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Assessing fish assemblages in reed habitats of a large shallow lake—A comparison between gillnetting and electric fishing

T. Erős*, A. Specziár, P. Bíró

Balaton Limnological Research Institute of the Hungarian Academy of Sciences, Klebelsberg K. u. 3., H-8237 Tihany, Hungary

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ABSTRACT

To know the possible bias of different fishing methods is essential in fisheries management, ecology and conservation. In this study species number, abundance, biomass, length class distributions and predefined ecological features of fishes were compared across two data sets collected simultaneously using gillnet sampling and electric fishing in the reed habitats of the shallow and eutrophic Lake Balaton, Hungary. With increasing sample size, electric fishing proved to be more effective in detecting new species, and samples collected with this method were more species rich when standardized to the number of individuals collected. Ordinations based on relative abundance and biomass data indicated highly contrasting differences between the two methods. Bleak were caught by multi-mesh gillnets in much higher relative numbers. However, the shape and size selectivity of the gillnets also reinforced differences between the two methods. Size distribution data showed that gillnets caught relatively more middle-sized fish compared with electric fishing. Estimates of the abundance and biomass of non-native species by gillnetting and electric fishing differed, and differences were found in the proportions of various guilds (feeding, spawning and habitat). However, it was not possible to conclude which gear's estimate is closer to reality. The study illustrates that reliance on single-gear surveys can be misleading in assessing fish assemblages in reed habitats of a large and shallow, eutrophic lake.

1. Introduction

The accurate estimation of biotic assemblage attributes (e.g. species richness and composition, relative abundances, functional metrics) is a fundamental requirement in environmental monitoring and assessment (Cao et al., 2003; Kennard et al., 2006). For sampling fish assemblages a variety of catching methods are available (Cowx, 1996; Murphy and Willis, 1996). However, catching effectiveness, including species selection and size selectivity patterns may differ for each gear, making it difficult to determine whether these differences allow for accurate characterization of assemblage attributes. Hence, there is a need for a more intensive evaluation of between-gear variations to determine their relative efficiency (Casselman et al., 1990; Jackson and Harvey, 1997; Cowx et al., 2001; Olin and Malinen, 2003; Goffaux et al., 2005).

Fish assemblage metrics are being intensively used to determine the ecological status of lakes (Randall and Minns, 2002; Gassner et al., 2003; Drake and Valley, 2005; Garcia et al., 2006), and fish as a group is one of the key biotic elements for such evaluation under the Water Framework Directive of the European Union (EU, 2000).

While there is a great need for a standardized fishing protocol for lake habitats, such a methodology is still under development in European countries. The two recommended sampling methods that are used most often are gillnet sampling (Appelberg et al., 1995; CEN, 2005) and electric fishing (CEN, 2003). Gillnets are passive tools, and as such their catching effectiveness depends largely upon fish activity. Even if multi-mesh gillnets are used, their species, morphological and size selectivity can be significant. Electric fishing, an active method, is generally considered to be the most adequate single tool for sampling shallow (i.e. less than 1.5 m deep) freshwater habitats (see e.g. Cowx, 1996). However, the efficiency of electric fishing can vary significantly with the physical and chemical characteristics of the habitat, the device used, etc. As a consequence, this sampling method can also show important species and size selectivity.

Very few studies have examined comparatively the effectiveness of gillnetting and electric fishing when assessing the assemblage attributes of fishes either from rivers (Growns et al., 1996; Goffaux et al., 2005) or lakes (Vaux et al., 2000). Vaux et al. (2000) concluded that when developing Environmental Monitoring and Assessment protocols the number of fish species and individuals collected per 4-min transect by electric fishing (Coffelt Mark-10 350 w backpack gear) was either superior or similar to that of gillnets set overnight in the lakes of the northeastern United States. However, their gill-

* Corresponding author. Tel.: +36 87 448 244; fax: +36 87 448 006.
E-mail address: ertib@tres.blki.hu (T. Erős).

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netting procedure included samples from a diverse array of large lake habitats (such as bottom sets in the hypolimnion, metalimnion, and epilimnion and pelagic epilimnetic sets), while electric fishing samples were confined to the littoral zone. Currently there are no detailed comparative data on electric fishing and gillnetting for samples taken from the same (or equivalent) lake habitats.

In studies of fish assemblages, generally, the open habitats of lakes are sampled with gillnetting, while electric fishing is used in the littoral zone along the shoreline or among macrophytes (e.g. Diekmann et al., 2005; Mehner et al., 2005). In previous studies, therefore, fish assemblage comparisons between habitats also implied differences in the bias of the sampling methods. Since the relative bias of both electric fishing and gillnet sampling is largely unknown, the aim of this study was to compare and evaluate electric fishing and gillnet catches, collected in the natural habitats of a large Central-European lake. Reed habitat is one of the most important natural habitat types in shallow eutrophic lakes and wetlands, providing feeding, spawning and refuge areas for fish. Consequently, we examined relationships between species richness and sampling effort, assemblage composition, size class variations and some important functional metrics (as used in fish-based evaluations) to get a deeper insight into the relative effectiveness of electric fishing and gillnetting in assessing fish assemblages in the reed habitats of Lake Balaton, Hungary.

2. Methods

2.1. Study area and sampling procedure

Lake Balaton is one of the largest shallow lakes in Central Europe (596 km^2). Its mean depth is 3.2 m and the lake is meso-eutrophic (Istvánovics et al., 2007). The littoral zone of the lake is mostly modified. Although widely distributed in the past, reed vegetated areas are now fragmented, with a total area of only 11 km^2.

Electric fishing and gillnetting were carried out in the summer of 2007 on five occasions (06, 07, 12, 27 June and 04 July). Five distinct reed habitats were examined, one each day, along the northern shoreline of the lake. The sites belonged to the littoral zone and were large enough to allow both electric fishing and gillnetting with many replicate samples (see below). The reed was fragmented enough for both setting the nets and conducting boat electric fishing. Finally, the sites were remote enough from boat harbours to be relatively infrequently used by anglers.

Electric fishing was carried out during daytime using a generator-powered machine (Hans-Grassl Gmbh EL64 II GI; DC, 7.5 kW, 300–600 V; see http://www.hans-grassl.com/ accessed 17 March 2008). The cathode, a 5 m long copper cable, was floated at the rear of the boat. To allow effective manuovering in the reed, a small rubber boat (Yamaha 300S) with an electric engine was used. The crew comprised two persons: one for catching the fish with the hand-held anode (2.5 m long pole with a net of 40 cm diameter, mesh size 6 mm) and one for driving the boat. Continuous electrofishing was carried out by dipping the anode into the water at approximately 3 m long intervals and pulling the anode toward the boat, while moving slowly ahead. For each electric fishing 35 m long sections were sampled (this being equal to the length of one gillnet set). A high precision GPS device (Garmin GPSMAP 76Cx; precision 2–4 m in the field) was used to measure the length of the sampling route. Altogether 17, 19, 16, 18, and 17 replicates of 35 m long sections were electrofished in the five habitats, which yielded a total of 87 samples (3045 m). Fishing time for each section took ~4 min. The captured fish were identified, their standard length measured (mm) and then released at the end of each section. To avoid recapture, each electric fishing started c. 10–15 m away from the previously sampled section. Based on both the electric fishing and the gillnet data (see below), NPUE was calculated as the standardized total number of fishes collected per hour.

Similarly to electric fishing, gillnetting was carried out during the daytime. Although it is suggested that gillnet sampling should be carried out at night (Appelberg, 2000; CEN, 2005), deviation from the standard was necessary for two reasons. First, setting gillnets in the daytime allowed comparison of the two methods during the same time period. Second, daytime sampling avoided the rapid accumulation of fish in the gillnets (see Olin et al., 2004), which can happen in under one hour at night in Lake Balaton (Specziár, 2001). For gillnetting, 1.5 m high European standard benthic gillnets (Appelberg, 2000; CEN, 2005) rigged with two more 2.5 m long panels of 65 and 80 mm mesh sizes were used. Thus our nets comprised 14 panels of 43, 19.5, 6.25, 10, 55, 8, 12.5, 24, 15.5, 5, 35, 29, 65 and 80 mm meshes and in total were 35 m long. The gillnets covered the whole water column in all cases. The duration of set was between one and two hours during the period 09:00–11:00 a.m. Such a relatively short time period was necessary to avoid excessive accumulation of fish in the nets so as not to exceed the 6 kg catch limit per net (CEN, 2005). At each site, five nets were set in random locations, and consequently 25 nets were used for this study.

The European standard multi-mesh gillnet is known to be ineffective for catching fish <5 cm (Appelberg, 2000; CEN, 2005). Similarly, general electric fishing techniques are largely ineffective for fish <2 cm, to an unknown extent (except devices specialized for catching 0-group fish; see e.g. Cowx et al., 2001). To avoid bias in our comparisons, all young-of-the-year fish were omitted from the analyses. This age group (i.e. 0+) could be distinguished easily by length-frequency analysis.

For biomass data, the weight of each individual fish was estimated based on previous length-weight regressions, calculated for the fishes of Lake Balaton (Specziár et al., 1997; Specziár unpublished data). Mean water depth ± S.D. was 1.18 ± 0.23 m and 1.27 ± 0.24 m for electric fishing ($n = 87$) and gillnetting ($n = 25$) samples, respectively, and did not differ between the sampling locations examined with the two methods (t-test, $P < 0.001$). Water transparency (Secchi depth) was 0.62 ± 0.20 and 0.63 ± 0.23 m, respectively, and did not differ between the sampling sites either (t-test, $P < 0.001$). Conductivity, an important parameter for the efficiency of electric fishing, varies between 550 and 671 μS/cm in Lake Balaton (Specziár and Vörös, 2001).

2.2. Data analysis

Sample-based and individual-based rarefaction analyses were used to examine changes in the estimated number of species as a function of both number of samples and number of individuals collected (Gotelli and Colwell, 2001; Colwell, 2005). Although it is not easy to standardize samples collected with an active (electric fishing) and a passive (gillnetting) catching method, rarefaction analyses can provide the least-biased evaluation of differences in the number of species collected with the two methods.

Two-dimensional nonmetric multidimensional scaling (NMDS) ordinations were run to visualise the variability and differences in fish assemblage composition between the two sampling methods. The analyses were run based on square-root-arcsine transformed relative abundance and biomass data. To obtain robust and readily interpretable results, samples from a certain reed site were pooled according to the collection method applied. Consequently, the positions of 10 sampling points (two collecting methods and five spatially separated reed habitats) were compared in the analyses. Species with an overall relative abundance or biomass of less than 1% were combined into a single "rare species" group to prevent the number of variables (i.e. species) from highly exceeding the number of objects (sampling points). Since the relative abundance