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Application of an electrified benthic frame trawl for sampling fish in a very large European river (the Danube River) – Is offshore monitoring necessary?

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ABSTRACT

The organization of fish assemblages in offshore, deep channel habitats is poorly known in very large rivers compared with shoreline, littoral areas. We report on the parameters and testing of an electrified benthic frame trawl (EBFT), developed for monitoring the distribution and abundance of benthic fishes in the Danube River, Hungary. We also compare the results of the benthic main channel survey with a shoreline electrofishing (SE) data set. Altogether 33 species were collected offshore during the 175 trawling paths (500 m long each). Both sample based and individual based rarefaction showed that night time SE detected significantly more species with increasing sampling effort than day time trawling of offshore areas. However, offshore surveys detected sterlet *Acipenser ruthenus*, which could not be detected by SE, even using extreme high sampling effort. Offshore trawling also proved the common occurrence and high abundance of the strictly protected endemic Danube streber *Zingel streber* in the river, which proved to be extremely rare in SE catches. The EBFT caught larger/older individuals of many species than SE, and indicated diverse size/age structure for many species offshore. Our survey revealed that offshore areas are intensively used by a variety of species, which occur relatively even, but with variable abundance in the Danube River. We suggest that even a relatively small (i.e. 2 m wide 1 m high) EBFT can be a very useful device for monitoring offshore fish assemblages in very large rivers and provide important data for bioassessment and conservation purposes.

1. Introduction

Sampling the biota in the main channel of large rivers presents a continuing challenge for freshwater ecologists. While our knowledge of the organization of shoreline fish assemblages and their representative sampling are increasing (e.g. Jurajda et al., 2001; Erős et al., 2008), information about the composition and spatial and temporal distribution of fishes in deep channel habitats is still relatively sporadic (Dettmers et al., 2001). Inferences about how main channel habitats contribute to the bioassessment of large rivers compared with shoreline monitoring data should also be more precisely developed (De Leeuw et al., 2007; Flotemersch et al., 2011). The highway analogy, a postulate of the flood pulse concept (Junk et al., 1989), which states that the main channel of large alluvial rivers is used by fishes mainly as a route for gaining access to floodplain habitats, has been proved to be oversimplified, because main channels were shown to maintain diverse fish assemblages with several species spending most of their life-time offshore (Galat and Zweimüller, 2001; Wolter and Bischoff, 2001; Stewart et al., 2002). However, detailed quantitative studies are restricted to only a very few large rivers even in the relatively well studied temperate large river systems of Europe and North-America (see for e.g. Wolter and Freyhof, 2004; Gutreuter et al., 2009; Ridenour et al., 2009). It would be thus important to develop deep channel fish monitoring methods in a variety of biogeographical and ecoregions for providing data for both basic research and the conservation management of riverine fish species.

With its 2872 km length, the Danube River is the second longest river in Europe. Although the river is the cradle of Europe's most diverse fish fauna (Reyjol et al., 2007), the large scale organization of its fish assemblages is relatively poorly known, compared with other central and especially western European large rivers. The monitoring of its fish assemblages is mainly based on shoreline electrofishing methods (Hirzinger et al., 2003; Erős, 2007).

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For example, the second Joint Danube Survey (JDS2), organized by the International Commission for the Protection of the Danube River (ICPDR) in 2007, provided the first data about the longitudinal distribution of fish assemblages along the river with a standardized methodology (http://www.icpdr.org/jds/). However, the electrofishing-based surveys were restricted to inshore areas, and consequently did not provide information on main channel fish assemblages. Further, although national monitoring programmes intend to address the deepwater main channel species in some countries (e.g. long line sampling in Austria) a really effective and routinely used methodology for sampling main channel species, to the best of our knowledge, has not been developed yet. Such an easily applicable monitoring methodology would be essential, for example to provide complementary information about the occurrence and abundance of conservationally important species.

Many small, benthic species are important for conservation purpose (Labonne et al., 2003; Ridenour et al., 2009), yet they are especially difficult to collect with conventional fishing gears (e.g. trammel nets, gillnets) used to sample deep habitats in slow flowing large rivers (Murphy and Willis, 1996; Herzog et al., 2005; Freedman et al., 2009). Additionally, entangling nets and hook and line (i.e. long line) sampling can injure these small fish seriously. Note that we by no means refer to boatable (raftable), but rather shallow (i.e. less than 2 m deep) rivers which are usually sampled with electrofishing from boats or with boom mounted electrofishing ships (see for e.g. Hughes et al., 2002). Monitoring the populations of benthic species with the more intensively used hydroacustic methods is still problematic, since their exact identification still present difficulties for researchers, especially in case of species from the same genus. Naturally, the combination of hydroacustic surveys with a suitable fishing gear can be fruitful, because the latter can help to collect fish for identification. For this purpose, trawling is the most preferred fish sampling method of the main channel trough (Dettmers et al., 2001; Wolter and Bischoff, 2001; De Leeuw et al., 2007; Doyle et al., 2008). Recently, different trawling gears has been developed and their efficiency tested for the more effective sampling of benthic species in very large rivers (Herzog et al., 2005; Freedman et al., 2009; Ridenour et al., 2009, 2011).

In this study, we report on the application of an electrified benthic frame trawl (EBFT), developed for monitoring the distribution and abundance of benthic fishes in the Danube River. Specifically, we show the parameters of the EBFT device and provide the first detailed data on sampling effort species richness relationships, abundance, and size structure of the most common benthic species in the offshore, deep channel habitats of this very large river. We also compare the results of our benthic main channel survey with an extensive shoreline electrofishing (SE) data set. Based on these comparisons we evaluate the applicability of main channel benthic surveys for the study of fish assemblages in a very large river for bioassessment and conservation purposes.

2. Materials and methods

2.1. Study area

The Danube has a drainage area of approximately 796,250 km^2. River regulation, namely the construction of hydroelectric schemes, especially in the Upper Danube (i.e. in Germany and Austria), and channelization has profoundly modified the physical structure of the Danube throughout its course. The Hungary section, referred to as the 'Middle Danube', runs for 417 km and has a mean annual discharge of 2000 m^3 s^{-1}. The main channel has a substratum dominated by gravel and sand, a mean depth of 4 m and a mean velocity of 0.6 m s^{-1}. The banks are relatively natural (except the section lying within Budapest), interrupted with embanked rip-rap shorelines of ~100–1000 m long sections.

2.2. Data collection

To construct the sampling device (EBFT) to be effective in catching small sized benthic species we combined the design of conventional trawl nets and framed sledge nets, the latter used to sample fish fry in deep habitats (Fig. 1). This consisted of 3.4 cm diameter stainless steel frame (2 m long × 1 m high) to which a drift net was attached. The drift net was 5 m long and consisted of a 5 mm-stretch inner mesh bag and an 8 mm-stretch outer mesh bag. A buoy was attached to the codend with a rope to indicate the position of the net while fishing. We used weighted metal wheels to help keeping the device close to the bottom and also keeping the frame 6 cm above the bottom to prevent the filling of the net with the substrate material. We electrified the frame with a 40 m long electrode cable which was connected to a Hans-Grassl EL65 IIGI electrofishing device operated with a VANGUARD HP21 14.9 kW generator. A 6 m long copper cathode cable was hanged freely and pulled approx. 2 m before the electrified frame (Fig. 1). Preliminary catching experiments, (specifically with and without electricity, different positions of cathode cables, different net mesh sizes and frame sizes) showed that this construction yielded the most acceptable compromise between catching rates and sampling from boat with a four person crew (see Szalóky et al., 2011). In this crew, 2 people handled the framed net, one handled the electrofishing device and one operated the boat. Fishing (hereafter trawling) was conducted with a 6.3 m long boat powered by a 50 hp outboard Mercury four stroke engine.

When starting trawling, the EBFT operators lowered the frame to the bottom while the boat was slowly moving downstream with the flow. Trawling route was started to be measured by a GPS only after EBFT reached the bottom, which could be easily felt while holding the central rope (Fig. 1) and right after electroshocking started. The direct current (approx. 350 V, 33 A) was given for 5–8 s with 3–5 s breaks between the operations to minimize fright bias and injury of fish. The applied trawling speed was slightly higher than the

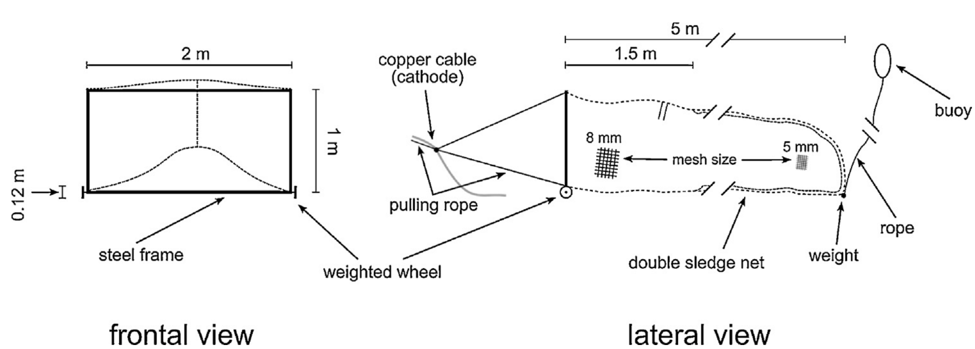

Fig. 1. Schematic picture and parameters of the electrified benthic framed trawl (EBFT) developed to sample fish in the offshore areas of the Danube River, Hungary.