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Measuring hook sink times to depth in small longline vessels

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SUMMARY

This report provides an update on recent research conducted on New Zealand longline vessels. Both demersal and pelagic longline fisheries in New Zealand are primarily executed by small vessels, and both fishing methods are known to pose seabird bycatch risk. The ability to provide fishers with accurate sink times to depth is particularly useful in the externally weighted demersal longline fishery where fishers can, and do, increase line weighting to reduce bycatch risk to seabirds.

A new 'Wet Tag' (www.zebra-tech.co.nz), originally designed to measure shellfish pot soak times, was trialled as a tool for providing fishers with an indication of hook sink times to depth on a set-by-set basis. Wet Tags are robust, and require no setup or data processing, and were able to be routinely deployed by fishers, with data automatically downloaded via Bluetooth. Feedback to fishers of estimated depths achieved by hooks within the extent of the bird scaring line was useful, and successful in raising awareness.

The Wet Tags were compared against Time Depth Recorders (TDRs) designed for animal deployment, which logged at a finer temporal resolution. Wet Tags underestimated depth during controlled drops and during paired deployments with TDRs. However, TDRs required pre-programming and downloading by a technician on board the vessel, and more post-collection data processing.

Further development of Wet Tags to produce a unit that logs a start or 'leave vessel' time and samples at one second intervals would allow for direct measurement of time to depth.

Bottle tests were also investigated and were found to be unreliable for small vessels in moderate weather conditions, especially when line setting was in the dark. Bottle tests were prone to underestimate time to depth due to losing sight of the bottle before it had been pulled underwater.

Accurate and user-friendly measurement of time to depth allows for the possibility of managing seabird bycatch risk in these fisheries by varying sink rates rather than focussing on line weighting specifications, allowing fishers maximum flexibility in gear setup whilst retaining suitable protection of hooks from seabirds.

1. INTRODUCTION

Sinking baited hooks to depth quickly, and underneath an effective bird scaring line, is one of the most widely accepted and well-regarded methods of reducing seabird bycatch in both pelagic and demersal longline fisheries.

Due to the variety of gear and vessel configurations employed by New Zealand pelagic, and particularly demersal, longliners, a one-size-fits-all approach to line weighting regulation is hard to develop. Therefore, the option of requiring skippers to sink gear rapidly to specified depths is being investigated. Whilst this approach allows fishers maximum flexibility it requires accurate measurement of time after deployment and depth of hooks. This report summarises two projects contracted by the New Zealand Department of Conservation:

1.1. Development of an adaptive management tool for line setting

Trials of a user friendly off-the-shelf 'Wet Tag' (www.zebra-tech.co.nz), originally designed to measure shellfish pot soak times, as a tool for providing fishers with an indication of hook sink times to depth on a set-by-set basis. Wet Tags were configured to start recording at a pre-determined depth, sample every 5 seconds above 20 m, and stop recording once back at the surface. Data download was automatic, via Bluetooth, shortly after recovery.

Middleton, DAJ, King, B, Wilson OL. 2021. Development of an adaptive management tool for line setting. Final report for MIT2018-03 prepared by Pisces Research Ltd and Fisheries Inshore NZ for the Department of Conservation, Conservation Services Programme. Available for download.

1.2. Longline sink rate verification

In addition to data collection by fishers during commercial fishing trips, Wet Tags were also compared to bottle tests and Time Depth Recorders (TDRs) designed for attachment to animals, which are commonly used to measure gear sink profiles.

Goad, D. 2021. Longline sink rate verification. Research Report prepared by Vita Maris for the Department of Conservation. Contract reference: BCBC202011c. Available for download.

2. METHODS

Wet Tags were supplied to skippers of two pelagic and six demersal longliners and a total of 953 deployments were undertaken. Data were download by skippers and forwarded by email or automatically via a cellular data-enabled unit installed on the vessel. Data were then processed to provide estimates of line sink rate and depth at the end of the bird scaring line.

2.1 Pelagic longline

Initially Wet Tags were attached to branchlines in place of a hook. Following review of the comparative data collected, and the literature, a portion of Wet Tags were deployed on standard branchlines with baited hooks.

2.2 Demersal longline

Wet Tags were deployed by fishers on the longline mainline, midway between weights, which was considered a reasonable approximation of slowest sinking hooks as the typical branchline length in the fishery is 0.6 m.

2.3 Comparative data collection

In addition to fisher-collected data four sets of were collected to compare Wet Tag performance to TDRs and bottle tests:

- Star Oddi TDR, CEFAS TDR, and Wet Tag data collected opportunistically on a pelagic longline vessel.
- Free fall tests of the sink rate of different pelagic longline branchline configurations, conducted on two trips from stationary vessels in sheltered water. Wet Tags and TDRs were tested alone and in paired deployments.
- Star Oddi TDR, CEFAS TDR, Wet Tag and bottle test data was collected on a demersal longliner, as part of normal fishing operations.
- Star Oddi TDR, CEFAS TDR, and Wet Tag data was collected during controlled drops to different depths, in static water.

3. RESULTS

3.1 Pelagic longline

It was necessary to attach Wet Tags to a normal branchline to estimate sink times to depth of baited hooks. Wet Tags on plain branchlines sank noticeably slower than those on branchlines with hooks, baits, and Hookpod-minis attached.

With the current logging start configuration, Wet Tags typically produced two or three measurements whilst hooks were sinking independently from the mainline, and under the bird scaring line, and better separation of the independent and line-mediated sinking phases is required to use these data. Comparison of TDR data from static drops and deployments during commercial fishing trips indicated that slower times to depth and considerably more within-set variation were returned during fishing operations.

3.2 Demersal longline

Hook depth at bird scaring line aerial extent was estimated based on mean sink rate from wet tag data, and fisher estimates of setting speed and line entry distance astern. Comparison with direct measurement of time to depth (when deployment times were also recorded) indicated that depths were generally slightly overestimated, likely because the delay in the start of logging after line entry missed initial slower sinking of hooks that are midway between weights.

3.3 Bottle tests

Bottle tests were conducted at night using reflective tape and a torch to track the bottle astern. With a sea height of 1 m and a height of eye of approximately 2.5 m bottles were lost behind waves intermittently. Out of eight tests one recorded a comparable time to TDR records, with the other times to 5 m depth shorter than those recorded by TDRs.

3.4 Utility

Star Oddi and CEFAS TDRs both required pre-programming and downloading with a PC for each deployment. This took some time and required pre-planning of deployments. It was necessary to apply a post-hoc pressure offset on a deployment-by-deployment basis to account for TDRs not reading 0 m prior to deployment. Star Oddi TDR records were also

adjusted to compensate for slow temperature sensor response, and processing algorithms using temperature to correct pressure readings to depths. Output csv files were large for both TDRs, and covered the full pre-programmed period at either 1 or 0.1 s intervals. Start times, when TDRs left the vessel, were recorded on deck, on paper, and were used to extract the relevant portion of the full data set.

Wet Tags produced small csv files with the useful data in the first few lines. Data were downloaded easily via Bluetooth and required much less processing. No calibration or offsets were recommended by the supplier, though static drops to controlled depths indicated that Wet Tags would benefit from small pressure offsets, as they tended to underestimate depth.

4. DISCUSSION

Directly measuring sink times to depth was not possible using the fisher-collected Wet Tag data, due to lack of a time they left the vessel. Estimates of depth at the bird scaring line aerial extent were made using the mean sink rate to 10m and fixed ranges for setting speed and line entry distance astern. Comparisons with data collected when deployment time was separately recorded suggested that whilst estimates gave a relative indication of depths achieved, there were biases in the measured mean sink rate. Pelagic longline hooks sank initially quickly, whilst the branchline was slack, and then more slowly when the mainline limited sink rate. Between weights demersal longline mainlines sank initially slowly and then more quickly once the following weight was clipped onto the longline. As a result depths achieved by hooks on pelagic longlines were underestimated and depths achieved by demersal longline hooks overestimated.

At night, with limited height of eye and a reasonable sea state bottle tests did not perform well. In better conditions much more comparable results could be expected, but it is important to be able to measure sink times under all conditions, to understand the full degree of variation in time to depth.

Externally weighted demersal longlines showed considerable within-set variation in sink times to depth. Much of this variation was related to the position recorders were placed on the line relative to floats and weights, but variation also arises due to changes in gear configuration. Factors such as weight size, weight spacing, and addition of floats directly alter sink rates of gear and can be easily altered by fisher between and within sets. For example, fishers commonly reduce weight spacing to sink hooks more quickly. Therefore, providing feedback to fishers on actual sink times to depth, relative to management targets, is potentially very useful. Feedback also allowed vessel managers to monitor changes over time, and differences between different skippers and crew.

Despite consistent branchline length and configuration, and branchlines sinking initially independently of the mainline, there was still considerable within-set variation in pelagic longline sink times to depth. This can, at least in part, be attributed to waves, bait size and buoyancy, delays between casting the hook and clipping the branchline on, propellor wash, and pressure waves behind the vessel. Other than ensuring branchlines are long enough to sink independently from the mainline under the bird scaring line, there is little pelagic longline skippers can do to alter sink rate of their gear on a set-by-set basis. Consequently, sink rate data are more helpful in understanding the real-world times to depth for different branchline weighting options, and the variation around the mean, rather than stimulating fishers to increase sink rates from set to set.

For both fisheries it is important to consider the slower end of variation in hook sink times to depth as birds have the ability to follow vessels and selectively target slowest sinking hooks.

In order to provide useful data for assessing sink rates on a set-by-set basis, and to facilitate skippers modifying demersal longline gear configuration to minimise times to depth, a new version of the Wet Tag is under development. There are a number of considerations for improving performance of such a device, although these will vary depending on the characteristics of the target fishery. Ideally, further tag improvement could include:

- Ability to handle a 2 m drop onto a steel deck
- A turn on switch
- A wet/dry switch
- 1s sample rate
- 0.2 m resolution
- 0.2 m accuracy and precision
- Capable of logging depth from surface to 20 m for 1 minute post start
- Instant pressure response
- Neutral buoyancy
- Ability to cope with a 10 degree temperature difference between air and water
- Defined and testable accuracy, precision, and sensitivity to instant temp changes
- Bluetooth download with the option of adding a text string header to each csv file
- Either no pressure offset or a consistent one
- Data storage onboard for last 100 deployments
- Recovery of data from either last deployment or a defined period as an option during download
- Direct viewing of internal clock when connected via Bluetooth

5. CONCLUSION

Providing fishers with information on sink times to depth is likely to increase awareness and promote improvements. The automatic downloading feature of Wet Tags and the potential for developing an app to immediately provide sink times to depth on a set-by-set basis is time saving and user-friendly for fishers. This allows for data to be collected without a technician or observer on board. However, in order to directly and accurately measure, rather than estimate, times to depth it will be necessary to further develop Wet Tags to reduce the sampling interval, record a ‘left vessel’ time, and adjust for pressure offsets.