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Avoidance reactions of fish in the trawl mouth opening in a shallow and turbid lake at night

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ABSTRACT

Fish avoidance behaviour in the trawl mouth at night was investigated in the extremely shallow and turbid Lake Neusiedl in Austria. To evaluate fish reactions, a fixed frame benthic trawl with three electricity modes (without electricity, with continuous electricity and with interrupted electricity) was used and the captured fish abundances, biomasses and size structures were compared between modes. Simultaneously, the dual-frequency identification sonar (DIDSON) monitored fish abundance and size in front of and beside the trawl mouth during all tows. White bream (*Blicca bjoerkna*), bleak (*Alburnus alburnus*) and razor fish (*Pelecus cultratus*) were dominant fish species in the trawl catches. We did not find differences in fish abundance or biomass when the tows with different electricity modes were compared. The length frequency distribution of fish was not significantly different between modes, but trawls with the two electrified modes contained a higher proportion of fish larger than 130 mm than trawls with the non-electrified mode. Additionally, the DIDSON recordings did not display any significant differences in abundance, length frequency distribution and from length–weight relationships calculated biomass between the electrical modes. Not even the two avoidance behaviour categories used as indicators of trawling error displayed significant differences between avoidance and biomass. Our results indicate that based on trawling abundance and biomass comparisons, and supported by observations by DIDSON, all electrical modes were similarly effective for all size groups of fish. The study found minimal avoidance reactions by the dominant fish species in the trawl mouth opening when a relatively small fixed frame trawl was used to sample fish in a shallow and turbid lake at night.

1. Introduction

Knowledge of the effectiveness of the sampling tool is necessary in order to estimate the basic ecological parameters of fish stocks such as abundance, biomass and length frequency distribution. Midwater trawling is an efficient method of sampling in deep open water areas of lakes and reservoirs (Schmidt et al., 2007; Emmrich et al., 2010; Rakowitz et al., 2012) while bottom trawling is also useful in benthic habitats of lakes (Krause and Palm, 2008; Yule et al., 2008). A considerable amount of research has recently focused on the avoidance behaviour of demersal fish in bottom trawls (Weinberg et al., 2002; Hoffman et al., 2009), however little is known about the overall catching efficiency of midwater trawls (Suuronen et al., 1997), particularly in freshwater.

A bottom trawl is necessary for sampling in extremely shallow lakes. However there are similarities with midwater trawling, particularly when sampling areas close to the surface of the water. Small-scale fixed frame trawls are used at night to sample fingerlings in artificial reservoirs, but it is not effective for sampling larger sized adult fish (Jůza and Kubečka, 2007). As such a special type of fixed frame trawl equipped with wheels was developed and proved to be the only useful tool for sampling the open water areas of a shallow lake (Kubečka et al., 2007). However without knowing how quantitatively valid our sampling tool is, one can not be sure about the accuracy of fish biomass and density estimates, because it is not known how many fish and of what sizes avoided the net.

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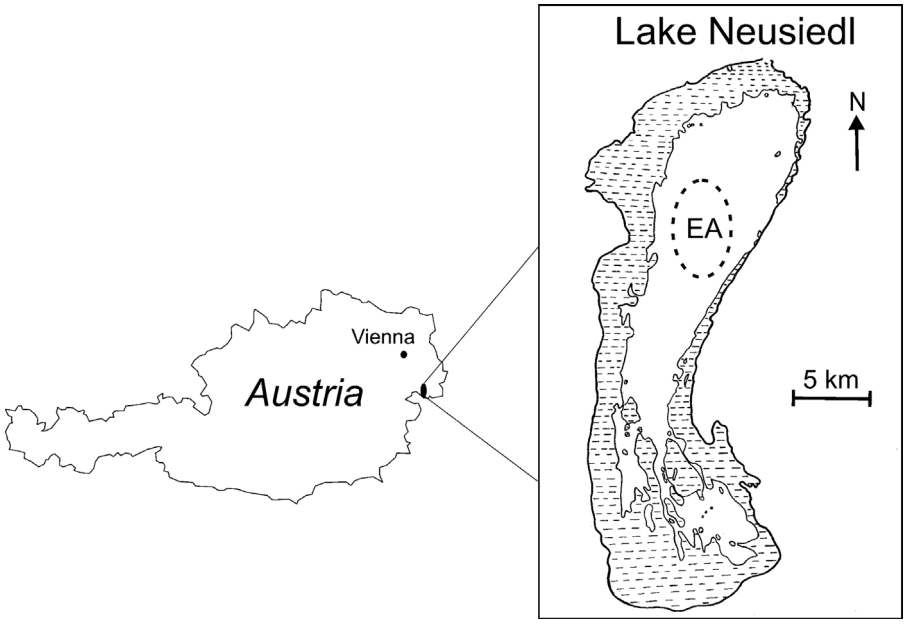

Fig. 1. Location of Lake Neusiedl in Austria and the exact position of the experiment area (EA) on the map of the lake.

The ability of fish to escape the trawl directly in the mouth opening can be influenced by the following factors: light intensity in the water (Glass and Wardle, 1989); water turbidity; body length of the fish (Wardle, 1993); size of the trawl mouth (Itaya et al., 2007; Jůza and Kubečka, 2007); and speed of trawling (Itaya et al., 2007; Winger et al., 2010). Except observations using different sized trawls (Itaya et al., 2007; Jůza and Kubečka, 2007; Jůza et al., 2010), the avoidance reactions of fish in the trawl mouth can be investigated by direct video observations (Graham et al., 2004, Trenkel et al., 2004) or hydroacoustics (Handegard et al., 2003, Schmidt, 2009). Another possibility of how to evaluate the avoidance reactions of fish is to compare the efficiency of electrified and non-electrified sampling methods (Bayley et al., 1989; Freedman et al., 2009). Electric currents have the ability both to attract and to incapacitate fish so we can hypothesize that the electrified trawl would be more efficient than a non-electrified one (Willemsen, 1990; Freedman et al., 2009). This hypothesis is valid only in the event of active avoidance behaviour in front of non-electrified trawl.

Comparison of the effectiveness of trawls with and without the application of electricity is only indirect proof of avoidance/non avoidance reactions of fish, so a direct observation technique also needs to be implemented simultaneously. The DIDSON (Dual frequency identification sonar) multibeam acoustic camera, which produces near video images of fish behaviour, has great potential for gear avoidance studies (Handegard and Williams, 2008; Rakowitz et al., 2012) especially in turbid or dark freshwater environments, where video or photographic observations are not effective.

The main aim of this study is to evaluate avoidance reactions of fish in the trawl mouth in an extremely shallow and turbid lake, analyze the effectiveness of using three different modes of electricity while trawling at night and to compare these results with simultaneous direct observations taken by DIDSON. Small-scale night trawling in an extremely shallow and turbid lake with a muddy bottom is a novel technique of fish sampling and this study provides a first step towards understanding its effectiveness. Understanding the effectiveness of a sampling method is the basic premise for study of fish ecology and for estimates of abundance.

2. Materials and methods

2.1. Study area

The study took place in the Austrian part of Lake Neusiedl (47°50′ N 16°45′ E), a mesotrophic, well-mixed steppe lake located 50 km southeast of Vienna on the Austrian-Hungarian border (Fig. 1). All experiments were done in the central part of the lake between Illmitz and Podersdorf (Fig. 1). The lake is 36 km long and 6–12 km wide from east to west, with a maximum depth of 180 cm and mean depth of 110 cm only. Considering its size, this lake is one of the shallowest large lakes in the world. The altitude of the lake is 115 metres above the sea level and the water level of the lake is controlled by precipitation (500–700 mm per year) and evaporation (Reitner et al., 1999). The open water zone (143 km^2) is characterized by the high concentration of suspended solids, which are stirred up from the bottom by wind actions. Due to the almost perpetual motion of the lake water, the high pH values of greater than 9.0, and low dissolved Ca^{2+} concentrations, the mineral particles form suspended colloids, which are responsible for the high turbidity of the lake ("white water", Krachler et al., 2009). The lake is surrounded by a reed belt (*Phragmites communis*), which is very important for water balance (Nobilis et al., 1991) and covers an area of 178 km^2 (Akbulut, 2000). The open water fish community of the lake is dominated by white bream (*Blicca bjoerkna*), bleak (*Alburnus alburnus*) and razor fish (*Pelecus cultratus*; Kubečka et al., 2007).

2.2. Data collection

2.2.1. Electrified trawling

Benthic trawling was conducted over one night from 18 to 19 August, 2010. A fixed-frame benthic trawl, with an opening of 2 m high and 4 m wide, towed with four nylon bridles was used for fish sampling. The mesh size of the trawl was 6 mm from knot to knot in the main belly and 4 mm in the codend. The trawl was equipped with a funnel, which prevented fish from escaping (Jůza and Kubečka, 2007). To keep the lower frame of the trawl in a desirable distance from the bottom, i.e. not digging into the mud and not lifting too high above it, a "wheeled trawl" (Kubečka