend the first 1-6 years of their lives in the river where they are born before migrating to open sea areas. After spending 1-4 years in the open sea, salmon make their first migration, returning to the river where they were born to spawn.

Salmon is a valuable species for fisheries however their stocks have suffered, especially as a result of damning of many spawning rivers.

Baltic herring *(Clupea harengus)*

Herring occur in large schools throughout the Baltic Sea region with clearly different stocks in the different areas. Herring tend to make seasonal migrations between coastal archipelagos and open sea areas, staying close to the coast during spring and autumn while spending summer in nutrient rich open sea areas. Older herrings move into deeper waters of the open sea during winter, whereas younger individuals tend to remain close to the coast.

Herrings feed primarily on zooplankton, however, older ones may feed on fish fry. The number of Baltic herring has decreased due to falling salinity levels, changes in the amount of zooplankton as well as over-fishing. The Baltic herring is one of the most important catches for fisherman in the Baltic Sea region.

Sprat *(Sprattus sprattus)*

Sprat live in schools throughout the Baltic Sea, though not as commonly in the Bothnian Bay. Sprat is an open sea species which is rarely found along the coast. Sprat migrate in open water areas seeking out warmer water layers during the different seasons because they freeze if the water temperature drops to less than 2-3 degrees. During harsh winters the distribution of sprat shrinks and the density of fish increases. Sprat eat plankton as well as cod fry.

Sprat is an important species in fisheries although the fluctuations in the stocks limit its use for commercial purposes.

regarding coastal fish. Suggested objectives are:

– To restore and maintain the structure and function of coastal fish communities;
– To restore and maintain the species and genetic diversity of coastal fish, including commercial species;
– To restore and maintain healthy fish on an individual level and to ensure healthy fish populations, without causing harm either to other marine biota or to human populations.

Relevant indicators for coastal fish objectives will be further developed and assessed from both an ecological and a statistical point of view. The indicators used for the assessment of coastal fish communities should be selected according to the properties of local fish populations. However, the assessment should always include indicators involving the most dominant species such as European perch and roach.

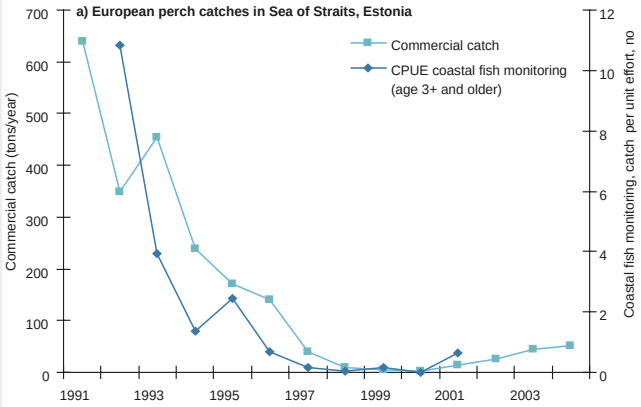


Figure 4.
Coastal monitoring programme results in the West-Estonian Archipelago Sea reflect the drastic decline in the abundance of European perch in this area owing to overexploitation. (CPUE = catch per unit effort)

The monitoring programme also needs to be extended to cover all HELCOM coastal areas, including the southern Baltic Sea and the Kattegat, and the procedures should be expanded to sample also small-sized fish and to cover the cold season and deeper waters. The monitoring of threatened and declining species should also be improved, and new methods for non-lethal surveillance should be developed for this purpose. Finally, an analysis of the impact of fishing activities on coastal fish communities should be included in all future assessments of coastal fish.

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