Cruise Report ZDLF2-10-2021

Net binding trials

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Iriarte, V. (2020). LOL 2020-X MMO Monitoring Report. Fisheries Department, Directorate of Natural Resources, Falkland Islands Government, Stanley, Falkland Islands. 22 pp.

Iriarte, V. (2020). LOL 2020-C MMO Monitoring Report. Fisheries Department, Directorate of Natural Resources, Falkland Islands Government, Stanley, Falkland Islands. 20 pp.

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1. Introduction

Seabird bycatch mitigation measures implemented in the Patagonian squid (*Doryteuthis gahi*, hereafter LOL) fishery comprise a toolbox with several strategies to monitor and mitigate incidental mortality (Table 1). Although in the LOL fishery seabird mortality was historically assumed to be low (Crofts, 2006; Sullivan et al., 2006; Kuepfer et al., 2018), observed the incidental mortality of black-browed albatross (*Thalassarche melanophris*, hereafter DIM) has increased five times between 2018-2021 (Fig.1). Because 82% of these mortalities are net related (Fig.2), and they occur mostly south of 52°S, and concentrate around Beauchêne Island -which has the world's second largest DIM breeding site (Crofts, 2020)-, a proposal to carry out net binding trials in grid squares XVAK (Beauchêne Island), XVAJ (west of Beauchêne) and XVAL (east of Beauchêne) was presented to the industry at the *Fisheries Advisory Committee* held on 5 December 2019 (Fig.3). Due COVID-19 pandemics, the trials were delayed until 2021.

Table 1. Implemented seabird bycatch mitigation measures in the LOL fishery.

Mitigation measure	Implementation year
Use of bird scaring lines (BSL)	2006
Halt of discards when BSL not in place	2011
100% Marine mammal/seabird observer coverage	2017
Halt of discards during manoeuvres (i.e. shoot, turn, haul)	2018
Net cleaning	2018
Cover of warp splices	2020
Discard management	2021

2. Objectives

The principal objective of the trials was to assess whether net binding will be effective for bottom trawlers. Secondary objectives were to record the sinking rate and opening performance of the trawl, to evaluate the efficiency of different binding materials and strategies, and to record seabird abundance and behaviour of the three vulnerable ACAP species that commonly interact with the fishery: the black-browed albatross (DIM), the giant petrel (MAX), and the white-chinned petrel (PRO).

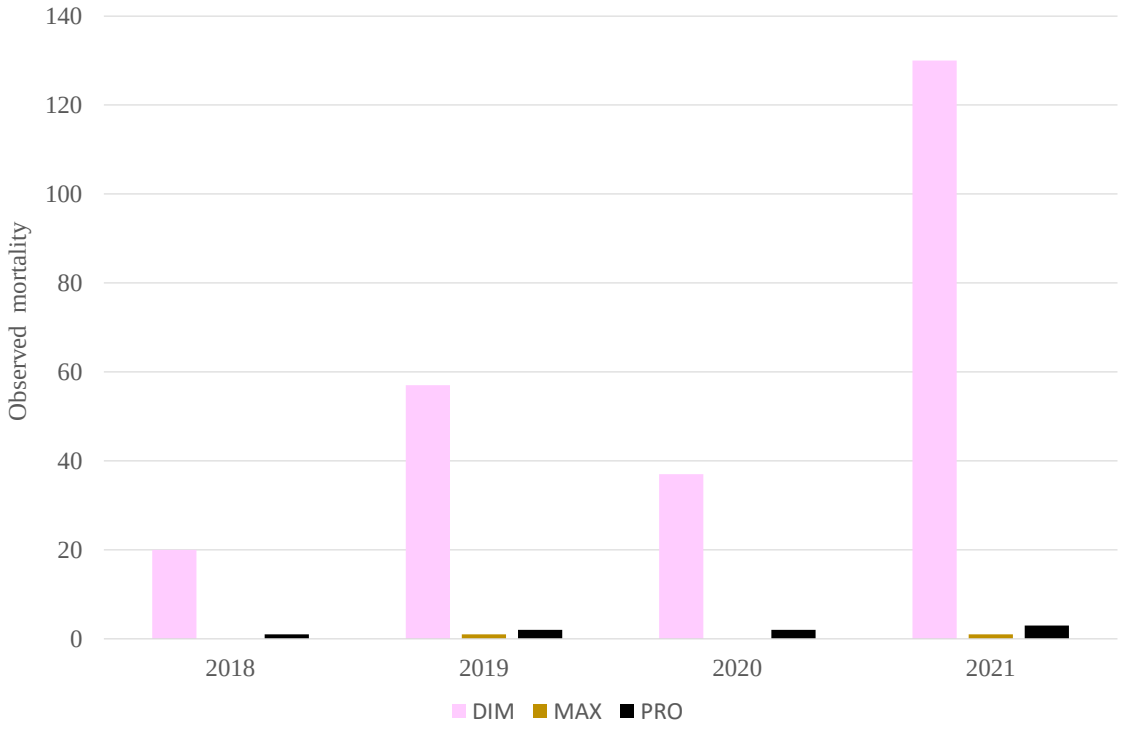

Fig.1. ACAP species observed mortality in the LOL fishery for seasons 2018-C-2021-X.

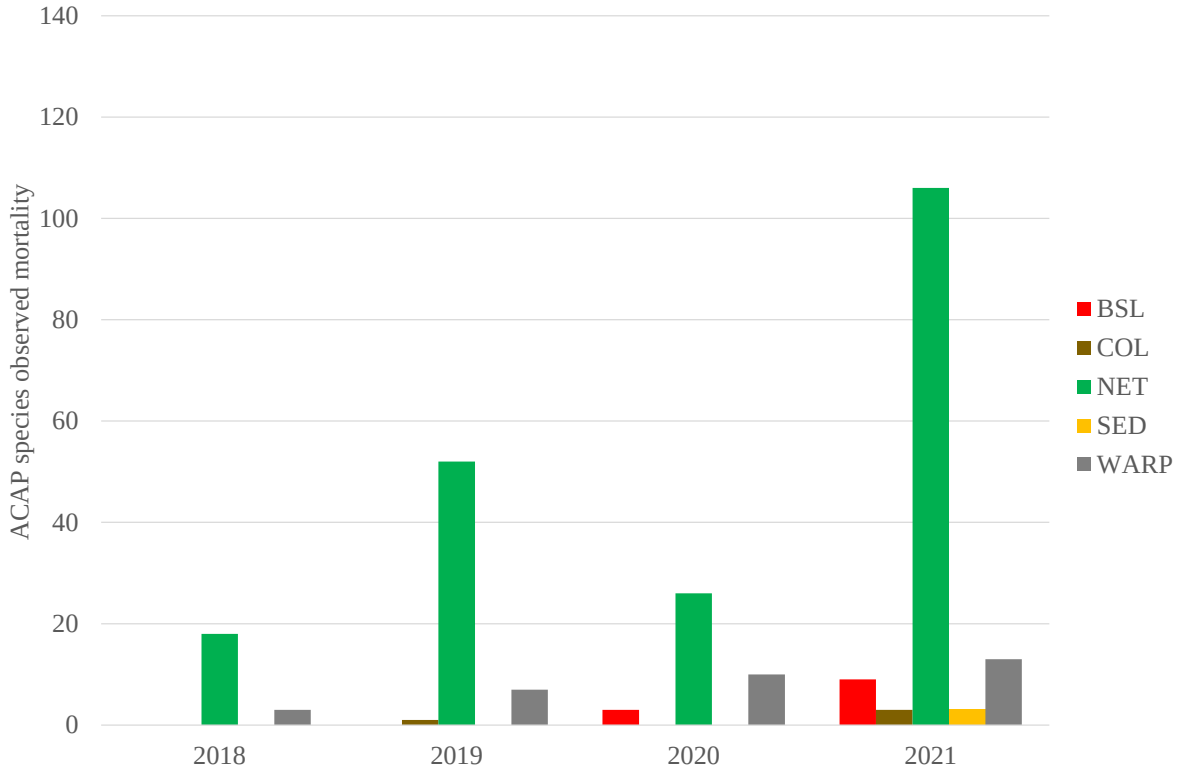

Fig.2. ACAP species cause of mortality in the LOL fishery for seasons 2018-C-2021-X.

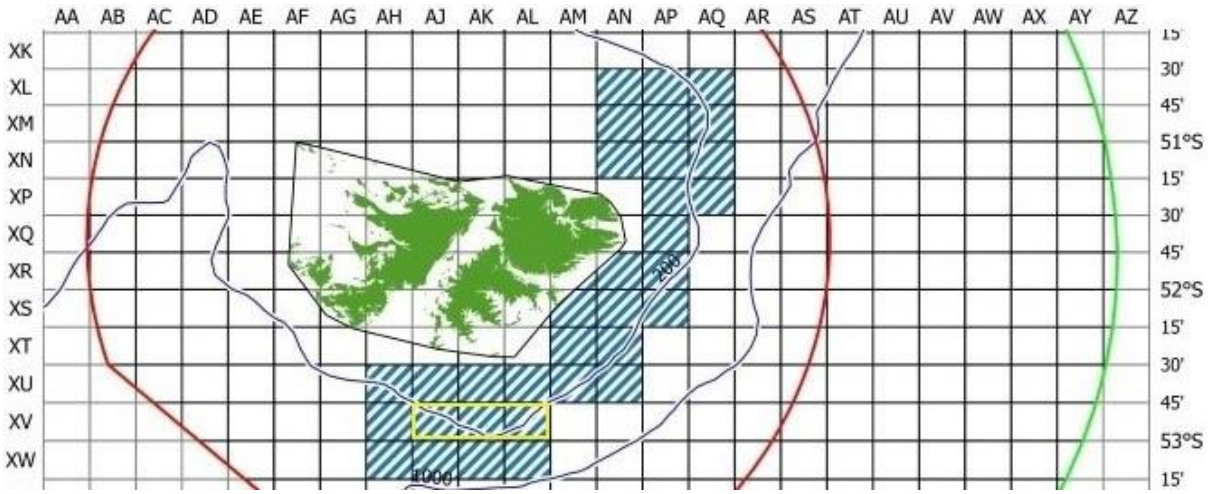

Fig.3. LOL fishing area. Study area highlighted in yellow.

3. Methods

3.1 Study area & itinerary

Trials were carried out by the *F/V New Polar*, a stern trawler which is equipped with a 15m fixed stern BSL and a 5m^3 discard storage tank. Fishing activity was carried out between 1-3 October 2021.

3.2 Fishing gear

The bottom trawl used had a total length of approximately 200 m, with mesh panels made of two different materials and mesh sizes ranging from 100 mm to 400 mm(Fig.4a). Floats were of 300 mm in diameter and of 10 kg of flotation. In order to allow the safe escape of South American fur seals *Arctocephalus australis* (ARA) and South American sea lions *Otaria flavescens* (OTB), a 5 m net extension containing a seal exclusion device-*model ii* (Iriarte et al., 2020) was attached between the net and the cod-end, the grid weighing approximately 200 kg (Fig.4a).

3.3 Binds

Three-ply sisal strings of around 2m of length were used to bind meshes approximately 3 m apart before shooting the trawl (Fig.4). Location of the binds and number of loops varied based on shooting observations:

- Stations 1-2: Following vessel's previous experience with net binding in the mackerel icefish (*Champsocephalus gunnari*, hereafter CHG) pelagic trawl fishery in CCAMLR waters, the first trial day started with single binds applied to the body of the net (Fig.4b). In the beginning these covered around 40 m from the SED net extension, being then increased to around 60 m to cover 200 mm meshes.

- Stations 3-6: Because most of the seabird entanglements have been recorded in the area with 400-200 mm meshes, net binding was concentrated to the mouth and net wing sections (Fig.4c, d). This arrangement aimed to join the net wings to close the whole net opening and eliminate seabird exposure to the dangerous area (Fig.4c). Throughout these four stations consecutive modifications included an increase in the number of binds, bind tightness, and manoeuvring efforts to maintain warp cables aligned during shooting.

- Stations 7-12: This arrangement intended to diminish seabird exposure to the wing meshes only, with double, triple and quadruple net binds being applied around the legs throughout the wings (Fig.4d, cover photo).

Cotton rope binds with slipknots were not trialled after the captain gave advise on the low probability for them to open after suffering tension and tighten up on deck during shooting.

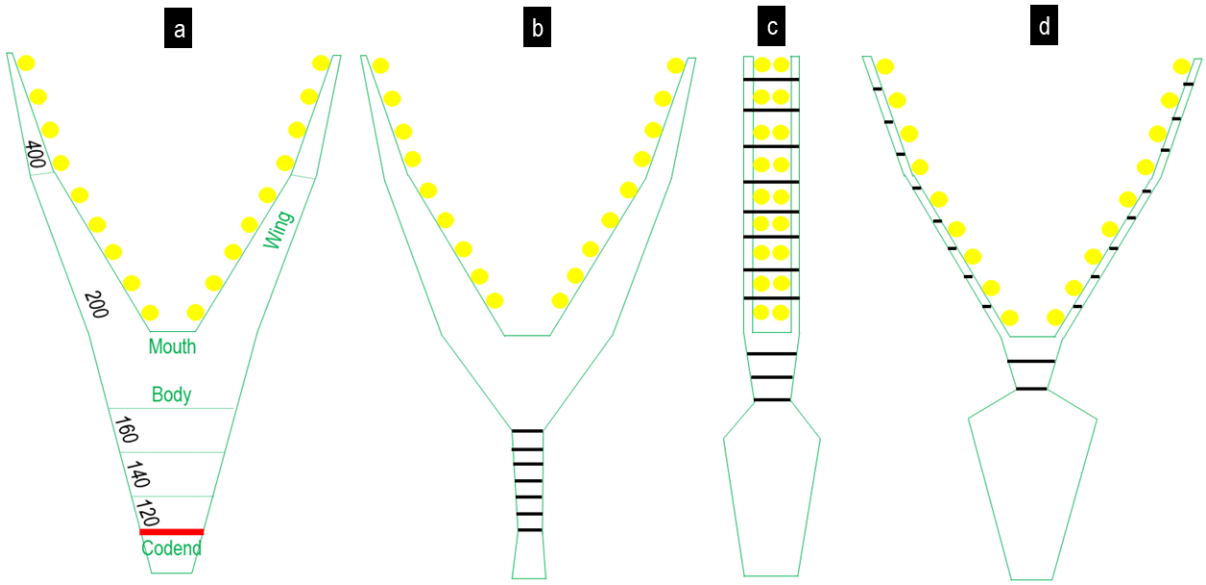

Fig.4. Trawl and bind types. (a) Diagram with net sections and mesh size in mm, SED net extension indicated in red; (b) black stripes indicate binds applied to body; (c) binds applied to net wings and body; (d) binds applied to wings and body. Diagrams not to scale.

3.4 Seabird interaction monitoring and biological sampling

Stations (i.e. shoots and hauls) were monitored from the gantry. Net surface behaviour, seabird abundance, and seabird behaviour were recorded during all manoeuvres. All stations were filmed using a GitUp camera, whilst photographs were taken using a Canon EOS 700D. In addition, seabird abundance and behaviour were also recorded every 10-min whilst trawling. Seabirds killed incidentally were frozen for posterior necropsy. In addition, squid length-frequency and maturity were sampled at two stations per day.

4. Results

A total of 12 net shoots with binds were carried out (Table 2). Although weather conditions were optimal, the trials were not successful.

4.1 Fishing gear behaviour & binds

Net binding did not cause any change in the net's sinking rate. During the trials several problems were faced and different strategies were applied to solve them (Table 2).

- Stations 1-2: Because the single net binds applied were located proximal to the cod-end, they did not suffer much stress during the shoot and did not break on deck during the manoeuvre, so actually prevented the 160-120 mm net meshes from opening in the surface. However, the area with binds (Fig.4) did not include the seabird high-risk entanglement zone, which is comprised by 400-200 mm meshes located in the mouth and net wings (Table 2, Fig.5).

- Stations 3-6: Despite the binding configuration applied to the net wings, the tension and force the trawl opening and wings occurring during shooting made the binds to break on deck. Consecutive modifications included an increase in the number of binds, double loops, bind tightness, and manoeuvring efforts to maintain warp cables aligned during shooting, however these were not successful (Table 2).

- Stations 7-12: Binding effort arrangement focused on wings also presented problems (Fig.4b, Table 2). Both single and double binds around the legs broke on deck during shooting (Table 2), so triple and quadruple net binds were then applied. Although some of these did not break on deck, an unknown number remained in place even after the

fishing gear started to be trawled, being net binds actually preventing the net to open in full (Table 2).

4.2 Seabird interaction monitoring

Trials were performed during DIM's egg laying season, being concentrations of birds around the vessel during manoeuvring in the low-middle thousands (Table 3). Because of the seabird bycatch mitigation in place (i.e. discard management and BSL), no interactions of birds with the warp cables were observed during trawling. However, two DIM mortalities of breeding males were recorded, one in the shoot of station 6 and one in the haul of station 10 (Table 2). The former animal entangled in the 200 mm mesh of the starboard net wing, while the latter entered the SED and died on deck during the net hauling (Table 2). Taking into account the high DIM concentrations on top of the net during manoeuvres, the low probability of detecting a seabird incidental mortality, and the fact that seabird carcasses can be lost via the SED (Iriarte et al., 2018), the possibility of further undetected DIM mortalities wasnot ruled out.

5. Discussion

Although net binding has been proved effective to reduce seabird interactions with pelagic trawlers in the CHG fishery (CCAMLR, 2006), the trials carried out aboard the F/V New Polar evidenced several differences and challenges regarding the application of net binding to mitigate seabird incidental mortality in the LOL bottom trawl fishery.

Pelagic trawls are larger (≥250 m) and made of panels which mesh sizes range from 16 m in the net wings to 90 mm in the codend (Fig.5). Because in CCAMLR's CHG fishery most of seabird net mortalities constitute PRO, the seabird dangerous zone is comprised by 200-150 mm meshes located in the body of the net, proximal to the codend (Fig.5). This seabird entanglement zone extends for around 40m along the body of the net, where applied net binds do not suffer any physical stress during the shooting manoeuvre (Fig.5).

Bottom trawls currently used in the LOL fishery have a length of around 220 m, and are made of panels which mesh sizes range from 600-200 mm in the net wings to 100 mm in the codend (Fig.5). Most of the seabird entanglements comprise DIM -a much larger species than PRO- being the seabird dangerous zone comprised by 400-200 mm meshes located mostly in the mouth and net wings. This seabird entanglement zone extends throughout the net opening -an

extension larger than 150 m- which includes the net wings and mouth, unstable areas that suffer a lot of tension and force during shooting (Fig.5).

Although in the Falkland Islands seabird net mortalities were minor due the average mesh size near the mouth of the net was around 120-140 mm (Sullivan & Reid, 2004), in the LOL fishery mesh sizes in these areas have increased to 400-600 mm (FIFD, *unpublished data*). Mesh sizes between 200-800 mm have been previously related to DIM entanglements in CCAMLR waters (Hooper et al., 2003).

The mesh size changes in the LOL fishery are presumably a combination of the recent modernisation of the fleet -which currently have more powerful engines- and the use of larger nets made of specialised materials, all which have made the fishery much more efficient.

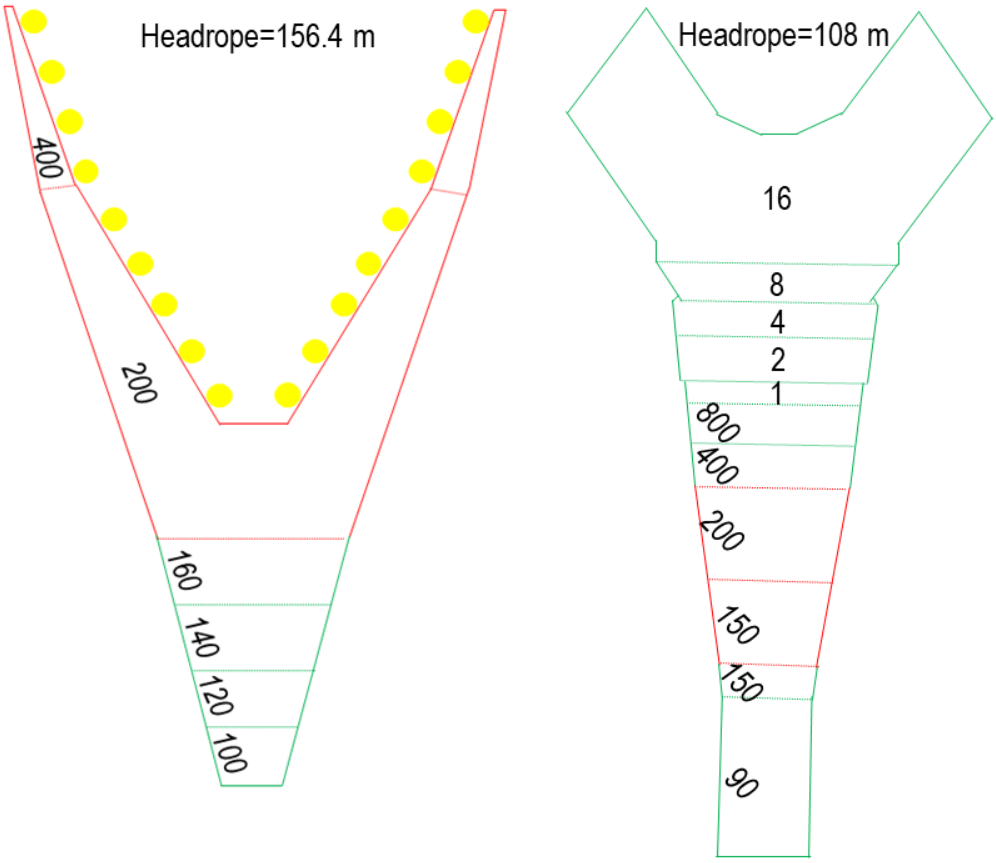

Fig.5. Seabird high-risk entanglement zone (in red). Example of a bottom-trawl used in the LOL fishery aboard the F/V New Polar (left) and a pelagic trawl used in CCAMLR's CHG fishery (right). In the pelagic net centred mesh sizes are in m. Diagrams not to scale.

Table 2. Net binding stations.

Date	St	Shoot	BA 200m	Sinking (min:sec)	Haul	BA 200m	N in S (min:sec)	B	BT	Bind Location	Problems	Comments
01/10/21	1	XVAL	201-500	4:23	XVAL	501+	3:50	4	S	Body of the net, within 40m from SED	No binds in net wings/mouth of the net	No birds entering BSL protected area; no warp contacts during trawling. Birds scavenging on top of the net during both shooting and hauling.1 ARA seen during shooting.
01/10/21	2	XVAL	51-200	3:19	XVAL	501+	5:06	3	S	Body of the net, within 60m from SED	No binds in net wings/mouth of the net	No birds entering BSL protected area; no warp contacts during trawling. Birds scavenging on top of the net during both shooting and hauling. 25 ARA foraging around the net during hauling.
01/10/21	3	XVAL	501+	3:54	XVAL	201-500	3:46	3	S	Body of the net and net wings	Most of binds in net wings broke while shooting	No birds entering BSL protected area. Birds scavenging on top of the net during both shooting and hauling.5 ARA foraging on top of the net during shooting; 3 ARA foraging around the net during hauling.
01/10/21	4	XVAL	501+	3:58	XVAL	501+	3:50	4	S	Body of the net and net wings	Most of binds in net wings broke while shooting	3000+ birds during hauling. No birds entering BSL protected area. Birds scavenging on top of the net during both shooting and hauling.
01/10/21	5	XVAL	501+	4:08	XVAL	501+	4:00	3	S	Body of the net and net wings	Most of binds in net wings broke while shooting	No birds entering BSL protected area. Birds scavenging on top of the net during both shooting and hauling. 2 ARA foraging around the net during hauling.
02/10/21	6	XVAL	501+	3:31	XVAL	501+	4:16	4	S	Body of the net and net wings	Most of binds in net wings broke while shooting	No birds entering BSL protected area; no warp contacts during trawling. Birds scavenging on top of the net during both shooting and hauling. 1 breeding male DIM carcass recovered during hauling, the bird presumably entered the 200 mm mesh during shooting and drowned after becoming stuck in the starboard side net wing.
02/10/21	7	XVAL	501+	4:49	XVAL	501+	3:51	4	S&D	Legs (mouth of the net). D=port; S=star	Most of binds broke while shooting	No birds entering BSL protected area; no warp contacts during trawling. Birds scavenging on top of the net during both shooting and hauling. Shoot a bit delayed due manoeuvring. 6 ARA foraging around the net during hauling.
02/10/21	8	XVAL	501+	4:24	XVAL	501+	4:17	4	D	Legs (mouth of the net)	Most of binds broke while shooting	No birds entering BSL protected area; no warp contacts during trawling. Birds scavenging on top of the net during both shooting and hauling.
02/10/21	9	XVAL	501+	3:03	XVAK	501+	3:00	4	T&F	Legs (mouth of the net). T=star; F=port	Binds took a while to break; net did not open before trawling began	No birds entering BSL protected area; no warp contacts during trawling. Birds scavenging on top of the net during both shooting and hauling. 35 ARA foraging around the net and 6 eating on top of the net during hauling.
02/10/21	10	XVAK	501+	5:24	XVAK	501+	03:26	3	D	Legs (mouth of the net)	Most of binds broke while shooting	Shooting delayed due net entanglement. No birds entering BSL protected area. Birds scavenging on top of the net during both shooting and hauling. 1 breeding male DIM mortality during hauling; the bird entered via SED and was alive, around 10m from the grid. On deck a strobe was attached just next to the bird. Four vessels around, huge clouds of birds astern. 35 ARA foraging on top of the net during shooting; 1 ARA swimming astern during hauling.
03/10/21	11	XVAH[α]	501+	7:00	XVAK[β]	501+	04:56	3	D	Legs (mouth of the net)	Most of binds broke while shooting	Shoot and haul delayed due mechanical problems. No birds entering BSL protected area; no warp contacts during trawling. Birds scavenging on top of the net during both shooting and hauling. 1 ARA swimming astern during shooting.
03/10/21	12	XVAJ	501+	4:06	XVAK[σ]	----------	----------	3	D	Legs (mouth of the net)	Most of binds broke while shooting	Birds scavenging on top of the net during shooting; haul not monitored. Scientific trawl extended to commercial.

St=station; **BA**=bird abundance; **N in S**=net in surface; **B**=Beaufort; **BT**=bind type.

[α] Due high percentage of spawning squid, the vessel was asked to move farther away from Beauchêne Island.

[β] Vessel continued fishing very close to Beauchêne Island.

[σ] Vessel was authorized to continue fishing while steaming to Stanley under the condition to trawl north of XVAK. However, the vessel moved from XVAJ to XVAK, and then in XVAL turned back to XVAK.

6. Conclusion and perspectives

6.1 It was not possible to develop a net binding protocol for the LOL bottom trawl fishery. The net binding trials carried out were found to be neither efficient nor practical, however discussions with the captain and crew were very fruitful and allowed FIFD personnel to have a better understanding of the problem.

6.2 It is necessary to explore the possibility of developing other measures to mitigate net mortalities.

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