

# Daily and seasonal dynamics of littoral zone fish communities in the lowland Włocławek Reservoir (central Poland), with a special emphasis on alien invasive gobies

Maciej Błażejowski,<sup>1\*</sup> Jarosław Król,<sup>2</sup> Tomasz Kakareko,<sup>3</sup> Katarzyna Mierzejewska,<sup>1</sup> Piotr Hliwa<sup>1</sup>

<sup>1</sup>Department of Ichthyology and Aquaculture, University of Warmia and Mazury in Olsztyn, Warszawska St. 117A, 10-701 Olsztyn;

<sup>2</sup>Department of Salmonid Research, The Stanisław Sakowicz Inland Fisheries Institute in Olsztyn, Oczapowskiego St. 10, 10-719

Olsztyn, Poland; <sup>3</sup>Department of Ecology and Biogeography, Faculty of Biological and Veterinary Sciences, Nicolaus Copernicus University, Lwowska St. 1, 87-100 Toruń, Poland

## ABSTRACT

The aim of the study was to examine the daily and seasonal dynamics of changes in fish communities in two environmentally different littoral zones of the Włocławek Reservoir (central Poland), i.e., the floodplain (limnic Dobięgniewo site) and lotic area (Murzynowo site). During seasonal catches using trawl nets, in the daily cycle (at 00.00, 06.00, 12.00, and 18.00 hours), the presence of 18 fish species representing 4 families (Cyprinidae, Percidae, Gasterosteidae, Gobiidae) was confirmed. In both localities, the domination of native taxa, such as roach *Rutilus rutilus* (L.) and Eurasian perch *Perca fluviatilis* L., in Dobięgniewo (26.6 and 26.6%, respectively) and Murzynowo (13.6 and 22.7%, respectively) of all caught specimens was noted. The quantitative share of three alien invasive gobies, racer goby *Neogobius gymnotrachelus* (Kessler, 1857), monkey goby *Neogobius fluviatilis* (Pallas, 1814), and western tubenose goby *Proterorhinus semilunaris* (Heckel, 1837), varied in the range between 2.7 and 35.3% in samples throughout the season. The results indicate the significant role of gobies in the structure of the sublittoral fish communities of Włocławek Reservoir and the necessity of expansion process studies, as well as the observation of the interactions with native fish species in invaded areas.

Corresponding author: maciej.blazejewski@uwm.edu.pl

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## INTRODUCTION

Spatial and temporal variations in abundance and fish population structure are fundamental to the processes driving biological diversity, community ecology, and ecosystem functioning (Tewson *et al.*, 2016). The structure of ichthyofauna and fish biomass in freshwater ecosystems are related mainly to environmental and anthropogenic factors (Moss, 1998). The activity of fish within water bodies depends on the season, light conditions, and temperature, in addition to the mutual interaction of fish species (Davenport and Sayer, 1993; Jepsen *et al.*, 1999; Järvalt *et al.*, 2005). In addition to species-specific generational fluctuations and seasonal cycles in abundance, fish assemblage structures can vary during the day, with some species or life stages undertaking substantial migrations to forage or avoid predators (Copp, 2010; Mehner, 2012; Muška *et al.*, 2013). As fish assemblages are often strongly size-structured, not only different species but also different size- or age-cohorts can be related to the avoidance of intra- and inter-cohort competition (Persson and Greenberg, 1990a, 1990b; Borcherding *et al.*, 2013). Habitats densely covered with macrophytes usually feature higher densities and richness, especially larvae/juveniles of fish species, than unvegetated sites (Randall *et al.*, 1996). Seasonal variations in fish community structures and biomass-size distributions of artificial reservoirs are well known

in mutual species interactions and activity (Holmgren and Appelberg, 2000; Olin *et al.*, 2002). However, introduction of non-native species may be a disturbing element to the stable trophic food web and interspecies relationships.

At the turn of the 21<sup>st</sup> century a few species of Ponto-Caspian gobies, i.e., round goby (*Neogobius melanostomus* Pallas, 1814), monkey goby (*Neogobius fluviatilis* Pallas, 1814), western tubenose goby *Proterorhinus semilunaris* Heckel, 1837, and racer goby *Babka gymnotrachelus* (Kessler, 1857), reached Poland's inland waters (Grabowska *et al.*, 2019). They are considered the most successful fish invaders in the inland waters of Europe which have expanded from the Ponto-Caspian region to west and central Europe through a system of artificial canals existing between the Black and Caspian Sea basins and the North and Baltic Sea basins (Bij de Vaate *et al.*, 2002). In many locations, these invasive gobies constitute the most numerous members of fish assemblages (Roche *et al.*, 2013; Van Kessel *et al.*, 2016).

In Włocławek Reservoir, monkey goby and racer goby were first found between 2000 and 2001 (Kostrzewa and Grabowski, 2001, 2002). In April 2008, another alien invasive fish species was recorded, when six individuals (five females and one male) of the western tubenose goby were found in the upper part of the Włocławek Reservoir (Grabowska *et al.*, 2008). In the following years, the number of gobies increased, occupying a larger area of the reservoir.

Alien gobies may be dominant in a different region of reservoirs depending on environmental conditions and their biology (*e.g.*, habitat preference, reproduction strategy) (Erös *et al.*, 2005; Kováč *et al.*, 2009; Borcharding *et al.*, 2013; Roche *et al.*, 2013). Gobies can reach a very high abundance within a short time after settling and are therefore among the most abundant fish in many invaded rivers (Borcharding *et al.*, 2011; Loisl *et al.*, 2014; Szalóky *et al.*, 2015). The impact of these goby species on native fauna has yet to be characterised, but habitat interspecific competition is one possible mechanism by which they may have a negative effect, as confirmed in experimental studies (Charlebois *et al.*, 2001; Kakareko *et al.*, 2016; Błońska *et al.*, 2017). However, some studies showed a neutral or even positive influence (Płachocki *et al.*, 2012; Janáč *et al.*, 2016).

The goal of this study was to determine the daily and seasonal changes in the structure and abundance of ichthyofauna inhabiting two different sublittoral zones of a lowland dam reservoir (Włocławek Reservoir) located in the middle course of the central European invasion corridor (the lower Vistula River), as well as to evaluate the contribution of alien invasive gobies in fish communities several years after their appearance.

## METHODS

Samples were collected seasonally (June = spring, September = summer, and November = autumn 2013 year) in two different habitats within the lowland Włocławek Reservoir, located in the lower course of the Vistula River (Fig. 1). The Włocławek Reservoir has a maximum surface area of about 70.0 km<sup>2</sup>, a total volume of 408 million m<sup>3</sup>, and an average flow of 900 m<sup>3</sup> s<sup>-1</sup>. It is characterised by a relatively short retention time (4–5 days) and a high level of macrozoobenthos resources (Żbikowski, 2000). The reservoir was divided into two areas: the lotic part along with the former river current on the right side of the reservoir, and the floodplain part in the form of shallows occurring in the upper and central part of the reservoir (Banach, 1994). Fish were caught using a trawl net in the sublittoral zone near the Dobięgniewo (52°36'N; 19°19'E -the floodplain area; site A) and Murzynowo (52°34'N; 19°31'E - the lotic area; site B) localities (Fig. 1). The water level depth at the Dobięgniewo sampling site was 0.2–1.0 m, and the water flow velocity ranged between 6 to 15 cm s<sup>-1</sup>. The substrate was mostly sand and silt of low thickness (Gierszewski, 2018). The bottom was overgrown with *Ceratophyllum demersum*, *Myriophyllum spicatum*, *Potamogetonacea* spp., and *Nuphar lutea*, which were especially abundant in the spring and summer (Żytkowicz *et al.*, 2008). In turn, the Murzynowo site was characterised by a sandy bottom about 1.0–1.5 m deep, and the water flow velocity ranged between 26 to 95 cm s<sup>-1</sup>. It was mainly covered with empty snail and mussel shells and was free of macrophytes (Kostrzewa and Grabowski, 2002; Gierszewski, 2018).

Samples at both sites were taken with a trawl net (mesh size 2.0 mm) on a daily cycle, with 6-hour intervals (at 00:00, 6:00, 12:00, and 18:00). After capture, fish were identified to the species level and measured (total length) using a calliper with an accuracy of ± 1 mm. At the same time, water quality parameters were measured, i.e., temperature, oxygen saturation, pH, ammonium nitrogen level value, and conductivity, using a YSI Professional Plus recorder (YSI Incorporated, USA). To study the changes in species diversity and to compare them between the two sites, the following indices were used:

1) Margalef's richness index (Margalef, 1968):

$$d = (S - 1) / (\log_e N)$$

where S is the total number of species, and N is the total number of individuals in the sample.

2) Simpson's evenness (dominance) index (Lande, 1996):

$$D = \frac{\sum n_i(n_i - 1)}{N(N - 1)}$$

where  $n_i$  is the total number of a specific fish species, and  $N$  is the total number of fish species. The value of  $D$  ranges between 0 and 1. Zero represents infinite diversity and 1 represents no diversity. Simpson's index was used to quantify the biodiversity of a habitat. It considers the number of species present, as well as the abundance of each species. Simpson's Index ( $D$ ) measures the probability that two individuals, randomly selected from a sample, will belong to the same species (or some category other than species).

## RESULTS

### Water parameters

Analysed physicochemical parameters of water at Dobięgniewo and Murzynowo sites were similar at both localities throughout the sampling period (June–November; Tab 1). The pH values slightly varied during this period (they oscillated between 8.06 and 8.91). In the spring and autumn, no deficits of dissolved oxygen were noted, and the concentration of  $O_2$  oscillated between 5.57–16.2 and 5.8–13.65  $mg\ L^{-1}$ , respectively. Additionally, the concentration of  $NH_4^+$  ions ranged between 0.25 and 1.16  $mg\ L^{-1}$  at the sampling stations. The highest fluctuations in the conductivity values were noted in different seasons be-

tween sites, varying between 396  $mS\ cm^{-1}$  in June at Dobięgniewo and 3050  $mS\ cm^{-1}$  at Murzynowo in late autumn (Tab. 1).

### Taxonomic structure of ichthyofauna

A total of 699 individuals, 338 and 361 for Dobięgniewo and Murzynowo, respectively, belonging to 18 species and representing four families (Cyprinidae, Gasterosteidae, Percidae, and Gobiidae) were caught (Tab. 2). Generally, cyprinids were most frequently represented numerically mainly by the roach (*Rutilus rutilus* L.), dace (*Leuciscus leuciscus* L.), and white bream (*Blicca bjoerkna* L.). All three native percids, i.e., perch (*Perca fluviatilis* L.), pikeperch (*Sander lucioperca* L.), and ruffe (*Gymnocephalus cernua* L.), were caught at Dobięgniewo, while only perch was recorded in Murzynowo (Tab. 2). However, at Murzynowo, a sunbleak (*Leucaspis delineatus* Heckel, 1843) and invasive western tubenose goby (*Proterorhinus semilunaris* Heckel, 1837) were caught but were not registered at the Dobięgniewo site (Fig. 2 A,B). Among alien invasive fish species at Dobięgniewo, the monkey goby had the largest quantitative share (9%), while the number of racer goby was estimated at 6% of all caught fish (Fig. 2A). At Murzynowo, three species of Gobiidae occurred in the Włocławek Reservoir.

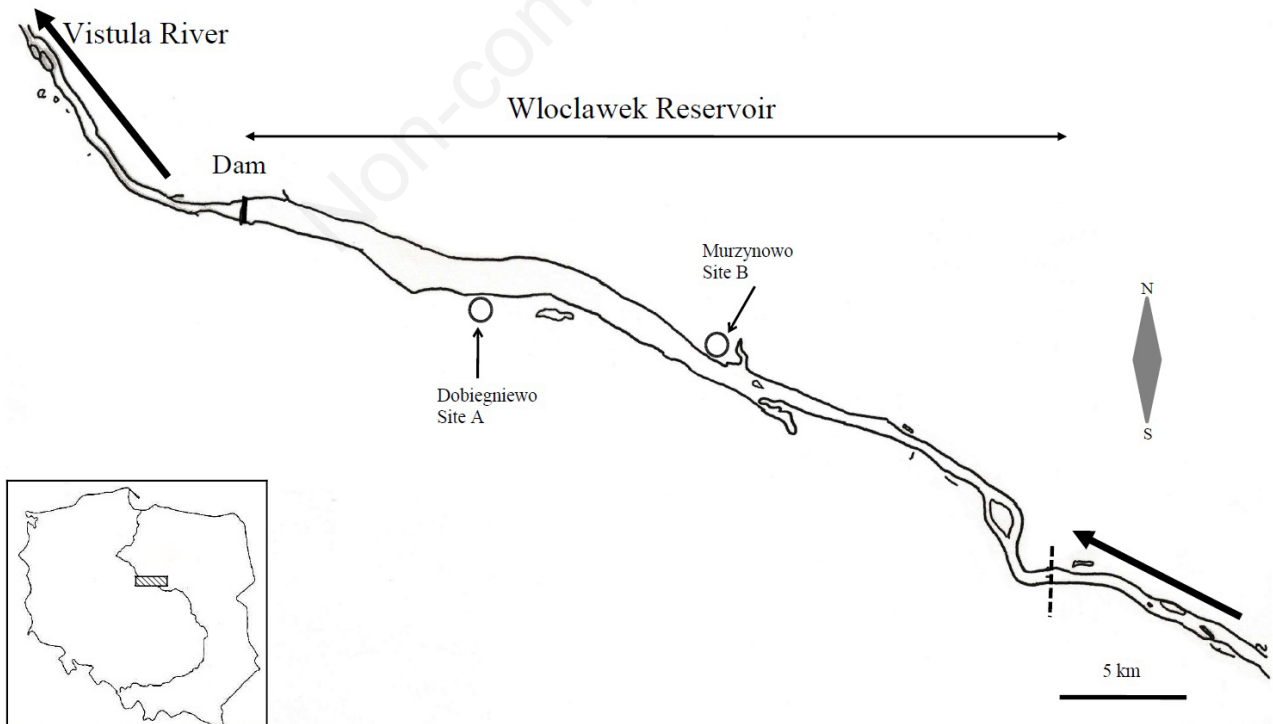


Fig. 1. Catching sites of fish samples within Włocławek Reservoir.

### Changes in ichthyofauna structure during a daily cycle

Diurnal changes in the number of individuals and fish species at Dobięgniewo varied seasonally. In June, the highest number of fish and species diversity was recorded at midnight (00.00), while at noon (12.00), only five specimens of chub were caught (Fig. 3). At 06.00 and 18.00, perch dominated the catches. In September, the highest number of individuals, as well as alien invasive species, were recorded at 06.00. In the remaining samples, mainly cyprinids, including roach and white bream, were dominant. In autumn, the activity of gobies was noticeable only at midnight. No fish were caught in the morning (around 06.00). At the Murzynowo site, in June, the highest number of fish was recorded at 06.00. Among 8 fish species, racer goby was the most numerous (62.9%). Equally numerous species were the native perch, constituting about half of all

fish caught at 18.00. In the sample collected in September, the highest number of specimens at 00.00 was recorded, whereas in November, the most abundant species in this site were alien gobies with the highest quantitative share of racer goby (75% of the total harvest) at 06.00. Any fish could not be caught at night (Fig. 4).

### Seasonal changes in the ichthyofauna structure

Seasonal changes in the ichthyofauna structure at Dobięgniewo were evident and probably dependent on the weather conditions. In June, the quantitative share of alien gobies constituted 21.9% of the total catch. In September, the water temperature was stable during the day and at night and oscillated between 14.2–15.5°C and 15.1–16.4°C at Dobięgniewo and Murzynowo, respectively (Tab. 1). At

**Tab. 1.** Parameters of water (min. – max.) at sampling sites during analysed season.

Parameter	Dobięgniewo			Murzynowo		
	June	September	November	June	September	November
Temperature (°C)	20.8-24.3	14.2-15.5	3.0-4.3	20.5-23.6	15.1-16.4	3.2-4.2
Dissolved O <sub>2</sub> (mg L <sup>-1</sup> )	8.18-16.2	5.57-7.8	7.65-10.48	5.91-13.65	5.8-9.62	8.55-10.22
pH	8.06-8.91	8.06-8.3	8.16-8.32	8.09-8.86	8.41-8.66	8.16-8.21
Concentration NH <sub>4</sub> <sup>+</sup> (mg L <sup>-1</sup> )	0.24-0.66	0.45-0.64	0.28-0.59	0.21-0.59	0.31-0.49	0.25-1.16
Conductivity (mS cm <sup>-1</sup> )	434-590	548-610	2338-2399	394-533	521-614	2646-3050
Total suspended solids (mg L <sup>-1</sup> )	323-409	356-396	447-477	299-377	363-403	365-410

**Tab. 2.** Fish species caught during season 2013 at both sites (n = number of fish).

Common name	Specific name	Site		
		Dobięgniewo(n=338)	Murzynowo(n=361)	Total(n=699)
Monkey goby	<i>Neogobius fluviatilis</i> (Pallas, 1814)	29	14	43
Racer goby	<i>Neogobius gymnotrachelus</i> (Kessler, 1857)	21	76	97
Western tubenose goby	<i>Proterorhinus semilunaris</i> (Heckel, 1837)	-	10	10
Asp	<i>Leuciscus aspilus</i> (L. 1758)	14	3	17
Bitterling	<i>Rhodeus sericeus</i> (Pallas, 1776)	3	33	36
Bleak	<i>Alburnus alburnus</i> (L.1758)	8	27	35
Bream	<i>Abramis brama</i> (L. 1758)	3	13	16
Chub	<i>Leuciscus cephalus</i> (L. 1758)	12	7	19
Common dace	<i>Leuciscus leuciscus</i> (L. 1758)	21	3	24
Gudgeon	<i>Gobio gobio</i> (L. 1758)	1	9	10
Ide	<i>Leuciscus idus</i> (L. 1758)	10	1	11
Roach	<i>Rutilus rutilus</i> (L. 1758)	90	49	139
Sunbleak	<i>Leucaspis delineatus</i> (Heckel, 1843)	-	1	1
White bream	<i>Abramis bjoerkna</i> (L. 1758)	20	3	23
Perch	<i>Perca fluviatilis</i> (L. 1758)	90	82	172
Pikeperch	<i>Sander lucioperca</i> (L. 1758)	5	-	5
Ruffe	<i>Gymnocephalus cernus</i> (L. 1758)	10	-	10
Three-spined stickleback	<i>Gasterosteus aculeatus</i> (L. 1758)	1	30	31

both sites, the number of fish caught during an analysed season was similar. The highest number of fish species was recorded in the sample caught in September (Figs. 5B and 6B). In September, the highest number of fish species (13 taxa) was noted, and domination of the native roach was noted. The samples carried out in June and November were characterised by high goby activity. Their total quantitative share in June was 47.1%, but racer goby constituted the majority in the catches (35.3% in June and 29.3% in November) (Fig. 6 A,C). Similarly, high numbers of roach and perch populations were found at Dobiegniewo. However, at Murzynowo additionally a racer goby population was

found. The only representative of the gobies caught in November, when the water temperature oscillated around 3–4°C at both sites, was racer goby. The results of catches made in the daily cycle revealed the largest share of all alien goby species at night and in early morning tests (Figs. 3 and 4). Ruffe were one of the fish species whose presence was noted in small quantities at Dobiegniewo. In contrast, the western tubenose goby was only caught in Murzynowo. Perch were the most dominant predatory species at both sites. In addition, in June, at night, several juvenile individual pikeperch with a maximum total body length of about 7.5 cm were noted at Dobiegniewo.

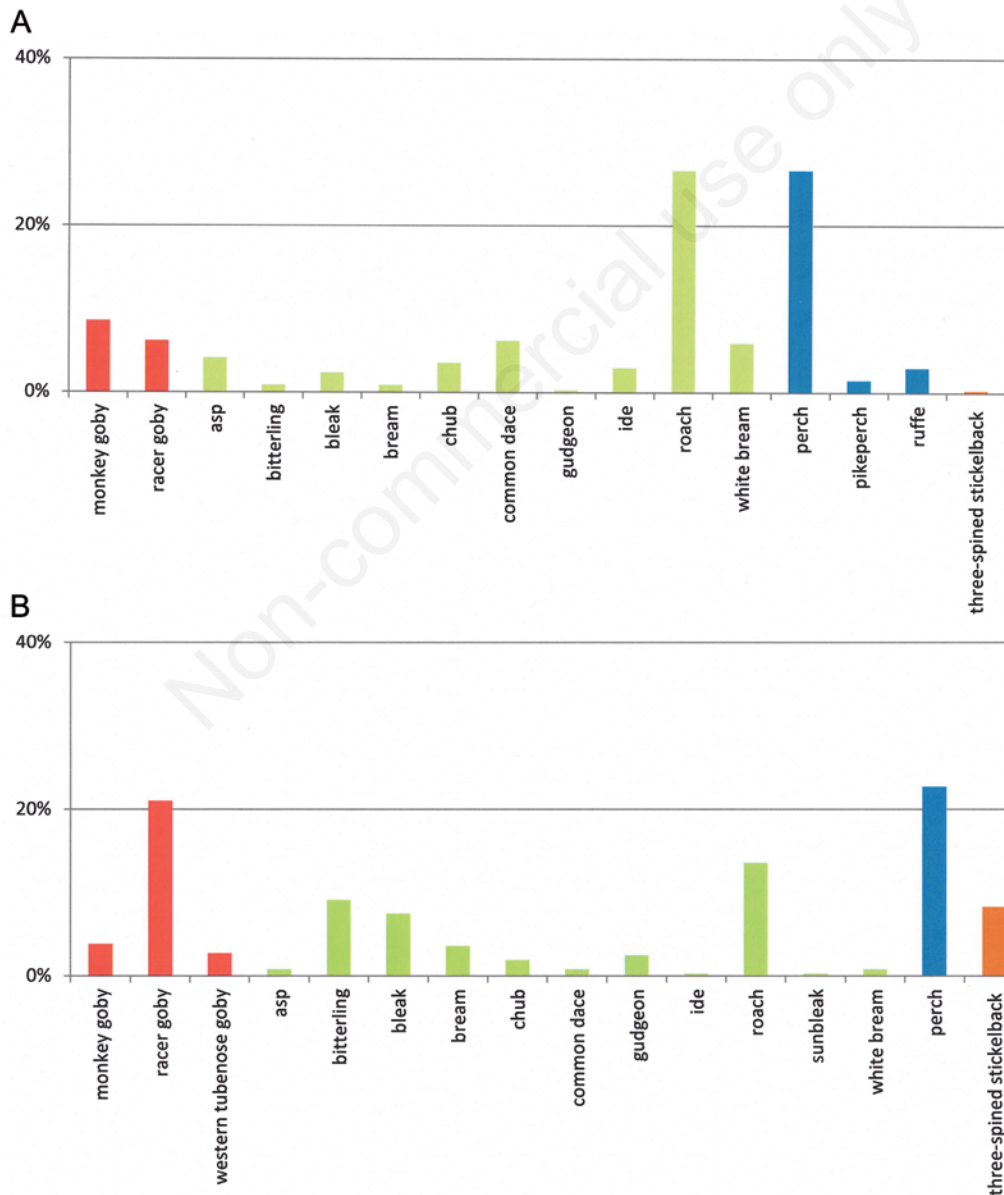


Fig. 2. Quantitative share of fish species in total catches at Dobiegniewo (A) and Murzynowo (B) sites.

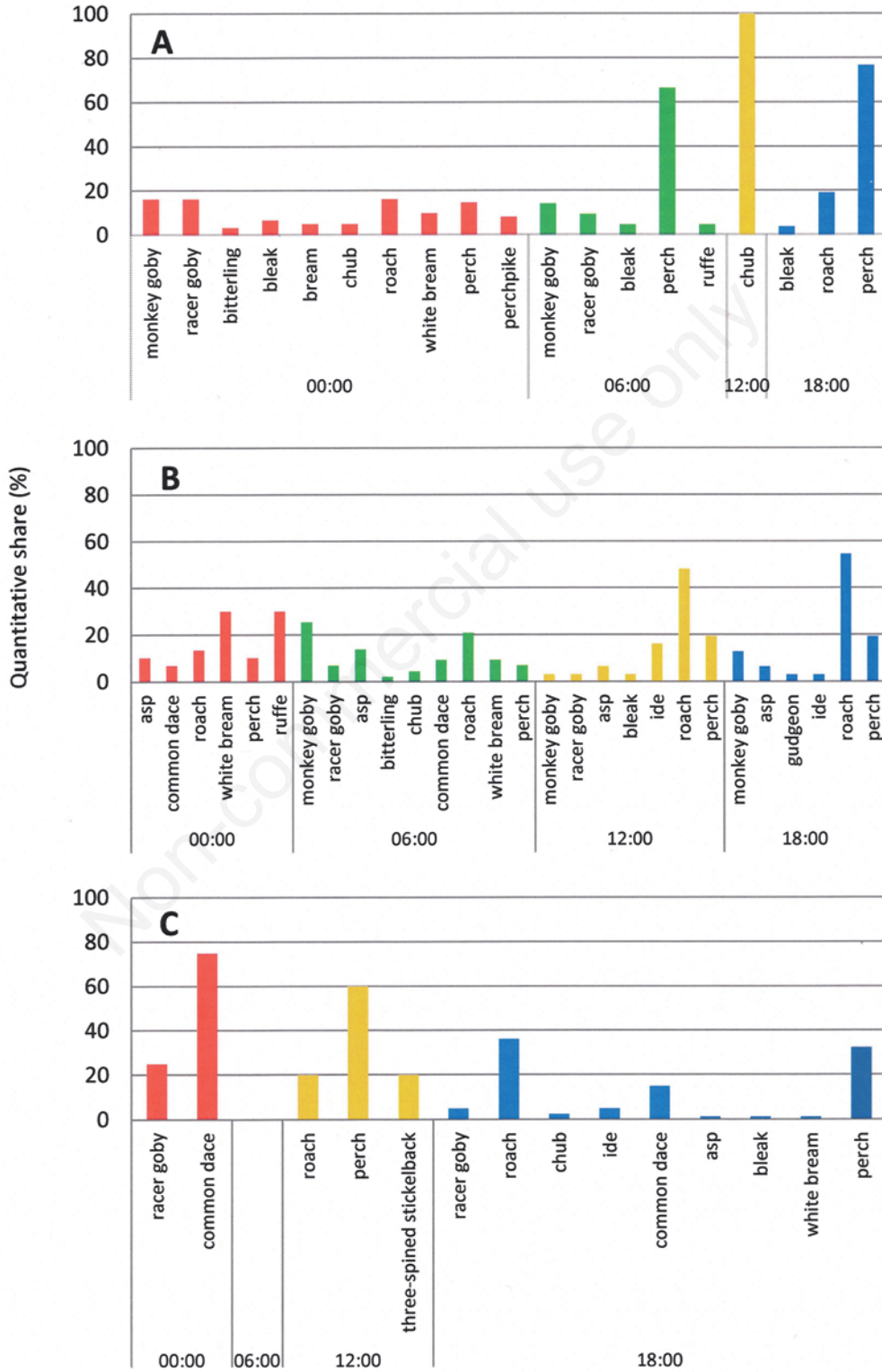


Fig. 3. Daily dynamics changes of ichthyofauna structure at Dobiegniewo in 2013: A) June; B) September; C) November.

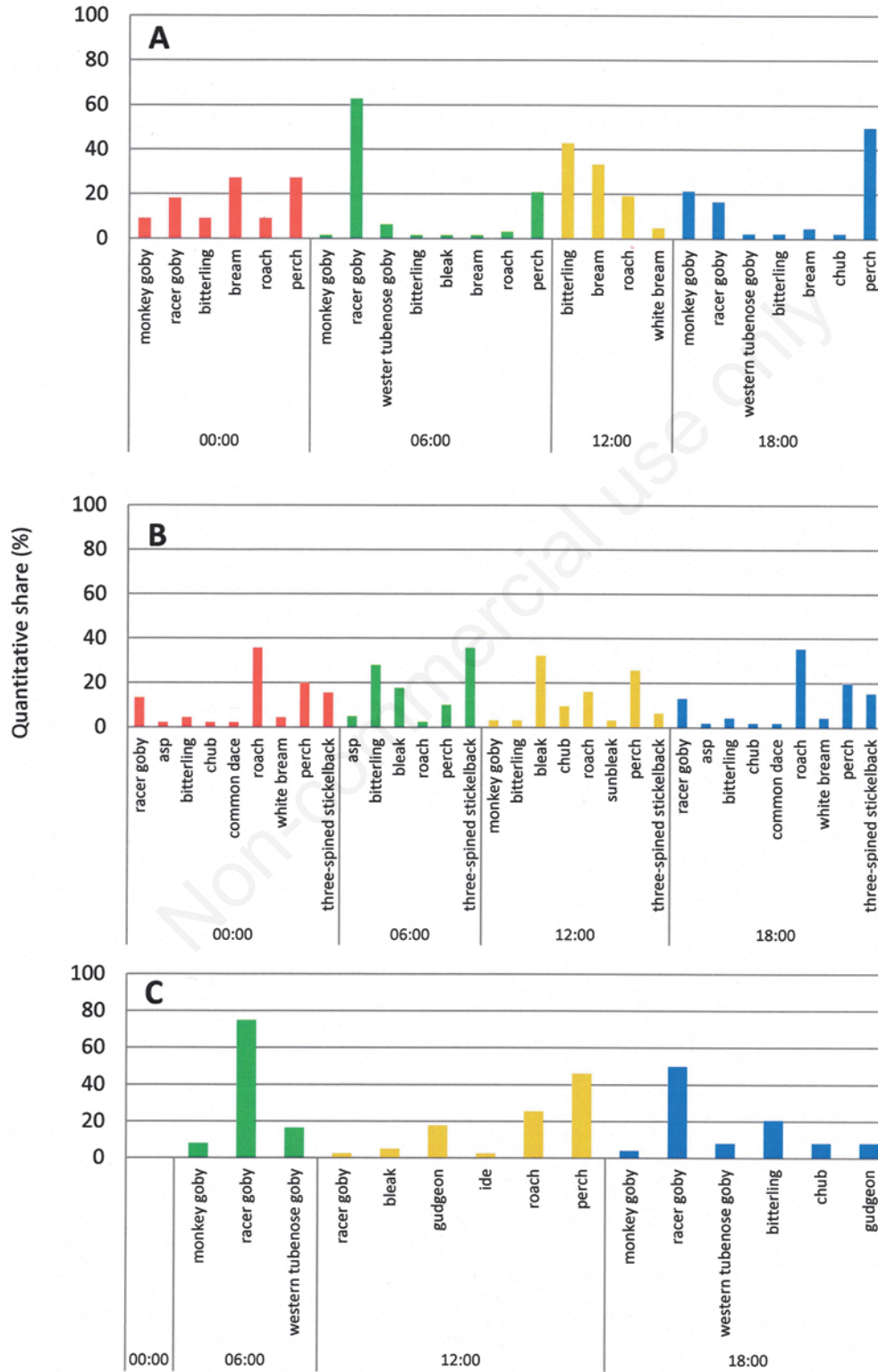


Fig. 4. Daily dynamics changes of ichthyofauna structure at Murzynowo in 2013: A) June; B) September; C) November.

### Biodiversity indices

The values of fish species richness (Margalef's index) were similar and did not differ statistically between analysed sites ( $p=0.878$ ;  $\chi^2$  test). However, the dominance (Simpson's) index noted for Dobiegniewo and Murzynowo were 0.1635 and 0.1375, respectively, indicating slight taxonomic domination at the floodplain limnic area of Włocławek Reservoir (Tab. 3).

### DISCUSSION

Spatial and seasonal dynamics of the fish assemblage structure may occur on a small scale as a microhabitat or on a large scale as a zone of reservoirs and may change in days or decades. Seasonal variability in fish assemblage structure provides information regarding the factors regulating assemblage among different streams and regions and migration tendencies in different taxa (Adams *et al.*, 2004). These seasonal phenomena are associated with changes in environmental conditions that occur in response to variations in solar irradiation and rainfall conditions throughout the year (Qadir and Malik, 2009). The Simpson's index (0.1635 and 0.1375 for Dobiegniewo and Murzynowo, respectively) and Margalef's index for fish species richness diversity suggest a slightly diverse structure of ichthyofauna in the sublittoral zone of analysed localities. In this study, there were no significant difference in the species composition between the two sites. Fourteen taxa, including up to ten cyprinid species were caught both in the floodplain area (Dobiegniewo) and the lotic area (Murzynowo). These results indicate a somewhat homogeneous structure of the ichthyofauna assemblages in the sublittoral zone of the middle part of the Włocławek Reservoir.

Understanding the spatial and seasonal dynamics of fish assemblages is fundamental to interpreting those factors that influence the structure of fish communities (Silvano *et al.*, 2000). Fish assemblages exhibit an increase in abundance and species richness downstream of the longitudinal gradient in rivers, which is most likely due to increases in detritus, habitat heterogeneity, and decreased water flow (Araújo *et al.*, 2009). The lotic area most often exhibits stressful environmental conditions, which make abiotic components of the ecosystem the limiting factor

for fish assemblage. Unlike the lotic area, environmental conditions at floodplains are less stressful; therefore, biotic factors, such as predation and competition, play a critical role in the structure of fish assemblages (Yan *et al.*, 2010; May *et al.*, 2020). Contrary to data recorded by Sabel *et al.* (2020) from Lake Constance, a large peri-alpine lake, where the study revealed large spatiotemporal variability in the juvenile fish community in the littoral zone, our results did not confirm similar variability of ichthyofauna. Analysis of the existing species of fish showed the highest occurrence of the three families, namely Cyprinidae, Percidae, and Gobiidae, both in the lentic and lotic habitats of the Włocławek Reservoir. These findings are typical because Cyprinidae and Percidae fish families are generally the most dominant groups in freshwater eutrophic bodies however, this does not apply to gobies, as their presence in Polish waters has only been observed in the past several years (Jewel *et al.*, 2018). Cyprinidae, with many species, represented the majority and the highest percentage of fish biodiversity at both Dobiegniewo and Murzynowo sites. However, the differences in the species composition concerned by the presence of ruffe and pikeperch juvenile individuals caught in June/September at the limnic area and sunbleak and western tubenose goby at the lotic zone, which were caught in September (summer) and June/November (spring/autumn), were noted respectively.

Samples taken over 24 hours showed certain trends in the occurrence of specific fish taxa living in the sublittoral zone of the Włocławek Reservoir. For example, juvenile chub specimens appeared exclusively only in the survey at 12.00 in the spring at Dobiegniewo, as well as higher non-native goby occurrence in some night and early morning surveys. The densities of perch and pikeperch (especially 0+ year juveniles), both potential predators, were stable throughout the daily cycle, especially in the limnic zone, which could also have had an influence on assemblage structure (Tewson *et al.*, 2016).

Daily and seasonal migrations of fish are stimulated by abiotic factors, such as fluctuations in oxygen concentration and water temperature, resulting in the occurrence of local oxygen deficiency in the littoral zone and hypolimnion, as well as stronger stratification in the water layers (Schwefel *et al.*, 2016). In the spring and summer, intensive migrations of many fish species from the pelagic/limnic part of reservoirs to the littoral zone were observed. They are motivated by the search for convenient spawning grounds and egg/offspring caring. Some of these features are characterised, among others, by alien invasive species, such as monkey goby, racer goby, and western tubenose goby, which inhabit the lower course of the Vistula River, including the Włocławek Reservoir (Grabowska *et al.*, 2008; Witkowski and Grabowska, 2012). Moreover, the dominance of non-native fauna at

**Tab. 3.** The values of richness and evenness (dominance) indices recorded for both localities.

Index	Dobiegniewo value	Murzynowo value	p-value
Margalef's	2.5759	2.5471	0.878
Simpson's	0.1635	0.1375	0.913



some of the midstream and downstream sites could also be linked with degraded water conditions, such as high nutrient loading, turbidity, a pH higher than the permissible limit, and low water velocity (Nazeer *et al.*, 2016). Takahashi *et al.* (2013) also reported a high abundance of

non-native species in nutrient-enriched aquatic systems. It is mentioned in the literature that at least some of the Ponto-Caspian gobies, in the region of their origin, move in autumn from shallow (below approx. 5 m deep) parts of coastal waters, which constitute the main area of

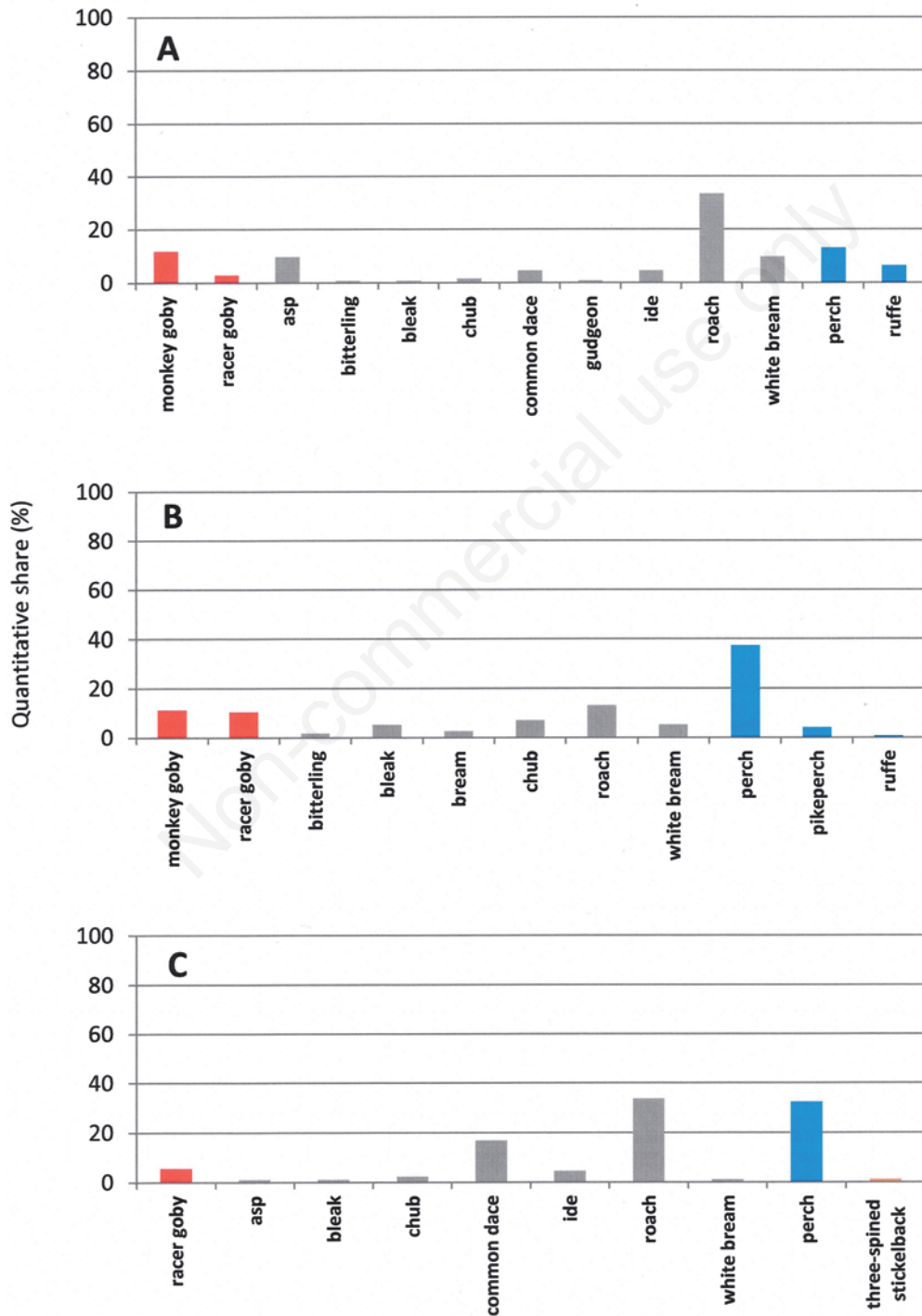


Fig. 5. Seasonal changes in the structure of ichthyofauna during 2013 at Dobięgniewo: A) June; B) September; C) November.

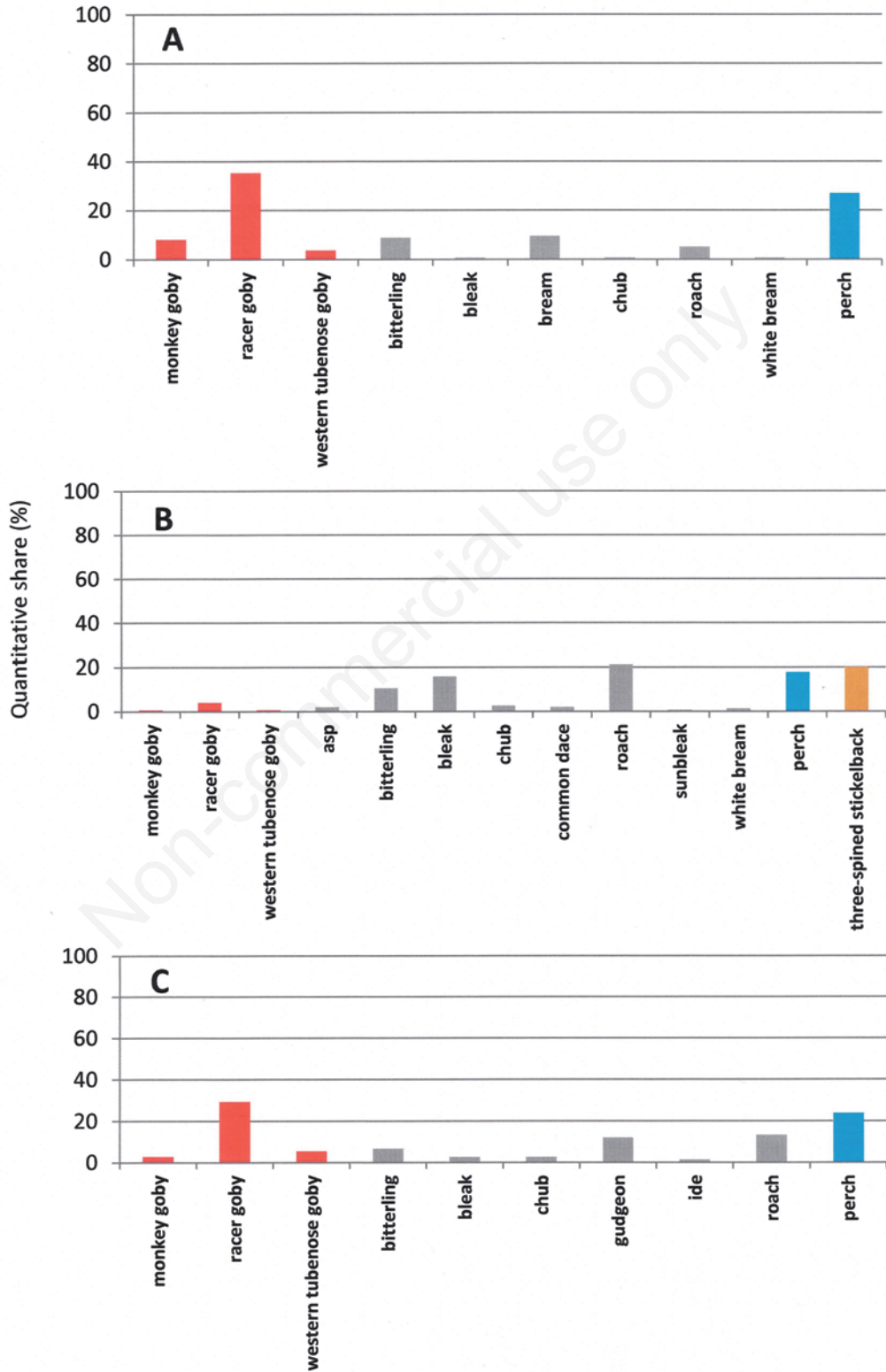


Fig. 6. Seasonal changes in the structure of ichthyofauna during 2013 at Murzynowo: A) June; B) September; C) November.

occurrence and spawning, to slightly deeper areas (Smirnov, 1986; Pinchuk *et al.*, 2003a, 2003b). In the Włocławek Reservoir, it was found (Kakareko, 2011) that alien gobies occur mainly in such a shallow zone, and only in this zone they spawn, although they do not move to deeper parts (the old river bed) in autumn, probably due to the faster water flow there. Ponto-Caspian gobies are considered to be nocturnal (Grabowska and Grabowski, 2005; Grabowska *et al.*, 2009; Kakareko *et al.*, 2013). This is basically confirmed by the results of the presented study showing the largest share of the gobies in catches at night and in early morning. The alien gobies differ in terms of their habitat preferences, and the type of substrate seems to be an important determinant here, because these fish that lack the swim bladder, spend most of their time on the bottom. It was documented (Płachocki *et al.*, 2020) that in the lower Vistula River monkey goby is associated with sandy bottom, racer goby is linked with the main channel complexity (artificial bank structures, macrophytes), and western tubenose goby is connected with off-channel areas with vegetation and a muddy bottom. These results are in line with the general descriptions of habitats occupied by the fish in their natural range (Smirnov, 1986; Pinchuk *et al.*, 2003a, b; Kottelat and Freyhof, 2007). This suggests that in the studied areas of the Włocławek Reservoir (Dobiegniewo, Murzynowo), most likely due to the significant dynamics of waters, the structural complexity (e.g. generated by empty snail and mussel shells in Murzynowo) and sand coverage of the bottom are so pronounced that they favour the racer and monkey gobies, but not the western tubenose goby preferring more stagnant conditions.

Because the goby species in the Vistula River appeared relatively recently (not less than 15 years), as in the case of racer goby, the population is well established (Grabowska *et al.*, 2019). Nowadays in many habitats, invasive goby species are the main component of fish communities. Presumably, their succession will progress and expand the range of their occurrence in Europe (Roche *et al.*, 2013; Van Kessel *et al.*, 2016).

The success of alien invasive gobies' expansion might be favoured by its broad diet (crustaceans, soft-bodied macroinvertebrates, dreissenids), aggressiveness, high fecundity, repetitive annual spawns, and male parental care (Corkum *et al.*, 2004; Brandner *et al.*, 2013). They are regarded as potential competitors of native benthic fish taxa (Freyhof, 2003). The increase in the tubenose goby population is believed to be the main reason for the decline in stock densities of bullhead (*Cottus gobio*) and whitefin gudgeon (*Gobio albipinnatus*) in the Slovak part of the Danube in the 1990s (Jurajda *et al.*, 2005). A different result, i.e., no negative trend in bullhead abundance after the invasion of the gobies (including tubenose goby) in the Austrian Danube, was also reported (Janáč *et al.*,

2017). Bullhead and tubenose goby share habitats in the River Moselle. The absence of bullhead in the headwater of the weir at Koblenz might be evidence of a negative effect of the increasing number of tubenose goby on native benthic species in the River Moselle and confirm that the introduced fish could be considered invasive species (Copp *et al.*, 2005).

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## CONCLUSIONS

Generally, racer goby, monkey goby, and tubenose goby are recognised as invasive due to their rapid colonisation of new areas (Naseka *et al.*, 2005) and often substantial predominance in joined fish communities (Prášek and Jurajda, 2005). Studies on the expansion process and observation of fish interactions with native organisms in the Vistula River, which remains the main corridor of the Gobiidae spreading to Polish waters (Copp *et al.*, 2005), are important from both scientific and practical action for the management of their populations. Gobies not only interact with native species but might also be affected by each other, as all invasive gobies have the similar bottom-ground lifestyle. Although an interaction between invasive gobies has not yet been studied in detail, data on pairs of other closely related fish species revealed high dietary overlap (Salgado *et al.*, 2004; Copp *et al.*, 2008), therefore suggesting the possibility of interspecific competition for food between invasive Ponto-Caspian gobies. Despite the noted dominance of two native fish species, i.e., roach and perch, the results indicate the important role of gobies in the structure of sublittoral fish communities in the Włocławek Reservoir and the necessity of expansion process studies, as well as the observation of the interactions with native fish species in invaded areas.

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