

## Abundance and distribution of round goby (*Neogobius melanostomus*)

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**Authors:** Riikka Puntila – Finnish Environment Institute; Solvita Strake – Latvian Institute of Aquatic Ecology; Ann-Britt Florin – Swedish University of Agricultural Sciences, Department of Aquatic Resources; Rahmat Naddafi, Swedish University of Agricultural Sciences; Maiju Lehtiniemi – Finnish Environment Institute; Jane W. Behrens – National Institute of Aquatic Resources, Technical University of Denmark; Jonne Kotta – Estonian Marine Institute, University of Tartu, Daniel Oesterwind – Thünen Institute of Baltic Sea Fisheries, Ivars Putnis – Institute of Food Safety, Animal Health and Environment (BIOR), Szymon Smolinski and Adam Wozniczka – National Marine Fisheries Institute (NMFRI), Henn Ojaveer – Estonian Marine Institute, University of Tartu, Linas Ložys – Nature Research Centre, Lithuania, Anton Uspenskiy – L.S. Berg State Research Institute on Lake and River Fisheries, Russia; Anastasia Yurtseva – Zoological Institute RAS, Russia.

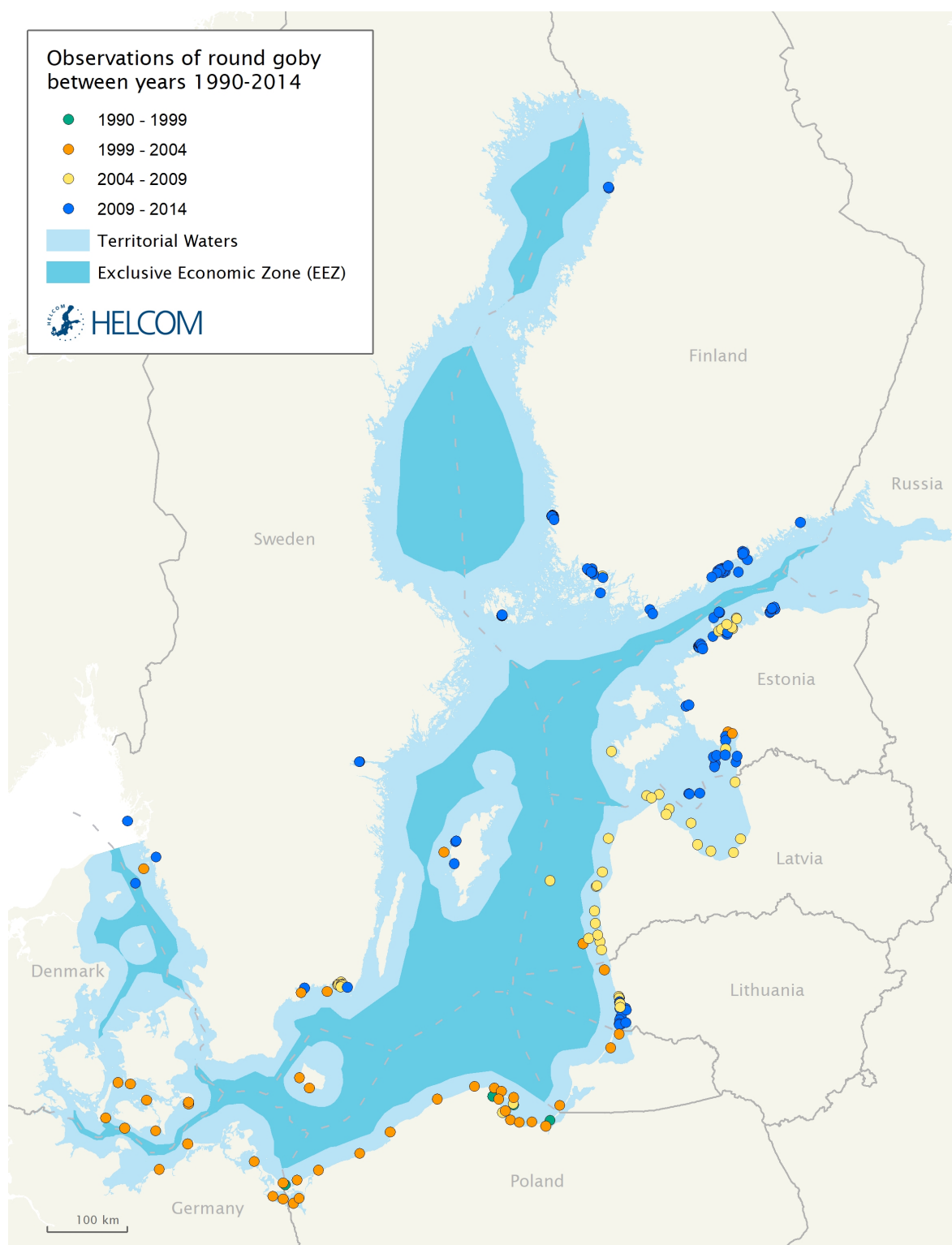
### Key message

The round goby has established in all Baltic Sea sub-basins and is continuously increasing its range and abundance in recently colonized habitats. The species has become the predominant fish species in many coastal areas and poses strong predatory pressure essentially on epibenthic mollusks. It has also become an important prey species in areas where it is numerous, with signs of individual-level benefits for some piscivorous fish.

### Results and assessment

#### Current status in the Baltic Sea

Round goby is an invasive species of Ponto-Caspian origin, likely transported to the Baltic Sea via ballast water (Sapota 2006). It was first observed in the Baltic Sea in Gulf of Gdansk in 1990 (Skóra and Stolarski 1993). Round goby is currently considered as one of the top invasive species in the Baltic Sea (Kornis et al. 2012, Ojaveer and Kotta 2015). It has been established in all Baltic Sea sub-basins (Figure 1).



**Figure 1.** Round goby finding locations in the Baltic Sea expressed as presences. Source: Kotta et al. 2016.

### Population densities

In the Gulf of Gdansk, being the site of first observation of round goby in the Baltic Sea and most likely source of secondary spread, densities up to 350 fish/100 m<sup>2</sup> have been observed (Sapota and Skora 2005). The densities are usually lower in deeper or open waters.

Round goby density along the Latvian open Baltic Sea coast is 1-3 fish per m<sup>2</sup>. The observations in different coastal zone depths show that the highest number of round goby was observed at a depth of 10-15 m, where also the maximum concentration of mussels along the Latvian coast can be found. Moreover, observations in offshore areas show that round goby is successfully colonizing shoal regions in the deepest parts of the Baltic Sea, Latvian EEZ (LIAE2017). Comparable high densities are seen in some Danish waters with 1.9 fish per m<sup>2</sup>, and the invasion front continues to expand here with approximately 30 km per year (Azour et al. 2015).

In Estonia round goby is spreading and expanding its range to new areas. In coastal habitats, its density remains between one and nine individuals per m<sup>2</sup> but occasionally densities above 20 fish per m<sup>2</sup> have been estimated (EMI 2017). In Muuga Bay (Gulf of Finland), the fish has made over 80% of catch biomass in gillnets of mesh size 36-44mm in the 2010s (ICES 2017).

In Muuga Bay (Gulf of Finland), the fish has accounted over 80% of catch biomass in gillnets of mesh size 36-44 mm in the 2010s (ICES 2017). Round goby is also continuing to expand its range in the Swedish waters now commonly occurring from the site of first observation in Karlskrona eastwards along the coast through Kalmar strait and up to Oskarshamn then a gap to the findings in Bråviken and the northernmost findings at Muskö, south of Stockholm (ICES 2017). Round goby was the most common species during test fishing in Muskö in 2017 (Floring & Tärnlund 2017).

One of the highest round goby commercial landings in the Baltic Sea is observed currently in Latvian coastal waters. The fishery logbook data evidence a sharp increase in catches from less than 1 ton in 2011 to over 500 tons in 2016 (Kornilovs 2017).

In Lithuanian coastal waters the density of round goby is not known, however, commercial catches suggest it being very high, as in a quite limited Lithuanian coastal area (100 km wide) over 200 tons of gobies were caught in 2016 and 2017. The species accounted for approximately one third of all catch (in numbers and weight) in research surveys (set of nets: 14, 17, 21, 5, 25, 30, 33, 38, 45, 50, 60 and 70 mm) and thus was the most abundant species in surveyed coastal waters in 2015-2016 (NRC 2016). On the other hand, round goby invasion since 2003 to the mostly freshwater Curonian Lagoon is still limited as numbers of round gobies are low despite that they are found in different parts of the Lagoon, mostly in shallow waters along the shore line. It is not clear what is the key limiting factor, yet possibly predation by piscivorous fish (pikeperch, perch, burbot) and cormorants (NRC 2017).

Round goby was first detected in Finland in the Archipelago Sea in 2005, but populations were probably scarce until the next observation, which was made in Helsinki in 2009. The species then begun to spread rapidly and currently has been detected almost throughout the Finnish coast and on archipelago islands (including Åland islands), indicating a wide-spread distribution (Kotta et al. 2016; current status available at vieraslajit.fi). The northernmost round goby observation has also been made in Finland, in Raahe at

latitude 64.6 °N (Kotta et al. 2016) and density of up to 4 fish/m<sup>2</sup> has been detected (unpublished data). In Finland, no monitoring of population density exists, but round goby appears to be more common every year. Based on angling on the coast of Helsinki, the catch per hour has increased either linearly (Eteläsatama) from 3.4 to 12.0 fish/hour or exponentially (Katajanokka) from 1.6 to 22.8 fish/hour in 2009 - 2013 (Lehtiniemi et al. 2014).

In the eastern part of the Gulf of Finland in the Russian EEZ, the population densities were estimated annually since 2012 by beach seine fishing (A. Uspenskiy, unpublished data). The species has become more common along the southern shoreline. Average densities of round goby were 0.2, 4 and 0.3 individuals per 100m<sup>2</sup> in the Luga and Koporye Bays and the SW part of the Saint Petersburg flood-prevention facility respectively. So far, the fish has not been observed to the east of this facility, inside the Neva Bay, as well as along the northern coast.

### **Invasion history**

The first record of round goby in Polish waters is from the tip of Hel Peninsula (Gulf of Gdansk) in 1990 (Skóra and Stolarski 1993). The species abundance has since increased, especially in the western part of the Gulf of Gdańsk, Puck Bay, where it settled into habitats previously occupied by native *Gobius niger* (Jażdżewski and Konopacka 2002). In 1994 the fish was reported to be present in almost the whole of the Polish part of the Gulf of Gdańsk, whilst already in the next year the first individuals were found outside the Gulf (Kuczyński 1995).

In 1999, the species was found for the first time in the Polish part of the Vistula Lagoon (ICES 2004) and German Rügen area (Sapota 2006). In 2002, the species was observed in Lithuanian coastal waters near Klaipėda port (Bacevičius 2008) and in the Gulf of Riga, in 2003 along the entire German coast, and in 2005 from the Gulf of Finland and Archipelago Sea (reviewed in Sapota 2006, Ojaveer 2006). Between 2006 – 2009 the species settled successfully the Szczecin Lagoon and the whole River Odra estuary (Czugala and Wozniczka 2010).

In 2008, the first observation was made in coastal waters of Bornholm and southern Sweden, Hanö bight and in 2009 in the coast of Helsinki, and in Smålandsfarvandet south of Zealand, Denmark (Azour et al 2015). In 2010, it had invaded the Belt Sea and was detected in the main harbor on Gotland Island in the central Baltic Sea as well as in Gothenburg in Kattegat and in 2011 round goby was detected from Åland islands (Mariehamn) and the Bothnian Sea (Raahe). In 2013 and 2014 round goby has continued its spread along the Swedish coast of the central Baltic Sea. Distribution is also expanding especially on the southern and western coasts of Finland (Kotta et al. 2016).

In 2012 round goby was firstly observed in the Russian coast of the Gulf of Finland (the Luga Bay, Uspenskiy and Naseka 2014). Since that time the species became more common along the southern coast, but was not observed in the eastern part of the Gulf of Finland, inside the Neva Bay, as well as along the northern coast. Along the southern coastline, the adult round gobies reach high abundance, and the species has become an unwanted catch in fisheries. The fish dominates in some catches of gillnet fisheries in the Narva and Luga Bays (A. Yurtseva, communications with fishermen). Round goby is also observed in high numbers in Koporye Bay around the Sosnoviy Bor nuclear power plant (SE of the

Gulf of Finland). Permanent release of heat into the marine environment from an operating nuclear power plant leads to increase in water temperature (Dvornikov et al., 2017) and appears to provide more suitable conditions for the fish. Similar increase in round goby densities can be expected to occur around other nuclear power plants in the Baltic Sea.

Round goby has also entered the freshwater environment; the species has been discovered in small rivers in Sweden (Gotland 2016 and nearby Kalmar 2017; Ann-Britt Florin, unpublished) and rivers situated at the northern coast of Estonia (Verliin et al. 2017). Round goby is often also found in the freshwater Curonian lagoon, delta of Nemunas River in Lithuania.

The biological and ecological features of the species, such as extremely aggressive behavior at individual level and ability to sustain variable biotic and abiotic conditions, indicate further range expansion and therefore round goby is considered as one of the top invasive species in the Baltic Sea (Kornis et al. 2012, Kotta et al. 2016, Ojaveer and Kotta 2015). For example, although physiological performance may be reduced to some extent under oceanic conditions, the increasing salinity towards the Skagerrak/North Sea will likely not prevent further northward spread (Behrens et al. 2016). Spread of the fish in the Baltic Sea has followed dual pattern: long-distance spread by means of shipping, followed by natural spread at short distances locally (Kotta et al. 2016). Furthermore, according to Björklund and Almqvist (2010), local sub-populations of the species are genetically differentiating in the southern Baltic Sea, indicating fast divergence and potential adaptation to local conditions. Further studies are needed to investigate the genetic structure of the species sub-populations on a Baltic Sea wide scale.

### Role in the food web

The ecology and reproductive biology of the species is reviewed by Charlebois et al. 2001, Kornis et al. 2012 and Sapota (2006). The round gobies are aggressive, territorial and voracious benthivorous fish (Charlebois et al. 1997) impacting the ecosystems greatly, especially where they are numerous (e.g. Laurentian Great Lakes (Balshine et al. 2005) and Gulf of Gdansk, Poland (Almqvist et al. 2010)). Round gobies are generalist predators reported to feed primarily on bivalves when available (Järv et al. 2011, Kornis et al. 2012, Skabeikis and Lesutiene 2015), but their diets are highly variable and consist of a variety of benthic prey organisms (French and Jude 2001, Kornis et al. 2012, Nurkse et al. 2016). In the Gulf of Gdansk, native European flounders, utilizing similar prey, have slightly shifted their foraging to deeper waters as a result of increased round goby densities (Karlson et al. 2007). There are also indications of competition with juvenile flatfish in nursery areas in Latvia (Ustups et al. 2016). In addition, the round goby can also consume small individuals of the native flounder *Platichthys flesus* (Schrandt et al. 2016). In many areas, native black gobies (*Gobius niger*) sharing similar habitats, have been observed to decline as round goby populations increase and spread (e.g., Jazdzewski and Konopacka 2002). Furthermore, the round goby appears to be able to sustain successful populations also in locations where bivalve prey is not available or very scarce (for example in Raahe, Bothnian Bay and in the coast of Helsinki, Riikka Puntila, unpublished) and they simply use other prey, such as barnacles, instead.

It is suggested that the high densities of round goby in the Lithuanian coast have locally depleted dense blue mussel banks (Darius Daynus, pers. comm., Stupelytė 2014). Bottom videos recorded at <5-<10-

<20 m depth intervals in 2015 suggest that in the Northern part of Lithuanian coastal waters the highly abundant blue mussel colonies prior to round goby invasion are now almost depleted (Linas Ložys, unpublished). A similar finding was recently made in the Latvian open coast inside the Nida-Perkone marine protected area (Solvita Strake, unpublished).

In regions where round gobies have become abundant, they have themselves become important prey items to both avian and fish predators (Jakubas 2004, Dietrich et al. 2006, Almqvist et al. 2010): round goby is the main food item for cod and perch in the Gulf of Gdansk (Almqvist et al. 2010), increasingly important prey for perch in Estonia (Liversage et al. 2017), and also an important prey item for Great cormorant and Grey heron, contributing locally up to 60-95% to their diets (Bzoma 1998, Bzoma and Stępniewicz 2001, Jakubas 2004, Oesterwind et al. 2017). In Lithuania round gobies were found in the diet of most piscivorous fish species including turbot or even such species as shorthorn sculpin (Linas Ložys, unpublished). Certain piscivorous and commercially valued fish can actually benefit from round goby, evidenced by better individual-level performance and higher length-at-age values after the invasion (Hempel et al. 2016).

Round goby is a target species for fishermen in its native range. It is considered tasty and it may gain popularity as a catch also in the invasive range (Ojaveer et al. 2015). Recently, recreational angling of the round goby became especially popular in Lithuanian coastal waters during April-June. To be able to more effectively utilize the abundant source, round goby management activities have been implemented in Latvia, including a definition of a new fishing gear and terms of its use to minimize the bycatch of non-target species (Bartule and Adamenko 2017).

### Policy relevance

This fact sheet adds supplementary information to the assessment of Good environmental status regarding the HELCOM Baltic Sea Action Plan (BSAP, HELCOM 2007) and the qualitative descriptor 2 'Non-indigenous species' of the EU Marine Strategy Framework Directive (Anon. 2008, 2010, 2017). This fact sheet also supports the Baltic Sea assessment carried out using HELCOM core indicators for [Trends in arrival of new Non-indigenous species](#).

The Baltic Sea Action Plan does not directly have an ecological objective for the distribution and abundance of non-indigenous species. The management objective 'No new introductions of non-indigenous species' addresses the new introductions and the ecological objective 'Thriving communities of plants and animals' addresses the whole community. Nonetheless, this fact sheet gives essential background information for the other HELCOM indicators and supports risk assessments of NIS in the region.

### Data

For more information on *Neogobius melanostomus* see [AquaNIS](#) and [NOBANIS](#).

### Metadata

**Data source:** Status and presence of the round goby has been reviewed by experts in contracting states. Presence of the species is based on data presented in Kotta et al. 2016 and supplemented by

observations in AquaNIS (presence of NIS at country-level) and from local experts.

### Geographical coverage

The information has been gathered for the entire Baltic Sea from various sources of information, from research studies and national monitoring (see Kotta et al. 2016 and references therein).

Experts of the HELCOM CORESET project (2010-2013) have recommended regular monitoring of non-indigenous species, including the round goby in ports and areas of intensive ship traffic in order to follow the effectiveness of the IMO Ballast Water Convention. However, as only one country in the Baltic Sea has marine alien species monitoring program in place (ICES, 2012), the knowledge of the current distribution range of the round goby is depending on mostly other monitoring programs and presented as presence only.

### Temporal coverage

The presence data has been collected from multiple sources and includes the data from Kotta et al. 2016 supplemented with more current observations. The data ranges from 1990 to current (2018).

### Quality of information

Data is variable in time and space, sometimes anecdotal, but even without full coverage of information the quality of information received from research studies is reliable. The list of presence from the expert group is not totally substantiated with references, and needs to be complemented.

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