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Preliminary assessment of the effect of seabird friendly (fast sinking) line weighting on catch rates of target and non-target fish in pelagic longline fisheries

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1. Introduction

Weights attached to pelagic branch lines increase the sink rates of baited hooks and reduce interactions with seabirds. Line weighting was introduced into the Australian pelagic longline fishery in 2007 following an experimental assessment of the effect of various gear configurations on hook sink rates (Robertson *et. al.,* 2010). A total of 45 combinations of baits species and life status, swivel weights and leader lengths were assessed and two weighting regimes recommended for the fishery: 60 g at ≤ 3.5 m from hooks or 100 g at ≤ 4 m from hooks. The study raised two other issues, which are important in terms of future research. First, the initial sink rate was mainly influenced by the proximity of the sinker to the hook and the final sink rate was determined by the weight of the sinker. Thus, to increase both the initial and final sink rates the weight of the sinkers must be increased and sinkers must be located closer to hooks. Second, small variations in weighting regimes were difficult to detect in the shallow depth ranges (0-6 m). Examples of small variations are shortening long (e.g., 4-5 m) leaders by increments of only about 1 m, and increasing the weight of the 60 g sinkers used in the experiment by increments of, say, 20 g, 30 g or even 40 g. With both these points in mind it was concluded that to reduce seabird mortality from that associated with 60 g leaded swivels 3.5 m from hooks (the industry standard) comparative trials should include branch lines with at least 120 g ≤ 2 m from hooks (or a close approximation thereof).

This paper reports the preliminary findings of two further line weighting trials in the Australian tuna fishery. The first trial compared the industry standard (60 g at 3.5 m) line weighting with 120 g lead weights 2 m from hooks, and the second compared the industry standard with 40 g leads placed at the hook. The idea for the second trial evolved during the course of the first trial. Because both trials were conducted in an area of low seabird abundance (a collaborator could not be found in a high risk area) the research was conducted in two stages. The first stage was to determine effects of the new line weighting regimes on catch rates of target and non-target fish and the operational aspects of fishing. The second stage, which depends on the results of the first stage, will be to determine the efficacy of a new weighting regime in reducing seabird mortality from that associated with the industry standard. To date the first stage (fish catch effects) of the first trial (60 g at 3.5 m versus 120 g at 2 m) has been completed and we are currently about halfway though the first stage of the second trial (60 g at 3.5 m versus 40 hook lead).

2. Methods

2.1 General: fishing vessel and gear

Both trials were conducted on the F/V *Samurai*, which is a 20-m fiberglass planning hull "Westcoaster". The *Samurai* operates out of Mooloolaba (26.68ºS; 153.1ºW) in south-eastern Queensland, Australia. The *Samurai* sets a 3.2 mm monofilament mainline through a line shooter to vary the depths targeted. The mainline is suspended on floats on a mix of 10 m and 20 m droppers. Branch lines are 1.8 mm monofilament nylon and 16 m long. The 60 g leaded swivels were placed 3.5 m from #14/0 circle hooks. Bait was a mix of squid and pilchards. All baits were dead. Branch lines with squid bait were always accompanied by a light stick placed 2 m from hooks. Light sticks were never used with pilchard bait. Sleeves and skirts were distributed randomly thought the branch lines and some branch lines were not equipped with either (see below). Sleeves are 10 cm x 0.5 cm sleeves of fluro rubber latex sleeves fitted tightly over branch lines immediately above the hooks. Skirts are placed in the same position and comprise a rosette of multi-coloured rubber latex strands that resemble squid tentacles and designed to dangle over the top section of the hook. Fishermen consider that skirts and sleeves attract fish.

A typical set on the *Samurai* involved deploying 1,200-1450 hooks at 8 knots vessel speed with 10 branch lines between floats and branch lines 35 m apart. Branch lines were set from bins every eight seconds off both sides of the vessel and hooks were deployed 3-4 m outside the outer edge of the vessel wake. Radio beacons were deployed every 200 hooks.

2.2 Sink rates

The sink rates of the various line weighting regimes were assessed under boat charter conditions on the *Samurai* in February 2011 using Star Oddi time-depth recorders (TDRs). However, for unknown reasons some of results were erroneous. To inform the decision whether to repeat the trial the sink profiles of the weighting regimes were examined in the dive pool in the Hobart Aquatic Centre. The purpose of this exercise was to provide a measure of the proportional differences between the regimes under controlled conditions and to confirm that the weighting regimes sank with distinctly different profiles. The sink rates were estimated with a single Cefas G5 TDR (3 cm resolution) attached to the monofilament at the hook. The same branch line (1.8 mm mono), hook (#14/0) and bait (a pilchard-sized latex lure – pilchards not allowed in the dive pool) were used for all regimes and each was deployed 12 times with the same throwing action (thrown so as to extend the leader). A total of nine weighting regimes were trialed - the three mentioned above and another six of various configurations for the purposes of comparison (see Results).

2.3 Trial designs

2.3.1. 120 g at 2 m versus 60 g at 3.5 m

This trial was conducted over six fishing trips and 30 sets of the longline between March and December 2010. The trial was supported by 80 days observer time provided by the Australian Fisheries Management Authority (AFMA). When the 80 days elapsed the trial ended. The design involved setting gear in pairs with each pair comprising 200 hooks with 60 g at 3.5 m branch lines and 200 hooks with 120 g at 2 m branch lines. Each group of 200 hooks was flanked by a radio beacon. A total of three pairs – or 1,200 hooks in total – were deployed in each set of the longline. The order in which weighting regimes were set was alternated between sets to avoid systematic bias associated with setting order. Bait species – squid alone, pilchards alone or an even mix of both - and setting depth were kept constant within pairs but occasionally changed between pairs. At the start of the trial the proportion of the 600 branch lines with 120 g at 2 m fitted with sleeves, skirts or nothing was 38%, 21% and 41%, respectively. The equivalent figures for the 600 branch lines with 60 g at 3.5 m were 54%, 21% and 25%. By the third set of the first trip of the trial the gear had been re-configure such that the proportions were equal for both gear types and the proportions were maintained for the remainder of the trial. Light stick were attached 2 m from hooks to all branch lines with squid bait but never to branch lines with pilchard baits. The 120 g sinkers were safe leads (see Sullivan, *et.al.,* in prep.) and were custom made for the trial (Figure 1). The main species targeted in this trial were yellow-fin tuna and big-eye tuna.

The variables recorded on each weighting regime during line sets were time of deployment of radio beacons associated with each group of 200 hooks (allows estimation of the time lines were in the water fishing). The variables recorded during line hauling were the taxa of all fish caught, time of landing, fate, life status, length, sex and whether branch lines had a light stick, skirt, sleeve or were plain ended.

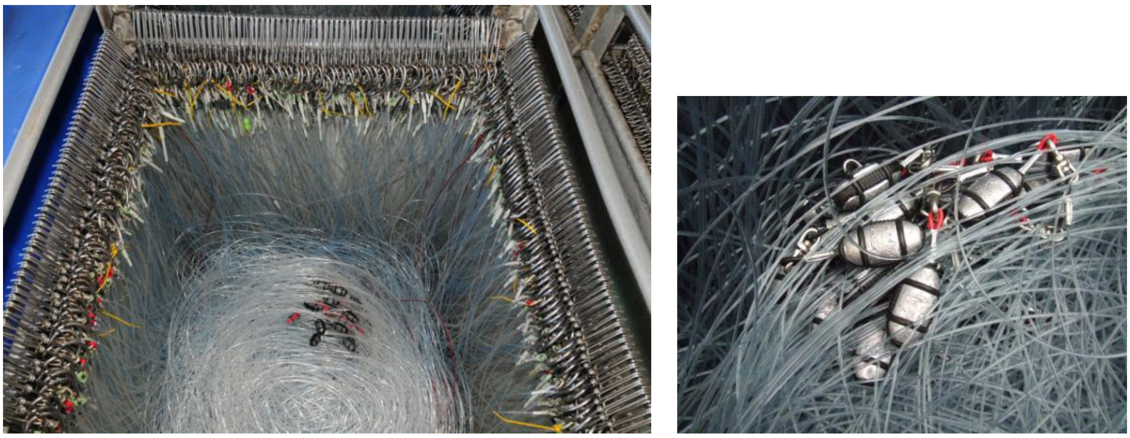

Figure 1. Snood bin of the Samurai *as used in the 120 g at 2 m trial (left). Clips (one end of the branch line) are attached to horizontal runners around the top of the bin and hooks (the other end of branch lines) are suspended from the clips. The branch lines are coiled in the bin along with the line weights. Some branch lines shown are fitted with sleeves adjacent to the hooks. The yellow cable ties shown were attached for experimental purposes and are not*

a normal part of the fishing gear. The leads in the photo on the left are 60 g safe leads. The 120 g safe leads used in the trial are shown in the photo on the right.

2.3.2. 40 g Lumo hook lead versus 60 g at 3.5 m

The trial above stimulated the idea for a second trial, which involved the development of a new type of lead sinker designed to be placed at the hook. Baited hooks abutted by a sinker should sink with a linear profile from the surface (with the rate primarily dependent on the amount of added weight) and achieve a fast initial sink rate compared to the slow initial rates typical of gear with long leaders (see Robertson *et.al*., 2010). Fast initial rates should reduce the visual ques to seabirds. The new leads - called 40 g lumo hook leads - were developed by Mr Nick Williams (owner/operator of the *Samurai*) and Mr Steve Hall (AFMA) and manufactured by Fishtek, U.K. These cylindrical leads come in two versions – with a rebated end to cover the swage at the hook or square ended (abuts the swage). The former weigh 40 g and the latter weigh 60 g. The leads are screw-tightened by hand onto the mono and are capable of sliding safe lead style. They are coated with 2 mm luminescent nylon and glow in the dark (Figure 2).

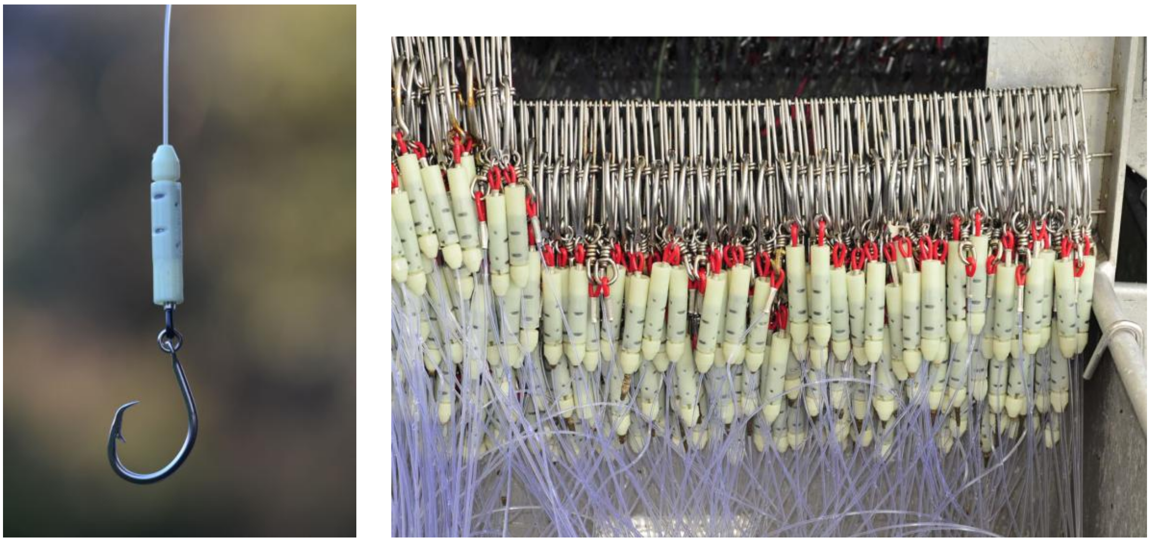

Figure 2. A 40 g Lumo hook lead and a # 14/0 circle hook (left). The lower on-third of the lead is rebated to fit over the crimp. The photo on the right shows 40 g Lumo leads stitched into the branch lines in a gear bin.

The hook lead trial commenced in February 2011 and to date a total five fishing trips and 29 sets of the line have been completed. The design of this trial followed that for the 120 g trial except that instead of alternating between groups of 200 hooks of each weighting regime the two regimes were alternated with each branch line deployed. The fishing gear and its specifications, bait species and the number of hooks deployed in sets were the same as for the 120 g trial. Before the first set of each fishing trip 200 hooks were counted to determine the proportion of branch lines with skirts, sleeves or were plain ended. Changes to these proportions throughout the 5-7 shot fishing trips were very minor. Skirts and sleeves were only fitted to 60 g gear, not to branch lines with 40 hook leads. The use of light sticks was consistent between weighting regimes. Light sticks were always attached to branch lines with squid bait and occasionally (rarely) to branch lines with pilchard baits. As in the 120 g trial the main species targeted in this trial were yellow-fin tuna and big-eye tuna.

Leads at the hook are likely to suffer a higher attrition rate than leads on leaders. During line hauling the number of leads of each type that required repairing or replacing was recorded.

2.4 Analysis

The statistical method for analyzing time to depth profiles and corresponding sink rates corresponds to that described in Robertson *et al*. (2010) except that the depths were not log transformed. This was due to replicate profiles for same treatment running close to parallel after the first (i.e. 1 s) time point rather than diverging. This is attributed to the highly stable environment of the dive pool compared to sink trials carried out through propeller turbulence as in Robertson *et al*. (2010).

With the 120 g trial, the fish counts were analysed as a random effects Poisson generalized linear mixed model (GLMM) with log link (see Robertson et al. 2006) using the R-software (R Development Core Team, 2008) and the ASREML-R library (Gilmour *et al*. 1999). This approach uses penalized quasi-likelihood to carry out the estimation. The response variable was the number caught in each 200 hook set for a given species or group of species. In the case of yellow-fin tuna the GLMM failed to converge so a linear mixed model was fitted to the log of the count after adding 1. This model converged. For the 120 g vs. 60 g trial each of these regimes were deployed in alternate 200 hook sets with these 'pairs' being uniquely identified as the random effect factor. For the 60 g versus 40 g at the hook trial, the weighting regimes were alternated by branch lines, however the count of fish caught was obtained within each nominal set of 1200 hooks (although some sets had close to 1800 hooks) along with the combination of bait species if mixed baits were used within a set. Since the number of hooks set per weight regime and bait species varied from as low as 300 up to 920, the log of number of hooks was included as an "offset" in the Poisson GLMM. The unique set identifier was used as the random effect factor and although "fishing trip number" was included as a random effect factor it was consistently estimated to contribute a non-significant (P>0.1) amount to the total variation. As all fits of the GLMM the within-set or within-pair variation were close to 1 an exact Poisson (conditional on the random effects) was assumed.

An analysis of the power to detect a difference between the 60 g and 40 g at the hook regimes was carried out assuming exact Poisson variation, since this comparison was made at the within-set level.

As mentioned above, the depth of setting varied depending on the main fish species targeted (sword fish shallower, tunas deeper down). In the analysis of the 120 g trial depth was kept constant within pairs. Therefore depth was not a confounding factor in the comparison between weighting regimes. Similarly, in the 40 g hook lead trial depth was varied with fishing strategy but only between (not within) sets. Thus depth of setting was not a confounding factor in the comparison of weighting regimes in the trial.

In the 40 g hook lead trial skirts and sleeves were only fitted to the 60 g at 3.5 m branch lines (these objects cannot be fitted to gear with lead at the hook). In this report the effect of skirts and sleeves on fish catch rates by the 60 g at 3.5 m branch lines has not been assessed, but will be at the end of the study.

3. Results

3.1 Sink rates

The sink profiles of the three line weighting regimes used in the two trials are shown in Figure 3. The 40 g hook lead sank the fastest followed by 120 g at 2 m and 60 g at 3.5 m.

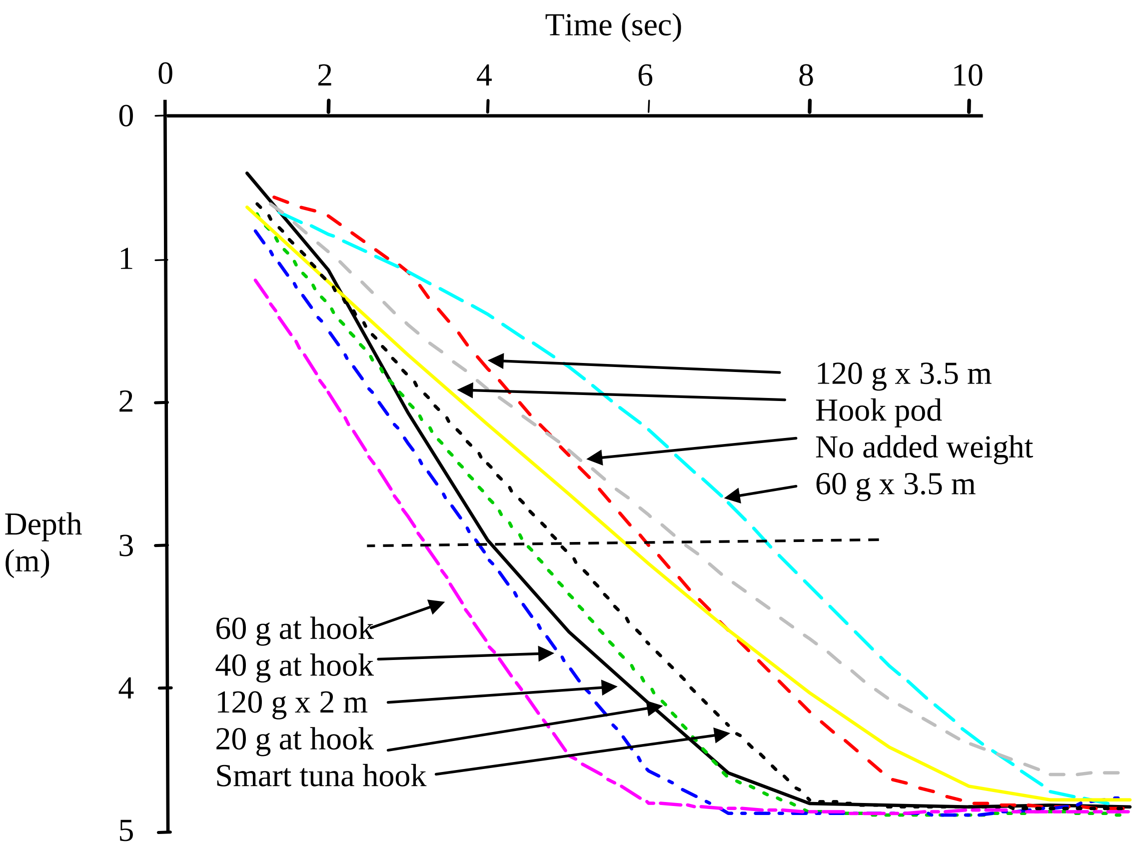

Figure 3. Mean (n = 12) sink profiles of the 60 g at 3.5 m, 120 g at 2 m and 40 g Lumo hook lead line weighting regimes used in the at-sea trials. Also shown for comparative purposes are profiles for no added weight, 60 g Lumo hook lead, 20 g hook lead, 120 g at 3.5 m, the hook pod and the smart tuna hook. Profiles of gear with leaders (60 g at 3.5 m, 120 g at 3.5 m and 120 g at 2 m) should not be compared below ~3 m deep (horizontal dashed line) because at that point the sinkers will have reached the bottom of the pool and ceased pulling on the hook (this is evident in the 120 g at 2 m profile). Profiles separated by 0.22 m

(equivalent to 2 at the average standard error of pairwise difference) are statistically significant.

3.2 Fish catch effects: 120 g versus 60 g at 3.5 m

3.2.1 Yellow-fin tuna

The trial comprised six fishing trips, 30 sets of the longline and a combined total of a total of 36,000 hooks. A total of 644 yellow-fin tuna were caught (both weighting regimes and all bait groups combined). Overall there was a statistically significant effect of baits species (Table 1). Irrespective of weighting regime gear with pilchard baits caught more YFT than gear with squid bait or a mix of squid and pilchards. This result was, however, strongly influenced by one of the six fishing trips when a large number of yellow-fin tuna were caught with pilchard baits by both weighting regimes (see below). There was no significant effect of weighting regime of catch rates of yellow-fin tuna (Table 1). Mean catch rates on sets with pilchard baits alone were nearly identical: 10.5 ± 0.33 (s.e.) tuna/200 hooks and 11.0 ± 0.33 tuna/200 hooks by 60 g and 120 g gear, respectively (n = 30 sets for a combined total . Mean catches with squid alone were 0.76 ± 0.18 tuna/200 hooks on 60 g gear and 0.61 ± 0.18/200 hooks on 120 g gear. Mean catches with a mix of pilchards and squid were 1.87 ± 0.22 tuna/200 hooks on 60 g gear and 1.54 ± 0.22/200 hooks on 120 g gear between. Within these three bait groups the effects of weighting regime on catch rates were not statistically significant (Table 1).

Source	Df	SS	Wald statistic	Prob. (chi squared)
Bait species	2	23.79	37.34	<0.0001
Weight regime	1	0.23	0.36	0.55
Bait spp. x weight regime	2	0.11	0.17	0.92
Residual		0.64		

Table 1. Results of an analysis of variance testing for the effect of bait species and line weighting regime on the catch rates (#/200 hooks) of yellow-fin tuna.

3.2.2 Other commercial species

Other commercial species include big-eye tuna, albacore tuna, broad-bill swordfish and dolphin fish. The numbers of these species caught were too low to be treated separately so the data were pooled. There was no significant effect of bait species (pilchards, squid and a mix of pilchards and squid), nor was there an effect of weighting regime (Table 2). Within bait group the mean catch rates per 200 hooks were similar. For example, mean catch rates on 60 g gear and pilchard bait was 2.13 ± 0.28 fish/200 hooks compared to 2.15 ± 0.27/200 hooks by 120 g gear.

Source	Df	SS	Wald statistic	Prob. (chi squared)
Bait species	2	8.9	4.71	0.095
Weight regime	1	2.14	1.13	0.287

Bait spp. x weight regime	2	1.35	0.71	0.699
Residual		0.64		

Table 2. Results of an analysis of variance testing for the effect of bait species and line weighting regimes on the catch rates (#/200 hooks) of other commercial species (see text).

3.3 Fish catch effects: 40 g hook lead versus 60 g at 3.5 m

3.3.1 Yellow-fin tuna

There was no statistical difference in catch rates of YFT between bait species and the between the two weighting regimes (Table 3). Mean catch rates were 13.12 ± 2.77/1200 hooks with the 40 g hook leads and 11.35 ± 2.1/1200 hooks with 60 g at 3.5 m gear. The sample size in the comparison was 20 set of the longline and a total of 385 tuna caught (both bait species combined)

Source	Df	SS	Wald statistic	Prob. (chi squared)
Bait species	1	0.24	0.265	0.61
Weight regime	1	1.04	1.13	0.29
Bait spp. x weight regime	1	2.42	2.63	0.105
Residual		0.92		

Table 3. Results of an analysis of variance testing for the effects of line weighting regime and bait species group on the catch rates of yellow-fin tuna.

3.3.2 Broad-bill swordfish

The catch rates of broad-billed swordfish on 40 g gear averaged 1.67 ± 0.41/1200 hooks compared to 3.77 ± 0.81/1200 hooks on 60 g gear (n = 29 sets; a total of 90 swordfish caught on all sets and all bait groups combined). The difference was statistically significant (Table 4). In the comparison the results were averaged among the three bait species groups – squid alone, pilchards alone and a mix of squid and pilchards. There was also a strong effect of bait species. Within the 60 g gear, when squid alone was used in a set or a mix of squid and pilchards, the mean catch rate was 4.97 ± 0.93 swordfish/1200 hooks (n = 22 sets) compared to zero swordfish when baits were either pilchards alone or a mix of squid and pilchards (n = 7 sets). The comparable results for 40 g gear were 2.20 ± 0.48 swordfish/1200 hook with squid bait n = 22 sets) and zero swordfish with pilchard baits (n = 7 sets).

Source	Df	SS	Wald statistic	Prob. (chi squared)
Bait species	1	1.96	4.86	0.027
Weight regime	1	2.60	6.43	0.011
Residual		0.40		

Table 4. Results of an analysis of variance testing for the effects of line weighting regime and bait specie son the catch rates of broad-billed swordfish. The interaction term has been omitted because it was not significant (P >0.1).

3.3.3. Dolphin fish

There was no significant effect of either weighting regime or bait species group on the catch rates of dolphin fish (Table 5). Mean catch rates were 6.58 ± 1.33 dolphin fish/1200 hooks (n = 29 sets; a total of 207 fish caught for all bait groups combined) and 6.23 ± 1.15 dolphin fish/1200 hooks.

Source	Df	SS	Wald statistic	Prob. (chi squared)
Weight regime	1	0.25	0.19	0.65
Bait spp. group	1	0.72	0.57	0.45
Bait spp. x weight regime	1	0.29	0.23	0.632
Residual		1.27		

Table 5. Results of an analysis of variance testing for the effects of line weighting regime and bait species group on the catch rates of dolphin fish.

3.3.4. All commercial species combined

The commercial species assessed were yellow-fin tuna, big eye tuna, blue-fin tuna, albacore tuna, broad-bill swordfish, dolphin fish, short-finned mako shark and long-finned mako shark. Within this combined group the effect of weighting regime and bait species group was not significant (Table 6).

Source	Df	SS	Wald statistic	Prob. (chi squared)
Weight regime	1	1.41	1.63	0.20
Bait spp. group	1	0.10	0.12	0.73
Bait spp. x weight regime	1	0.35	0.41	0.522
Residual		0.86		

Table 6. Results of an analysis of variance testing for the effects of line weighting regime and bait species group on the catch rates of all commercial species combined.

3.3.5 Sharks

There is potential for hook leads to increase shark bycatch. The leads abut the hooks and cover the lower 10 cm of the branch line, which is a section of the branch line that is commonly bitten, and weakened, by sharks. Thus hook leads may reduce the number of bite-offs compared to 60 g at 3.5 m branch lines. In the analysis the data for shark catch were combined to increase the sample size. The species considered were dusky, silky, smooth hammer head, blue, short finned mako and long-finned mako sharks. There was no significant effect of line weighting regime on the catch rates of sharks, nor was there an effect of bait species (Table 7). Mean catch rates were 3.73 ± 0.85 sharks/1200 hooks by hook lead branch lines and 3.44 ± 0.63

sharks/1200 hooks by 60 g at 3.5 m gear, respectively (n = 29 sets and a total of 118 sharks caught on both weighting regimes combined).

Source	Df	SS	Wald statistic	Prob. (chi squared)
Weight regime	1	0.12	0.12	0.73
Bait spp. group	1	1.41	1.41	0.23
Bait spp. x weight regime	1	0.18	0.18	0.67
Residual		1.00		

Table 7. *Results of an analysis of variance testing for the effects of line weighting regime and bait species group on the catch rates of six species of sharks.*

3.3.6 Maintenance issues

Leads at the hook are more likely to be damaged or bitten off by sharks and other species. Unfortunately, no data are yet available on this topic. A comparison of lost and damaged leads between the two gear types will be included in the final report.

3.3.7 Sample size analysis

The number of sets required to complete the study were estimated using catch data for yellow-fin tuna which, along with big-eye tuna, is the most valuable of the commercial species caught in the fishery. The relevant values are shown in Table 8. The decision about the sample size depends on the detectable difference chosen, which reflects the economic risk (and market value of the product) involved in choosing detectible differences that are too coarse. Similar estimates for the less common commercial species will likely require larger samples sizes than those shown for yellow-fin tuna.

Power	Difference (%)	Total hooks	# sets required	# YFT caught
0.90	10	212,400	152	2018.0
0.90	15	96,000	68	888.0
0.90	20	55,200	40	496.0

Table 8. Sample size estimates based on catch data for yellow-fin tuna over the 36,820 hooks set in the trial to date. The three options presented are based on the 90 % chance an estimate will be correct. The table indicates that to detect a 10 % difference between the two weighting regimes in the catch rates of tuna > 212,000 hooks in 152 sets of the longline must be set and >2,000 tuna will be caught. If a 20 % difference is considered satisfactory the number of hooks required, number of sets required and number of tuna caught reduces to > 55,000, 40 and about 500, respectively. The estimates for the numbers of hooks, total number of sets required and number of YFT caught are for both line weighting regimes combined.

4. Discussion

4.1 Sink rates

The 40 g hook lead sank with a linear profile from the surface whereas the two regimes with leaders sank in two stages - slower initially and then faster. This is the same pattern recorded in a previous study at sea where the initial sink rates of branch lines with 2-4 m leaders were between one-third and one-half the final rates (Robertson, *et. al*., 2010). The benefit of weight at the hook is exemplified by comparison of the 40 g hook lead with 60 g at 3.5 m. The 40 g hook lead reached 3 m deep in half the time taken by the latter regime. Interestingly, the 40 g lumo hook lead took about the same time on average to reach 3 m deep as the 120 g at 2 m even though the 40 g lead is one-third the weight of the latter. The next step is to repeat the study at sea where the gear will be affected by vessel movement and propeller turbulence. This work is scheduled for completion later this year.

4.2. 120 g at 2 m versus 60 g at 3.5 m

There were a disproportionate number of sleeves and plain-ended branch lines (but not those with skirts) between the two weighting regimes when the trial started. In the first set there were 16 % more branch lines with sleeves and 16 % fewer plain-ended branch lines in 60 g gear than in 40 g gear. By the third set in the trial the proportions of skirts, sleeves and plain-ended branch lines were in equal proportions. Thereafter every effort was made to maintain the proportions as gear was repaired at the end of sets. We consider the effect of the lack of balance in the distribution of skirts and sleeves in the initial phases of the trail to be minor overall and unlikely to affect the comparison of fish catch rates between the two line weighting regimes.

There was a strong effect of bait species which applied equally to both weighting regimes. However, it is inappropriate to draw conclusions from this result because it was confined to a single trip with pilchard baits only and a large number of yellow-fin tuna were caught. Further data are required to properly assess the effect of bait species on catch rates of yellow-fin tuna. The catch rates of both yellow-fin tuna and all other commercial species combined by both weighting regimes were virtually identical. This was the case for all bait groups - squid bait, pilchard bait and a mix of both. To our knowledge this is the first evidence to show that branch lines configured to sink quickly in both the initial and final stages of profiles have no detrimental effect on the catch rates of the commercial fish species targeted.

4.3. 40 g hook lead versus 60 g at 3.5 m

The mean catch rates of yellow-fin tuna on branch lines with each line weighting regime were virtually the same, as were those for dolphin fish and a mix of other commercial species. At this preliminary stage in the trial the evidence suggest that the location of a lead sinker at the hook has no negative effect on the catch rates of the main target species and some of the more common by-caught species.

Given this result, it was surprising that catch rates of swordfish differed considerably between weighting regimes. On average twice as many swords were caught on standard 60 g at 3.5 m gear than on gear with hook leads. Although the sample size is relatively small (90 sword fish captured in 29 sets) it is large enough and the differences between the means substantial enough to suggest catch rates may not reach parity with the acquisition of further data. Still, this is a preliminary assessment conducted at the mid-point in the trial. It will be prudent to delay drawing conclusions regards catch rates of swordfish until the trial has been completed and a much larger data set has been analysed.

4.4. Operational benefits of hook leads

The operational benefits of the 40 g hooks leads are:

1) Branch lines with hook leads require less labour and crew time to build when new and to repair when damaged. This is because branch lines comprise a continuous length of monofilament, rather than the two sections of gear with leaders. Branch lines with hook leads require half the number of crimps than to gear with leaders.

2) Unlike leaded swivels, hook leads do not have a swivel incorporated into them. Swivels minimise the incidence of twist-ups and tangles in branch lines. Twist-ups and tangles can be avoided with hook lead gear by using clips (or snaps) with swivels incorporated into them (clips are attached to the other end of the branch line than the hooks/leads and are attached to the mainline).

3) Hook leads do not incorporate swivels and are considerably cheaper to produce, resulting in cost savings to the consumer.

4) Hook leads may reduce the incidence of dangerous fly-backs when branch lines are being hauled. When the line breaks under tension the hook and lead are often under the water surface. The water provides a degree of resistance against the tendency for the end of the branch line (where the leads are located) to recoil towards the vessel. When a 60 g at 3.5 m branch line breaks the leaded swivel is usually suspended in the air on the stretched branch line. If the line breaks the swivel is propeller unimpeded towards the vessel.

5) Branch lines with hook leads are easier to deploy. Since the hook and lead are together they can be picked up with one hand, baited and thrown as one. The deployment procedure of gear with 3.5 m leaders involves removing the leaded swivel and leader from the snood bin so that they trail in the water behind the vessel, then baiting and throwing the hook.

6) The hook leads reduce the incidence of line tangles in the bins. The leads on gear with leaders are scattered throughout the monofilament branch lines (see Figure 1) and occasionally tangle during deployment. In contrast, the hook leads are not mixed in with the branch lines - they hang directly beneath the hooks on the horizontal runners (see Figure 2). Bin tangles associated with line weights are unlikely to occur with weights at the hook.

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