

Chapter 19

Ways of Penetration and Further Spread of White-Eye Bream (*Ballerus sapa*, Pallas, 1814) in Inland Water Bodies of Kaliningrad Oblast (Russia)



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Abstract In the 19th century, the white-eye bream started its spread beyond its native range, reached the basins of the White, Baltic and North Seas and in recent decades has been recorded in brackish and fresh water bodies of Kaliningrad oblast. The pathways of white-eye bream spread beyond its native range and its penetration into the water bodies of Kaliningrad oblast are analyzed in the article. The data of about seven thousand fishing operations performed using five different fishing gear have been analyzed. From 2009 to 2017, solitary specimens of white-eye bream were annually recorded in the Pregolya River of the Vislula Lagoon basin along a 10–80 km distance from its mouth, and in 2017, it was captured in the Neman River of the Curonian Lagoon basin, 80 km from its mouth. White-eye bream in water bodies of Kaliningrad oblast has an average length of 21.5 cm and average weight of 184 g in the Pregolya River and a single specimen captured in the Neman River had a length of 18.5 cm and a weight of 111 g. White-eye bream penetrated to the Baltic Sea basin via the central European invasion corridor at the end of the twentieth century and since 2009, it has reached large rivers of Kaliningrad oblast probably via the Vistula Lagoon, namely the Vistula River basin. Further spread of white-eye bream is possible upstream of the Pregolya River basin but can be limited by a hydraulic structure and along its tributary (the Lava River). The distribution in the Neman River basin can occur in two directions, upstream and along its major tributaries flowing through the territories of the Republic of Lithuania and the Republic of Belarus.

Keywords White-sea bream · Spread invasion corridors · Pergolya River basin · Neman River basin

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19.1 Introduction

The white-eye bream (*Ballerus sapa* (Pallas, 1814)) is a closely related species of bream and a rather large fish of a length up to 40 cm (Reshetnikov 2002; Spotlight Resources n.d.), associated with deep river sections in its native range and, despite the formation of semi-anadromous forms in the lower reaches of large rivers, unlike bream, it prefers fresh waters. It avoids water bodies with a slow flow and is absent in floodplain water bodies, lakes, small rivers (Reshetnikov 2002; Zhukov 1965, 1988). It should also be mentioned that before the nineteenth century, the range of white-eye bream was limited to the Ponto-Caspian basin, which is its natural range (Kazarinov et al. 2021).

Since the nineteenth century, white-eye bream has started its spread in the northern direction, to the basins of the White, Baltic and North Seas (Zhukov 1965; Novoselov 2000; Alimov and Bogutskaya 2004; Terlecki 1990; Kakarenko et al. 2008; Skóra and Skóra 2013; Bischoff et al. 1998). In the Baltic Sea basin, it has reached brackish-water coastal water bodies, namely, the practically freshwater Curonian Lagoon and the brackish-water Vistula Lagoon, which makes it possible to predict its appearance in the freshwater water bodies of Kaliningrad oblast, which are directly connected to the abovementioned lagoons.

Despite the high-intensity monitoring studies in the water bodies of Kaliningrad oblast conducted by the Kaliningrad State Technical University for more than 20 years, the white-eye bream had not been recorded in catches until 2009; later it has become a rare but rather stable component of the ichthyofauna in a number of water bodies of Kaliningrad oblast.

The aim of this work is to analyze the routes of white-eye bream spread beyond its native range, to determine the ways of its penetration into the water bodies of Kaliningrad oblast and to predict its possible further spread.

19.2 Materials and Methods

The work is based on the data of monitoring studies of the Department of Ichthyology and Ecology, Kaliningrad State Technical University. The regular observations in the Vistula Lagoon basin in Kaliningrad oblast have been conducted since 1996, and since 2007, they have also started in the basin of the Curonian Lagoon. The number of fishing operations was about 200 per year in the period from 1996 to 2009.

During 2009 to 2017, the studies in the inland waters of Kaliningrad oblast were intensified; about 4.5 thousand catches were performed using five types of fishing gear, on average about 500 catches per year (see Table 19.1).

Control catches were conducted using the following fishing gear:

- fry dragnet of 10 m long with a 4 mm mesh codend;
- beach seine of 120 m long with a 12 mm mesh codend and tow line length of 150–300 m;

Table 19.1 Number of catches in water bodies of Kaliningrad oblast

Water body	Years									Total
	2009	2010	2011	2012	2013	2014	2015	2016	2017	
<i>Vistula lagoon basin</i>										
Vistula lagoon	19	158	–	102	80	8	55	–	78	500
Pregolya river	139	1	–	121	–	201	97	185	146	890
<i>Curonian lagoon basin</i>										
Curonian lagoon	117	138	76	3	–	–	–	–	–	334
Neman river	120	55	208	406	198	411	319	510	332	2559
Deyma river	105	–	–	80	–	–	–	–	–	185
Total	500	352	284	712	278	620	471	695	556	4468

Source Our data

- drift nets of 30–60 m long with a mesh size of 14–70 mm;
- set gillnets of 15–60 m long with a mesh size of 12–70 mm;
- handy electric fishing device.

The catches were carried out in the estuary area of the Pregolya River in the Vistula Lagoon in the summer (June–July). The studies in the lower reaches of the Neman River (at stations up to 80 km from the mouth) were conducted from April to October. Fish were caught both in the riverbed and in floodplain water bodies (backwaters). Studies in the Pregolya River were carried out in its lower course, along the river from the city of Kaliningrad to the city of Gvardeysk (10–80 km from the mouth) and in floodplain water bodies (Lake Pustoe, Lake Voronye, Sokolniki quarry) from April to October. The studies in the Deyma River were carried out in its upper (city of Gvardeysk) and lower (city of Polesk) reaches.

Fish samples were collected and processed according to the common methods (Pravdin 1966). The length was measured with accuracy to within one millimeter, the weight, to a gram. The commercial length (to the end of the scale cover) and the total weight were measured.

19.3 Results

White-eye bream was first caught in the Pregolya River basin in Kaliningrad oblast in 2009, and in 2017, in the Neman River basin (see Table 19.2). The size and weight characteristics of white-eye bream varied between 18 and 26 cm and between 111 and 372 g, respectively.

After the first capture of white-eye bream in the Pregolya River basin in 2009, now it is consistently found in catches almost annually at a distance of 10–40 km from the mouth of the Pregolya River. In the Neman River, it was recorded 8 km from the mouth of the river.

Table 19.2 Length–weight parameters of white-eye bream from water bodies of Kaliningrad oblast

Water body	Parameters	Years						Total
		2009	2012	2014	2015	2016	2017	
Pregolya river	N, items	1	1	5	1	2	–	10
	L _{avg} , cm	26.5	19.5	20.0	24.5	22.3	–	21.5
	W _{avg} , g	372	107	149	244	188	–	184
Neman river	N, items	–	–	–	–	–	1	1
	L _{avg} , cm	–	–	–	–	–	18.5	18.5
	W _{avg} , g	–	–	–	–	–	111	111

Source Our data

19.4 Discussion

A number of Ponto-Caspian species enter the Baltic Sea basin via invasion corridors, among which central, northern and southern ones are distinguished (Bij de Vaate et al. 2002). The expansion of the range of such fish species as round goby occurred via these pathways (Tylik 2003; Rizevsky et al. 2016).

The spread of white-eye bream along the northern invasion corridor has started earlier, since the end of the nineteenth century. The first finding of white-eye bream beyond the Black Sea-Caspian Sea and Sea of Azov basins was reported in the publications of Varpakhovsky (1898) and Sabaneev (1911). In the authors' opinion, white-eye bream penetrated to the Volkhov River from the upper reaches of the Volga River. The next finding of white-eye bream beyond its native range was recorded in the Vyehgda River, a tributary of the Severnaya Dvina River in the basin of the White Sea, in 1975 (Novoselov and Studionov 2000).

In the twentieth century, the construction of hydraulic facilities, climate change, intensive shipping led to a change in natural biodiversity and transformation of natural ecosystems. Global warming is considered a factor of successful dispersal of white-eye bream in the Northern Dvina basin (Alimov and Bogutskaya 2004).

Despite the milder climate in the Baltic Sea basin compared to the White Sea and a hydraulic connection with the Ponto-Caspian Basin (the Dnieper-Bug Canal 1783), the dispersal of white-eye bream in the Baltic Sea basin started via the central invasive corridor only at the end of the twentieth century.

The spread of white-eye bream in this direction began in 1989, when it was found in the reservoir on the Bug River (Terlecki 1990). Around the same time (1985), white-eye bream was found in the Vistula River (Kakarenko et al. 2008). The spread rate of white-eye bream in the Bug-Vistula river system was relatively low and amounted to 400 km for 20 years (Skóra and Skóra 2013). At the beginning of the 21st century (2006–2007), white-eye reached the Baltic Sea basin, namely the Gulf of Gdansk (Skóra and Skóra 2013) (see Fig. 19.1).

Along the southern invasion corridor and the Rhine River basin, white-eye bream began to penetrate into the North Sea basin in 1995 at a rate of 190 km per year (in

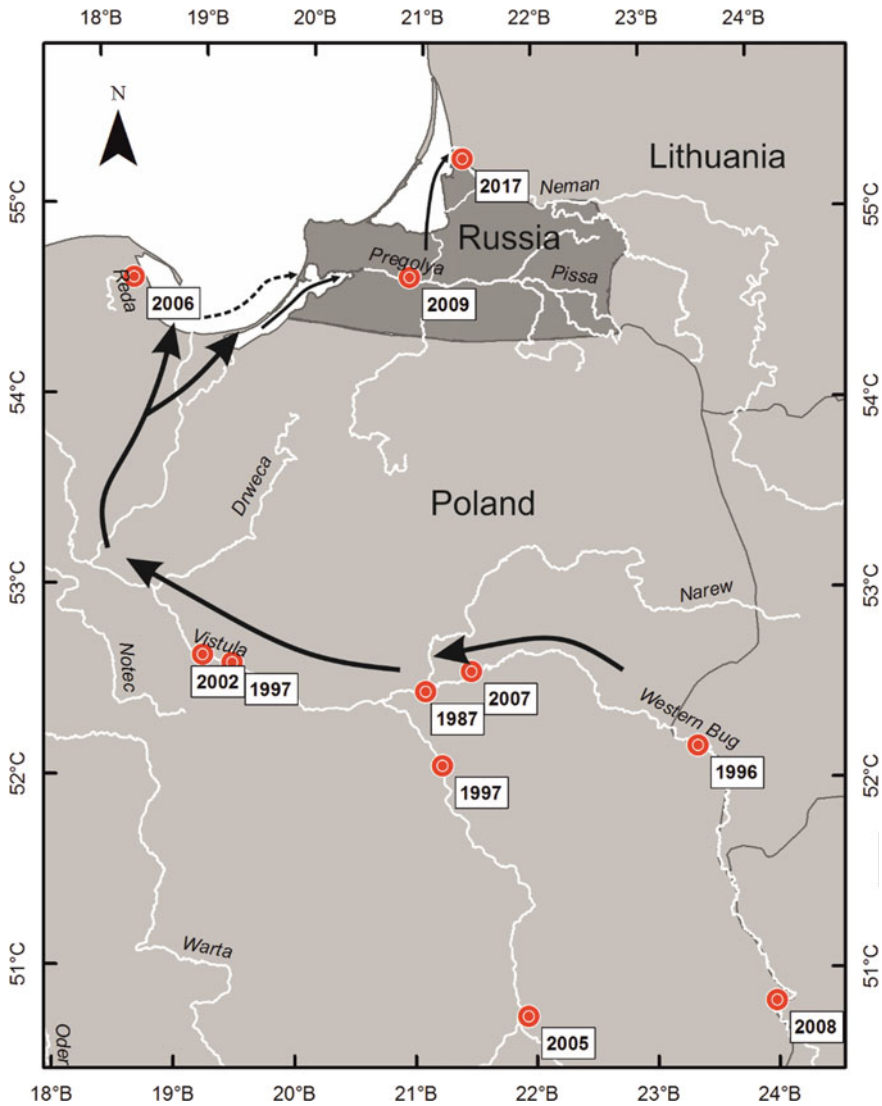


Fig. 19.1 Scheme of white-eye bream penetration into the Baltic sea basin (Source Catches in Poland presented by Skóra and Skóra (2013), in Russia—our data)

the first year), and 100 km in the second year (Bischoff et al. 1998). Thus, by 2017, white-eye bream had been found in the basins of the White, Baltic and North Seas.

Since 2009, white-eye bream has been recorded within the territory of Kaliningrad oblast and 11 specimens of white-eye bream were caught during the period of monitoring studies.

Most of the specimens were caught in the area of the former quarry for the extraction of the sand-gravel mixture, connected to the Pregolya River by several channels in the autumn period. A solitary specimen was caught at a distance of 15 km from the mouth in the Pregolya River channel. Despite regular fishing in the Vistula Lagoon (the near-mouth area of the Pregolya River), white-eye bream was not found there which is also confirmed by surveys of fishermen engaged in industrial fishing. It should be mentioned, that morphological differences between white-eye bream and bream are insignificant for fishermen and they did not identify their species.

In our opinion, despite the absence of white-eye bream in catches in the lagoon, its penetration to the Pregolya River occurred via the Vistula Lagoon, where it entered from the Vistula River through the system of the Nogat and Szarpawa branches. This is also confirmed by the fact that the hydrographic network connects the Vistula River basin with the territory of Kaliningrad oblast only through the Vistula Lagoon.

This assumption is indirectly confirmed by the presence of white-eye bream in the Reda River in 2006–2007 (Skóra and Skóra 2013). The distance from the site where the Reda River splits from the Nogat River is about 100 km, and the distance to the site of the first capture in the Pregolya River basin is about 180–200 km, which she could overcome for 3 years. The ability of white-eye bream to perform long-distance migrations is confirmed by other literature data (Bischoff et al. 1998; Skóra and Skóra 2013).

At the same time, it cannot be excluded that white-eye bream can penetrate to Kaliningrad oblast via the coastal area of the Baltic Sea as well, where water salinity does not exceed 7‰ in the horizon of 0–10 m (Dubravín 2017). The possibility of this route of penetration is confirmed by the spread of another Ponto-Caspian representative, round goby in the coastal waters of the Baltic Sea (Tylik 2003; Kodukhova et al. 2017; our unpublished data).

In the basin of the Neman River, white-eye bream was recorded in the floodplain water body of the Skirvyte River during the spring flood of 2017. In our opinion, the penetration occurred via the following pathway: the Pregolya River—the Deyma River—the Curonian Lagoon—the Skirvyte River (branch of the Neman River). This route is about 100 km.

Another theoretically possible way of white-eye bream penetration to the Neman River basin from the Vistula River basin may be through the Augustow Canal with a length of more than 100 km (Noviczkiĵ et al. 1911). However, regular studies in the Neman River upstream of the delta system have shown the absence of white-eye bream in the river both in the territory of Russia and Lithuania.

Thus, the conclusion can be made that white-eye bream has currently penetrated from the Vistula River basin to the basins of the Pregolya and Neman rivers, which is a transboundary body of water connecting Russia, the Republic of Lithuania and the Republic of Belarus. The biological features of the species make it possible to predict its distribution only in the largest rivers of Kaliningrad oblast, the Pregolya River and the Deyma River. In the Pregolya River, white-eye bream can reach the city of Chernyakhovsk, located at a distance of about 100 km from the mouth or 70 km from the site of capture, where its distribution will be limited by a dam. In the Lava River, the tributary of the Pregolya River, through which white-eye bream

could theoretically penetrated to the system of the Masurian lakes, there are also dams that almost completely exclude this pathway of the species spread.

In our opinion, further spread of white-eye bream in the Neman River basin, will occur along the main channel to the city of Kaunas (Lithuania), where the river is blocked by the dam of the Kaunas hydroelectric power plant and into the tributaries, the Sheshupe River in the territory of Kaliningrad oblast, the Jura (the length of 177 km), Nyavezis (the length of 210 km), Viliya (the length of 500 km), Miniija (the length of 200 km) rivers on the territory of the Republic of Lithuania and further to the Republic of Belarus. The penetration along the Baltic Sea coast in the northern direction to more desalinated waters also remains possible.

The available literature data show that the introduction of white-eye bream into new water bodies can cause tense relationships with native species, in particular in the Northern Dvina River; the index of food similarity of white-eye bream and whitefish is 62.8%, and the index of overlapping of food niches is 89.9% (Novoselov 2020). Thus, in view of the dominance of benthic fish in the commercial ichthyofauna (Hlopnikov 1992), the appearance of a new food competitor can lead to changes in the sustainability of industrial fisheries.

19.5 Conclusion

The transformation of aquatic ecosystems in the Baltic Sea basin occurs under the effect of the penetration of a number of Ponto-Caspian species. Following the round goby, another benthivorous species, white-eye bream, has naturalized in the area of the southern Baltic Sea, which may lead to a change in the stability of the fishery. Its biological features make it possible to suggest its further spread along the river systems of the Pregolya River and Neman River basins, as well as its subsequent penetration northwards along the sea coast. The further expansion of the natural range, in addition to the ongoing processes of global warming, can be facilitated by the potential implementation of the E 40 Inland Waterway, a transnational project of the European Union aimed at the connection of the Vistula water systems with the Dnieper-Bug canal [United Nations Economic Commission for Europe (UNECE), ECE/TRANS/SC.3/WP.3/2016/13, 2016].

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