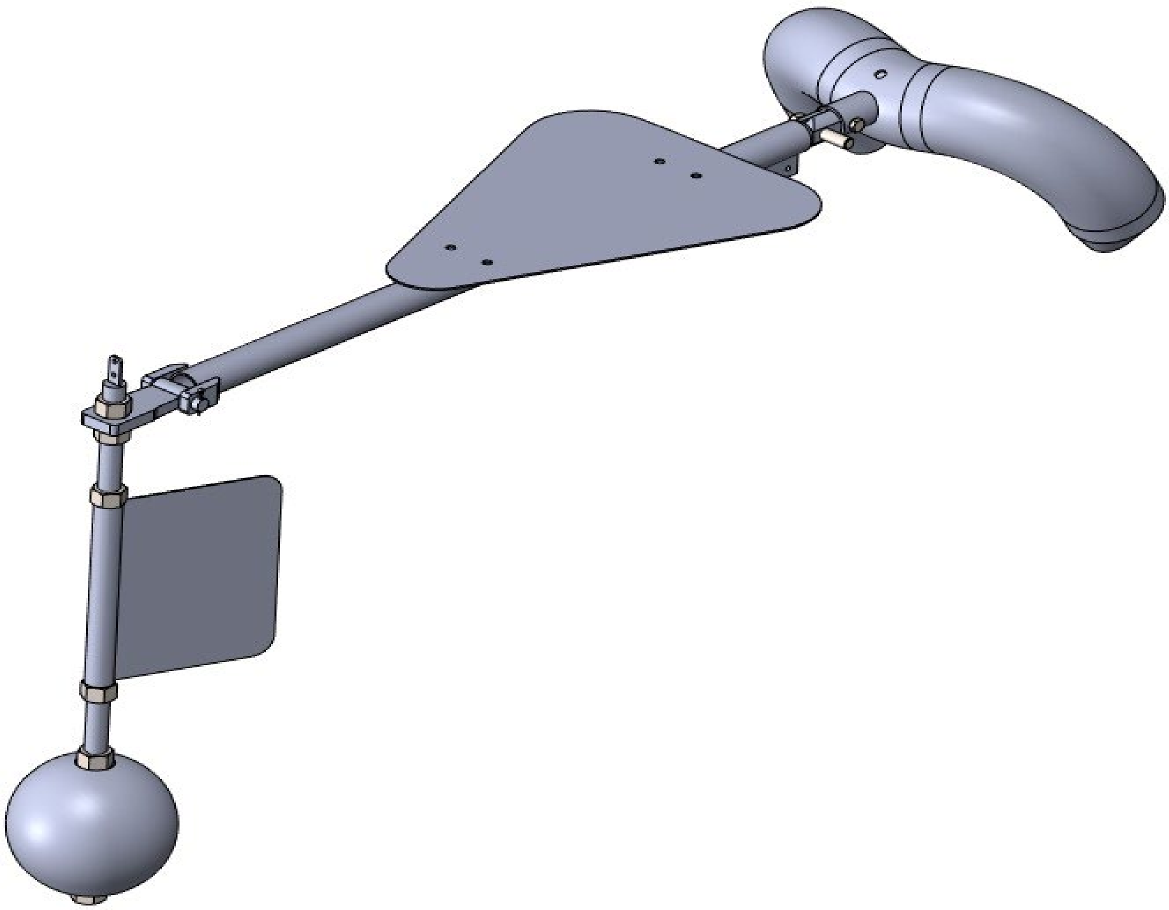
Underwater line setter development

Draft report.



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Introduction

The Agreement for the Conservation of Albatrosses and Petrels (ACAP) best practice guidance for bottom longline fishing includes use of the following three measures at all times: night setting, line weighting, and tori lines (ACAP, 2019). Setting lines for the 'bite time' over the change of light means some sets targeting snapper in the summer months do not meet the ACAP definition of best practice (Pierre et al., 2018). Additionally, the ACAP advice recognises that night setting may not be effective in bright moonlight, or for crepuscular/nocturnal foragers, and notes that mitigation measures need to be acceptable to fishers and not affect fish catch rates. Similarly, tori lines are often not fully effective to the prescribed aerial extent (pers. obs. DG).

The introduction of mitigation standards for demersal longliners (MPI, 2019) and subsequent changes to regulation (MPI, 2021) require a hook depth of five metres at the end of the tori line aerial extent, and likely require substantial changes to gear configuration and setting speed for some of the fleet (Goad & Olsen, 2022).

Underwater setting has the potential to increase sink rates and reduce risk to birds. It is particularly relevant to meeting the latest regulations, whilst maintaining flexibility of gear configuration for fishers. It also has the potential to meet the 10 m depth at the end of tori line mitigation standard.

Efforts to reduce the availability of pelagic longline hooks to birds have focused on increasing the sink rate of the hook, either mechanically (Gilman et al., 2003; Ryan & Watkins 2002; Robertson & Ashworth 2010), or by adding weight (e.g., Robertson 2013), or protecting the barb of the hook (Oceansmart, 2011; Hookpod, 2020). These 'hook by hook' approaches are feasible for pelagic longlines where branchlines are longer than 10 m, baited as they are set, set relatively slowly (e.g., Robertson 2013; Goad et al., 2019), and the hook sinks, certainly initially, independently from the mainline (Robertson et al., 2010).

Conversely, the manual baiting demersal longline fleet in New Zealand clip on pre-baited hooks with short branchlines (or snoods, typically 0.6 m length) to a stoppered mainline relatively quickly (Goad et al., 2010). Therefore, in order to set demersal longlines underwater, both the hook and the mainline have to be deployed at depth. This presents a different set of challenges, and a downward force must be applied to the mainline in order to achieve sufficient depth. The underwater setter described in this report uses a guide towed behind the vessel at depth to force the mainline underwater.

Underwater setter description

A lead ball is towed behind the vessel at depth. Attached to the ball is an upside down 'U' shaped guide which is placed over the longline, forcing the longline down to the depth of the ball. In order to separate the tow cable from the longline, and to keep the device tracking in a straight line, the guide is attached behind the lead ball on an arm. A paravane holds the arm horizontal behind the tow point and the lead ball is attached below the tow point to provide roll stability. A rudder also controls roll, as well as pushing the setter sideways. The setter is towed on a cable from one side of the vessel, and the longline enters from the other side with hooks passing beside the guide. (Figure 1). Dimensions of the towed unit are 400 mm wide by 1200 mm long by 610 mm deep.

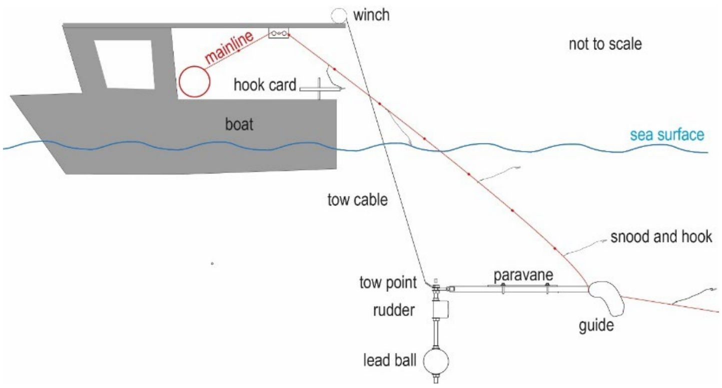

Figure 1. Schematic diagram showing the underwater setter.

Previous work is described in Goad, 2011; Baker et al., 2013; 2016; Goad et al., 2020; and Goad and Kiddie 2022. Recent developments showed promise, setting gear at depth and catching fish, however bait retention was variable. Despite rarely contacting the guide the action of rapidly pulling baits downwards through the water was enough to damage and remove softer pilchard baits at unacceptable rates. Increasing line tension resulted in baits being pulled downwards more gradually and snoods passing through the setter more smoothly with lower bait loss rates. However, catch rates were also reduced at high line tension.

This report describes four days' trialling aimed at testing retention rates of tougher bait types.

Project Objectives

Examining the effect of different bait types on bait retention and catch rates

Refining setter adjustments to minimise bait loss / damage.

Methods

At sea testing was conducted during commercial fishing operations, deploying a portion of the line as a control, followed by a portion of the line through the underwater setter.

Line setup was consistent with droppers comprising of a 2.2 or 3.2 kg lead weight, a 3.0 m rope and a 100 mm float every 60 m when setting control gear. Dropper spacing was either 60 or 120 m when setting gear through the setter, with a string of 2 or 3 gillnet floats used between wider spaced droppers. Data were collected using a combination of methods.

Line tension was measured using ta purpose-built tension meter and automatically logged to a PC, throughout the set. Setter depth was measured using CEFAS G5 time depth recorders (TDRs) placed on the setter. Depth was also calculated using tow cable length and angle.

GoPro cameras were mounted on the setter to examine the passage of gear through the device. Three cameras were used; two to assess bait loss at the setter and one to assess the angle of the longline entering the setter. Cameras also recorded the roll and pitch of the setter using inclinometers attached within the field of view. Review of video footage was conducted at reduced speed and often rewound or re-viewed to check counts. Bait loss was classified by location and into three categories: bait OK with no visible damage, bait damaged (mostly comprising of lost muscle tissue), and bait lost.

Fish catch and bait returns were recorded manually during the haul, typically per 60 hook section.

Iterative adjustments and modifications were made to the setter between trips, aiming to smooth the passage of gear through the setter and reduce bait loss and damage. Individual trips are described in more detail in trip-by-trip progress reports (Appendix 1).

Additionally, a set of technical illustrations of the setter were completed.

Results

Four trips were undertaken with the setter deployed for a portion of a set each trip. In total 3300 hooks were deployed through the setter. Squid bait was very robust and least susceptible to damage. Barracouta baits varied in quality with 'flaky' fillets susceptible to loosing bits of muscle tissue furthest from the hook. Pilchard baits were trialled on the first trip and due to high loss rates were not used on subsequent trips. Bait loss and damage often occurred before snoods reached the setter due to baits being pulled rapidly downwards. Line tension and setter configuration reduced this somewhat but forcing baits to depth quickly will always exert more pressure on the bait than if it was sinking slowly.

Between all trips modifications were made to improve and measure setter performance. Some lateral separation between the setter and the shooting position on the vessel improved performance. This was initially achieved using a rudder on the setter which increased drag and induced roll. Moving the tow point outboard proved a better solution and made recovery and deployment easier. The addition of a longitudinal fin on the setter improved performance by keeping the guide directly behind the tow point.

During the final trip gear was deployed at 8.5m, on 15 m of cable, with a line tension of 8 kg. Barracouta bait loss was in the order of 2% and damage 8.5% (Table 1, Appendix 1).

Control cards	Setter cards	Tow cable (m)	Setter Depth (m)	Line tension	Bait type	Catch rates on setter	Modifications
16	10	15, 20	8, 11	8 kg	B, S, P	Similar	Guide angle
5	23	15, 20	6-7, 8-9	7 kg	B	Better, patchy	Rudder closer to tow point
5	14	20, 25	8-8.5, 11-11.5	7 kg	B	Similar, patchy	Less rudder, outboard tow point
21	8	15	8.5	10 kg	B	Less, patchy	Fin for longitudinal stability

Table 1. Summary of results, by trip. Each card comprised 60 hooks. Bait type codes B = Barracouta, P = Pilchard, S = squid

Discussion

Bait use in the snapper fleet is driven by price and availability as well as skipper preference. The use of barracouta has increased and it has become the most popular choice in recent years. This is in part due to reduced availability and higher prices of imported sanma and pilchard. It is likely that the underwater setter will result in unacceptably high loss rates of fresh pilchard baits. However, use of sanma or salted pilchard may provide an option for fishers keen on using oily fish baits on a proportion of hooks.

At present the setter can deploy tougher baits at depth with reasonable retention rates at speeds up to approximately five knots with line tension set slightly higher than a free-wheeling drum. Weight spacing does not appear to affect setter performance however weights and weight-float combinations need to be heavy enough to sink in front of the setter rather than falling behind it. Influence on catch rates is likely to be small enough to require multiple sets to tease out any differences.

Refinement of the setter is ongoing and it is likely that subsequent trips will be separated by further modification and development of the design. Adjusting depth and distance behind the vessel may reduce bait loss and damage. Similarly, salted bait will have better retention rates and should be further investigated, especially if fishers are keen use more fragile bait types.

Recommendations

1. Continue trials of the underwater setter, during commercial fishing operations, to collect catch rate comparison data.
2. Continue to develop the design to minimise bait damage and loss for more fragile bait types.

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Appendix 1. Individual trip reports

Trip 1

Aim

Trialling tougher bait types through the setter

Methods

Hooks were baited with a mixture of squid, barracouta and pilchard pieces. 26 cards each comprising 60 hooks were deployed, with a 2.5 – 3.5 kg weight and 100 mm float deployed in a dropper configuration every 30 hooks. 16 cards were set normally as a control with a line tension of around 4 kg, and then the final 10 cards of hooks were deployed through the setter. The longline was set in 25 m of water, in a 'U' shape with the control and setter gear in close proximity. Four GoPro cameras were deployed, three on the setter and one onboard the vessel. Gear was hauled in the same order as it was set. Bait retention and other setter performance metrics were recorded between droppers (per 30 hooks), and fish catch and bait returns were recorded card by card (per 60 hooks).

Results

Initially, the setter was deployed with a guide rake back angle of 128 degrees and a rudder angle of 45 degrees, with the rudder immediately below the tow point. A dropper forced the line out of the setter, and it was redeployed. The line came out of the setter again, this time due to a hook on the mainline.

Due to losing the line, adjustments were made to improve line retention: The guide rake angle was reduced to 112 degrees and the rudder was moved downwards, away from the tow point. This resulted in a greater roll angle but increased bait loss as the mainline sat further up the 'U' of the guide, and hooks were pulled around the guide rather than snoods dropping off the bottom. Line tension was also increased. Cable length was increased during the last 60 hooks.

Squid baits were very robust. Barracouta bait was not good quality with flaky and 'gaping' fillets, so was easily damaged with similar performance to pilchard baits. However, barracouta was rarely lost entirely, and often the skin and a small piece of flesh were left on the hook after wrapping around the guide (Table 1).

The setter ran at between 8 and 11 metres depth, and tension was set higher than the gear set normally, in the region of 8 kg (Figure 1). Video footage indicated that the setter was towed slightly sideways with the guide to starboard of the tow point.

Catch rates were similar or better through the setter, but bait returns were lower than with the control gear, supporting the loss rates recorded on the video (Table 2).

Next steps

Next trip the setter will be run with a less aggressive rudder angle allowing the guide to stay in line with the tow point and to reduce the roll angle. This should, in turn, reduce the frequency of baits wrapping around the guide. The tow point will be moved outboard, to port, to increase lateral separation between the setting point and the setter.

Table 1. Setter configuration and performance metrics, per 30 hooks, derived from camera footage, for trip 1. Roll angle is starboard side down, and pitch angle is forward end down. The angle of the line entering the setter is measured relative to the tube separating the guide from the tow point.

					bait fate									
speed over ground (knots)	cable length (m)	line tension (kg)	guide rake angle (degrees)	bait species	ok	lost above camera view	lost immediately above setter	lost round guide	damaged above setter	damaged round guide	roll angle (degrees)	line entry angle (degrees)	pitch angle (degrees)	comments
4.5	23	6.3	128	mix	24	1	3		2	1	3-5	65	4-5	lost line at dropper
4.5	23	6.8	128	mix	15	4	3	2	2	4	3-4	60	2-3	lost line due to hook round mainline
4.5	23	9.3	112	bar	12	3		2	3	10	8-10	50	4-8	baits now wrapping round guide
4.5	23	9.3	112	squ	29						9-11	45-50	4-6	tough baits
4.5	23	9.6	112	squ	30						8-12	50-52	5-7	tough baits
4.5	23	8.8	112	mix	14		3	1	3	9	9-11	55-60	5-7	
4.5	23	9.0	112	mix	18		1	1	3	7	9-11	55-60	5-7	
4.8	23	9.1	112	mix	15		1	2	5	7	10-12	55	4-6	brief catchup on dropper
4.8	23	9.0	112	mix	12			5	3	10	11-13	50/55	4-6	
4.8	23	9.0	112	mix	16		1	4	1	8	11-15	50-55	4-6	
4.8	23	9.0	112	mix	14		4	1	1	10	12-15	50-55	4-6	
4.8	23	9.0	112	mix	15		2	1	2	10	12-15	50-55	4-6	
4.8	23	8.7	112	mix	16		2	1		11	11-17	45-55	4-10	gap with no snoods
4.8	23	8.1	112	mix	16	1	4	1	4	4	11-14	55-60	4-6	
4.8	23	8.1	112	mix	10	3	5	3	3	6	11-14	57-62	4-6	gap in this section
4.8	30	7.4	112	mix	12	2	1	1	4	10	8-14	65-70	6-9	increased cable length
4.8	30	7.6	112	mix	11	1	2	5	1	5	3-14	67-72	6-10	end of line

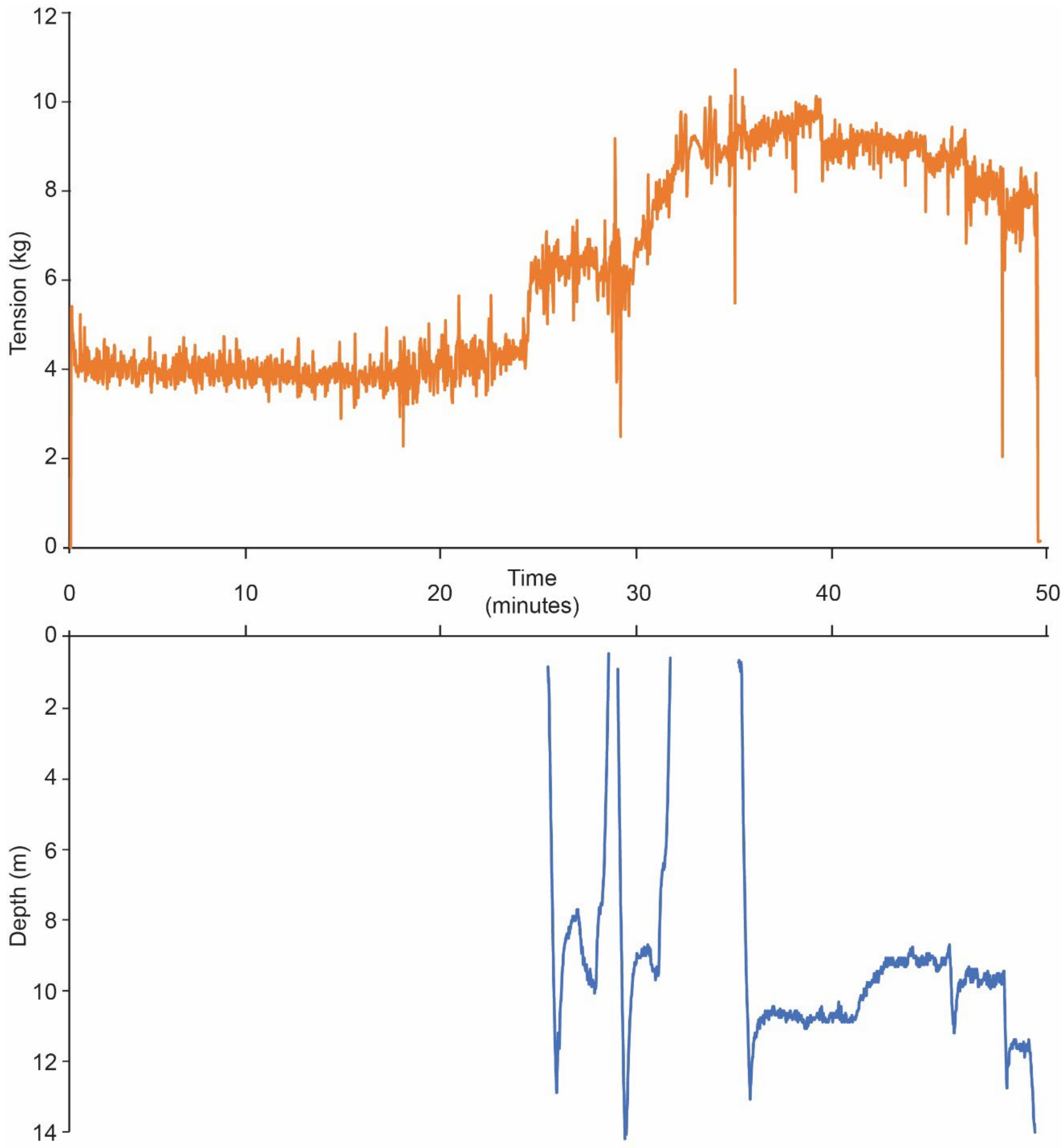

Figure 1. Line tension and setter depth over time during trip 1.

Table 2. Catch and bait returns, per card (trip 1).

Card number	Through setter?	SNA	KAH	GUR	KIN	TRE	EGR	baits
1	no	7	0	1	0	0	0	17
2	no	7	4	0	0	0	0	18
3	no	7	3	0	0	0	0	20
4	no	4	2	0	0	0	0	23
5	no	4	0	0	0	0	0	34
6	no	10	0	0	0	0	0	16
7	no	10	0	0	0	1	0	20
8	no	12	0	0	0	0	0	27
9, 10, 11	no	21	2	1	4	0	0	38
12	no	2	0	0	0	0	0	38
13	no	6	0	0	0	0	0	14
14	no	3	0	0	1	0	1	9
15, 16	no	11	1	0	0	0	0	26
Average normal gear		**6.5**	**0.8**	**0.1**	**0.3**	**0.1**	**0.1**	**18.8**
1	half	14	0	0	0	0	0	4
2	half	8	2	0	0	0	0	12
Average, 1st setting		**11.0**	**1.0**	**0.0**	**0.0**	**0.0**	**0.0**	**8.0**
3	half	6	0	0	0	0	0	2
4	yes	15	0	0	0	0	0	12
5	yes	13	0	0	0	1	0	5
6	yes	12	0	0	0	0	0	19
7	yes	11	0	0	0	1	0	5
8, 9	yes	15	0	1	0	0	0	4
1	yes	10	0	0	0	0	0	4
Average, 2nd setting		**10.3**	**0**	**0.1**	**0.0**	**0.3**	**0.0**	**6.4**

Trip 2

Aim

Comparing catch rates and bait loss for gear baited with barracouta deployed normally and through the setter

Methods

Hooks were baited with barracouta pieces. 28 cards each comprising 60 hooks were deployed, with a 2.5 – 3.5 kg weight and 100 mm float deployed in a dropper configuration every 30 hooks. Five cards were set normally as a control and then the final 24 cards of hooks were deployed through the setter. Two cards deployed through the setter had a weight every 60 hooks, one of which had two small egg floats between weights. The longline was set in area where the skipper had recently fished successfully. The set was initially parallel to Papamoa beach along a contour and then followed the side of a ridge extending seawards towards Motiti Island. Four GoPro cameras were deployed, three on the setter and one onboard the vessel. Gear was hauled in the reverse order to which it was set. Bait retention and other setter performance metrics were recorded between droppers (per 30 hooks), and fish catch and bait returns were recorded card by card (per 60 hooks).

Results

The setter was deployed with a guide rake back angle of 112 degrees and a rudder angle of 25 degrees, with the rudder immediately below the tow point. Tow cable length was initially 15 m and increased to 20 m for the last seven cards, resulting in a depth increase from 6 - 7 m to 8 – 9 m (Figure 2). Line tension was initially set at 4 kg and increased to 7 kg when deploying gear through the setter. Tension was more variable through the setter, likely due to floats momentarily catching on the guide. The increase in tension over time can be attributed to the reducing diameter of the line drum.

Video footage indicated that the setter was running straighter than the previous trip, but the smaller rudder angle was still causing the setter to tow with a roll to starboard. This roll likely contributed to baits wrapping around the guide and bait damage on the guide. Barracouta baits were rarely lost completely, though a reasonably high proportion were damaged (Table 3). Despite damage to bait catches were good and similar to gear set normally (Table 4). However, the gear set normally did have a longer soak so arguably bait returns could be expected to be lower. Variation in catch along the line precluded firm conclusions of the effect of the setter on catch rates, other than having a successful day's fishing with most of the gear set underwater.

Next steps

Next trip the setter will be run with even less rudder to further reduce the roll angle. This should, in turn, reduce the frequency of baits wrapping around the guide and reduce damage. The tow point will be moved outboard, to port, to increase lateral separation between the setting point and the setter.

Table 3. Setter configuration and performance metrics, per 30 hooks, derived from camera footage, for trip 2. Note the last section was only 53 hooks

speed over ground (knots)	cable length (m)	bait fate: ok	bait fate: lost above camera view	bait fate: lost immediately above setter	bait fate: lost round guide	bait fate: damaged above setter	bait fate: damaged round guide	lost clip	hook backbone (counted elsewhere too)	roll angle (degrees stbd side down)	line entry angle (degrees from horiz.)	pitch angle (degrees fwd down)	comments
4.6	15	18		1		10	2			12 - 15	57 - 82	-1.0 - 4.0	
4.6	15	23				6			1	10 - 15	57 - 59	2.5 - 3.5	
4.6	15	20				6	4			5 – 15	59 - 63	3.0 - 5.0	
4.6	15	16				10	4			10 - 15		3.5 - 5.0	
4.6	15	22	1	1		1	5			11 - 15	52 - 62	3.5 - 6.0	
4.6	15	16	2			5	4	3	2	11 - 15	57 - 65	5.0 - 6.0+	
4.6	15	16	1			5	8		1	12 - 16	57 - 61	4.0 - 5.0	
4.6	15	20				4	5	1		13 - 17	47 - 59	4.0 - 5.0	
4.6	15	15				1	15		1	12 - 17	55 - 62	3.0 - 4.0	
4.6	15	19		1		1	10			12 - 17	52 - 57	2.5 - 4.0	int float after
4.9	15	16				3	11			13 - 18	52 - 59	1.5 - 3.0	
4.9	15	19				2	9			13 - 18	59 - 63	2.0 - 4.5	
4.9	15	19				1	10			13 - 18	50 - 57	3.0 - 5.0	
4.9	15	16			1	4	9			13 - 18	45 - 55	3.0 - 5.0	catchy float after
4.9	15	9	2	1	2	0	15			13 - 18	48 - 52	2.5 - 3.5	
4.9	15	13	1			3	13			13 - 17	52 - 58	2.5 - 3.5	turn then catchy float after
4.9	15	20				1	9			13 - 17	55 - 59	2.5 - 4.5	
4.9	15	14				4	12			13 - 17	51 - 58	2.5 - 4.0	
4.9	15	16		1		1	12			13 - 18	52 - 54	2.5 - 4.0	catchy float after
4.9	15	16					14			13 - 18	52 - 55	2.5 - 4.0	
4.9	15	13			1	3	15			13 - 17	50 - 56	2.5 - 4.5	int float after
4.9	15	14		1	3	2	10			13 - 17	50 - 56	2.5 - 3.5	
4.9	15	15				1	15		1	13 - 17	55 - 60	2.5 - 3.5	
4.9	15	14				1	15			13 - 19	51 - 55	2.5 - 3.5	
4.9	15	17		1		3	9			15 - 19	54 - 59	2.5 - 3.5	
4.9	15	17		1		1	11			15 - 19	52 - 57	2.5 - 3.5	unstable roll wise
4.9	15	15		1		3	13			10 - 20	52 - 55	2.5 - 4.0	
4.9	15	16					15			13 - 17	52 - 57	2.5 - 4.0	
4.9	15	20			1	3	6			13 - 18	52 - 58	2.5 - 4.0	int after
4.9	15	17				4	8			10 - 15	55 - 65	2.5 - 4.0	
4.9	15	16		1		3	10			13 - 17	52 - 58	2.5 - 4.0	
4.9	15	14				5	11			13 - 16	52 - 55	3.0 - 5.0	
4.9	20	13		1		1	15			13 - 17	55 - 60	4.0 - 6.0	
4.9	20	10		2	1	3	14			11 - 16	58 - 65	4.0 - 6.0+	
4.9	20	17				4	9			12 - 16	65 - 70	4.0 - 6.0	
4.9	20	17	1		2	4	6			12 - 17	58 - 68	4.0 - 6.0	catchy float after
4.9	20	19	1			1	9			12 - 17	56 - 60	4.0 - 6.0	eggs after
4.9	20	18	1			1	10			12 - 17	52 - 66	4.0 - 6.0	
4.9	20	24				2	4			12 - 16	61 - 73	4.0+	turn and int after
4.9	20	20				4	5			13 - 18	58 -	4.0 - 6.0	
4.9	20	11	2		1	2	14		3	13 - 17	52 - 56	3.0 - 6.0	
4.9	20	25	1		1	6	9		2	13 - 18	50 - 58	3.5 - 5.5	
4.9	20	17			1	4	8		1	13 - 17	52 - 58	3.5 - 5.5	
4.9	20	37		1		8	14		1	13 - 17	48 - 56	2.5 - 6.0	1 weight a card
4.9	20	14				3	6			2 - 15	45 - 56	4.0 - 6.0	end set

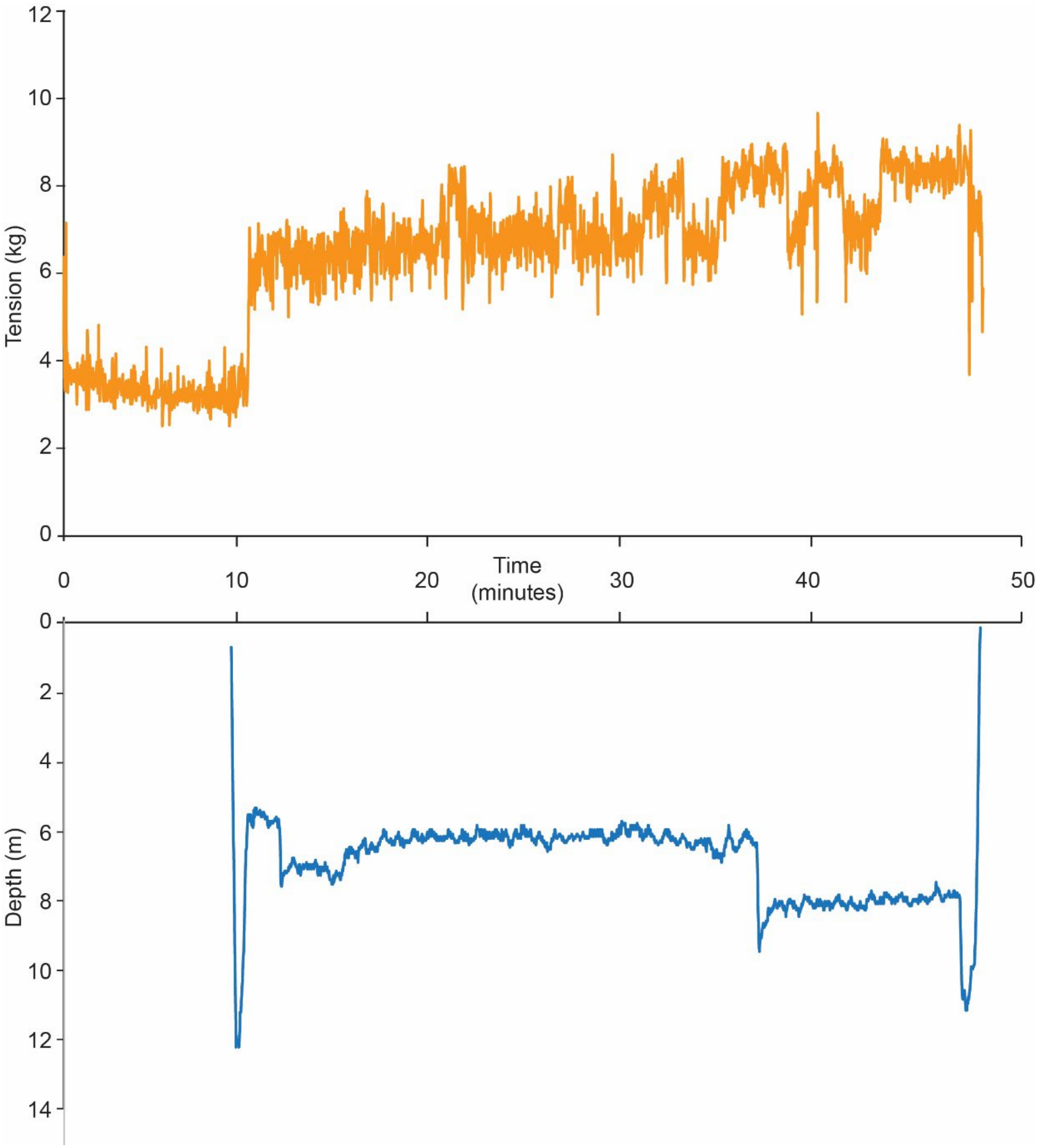

Figure 2. Line tension and setter depth over time during trip 2.

Table 4. Catch and bait returns, per 60 hook card (trip 2). Note the last card was only 53 hooks.

Card	Through setter?	Catch SNA	KAH	GUR	KIN	TRE	BCO	EMA	POP	OSE	SFI	Bait whole	pieces
1	no	4										19	32
2	no	14										8	22
3	no	13		1		1			1			4	10
4	no	8									3	10	18
5	no	12		1							3	1	10
6	yes	6									1	10	28
7	yes	9						1				11	28
8	yes	7		1							3	0	15
9	yes	10	1									12	33
10	yes	12	1								2	13	23
11	yes	6										20	35
12	yes	12			1							12	28
13	yes	12									4	13	12
14	yes	23									4	3	27
15	yes	23										6	17
16	yes	15									2	5	22
17	yes	25										12	15
18	yes	10						1				17	29
19	yes	19						1				4	35
20	yes	12		1				2			2	5	16
21	yes	12									1	5	30
22	yes	14						1				0	15
23	yes	14									1	4	20
24	yes	16	1	1				2				12	29
25	yes	12										12	26
26	yes	19								1	1	14	16
27	yes	7									6	15	20
28	yes	2									3	11	10

Trip 3

Aim

Comparing catch rates and bait loss for gear baited with barracouta deployed normally and through the setter, with a smaller rudder angle and an outboard tow point

Methods

Hooks were baited with barracouta pieces. 19 cards each comprising 60 hooks were deployed, with a 2.5 – 3.5 kg weight and 100 mm float deployed in a dropper configuration every 30 hooks, initially and then every 60 hooks for the final three cards. Five cards were set normally as a control and then the final 14 cards of hooks were deployed through the setter. The longline was set in area where the skipper had recently fished successfully. Though in slightly clearer, deeper water. The set was initially parallel to Matakana Island, South of Karewa Island. Four GoPro cameras were deployed, three on the setter and one onboard the vessel. Gear was hauled in the reverse order to which it was set. Bait retention and other setter performance metrics were recorded between droppers (per 30 hooks), and fish catch and bait returns were recorded card by card (per 60 hooks).

Results

The setter was deployed with a guide rake back angle of 112 degrees and a rudder angle of 2 degrees, with the rudder immediately below the tow point. Tow cable length was initially 20 m and increased to 25 m for the last two cards, resulting in a depth increase from 8-8.5 m to 11-11.5 m (Figure 3). Line tension was initially set at 6 kg and increased to 10 kg when deploying gear through the setter. Line tension was adjusted to compensate for the reduction in drum diameter.

Video footage indicated that the setter was running with a less roll angle than the previous trip (approximately 6 versus 12 degrees) and this can be attributed to the smaller rudder angle.

However, the setter was running with a yaw angle (and therefore effective rudder angle) of 15 to 20 degrees. Higher tension was needed to run the setter with more cable than the previous trip (circa 10 kg tension at 8.5 m depth versus 7 kg tension at 6.5 m depth).

Two line breaks occurred, one with a float caught on the setter and one when two snoods came into the setter and tangled round the leg.

Bait damage was in the region of a third, but this was usually flakes of flesh detaching from the skin. Most hooks still had a reasonable-sized bait attached. Where baits were lost entirely this was usually above the setter and often above the camera view. Snapper catch rates were similar between gear set normally and gear deployed through the setter (Table 6), although catches were patchy.

Shifting the tow point just outside of the gunwale made deployment and recovery easier.

Loss of JVI clips was greater than previous trips, possibly due to higher tension.

Next steps

Try to get the setter running straighter (with less yaw) by either removing the side camera and / or adding a fin.

Stick to 15 m of cable initially, and run at lower line tension.

Rake the legs back further again to reduce catchups.

Table 5. Setter configuration and performance metrics, per typically 30 section, derived from camera footage, for trip 3..

speed over ground (knots)	cable length (m)	bait fate: ok	bait fate: lost above camera view	bait fate: lost immediately above setter	bait fate: lost round guide	bait fate: damaged above setter	bait fate: damaged round guide	lost clip	hook round backbone (counted elsewhere too)	roll angle (degrees stbd side down)	line entry angle (degrees from hoiz.)	pitch angle (degrees fwd down)	comments
4.6	20	26	2	1		1	3	1		-4 - 5	45-50	6	line initially 80 degrees
4.6	20	17				1	8			5-9	48 - 53	6	
4.6	20	22					8			11	48 - 52	7	
4.6	20	18		4		1	7			8	45 - 65	7	
4.6	20	20				1	8			7	52 - 56	7	
4.6	20	17	1			5	7			9	48 - 55	6	
4.6	20	20		2		4	5			11	48 - 53	6	
4.6	20	24					6				46 - 52	6	line break after
4.6	20	24					1		1	0	60 - 75	5	still being lowered
4.6	20	29				1				5	56 - 63	5	clips waiting for stopper
4.6	20	25			1	2				5	58 - 68	6	
4.6	20	26		1			3			6	53 - 60	7	
4.6	20	17		5		1	7			7	50 - 56	7	
4.6	20	19	3	2		2	8			7	50 - 58	7	
4.6	20	14	1			1	4	7		6	50 - 58	7	jvi clips
4.6	20	16				4		10	7	6	50 - 59	6	jvi clips
4.6	20	20				1		5	4	5	50 - 60	6	jvi clips
4.6	20	14				4	6	9		6	50 - 58	6	jvi clips
4.6	20	22				1	7			5	53 - 58	7	
4.6	20	24		1		2	3				52 - 58	7	
4.6	20	22		1		4	4			6	53 - 58	6	
4.6	20	24					6			5	53 - 58	6	
4.6	20	27		1		1	1			6	48 - 55	7	
4.6	20	29				1				5	54 - 59	6	
4.6	20	18	2			8	3			5	58 - 65	7	
4.6	20	26	1			2	1			4	59 - 67	6	
4.6	20	25				1	4			4	64 - 70	7	
4.6	25	23	2			2	4			4	60 - 68	7	
4.6	25	17				1	4			0-3			Two hooks round leg, line break.

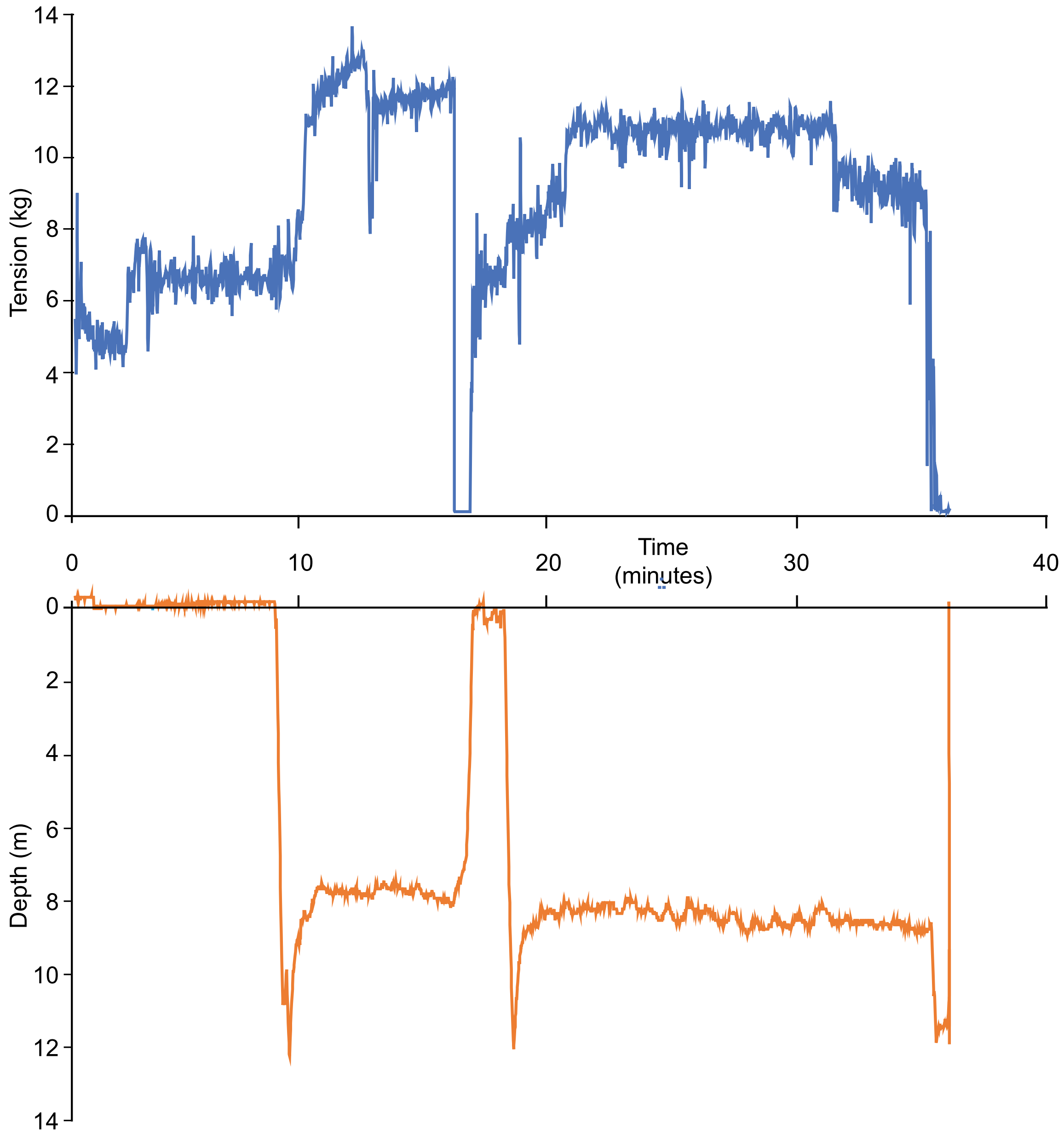

Figure 3. Line tension and setter depth over time during trip 3.

Table 6. Catch and bait returns, per 60 hook card (trip 2). Note the last card was only 53 hooks.

Card (60 hooks)	Through setter?	Catch				Bait returned
		SNA	KAH	GUR	SFI	large pieces
1	no	9	1			0
2	no	14	9			2
3	no	9	7			8
4	no	4	2			24
5	no	0				10
6	yes	2			1	10
7	yes	5	1			8
8	yes	18				1
9	yes	1				1
10	yes	6				0
11	yes	15				5
12	yes	8		2	1	2
13	yes	5				0
14	yes	8				1
15	yes	9				1
16	yes	4		2	1	26
17	yes	7				2
18+19	yes	28				3

Trip 4

Aim

Comparing catch rates and bait loss for gear baited with barracouta deployed normally and through the setter, with a fin added and using 15 m of cable

Modifications

A fin was added to the setter, on top of the paravane to ensure that the guide towed directly behind the tow point.

Methods

The setter was deployed with a guide rake back angle of 112 degrees and a rudder angle of 2 degrees, with the rudder immediately below the tow point. Tow cable length was 15 m. Hooks were baited with barracouta pieces. 29 cards each comprising 60 hooks were deployed, with a 2.5 – 3.5 kg weight and 100 mm float deployed in a dropper configuration every 30 hooks, initially and then every 60 hooks with egg floats between for the final two cards. Twenty-one cards were set normally as a control and then the final 8 cards of hooks were deployed through the setter once there was sufficient light. The longline was set off Papamoa beach in approximately 17 m of water. Three GoPro cameras were deployed on the setter. Gear was hauled in the reverse order to which it was set. Bait retention and other setter performance metrics were recorded from the video per half-card (per 60 hooks), and fish catch and bait returns were recorded on deck per card (per 60 hooks).

Results

A tow cable length was 15 m resulted in a consistent depth of 8.5 m. The tension meter did not pass data to the PC so tension readings were recorded manually on deck, rather than logged automatically. Line tension was initially set at 6 kg and increased to 8 kg when deploying gear through the setter. Line tension was adjusted to compensate for the reduction in drum diameter.

Video footage indicated that the setter was running with a roll angle of -5 degrees (line side high) as opposed to 6 degrees on the previous trip. This can be attributed to the fin forcing the setter to tow straight behind the tow point with no appreciable yaw. Consequently, the rudder did not fully combat roll induced by the line lifting one side of the guide.

Bait loss and damage was less than previous trips, but may have been underestimated due to low light levels. Damage was usually flakes of flesh dethatching from the skin. Where baits were lost entirely this was usually above the setter and often above the camera view. Snapper catch rates were slightly higher on gear set normally and bait returns were slightly higher on gear deployed through the setter (Table 8). Patchy catches preclude firm conclusions but it is possible that higher tension through the setter may have been reducing catches, as bait loss was negligible.

Next steps

Rake the legs back further again to reduce catchups.

Try a lighter lead ball to shift the setter further astern, aiming to smooth the passage of gear through the setter.

Table 7. Setter configuration and performance metrics, per typically 30 hook section, derived from camera footage, for trip 4.

		bait fate										
speed over ground (knots)	cable length (m)	ok	lost above camera view	lost immediately above setter	lost round guide	damaged above setter	damaged round guide	lost clip	hook round backbone (counted elsewhere too)	roll angle (degrees stbd side down)	line entry angle (degrees from hoiz.)	pitch angle (degrees fwd down)
4.6	15	27				1		2		-5	55-65	5
4.6	15	28					1	2		-5	58-62	5
4.6	15	24	2				4			-5	55-60	6
4.6	15	30								6	52-58	6
4.6	15	27	1				3			-6	54-58	5.5
4.6	15	23					5			-6	52-58	5.5
4.6	15	29					1			-5	53-58	5.5
4.6	15	29					1			-5	52-57	6
4.6	15	29					1			-5	55-58	6
4.6	15	27	1				2			-5	52-56	5.5
4.6	15	26			1		3		1	-5	55-60	5.5
4.6	15	25			1		4			-4	54-58	5.5
4.6	15	28					2			-6	55-59	5.5
4.6	15	25		1		3	1			-5	55-60	5.5
4.6	15	25					5			-5	52-57	6
4.6	15	25			1		4			-5	56-62	6

Figure 4. Setter depth over time during trip 4.

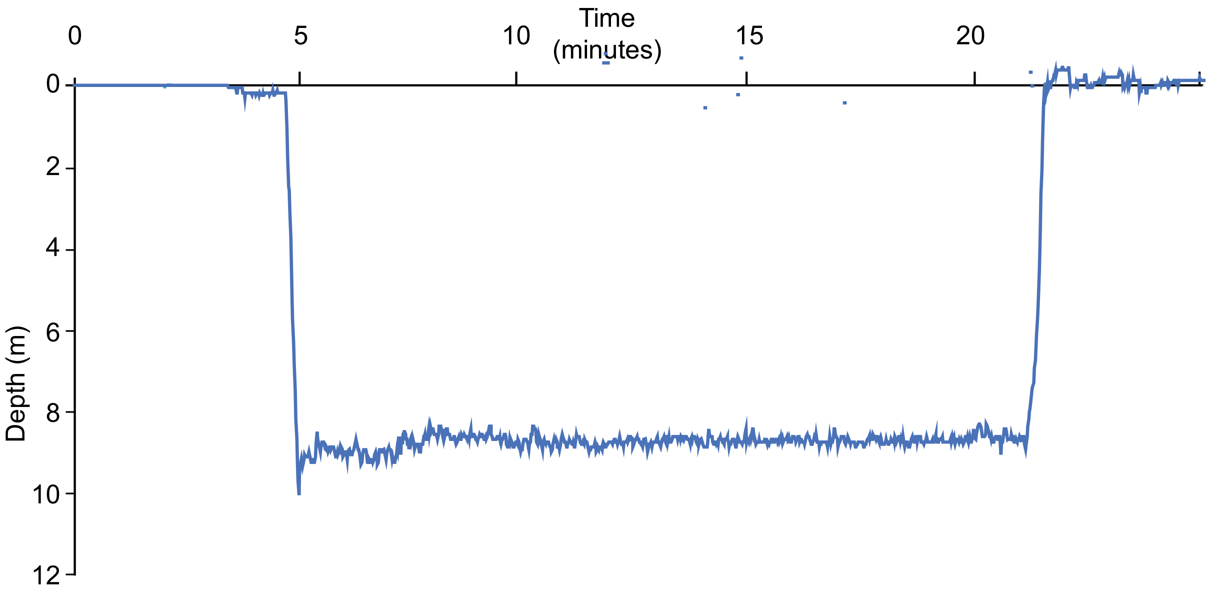

Table 8. Catch and bait returns, per card (trip 4).

Treatment	Speed (knots)	Hooks	Tension	Per 100 hooks SNA	KAH	GUR	KIN	SCA	SFI	whole baits returned	partial baits returned
Setter	4.6	60	8.3	5.0	0.0	1.7	0.0	0.0	0.0	11.7	13.3
Setter	4.6	60	8.9	8.3	1.7	1.7	0.0	0.0	3.3	11.7	16.7
Setter	4.6	60	8.3	10.0	3.3	0.0	0.0	0.0	0.0	1.7	25.0
Setter	4.6	60	8.5	3.3	1.7	0.0	0.0	0.0	0.0	31.7	3.3
Setter	4.6	60	8.9	3.3	5.0	0.0	0.0	0.0	0.0	23.3	30.0
Setter	4.6	60	9.4	5.0	5.0	1.7	0.0	0.0	0.0	21.7	25.0
Setter	4.6	60	8.5	15.0	10.0	1.7	0.0	0.0	0.0	10.0	28.3
Setter	4.6	60	6.9	10.0	6.7	0.0	0.0	0.0	0.0	15.0	25.0
Control	4.6	60	6.9	8.3	1.7	1.7	0.0	0.0	0.0	25.0	3.3
Control	4.6	60	4.7	6.7	3.3	0.0	0.0	0.0	0.0	1.7	11.7
Control	4.6	60	4.9	15.0	5.0	0.0	0.0	0.0	0.0	3.3	21.7
Control	4.6	60	5.6	20.0	5.0	0.0	0.0	0.0	0.0	8.3	41.7
Control	4.6	60	5.3	16.7	6.7	3.3	0.0	1.7	1.7	10.0	30.0
Control	4.6	60	6.2	5.0	0.0	1.7	0.0	0.0	0.0	1.7	36.7
Control	4.6	60	5.8	23.3	13.3	3.3	0.0	0.0	3.3	16.7	43.3
Control	4.6	60	5.8	10.0	1.7	0.0	0.0	0.0	0.0	6.7	16.7
Control	4.6	60	5.4	8.3	6.7	0.0	0.0	0.0	0.0	5.0	21.7
Control	4.6	60	6.0	3.3	5.0	0.0	0.0	0.0	0.0	3.3	38.3
Control	4.6	60	6.0	8.3	5.0	0.0	0.0	0.0	0.0	5.0	11.7
Control	4.6	60	6.3	10.0	5.0	0.0	0.0	0.0	0.0	1.7	18.3
Control	4.6	60	6.5	15.0	0.0	0.0	0.0	0.0	0.0	0.0	16.7
Control	4.6	60	0.7	15.0	11.7	0.0	0.0	0.0	0.0	6.7	15.0
Control	4.6	60	6.9	21.7	5.0	0.0	0.0	0.0	0.0	10.0	23.3
Control	4.6	60	6.5	11.7	3.3	0.0	1.7	0.0	1.7	1.7	10.0
Control	4.6	60	7.1	16.7	8.3	0.0	0.0	0.0	0.0	1.7	13.3
Control	4.6	60	6.3	10.0	5.0	1.7	0.0	0.0	0.0	0.0	10.0
Control	4.6	60	5.6	10.0	6.7	0.0	0.0	0.0	0.0	0.0	8.3
Control	4.6	60	5.6	25.0	5.0	0.0	0.0	0.0	0.0	3.3	25.0
Control	4.6	60	6.0	3.3	1.7	0.0	0.0	0.0	0.0	5.0	33.3