Progress report on the development and testing of the underwater bait setter for pelagic longline fisheries

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ABSTRACT

1. This paper summarises recent and future work relating to the development, construction and testing of a device that sets hooks several metres underwater to avoid detection by seabirds.
2. The underwater setter is a stern-mounted, hydraulically-driven device. The baited hook is placed into a capsule that is driven down into the water column each time a hook is set. This design provides a more fuel efficient method than devices that remain underwater while setting (e.g., underwater setting chutes). The device can be readily fitted to most tuna fishing vessels, including after their construction.

THE UNDERWATER SETTER

The underwater setter is a stern-mounted hydraulically-driven device that delivers baited hooks underwater to avoid detection by seabirds. It comprises components that are fixed to the vessel and a component (a capsule that holds the baited hook) that is driven down into the water column each time a hook is set. This design is a more fuel efficient method of delivering baited hooks at required depths underwater because it minimises the drag associated with devices that remain underwater while setting (e.g., underwater setting chutes). The device is modular and can be readily fitted to most tuna fishing vessels, including after their construction.

The underwater setter comprises a vertical track on the transom, bait-holding capsule, a box with hydraulics, relays and pulleys and a control box which houses a programmable logical controller (PLC). The PLC runs the system and records data. The bait-holding capsule is mounted in a docking station and secured to the vertical track by 5 mm spectra rope attached via pulleys to the hydraulic motors. To operate the device the deckhand simply places a baited hook in the bait chamber of the capsule and presses the release button. The pull-down motor propels the capsule down the track at >3 m/s. At the end of the track (which extends ~ 1 m underwater but able to be varied to accommodate various sea states) the capsule freefalls to a pre-set depth. Depth attained is a function of capsule descent speed, capsule weight and cycle time. The cycle time is programmed into the PLC. At the end of the descent phase the PLC engages the recovery motor and the capsule returns to the start position. The baited hook is flushed from the capsule on the ascent phases through a spring loaded door at the bottom of the capsule. The cycle is repeated every 8 seconds.

Target release depth can be varied from 4 m to > 8 m, depending on the diving capabilities of the species of seabirds interacting with gear. Ideally, releasing baited hooks beneath the lower limit of propeller turbulence will be sufficient to deter diving seabird species. Opaque water from the propeller masks the sinking bait. The leaded swivels (60-75 g) used in most southern hemisphere pelagic longline fisheries will ensure baited hooks continue to sink (at ~ 0.4 m/second) once released from the capsule.

Various aspects of the design of the machine and its operation are shown in Figures 1-4.

Figure 1. The underwater setting machine being trialled off eastern Australian in January 2010. The hydraulics and control box are mounted on the roof to reduce the number of pulleys involved in connecting the hydraulic motors to the capsule. Fewer pulleys increase the transfer of energy from hydraulic motors to the capsule, which increases depths attained for a given cycle time.

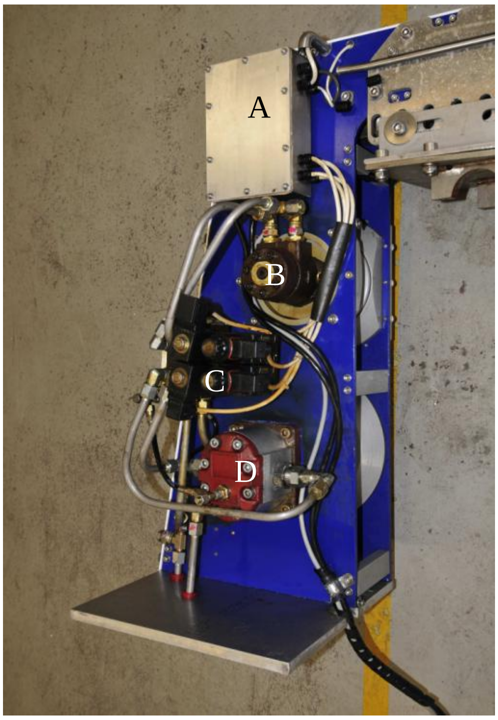

Figure 2. The drive system of the underwater setter. Shown are the control box (houses the PLC, data recorder and GPS; A), recovery motor (B), solenoid and relays (C) and pull-down motor (D). The on/off button and brake and timer are on the other side. The pulleys holding the spectra rope are barely visible beneath the hydraulic motors.

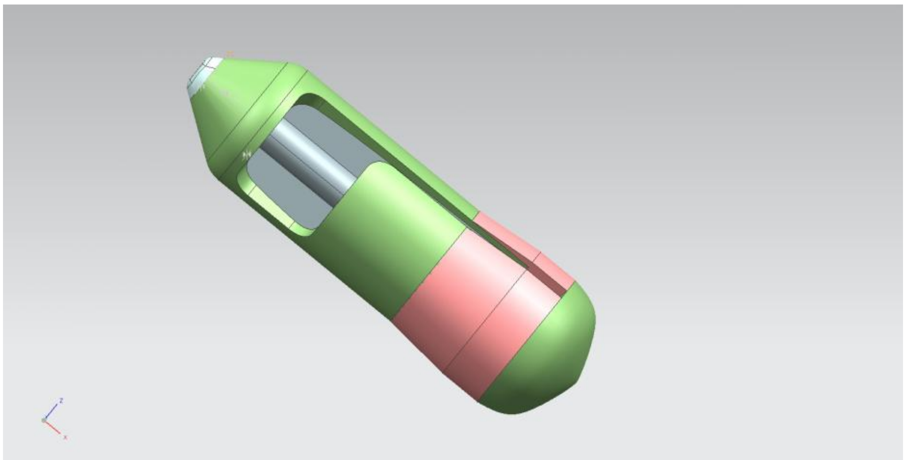

Figure 3. Latest design of the bait holding capsule (differs from that shown in Figure 1). Following extensive computer modelling and at-sea testing, this design incorporates twin (opposing) bait chambers and refines the orientation between the centre of gravity and the centre of buoyancy. The latter is considered critical to maximizing depths attained and minimising the time between deployments.

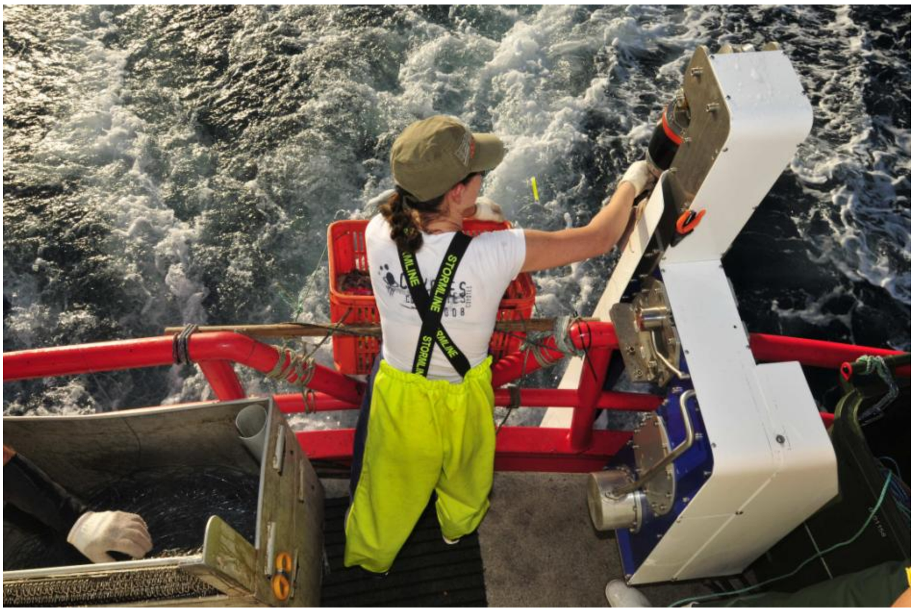

Figure 4. Operating the machine involves two steps – placement of baited hook in capsule and firing the release button on cue from vessel audio beep timer. The release button is the small cylindrical object beneath and slightly to the right of the deckhand's elbow.

Potential benefits

The underwater setter has the potential to:

- eliminate the mortality of surface-seizing species, such as albatrosses, and reduce or eliminate mortality of deep diving species, such as white-chinned petrels, grey petrels and shearwaters;
- eliminate bait loss to seabirds;
- facilitate fishing at any time of day/night without the need for a bird streamer (tori) line;

- remove the threat of seasonal closures to protect seabirds, including in seasons when seabird bycatch is most common;
- facilitate data collection on various aspects of fishing operations (e.g. the number of hooks and when they were set) of importance to the fishers, government fisheries management agencies and working groups responsible for monitoring seabird by-catch; and
- reduce the need for onboard, independent fisheries observers to monitor compliance with mitigation requirements. The PLC operational data can be recorded on duplicated memory (camera SD) cards in the control box and downloaded via USB to a computer on return to port. These data can be used to assess compliance with, for example, requirements to set gear using the underwater setter. The underwater setter is one of the few mitigation devices that incorporates compliance aspects as a design feature.

Progress to date

We have completed three years of research and development and a large number of sea trials to refine the performance of the machine. In August 2009, we completed the first trip to sea which saw the deployment of 6,200 hooks and the capture of 5.5 tonnes of fish product in five sets of the longline. Since then the capsule has been re-modelled to achieve a greater maximum depth and shorter cycle time and the hydraulics and control box have been reduced in size. The machine is now modular and can be fitted to virtually any vessel configuration.

We have completed preliminary trials to determine if setting underwater affects bait retention on hooks. The data thus far on setting are shown in Figure 4. In this trial, baits were deployed (both setting by hand and setting with the machine) by retaining onboard the clips of branch lines and hauling them onboard following each deployment. Once the baits were sighted behind the vessel the presence or absence of baits on hooks was recorded. This technique puts more stress on baits than the normal gear deployment method (e.g., using mainline, floats etc) because the baits were hauled back through propeller turbulence to the vessel. This is the least expensive method to examine bait retention and avoids vessel charter, which would be required if gear was set as in normal fishing operations. If this approach is acceptable to fishers we will complete further trials to increase the sample sizes. If it is not acceptable then we will conduct trials typical of the way gear is deployed in normal fishing operations.

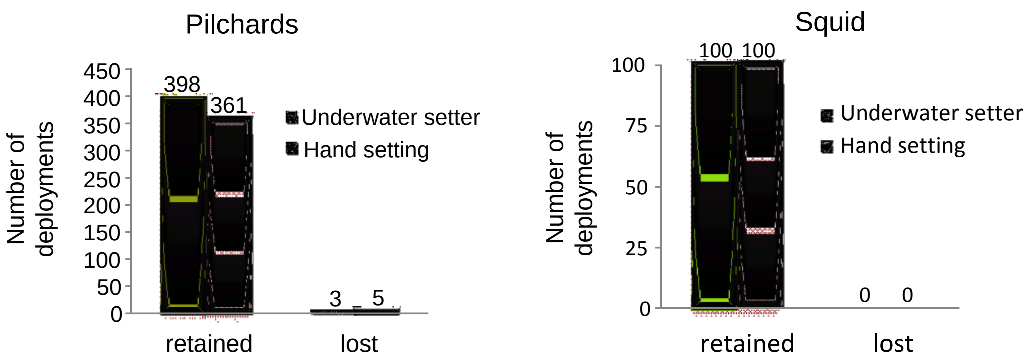

Figure 4. Results of a preliminary comparison of bait retention on hooks deployed with the underwater setting machine and deployed conventionally by hand.

In this preliminary trial bait loss by both setting methods with pilchard bait was similar. Observations during the trial suggest that bait quality – not method of setting – is the main determinant of bait retention on hooks. Pilchard baits that are too soft or have been damaged during the packing and freezing process have a greater tendency to fall off hooks than those that are not completely thawed and are intact.

In 2011, a submission was made to Commercialisation Australia (CA) for funding to conclude development of the underwater setter and bring it to a market-ready stage. (Commercialisation Australia is an Australian Government agency that operates a merit based, competitive assistance program that aims to assist products, processes and services from the development stage to commercial maturity.). In December 2011, CA agreed to contribute funding of approximately AU$250,000 which, combined with similar funding from industry, is a major step in achieving our aim of producing a market-ready, underwater setter as soon as possible, hopefully by late 2012.

The next steps

Our aim is to have a market-ready, underwater setting machine by the end of 2012. To this end, work in 2012 includes further design refinement of some components and engineering construction in preparation for further commercial fishing trials in Australia and elsewhere, including a second, major fishing trial in a major Uruguayan pelagic longline fishery.

Trials being conducted currently (at the time of writing this paper) in Australia include continued at-sea testing to further quantify sink-rates of different branch line weighting regimes (both in respect of differing total weights and distances from the hook) and to evaluate recent design refinements.

The Uruguayan trial is scheduled to occur in April 2012 and is being conducted in collaboration with the Uruguayan government, Proyecto Albatros and Petreles, and the Uruguayan fishing industry. The fishery involved operates in area where seabird bycatch is a significant risk and it follows an earlier collaborative trial conducted in the same Uruguayan fishery in 2010.

The aim of the fishing trial is to deploy a large number of hooks (> 150,000) to further test the reliability and durability of the machine – several components of which have been refined since earlier fishing trials – under commercial fishing conditions and also in an area where there is a high level of seabird activity and potential seabird bycatch. Other trials may also be conducted if required.