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Research into undetected seabird mortality in a demersal trawl fishery

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SUMMARY

In the Falkland Islands long-winged seabirds such as Black-browed Albatrosses and giant petrels suffer heavy contacts with trawl warps (warp strikes); sometimes their wings become entangled and the birds are dragged underwater and are drowned. The bodies of the drowned birds are not always recovered on trawl warps, resulting in an unknown level of undetected or 'cryptic' mortality. Research into the extent and nature of cryptic mortality is vital to better understand the relationship between heavy contacts of seabirds with trawl warps and mortality. The aim of our study was to investigate whether the outcome of interactions between seabirds and warp cables (particularly heavy contacts with warps) could be confirmed by observing the wake of the trawler, beyond the detection range of observer(s) positioned on the fishing vessel, for injured or dead birds. We also trialled the use of a warp attachment device to investigate whether it would increase the probability that seabirds killed on trawl warps would be retained until hauling. Results from our preliminary study indicate that at least 23% of the total mortalities (and severe injuries, which were judged ultimately to be fatal) recorded, were not observed from the trawler. These early results highlight that data obtained by observers located on trawlers underestimate seabird mortality rates. This preliminary study provides a platform for further work to develop a correction factor to account for undetected (cryptic) mortality of seabirds in the trawl fisheries of the Falkland Islands.

RECOMMENDATIONS

1. The purpose of this paper is to inform the SBWG of work currently underway to improve estimates of seabird bycatch associated with trawl fisheries in the Falkland Islands. The SBWG is asked to provide any feedback that could be used to progress this work.
2. That the SBWG should encourage further work to quantify the nature and extent of undetected mortality associated with trawl fisheries, and improve the accuracy of seabird bycatch estimates.

Investigación sobre la mortalidad de aves marinas no detectada en la pesca de arrastre demersal

En las Islas Malvinas, las aves marinas de alas largas como el albatros de ceja negra y los petreles gigantes sufren de golpes fuertes contra los cables de arrastre (choques contra los cables de arrastre); en ocasiones las aves enredan sus alas y son arrastradas por debajo del agua y mueren ahogadas. Los cuerpos de las aves ahogadas no se recuperan siempre en los cables de arrastre, lo que da como resultado un nivel desconocido de mortalidad no detectada o “críptica”. Las investigaciones sobre el grado y las características de mortalidad críptica son fundamentales para comprender mejor la relación entre los golpes fuertes de las aves marinas contra los cables de arrastre y la mortalidad. El objetivo de nuestro estudio fue investigar si el resultado de las interacciones entre las aves marinas y los cables de arrastre (en particular los golpes fuertes contra los cables) podía confirmarse al observar la estela del arrastrero, más allá del rango de detección del observador ubicado en el buque de pesca, para detectar aves lesionadas o muertas. También evaluamos el uso de un dispositivo de sujeción del cable para investigar si éste aumentaría las probabilidades de que las aves marinas que mueren en los cables de arrastre se retengan hasta izarlos. Los resultados de nuestro estudio preliminar indican que, al menos, el 23% del total de las muertes (y lesiones graves, que se consideraron en última instancia fatales) registradas, no se observaron desde el arrastrero. Estos primeros resultados destacan que los datos obtenidos por los observadores ubicados en los arrastreros calculan tasas de mortalidad de aves marinas demasiado bajas. Este estudio preliminar proporciona una base para que los trabajos futuros desarrollen un factor de corrección para dar cuenta de la mortalidad no detectada (críptica) de aves marinas en las pesquerías de arrastre en las Islas Malvinas.

RECOMENDACIONES

1. El propósito de este documento es informar al GdTCS sobre el trabajo que se está realizando para mejorar las estimaciones de la captura secundaria de aves marinas asociada con la pesca de arrastre en las Islas Malvinas. Se le solicita al GdTCS que proporcione comentarios que puedan usarse para avanzar con este trabajo.
2. El GdTCS debe recomendar que se continúe trabajando para cuantificar las características y el grado de mortalidad no detectada asociada con la pesca de arrastre, y mejorar la precisión de las estimaciones de la captura de aves marinas.

Étude sur les décès non détectés d'oiseaux marins dans la pêche chalutière démersale

Dans les îles Falkland, les oiseaux marins longipennes, tels que les albatros à sourcils noirs et les pétrels géants, sont très régulièrement en contact avec les funes de chaluts (collisions avec les funes) ; parfois, leurs ailes sont prises au piège et les oiseaux, qui sont emmenés sous l'eau, se noient. Les cadavres des oiseaux ne restent pas toujours prisonniers des funes du chalut ; on ignore donc à combien s'élève le nombre de décès "cryptiques" non détectés. Il est essentiel de mener des recherches sur la portée et la nature de la mortalité cryptique afin de mieux comprendre le lien entre mortalité et contact fréquent des oiseaux

avec les funes du chalut. L'objectif de notre étude était le suivant : établir si le résultat des interactions entre les oiseaux marins et les câbles du chalut (en particulier, contacts fréquents avec les funes) pouvait être confirmé en observant le sillage du chalutier, au-delà du rayon de détection des observateurs positionnés sur les bateaux de pêche, pour les oiseaux morts ou blessés. Nous avons également utilisé un système d'attache pour comprendre si ce dispositif était susceptible d'augmenter la probabilité que les oiseaux marins tués sur les funes du chalut y restent attachés jusqu'à la remontée du chalut. D'après les résultats de notre étude préliminaire, au moins 23% des décès enregistrés (et des blessures graves qui se sont révélées fatales) n'ont pas été détectés depuis le chalutier. Ces premiers résultats mettent en exergue le fait que les données obtenues grâce aux observateurs positionnés sur les chalutiers sous-estiment le taux de mortalité des oiseaux marins. Cette étude préliminaire fournit une plateforme qui permettra de développer un facteur de correction pouvant expliquer les décès (cryptiques) d'oiseaux marins dans les pêches chalutières des îles Falkland.

RECOMMANDATIONS

1. Ce document vise à informer le GTCA des travaux en cours destinés à améliorer les estimations en matière de captures accidentelles d'oiseaux marins dans les pêches chalutières des îles Falkland. Le GTCA est appelé à formuler tout commentaire pouvant faire avancer ces travaux.
2. Il est recommandé que le GTCA encourage la tenue d'autres travaux destinés à quantifier la nature et la portée des décès non détectés dans les pêches chalutières et à renforcer la précision des estimations en matière de captures accidentelles d'oiseaux marins.

1. INTRODUCTION

Over the past 10 years, considerable efforts have been directed towards assessing and reducing seabird bycatch in the demersal trawl finfish fishery in the Falkland Islands. In this document we report on two initiatives that aim to better understand the nature and extent of seabird bycatch in this fishery.

Research into the nature and level of undetected mortality is vital to better understand the relationship between heavy contacts of seabirds with trawl warps and mortality (Brickle *et al.* 2011). Data from the Falkland Islands', New Zealand and South African trawl fisheries have demonstrated that warp strikes are recorded far more frequently than carcasses are hauled aboard (Abraham and Thompson 2009; Watkins *et al.* 2008; Sullivan *et al.* 2006). An unknown proportion of birds that are killed following warp strikes are not recovered during hauling. Currently, seabird bycatch estimates in the trawl fisheries of the Falkland Islands are based on the number of carcasses that are subsequently hauled aboard, normally on warp cable splices. Observers on board trawlers in the Falkland Islands conduct systematic observations of seabird interactions with warps and other fishing gear, and birds that are observed directly to have suffered severe injury or death are recorded, and included in the bycatch estimates if carcasses are not subsequently hauled aboard. However, it is not always possible to confirm the outcome of a warp strike, and so bycatch estimates remain underestimated. The likelihood of recovering dead birds is influenced by a number of factors,

including the trawl's soak time, weather conditions and the presence and condition of warp splices, which may snag birds that have been dragged underwater and drowned.

By estimating the extent of cryptic mortality, correction factors can be developed (Moore and Zydelis 2008) that enable statistical estimation of actual seabird bycatch in trawls from records of heavy contacts or warp strikes. Such an approach requires the number of birds injured or killed that are left in the wake of a fishing vessel, and not observed from the trawler, to be quantified. The key premise of this approach is that an observer positioned on the stern of a fishing vessel is unable to detect all injured or dead birds floating on the surface after interactions with warp cables.

In this paper, we report preliminary results of research aimed at estimating the number of seabirds killed but not hauled aboard, and therefore not accounted for in bycatch estimates. We also describe a warp attachment device that has been developed to improve retention (and thus detection), of seabirds drowned on trawl warps.

2. METHODS

For the purposes of this research, a 72.2m fishing (trawl) vessel (FV) was followed by the Fishery Patrol Vessel (PV), each with a set of two observers who were responsible for conducting systematic observations of seabird interactions with trawl gear using standardised protocols. The FV followed all current Falkland Island Fisheries Department (FIFD) license requirements in respect of seabird bycatch mitigation measures. These include the deployment of two 30m bird scaring lines (BSLs) during all trawling, and the cessation of discarding during shooting, hauling and trawling unless the BSLs are deployed. The PV was positioned approximately 900 – 1300m behind the FV and adjusted its speed to maintain this following distance.

2.1. On the trawler

The observers on the FV recorded the number and type of seabird contacts with the fishing gear as well as the environmental and discharge conditions, following standardised FIFD data collection protocols adapted from Wienecke and Robertson (2000). Observations began once the net entered the water and continued during the trawl until the vessel stopped discharging waste. Observation periods were a maximum of 60 minutes long and contacts were summarised by 10 minute periods. If any of the environmental factors or discharge volume changed, a new observation period was initiated. All trawls during which discharging occurred were observed continuously for the entire duration of factory processing and discharge.

Seabird abundance was estimated during the initial 1-5 minutes of observations by scanning the area and identifying species present in an area 500m astern and 500m abeam (250m to both starboard and port sides) of the FV. Bird abundance was recorded in five abundance categories: 1-10, 11-50, 51-200, 201-500 and >500 individuals.

Seabird bycatch was calculated from the number of dead birds recovered during hauling. All warp splices were checked for feathers during every shoot and haul. If the splice was positioned at more than 40m depth during the trawl and if it contained feathers at a haul which were not present in the preceding shoot, this was also recorded as evidence of seabird mortality.

The observers on the FV communicated with the PV every ten minutes via VHF radio. This was to co-ordinate observation periods, and specifically to alert the observers on the PV when heavy contacts with unknown outcomes were recorded from the FV.

2.2. Corpse catcher: experimental device attached to warps

In order to increase the probability that seabirds killed on trawl warps would be retained until hauling, a corpse-catching device was used during the study (Figure 1). The likelihood of retaining dead birds until hauling depends *inter alia* on the presence, condition and location(s) of warp splices (which may snag birds that have been dragged underwater), the environmental conditions, and the number of birds killed during the trawl operation. The device, henceforth the 'corpse catcher', had previously been trialled successfully on a separate vessel in the waters of the Falkland Islands.

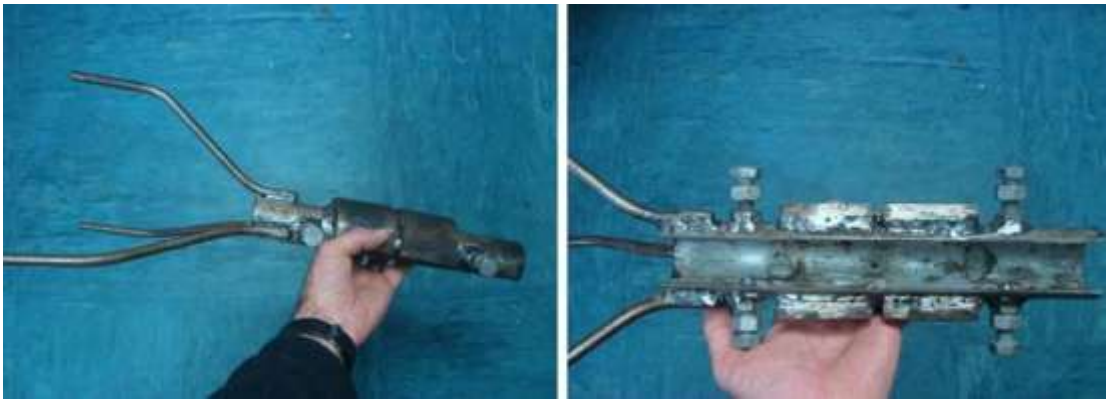

Figure 1. The corpse-catcher used to increase the likelihood of retaining seabird corpses on the warps until hauling (Photos: G. Parker).

2.3. On the Patrol Vessel

Observations from the PV were conducted in 10 minute periods during the factory processing and discharge period for all trawls. The time lag between an observed contact on the FV and the field of view of observers on the PV was approx. 5-10 minutes.

In the first trawl, different observation positions were trialled on the PV, and the bridge was identified as the optimal position, given its elevation and broad field of view. Observers on the PV recorded the distance between the PV and FV during observation periods, observer positions and bird abundance on starboard and port sides of the PV in a 200m box (area that was systematically scanned for bird outcomes). We used five categories to identify the state of injured or dead birds observed from the PV (Table 1).

Table 1. Codes for bird contact outcomes observed from the PV

Code	Description
1	Conscious but not alert
2	Light injury
3	Heavy injury – leading to death
4	Dead
5	Mobbed by conspecifics (leading to death)

3. RESULTS

3.1. Observation effort

Observations were conducted for seven days of fishing. The PV did not cause any disruption to the FV's net monitoring equipment when it was in position behind the FV. It was determined in the first trawl that the PV was better positioned to observe seabirds if it followed on the windward side of the FV. Thirteen trawls were observed by the FV and PV concurrently. Except for the first trawl, where positioning and observation protocols were being established, only trawls conducted whilst the FV discharged offal and unwanted fish from the factory were observed. Average trawl duration was 345 minutes but discarding only occurred for an average of 138 minutes; the length of the discharge period was dependent on catch volume and composition.

A total of 41.1 hours of observation focussing on seabird interactions with fishing gear was conducted from the stern gantry of the FV. The majority of the observations (30.3 hrs) took place during trawling. Observations during shooting and hauling amounted to 5 and 5.8 hrs, respectively. Observations from the PV for injured or dead seabirds amounted to 31.7 hrs. All of this time was dedicated to attempting to determine the outcomes of seabird collisions with warps and other trawl gear that were observed from the FV.

3.1. Mortalities

Ten seabirds were recorded incidentally killed on the FV. Nine mortalities were due to strikes with a warp cable and one was killed after becoming entangled in the Bird Scaring Lines (BSL) (at the tow device, a net covered buoy). All mortalities were Black-browed Albatrosses with exposed brood-patches, indicating they were reproductively active birds at the time. Nine of the corpses were landed on the vessel. One corpse fell off the warp when it reached the water's surface.

The corpse catcher was deployed on alternate days in the second trawl of the day for a total of three deployments. The device was deployed on the port-side warp adjacent to a splice located 150m from the water's surface. Of the ten mortalities recorded, three were caught on the warp slices and six were caught by the corpse catcher, the latter in a single trawl. It was during this event that one corpse fell off the warp, suggesting that the three prongs of the corpse catcher had reached saturation with five corpses.

For all three stations (individual trawls) during which seabird mortality was recorded from the FV, additional mortalities were recorded from the PV. In total, two confirmed mortalities and one bird with an ultimately fatal injury (broken wing) were recorded from the PV (Table 2). In addition, two suspected deaths were recorded and one possible death. Four of these records (67%) came from station 2 (Table 2), the same station in which observers on the FV recorded six of the 10 mortalities. All deaths, suspected deaths and injuries recorded from the PV were of Black-browed Albatrosses.

Table 2. Number of seabird mortalities and serious injuries recorded from the seven day research trip. The unknown outcomes were only recorded from the Fishing Vessel.

	Day (n=7)	**Station** (n=13)	**Dead**	**Broken wing**	**Suspected death**	**Possible death**	**Unknown outcome**
Patrol Vessel	2	2	1	-	2	1	-
	5	9	1	-	-	-	-
	7	13	-	1	-	-	-
Trawl Vessel	2	2	6	-	-	-	8
	5	9	1	-	-	-	4
	7	13	3	-	-	-	7
Total			12	1	2	1	19

3.2. Seabird contacts with trawl gear

A total of 2250 light and heavy contacts between seabirds and warp cables or BSLs were recorded, almost all Black-browed Albatrosses and giant petrels. Light contacts involve a bird coming into very light contact with vessel/gear and heavy contacts are those which cause at least part of the bird to be dragged underwater. Heavy contacts of Black-browed Albatrosses and giant petrels with fishing gear accounted for 371 (17%) of all recorded contacts. The majority of these heavy contacts, 303 (82%), involved birds on the water and the remaining 68 (18%) involved birds in flight. A total of 54 heavy contacts (on the water) of Black-browed Albatrosses and giant petrels with the bird scaring line (BSL) was recorded. Seven of these resulted in a possible minor injury and one in death, when an adult black-browed albatross caught on the BSL net float was drowned. Black-browed Albatrosses were observed entangled in the BSL on 18 occasions, during three separate trawls, both in the streamers and on the net float.

3.2. Unknown outcomes

Of the heavy contacts observed, 26 were recorded as being of unknown outcome. These were recorded from 13 observed stations. Nineteen of the 26 unknown outcomes (73%) were from the three stations at which mortalities were recorded (Table 2). Eight unknown outcomes were recorded from station two, the station where seven mortalities, two

suspected deaths and one possible death also occurred. Four unknown outcomes were recorded from station nine, at which two mortalities were also recorded. Six of the 40 heavy contacts incidents for which the outcome from observations on the FV was unknown, subsequently resulted in an injured or dead bird being observed from the PV.

3.2. Observations from the Patrol Vessel

Observers on the PV determined that rafts of birds, particularly giant petrels, were indicative of competition for larger prey items. Towards the end of the factory discharge period the rafts were typically a mixed assemblage of Black-browed Albatrosses, Southern and Northern Giant Petrels and Royal Albatross spp. targeting large offal such as fish heads and ray frames. Royal Albatrosses targeted larger offal, but were not as aggressive as the giant petrels. In some cases larger prey items included dead or injured seabirds.

In station two, giant petrels were observed rafting around and mobbing a Black-browed Albatross that was still alive, but presumably injured. The fate of this bird was recorded as probable death. An attack of an injured Black-browed Albatross by a large raft of giant petrels was also observed from the station 9. During station 13 the observers on the PV detected an adult Black-browed Albatross with severe wing damage. The bird appeared to be preening but upon closer inspection it was revealed to be nibbling its wing bone. This was the first bird observed injured that was not being mobbed by giant petrels suggesting that other similar incidences may have been missed.

3. DISCUSSION

Using a second, following, vessel, we were able to record injured and dead birds trailing in the wake of the trawler that were not detected by observers positioned on the stern of the trawler. Dead or injured birds remain positively buoyant and thus float in the wake, but are too far behind the vessel or are quickly mobbed by giant petrels to be detected by observers aboard the fishing vessel. This evidence highlights that observers stationed on trawlers underestimate the extent of seabird mortality associated with trawl fisheries. The estimated incidental mortality of seabirds in the Falkland Islands trawl fishery has been greater than 500 birds per annum in four out of the last five years (Parker 2013; Parker 2012; Black 2011; Sancho 2009a). All these estimates have been based on data collected by single observers stationed on the trawlers, and so must be considered underestimates of actual mortality.

During this study, mortalities observed from the PV (i.e. the following vessel) comprised 17% (2/12) of all recorded mortalities. When the bird with the fatal injury (broken wing) is included this figure increases to 23% (3/13) of total mortality, and if the suspected and possible deaths observed from the PV are also included the mortalities detected from the PV amount to 38% of the total (6/16). In the absence of relevant data and correction factors to account for undetected mortality, seabird bycatch in trawl fisheries will remain underestimated. Since mandatory seabird bycatch mitigation measures (BSLs and discard timing) were introduced the number of seabirds killed in the Falkland Islands' trawl fishery has decreased (Reid and Edwards 2005). More recent work (Parker 2013; Parker 2012; Black 2011; Sancho 2009a)

has shown the reduction in seabird mortality in four of the last five years to be substantially less than that recorded by Reid and Edwards (2005).

Our results are of an interim nature, are based on research conducted over a short period with limited environmental variation, and so should be interpreted cautiously. Mortality associated with the FV was higher than is normally recorded over a seven day period since BSLs were introduced (FIFD unpubl. data). This was largely due to the corpse-catcher retaining six carcasses in one trawl. Although clusters of mortalities have been recorded in the past, observer coverage has historically been low (ca. 2-4.5%) and suggests our ability to detect clustered mortality events is poor (Parker 2012). Importantly, of 710 hauls observed by FIFD observers between 2009 and 2013, single corpses have been recorded hauled on a warp 44 times, two corpses on only three occasions and three corpses only once (Black 2010; Parker 2012; Parker 2013). The corpse catcher has been deployed on three further vessels for 22 trawls and in the single trawl that mortality was detected two corpses were caught in the device. Clearly further investigation of the corpse catcher is required but early results suggest it is better at detecting multiple mortalities than relying on fishing gear (warps, warp splices, trawl doors) alone.

This research needs to be conducted over a broader range of environmental conditions, particularly because contact rates involving Black-browed Albatross are significantly greater in sea states in excess of Beaufort Scale 4 (Sullivan *et al*. 2006; Parker 2012). The conditions during the week in which this research was conducted were remarkably calm; sea states of 3 and 4 occurred in 38% of trawls and sea state 5 only once. Rougher seas cause vessels to pitch more causing the warp cables to move through the water rapidly and with more force, leading to increased contact rates and mortality (Parker 2012).

The observers on the FV reported 26 heavy contacts for which the outcomes were unknown. Three seabird mortalities were recorded by observers on the PV that did not follow observations on the FV of heavy contacts with unknown outcomes. If we assume that all mortalities undetected by observers on the FV were later recorded by observers on the PV, the rate of unknown outcomes to mortality is roughly three to one. However, eight unknown outcomes were recorded from station two, the station in which seven mortalities, two suspected deaths and one possible death occurred. In that case the unknown outcomes reflected the combined (FV and PV) recorded mortality, and actually overestimated it. It is possible that the observers on the FV did not record all heavy contacts between seabirds and fishing gear, which may account for the apparent overestimation. This would mostly likely occur if warp strikes occurred underwater, while birds were diving.

Injured birds are vulnerable to the vast numbers of giant petrels following trawlers. Our observations indicate that giant petrels quickly target injured albatrosses and predate them. Giant petrels are capable of capturing and drowning adult northern rockhopper penguins on the water before consuming them (Ryan *et al*. 2008). Immature Black-browed Albatrosses are similarly predated (Cox 1978), so predating an injured Black-browed Albatross would be well within the capabilities of a group of giant petrels. It is difficult for a single observer positioned on a trawler to accurately quantify the incidence of seabird injuries associated with

trawl interactions, partly because it is difficult to determine exactly what rafts of giant petrels are encircling. Even for observers on the PV it was not always clear if a raft of giant petrels were targeting an injured or dead seabird or discards from the FV factory. This work shows that injuries that facilitate predation by giant petrels are not rare events, and are an important and rarely detected component of fisheries-related mortality in trawl fisheries.

Our results provide evidence that a proportion of seabird bycatch associated with trawl fisheries is not being detected, resulting in underestimates of actual bycatch. Given the limited sample size and period, we are not yet able to quantify robustly the level of undetected mortality. Acquiring further data will enable the Falklands Islands Government to meet their objectives under the Agreement on the Conservation of Albatrosses and Petrels (ACAP) (Wolfaardt *et al.* 2010) and the FI National Plan of Action – Trawling (NPOA-T) (Sancho 2009b). We recommend that further research into cryptic mortality should be conducted, both in the Falkland Islands and elsewhere, so that more accurate estimates of seabird bycatch in trawl fisheries can be derived. For the Falkland Islands, this will help meet priority objectives of the FI National Plan of Action – Trawling (NPOA-T) (Sancho 2009b), and ACAP Action Plan (Wolfaardt *et al.* 2010): to better quantify and reduce seabird bycatch rates in the trawl fishery.

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