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The role of the electrofishing equipment type and the operator in assessing fish assemblages in a non-wadeable lowland river

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ABSTRACT

The wider the spatial and temporal scales of a fish survey are the higher the chance that the methodology will vary, most probably in the configuration of the sampling equipment or the composition of the crew. It is important to know how these changes affect data quality. The objective of this study was to assess the effect of the differences both in the electrofisher equipment type (low power, battery powered vs. high power, generator supplied units) and in the operators when assessing fish assemblages in a non-wadeable lowland river in Hungary. We found that compared to the superior effect of "natural" spatio-temporal heterogeneity, pure methodological factors accounted for a low or moderate (<15%) part of the variance in fish data. The most commonly measured assemblage level variables, such as rarefied species richness, similarity based assemblage composition (i.e. presence/absence) and relative abundance data were the most insensitive to changing the equipment type and/or the operator. However, the shared effect of methodological and spatio-temporal factors was important in shaping CPUE data and mean fish size of some species, suggesting that the sensitivity of these variables to methodological variations can vary in space and time. We concluded that in systems with high spatio-temporal heterogeneity, the relative importance of the herein investigated methodological bias is likely to remain within an acceptable range. Thence, in studies examining large-scale ecological patterns over wide range of habitats and/or large areas, some flexibility in the methodology may be a reasonable compromise in favor of sampling more sites and increasing effort. Nevertheless, if any change in the methodology is indispensable, at least its effect on sample quality should be assessed.

1. Introduction

The accurate estimation of biotic assemblage attributes is a fundamental requirement in both basic and applied research (e.g. Cao et al., 2001; Kennard et al., 2006; Fisher and Paukert, 2009; Sály et al., 2009). For sampling fish assemblages a variety of methods are available (Murphy and Willis, 1996). It is well known that catching effectiveness vary among gears, which can seriously influence inferences about assemblage level attributes (e.g. Jackson and Harvey, 1997; Penczak et al., 1998; Goffaux et al., 2005; Erős et al., 2009). Quantifying the effects of methodological differences between and within gear types among a variety of field conditions is therefore an intensively studied area, especially in the context of improving sampling methodologies for fish assemblage monitoring.

Sampling by electrofishing is the most widely used technique to collect data about fish assemblages in streams and rivers (Cowx and Lamarque, 1990; Reynolds, 1996; CEN, 2003; FAME Consortium, 2004). A series of studies have dealt with optimizing sampling effort for different electrofishing protocols, to attain the best compromise between representativeness and logistic cost (i.e. time, staff and expenditure). For example, the relative performance of single- versus multiple-pass electrofishing was compared over a wide range of habitats (Penczak, 1985; Meador et al., 2003; Meador, 2005; Kennard et al., 2006; Reid et al., 2008; Sály et al., 2009), or the determination of the optimal sampling length was in the focus of many methodological studies (Hughes et al., 2002; Meador, 2005; Kennard et al., 2006; Hughes and Herlihy, 2007; Fisher and Paukert, 2009; Kanno et al., 2009). It was shown that to attain the same level of representativeness (i.e. the same proportion of species richness detected, or the same level of similarity among repeated relative abundance estimates), sampling effort varies over time and space even within the same region in relation to biological and habitat heterogeneity, and sampling efficiency (Lyons, 1992; Angermeier and Smogor, 1995; Meador, 2005; Holtrop et al., 2010). Required sampling effort was also found to vary depending on the examined assemblage attribute (e.g. species richness and composition, relative abundance) (Kennard et al., 2006; Kanno et al., 2009; Sály et al.,

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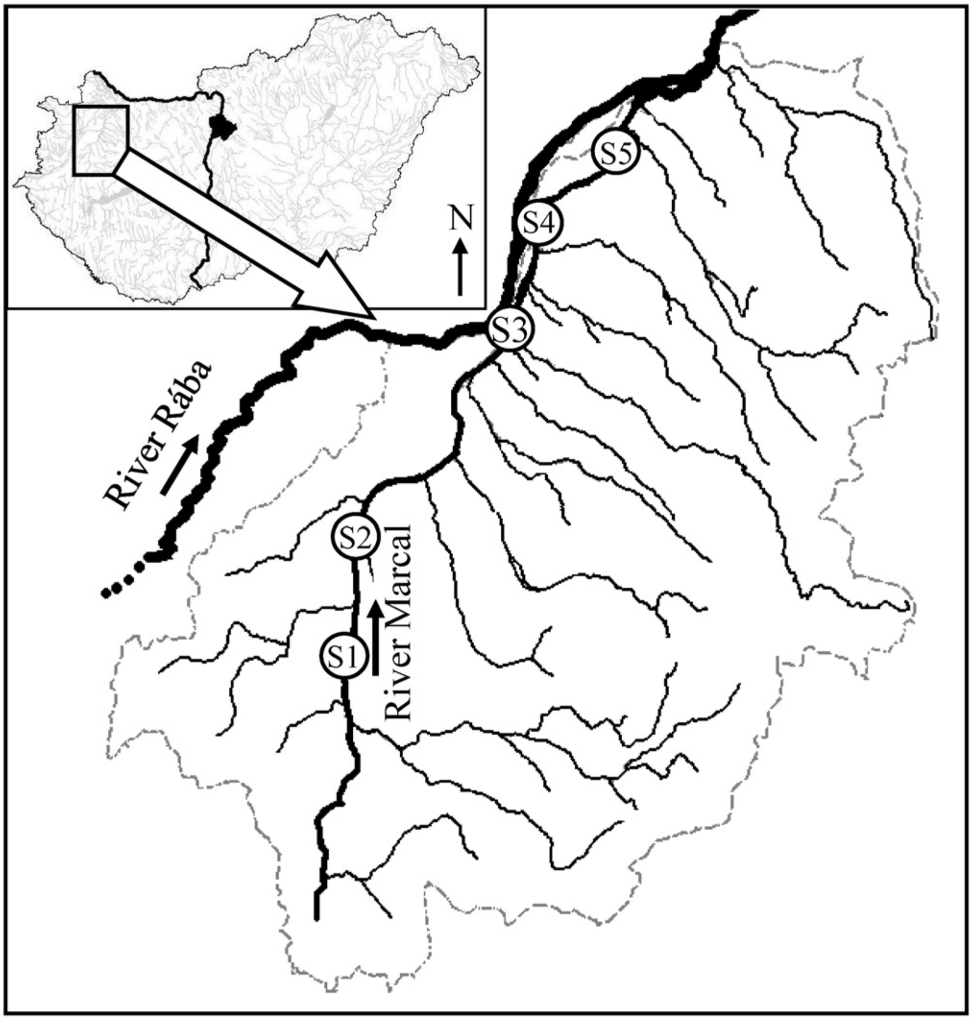

Fig. 1. Location of the River Marcal and its tributary system in Hungary. Sampled river sections (S1–S5) are indicated.

2009; Holtrop et al., 2010). For example, Hughes and Herlihy (2007) and Maret et al. (2007) found that shorter sampling distances were required to estimate the index of biotic integrity versus species richness.

However, relatively little attention has been paid to evaluate some common methodological variations occurring probably in many sampling programs covering wide range of habitats, and extended spatial and temporal scales. Variations, which may occur in the composition of the crew or the type and configuration of the equipment used for sampling, can also affect sampling efficacy. For example, Hardin and Connor (1992) found a significant but not consistent difference among the electrofishing performance of six sampling crews for various sizes of three sport fish species in Florida lakes. Recently, Benejam et al. (2012) assessed fish catchability in Mediterranean streams and concluded that the effect of electrofishing crew is negligible for estimation of species richness and composition but considerable for fish abundance. Heindinger et al. (1983) detected a substantial difference in the number of fish caught, but not in the number of species detected, when using three different, alternating current (AC) electrofishing machines. Vaux et al. (2000) showed that the relative performance of a low power (350 W) backpack electrofisher and a high power (5 kW) electrofishing boat varied with the conductivity of the water when assessing species richness and the number of fish captured. Finally, Miranda and Kratochvíl (2008) proved that catch rate and fish size composition in the sample can vary even with the arrangement of the anode in boat electrofishing.

Although it would be ideal to standardize any human and equipment related factors, this is an unfeasible task in large scale monitoring studies, which generally require considerable compromising among science, logistic and human and financial resources (see e.g. Hughes and Peck, 2008). Therefore, to avoid the inherent effects of seasonal heterogeneity in fish assemblages and sampling efficiency (e.g. Zalewski and Naiman, 1985; Taylor et al., 1996; Zalewski and Cowx, 1990), samplings should be done within a restricted time over all study sites. However, sampling over large study extents may require multiple sampling crews. It is also possible that sampling teams may differ in equipments due to limited financial sources or other methodological constrains. Different types of habitats may also require different sampling implements. Wadeable streams are generally sampled with low power (LP; $\leq$500 W) backpack elecrofishing units while rivers and lakes are usually sampled with high power (HP; $\geq$3 kW) generator driven electrofishing machines from boats (e.g. Cowx and Lamarque, 1990; Meador, 2005; Kennard et al., 2006; Erős et al., 2009; Sály et al., 2009). In addition, choice of the sampling equipment may be constrained by either logistical reasons (i.e. out-of-way sites, lack of boat cradle), due to regulatory restrictions (i.e. the use of gasoline powered boats or electrofisher devices may be prohibited in some protected areas) or depending on habitat specificity