

LOL 2021-X MMO Monitoring Program Report



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

Iriarte V., Arkhipkin A., Blake D. (2018). License X-2017 Pinniped Bycatch Mitigation Report: Implementation of seal exclusion devices (SEDs) in the Loligo (*Doryteuthis gahi*) fishing fleet during the 2nd season 2017. Fisheries Department, Directorate of Natural Resources, Falkland Islands Government, Stanley, Falkland Islands. 28 pp.

Iriarte V., Pompert J. (2016). Pinniped Bycatch Report: Squid & Finfish Trawlers. Preliminary information on the bycatch of pinnipeds in the Falkland Islands. Fisheries Department, Directorate of Natural Resources, Falkland Islands Government, Stanley, Falkland Islands. 13 pp.

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1. Introduction

The Falkland Islands Patagonian squid (*Doryteuthis gahi*) fishery is currently the only bottom-trawl fishery in the Southwest Atlantic with full observer coverage and Seal Exclusion Device (SED) usage (Iriarte *et al.*, 2020). This aligns with the 2030 Agenda and Sustainable Development Goals of the United Nations, and supports the *D. gahi* (hereafter LOL) product potential eco-labelling and its possible expansion to new markets.

The Pinniped Observer Program is a result of a partnership between the Falkland Islands Government (FIG) and the Loligo Producers Group (LPG), with Marine Mammal Observers (MMO) recording South American sea lion (*Otaria flavescens*, hereafter OTB) and South American fur seal (*Arctocephalus australis*, hereafter ARA) abundance, behaviour, net interactions, live deck releases, live SED escapees and incidental mortalities in at least three trawls per day. Following discard management policy that came into effect on 1 January 2021, observations of the discard management plan aboard and monitoring the occurrence of organic material in the water was added to the primary MMO duties. Secondary MMO activities include monitoring bird scaring lines (BSL) efficiency, recording seabird interactions with the fishing gear, mortalities, and seal or seabird carcass collection.

The LOL 2021-X season started on 28 July 2021, with all vessels using a trawl fitted with a SED. The 16 MMOs were supplied by MRAG (U.K) and were briefed at the Falkland Islands Fisheries Department (FIFD) on 21, 22, 23 and 26 July. On the first three days the first part of the briefing focused on the Seabird and Marine Mammal Bycatch Mitigation Program, including an introduction to local otariids (eared seals, OTB and ARA) and seabird species, identification, behaviour, types of interactions with fishing vessels and mortality mitigation methods. The second part of the briefing concentrated on discard management, monitoring interactions, examining carcasses, data gathering and recording, biometrics of LOL and Patagonian toothfish (*Dissostichus eleginoides*, hereafter TOO), and License conditions. The last training day introduced the MMOs to monitoring and bycatch recording of common hake (*Merluccius hubbsi*, hereafter HAK).

2. Objectives

The objective of this report is to present all data collected during the 2021-X season regarding marine mammal and seabird interactions with the LOL fleet and to evaluate the mortality mitigation methods in place and the discard management implementation process. Information includes data and samples collected by the MMOs and collated by the FIFD.

3. Methods

3.1 *Manoeuvre monitoring*

MMOs principal duty is to monitor the shoot and haul of at least three trawls per day to record seal abundance and behaviour, and to observe any seal and seabird bycatch. As shoots and hauls represent the most critical moment for both seabird and marine mammal incidental mortality, and as seabird bycatch is extremely cryptic and very difficult to detect (Parker *et al.*, 2013a; Iriarte & Pompert, 2016; Kuepfer, 2016b), MMOs are required to carry out their observations principally from the gantry. Observer monitoring from the bridge, bridge wings and deck do not provide enough view to properly assess seabird and seal interactions with the fishing gear. However, as a secondary option monitoring from the bridge/bridge wings may be used during night hours and unsafe weather conditions.

3.2 *Bird scaring lines monitoring*

The LOL fleet has been directly involved in the development and implementation of both *tori lines* (Sullivan *et al.*, 2006; Snell *et al.*, 2012) and the *fixed aerial array* (Parker, 2012; Parker *et al.*, 2013b). Although *tori line* (TL) requirements are included in the License conditions, specific *recommendations* for the fixed aerial array (FAA) had been produced by the FIFD (Kuepfer, 2016a, 2017, 2018) and general FAA conditions were introduced for season 2021-C. As different FAA models have been fitted on vessels, in order to evaluate their performance and to compare them to TL, MMOs are required to carry out one hour of BSL daily observations from the gantry, preferably while the vessel is processing catch. This also allows monitoring discard management and observing discard storage tank performance. At the beginning of the observations the MMO estimates the overall vulnerable seabird abundance within 200 m astern, followed by 40 m estimations in 10 min periods and counting seabird presence within 2 m of the warp-water interface during each period. Vulnerable seabirds comprise species with large wing-span, which are prone to fishing gear entanglement (i.e. albatrosses and big petrels). Although the most common species interacting with the LOL fishery are the black-browed albatross (*Talassarche melanophris*, hereafter DIM) and the giant petrel species (*Macronectes giganteus* and *Macronectes halli*, hereafter MAX), other species can also interact with the vessel, like the Cape petrel (*Daption capense*, hereafter DAC), the common diving petrel (*Pelecanoides urinatrix*, hereafter PEL) the grey-backed storm petrel (*Garrodia nereis*, hereafter GAN) and the kelp gull (*Larus dominicanus*, hereafter LAD).

3.3 *Seabird and marine mammal bycatch mitigation measures*

In order to mitigate seabird and seal mortality in the fishery, Part 2 of the license conditions mandates the use and maintenance of BSL, prohibits discarding during manoeuvres (i.e. shoot, turn, haul), requires cleaning the net thoroughly prior to shooting, and establishes parameters

for discard management as a long-term seabird bycatch mitigation measure. License conditions also describe three SED models approved by the FIFD and emphasize that “*during the haul crew should make their bests efforts to detect seals trapped in the net and facilitate their escape whilst the SED is still in the water, by working cables/bridles back and forth*”.

As overall compliance to good practices is a key factor to megafauna bycatch mitigation efficiency, good practices aboard are also monitored by the MMOs.

3.4 *Mortalities & necropsies*

Observers must report seal mortalities to the FIFD via WhatsApp as soon as they occur, providing photographs of the head and genital area, and possible cause of mortality. If female, observers are instructed to preserve the carcass for necropsy ashore, while male carcasses are marked (partially cut/complete removal of the left pectoral fin) and dumped overboard, unless instructed for preservation.

In the case of seabirds, all carcasses recovered should be preserved frozen for posterior necropsy. Collected individuals are then aged following Prince and Rodwell (1994).

3.5 *Data reporting*

Collected data by the observers are daily entered in an excel file which is sent to the FIFD, MRAG and the respective fishing companies twice a week (Mondays and Thursdays). BSL data is entered into a separate file and sent once a week (Fridays).

4. Results

4.1 *Manoeuvre monitoring*

A total of 2716 trawls were reported, of which 2692 (99%) were monitored in at least one manoeuvre (i.e. either a shoot or haul). Of a total of 2689 shoots observed, 2049 (76%) were monitored from the gantry, 496 (19%) from the bridge/bridge wings, and 144 from the stern deck (5%) (Fig.1). Regarding the 2710 hauls observed, 2167 (80%) were monitored from the gantry, 417 (15%) from the bridge/bridge wings, and 124 (5%) from the stern deck (Fig.1).

Fishing effort was mostly carried out south of 52°S, with 79% of the trawls taking place in the south and 21% in the north. The most visited grid squares in the south were XVAK (708 shoots; 697 hauls) and XVAL (621 shoots; 581 hauls), while in the north most of the fishing activity took place within XNAQ (123 shoots; 102 hauls) and XPAP (111 shoots; 112 hauls) (Fig.2).

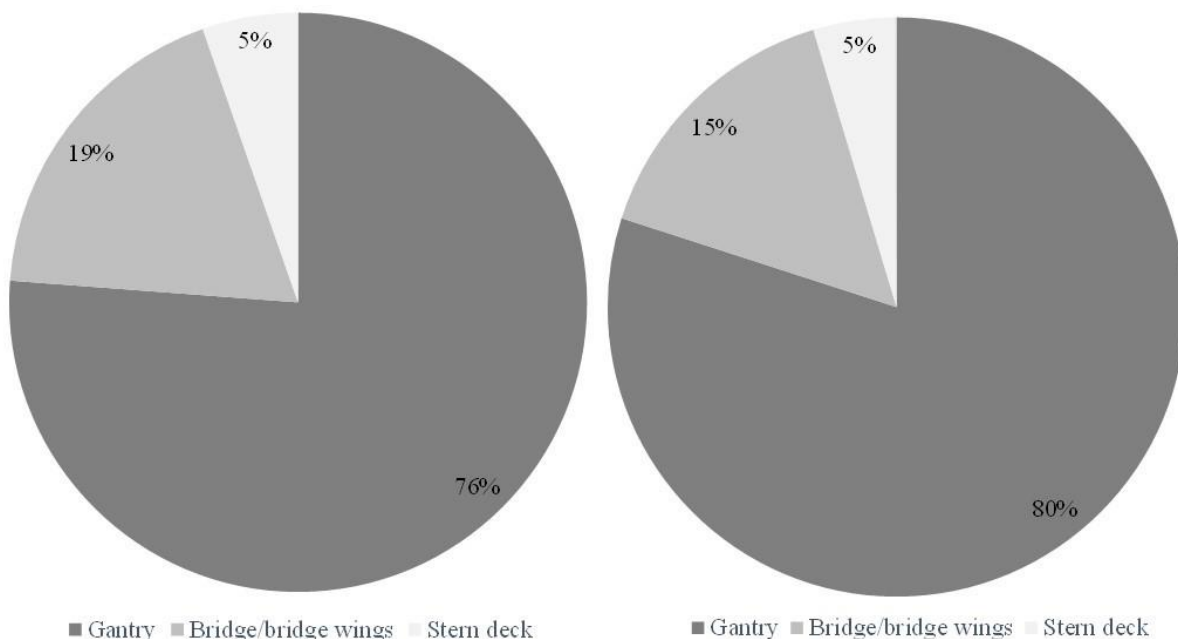


Fig.1. MMO manoeuvre position in shoots (left) and hauls (right).

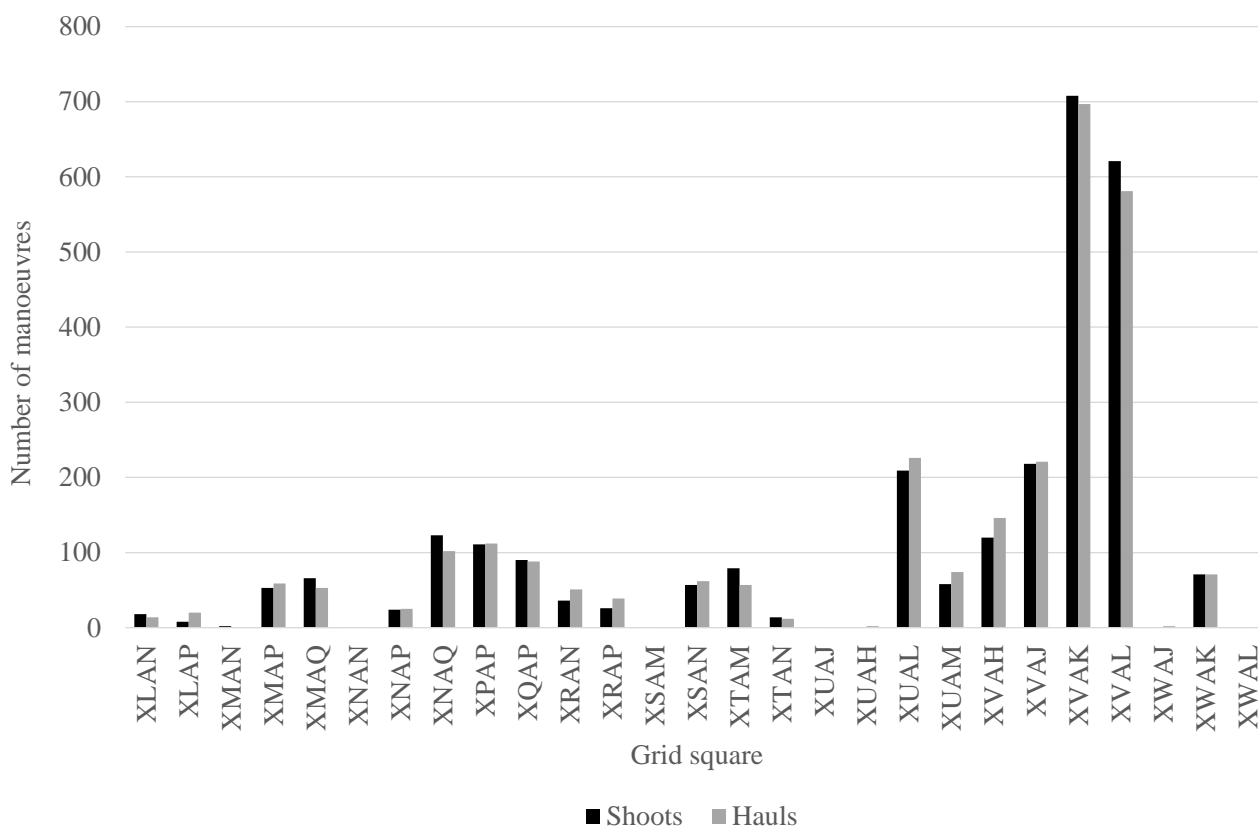


Fig.2. Fishing effort per grid square.

4.2 Pinniped sightings

A total of 10309 seals [9767 ARA, 361 OTB, 181 unknown species (UN)] were seen attending vessels. Ninety-seven percent of the interactions occurred south of 52°S (Table 1) with ARA representing 95% of the sightings (Table 1).

Overall pinniped attendance to vessels remained around the thousands throughout the season, with a trough recorded during week 7 (7-13 Sep) due to increased transfer of fishing effort (~56%) north of 52°S (Fig.3).

Table 1. Pinniped interactions per region.

Region	Species	N° sighted	SED escapees	Deck releases	Mortalities	Total
North 52° S	OTB	112	1	0	2	115
	ARA	181	0	0	0	181
	UN	27	0	0	0	27
Sub-total north		320	1	0	2	323
South 52° S	OTB	247	1	0	0	248
	ARA	9490	88	8	42	9628
	UN	154	0	0	0	154
Sub-total south		9891	89	8	42	10030
TOTAL		10211	90	8	44	10353

4.2.1 Pinniped attendance to vessels and behaviour

Of the 10309 seals sighted, 7381 (6934 ARA, 294 OTB, 153 UN) were observed during hauling, comprising 72 % of the individuals recorded. The remaining individuals (2928) were seen during shooting (14%), trawling (10%), turning (3%) and steaming (1%). In 96% of the hauling attendance, seal behaviour was strictly related to foraging, with both ARA and OTB directly targeting lost catch around the fishing gear (50%) and eating from the net (46%) (Fig.4).

The most common pinniped behaviour in the remaining vessel activities was to follow the vessel (47%), swim astern (25%) and forage around the net during shoots and turns (20%) (Fig.5). The presence of seals foraging in the discard chute area (4%) was mostly related to the availability of small pieces of organic material coming out from the factory pumps (Fig.5).

4.3 Pinniped bycatch

Bycatch concentrated south of 52°S (98%), particularly in grid squares XVAK (30%) and XVAL (34%) (Fig.6), where most of the fishing effort occurred (Fig.2). A total of 142 seals were bycaught, of which 91 were seen escaping through the SED during hauling (89 ARA, 2 OTB), seven ARA were safely released from deck, and 44 (42 ARA, 2 OTB) comprised incidental mortalities (Table 2).

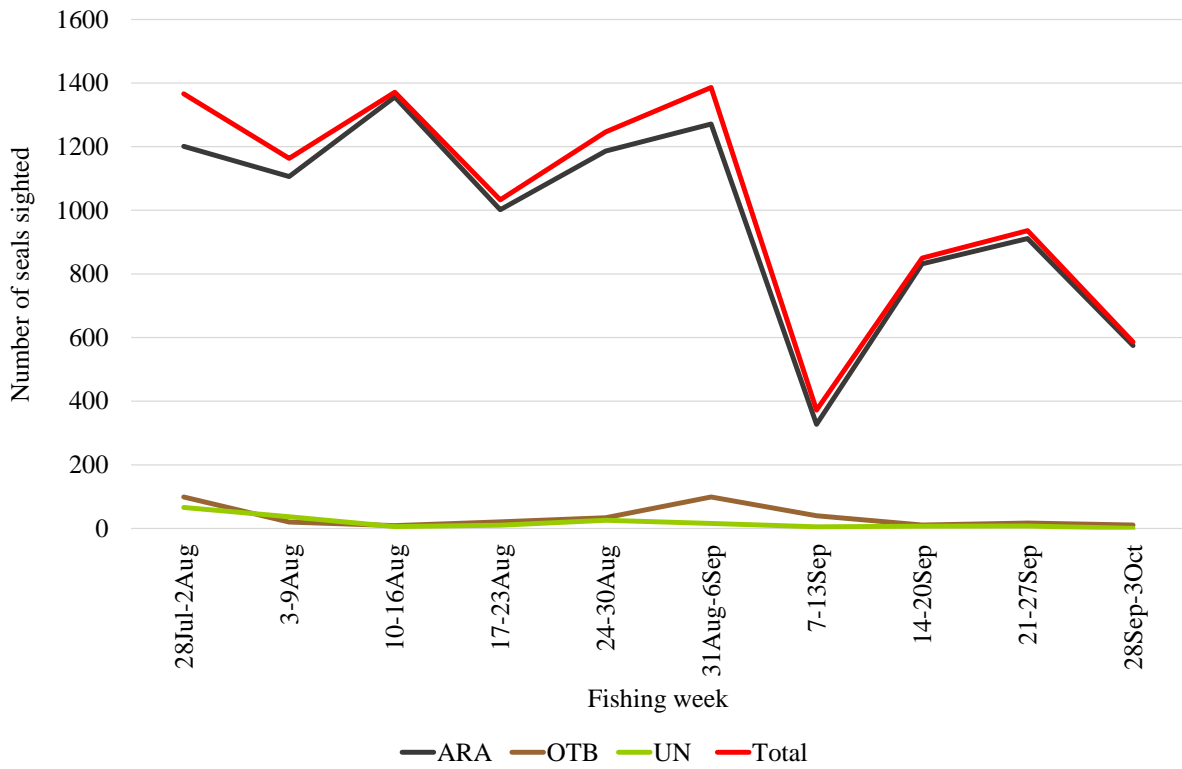


Fig.3. Cumulative pinniped sightings per fishing week.

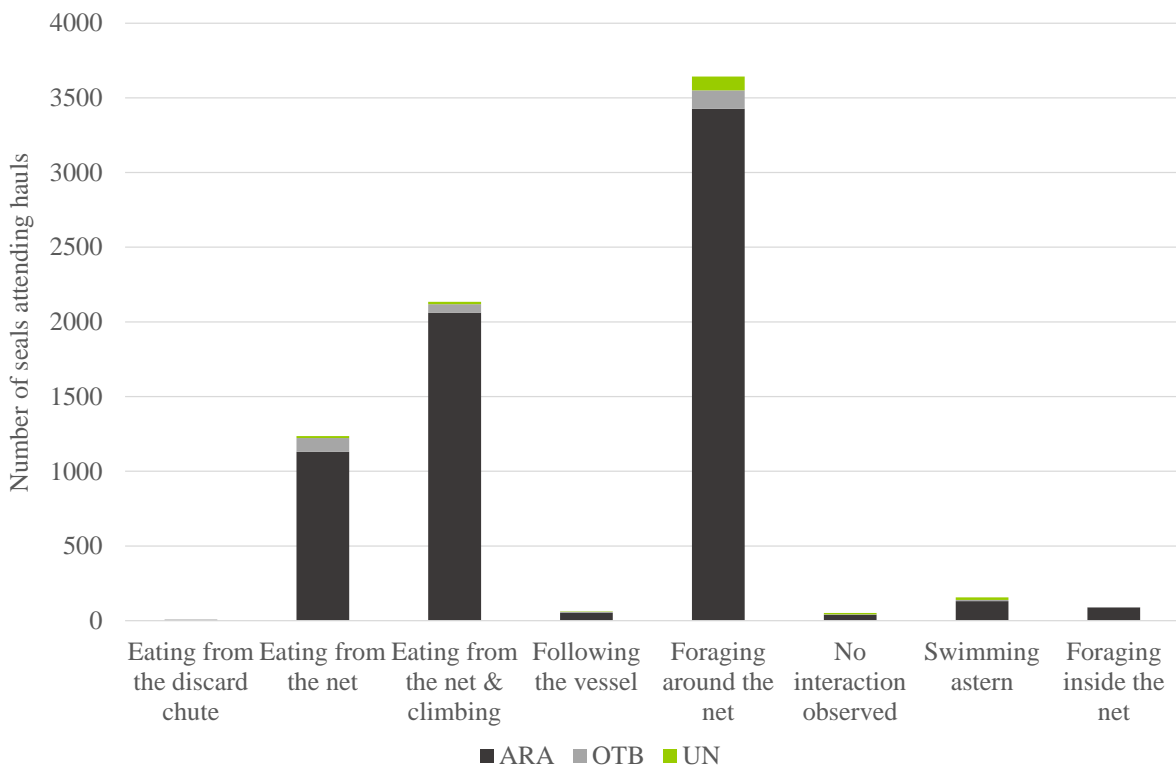


Fig.4. Pinniped behaviour exhibited during hauling.

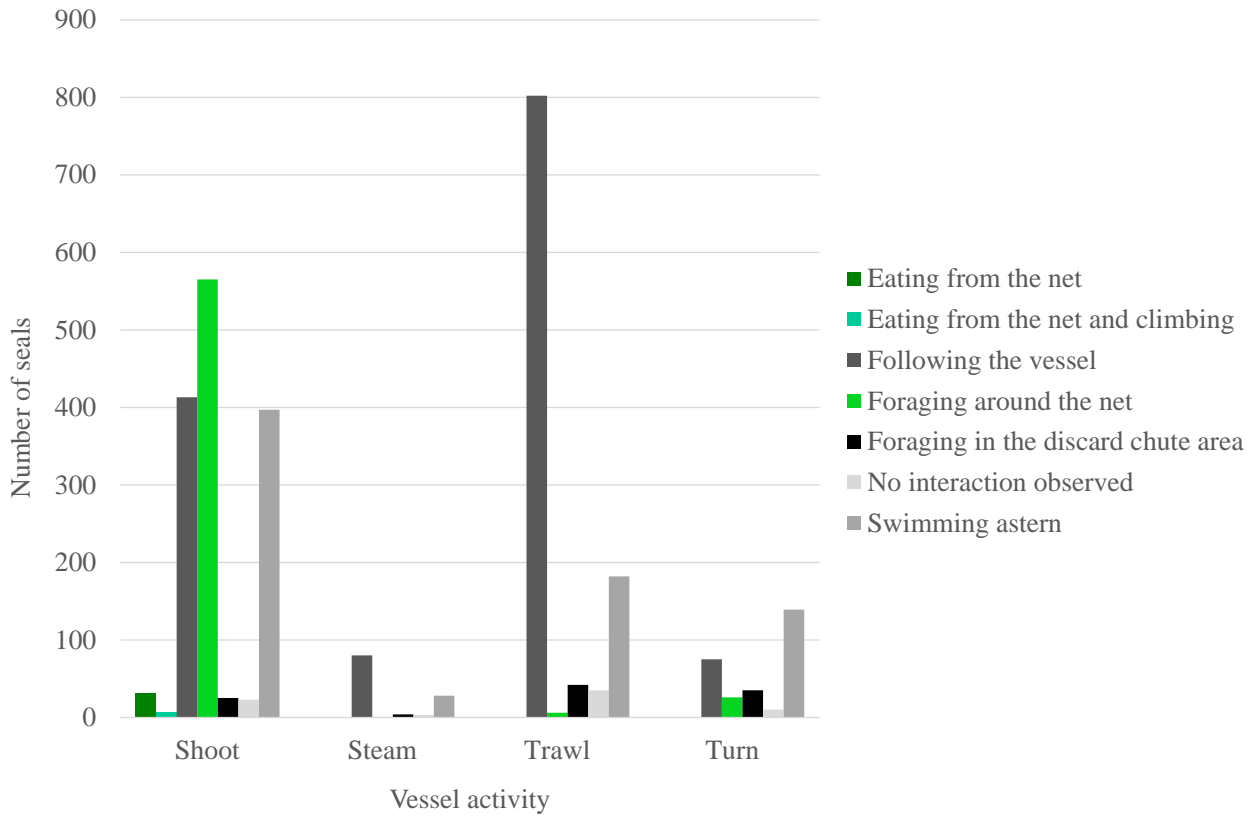


Fig.5. Pinniped behaviour exhibited during vessel manoeuvres.

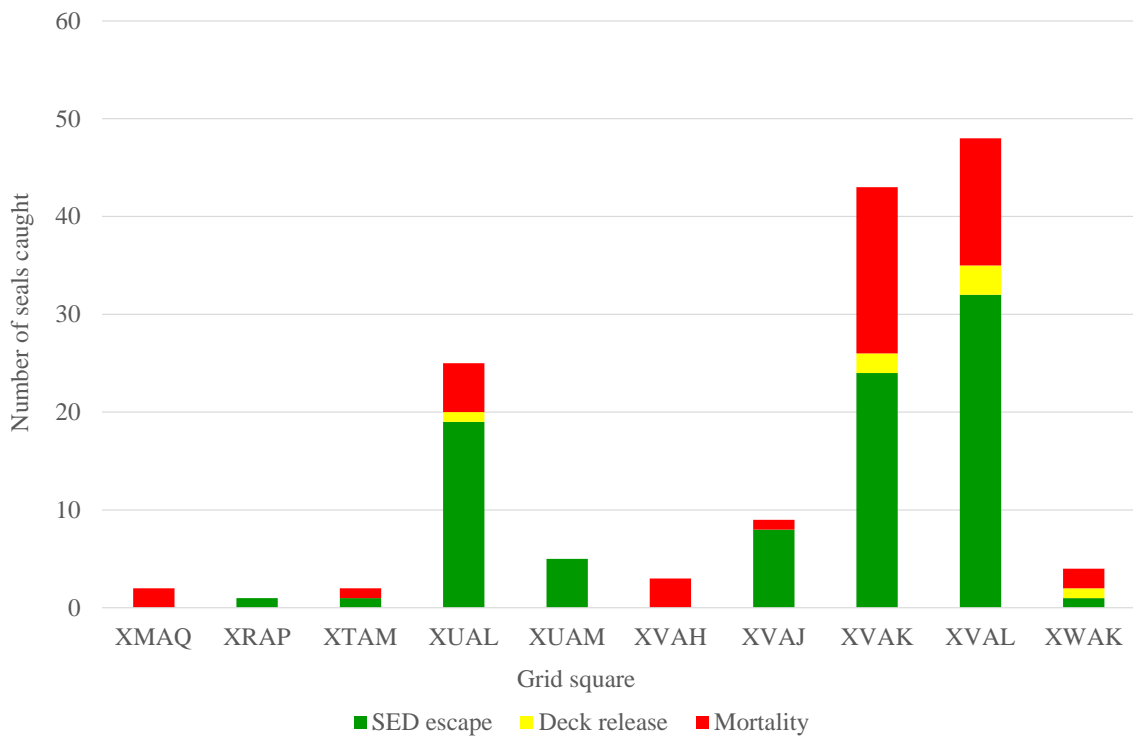


Fig.6. Pinniped bycatch per grid square.

4.3.1 Incidental mortalities

Pinniped mortalities associated to fishing effort (39% recorded in XVAK and 30% in XVAL), with 61% of them being related to drowning [27 ARA: 22 male, 1 lactating female (pup ashore), 1 lactating (pup ashore) and pregnant female (43.5 cm/2.1kg fully developed male foetus; Fig.7)], 39.5% to propeller strikes (6 male ARA, 1 lactating (pup ashore) OTB female), and 39.5% to unknown cause of mortality (8 male ARA) (Fig.8, Table 2). Drowning of seals in trawls fitted with a SED is usually correlated to the loss of tension of the net during manoeuvres, which results in the blockage of the escape path towards the SED. During the present season this was exacerbated by very rough weather conditions recorded between 28 Jul-16 Aug, which peaked to Beaufort 8 during the third fishing week (Fig.8, Table 2).



Fig.7. ARA male foetus.

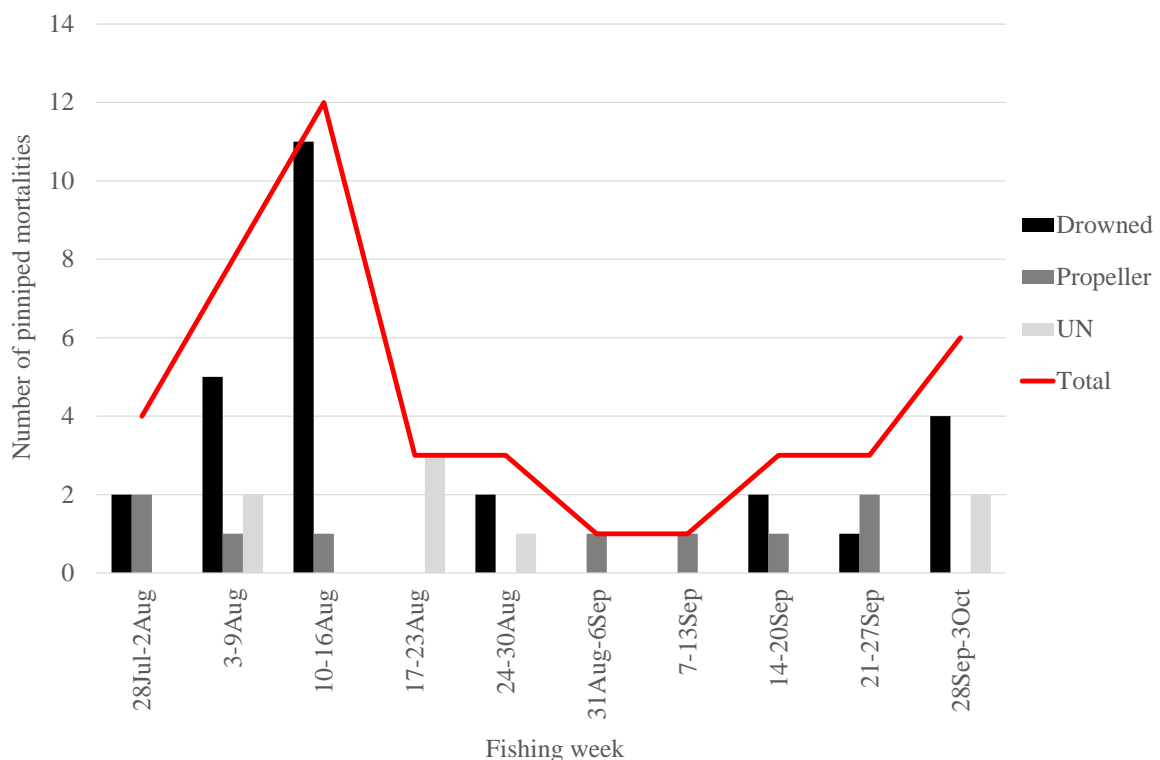


Fig.8. Pinniped mortality and type per fishing week.

Table 2. Pinniped incidental mortalities

Date	Grid	Beauf.	Trawl (min)	#Turns	Spp.	#Mort.	Cause mort.	Comments
31/07/21	XVAL	4	370	0	ARA	1	D	FC; net entanglement in haul
31/07/21	XMAQ	4	300	UN	OTB	1 (+1)	P	UC; lactating female
01/08/21	XVAL	5	255	UN	ARA	1	D	FC; sand in fur; no RM; PKS
03/08/21	XUAL	8	550	UN	ARA	1	P	UC
03/08/21	XVAL	8	370	0	ARA	1	D	FC; sand in fur; RM; PKS
05/08/21	XVAJ	5	600	UN	ARA	1	D/PLE	Unconscious w/froth in aerial ways; PPRM
06/08/21	XVAK	7	205	0	ARA	2	D	FC; PKH; very bad weather
07/08/21	XVAK	9	800	UN	ARA	1	UN	UC in decomposition
09/08/21	XVAL	5	220	UN	ARA	1	D	PFC lost during hauling
09/08/21	XVAK	8	345	UN	ARA	1	UN	UC in decomposition
10/08/21	XUAL	8	425	1	ARA	2	D	FC; KH; course change due bad weather
10/08/21	XVAL	8	295	1	ARA	1	D/CbyN	FC; KH; course change due bad weather
11/08/21	XVAK	8	300	UN	ARA	1	D/PLE	Unconscious w/froth in aerial ways; PPRM
12/08/21	XVAK	5	365	1	ARA	1	D/CbyN	FC; yearling; PKT
12/08/21	XVAK	5	265	1	ARA	1	D/CbyN	PKT
12/08/21	XVAK	6	365	1	ARA	1	D/CbyN	FC; PKH
13/08/21	XVAK	6	590	1	ARA	2	D/CbyN	FC; PKT/H (bad weather)
13/08/21	XVAK	4	325	1	ARA	1	D/CbyN	FC; PKT
13/08/21	XVAK	5	235	UN	ARA	1	P	UC
14/08/21	XVAK	5	580	2	ARA	1	D/CbyN	FC; PKT
17/08/21	XVAK	2	660	UN	ARA	1	UN	UC in decomposition
21/08/21	XVAL	4	405	UN	ARA	1	UN	UC in decomposition
22/08/21	XTAM	3	480	UN	ARA	1	UN	UC in decomposition
29/08/21	XWAK	3	780	4	ARA	1 (+1)	D/CbyN	FC; lactating female; PKT
29/08/21	XUAL	4	470	UN	ARA	1	UN	UC in decomposition
03/09/21	XUAL	6	420	UN	ARA	1	P	UC in decomposition
08/09/21	XVAL	4	570	UN	ARA	1	P	UC
14/09/21	XVAH	5	905	UN	ARA	1	P	UC in decomposition
16/09/21	XVAK	7	545	UN	ARA	1	D/PLE	Unconscious w/froth in aerial ways; PPRM
19/09/21	XVAL	6	570	1	ARA	1	D	FC; PKT
21/09/21	XVAL	3	350	UN	ARA	1	P	FC
25/09/21	XVAK	3	410	UN	ARA	1	P	UC in decomposition
27/09/21	XVAK	3	510	2	ARA	1	D	FC; PKT
28/09/21	XVAH	3	540	1	ARA	1	D/CbyN	FC; female; head entangled in mouth of the net
29/09/21	XVAH	3	505	UN	ARA	1	UN	UC in decomposition
30/09/21	XVAL	2	560	UN	ARA	1	UN	UC in decomposition
01/10/21	XVAL	4	275	1	ARA	1 (+2)	D/CbyN	FC; P&L; PKT

D=drowned; P=propeller; UN=unknown; D/PLE=drowned/ presumed lung oedema; D/CbyN=drowned/confirmed by necropsy. FC=fresh carcass; UC=unmarked carcass; RM=*rigor mortis*; PKS=presumably killed in shoot; PKH=presumably killed in haul; PFC=presumably FC; PPRM=presumable post release mortality; KH=killed in haul; PKT=presumably killed on a turn; P&L=pregnant and lactating.

4.3.2 *SED escapees and live deck releases*

During hauling 89 ARA and two OTB were seen escaping from the fishing gear through the SED hatch. It is important to mention that one of the escaping ARA was first seen entangled by the head inside a net wing, its survival being achieved only due to the correct manoeuvring of the captain and handling by the crew. The trawl was hauled very slowly until the animal was on deck, and crew were able to safely disentangle its head from the mesh. After being mesh-free, the seal displaced itself towards the SED (from within the net) and safely escaped through its hatch.

The number of individuals that escaped when the SED was below the surface during both shooting and hauling remains unknown.

Regarding deck releases, 10 ARA were brought aboard inside the SED net extension, three of them unconscious and expelling froth from their nostrils and/or mouth. Although these animals did recover consciousness and were allowed to rest on deck for around 20 min before returning to the water, they were categorised as post-release mortalities due to their certain lung oedema and haemorrhage. The remaining seven individuals were safely released from deck after cutting the net.

4.3.3 *Necropsies*

Following the increasing number of mortalities recorded during the second and third weeks of the fishery (with 8 and 12 mortalities, respectively), the observers were asked to preserve 11 ARA carcasses for post-mortem examination (Table 2). The overall sample was comprised by eight males and three females, of which one was lactating while another was both pregnant and lactating (Fig.7, Table 2); these offspring were included in the complete mortality numbers (Table 2). Necropsies were carried out by a team of three DoNR professionals, which included one Scientific Fisheries Observer (usually D. Evans) a Veterinary Officer (P. Van der Riet), and the Seabird and Marine Mammal Scientific Officer (V. Iriarte). Upon examination of the Respiratory System of the ARAs, it was confirmed that the cause of mortality of all the individuals was drowning (Fig.9, Table 2).

4.4 *Seabird bycatch*

A total of 182 seabird interactions were recorded throughout the season, of which 96 (53%) comprised net entanglements, 46 (25%) entanglements in FAA streamers, and 23 (13%) landings on deck (Fig.10). The outcome of these interactions was 82 (45%) mortalities, 59 (32%) live escapes and 41 (23%) live releases (Fig. 11). The average bird bycatch during the first six weeks of the fishery (28Jul-6Sep) was 8.16, with 49 interactions recorded (22 live escapes, 12 live releases, 15 mortalities) (Fig.11). However, in the last four weeks of the fishery (7Sep-30Oct) a 171% increase in interactions occurred (37 live escapes, 29 live releases, 67

mortalities), being the average weekly bycatch 33.25 and comprising 82% of the mortalities for the season (Fig.11).

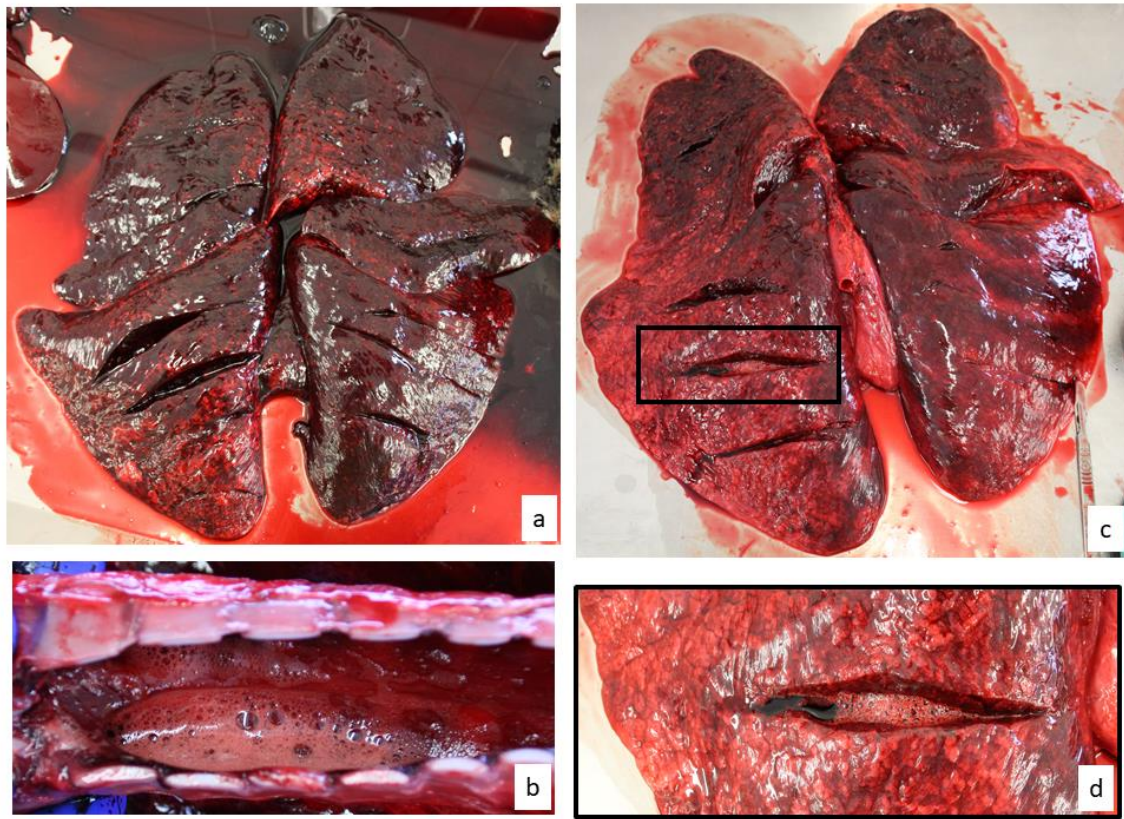


Fig.9. Indicators of drowning in the Respiratory System of the necropsied ARA: massive haemorrhage in lungs (a); bloody froth in trachea (b); haemorrhagic lungs with oedema (c); close-up view of lung haemorrhage and oedema (d).

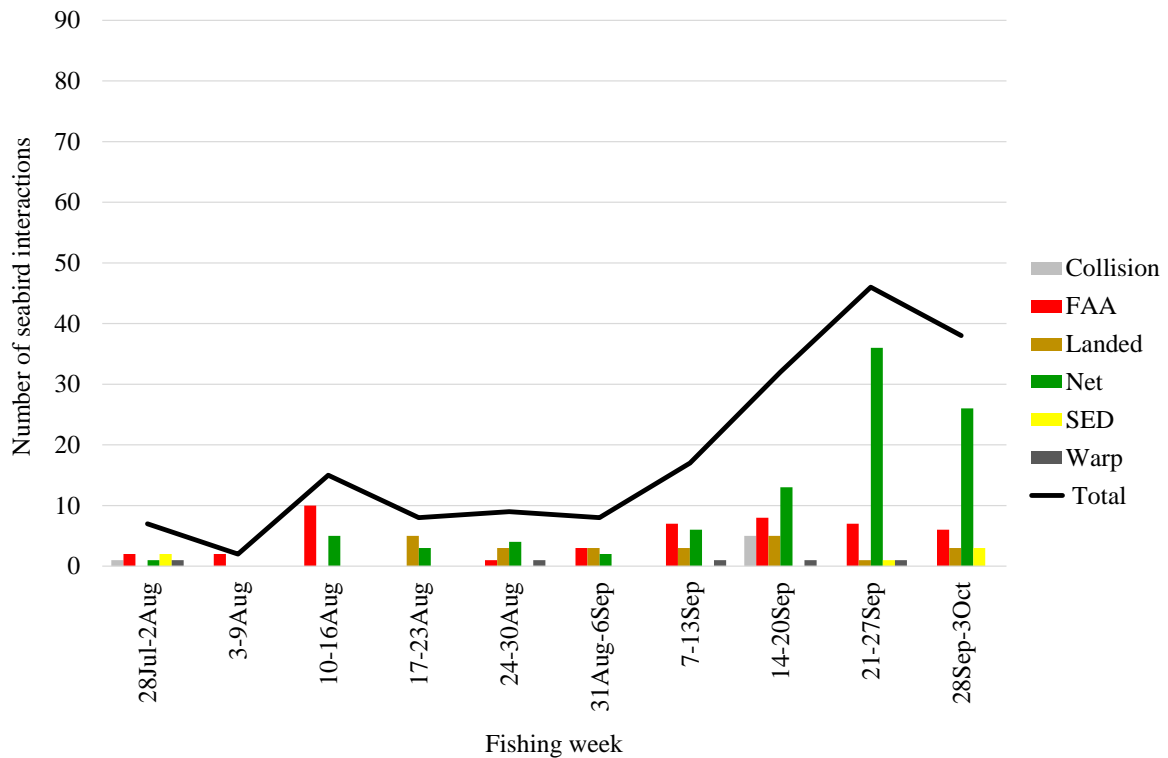


Fig.10. Number and type of seabird interactions recorded per fishing week.

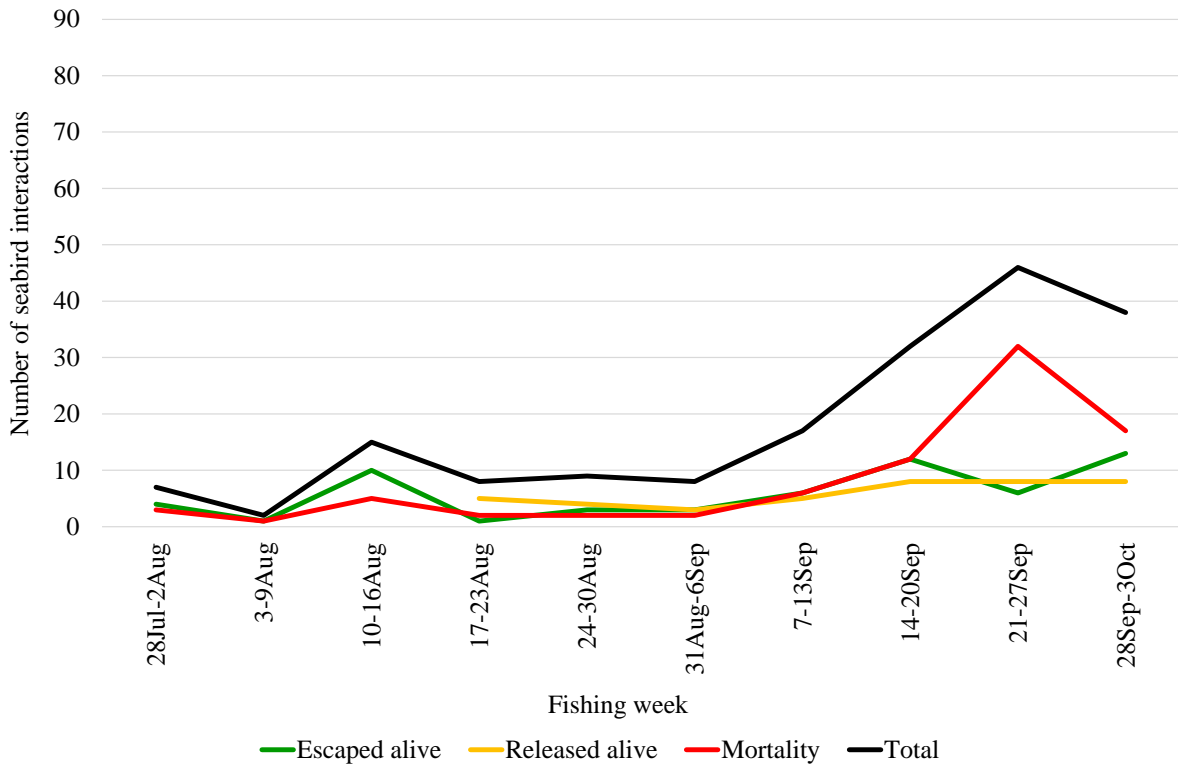


Fig.11. Outcome of the seabird interactions recorded per fishing week.

Ninety-six percent of the interactions were recorded south of 52°S, particularly in grid squares XVAK (35%), XVAL (25%), XVAJ (19%) (Fig.12), and while the fishing gear was either being shot (51%) or hauled (40%).

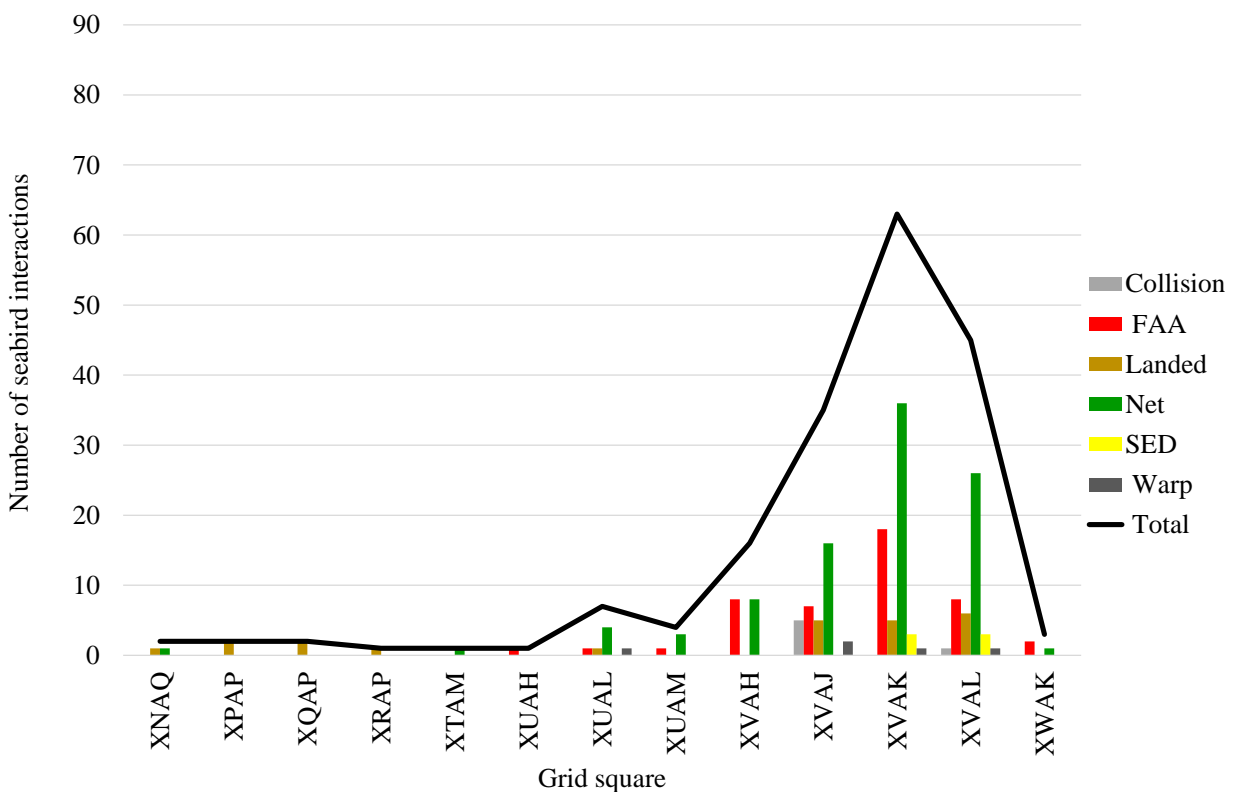


Fig.12. Number and type of seabird interactions per grid square.

4.4.1 Live interactions

Seabird live interactions involved 100 individuals and were mostly recorded during hauling (65%) and shooting (22%). Fifty-nine percent of these interactions comprised live escapes (54 DIM, 2 MAX, 1 DAC, 1 GAN, 1 LAD) and 41% live releases (30 DIM, 1 MAX, 6 PEL, 4 GAN). Of these, 43% comprised FAA streamers entanglements, 24% net entanglements, and 22% landings on the vessel (Fig.13).

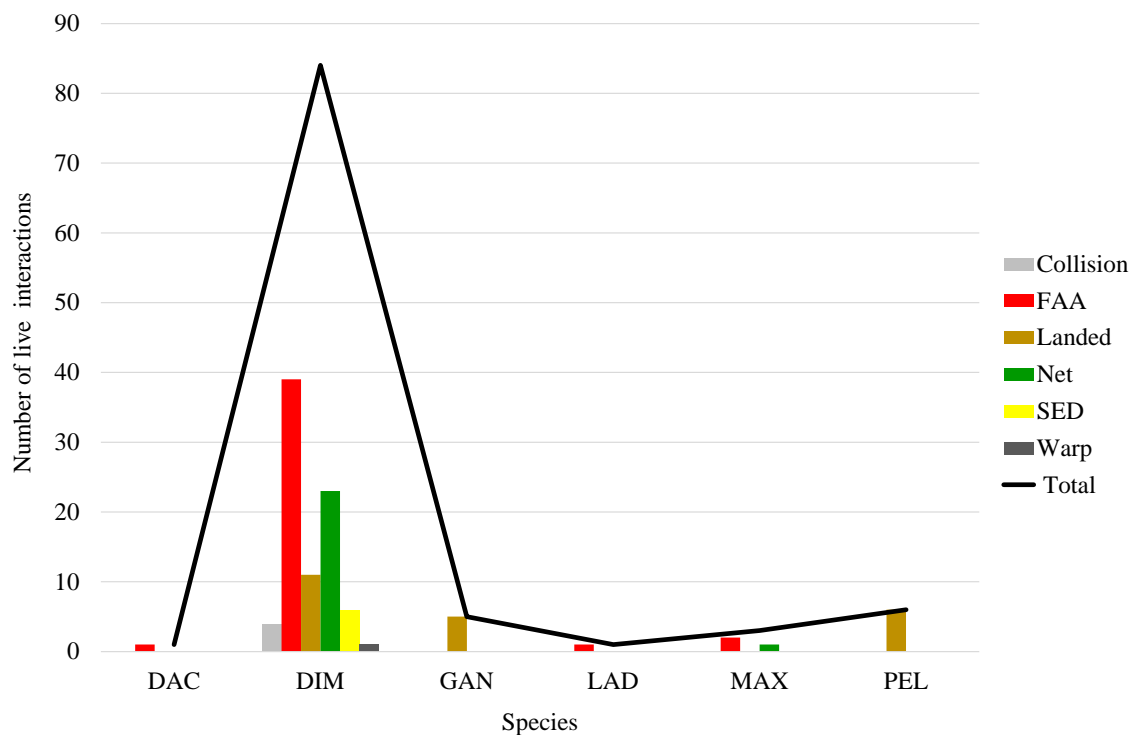


Fig.13. Number and type of live seabird interactions per species.

4.4.2 Incidental mortalities

A total of 82 seabird mortalities were recorded (81 DIM and 1 MAX) south of 52°S, particularly in grid squares XVAK (38%), XVAL (32%) and XVAJ (15%) (Table 3). The causes of death were net entanglements (88%), warp cables (5%), FAA streamers (4%) and vessel collisions (3%) (Table 3, Fig.14). Sixty-one of the mortalities (74%) were recorded during the last three weeks of the fishery (14Sep-3Oct), when the number of bird flocks' astern vessels were estimated to contain up to 7000 individuals (*personal observations made between 1-3Oct21 aboard the New Polar*) (Fig.14). Mortalities were recorded during shooting (61%), hauling (33%), and trawling (6%) (Table 3).

4.4.3 Seabird necropsies

Of the 82 incidental mortalities recorded, 55 DIM carcasses were collected and preserved, with necropsies performed on 48 individuals (Table 4). Of the DIM, 34 were male (31 confirmed breeding adults) and 13 female (10 confirmed breeding adults) (Table 4).

Table 3. Seabird incidental mortalities.

Date	M	Grid	Spp.	#Indiv.	Int.	S	Date	M	Grid	Spp.	#Indiv.	Int.	S
30/07/21	S	XVAK	DIM	1	Net	N	23/09/21	S	XVAK	DIM	1	Net	Y
01/08/21	T	XVAK	MAX	1	Warp	N	23/09/21	S	XVAK	DIM	1	Net	Y
02/08/21	T	XVAL	DIM	1	Col	N	23/09/21	S	XUAL	DIM	1	Net	Y
06/08/21	H	XWAK	DIM	1	FAA	N	23/09/21	H	XVAL	DIM	1	Net	Y
12/08/21	S	XVAK	DIM	1	Net	N	24/09/21	H	XVAL	DIM	3	Net	Y
12/08/21	S	XVAK	DIM	1	Net	N	24/09/21	S	XVAK	DIM	1	Net	Y
13/08/21	S	XVAK	DIM	1	Net	Y	25/09/21	H	XVAK	DIM	1	Net	Y
13/08/21	S	XVAK	DIM	1	Net	Y	25/09/21	S	XVAL	DIM	1	Net	N
16/08/21	S	XVAK	DIM	1	Net	Y	25/09/21	S	XWAK	DIM	1	Net	Y
20/08/21	H	XVAL	DIM	1	Col	N	25/09/21	S	XVAK	DIM	1	Net	Y
23/08/21	H	XUAL	DIM	1	Net	Y	25/09/21	H	XVAL	DIM	1	Net	Y
24/08/21	T	XVAL	DIM	1	Warp	N	25/09/21	S	XVAK	DIM	1	Net	Y
25/08/21	H	XVAL	DIM	1	Net	Y	25/09/21	S	XVAK	DIM	1	Net	Y
03/09/21	S	XVAK	DIM	1	Net	Y	25/09/21	S	XVAL	DIM	1	Net	Y
05/09/21	S	XUAM	DIM	1	Net	N	26/09/21	T	XVAJ	DIM	1	Warp	N
07/09/21	S	XVAL	DIM	1	Net	N	26/09/21	S	XVAL	DIM	1	Net	Y
07/09/21	S	XVAK	DIM	1	Net	Y	26/09/21	S	XVAL	DIM	1	Net	N
08/09/21	T	XUAL	DIM	1	Warp	N	27/09/21	S	XVAL	DIM	1	Net	Y
08/09/21	H	XVAL	DIM	1	FAA	N	27/09/21	S	XVAL	DIM	1	Net	Y
08/09/21	S	XVAK	DIM	1	Net	Y	27/09/21	S	XVAL	DIM	1	Net	Y
08/09/21	S	XVAK	DIM	1	Net	Y	27/09/21	S	XVAL	DIM	1	Net	Y
14/09/21	S	XVAK	DIM	1	Net	Y	27/09/21	H	XVAK	DIM	1	Net	N
14/09/21	H	XVAJ	DIM	1	Net	Y	27/09/21	S	XVAH	DIM	1	Net	Y
15/09/21	H	XVAJ	DIM	1	Col	N	29/09/21	S	XVAL	DIM	1	Net	Y
15/09/21	H	XVAJ	DIM	1	FAA	N	29/09/21	S	XVAL	DIM	1	Net	Y
17/09/21	H	XVAJ	DIM	1	Net	Y	29/09/21	H	XVAK	DIM	1	Net	N
19/09/21	S	XVAJ	DIM	1	Net	Y	30/09/21	S	XVAH	DIM	1	Net	N
19/09/21	S	XVAK	DIM	1	Net	Y	30/09/21	S	XVAJ	DIM	1	Net	N
19/09/21	H	XVAJ	DIM	1	Net	Y	30/09/21	H	XUAL	DIM	1	Net	N
19/09/21	H	XVAJ	DIM	1	Net	N	30/09/21	S	XVAJ	DIM	1	Net	Y
20/09/21	S	XVAK	DIM	1	Net	Y	30/09/21	S	XVAH	DIM	1	Net	Y
20/09/21	S	XVAJ	DIM	1	Net	Y	01/10/21	S	XVAL	DIM	1	Net	Y
20/09/21	H	XVAH	DIM	1	Net	Y	01/10/21	S	XVAL	DIM	1	Net	Y
21/09/21	S	XVAJ	DIM	1	Net	Y	02/10/21	H	XVAK	DIM	1	Net	Y
21/09/21	H	XVAH	DIM	1	Net	Y	02/10/21	S	XVAK	DIM	1	Net	Y
22/09/21	H	XTAM	DIM	1	Net	Y	02/10/21	H	XVAK	DIM	1	Net	N
22/09/21	S	XVAK	DIM	1	Net	Y	02/10/21	S	XVAL	DIM	1	Net	Y
22/09/21	S	XVAK	DIM	1	Net	Y	02/10/21	H	XVAK	DIM	1	Net	Y
22/09/21	S	XVAK	DIM	1	Net	N	03/10/21	S	XVAK	DIM	1	Net	N
23/09/21	S	XVAL	DIM	1	Net	Y	03/10/21	H	XVAL	DIM	1	Net	N

M=manoeuvre; S=shoot; T=trawl; H=haul; Int=interaction; Col=collision; S=sampled.

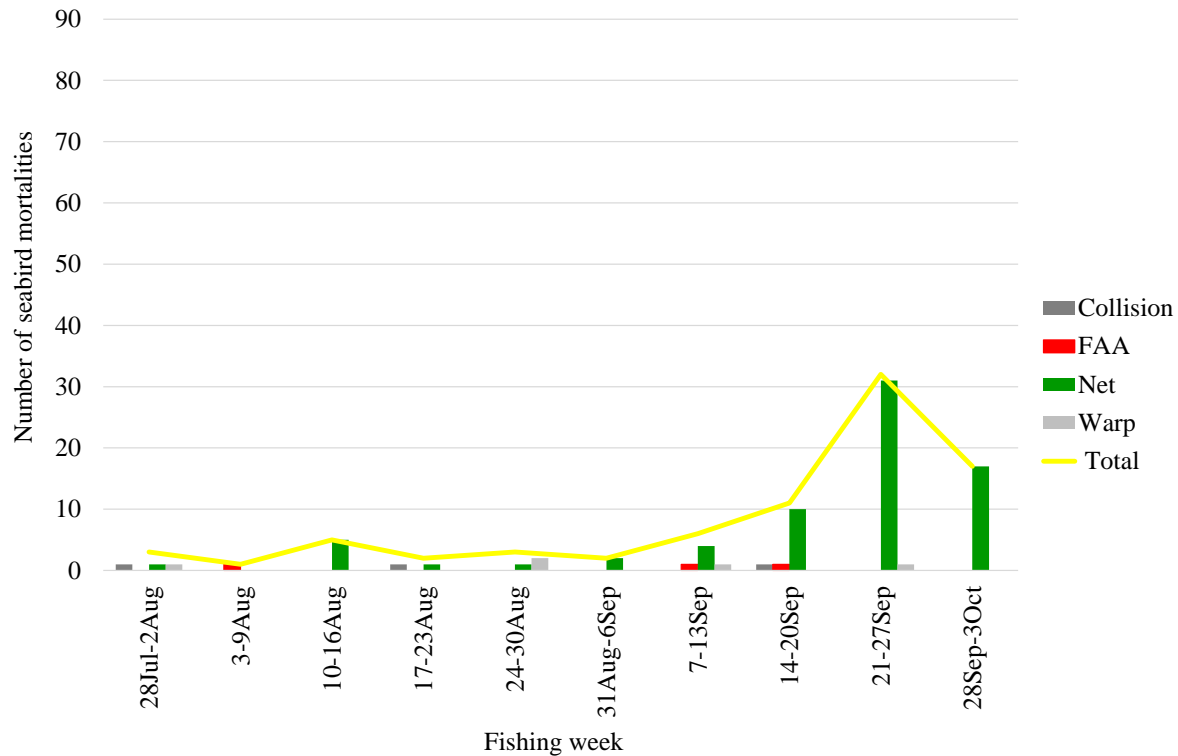


Fig.14. Number and type of seabird incidental mortalities per fishing week

Table 4. Seabird necropsies.

Date	M	Grid	Int.	Spp.	#Indiv.	S	Age	B	Comments
13/08/21	S	XVAK	NET	DIM	1	F	5+	Y	Inside mouth of the net; brood patch.
13/08/21	S	XVAK	NET	DIM	1	M	5+	UN	Inside mouth of the net; small testes, brood patch absent.
16/08/21	S	XVAK	NET	DIM	1	M	5+	Y	Found inside SED; big testes, brood patch absent.
25/08/21	H	XVAL	NET	DIM	1	UN	5+	UN	Found inside SED, entangled in the net for a couple of days.
02/09/21	S	XVAK	NET	DIM	1	M	5+	UN	Inside net wings; medium size testes, brood patch absent.
07/09/21	S	XVAK	NET	DIM	1	M	5+	Y	Entangled outside cod-end (chafer), right leg broken and injury in right wing joint; big testes with sperm, brood patch absent, soil inside bill.
08/09/21	S	XVAK	NET	DIM	1	M	5+	Y	Entangled outside cod-end (chafer); big testes with sperm, brood patch present.
14/09/21	S	XVAK	NET	DIM	1	F	5+	UN	Inside net wings; right wing and leg broken; exposed organs; could rom previous station.
14/09/21	H	XVAJ	NET	DIM	1	M	5+	Y	Inside mouth of the net; big testes with sperm, brood patch present.
17/09/21	H	XVAJ	NET	DIM	1	F	5+	UN	Entangled outside cod-end (chafer), died on deck; brood patch absent.
19/09/21	S	XVAJ	NET	DIM	1	F	5+	Y	Seen entangled inside mouth of the net (recovered from cod-end); LOL inside bill; huge brood patch.
19/09/21	S	XVAK	NET	DIM	1	M	5+	Y	Head entangled in net wing; big testes with sperm, brood patch absent.
19/09/21	H	XVAJ	NET	DIM	1	F	5+	Y	Inside net wings; fully developed egg, brood patch absent.
20/09/21	S	XVAK	NET	DIM	1	M	5+	Y	Inside mouth of the net; big testes with sperm, brood patch present.
20/09/21	S	XVAJ	NET	DIM	1	F	5+	Y	Inside net wings; fully developed egg, brood patch present.
21/09/21	H	XVAH	NET	DIM	1	M	5+	Y	Entangled outside cod-end (chafer); exposed fracture in left wing; big testes, brood patch present.
21/09/21	S	XVAJ	NET	DIM	1	F	5+	Y	Inside net wings; left wing and leg broken; fully developed egg, brood patch present.
21/09/21	H	XVAH	NET	DIM	1	M	5+	Y	Inside body of the net; big testes with sperm, brood patch absent.
22/09/21	H	XTAM	NET	DIM	1	M	5+	Y	Inside mouth of the net; big testes with sperm, brood patch present.
22/09/21	S	XVAK	NET	DIM	1	F	5+	Y	Inside mouth of the net; right wing broken, brood patch present.
22/09/21	S	XVAK	NET	DIM	1	M	5+	Y	Inside mouth of the net; big testes with sperm, brood patch absent.
23/09/21	S	XVAL	NET	DIM	1	M	5+	Y	Entangled outside net wing; right wing broken; big testes with sperm, brood patch present.
23/09/21	S	XVAK	NET	DIM	1	M	5+	Y	Head entangled in net wing; big testes with sperm, brood patch present.
23/09/21	S	XVAK	NET	DIM	1	M	5+	Y	Entangled outside net wing; big testes with sperm, brood patch present.
23/09/21	S	XUAL	NET	DIM	1	M	5+	Y	Inside mouth of the net; big testes with sperm, brood patch present.
23/09/21	H	XVAL	NET	DIM	1	M	5+	Y	Inside mouth of the net; big testes with sperm, brood patch present.
24/09/21	S	XVAK	NET	DIM	1	M	5+	Y	Inside mouth of the net; big testes, brood patch absent.
25/09/21	H	XVAK	NET	DIM	1	M	5+	Y	Inside net wings; big testes with sperm, brood patch absent.
25/09/21	S	XWAK	NET	DIM	1	F	5+	Y	Inside net wings; fully developed egg, brood patch absent.
25/09/21	H	XVAL	NET	DIM	1	M	5+	Y	Entangled outside cod-end (chafer); big testes with sperm, brood patch present.
25/09/21	S	XVAK	NET	DIM	2	M	5+	Y	Inside body of the net; big testes with sperm, brood patch present.
25/09/21	S	XVAL	NET	DIM	1	M	5+	Y	Inside net wings; big testes with sperm, brood patch present.
26/09/21	S	XVAL	NET	DIM	1	M	5+	UN	Inside mouth of the net; medium size testes, brood patch absent.
27/09/21	S	XVAL	NET	DIM	1	F	5+	UN	Inside mouth of the net; right leg broken; brood patch absent.
27/09/21	S	XVAL	NET	DIM	3	M	5+	Y	Inside cod-end; big testes with sperm, brood patch present.
27/09/21	S	XVAH	NET	DIM	1	F	5+	Y	Inside net wings; broken wings; eggs in formation, brood patch present.
29/09/21	S	XVAL	NET	DIM	1	F	5+	Y	Inside net wings; broken wings; fully developed egg, brood patch present.
29/09/21	S	XVAL	NET	DIM	1	M	5+	Y	Inside net wings; big testes with sperm, brood patch present.
30/09/21	S	XVAJ	NET	DIM	1	F	5+	Y	Inside mouth of the net; fully developed egg, brood patch present.
01/10/21	S	XVAL	NET	DIM	1	M	5+	Y	Inside net wings; fat remains (galley) inside bill; big testes, brood patch present.
01/10/21	S	XVAL	NET	DIM	1	M	5+	Y	Inside net wings; big testes with sperm, brood patch present.
02/10/21	S	XVAL	NET	DIM	1	M	5+	Y	Inside net wings; left leg broken; big testes with sperm, brood patch present, soil inside upper bill.
02/10/21	H	XVAK	NET	DIM	1	M	5+	Y	Inside the throat, 2-3m before SED net extension; alive but died at the ramp/on deck; big testes with sperm, brood patch absent.
02/10/21	H	XVAK	NET	DIM	1	M	5+	Y	Entangled outside net wing; right wing broken; big testes, brood patch present.
02/10/21	S	XVAK	NET	DIM	1	M	5+	Y	Entangled outside net wing; big testes with sperm, brood patch absent.

M=manoeuvre; S=shoot; H=haul; Int=interaction; S=sex; B=breeding.

5. Conclusions

5.1. As in previous seasons, both pinniped and seabird interactions with the fleet were concentrated in grid squares XVAK, XVAL, XVAJ, attending the vessels to directly depredate from the net or forage around the fishing gear during manoeuvres.

5.2. In comparison to 2020-X, seal attendance to the vessels increased by 51% and their bycatch increased by 106%. This increase in combination with bad weather resulted in an 108% increase in mortalities in nets fitted with a SED.

5.3. In comparison to 2020-X, seabird live interactions increased by 488%, with DIM mortalities reaching a 636% rise. These mortalities recorded during the last three weeks of the fishery were mostly related to net entanglements, which supports future research on possible trawl mesh size changes in the mouth/net wing sections from 2018 onwards.

5.4. Regarding discard management implementation, overall discard storage tank usage was efficient, with birds attending vessels mostly during manoeuvres.

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