Assessment of weighted hooks as a seabird bycatch mitigation option for surface longline fisheries

MIT2024-03

Final report

D. Goad, C Schweder-Goad

Prepared by Vita Maris for the Department of Conservation

March 2026

Executive summary

The use of line weighting to rapidly sink baited hooks under the protection of a tori line is recognised as an effective mitigation measure to reduce the bycatch of seabirds during the deployment of pelagic longlines.

Time depth recorders (TDRs) were used to compare sink profiles of heavy hooks and hook shielding devices to established best practice line weighting configurations. Tests were conducted both from a stationary vessel and during fishing operations. Sink times to depth were slower and more variable under real-world fishing conditions than under controlled conditions.

Both 60 g and 50 g heavy hooks sank with similar profiles to the current ACAP best practice line weighting recommendations of 60 g at a metre from the hook or 40 g at half a metre. The size and density of hook shielding devices reduced sink times, particularly under fishing conditions, indicating that the bulk of devices added to branchlines should be considered.

To be cited as:

Goad, D.; Schweder-Goad, C. 2025. Assessment of weighted hooks as a seabird bycatch mitigation option for surface longline fisheries. MIT2024-03. Final Report prepared by Vita Maris 9 p.

Introduction

The use of line weighting to rapidly sink baited hooks under the protection of a tori line is recognised as an effective mitigation measure to reduce the bycatch of seabirds during the deployment of pelagic longlines (ACAP 2024). Regulations specifying weight size and position from the hook vary between jurisdictions. However, it has been demonstrated that weight close to the hook is most effective as it reduces the lag in sink time, and weight directly attached to the hook has been adopted by several vessels in the New Zealand fleet, and encouraged through the development of the 'Procella' heavy hook (Brothers 2024). Hookpods, which enclose the barb of the hook until it reaches 10 m depth have gained acceptance in the New Zealand fishery, and are used by many vessels. However, Hookpods are not particularly heavy or dense and so some fishers have switched to using Hookpods and line weighting, partially to reduce hook availability during the soak period.

Although these recent changes to branchline weighting have increased hook depth during the soak period, and likely reduced capture rates, the relative efficacy in terms of reducing sink time to depth has not been directly compared.

Methods

Static tests

A set of 13 m long branchlines were made up using new 2.0 mm diameter monofilament, with a Star-Oddi (Garðabær, Iceland) DST Centi time depth recorder (TDR) taped to the branchline immediately above the hook. A float was also attached with the TDR which made the TDR-float combination neutrally buoyant (Figure 1). Hooks were baited with defrosted squid with a mantle length of between 140 and 160 mm.

Figure 1. Time depth recorder attachment for static tests, with 16/0 50 g Procella hook, Star-Oddi DST Centi time depth recorder and float.

Branchlines were deployed from a vessel anchored in fresh water with a depth of 18 m. Clips were attached to a short rope which held them at water level. A coil of monofilament and the baited hook were cast beside the vessel. Start time was recorded as the time when the hook hit the water. On recovery of the branchline instances of missing bait or tangles were recorded and resulted in exclusion of the measurement and a replacement cast was made. Whether Hookpods opened was also recorded. Three branchlines were made for each of the treatments in Table 1, Figure 1, and each branchline was cast at least three times.

A set of static TDRs logged temperatures at 1, 2, 3, 4, 5, 6 7, 8, and 10 m depths throughout the data collection period.

Table 1. Branchline configurations tested during static tests:

50g 16/0 Procella weighted hook (a 62 g Procella with the lead trimmed to give a total weight of 50 g)

62g 16/0 Procella weighted hook

14/0 circle hook with weighted swivel (total weight 53 g)

16/0 circle hook (22 g) with Hookpod and 60g lumo lead at 2.0 m from hook

16/0 circle hook (22 g) with Hookpod and 60g lumo lead at 1.0 m from hook

16/0 circle hook hook (22 g) with Hookpod at 1.0 m from hook

16/0 circle hook (22 g) with 60g lumo lead at 1.0 m from hook

16/0 circle hook (22 g) with 40g lumo lead at 0.5 m from hook

Figure 2. Branchline weighting options tested, from left to right: 50 g 16/0 Procella hook, 62 g 16/0Procella hook, 14/0 weighted swivel hook (53 g total weight), Hookpod and 60 g lumo lead with 22 g 16/0 hook. Hookpod with 22 g 16/0 hook, 60 g lumo lead, 40 g lumo lead. Note lumo leads were deployed on branchlines with 22 g 16/0 circle hooks.

At-sea tests

At sea testing was undertaken on two trips on two separate vessels. Baskets were separated by 300 mm diameter hard floats and all gear was set slack, directly from a free-spooling drum with gear setups typical of the New Zealand fleet (Table 2).

A set of new branchlines was constructed at the beginning of each trip for TDR deployments, and these were stored separately. TDRs were taped onto the branchline 0.5 m from the hook, and then hooks were baited and deployed as per normal operations. CEFAS G5 TDRs (Lowestoft, UK) weighed 2.5 g in water and Star Oddi TDRs were deployed with a float, as per the static tests. TDRs were configured on a per-set basis and pre-programmed to record at one-second intervals. Deployment times, position in the basket, and gear setup were recorded during the set.

TDRs were deployed on branchlines beside the float, a quarter of the way into a basket, and midway into a basket. TDRs were programmed and data were 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.

Table 2. Trip details, including gear configurations tested. Baskets containing 150 mm hard floats at the midpoint are suffixed "m". Mitigation is coded as hp & w = Hookpod with 60 g siding lead at 1.8 m from hook, 53 g ws = leaded swivel at the hook (total weight = 53g), 60 g p = 60g Procella hook.

			Branchline					
Vessel trip	Date	Target species	length (m)	timer (s)	mitigation	Basket size (hooks)	Speed (knots)	Float rope length (m)
A	Apr 25	bluefin	11	14	hp & w	12	6.7 - 6.9	9 - 16
B	Feb 25	bigeye	10	12	hp, l, s, 60 g p, 53 g ws	10, 20 m	6.2 - 6.8	8 - 16

Fisher-collected Procella performance data

Fishers collected additional data into paper 'Procella Logbooks' to assess performance. Logbook data were available from 97 sets on two vessels. Both vessels incorporated Procella hooks into their gear over a period of time before switching to 100% Procella hooks. Histograms were plotted of fish catch and hook loss to bite-offs per hook for sets where different hook types were used.

Data processing

Static tests

Raw TDR records were converted to depth using three-minute rolling mean temperatures derived from the closest static TDR. Pressure offsets were initially based on the average depth prior to deployment and then refined based on the minimum three-second rolling mean depth within 20 seconds of the start time, to account for re-casts after a short period of time.

Start times were adjusted to account for clock drift based on video records and time-depth profiles.

Twenty records were re-cast due to tangles, lost bait and drift at anchor and records were discarded if they were not consistent with other repeats of the same treatment, for example due to incorrect start times or inconsistent pressure offsets. Where replacement repeats were made and the original profile appeared consistent both records were kept.

At-sea tests

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. CEFAS TDRs process 'onboard' and no temperature correction is available. Star-Oddi TDRs provide raw data and this was processed to use maximum water temperature within the first 100 seconds after deployment to correct pressure readings. Individual sink profiles were examined to ensure clip-on times were recorded accurately and tangles did not occur and if either of these were apparent records were discarded. Pressure readings were variable after deployment, and those above zero m depth were discarded.

Results

Static tests

All TDRs sank with a linear profile initially during static tests (Figure 3).

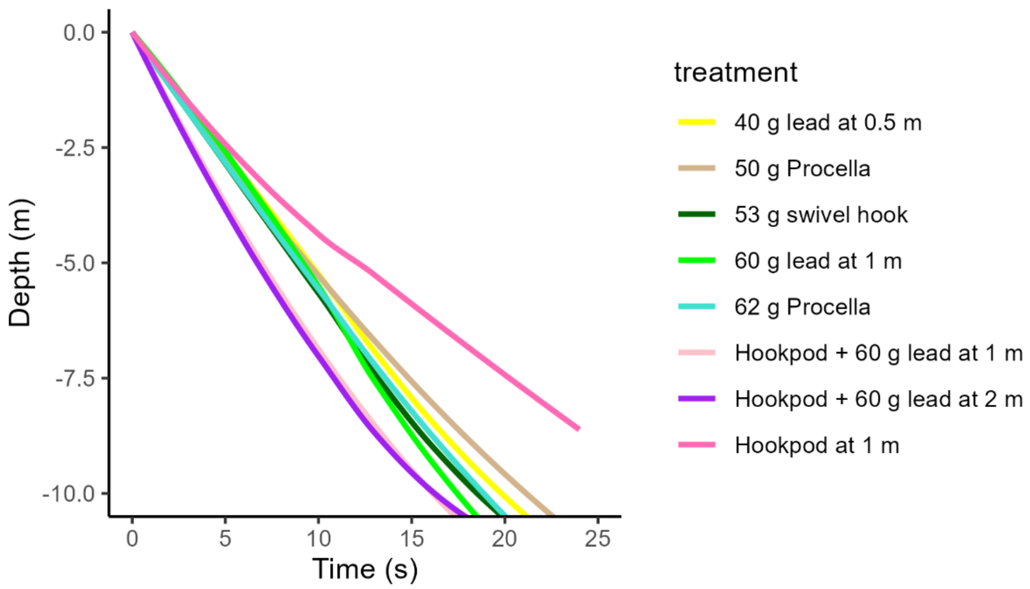

Figure 3. Time depth plot from static tests, loess smoothed to pass through 0,0.

In static tests Hookpods with 60 g weights sank fastest and Hookpods without added weight sank slowest. Weighted gear sink times appeared to be determined by a combination of weight and leader length (Table 2).

Table 2. Static test sink times to five metres depth for different branchline treatments.

Treatment	mean time to 5 m (s)	standard deviation	n repeats
Hookpod + 60 g lead at 1 m	7.6	2.0	10
Hookpod + 60 g lead at 2 m	7.5	1.7	8
62 g Procella	9.2	1.0	9
53 g swivel hook	9.5	1.4	8
60 g lead at 1 m	9.7	0.6	11
50 g Procella	10.0	1.6	8
40g lead at 0.5 m	10.2	1.4	12
Hookpod at 1 m	13.1	3.9	10

At sea tests

At-sea testing produced much slower sink times, with greater variability (Figure 4). Star-Oddi TDR deployments resulted in slower times to depth than CEFAS TDRs (Table 3). In contrast to the static tests, Hookpods with 60g weights did not sink noticeably faster than the other weighted treatments to 5 m depth.

Table 3. At sea sink times to five metres depth for different branchline treatments.

Treatment	CEFAS TDRs			Starr-oddi TDRs		
	time to 5 m (s)	std dev	n	time to 5 m (s)	std dev	n
Hookpod + 60 g lead at 1.8 m	13.2	3.9	111	18.7	5.4	84
62 g Procella	13.6	3.1	32	15.7	3.2	31
53 g swivel hook	14.1	3.5	31	17.5	3.7	31
60 g lead at 1 m	14.3	3.5	21	16.4	2.6	31
Hookpod at 1.8 m	19.8	3.4	20	23.1	2.4	12

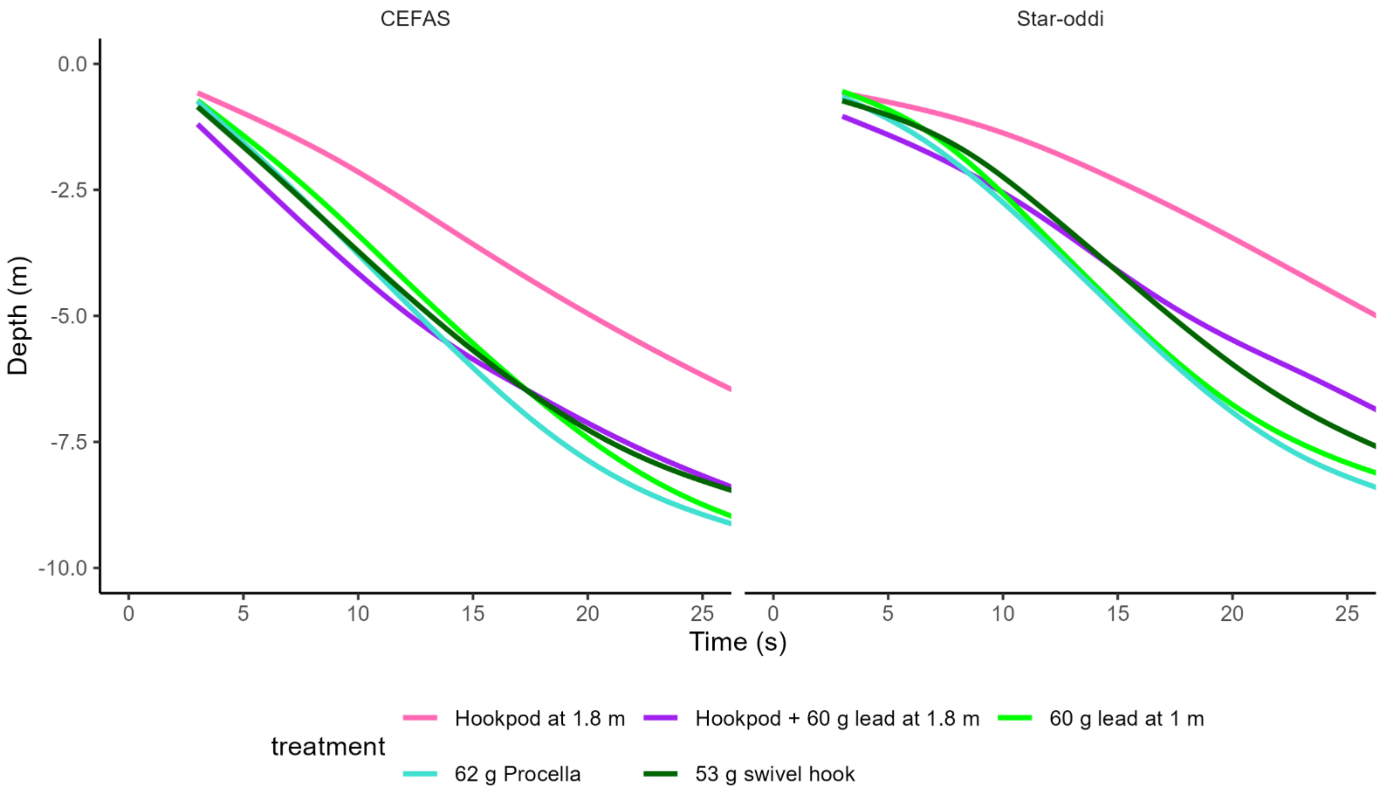

Figure 4. Time depth plot from at-sea tests, loess smoothed to pass through 0,0.

Logbook data

Over the 97 sets recorded in logbooks, the two vessels deployed 55340 Procella hooks, 9550 weighted swivel hooks, and 16920 16/0 circle hooks. One seabird was reported caught on a Procella hook, next to a dead floating swordfish.

Both skippers switch over to 100% Procella hooks reasonably quickly, indicating that they were happy with their performance. Although this is likely the best indication of performance in terms of practicality and target catch rate, it resulted in limited data for quantitatively comparing catch rates within sets containing Procella hooks and other hooks.

Vessel K replaced weighted swivel hooks with Procella hooks and vessel T replaced 16/0 circle hooks with Procella hooks. Fish catch rate data were available from 37 sets from vessel K and 18 sets on vessel T, where both types of hook were used within the same set. Catch rates (Figure 5) and bite-off rates (Figure 6) were similar between hook types.

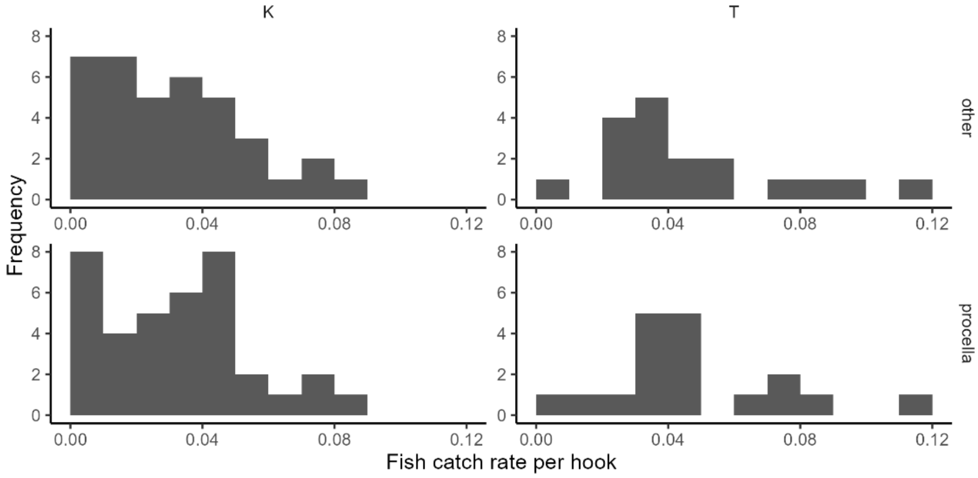

Figure 5. Histograms of target fish catch per hook comparing Procella hooks against weighted swivel hooks (Vessel K) and 16/0 circle hooks (Vessel T).

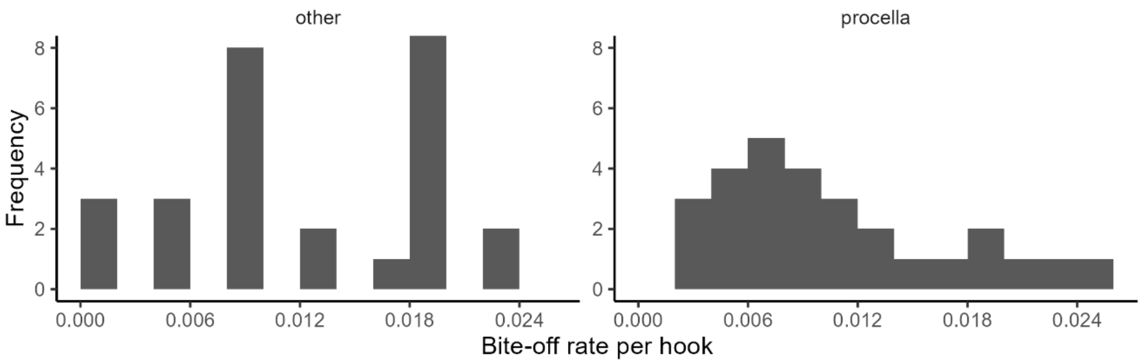

Figure 6. Histograms of bite-off rate per hook comparing Procella hooks against weighted swivel hooks on Vessel K.

Discussion

Static tests

Static sink times reported here are marginally slower sink times than reported by Brothers (2024) and Robertson (2013), but provide a similar ranking. A 50 g Procella hook produced a similar sink time to 5 m as a 40 g lumo lead at 0.5 m or a 60 g lumo lead at 1.0 m. Adding 60 g immediately below Hookpods markedly improved their sink time to depth, from slowest to fastest-ranking.

Adding a neutrally buoyant TDR and float combination increased drag and so could have contributed to slower sink times. Therefore, it provides a conservative estimate of sink times to depth, but was deemed preferable to ignoring the added weight of a TDR.

Data processing took account of the lower density of freshwater when converting pressure to depth. However, gear would be expected to sink marginally slower in seawater and Hookpods open marginally shallower.

At-sea tests

Markedly slower sink times were recorded in real-world at-sea conditions. This is likely due to a combination of having the TDR away from the hook, propellor wash, pressure variation behind the vessel, and weather effects. Larger variation can be attributed to swell, pressure waves behind the stern, and inconsistent casting of baits relative to the stern.

CEFAS TDRs ranked treatments in the same order as static tests and produced faster sink times to depth than Star-Oddi TDRs (Table 3). CEFAS TDRs were 2 g heavier in water and the greater bulk and associated drag of the Star-Oddi TDRs and float combination may have contributed to this difference. Star-Oddi TDR processing was consistent between static tests which showed linear sink profiles and at-sea tests which produced sink rates initially increasing with depth, indicating that this difference is likely not due to the TDRs themselves but rather due to different sink profiles at-sea compared to those under more controlled conditions.

With both TDR types it was notable that Hookpods with a 60 g weight had similar sink profiles to the other weighted treatments, rather than a faster sink profile as found in the static tests. Assuming no vessel effect, this indicates that the volume or 'bulk' of devices attached to branchlines reduces sink rate to a larger degree in the dynamic environment behind a vessel, relative to tests in static water. It is therefore important to consider 'real world' sink rates and the density of any weight added to branchlines, including hook shielding devices and light emitting devices, when developing regulations.

Logbook data

The two skippers involved in trials both switched to 100% Procella hooks and have continued to use them after this study. This indicates that in addition to performing similarly to other ACAP-endorsed weighting from a sink rate perspective they are workable in a fishing context and provide fishers with an alternative, and for these two skippers an attractive alternative, to other weighting options.

In order to record catch rates on different hook types skippers had to keep track of fish counts and record these into a paper logbook in addition to their electronic logbooks. This likely contributed to incomplete data on catch rates, with on occasions 'same' or 50:50 noted in the fish catch section which was not able to be used in the plots in Figures 5 and 6. Skippers generally have long busy days and adding in extra reporting requirements is onerous. Where such data is required for long-term trials options for either incorporating this reporting into electronic logbooks or utilising the electronic camera monitoring in the fishery should be explored. Both these options would also provide the opportunity to assess effects on non-target catch. Similarly, if data are required long-term then compensating skippers for using and recording data on two different hook types could be considered. In this case the relatively quick adoption of Procella hooks onto all branchlines is an endorsement of the hooks, albeit at the expense of a more complete and robust catch rate comparison.

Conclusion

The 62 g Procella hooks outperformed the other weighting-only treatments, and 50 g Procella and 53 g weighted swivel hooks had equivalent or possibly slightly faster sink times to 5 m depth than a 60 g lumo lead at a metre from the hook.

Hookpods with 60 g lumo leads weight sank fastest initially and performed similarly to other weighting-only configurations to 5 m depth at sea, whereas without the added weight Hookpods sank markedly slower than all weighting treatments.

Density and volume of 'weight' or other devices added to branchlines, as well as distance from hook, should be considered when developing minimum specifications for line weighting regimes.

References

ACAP 2024. Review of Seabird Bycatch Mitigation Measures for Pelagic Longline Fisheries. Reviewed at the Fourteenth Meeting of the Advisory Committee. Lima, Peru, 12 - 16 August 2024.

Brothers, N. 2024. Minimum Weight at the Hook Allowance of 50 g Inclusive of Hook Weight for Pelagic Longlines. Twelfth Meeting of the ACAP Seabird Bycatch Working Group, Lima, Peru, 5 – 7 August 2024

Robertson, G.; Candy, S.; Hall, S. 2013. New branch line weighting regimes to reduce the risk of seabird mortality in pelagic longline fisheries without affecting fish catch. Aquatic Conservation 23 (6) 885-900. doi10.1002/aqc.2346