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Fish orientation along the longitudinal profile of the Římov reservoir during daytime: Consequences for horizontal acoustic surveys

RNDr. Thesis

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Annotation

The orientation of fish has important consequences for estimating their true size from horizontal acoustic records. The aim of this study was to verify the assumption of randomly-orientated fish in the lacustrine zone of the canyon-shaped Římov reservoir during daytime and to compare distributions of fish orientation between the lacustrine and tributary (riverine) zones.

Declaration [in Czech]

Prohlašuji, že svoji rigorózní práci jsem vypracoval samostatně pouze s použitím pramenů a literatury uvedených v seznamu citované literatury.

Prohlašuji, že v souladu s § 47b zákona č. 111/1998 Sb. v platném znění souhlasím se zveřejněním své rigorózní práce, a to v úpravě vzniklé vypuštěním vyznačených částí archivovaných Přírodovědeckou fakultou elektronickou cestou ve veřejně přístupné části databáze STAG provozované Jihočeskou univerzitou v Českých Budějovicích na jejích internetových stránkách, a to se zachováním mého autorského práva k odevzdanému textu této kvalifikační práce. Souhlasím dále s tím, aby toutéž elektronickou cestou byly v souladu s uvedeným ustanovením zákona č. 111/1998 Sb. zveřejněny posudky školitele a oponentů práce i záznam o průběhu a výsledku obhajoby kvalifikační práce. Rovněž souhlasím s porovnáním textu mé kvalifikační práce s databází kvalifikačních prací Theses.cz provozovanou Národním registrem vysokoškolských kvalifikačních prací a systémem na odhalování plagiátů.

České Budějovice, 22. dubna 2013 Mgr. Michal Tušer

Co-author´s agreement
We hereby declare that Michal Tušer had a major contribution to the following paper:

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Michal Tušer was responsible for field acoustic measurement, data assembly and processing, statistical analysis, and writing the manuscript.

Prof. Jan Kubečka, Ph.D. Ing. Jaroslava Frouzová, Ph.D.

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Fish orientation along the longitudinal profile of the Římov reservoir during daytime: Consequences for horizontal acoustic surveys

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ABSTRACT

The orientation of fish in a horizontal plane has important consequences for estimating their true size from horizontal acoustic records. The aim of this work was to verify the assumption that during the daytime fish are randomly orientated in the lacustrine zone of the canyon-shaped Římov reservoir and to compare distributions of fish orientation between the lacustrine and tributary (riverine) zones. Fish orientation was acoustically surveyed at fixed locations using the SIMRAD EK 60 split-beam echo sounder (elliptical beam, 120 kHz) with a horizontally aligned transducer. The horizontal aspect (angle between the fish body and the transducer axis) was used to describe their orientation. The conventional single-echo detector (SED) and the cross-filter detector (CFD) were applied. No trend was found along the reservoir when comparing records from four sites processed with the conventional SED. At all sites, most fish appeared to move predominantly in directions perpendicular to the central axis of the acoustic beam, i.e. the side-aspects (90°) of fish prevailed over other aspects. The CFD registered tracked fish several times more often than the SED. In the lacustrine zone the frequency distribution of fish aspect appears very similar when recorded by sonar beams oriented parallel to and across the longitudinal axis of the reservoir (criss-cross-beaming experiment). In the tributary zone, beaming perpendicular to the longitudinal axis of the reservoir revealed a significantly higher proportion of fish moving along the longitudinal axis. Therefore, the assumption of random fish orientation is not applicable in the tributary zones of such reservoirs.

1. Introduction

For several decades, echo sounders have been employed as important devices for estimating fish-stock abundance and for visualizing their spatio-temporal distributions and behaviour (Simmonds and MacLennan, 2005). Nevertheless, unbiased interpretation and conversion of acoustic parameters, such as target strength (TS), to fish parameters such as length and weight is still not a routine procedure. Many *ex situ* experiments have attempted to relate TS to fish length or weight, and the TS–length regressions derived from these studies are often used in estimations of fish abundance and size (Simmonds and MacLennan, 2005). However, since variability in the TS is strongly influenced by the orientation of the fish's body (i.e. fish aspect) relative to the incident sound wave (e.g. Foote, 1980a, 1980b; Midttun, 1984; MacLennan, 1990; Rose and Porter, 1996; Horne and Clay, 1998; Frouzová et al., 2005), some assumption of fish-aspect distribution in the observed population of targets is always needed for converting TS to fish length (e.g. Kubečka et al., 1994). The orientation of a fish relates to the type of behaviour it is exhibiting, as well as to the environmental conditions where it lives. Therefore, it is important to know the distribution of the orientations of free-swimming fish in various conditions.

In rivers, as well as in many mesotrophic and eutrophic lakes or reservoirs, most of the fish community often lives predominantly within the uppermost layer of the water (4 m, Kubečka and Wittingerová, 1998; Čech and Kubečka, 2002; Vašek et al., 2004) which is suitable for horizontal rather than vertical beaming (Kubečka and Wittingerová, 1998). Horizontal beaming, however, encounters the problem of the different reflectivity of various aspects of the fish (Kieser et al., 2000; Simmonds and MacLennan, 2005). In most riverine situations, fish are assumed to present mostly their side-aspect to the transducer as they swim upstream or downstream through the sonar beam, due to the river current (e.g. Burwen and Fleischman, 1998; Kubečka and Duncan, 1998; Lilja et al., 2000). In lakes and reservoirs, random fish orientation is usually assumed (Kubečka et al., 1994; Draštík and Kubečka, 2005), but

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