

LOL 2020-X MMO Monitoring Program Report



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LOL 2020-X



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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 result of a partnership between 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. Secondary MMO duties include monitoring bird scaring lines (BSL) efficiency, recording seabird interactions with the fishing gear, mortalities and carcass collection.

The LOL 2020-X season started on 30th July 2020. Two of the vessels had a FIFD observer aboard, however it was mandatory for the 16 vessels to carry out their fishing operations with a trawl fitted with a SED. On 6th August the 16 MMOs were deployed in the fleet, providing 100% of coverage from 7th August onwards. MMOs were supplied by MRAG (U.K) and were briefed at the Falkland Islands Fisheries Department (FIFD) on 5th August. 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 concentrated in monitoring interactions, extracting information from carcasses, data gathering and recording, biometrics of LOL and Patagonian toothfish (*Dissostichus eleginoides*, hereafter TOO), and License conditions.

2. Objectives

The objective of this report is to present all the data collected during the 2020-X season regarding marine mammal and seabird interactions with the LOL fleet and to evaluate the mortality mitigation methods in place. 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 at least three stations per day (one station comprised by a shoot and a haul) 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; Küepfer, 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 monitoring from the bridge/bridge wings may occur 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 *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 (Küepfer, 2016a, 2017, 2018). 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 and discarding. In vessels fitted with a discard tank observations are carried out even without any factory discharge being made. 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). The most common species interacting with the LOL fishery are: black-browed albatross (*Talassarche melanophris*, hereafter DIM), giant petrel species (*Macronectes giganteus* and *Macronectes halli*, hereafter MAX), sooty shearwater (*Ardenna grisea*, hereafter PFG), Gentoo penguin (*Pygoscelis papua*, hereafter PYP), black-bellied storm petrel (*Fregetta tropica*, hereafter FRT) and the common diving petrel (*Pelecanoides urinatrix*, hereafter PEL).

3.3 *Seabird and marine mammal bycatch mitigation measures*

MMOs also monitor compliance to good practices, bycatch mitigation methods efficiency (i.e. BSL and SED) and discard storage tank usage and functioning. In the LOL fishery incidental mortality of both seals and seabirds occur mostly during shooting, when animals approach the net to forage in catch leftovers (“stickers”) that remain adhered to the net after the previous trawl. In order to mitigate seal and seabird mortality in the fishery, Part 2 of the license conditions mandate the use of BSL, prohibit discarding during manoeuvres (i.e. shoot, turn, haul) and requires to clean the net thoroughly prior to shooting. Besides, license

conditions describe three SED models approved by the FIFD, mandating its usage after two seal mortalities within the fleet.

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 posterior necropsy, while male carcasses are usually marked (partially cut/complete removal of the left pectoral fin) and dumped overboard.

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*

Except BSL monitoring, all 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*

Upon observer embarkation, a total of 2920 trawls were carried out by the fleet, of which 2884 (98.7%) were monitored in at least one manoeuvre (i.e. either a shoot or haul). Of a total of 2858 shoots observed, 1785 (62%) were monitored from the gantry, 131 from the stern deck (4%), and 942 from elsewhere (33%) (Fig.1). Regarding the 2866 hauls observed, 1877 (65%) were monitored from the gantry, 137 (5%) from the stern deck and 852 (30%) from elsewhere (Fig.1).

Fishing effort was mostly carried out south of 52°S, with 54% of the trawls taking place in the south and 46% in the north. The most visited grid squares in the south were XVAK (343 shoots; 337 hauls) and XVAL (355 shoots; 319 hauls), while in the north most of the fishing activity took place in XMAP (261 shoots; 273 hauls) and XLAP (187 shoots; 198 hauls) (Fig.2).

4.2 *Pinniped sightings*

A total of 6849 seals [1022 OTB, 5593 ARA, 234 unknown species (UN)] were seen in 1907 occasions, of which 30% occurred north of 52°S and 70% south of 52°S (Table 1). The southern region concentrated 79% of the total seal abundance, with ARA representing 82% of the individuals sighted (Table 1).

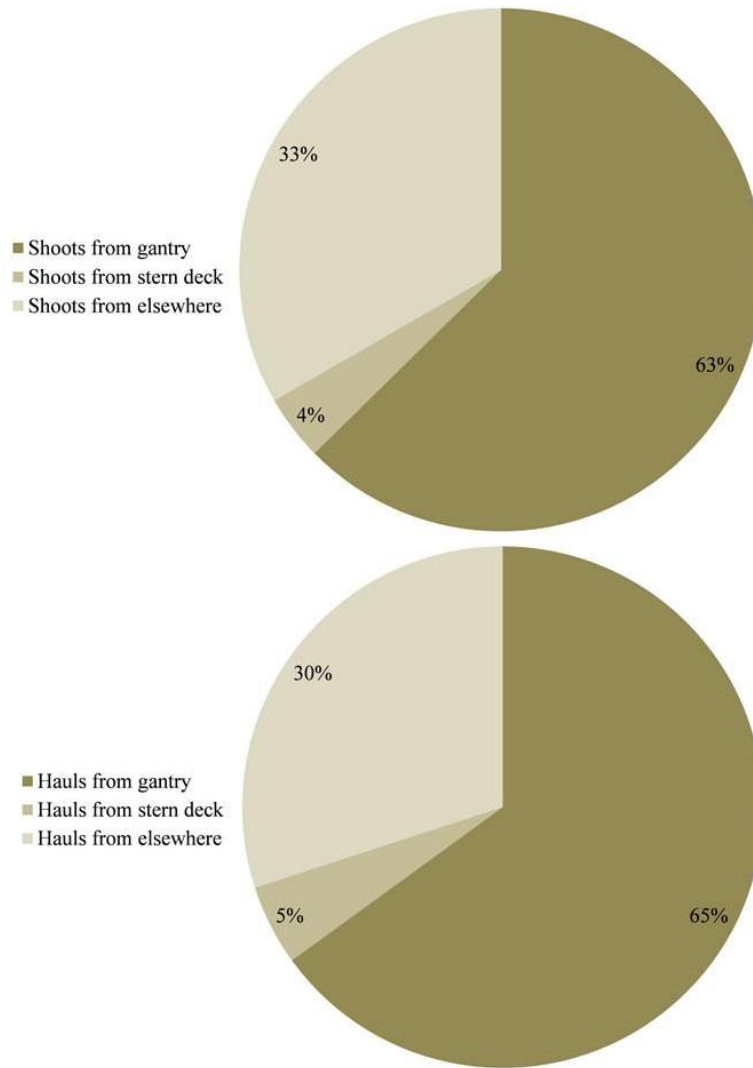


Fig.1. MMO manoeuvre observation point.

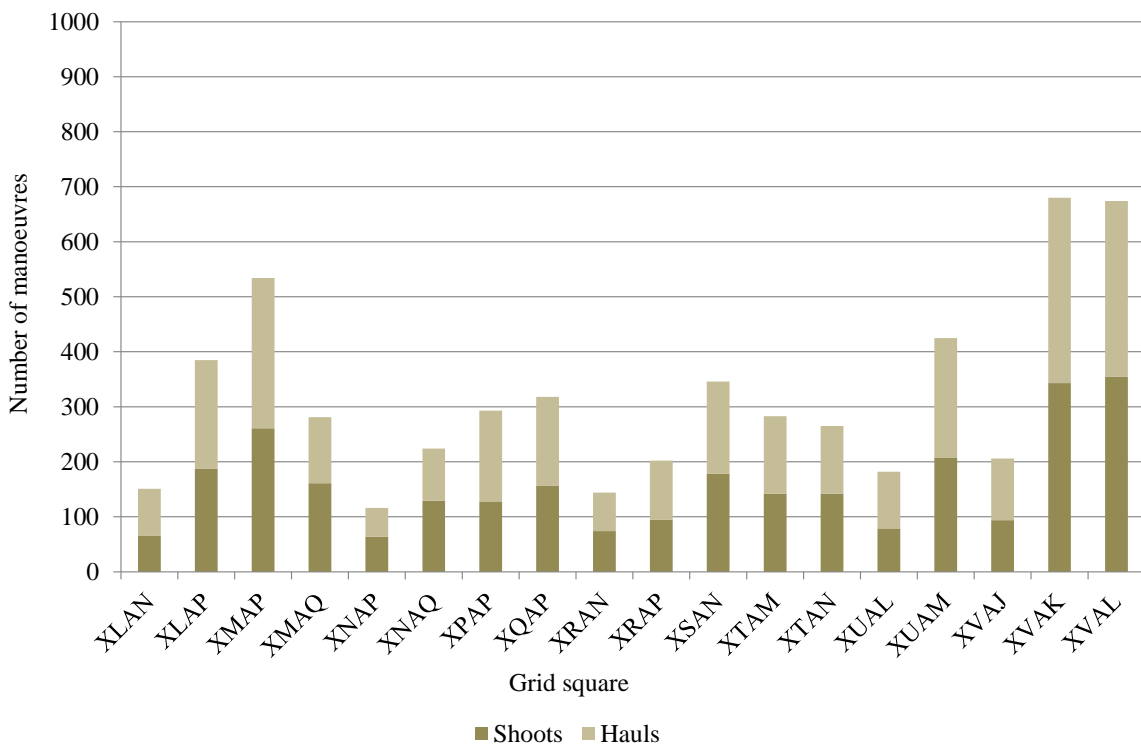


Fig.2. Fishing effort per grid square.

Table 1. Pinniped sighting and abundance per region.

Region	Species	N° sightings	N° individuals
North 52°S	OTB	270	500
	ARA	313	818
	UN	51	89
Sub-total north		634	1407
South 52°S	OTB	244	522
	ARA	965	4775
	UN	64	145
Sub-total south		1273	5442
TOTAL		1907	6849

When MMO monitoring started during the second week of the fishery, the overall seal abundance was almost at its maximum, with a peak reached during the 3rd week of the fishery (14-20 August), with 1568 individuals sighted (1438 ARA, 82 OTB, 48 UN) (Fig.3). From 21-27 August the fleet moved north of 52°S, ARA sightings dropping 80% from the previous week, while OTB increased (Fig.3). Although during the 5th week 70% of the effort was carried out in the north, 91% of the sightings corresponded to ARA seen south of 52°S, following a 30% of the fishing effort carried out in the south. Although after 3rd September fishing effort in the south slowly increased around 10% per week, ARA sightings continuously diminished while OTB attendance to vessels increased, reaching a peak between 11-17 September (205 OTB) (Fig.3). As a result of bad weather and reduced fishing effort, the lowest number of sightings was recorded on the 8th fishing week (278 ARA, 143 OTB, 9 UN). During the last week of the fishery 73% of the effort took place in the south, with 565 individual seals recorded (387 ARA, 157 OTB, 21 UN). Reduced sightings between 2-6 October corresponded to a decreasing number of vessels fishing under compensatory days (e.g. 14 vessels on the 2nd, 7 vessels on 5th, 1 vessel on the 6th) (Fig.3).

4.2.1 Pinniped attendance to vessels and behaviour

Of the 6,849 seals sighted, 4813 (3821 ARA, 801 OTB, 191 UN) were observed during hauling, comprising 70% of the individuals recorded. The remaining individuals (2,036) were seen during shooting (13%), trawling (12%), and turning (5%). In 92% of the hauling attendance, seal behaviour was strictly related to foraging, with both ARA and OTB directly eating from the net (64%) or targeting lost catch around the fishing gear (29%) (Fig.4; cover photo).

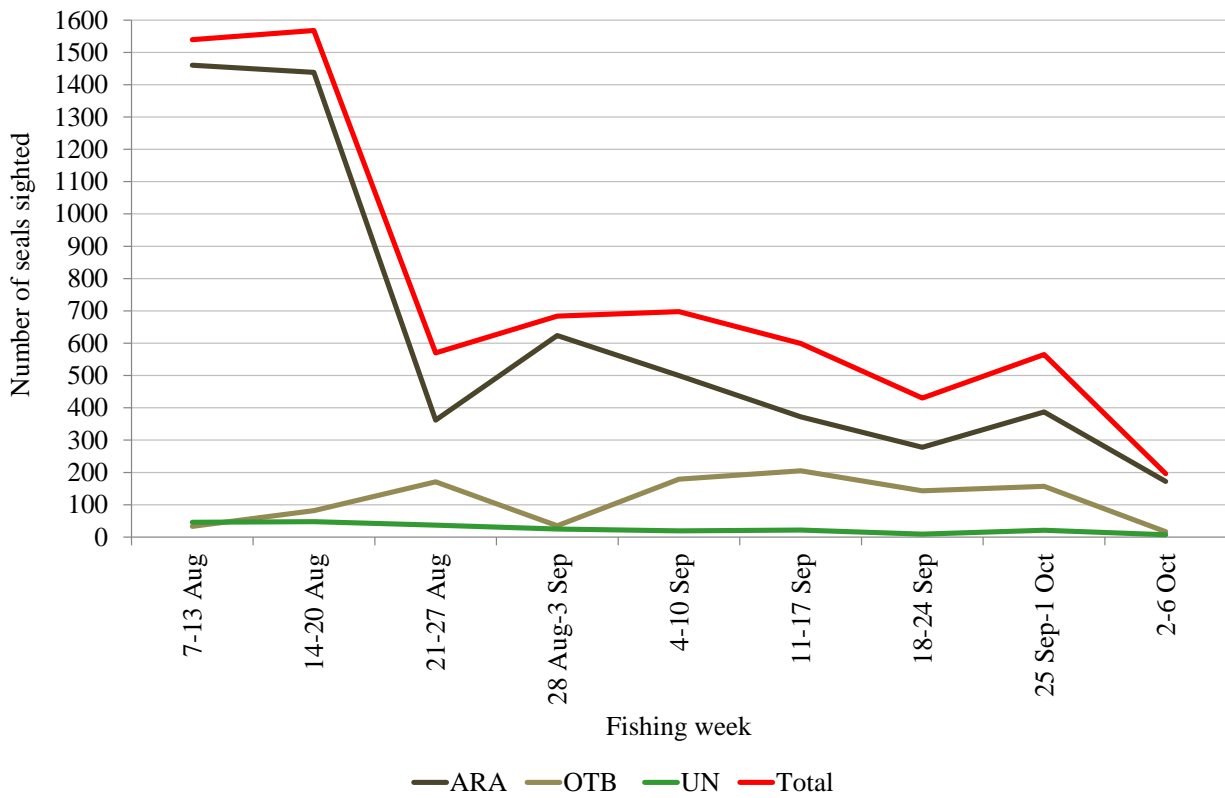


Fig.3. Cumulative pinniped sightings per fishing week. As during the second week ARA attendance to vessels was already in decrease, it is unknown whether their abundance peaked during the first fishing week.

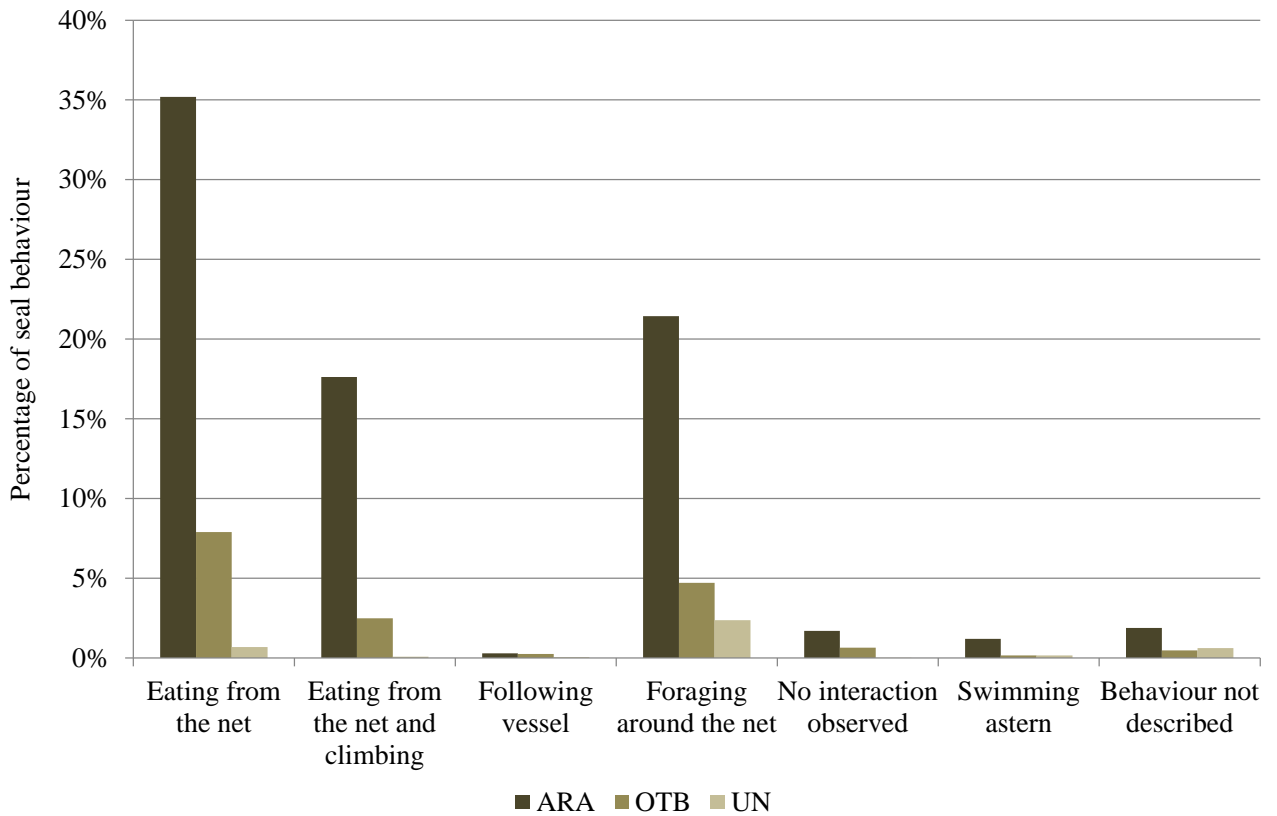


Fig.4. Pinniped behaviour exhibited during hauling.

Furthermore, during both shooting and trawling pinniped vessel attendance was also related to foraging (Fig.5). During shooting, 56% of the seals were principally seen feeding on stickers both still attached to the net or lost floating ones, while during trawling 26% of the individuals were recorded eating discards and 66% following the vessel (Fig.5).

4.3 Pinniped bycatch

Under MMO monitoring, a total of 69 seals were bycaught, of which 13 ARA were incidentally killed, 40 were seen escaping through the SED hatch during hauling (34 ARA, 5 OTB, 1 UN), and 16 arrived on deck and were safely released (14 ARA, 2 OTB). In addition, seven unmarked ARA carcasses in decomposition were recovered during the 2nd and 3rd weeks of the fishery.

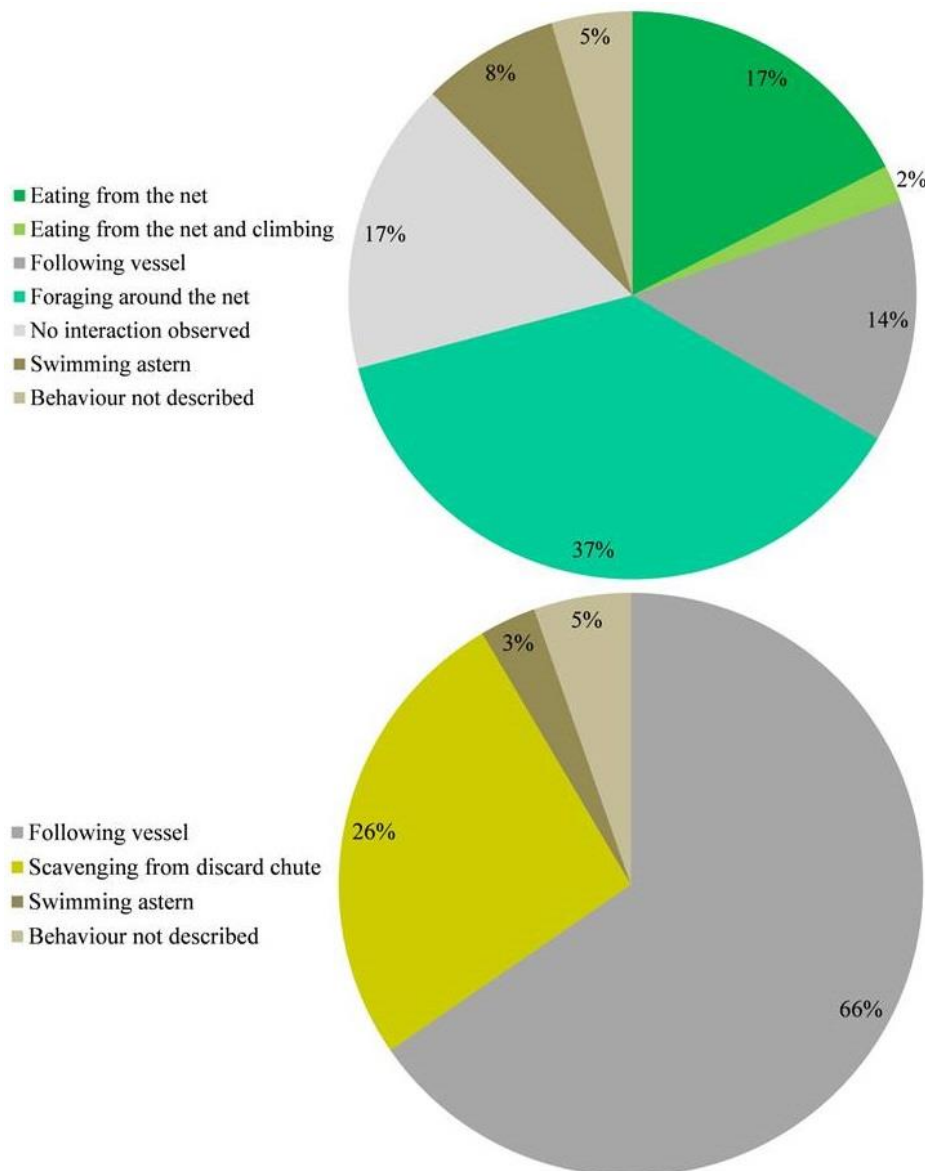


Fig.5. Pinniped behaviour exhibited during shooting (top) and trawling (bottom).

4.3.1 Incidental mortalities and SED implementation

MMOs embarked on 6 August, with the fleet's fishing activity being monitored by the MMOs on the 7th from 00:00 onwards, with the use of SEDs as optional. Following license conditions for the *Loligo* fishery, SEDs are to be immediately deployed after the mortality of two marine mammals in the fleet. Fourteen vessels began their daily fishing using standard fishing gear without SED, while two had a SED fitted in the net. The first two hauls of the day recorded multiple male ARA incidental mortalities on two vessels (Table 2), however both vessels continued their fishing activities without fitting a SED in the net. After receiving reports about 6 ARA mortalities, at 09:00 FIFD notified the fleet SED mandatory usage south of 52°S. Following three further ARA male mortalities in the south and one female in the north before midday (Table 2), at 14:12 FIFD sent a second message to the LPG about SED mandatory use in the whole LOL Box from 00:01 on 8 August.

In addition to the 10 incidental mortalities reported, one vessel recovered an unmarked ARA carcass (i.e. with both forelimbs present). Although this carcass was described by the MMO as fresh (i.e. being an incidental mortality), photographic record evidence the carcass was actually in decomposition (Fig.6b). Its post-mortem characteristics indicate a >24h period, death presumably occurring >72h (Table 2, Fig. 6b).

Of the 11 carcasses recorded on 7 August, nine were marked by the MMOs, one was immediately dumped by crew before the observer could examine/photograph/mark the carcass, and one was frozen for later necropsy ashore (Table 2).

Table 2. ARA mortalities reported per MMO station on 07/08/20.

Station	Time (haul)	Grid (shoot/ haul)	Trawl duration (min)	SED	Carcass #	Species	Carcass condition
1	04:00	XVAL/XVAK	225	NA	3	ARA	Fresh
1	04:55	XVAK/XVAK	280	NA	2	ARA	Fresh (Fig.6a)
1	05:50	XVAL/XVAK	325	NA	1	ARA	Fresh
1	09:10	XUAL/XVAL	502	NA	1	ARA	UN (dumped before MMO inspection)
2	09:50	XVAK/XVAK	205	NA	1	ARA	Fresh
2	10:20	XVAK/XVAL	290	NA	1	ARA	Fresh
2	10:50	XVAK/XVAL	230	NA	1	ARA	In decomposition (Fig. 6b)
2	11:30	XMAQ/XLAP	315	NA	1	ARA	Fresh/frozen for necropsy

After SEDs were fully employed in the fishing area, three additional mortalities occurred (Table 3). Although two of these mortalities were possibly related to manoeuvring that led to the blockage of the SED escape passage, the third occurred after a live fur seal inside the net tried to escape through a hole in a net wing, became stuck by the neck, and died during hauling (Table 3). All carcasses were marked by the MMO and dumped overboard (Table 3).



Fig.6. Level of decomposition of ARA carcasses recovered on 07/08/20. Note clear and lubricated eye in the fresh carcass (a) and blurry eye, dry mucous membranes and white top eyelid in the >24h post-mortem carcass (b).

Table 3. Post-SED mortalities.

Date	Grid (shoot/haul)	Spp	Carcass #	Activity	Comments
08/08/20	XVAK/XVAK	ARA	1	Shoot/turn	Fresh male with <i>rigor mortis</i> , water and froth coming out from the nose and mouth. Presumably killed during shoot/haul after manoeuvring blocked escape passage to the SED.
08/08/20	XVAK/XVAL	ARA	1	Turn/haul	Fresh male, light <i>rigor mortis</i> . Presumably killed during either the turn or haul, when the SED came bottom up.
18/08/20	XVAK/XVAJ	ARA	1	Haul	Juvenile male. During the haul its head became stuck in a net wing and died during manoeuvring.

In order to investigate the sexual maturity and reproductive state of the incidentally killed ARA female, its carcass was preserved aboard for posterior necropsy (Table 4). It was confirmed she was in an advanced stage of her first pregnancy, being the foetus a 25 cm female (Fig.7). Stomach contents of the mother were comprised by 17 partially digested *Loligo*, 2 *Patagonotothen spp.* heads, 2 body pieces of *Patagonotothen tessellata* (PTE), and several squid beaks, including *Morotheuthis ingens* (ING).

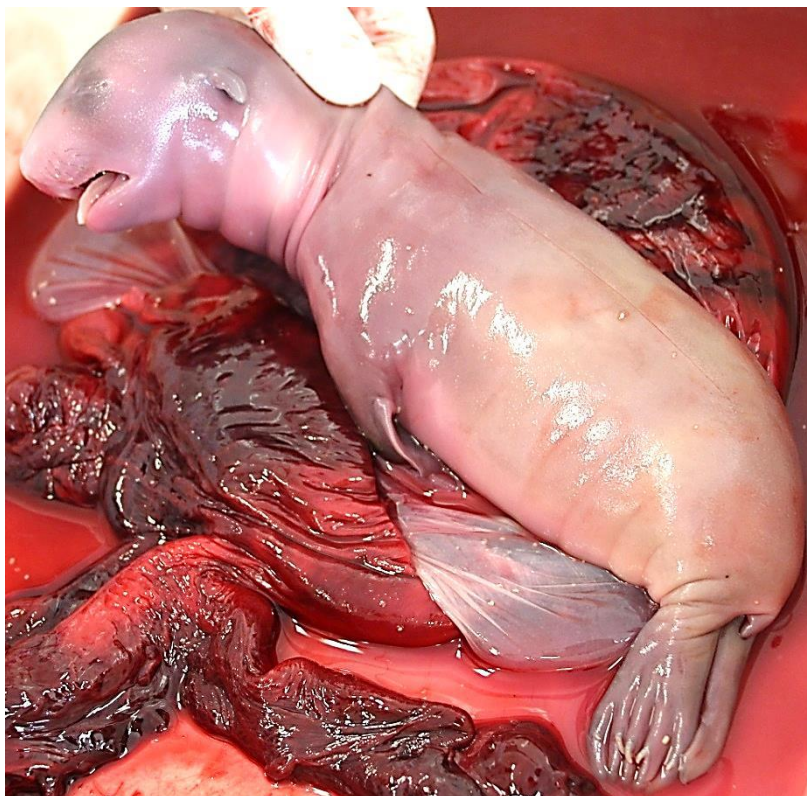


Fig.7. Fully developed female ARA foetus.

Table 4. Female ARA necropsied.

<i>Mortality date</i>	<i>Necropsy date</i>	<i>Total length (cm)</i>	<i>Axillary girth (cm)</i>	<i>Weight (kg)</i>	<i>Approx. age (y)</i>	<i>Comments</i>
07/08/20	22/10/20	133	91	47.52	≥3	Healthy robust adult t individual with a 25cm female foetus. Mammary glands without milk. Trachea with froth and water; edematous lungs with froth. Ovary condition did not indicate previous pregnancies.

4.3.2 SED escapees and live deck releases

A total of 40 seals (34 ARA, 5 OTB, 1 UN) were seen escaping through the SED hatch during hauling (Table 5, cover photo). It should be pointed out that these SED escape events are visible only when the SED is already on the surface of the water. The number of individuals that escaped when the SED was below the surface during both shooting and hauling remains unknown. Seventy-eight percent of the escapees (31 individuals) were observed south of 52°S, principally in grid squares XVAK (55%) and XVAL (32%), which corresponded to 31 ARA and one OTB (Table 5). The rest of the SED escapees were observed in the north, principally in grid squares XPAP (44%) and XMAP (22%), which were comprised by four OTB, four ARA and one UN species (Table 5).

Table 5. SED escapees observed during hauling.

<i>Date</i>	<i>Grid haul</i>	<i>Spp</i>	<i># Individ.</i>	<i>Date</i>	<i>Grid haul</i>	<i>Spp</i>	<i># Individ.</i>
08/08/20	XVAK	ARA	1	26/08/20	XVAK	ARA	1
08/08/20	XVAK	ARA	1	26/08/20	XRAP	OTB	1
09/08/20	XVAK	ARA	1	26/08/20	XMAP	OTB	1
09/08/20	XVAL	ARA	1	27/08/20	XVAK	ARA	2
10/08/20	XVAJ	ARA	1	29/08/20	XVAL	ARA	2
10/08/20	XVAK	ARA	1	29/08/20	XVAL	ARA	1
12/08/20	XVAK	ARA	1	31/08/20	XVAL	ARA	2
12/08/20	XVAL	ARA	1	05/09/20	XNAP	OTB	1
12/08/20	XVAL	ARA	1	10/09/20	XPAP	ARA	2
12/08/20	XVAK	ARA	1	14/09/20	XPAP	UN	1
13/08/20	XVAL	ARA	1	18/09/20	XQAP	ARA	1
13/08/20	XVAK	ARA	2	21/09/20	XMAP	ARA	1
14/08/20	XVAL	ARA	1	22/09/20	XUAM	OTB	1
14/08/20	XVAJ	ARA	1	24/09/20	XSAN	ARA	1
15/08/20	XVAK	ARA	1				
16/08/20	XVAK	ARA	2				
17/08/20	XVAK	ARA	1				
19/08/20	XVAK	ARA	1				
20/08/20	XVAK	ARA	1				
24/08/20	XPAP	OTB	1				

ARA=34
 OTB=5
 UN=1
Total =40 indiv.

Regarding deck releases, 16 individuals (14 ARA, 2 OTB) arrived on deck during hauling and were safely released by the crew (Table 6). Of these, 13 (81%) took place south of 52°S, principally in grid squares XVAK (46%) and XVAL (23%), all of them being ARA. Of the three individuals freed in the north, two were OTB and one ARA (Table 6).

Table 6. Live deck releases.

<i>Date</i>	<i>Grid haul</i>	<i>Spp</i>	<i># Individ.</i>	<i>Date</i>	<i>Grid haul</i>	<i>Spp</i>	<i># Individ.</i>
11/8/20	XVAL	ARA	1	27/8/20	XVAK	ARA	1
14/8/20	XVAK	ARA	1	29/8/20	XVAL	ARA	1
14/8/20	XVAK	ARA	1	1/9/20	XUAL	ARA	1
15/8/20	XVAK	ARA	1	23/9/20	XUAM	ARA	1
15/8/20	XVAK	ARA	1	28/9/20	XNAQ	OTB	1
17/8/20	XWAK	ARA	1	28/9/20	XSAN	ARA	1
17/8/20	XVAL	ARA	1	30/9/20	XVAK	ARA	1
23/8/20	XRAP	OTB	1	1/10/20	XQAP	ARA	1

4.3.3 Carcasses in decomposition

An unusual recording of seven unmarked ARA carcasses (i.e. both forelimbs present) was recorded during the first two weeks of MMO monitoring. In addition to the unmarked ARA carcass recovered on 7th August (Fig.6b, Table 2), six more came in trawls carried out south of 52°S (XVAK/XVAL) (Table 7). Level of decomposition indicated mortalities possibly occurred around 7-20 days before recovery (Fig.8).

Table 7. Carcasses recovered during 2nd and 3rd week of the fishery.

Date	Grid (shoot/ haul)	Carcass #	Spp	Carcass condition
09/08/20	XWAK/XVAK	1	ARA	Unmarked; moderately decomposed (Fig.8a)
10/08/20	XVAK/XVAK	1	ARA	Unmarked; moderately decomposed (Fig.8b)
13/08/20	XVAJ/XVAJ	1	ARA	Unmarked; moderately decomposed (Fig.8c)
14/08/20	XVAJ/XVAJ	1	ARA	Recaptured carcass (Fig.9)
18/08/20	XVAK/XVAK	1	ARA	Unmarked; advanced decomposition (Fig.8d)
19/08/20	XVAL/XVAL	1	ARA	Unmarked; advanced decomposition (Fig.8e)
20/08/20	XVAK/XVAK	1	ARA	Unmarked; advanced decomposition (Fig.8f)

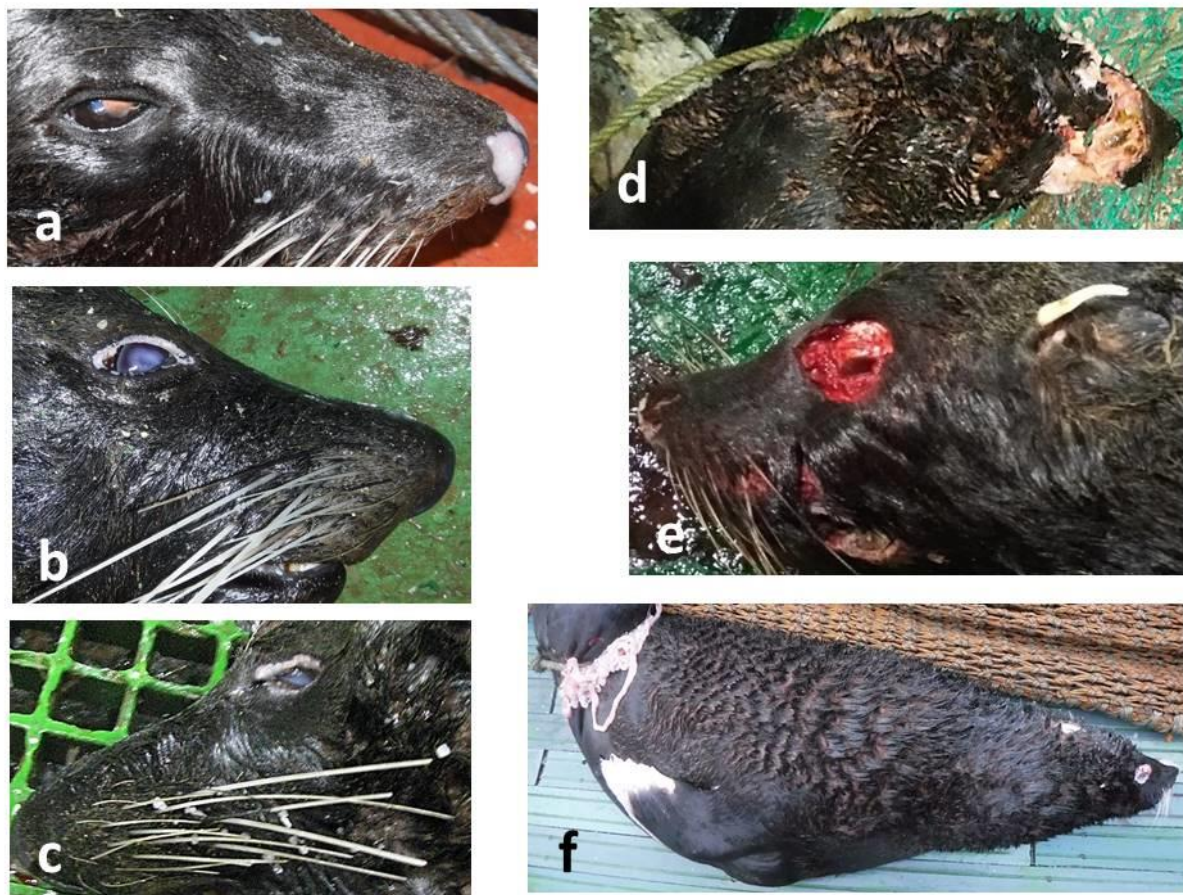


Fig.8. Unmarked ARA carcasses. Decomposition signs include blurry red eyes and white snout (a); sunken white eyes, dry mucous membranes, white eyelids (b,c); cranial area collapsed, strong odour (d); white snout, ears and genital area; missing eyes, strong odour (e); sunken white eyes, white snout, flippers and ears; exposed skull, eye sockets and intestines; strong odour (f).

Of a total of 11 carcasses marked by the MMOs (i.e. removal of left forelimb), only one was recaptured (Fig.9).

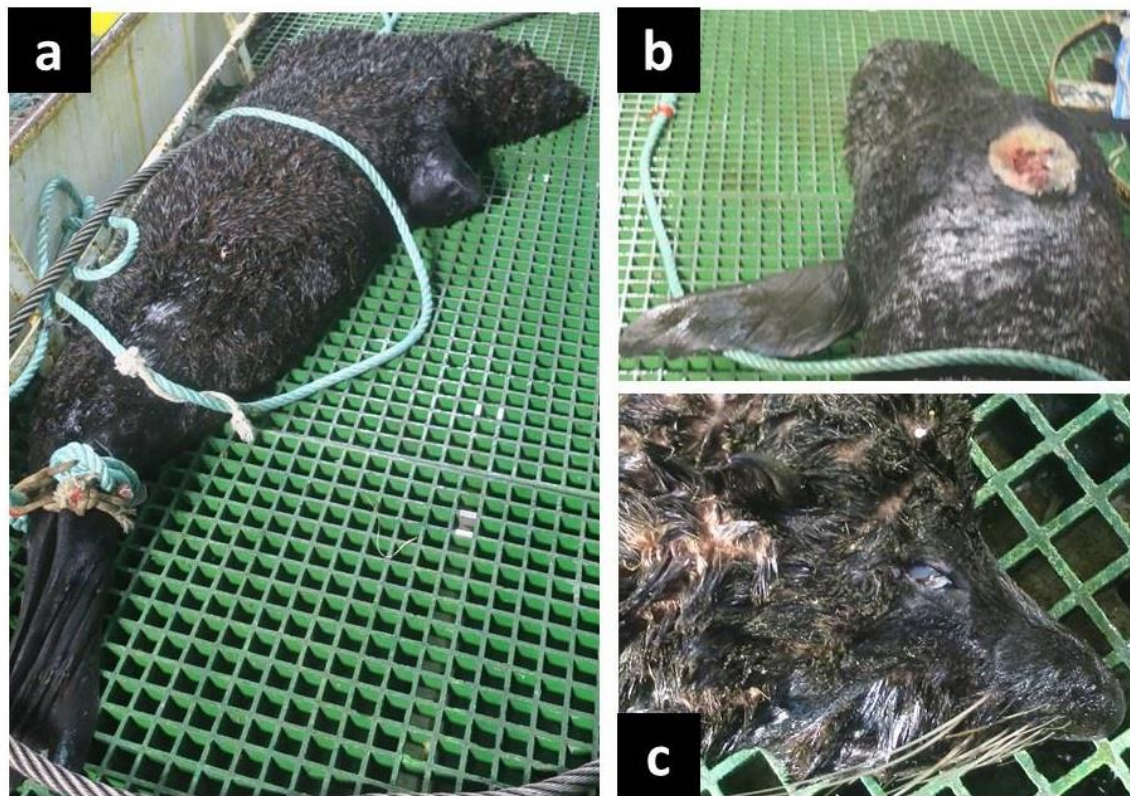


Fig.9. Recaptured ARA carcass. Note absence of left flipper, white sunken eyes, dry mucous membranes and eyes. Dorsal view (a), ventral view (b) and rostrum (c).

4.4 Seabird bycatch

Seabird interactions with the fishery occurred mostly south of 52°S (57%), particularly when the vessel activity was either shooting (33%) or hauling (54%) (Fig.10, Table 8). Seventy percent of the interactions involved the sooty shearwater (*Ardenna grisea*, PFG), while 23% comprised the black-browed albatross (DIM) (Fig.10). Interactions took place mostly in grid square XRAP (29%) and XUAM (17%) (Fig.10). During the fishing season a total of 69 seabirds were incidentally caught, of which 52 were incidentally killed (40 PFG, 11 DIM, 1 PYP) (Fig.11) and 17 were safely released alive (8 PFG, 6 DIM, 1 MAX, 1 PEL, 1 FRT) (Table 8).

4.4.1 Incidental mortalities

Similar to the second season 2018, seabird species with higher agonistic interactions with the fishery was PFG, representing 77% of the mortalities. Following the trend of 2017-2018 (FIG, 2019) and 2018-2019 (FIG, 2020), seabird mortalities were mostly related to net entanglements (96%) (Fig.11, Table 8). These 50 net-related mortalities occurred both during shooting (44%) and hauling (52%). Although entanglements during shooting always result in

mortality, during hauling the seabird may be rescued alive. The latter is supported by the 10 net entanglements with live releases reported (Table 8). However, 26 net entanglements during hauling did result in mortalities (19 PFG, 7 DIM), while a flying DIM became entangled in a warp splice while the cable was being retrieved, being killed upon reaching the pulley (Fig.11, Table 8).

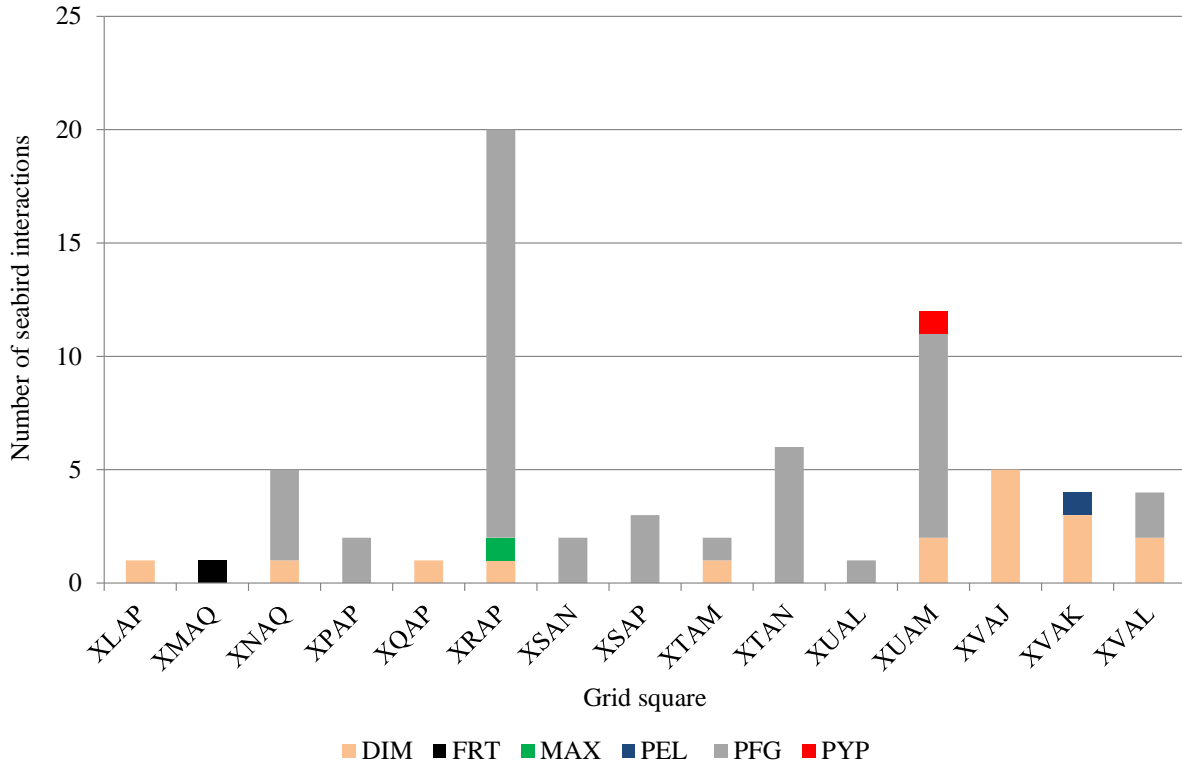


Fig.10. Seabird bycatch per species per grid square.

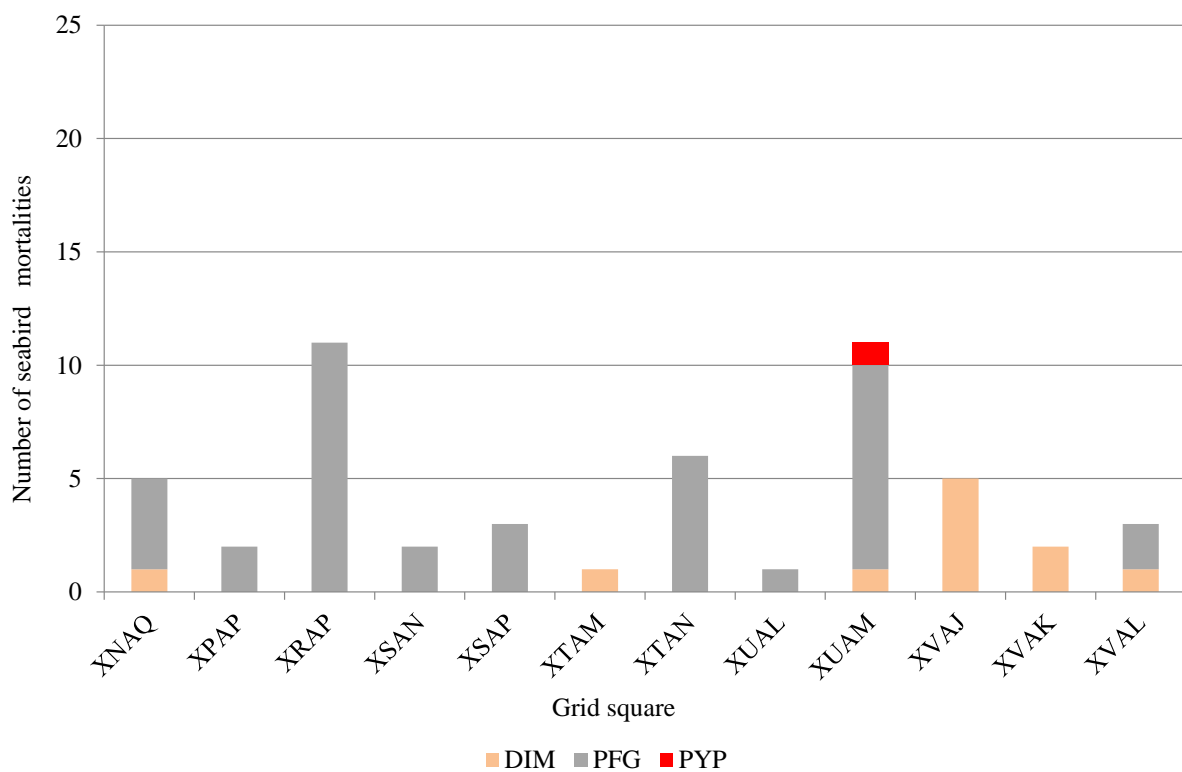


Fig.11. Seabird incidental mortality per species per grid square.

Table 8. Seabird bycatch recorded.

Date	Grid	Spp	Activity	#indiv	Interaction	Sample	Comments
12/8/20	XVAJ	DIM	Haul	1	Net entanglement	Y	5+ male; grown brood patch.
12/8/20	XVAJ	DIM	Haul	1	Net entanglement	Y	5+ male; grown brood patch.
14/8/20	XVAK	PEL	Trawl	1	Landed on vessel	NA	Released alive.
18/8/20	XRAP	MAX	Trawl	1	Landed on vessel	NA	Released alive.
18/8/20	XRAP	DIM	Trawl	1	Landed on vessel	NA	Released alive.
22/8/20	XLAP	DIM	Trawl	1	Entanglement in FAA streamers	NA	Released alive.
28/8/20	XVAK	DIM	Haul	1	Landed on vessel	NA	Released alive.
28/8/20	XVAL	DIM	Haul	1	Vessel collision	NA	Released alive.
11/9/20	XMAQ	FRT	Trawl	1	Landed on vessel	NA	Released alive.
15/9/20	XUAM	DIM	Trawl	1	Landed on vessel	NA	Released alive.
18/9/20	XNAQ	DIM	Trawl	1	Landed on vessel	N	Soaked; presumably killed by a wave.
18/9/20	XPAP	PFG	Haul	2	Net entanglement	Y (1)	Developed testes with sperm; no brood patch.
23/9/20	XTAN	PFG	Haul	1	Net entanglement	Y	Female; no brood patch.
24/9/20	XSAN	PFG	Shoot	1	Net entanglement	Y	Female; no brood patch.
25/9/20	XTAM	PFG	Haul	1	Net entanglement	NA	Released alive.
25/9/20	XTAN	PFG	Haul	1	Net entanglement	Y	Male; no brood patch.
25/9/20	XTAN	PFG	Haul	1	Net entanglement	Y	Male; no brood patch.
25/9/20	XTAN	PFG	Haul	1	Net entanglement	Y	Male; no brood patch.
25/9/20	XVAL	PFG	Haul	2	Net entanglement	Y	Males; no brood patch.
25/9/20	XUAM	PFG	Shoot	6	Net entanglement	Y	Five males and one female; no brood patch.
25/9/20	XQAP	DIM	Trawl	1	Landed on vessel	N	Released alive.
26/9/20	XUAM	PYP	Shoot	1	Net entanglement	Y	Male with developed testes with sperm; brood patch present.
27/9/20	XUAL	PFG	Haul	1	Net entanglement	Y	Male; no brood patch.
27/9/20	XNAQ	PFG	Shoot	1	Net entanglement	Y	Male with developed testes with sperm; no brood patch.
29/9/20	XTAN	PFG	Haul	2	Net entanglement	Y	Male, one w/ developed testes with sperm. No brood patch.
29/9/20	XRAP	PFG	Shoot	1	Net entanglement	Y	Male; no brood patch.
30/9/20	XVAK	DIM	Haul	1	Warp cable & pulley	N	Entangled in warp splice; killed at pulley; carcass lost.
30/9/20	XRAP	PFG	Haul	6	Net entanglement	NA	Released alive.
1/10/20	XNAQ	PFG	Haul	3	Net entanglement	Y	Two males, one female. No brood patch.
2/10/20	XRAP	PFG	Shoot	4	Net entanglement	Y	Three males, one female. No brood patch.
3/10/20	XVAK	DIM	Shoot	1	Net entanglement	Y	5+ breeding male; brood patch present.
3/10/20	XTAM	DIM	Haul	1	Net entanglement	Y	5+ breeding male; brood patch present.
4/10/20	XVAL	DIM	Haul	1	Net entanglement	y	5+ breeding male; brood patch present.
4/10/20	XRAP	PFG	Shoot	6	Net entanglement	Y	Five males, one female. No brood patch present.
4/10/20	XSAP	PFG	Haul	3	Net entanglement	Y	Three males, one with developed testes with sperm. No brood patch.
4/10/20	XUAM	DIM	Haul	1	Net entanglement	Y	5+ male; grown brood patch.
4/10/20	XVAJ	DIM	Haul	2	Net entanglement	Y	5+ male; grown brood patch.
4/10/20	XVAJ	DIM	UN	1	Net entanglement	Y	Pending necropsy.
5/10/20	XRAP	PFG	Haul	1	Net entanglement	NA	Released alive.
5/10/20	XUAM	PFG	Haul	2	Net entanglement	Y	One male, one female. No brood patch.
5/10/20	XUAM	PFG	Shoot	1	Net entanglement	Y	Male; no brood patch.
6/10/20	XSAN	PFG	Shoot	1	Net entanglement	Y	Male; no brood patch.

4.4.2 *Seabird necropsies*

Of the 52 incidental mortalities recorded, 48 carcasses were preserved (39 PFG, 8 DIM, 1 PYP) and necropsied (except 1 DIM) (Table 8). Of the PFG, 32 were male (four of which were breeding adults) and seven female (Table 8). Regarding the DIM, all were males, of which three were breeding adults, four were 5+ years-old and non-breeding, and one is still unknown (Table 8).

5. Discussion

5.1 *Seal attendance to vessels previous MMO embarkation*

Although the second *Loligo* season started on 30th July 2020, the COVID-19 pandemic delayed MMO embarkation for a week. As a consequence, from 30 July to 5 August two vessels operated with a FIFD science observer aboard, while 14 vessels carried out their activities without observer monitoring. However, SED usage remained mandatory for the whole fleet and companies were reminded to inform vessels to report seal bycatch.

During the first fishing week a total of 351 unobserved trawls were carried out, with 77% of the fishing effort (271 trawls) occurring south of 52°S. These were concentrated in grid squares XVAK (48%) and XVAL (48%), totalling 1302 hours of effort. Neither live seal deck releases, SED escapees, nor mortalities were reported by these vessels during the first week of the fishery. This seems surprising, as a very high level of seal sightings (Fig.3), SED escapees (Table 5) and deck live releases (Table 6) were recorded upon MMO embarkation, particularly south of 52°S (i.e. XVAK and XVAL). Following the trend of the cumulative sightings along the two previous seasons (Fig.12) and comparing to the sightings curve for 2020-X, it is highly unlikely that none of the unmonitored vessels experienced any seal bycatch during the first fishing week, especially because vessel attendance by ARA might have peaked during the first week (Fig.3).

5.2 *Unmarked carcasses in decomposition*

Excluding season 2017-X, recovery of unmarked carcasses in the *Loligo* fleet has been uncommon (Table 9). In season 2017-X unmarked carcasses in decomposition exceeded reported mortalities. This was a combined result of a late inclusion of carcass marking and mortality misreporting by vessels without observer coverage (75%).

Despite in 2018 vessels were monitored by MMOs during the entire fishing period, observer performance did not meet expectations, particularly in season X. Errors in species identification, absence of photographic record, carcass condition description, and carcass marking confirmation make data unreliable (Table 9).

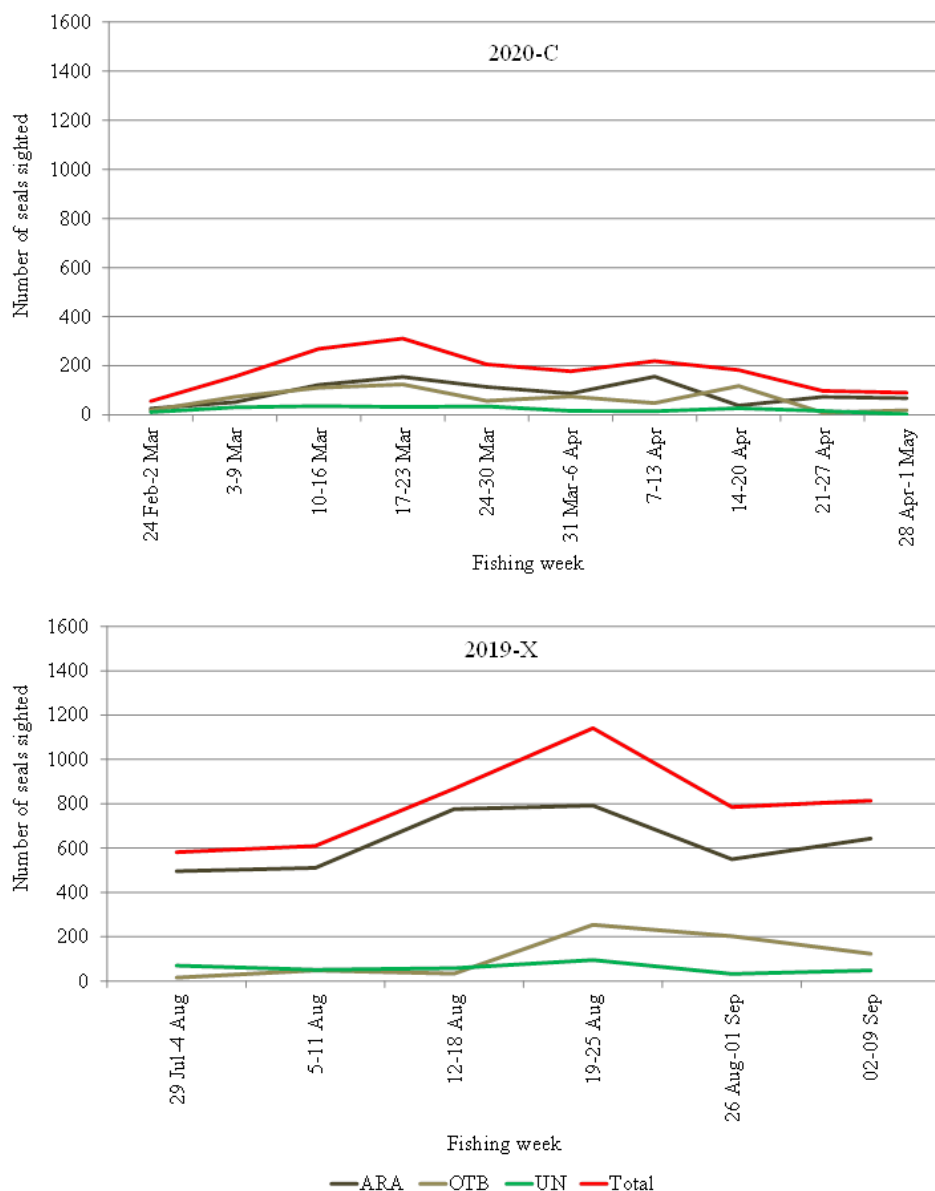


Fig.12. Pinniped sighting trends in seasons 2020-C and 2019-X.

Although in 2019 MMO performance improved, information on fresh carcass marking (i.e. cutting the left flipper) remained scarce (Table 9). Two unmarked carcasses (1 ARA, 1 OTB) in decomposition were reported for the 2nd season; the ARA recovered on 1st August could have corresponded to the mortality reported on 29th July (Table 8).

Following the trend of previous first seasons, in 2020-C no unmarked carcasses were brought aboard. Three fresh carcasses (1 ARA, 2 OTB) were marked and dumped overboard. As vessels usually repeat trawl coordinates, the ARA carcass was recaptured by the same vessel on the following day.

Table 9. Seal carcasses recorded from season 2018-C onwards.

Season	Date	SED	Grid (shoot/haul)	Carcass #	Spp	Carcass condition
2018-C	04/03/18	NA	XNAP/XPAP	1	OTB	Fresh, incidentally killed. Marked by MMO
	15/03/18	NA	XNAP/XNAQ	1	ARA	Advanced decomposition; Marked by MMO
	19/03/18	NA	XNAQ/XPAP	1	ARA	Fresh, incidentally killed. Marked by MMO
	09/04/18	NA	XNAQ/XUAL	1	OTB	Fresh, incidentally killed. Marked by MMO
	24/04/18	NA	XUAL/XUAL	1	OTB	Fresh, incidentally killed. Marked by MMO
	22/04/18	NA	XNAQ/XMAQ	1	OTB	Fresh, incidentally killed. Marked by MMO
	02/05/18	NA	XUAL/XVAL	1	ARA	Fresh, incidentally killed. Marked by MMO
Total 2018-C: 6 mortalities, 1 unmarked carcass in decomposition, 0 recaptures.						
2018-X	01/08/18	NA	XVAL/XVAK	1	ARA	Fresh, incidentally killed. UN if marked by MMO
	03/08/18	NA	XVAJ/XVAJ	3*	ARA	Fresh, incidentally killed. Marked by MMO
	04/08/18	NA	XVAH/XVAH	1	ARA	Recaptured carcass (marked)
	06/08/18	NA	XMAP/XNAQ	4*	OTB	Fresh, incidentally killed. Marked by MMO
	15/08/18	C	XVAK/XVAJ	1	ARA	Advanced decomposition; marked by MMO
	27/08/18	B	XUAL/XVAL	1	ARA	Advanced decomposition; marked by MMO
	01/09/18	B§	XVAJ/XVAK	1	ARA	Decapitated. UN if marked by MMO
	03/09/18	B§	XVAJ/XVAK	1	ARA	Not mentioned; UN if marked by MMO
	05/09/18	B§	XVAJ/XVAK	1	ARA	Fresh; UN if marked by MMO
	06/09/18	B§	XVAJ/XVAK	1	ARA	Not mentioned; UN if marked by MMO
	07/09/18	B§	XVAK/XVAJ	1	ARA	Recaptured carcass (marked)
	07/09/18	C	XVAJ/ XVAJ	1	ARA	Moderately decomposed; marked by MMO
	08/09/18	B§	XVAJ/ XVAK	3	ARA	Not mentioned; UN if marked by MMO
	09/09/18	B§	XVAJ/ XVAK	2	ARA	Not mentioned; UN if marked by MMO
11/09/18	B	XVAK/ XVAK	1	ARA	Not mentioned; UN if marked by MMO	
22/09/18	A	XVAK/ XVAL	1	ARA	Fresh, incidentally killed; UN if marked by MMO	
Total 2018-X: 6 ARA mortalities (3 UN if marked), 8 undescribed/UN if marked ARA carcasses, 1 decapitated ARA, 4 OTB mortalities, 3 unmarked ARA carcasses in decomposition, 2 recaptured ARA carcasses.						
2019-C	15/03/19	NA	XPAP/XQAP	1	OTB	Fresh; UN if marked by MMO
	15/03/19	NA	XQAP/XPAP	1	OTB	Fresh, marked by MMO
	25/03/19	NA	XVAL/XVAK	1	ARA	Fresh, marked by MMO
	28/03/19	NA	XVAL/XVAL	1	ARA	Fresh; UN if marked by MMO
	28/03/19	NA	XVAL/ XVAL	1	ARA	Fresh; UN if marked by MMO
	29/03/19	NA	XVAL/ XVAL	1	ARA	Fresh; UN if marked by MMO
	29/03/19	NA	XVAK/XUAL	1	ARA	Fresh, marked by MMO
Total 2019-C: 5 ARA mortalities (3 UN if marked), 2 OTB mortalities (1 UN if marked), 0 unmarked carcasses, 0 recaptures						
2019-X	29/07/19	NA	XVAJ/XVAK	1	ARA	Fresh; UN if marked by MMO
	29/07/19	NA	XVAL/XVAL	1	ARA	Fresh, marked by MMO
	01/08/19	B	XVAK/XVAJ	1	ARA	Moderately decomposed; UN if marked by MMO
	12/08/19	B	XVAL/XVAL	1	ARA	Killed by propeller; UN if marked by MMO
	21/08/19	B	XMAQ/XLAP	1	OTB	Advanced decomposition; marked by MMO
	22/08/19	C	XTAN/XSAN	1	ARA	Fresh, marked by MMO
	26/08/19	B	XRAP/XSAN	1	ARA	Killed by propeller; carcass not recovered.
Total 2019-X: 3 ARA mortalities (2 marked), 1 ARA mortality propeller (not recovered), 2 unmarked carcasses in decomposition (1 ARA, 1 OTB), 1 ARA carcass-propeller, 0 recaptured carcasses.						
2020-C	01/03/20	NA	XQAP/XPAP	1	OTB	Fresh, marked by MMO
	05/03/20	NA	XTAM/XSAN	1	OTB	Fresh & frozen for necropsy
	09/03/20	NA	XUAL/XVAK	1	OTB	Fresh, marked by MMO
	17/03/20	NA	XUAL/XVAL	1	ARA	Fresh, marked by MMO
	18/03/20	B	XUAL/XUAL	1	ARA	Recaptured carcass (marked)
	19/03/20	B	XQAP/XNAP	1	OTB	Fresh & frozen for necropsy
Total 2020-C: 4 OTB mortalities (2 marked, 2 frozen), 1 ARA mortality, 1 ARA recaptured, 0 unmarked carcasses.						
2020-X	07/08/20	NA	XUAL/XVAL	1	ARA	UN (dumped before MMO inspection)
	07/08/20	NA	XVAK/XVAK	1	ARA	Fresh, marked by MMO
	07/08/20	NA	XVAK/XVAL	1	ARA	Fresh, marked by MMO
	07/08/20	NA	XVAL/XVAK	1	ARA	Fresh, marked by MMO
	07/08/20	NA	XVAK/XVAL	1	ARA	Moderately decomposed (Fig.1b), marked by MMO
	07/08/20	NA	XVAK/XVAK	2	ARA	Fresh, marked by MMO
	07/08/20	NA	XVAL/ XVAK	3	ARA	Fresh, marked by MMO
	07/08/20	NA	XMAQ/XMAN	1	ARA	Fresh & frozen for necropsy
	08/08/20	B	XVAK/XVAK	1	ARA	Fresh, marked by MMO
	08/08/20	B	XVAK/XVAL	1	ARA	Fresh, marked by MMO
	09/08/20	B	XWAK/ XVAK	1	ARA	Unmarked; moderately decomposed (Fig.2a); cut in right under flipper
	10/08/20	B	XVAK/ XVAK	1	ARA	Unmarked; moderately decomposed (Fig.2b); marked by MMO
	13/08/20	B	XVAJ/XVAJ	1	ARA	Unmarked; moderately decomposed (Fig.2c); marked by MMO
	14/08/20	B	XVAJ/ XVAJ	1	ARA	Recaptured carcass (Fig.3)
	18/08/20	B	XVAK/ XVAJ	1	ARA	Fresh (net mortality), marked by MMO
	18/08/20	B	XVAK/ XVAK	1	ARA	Unmarked; advanced decomposition (Fig.2d); marked by MMO
19/08/20	B	XVAL/ XVAL	1	ARA	Unmarked; advanced decomposition (Fig.2e); marked by MMO	
20/08/20	B	XVAK/ XVAK	1	ARA	Unmarked; advanced decomposition (Fig.2f); marked by MMO	
Total 2020-X: 12 ARA mortalities (11 marked, 1 frozen); 1 ARA unknown (dumped before inspection); 7 ARA unmarked carcasses in decomposition; 1 ARA recapture						

*SED implementation rules not yet established in license conditions

§ Same vessel

Although there is no clear explanation to the occurrence of seven unmarked seal carcasses during the 2nd and 3rd fishing weeks of season 2020-X, the stage of carcass decomposition and recovery location would appear to indicate these mortalities took place during the first week of the fishery. Considering that seal mortality in nets fitted with a SED is negligible, unreported mortalities might indicate non-compliance to license conditions by some vessels or improper use of their SEDs during the first week of the second season. In view of the number of seal mortalities per fishing effort (h) recorded on 7 August in the morning (154.2h), trawling carried out in the south during the first week (1302h) could have led to 84.4 incidental mortalities.

Taking into account the proportion of dumped marked fresh carcasses (11) and their recapture within the season (1), the 7 unmarked recovered carcasses could reflect 77 incidental mortalities during the first week.

6. Conclusion

- The MMO Program in the LOL fleet delivers a valuable service for the monitoring of marine mammal and seabird interactions, and supports FIG's sustainable fisheries management objectives;
- As in previous seasons, pinniped interactions with the fleet were more abundant south of 52°S, with seals attending the vessels to depredate from the net or scavenge from discards;
- The high proportion of seal mortalities recorded along the first morning under MMO monitoring supports SED implementation since the beginning of the second season;
- Net entanglements continue to be the principal cause of seabird mortality, which supports continuous efforts to ensure proper net cleaning and discard management;
- The success in both seabird and seal mortality mitigation relies heavily on compliance to conservation measures, which can only be guaranteed by the presence of independent observers;
- Indications of possible non-compliant fishing activities by some unidentified *Loligo* vessels questions the validity of allowing fishing in the Loligo Box without the presence of MMOs aboard.

7. References

Falkland Islands Government. 2020. Fisheries Department Fisheries Statistics, Vol.24 (2019), FIG Fisheries Department, Stanley, Falkland Islands, 98pp.

Falkland Islands Government. 2019. Fisheries Department Fisheries Statistics, Vol.23 (2018), FIG Fisheries Department, Stanley, Falkland Islands, 102 pp.

Iriarte V., Pompert J., 2016. Pinniped bycatch report: squid and 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.

Iriarte V., Arkhipkin A., Blake D. 2020. Implementation of exclusion devices to mitigate seal (*Arctocephalus australis*, *Otaria flavescens*) incidental mortalities during bottom-trawling in the Falkland Islands (Southwest Atlantic). Fish Res, DOI: 10.1016/j.fishres.2020.105537.

Küepfer A. 2016a. Requirements for the use of a fixed aerial array in the Falkland Islands trawl fishery. Fisheries Department, Directorate of Natural Resources, Falkland Islands Government, Stanley, Falkland Islands, 3 pp.

Küepfer A. 2016b. *Loligo* pre-recruitment survey, February 2016 –seabird observations. Fisheries Department, Directorate of Natural Resources, Falkland Islands Government, Stanley, Falkland Islands, 7 pp.

Küepfer A. 2017. Requirements for the use of a fixed aerial array in the Falkland Islands trawl fishery. Fisheries Department, Directorate of Natural Resources, Falkland Islands Government, Stanley, Falkland Islands, 3 pp.

Küepfer A. 2018. Guidelines for the fixed aerial array in the Falkland Islands trawl fishery. Fisheries Department, Directorate of Natural Resources, Falkland Islands Government, Stanley, Falkland Islands, 9 pp.

Parker G. 2012. A possible new bird scaring method for trawl fisheries. Fisheries Department, Directorate of Natural Resources, Falkland Islands Government, Stanley, Falkland Islands. 15 pp.

Parker G., Crofts S., Pompert J., Wolfaardt A. 2013a. In the wake of a factory trawler: research into undetected seabird mortality. Fisheries Department, Directorate of Natural Resources, Falkland Islands Government, Stanley, Falkland Islands, 25 pp.

Parker G., Brickle P., Wolfaardt A., Pompert J. 2013b. Early results from trials of bird scaring lines (BSLs) attached to 14 m booms on a demersal trawler. ACAP research paper, 10 pp.
<https://acap.aq/documents/working-groups/seabird-bycatch-working-group/seabird-bycatch-wg-meeting-5/2037-sbwg5-doc-08-early-results-from-trials-of-bird-scaring-lines-bsls-attached-to-14-m-booms-on-a-demersal-trawler/file>

Prince P.A., Rodwell S.P. 1994. Ageing immature black-browed and grey-headed albatrosses using moult, bill and plumage characteristics. Emu. (94): 246-254.

Snell K.R.S., Brickle P., Wolfaardt A.C. 2012. Refining Tori lines to further reduce seabird mortality associated with demersal trawlers in the South Atlantic. Polar Biol. (35): 677-687.

Sullivan B.J., Brickle P., Reid T.A., Bone D.G., Middleton D.A.J. 2006. Mitigation of seabird mortality on factory trawlers: trials of three devices to reduce warp cable strikes. Polar Biol. (29): 745-753.