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Instruments and Methods

Development of a new multiple sampling trawl with autonomous opening/closing net control system for sampling juvenile pelagic fish

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ABSTRACT

A new multiple layer sampling trawl with an autonomous net opening/closing control system was developed to sample pelagic juvenile fish quantitatively. The new trawl system, based on the Matsuda–Oozeki–Hu Trawl (MOHT), has a rigid-frame 3.3 m high and 2.35 m wide and five nets of 11.0 m length with a rectangular mouth of 2.22 m × 1.81 m (4 m^2 mouth area; large-scale prototype). A cambered V-shape depressor is hung below the frame and two bridles are attached at the midpoint of the side frames. A net-release controller is used, which not only controls the net release mechanism but also records the net depth, temperature and flow rate during net towing. The controller sends stored command signals to the net release mechanism as depth settings and/or time settings and does not require any commands from the surface through a conducting cable or by acoustic signals. Two other models were constructed before the construction of the large-scale prototype, which are a small-scale prototype (2 m^2 mouth area) for testing the net release mechanism and a 1/4-scale model of the large-scale prototype for flume tank tests. Flume tank tests with the 1/4-scale model showed that the frame leaned forward at a tilt angle from 5 to 15 degrees at towing speeds from 0.8 to 1.4 m s^{-1}. Opened nets closed smoothly and sequentially nets were completely opened when the trigger was released by the command. Net depth rarely changed even during changes in towing speed. Sea trials both by the small-scale and the large-scale prototype demonstrated the same towing characteristics expected from the flume tank tests. The newly developed multiple layer opening/closing MOHT (MOC-MOHT) is considered to be suitable for quantitative layer sampling of juvenile fish.

1. Introduction

Accurate stock assessments of pelagic fishes are supported both by precise catch data from fisheries and by quantitative fish sampling from research cruises. Fishing quotas are assigned based on the results of stock assessments with consideration of recent population recruitment levels. Estimations or predictions of the recruitment are, however, difficult due to uncertainty related to their natural mortality rates. Quantitative sampling of juvenile and pre-mature pelagic fishes (here termed "young fishes") is one of the most effective tools for understanding survival processes and for reducing uncertainty in estimation of natural mortality rates. A major reason for difficulties in sampling young fishes is that they are sparsely distributed and have sufficient swimming capability to evade nets (Heath and Dunn, 1990). Further non-homogeneous horizontal and vertical distribution means that conventional oblique tows by single nets tend to underestimate their densities (Heath, 1992). Previous studies demonstrated that effective sampling of juvenile fish can be performed by towing a large effective mouth opening net at a constant depth as fast as possible (Dunn et al., 1993; Aoki et al., 2000; Itaya et al., 2001; Oozeki et al., 2004). Because of their large mouth area, midwater trawls with a stratified layer sampling system are appropriate for sampling young fishes (Pearcy et al., 1977; Pearcy, 1980; Engås et al., 1997), however, midwater trawls have several disadvantages for quantitative sampling because of their variable mouth opening and non-uniform mesh size. High-speed stratified layer sampling nets, with large fixed mouth opening and uniform size of mesh, are required for quantitative assessment of the density of young fishes.

Historically a wide variety of net devices have been used for sampling marine organisms (*e.g.*, Wiebe and Benfield, 2003) but new acoustic and optical technologies have the potential to replace traditional net survey methods in systems in the near future. These newly innovated sampling instruments can differentiate marine organisms to species levels and supply

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