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Short communication

Comparison of two passive methods for sampling invasive round goby (*Neogobius melanostomus*) populations at different depths in artificial lakes

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ABSTRACT

Sampling of benthic fish is complicated, especially in deep inland water bodies with a structured bottom. The catches were compared of rapidly spreading round goby (*Neogobius melanostomus*) using small fykes nets and benthic gillnets in three artificial lakes in The Netherlands over a two year period. Round gobies were captured at all depth layers in each sampled lake. Significantly larger individuals were captured in gillnets compared to fyke nets. Reference sampling in littoral areas captured a wide range in size of round gobies with beach seines. With fyke nets, the highest catches were usually achieved in the shallowest and deepest depth strata. Gillnets catch decreased at deeper layers. Both methods are passive sampling tools and did not provide the absolute catch per bottom area, however relative density estimates of round gobies at different depths or habitats are possible. Round gobies showed a significant size bias associated with capture method. Because it is important to understand the biology and ecology of invasive species like round goby, the combination of small fyke nets and gillnets appears to be a good solution to sample a variety of ranges in deep or/and structured benthic habitats.

1. Introduction

Round goby (*Neogobius melanostomus*), of the family Gobiidae, is a benthic euryhaline species that is native to central Eurasia including the Black, Azov and Caspian Seas (Verreycken et al., 2011). The species was transported via ballast water to different parts of Europe and North America (Corkum et al., 2004). In newly colonized regions, round goby spread rapidly and reach densities of over 100 individuals per m^2 in some habitats (Cooper et al., 2009). Round goby invasion have had detrimental effects on native fish species such as mottled sculpin (*Cottus bairdi*, Janssen and Jude, 2001), logperch (*Percina caprodes*, Balshine et al., 2005), river bullhead (*Cottus perifretum*, van Kessel et al., 2011, 2016) and ruffe (*Gymnocephalus cernua*, Jůza et al., 2018) and it is included in the list of 100 worst European invasive species (www.europe-aliens.org). Similar to many other European and North American water bodies, the River Rhine and, subsequently the River Meuse have been invaded by many Ponto-Caspian species (van Kessel et al., 2016). The first occurrence of round goby in The Netherlands was observed in 2004 (van Beek, 2006). By 2012 round goby were found in three lakes of the Biesbosch lake system (Kruitwagen, 2013). A detailed understanding of biology and ecology is an important prerequisite to prevent future expansions and therefore, an unbiased sampling strategy is absolutely necessary to fulfill it.

Methods used to sample and monitor round goby populations include electrofishing (van Kessel et al., 2011; Janáč et al., 2016), seining (van Kessel et al., 2011; Žák et al., 2018), angling (Chotkovski and Marsden, 1999), fyke netting (Sapota and Skóra, 2005), gillnetting (Sapota and Skóra, 2005; Shemonaev and Kirilenko, 2009), bottom trawling, SCUBA diving (Sapota and Skóra, 2005) and video recording (Taraborelli et al., 2010). Because round gobies utilize the pelagic zone during larval and early juvenile stages, fry trawling is an efficient sampling tool in these phases (Jůza et al., 2016). For sampling of round

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gobies in deep benthic habitats, or in habitats with a structured bottom, angling, fyke netting and gillnetting can be used. Because round goby can be underestimated in gillnet catches (Diana et al., 2006; Žák et al., 2018) owing to the relatively small body size and also body constitution (an especially large head), fyke netting could be an efficient supplementary passive method for round goby sampling in structured or deep benthic habitats. Differences between active (beach seining) and passive (gillnets) sampling techniques were also found, when less active females were underestimated in gillnet catches compared with more active males (Žák et al., 2018). In the Great Lakes region relatively large fyke nets (mouth opening 0.5 × 1 m or 1 × 1 m with few meters long wings) were used to sample round gobies especially in coastal areas (Uzarski et al., 2005; Cooper et al., 2007), but in some studies smaller versions of fyke nets (so-called minnow traps) were successfully used (Diana et al., 2006; Kornis and Vander Zanden, 2010).

It is major challenge to actively sample fish living close to the bottom in lakes and reservoirs when unpredictable bottom contours, boulders, stumps, roots, or areas of soft mud make traditional benthic fry trawling impossible (Čech et al., 2017). In this study two passive gears (small fykes and benthic gillnets) were compared for the ability to catch invasive round goby at different depths in three lakes of the Biesbosch lake system in The Netherlands. Fyke nets are similar in size to minnow traps or Breder traps (Breder, 1960) but, unlike Breder traps, they do not have wings. Fyke nets and gillnets can be useful for comparison of catch rates between depths or habitats, which are not accessible for active sampling methods, such as seining (because of depth), or bottom trawling (because of a structured bottom). In comparison with destructive gillnets, fyke nets are supposed to be fish-friendly (Kubečka et al., 2012). Round gobies captured by fyke nets are therefore in good condition and can be later used for better understanding of the biology and ecology of this rapidly spreading species, (e.g. the use of fish in laboratory experiments or diet analyses).

The main aim of this study was to answer if (1) passive sampling tools like fyke nets and gillnets are useful for sampling relatively sedentary species like round goby; (2) if there are differences in length frequency distribution of round goby observed by both methods and if this distribution is different from the distribution observed with the active sampling method (beach seining) and; (3) if there are differences in depth distribution between fyke nets and gillnets.

2. Material and methods

2.1. Study area

The study was conducted in the Biesbosch lake system in The Netherlands (Fig. 1), in which there are three interconnected cascading lakes: De Gijster (DG, 51.6773 N, 4.8041 E, area: 320 ha, max. depth: 27 m), Honderd en Dertig (HD, 51.7347 N, 4.7744 E, area: 219 ha, max. depth: 27 m) and Petrusplaat (PP, 51.7572 N, 4.7745 E, area: 105 ha, max. depth: 15 m). The lakes were constructed during the 1970 s, and they provide high-volume storage and serve as the first step in the treatment of river water for drinking water production by several waterworks in the southern and western parts of The Netherlands, e.g., the municipality of Rotterdam and its surrounding area (Oskam and van Breemen, 1992). The lakes were built as basin-shaped embanked impoundments along the River Meuse, with artificial sides of asphalt-concrete and clay bottoms. The moderately polluted, but highly eutrophic water from the River Meuse is first pumped into De Gijster, followed by Honderd en Dertig, and finally, Petrusplaat (Oskam and van Breemen, 1992). The lakes do not stratify during summer because the water is artificially mixed with strong aeration. The average summer water transparency is approximately 2.5, 3.5 and 4 m in De Gijster, Honderd en Dertig and Petrusplaat, respectively and the trophic status (phosphorus concentration) decreases from De Gijster towards Petrusplaat.

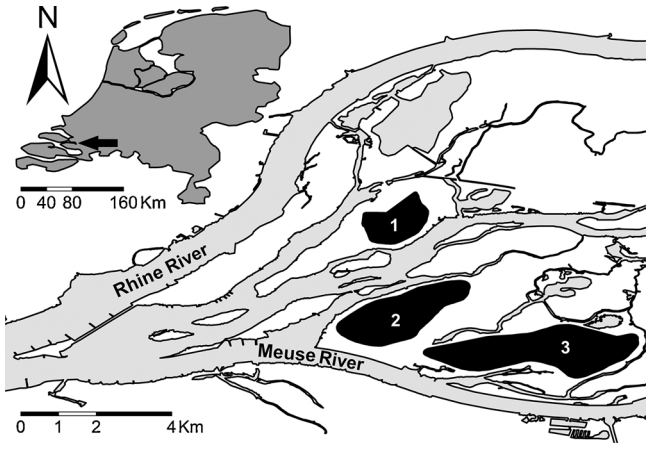

Fig. 1. A map of the Biesbosch lakes (1 - Petrusplaat, 2 - Honderd en Dertig, 3 - De Gijster) at the confluence of the Rhine and Meuse rivers and its location within The Netherlands (indicated by black arrow).

2.2. Fish sampling

2.2.1. Fyke nets

Fyke nets (25 × 25 x 45 cm, Fig. 2) have a mesh size of 4 mm and in front and back sides, netting created small funnels with mouth openings at the ends (6 cm in diameter). Dog granules or dead perch were used as bait, because baited minnow fyke nets captured more round gobies than non-baited fyke nets (Diana et al., 2006). Each fyke net was equipped with a floater with rope for lowering and raising the net. Fyke nets were set before sunset (5 −7 pm) and checked in the morning after sunrise (9 −11 am, approximately 15 h of installation). Sampling was performed in August 2015 and 2016 (exact dates in Table 1) but in 2015, De Gijster was not sampled because the water level was too low that year (surveying prohibited by Evides Water Company). Two localities were sampled each year in each lake and five (2015) or ten (2016) fyke nets were installed at each depth in each locality (Table 1). Bottom substrate can be important for distribution of round gobies. In this study the information about type of bottom in the places, where fyke nets and gillnets were set were not known. On the other hand, both methods were used in exactly the same places and there were, therefore no differences in the bottom character between methods.

2.2.2. Gillnets

Benthic gillnets were 1.5 m high and 30 m long and were placed in the benthic habitat, parallel with the shore to ensure a similar depth range. They consisted of 2.5 m long blocks of different mesh sizes that were sewn together along the full height (CEN, 2015). Twelve mesh sizes were used following a geometric series with a ratio of about 1.25 (5, 6.25, 8, 10, 12.5, 15.5, 19.5 24, 29, 35, 43 and 55 mm knot to knot). Gillnets were deployed in sets consisting of three gillnets joined by a 30 m long rope. They were set overnight at exactly the same time, depth and localities as the fyke nets were deployed (Table 1). Gillnets were installed together with fyke nets before sunset and lifted the following morning after sunrise to cover the main peaks of fish activity (Prchalová et al., 2010). The depth of gillnets, as well as fyke nets, were measured by an acoustic depth gauge (Piranha Max 10). As in the case of the fyke nets, De Gijster was not sampled with gillnets in 2015.

2.2.3. Beach seining

Night shore seining using 10 m long and 2 m deep beach seine net with mesh size 1 × 1.35

mm was performed to obtain an unbiased size distribution of round goby from the shallow littoral area. A total of 10 seines were used in each lake each year (Table 1). As in the case of gillnets and fyke nets, De Gijster was not sampled in 2015.