MIT2023-02 Understanding and mitigating seabird and turtle bycatch during the pelagic longline soak period

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Introduction

Capture rates of seabirds during the deployment or setting of pelagic longlines are well documented in the literature (Clarke et al., 2011; Anderson et al., 2016). Best practice methods for mitigating these captures are reasonably well accepted (ACAP, 2023) and are supported by a considerable volume of literature (e.g. Robertson et al., 2013; Domingo et al., 2017).

Captures of seabirds also occur during recovery or hauling of longlines in New Zealand, often with birds released alive, with largely unknown survival rate (Edwards et al. 2023). Mitigation measures addressing haul captures are less well developed, but comparatively straight forward (Gilman et al., 2014, Goad & Peatman 2021).

Seabirds are also vulnerable to capture during the soak period, between setting and hauling, especially if baited hooks are close to the surface. Other vulnerable and unmarketable taxa, notably marine mammals, turtles, and sharks may be bycaught during the soak period.

Skippers control the depth of pelagic longline gear by varying float rope length, basket size, hook spacing, and any slack or tension in the mainline (FAO, 2003; Ward & Hindmarsh, 2007). Once they have set the longline, skippers have no further control on the fishing depth until the line is hauled.

In New Zealand there are currently no specific recommendations for mitigating captures during the soak period, however setting hooks deeper and adding weight near the hook are suggested as options to reduce risk to birds during setting of longlines (Fisheries Inshore New Zealand, 2021). These measures will also increase hook depth during the soak and likely reduce bycatch of turtles, mammals, and birds.

Following adoption of Hookpods by a large portion of the pelagic longline fleet, and verifiable protected species bycatch reporting via electronic monitoring, efforts to reduce bycatch has shifted to captures during the soak. Assuming Hookpods largely eliminate seabird bycatch during the setting process, and captures during hauling are likely to be reasonable easy to identify, it follows that and 'residual' captures can be attributed to the soak period.

Following a recent increase in reported, particularly leatherback (*Dermochelys coriacea*, honu), turtle captures there has also been an increase interest in gear depth during the soak and how this, among other gear variables, may influence risk to turtles.

This project aims to better understand the depth of pelagic longline hooks during the soak period, and the frequency at which they are brought close to the surface. Similarly, the project seeks to identify factors influencing depth, particularly those under the control of skippers which may help reduce bycatch risk.

This progress report aims to communicate initial results and to seek feedback on the methods prior to completing a second trip to sea.

Project Objectives

1. Characterise surface longline hook depth profiles throughout the fishing period via the deployment of TDRs.
2. Assess risk of captures during the soak period by identifying incidents of exposed hooks at the surface during the 'soak period'.
3. Compare depth profiles of sets with and without protected species captures and identify any apparent patterns.
4. Review international research and consider the effectiveness of existing mitigation practices on hook exposure during the soak period.

(Conservation Services Programme Annual Plan 2023/24 (, 2023))

Methods

Objectives one to three were addressed in two parts. Wet Tags (made by Zebra-Tech) originally purchased by the Department of Conservation for a previous CSP project (Development of an adaptive management tool for line setting. MIT2018-03) but no longer used were repurposed and distributed to pelagic longline skippers. This approach aimed to provide ongoing data collection across multiple vessels sets and trips at minimal cost. Additionally, two trips to sea were planned to collect data more intensively, and to modify gear set up to understand how skippers can influence soak depth.

This report summarises the methods and results from the first trip to sea, which was undertaken in response to high bycatch rates during the full moon period in the south east coast southern bluefin tuna (*Thunnus maccoyii,* Ika Tira iti) fishery.

Trip 1

At 20 m the vessel chosen for the trials was typical of the heavier-displacement steel vessels in the fleet. It had a steel hull and full shelter deck. Longlines were deployed from a free-spooling drum at 5.6-6.5 knots with shooting speed partially dictated by weather and current conditions. Baskets were separated by 300 mm diameter hard floats which were deployed on 10 m long ropes. The branchline timer was set to 14 seconds throughout the trip. The skipper's typical setup comprised 11 or 12 hook baskets, and this was altered to 13 or 14 hooks for some trial sections. Other gear modifications included lengthening float ropes to 13 m and adding 250 g weights to the float ropes, 0.5 m from the mainline.

Branchlines were 13 m long, two-millimetre diameter monofilament nylon. Hookpods were attached 1.8 m from the hook, and 40 g or 60 g sliding lead weights were attached immediately below Hookpods, closer to the hook. Some clips had 60g weighted swivels attached though most were unweighted. Branchlines were shortened over time as they were repaired to remove damaged sections close to the hook. Minimum branchline length was approximately eight metres. Hooks were baited with whole squid and were set by two crew, from two bins. Generally, branchlines were set tight, as crew waited for the branchline timer before clipping them on.

A set of new branchlines were made up for time depth recorder (TDR) deployment, with unweighted clips, Hookpods and 40 g sliding weights, and these were stored separately. Several of them were shortened during the trip, but they were replaced if the length was less than 11 m. CEFAS and Starr-Oddi time depth recorders (TDRs) were taped onto the branchline 0.5 m from the hook, and then hooks were baited and deployed as per normal operations. For each treatment TDRs were deployed on hooks one, three, and six or seven. Three repeats of each basket position were deployed, per treatment, with typically 27 TDRs deployed across three treatments, per set. TDRs were programmed and data was downloaded on a set-by-set basis. Between sets TDR clocks were reset to the PC time and this was checked against the clock used on deck to manually record clip-on times. A GoPro camera was used to check TDR deployment times.

Data processing

Data manipulation was conducted in R (R Core Team 2021). Initially, Star-Oddi TDR records were reformatted to match CEFAS TDR outputs. TDR depth was then adjusted with an offset derived from mean readings from one to two minutes prior to deployment. Individual sink profiles were examined to ensure clip-on times were recorded accurately. To monitor depth during the soak, depths were extracted at one-minute intervals. Records prior to five minutes after branchlines were clipped on were discarded to allow the gear to settle, and to remove records once TDRs were back onboard the vessel any records with a depth less than 1.5 m were discarded. Individual TDR profiles were examined to ensure that this filtering was appropriate and adjustments were made on a per line or per TDR record basis to ensure that the soak period was appropriately extracted. Histograms were plotted of depth during the soak, using five-metre depth bins and split by treatment and set.

Results

The trip commenced just after the full moon, and the vessel had added weights into the gear, in addition to Hookpods, in response to captures on the previous moon. Despite having two potentially catchy additions to branchlines the combination of weights and Hookpods proved to be workable with minimal bin tangles, and all hooks were released from Hookpods. The Hookpods and weights were set at 1.6 – 1.8 m from the hook and branchline configuration was consistent.

All efforts were made to minimise risk to birds during the trip and the vessel was operating in line with an industry code of practice. This included tori lines, night setting, Hookpods, weighted branchlines, hauling mitigation, bait retention, and holding and batch discarding of offal. Consequently, gear modifications were limited to those deemed to be likely to increase gear depth and hence further reduce risk.

Typical bird abundance around the vessel for the first few days was; 5-10 great albatross (*Diomedea spp.*), 5-10 Salvin's albatross (*Thalassarche salvini*), 5-10 white-capped albatross (*Thalassarche cauta*), 0-5 Buller's albatross (*Thalassarche bulleri*), 0-5 black-browed albatross (*Thalassarche melanophris*) and 20-50 White-chinned petrels (*Procellaria aequinoctialis*). Storm petrels, cape petrels (*Daption capense*) and prions (*Pachyptila spp.*) were seen occasionally. Generally, numbers of birds were lower in the second half of the trip, when other surface longliners were working in the same general area. One Buller's albatross, one white-capped albatross, and two white-chinned petrels were caught dead, all on separate sets and none in baskets with TDRs. All birds caught were hooked in the bill and had wet, but not completely waterlogged, plumage.

Eight lines were fished, typically set between 0100 and 0430, and hauling usually started at 1500. Sets comprised of approximately 900 hooks. The branchline timer was held constant at 14 seconds for the whole trip. Gear was modified for a portion of each set with two to four, usually three, different gear configurations tested. Altered gear sections were deployed for five to seven baskets, reverting to the skipper's normal setup between experimental sections. Setting speed varied between sets, and was partially dependant on weather conditions.

Time depth recorder data - depth

A total of 200 valid TDR records were collected across eight treatments. Two TDRs were lost and one malfunctioned. All TDRs initially settled out below 20 m depth, and depth profiles over the first ten minutes, particularly for baskets which did not catch fish, reflected changes made to increase depth (Figure 1). However, as the soak progressed gear depth was influenced by current, drift, and catch which produced more variation in depth and at times gear was above 20 m (Figure 2). Concentrating on time spent above 10 m, instances were almost exclusively around fish caught on the line (Figure 3).

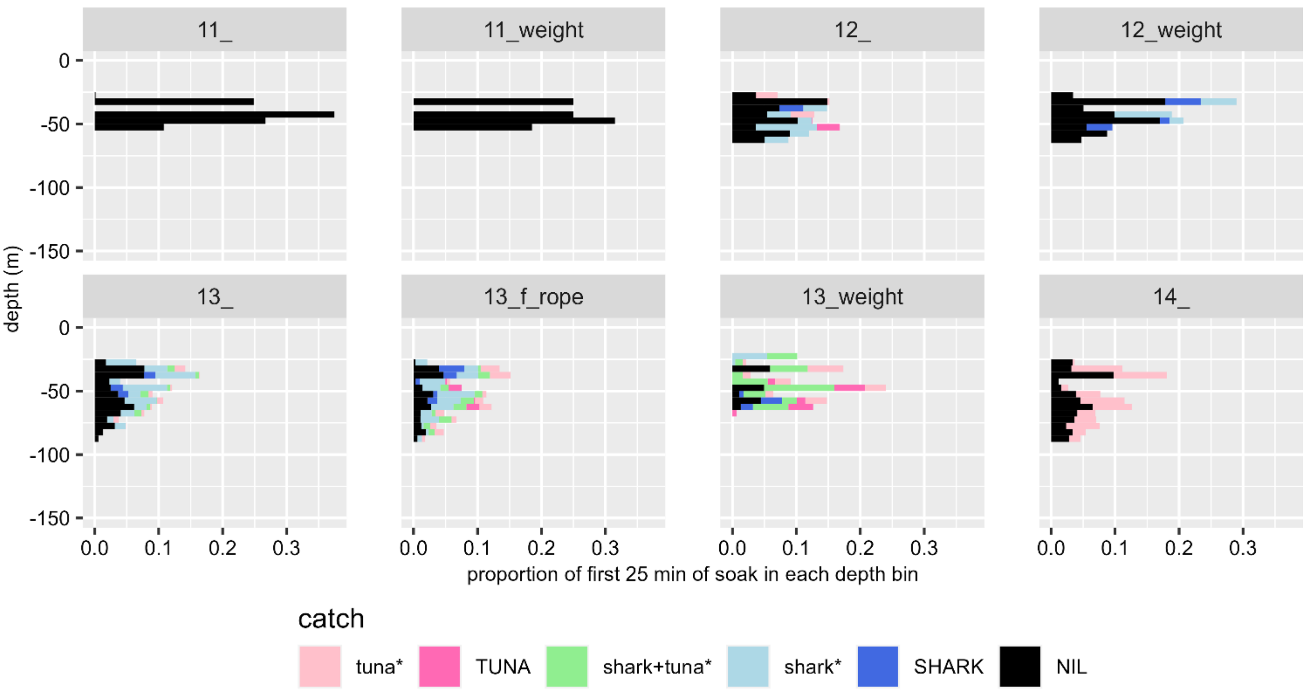

Figure 1. Histograms of TDR depth during the first 10 minutes of the soak, by treatment, with number indicating the basket size, weight = 250 gram weight on the float rope, and f_rope = a longer float rope (13 m vs 10 m). Colours indicate catch with bright colours and capital letters indicating catch on the TDR snood, and weaker colours and lowercase letters indicating catch in the same basket, NIL = no catch in the TDR basket.

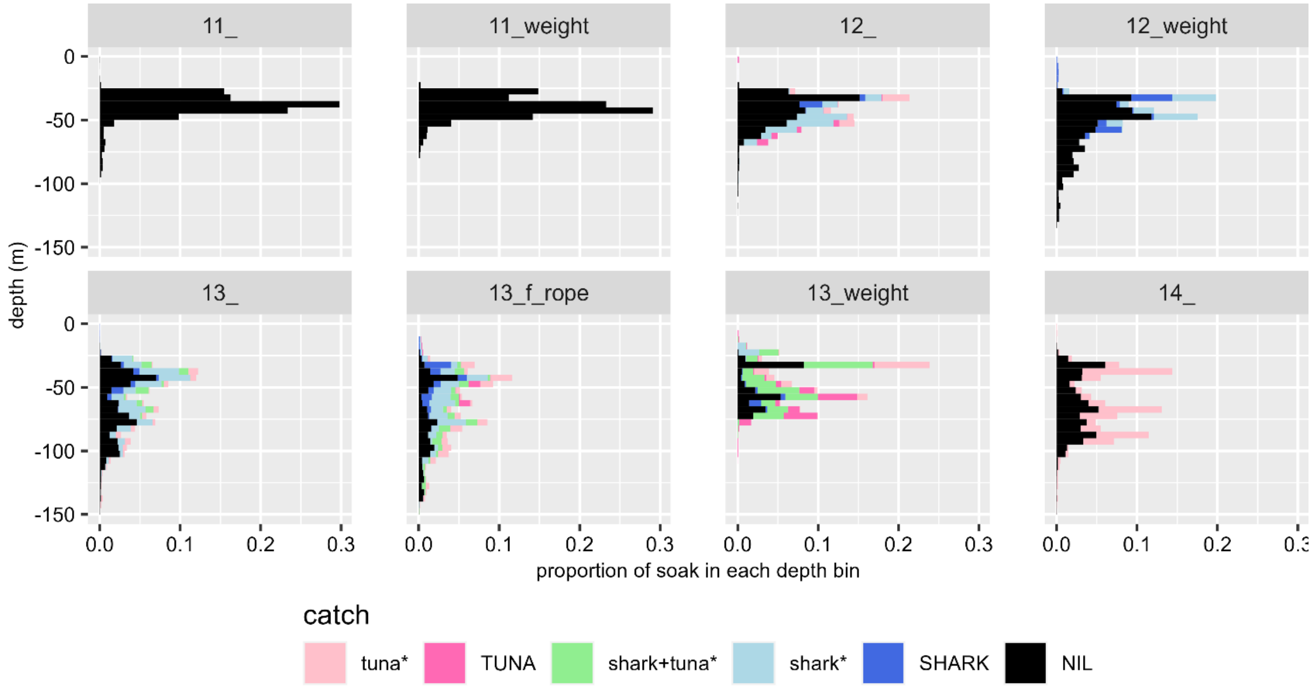

Figure 2. Histograms of TDR depth during the whole soak, by treatment, with number indicating the basket size, weight = 250 g weight on the float rope, and f_rope = a longer float rope (13 m vs 10 m). Colours indicate catch with bright colours and capital letters indicating catch on the TDR snood, and weaker colours and lowercase letters indicating catch in the same basket, NIL = no catch in the TDR basket.

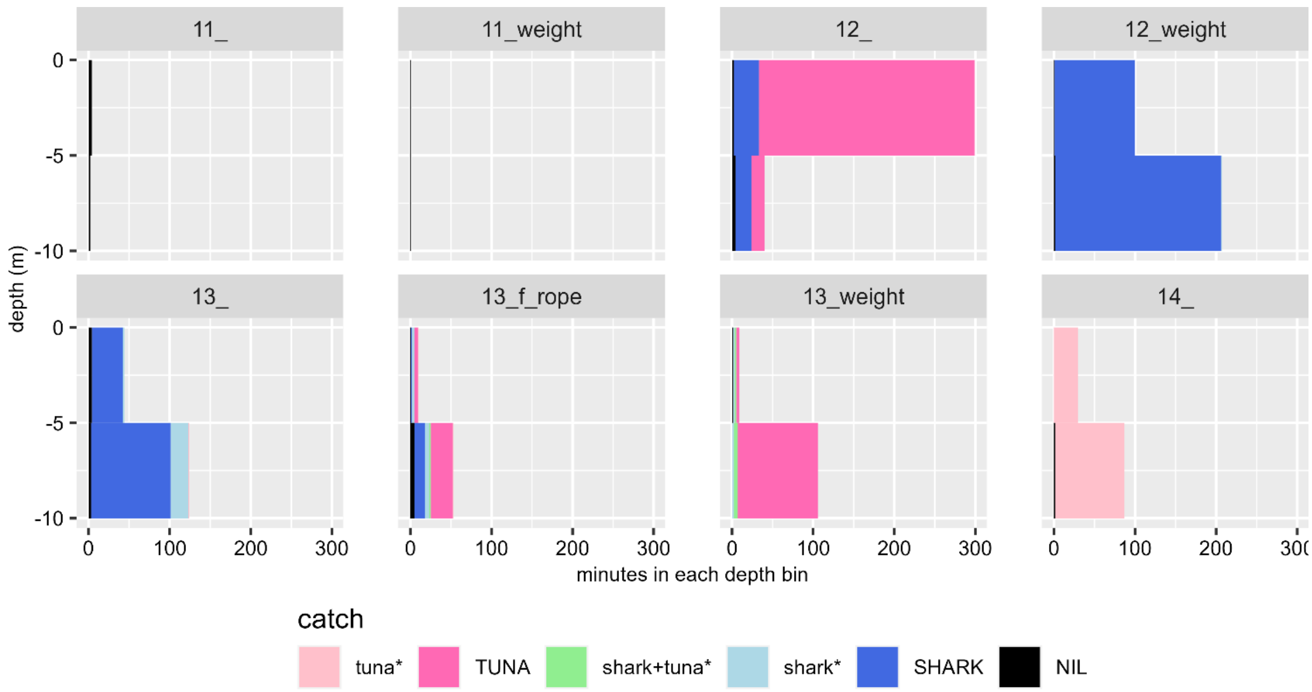

Figure 3. Histograms of time TDRs spent in the top 10 m during the whole soak, by treatment, with number indicating the basket size, weight = 250 g weight on the float rope, and f_rope = a longer float rope (13 m vs 10 m). Colours indicate catch with bright colours and capital letters indicating catch on the TDR snood, and weaker colours and lowercase letters indicating catch in the same basket, NIL = no catch in the TDR basket. Total number of TDR deployments = 200.

Examining individual TDR records provided some insight into how catch affects gear depth. For example, in one instance a tuna was caught on a TDR snood six in the middle of a basket and spent considerable time at the surface (Figure 4). Whilst

TDRs on snoods one and three were brought closer to the surface they were not above 20 m, indicating that the tuna had a very localised effect on hook depth.

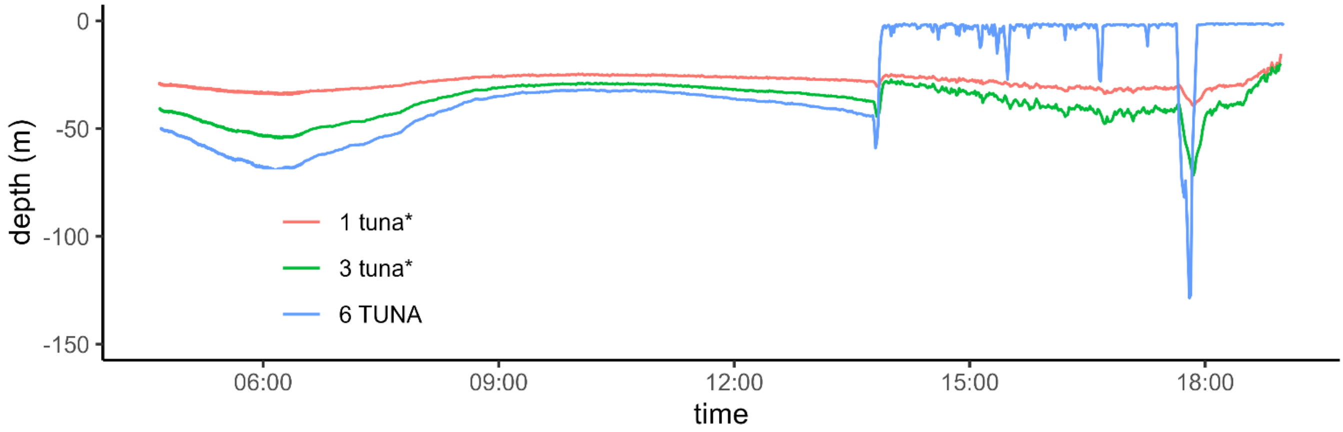

Figure 4. Plot of TDR depth over time for three branchlines in the same basket in positions one (red), three (green) and six which caught a tuna (blue).

Similarly, a blue shark (Prionace glauca, taha pounamu) also had a localised effect on TDR depth (Figure 5)

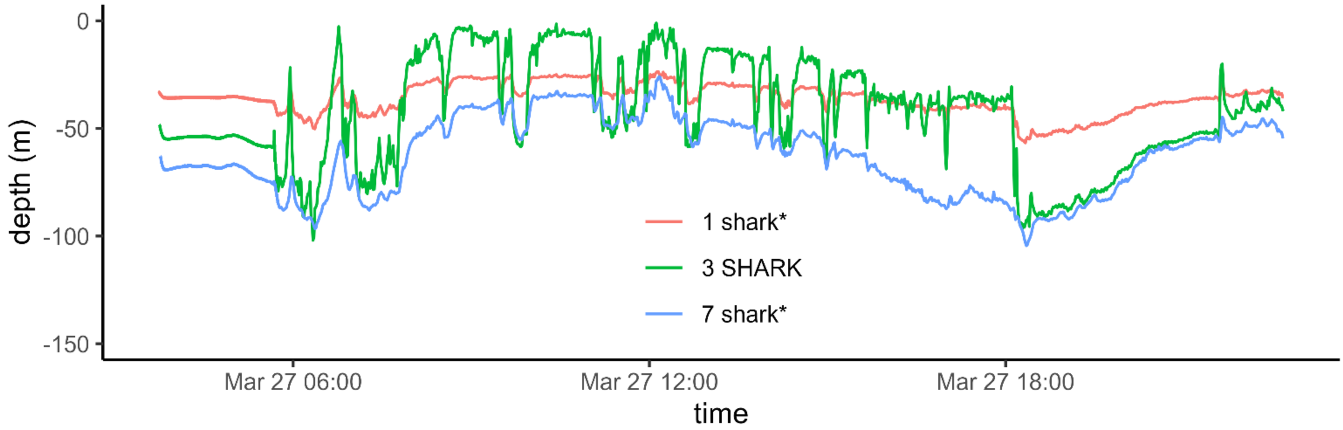

Figure 5. Plot of TDR depth over time for three branchlines in the same basket in positions one (red), three, which caught a blue shark (green), and seven (blue).

Tuna and sharks did not always bring gear closer to the surface (Figure 6).

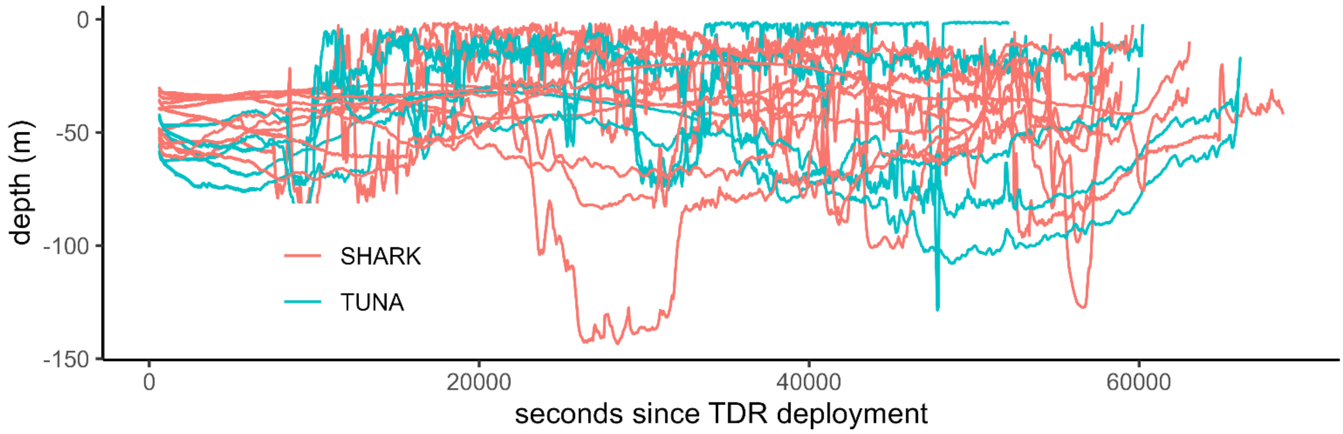

Figure 6. Plot of TDR depth over time for all branchlines which caught fish (n = 11 for shark captures and n = 5 for tuna captures).

Time depth recorder data - temperature

Temperature-depth profiles vary within the same set and also between sets (Figure 7). Surface temperatures were between 11 and 14 degrees centigrade, and thermocline depth varied between 75 and 125 m.

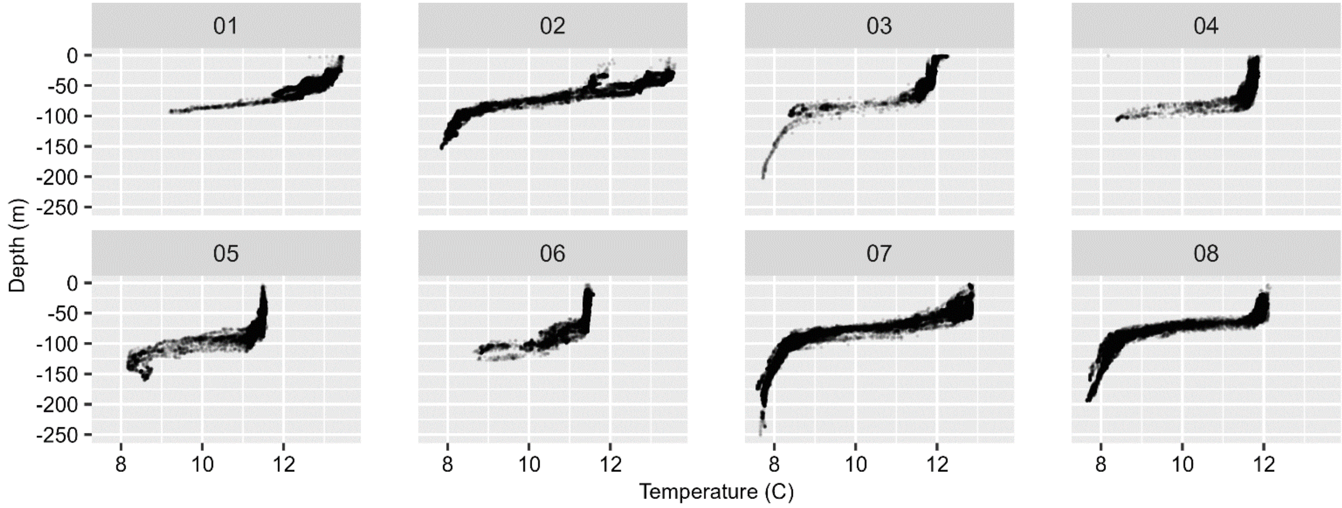

Figure 7. Plots of temperature versus depth or all TDR records, by set.

During most sets TDRs spent most of the soak above the thermocline in temperatures around 11-12 degrees centigrade (Figure 8).

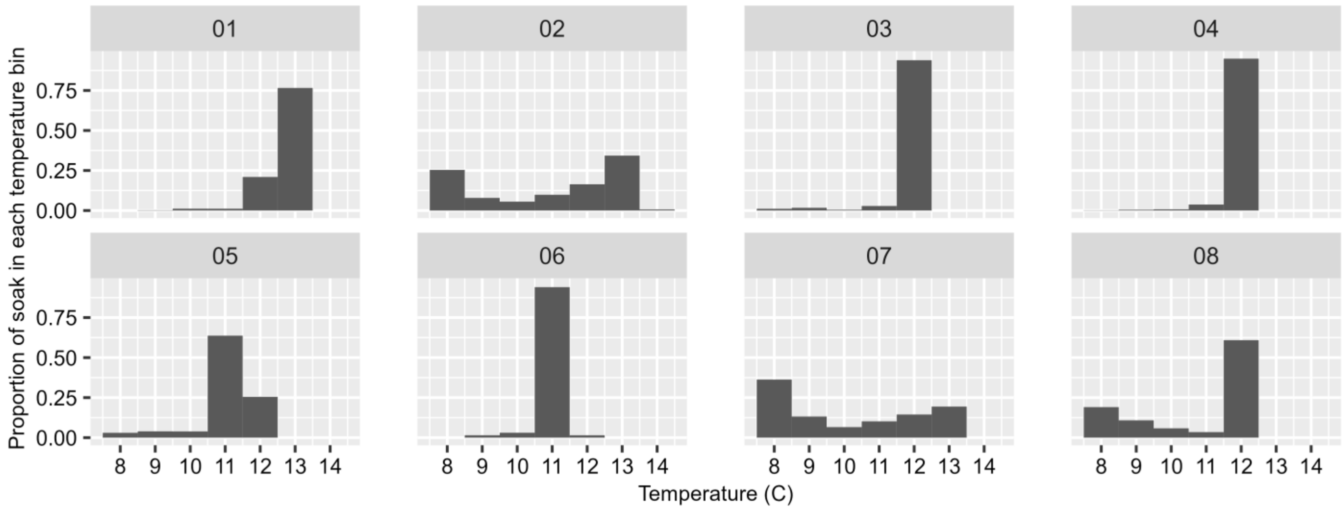

Figure 8. Histograms of TDR temperature during the whole soak, by set, with one-degree centigrade temperature bins.

Discussion

Depth

The skipper reported a marked decrease in captures after adding weight into snoods, in addition to Hookpods. This indicates that the depth of gear during the soak period is important. Consideration should be given to adding more weight to Hookpods to avoid having to add weights separately. This would also be desirable from a safety point of view as, during a fly-back, one object is likely to slide better than two. It would have been interesting to measure any increase in soak depth attributable to adding weight to Hookpods. However, due to undertaking the trip close to the full moon and with reasonably high overlap with birds, it was not considered prudent during this trip.

Whilst gear setup does initially influence soak depth it appears that other variables such as tide, weather, current and drift acting differently along different parts of the line during the soak are important factors. The nature of pelagic longlining is that skippers often actively target fish in patches of water where these variables change over relatively short spatial scales, such that different parts of the line move in different directions. This often results in some baskets being stretched out and shallower and other baskets compressed and, hence, deeper. This confounds the data presented here and is thought to generally result in 'longline shoaling' such that gear sits shallower than it would if set in a static body of water (Bigelow et al. 2006, Bach et al. 2009).

Fish caught on the line also influenced neighbouring hook depth. Although initial indications are that this effect is localised and relatively rare it can still result in considerable 'hook-minutes-of availability-to-birds' (Figure 3). This this 'hook availability' is potentially greater than that at the set. Given that this hook availability is unmitigated, and occurs largely in daylight, and is associated with fish on or close to the surface it is likely to lead to bycatch in areas of high overlap.

Mitigating these instances of shallow hooks is not straightforward as they are largely beyond control of the skipper. However, all other factors being equal, both shooting deeper, and with weight close to the hook are likely to help but, based on the data presented here, it is fish that bring the gear close to the surface. Whether he frequency of this alters with fishing depth is not yet clear. Given that sharks may bring hooks close to the surface, and are generally released, any method that reduces shark bycatch, such as not using lightsticks, will reduce hook availability during the soak.

Larger snood spacing and longer (weighted) snoods may both reduce the frequency with which hooks adjacent to fish are brought close to the surface.

Providing catch rates are maintained, shooting shallower is desirable in that skippers can haul faster, work more gear, cover more miles, catch more fish per set, and have less fishing days to catch a given portion of the TAC. This gain in efficiency should be considered with respect to any increase in risk to birds due to shallower hooks.

More generally mitigation should be considered in the context of how best to minimise risk to birds per kilogram of fish caught. This is slightly different to minimising risk per hook and is important when fisheries operate with high catch rates and at times and in areas of high overlap. The goal should be to catch the TAC whilst catching least number of birds, or with the least number of shallow hook soak hours, normalised by the overlap.

Regulations or codes of practice should be carefully considered so as to minimise risk on a fishery basis, rather than per set or hook. For example, requiring fishers to reduce hook numbers or drop hooks next to floats may not actually reduce risk as it is (presumably) forcing them to fish inefficiently. Similarly, setting gear deeper may be less efficient in terms of fish per hook but may be more efficient in terms of fish per bird. The challenge is clearly balancing fishing efficiency with fishing efficiency per bird, whilst maintaining a profitable operation which is, arguably, best left to conscientious skippers. Providing skippers with more information around how these factors change will help them make responsible trade-offs.

Temperature

Despite set being in relatively close proximity the surface temperatures recorded by TDRs varied from 11.5 to 13.5 degrees centigrade. This indicates that fishing occurred in areas where temperature changed over relatively short horizontal distances. Similarly, fishing depth influences temperature with thermoclines starting as shallow as 50 m and some deeper hooks fishing in water down to eight degrees centigrade. Whilst the water temperatures and location of hooks in the summer bluefin fishery from Dunedin, as per this trip, are unlikely to overlap with leatherback turtles considering temperature as well as depth is likely to be useful when considering overlap with turtles in warmer waters, both spatially and vertically.

Feedback requested from Technical Working Group

The author would appreciate feedback from the CSP TWG on data analysis, particularly:

Defining the soak period. The method presented here samples soak depth by removing the first five minutes and then takes a depth every minute, starting at the next whole minute. The last record is on the last whole minute prior to the line being hauled above 1.5 m depth.

Dealing with TDR records from branchlines that catch fish. Once these branchlines have caught a fish that particular hook does not pose a risk. However these instances are important in assessing how often adjacent hooks are brought close to the surface. Potentially they should be 'discounted' when plotting histograms. On some occasions rapid changes in depth indicated when fish took hooks, however this was not always clear cut.

Deploying TDRs in blocks. The approach taken here was to aim to run a block of five baskets of a treatment and place three TDRs in each of the middle three baskets. Generally, gaps between treatments were one to two baskets but sometimes larger as three baskets were left either side of a beacon.

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Appendix

Set by set summary of gear configurations tested, catches, and weather conditions

The skipper decided to fish to the east of Dunedin, based on previous catches and reports from other vessel, and the weather forecast. Some vessels had also been having good catches further south but the forecast was not so good.

Set 1. Skipper shot 11 hook baskets, modified to 11 hooks with weight on float rope and 12 hooks. Set at six knots with 10 knots of wind, 0.5-1.0 m swell. 15 knots of wind and 1.0 m swell during the haul. Little drift and catches were poor so skipper shifted south as far as time allowed. One deployment of Jonathan's microphone setup

Set 2. Set with a turn, TDRs deployed on last section set so all in a straight line, speed dropped to 5.5 knots. 25 knots of wind, 1-2 m swell. Tested: 12 hooks, 12 hooks with a weight on the float rope, 13 hooks. Gear all closed up a bit during soak, more drift, poor catches again so shifted to north. Downloaded Jonathan's microphones and IGotUs. Caught a White-chinned petrel on unobserved section of gear. Lost one TDR.

Set 3. Straight line set to NNE, 25 knots of wind, 2.0 m swell. Tested: control gear 12 hooks (6.5 knots), 12 hooks and weights on float ropes (6.5 knots), and 13 hooks (6.1 knots as turned a bit). Lots of tide to north, weather beam on, rolly set. Better catches, lots of drift. 15 knots of wind and 2 m swell for haul.

Set 4. Shifted further north again – partly due to lack of time to re-position prior to shooting again. Tested: 12 hooks, 12 hooks and weight on float rope (both at 6.5 knots), 13 hooks (6.1 knots – skipper changed his mind and turned into swell a bit). 10 knots of wind and 1.5 m swell. Another microphone deployment. Outside steering broke so I steered up the line whilst skipper hauled outside and crew recovered TDRs. Worked OK but no spare time during haul to look at data hence reduced opportunity for further microphone deployments. 30 knots of wind and 3 m swell during haul, better catches, more sharks too, lots of drift (20 nm) again.

Set 5. Minimal re-positioning prior to shooting. 15-20 knots of wind, 1.5-2.0 m swell. Set less gear due to poor forecast (and lack of steering). Tested 13 hooks with and without longer float ropes at 5.8 knots. 25-35 knots of wind during haul, 3.5-4.0 m swell, lost one TDR and caught a Buller's albatross, beside a tuna. Reasonable catches and more sharks again.

Set 6. Shooting with weather: 30 knots of wind, 3 m swell, rain, back up to 900 hooks – haul went OK yesterday and not going in to get steering repaired. Tested 13 hooks, 13 hooks with long float ropes, and 13 hooks with weight on float rope, at 6.1 knots. 25 knots of wind dropping to 5 knots during haul, 2.0 m swell. Caught one white-chinned petrel four hooks into a basket (two hooks away from a blue shark). Reasonable catches. Limited time to reposition.

Set 7. Shooting into weather, 20 knots wind, 1.5 m swell, 5.8 knots. Tested: 13 hooks, 13 hooks with longer float rope, and 14 hooks. Weather dropped off for haul, 10 knots, 1.0 m swell, caught one white-capped albatross four hooks from a tuna and beside a float.

Set 8. Variable 10 knots of wind, 1.0 m swell during set. Tested: 13 hooks, 13 hooks and weight on float rope, 13 hooks and longer float rope, and 14 hooks, only two repeats of each though, rather than three. Very little drift, reasonable catches, 5 knots of wind and 1.0 m swell during haul – noticeably less birds with less wind.