Net captures of seabirds during trawl fishing operations in New Zealand waters

NIWA Client Report: WLG2008-22
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Prepared for

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Executive Summary

The overlap of fishery operations with foraging activity over continental shelf waters in time (particularly the breeding season) and space (close to breeding colonies) results in seabird captures during commercial fishing. Seabirds are known to be caught during trawling operations as a result of hitting trawl gear such as the trawl warps (in the air and on the water) or becoming entangled in the net itself. In New Zealand waters, vessels now use regulated mitigation measures in the form of seabird deterrents to minimise warp strikes in tandem with voluntary offal management regimes aimed at controlling any discharge or discarding to times when seabirds are less vulnerable to capture. Captures of seabirds continue to occur in the ropes and meshes of trawl nets and to attempt to minimise these captures, greater understanding of the interaction is required. Comments written by Ministry of Fisheries observers during their placements on commercial fishing trawlers in New Zealand waters were used to identify a subset of observed tows with seabird captures that were likely to be a result of direct interaction with the trawl net, during fishing years 1999–2000 to 2006–07.

Fisheries on the Chatham Rise, off Puysegur, on the Stewart-Snares shelf, and the Auckland Islands part of SQU 6T (SCI 6A), particularly during January–June accounted for most of the birds identified as being net captures. Albatrosses, petrels, and shearwaters were caught during the shoot and haul of bottom trawl and midwater nets, as well as during the tow when the net was lifted near to or to the surface, often for a turn, before being reshot. Birds were tangled, meshed, or drowned when recovered from the net during the haul. Bottom trawl nets appeared to catch more petrels on the haul. Korean and New Zealand vessels using bottom trawl nets and Polish vessels using midwater nets were more likely to catch petrels than albatrosses. Of the seabirds caught on the haul, more were landed dead than released alive from midwater nets, but more petrels were released alive from Korean bottom trawl nets than landed dead. These results often relate to vessel practices in retrieving the birds from the hauled net as well as the reason for the capture incident.

Birds were caught when they attempted to directly feed from the net or on escaped fish nearby and when they swam, dived, or flew into the net or between the meshes (usually the smaller birds). They were recovered from the codend through to the net wings of both bottom trawl nets and midwater nets.

Comments on the potential cause for net captures that relate to fishing practices (and thus may be mitigated against by a vessel) were primarily related to the net being at or near the surface for a prolonged length of time. Reasons for this were: gear event (when there was a breakage in some part of the gear); difficulties in getting the net to shoot correctly (such as tangled headline, or difficult weather conditions) or shooting practices that increase the time the net is splayed out on the surface; fishing practices where the net is not completely hauled between tows; long tows with several partial hauls (and turns) throughout the tow; slow hauls due to breakages, lack of net rollers, short decks, less powerful winches, or difficult weather conditions.

Other fishing-related factors suggested as causes included any offal discharge, deployment of unclean nets, nets shot immediately after a codend has been lifted (when bird presence is greater), few vessels in the area (so that birds were concentrated around the vessel). Much of the available information suggested that individual vessel practices increased the likelihood of captures in the nets, with gear breakdowns the major reason for multiple captures. However, on some occasions, observers noted that there appeared to be no obvious reason for capture other than the presence of the birds and the normal shooting and hauling practices.

A preliminary summary of observer data from May 2007 to May 2008 looked at several new data fields, specifically the "capture method" and "gear event" records, based on revised MFish observer forms. About 70% of the 4891 observed bottom trawl records and 66% of the 2566 observed midwater trawl records had no problems or "events" with the gear. The most common "gear event" was when a vessel made a partial haul, then turned, and reshot the net during a tow: this was the event recorded for 11% of observed bottom trawl records and 22% of midwater trawl records. Another 9% of bottom tows had some form of net damage, and 4.5% of midwater tows were recorded as being towed in "non-fishing depths". Seabirds were caught on 158 observed tows, 73 of which had no gear event, 61 were tows with a partial haul, turn, and reshoot of the net, 13 had net damage, and the remainder were tows, either with another gear breakage, in non-fishing depths, with a winch failure at the set, or a mixture of these. For the three observed tows with more than 3 seabirds per tow, the largest capture event of 14 seabirds occurred on a tow with no gear problems, 9 were caught on a tow that had net damage, and 7 on a tow with winch failure during the set of the tow.

1. Introduction

Albatrosses and petrels are known to be attracted to and follow vessels at sea. Those that attend trawlers scavenge from the offal discards, factory washings, or meal plant slurry produced during the processing of the catch and attempt to feed from fish caught in the nets, usually during the haul of the net. It is at this time that numbers of birds around the vessel increase, sometimes to thousands of birds, depending on the time of day, the time of year, the area fished, and the prevailing weather conditions. The feeding behaviour of the birds is intensified when the competition for food and space to feed is under pressure, and the composition of the seabird population around a fishing vessel can determine the success of certain species in obtaining food. This can also play a part in the likelihood of a seabird taxon being caught during the fishing operation, with some taxa dominant in the air and on the water.

Seabirds known to feed around trawlers in the New Zealand Exclusive Economic Zone, resulting in capture in the trawl gear, represent at least 11 albatross taxa and 14 petrel and shearwater taxa (MFish observer data). Seabirds are caught on the wing and on the water, particularly on the trawl warps, and may also be injured or killed when they attempt to feed directly from the net, either as it is being shot, is resting on the surface, or is being hauled during a tow or at the end of a tow. In New Zealand waters, since the 2005–06 fishing year, vessels > 28 m have used some form of regulated mitigation on the trawl warps to minimise seabird strikes on these wires, in the air or on the water, during the tow. This mitigation is coupled with voluntary management of offal discharge and fish discarding practices that are often vessel specific and are aimed at minimising any discharge. There is no current management practice in place to attempt to deter seabirds from being caught in the net.

Understanding the ways in which seabirds are captured in the trawl nets is the first step in the attempt to mitigate against such captures which result in fatalities on the shoot and haul of a net. Some taxa are more adept at escaping from the net than others and some seabirds survive capture in a trawl net during the haul and are released as the net is hauled aboard.

Ministry of Fisheries (MFish) observers collect data on the incidental capture of seabirds during commercial fishing operations. Often they provide comments about the events that led to these captures, though these comments are not necessarily written in a consistent manner and the purpose or theme of the comments may vary from observer to observer. In the absence of information specific to each tow that describes whether a bird capture was a result of direct interaction with the trawl net, as opposed to being recovered from a trawl net after hitting a trawl warp, these comments are useful in isolating those captures made in the net and provide insight into the activities of the seabirds and the fishing operations that result in capture.

This report summarises data and associated information based on the observer comments provided on the Nonfish Bycatch Form by MFish observers during trawl fishing operations in New Zealand waters, 1999–2000 to 2006–07. Thus, where an observer comment suggested or stated that a seabird was definitely, or likely, caught in a net, the seabird record was included. For records collected since January 2007, when a new data form that included a "capture method" (for example, caught in net, on warp) was instigated, the records with an "N" for "caught in net" were included.

It is not the intention to report catch rates by vessel, fleet, fishery, or time period; rather this report broadly summarises data for those observed trawls with seabird captures and associated comments that suggest or state that the seabird was a net capture. It is important to stress that any data presented here represent a subset of the total observed seabird data and may also be a subset (of unknown proportion) of seabirds caught in the net. Thus, the data do not take into account any sampling variation between years, fleets, or fisheries.

As an addendum to the original specifications of this work, a preliminary summary of observer data from May 2007 to May 2008 looked at several new data fields, specifically the "capture method" and "gear event" records, based on revised MFish observer forms. This is provided in Appendix 3.

2. Seabird taxa caught in trawl nets

Data summarised here are for tows observed (during 1999–2000 to 2006–07) with seabird captures as a result of interaction with the trawl net only. When a seabird is caught, an observer records his/her identification of the seabird, and if the seabird was killed and returned for autopsy a record of the verified identification is available. The verified taxa data are used in this summary in any discussion of seabirds by taxon.

To incorporate seabirds with no verified identification, that is, those released alive, or killed and not returned (generally because the seabird was lost from the net during the haul), one of two categories was assigned to each bird, based on the verified identification or the observer identification where the former was not available. The two categories are "albatrosses" — consisting of all the albatross taxa — and "petrels" — including all petrels and shearwaters. In terms of net captures, birds in the first group are more likely to be feeding from the surface, or making shallow dives, whereas the birds in the second group are more varied in their feeding ability and feed from the surface as well as swim, fly, or dive into the net or between meshes. These smaller birds are also more manoeuvrable in flight, and perhaps better at escaping from the net.

Captures of seabirds in trawl nets during the 1999–2000 to 2006–07 fishing years included at least 8 taxa and 11 petrel and shearwater taxa (Table 1). The majority of captures were sooty shearwaters, white-capped albatrosses, and white-chinned petrels (Table 2), and these taxa were often caught on the same trips. These taxa dominate the seabird catch composition reported from all observed trawl fishing operations (for example, Baird & Smith 2007).

Table 1: Seabird taxa reported from observed trawl nets as net captures.

Target code	Seabird taxa		IUCN*	DOC*
Verified albatross taxa				
XAN	Antipodean (Antipodes I.)	*Diomedea antipodensis antipodensis*	V	RR
XBM	Buller's (southern)	*Thalassarche bulleri bulleri*	V	RR
XCM	Campbell	*Thalassarche impavida*	V	RR
XSA	Salvin’s	*Thalassarche salvini*	V	RR
XRA	Southern royal	*Diomedea epomophora*	V	NV
XWM	White-capped	*Thalassarche steadi*	NT	RR
Verified petrel and shearwater taxa				
XBP	Black petrel	*Procellaria parkinsoni*	V	RR
XCC	Southern cape petrel	*Daption capense capense*	LC	NT
XFP	Fairy prion	*Pachyptila turtur*	LC	NT
XFS	Flesh-footed shearwater	*Puffinus carneipes*	LC	GD
XGB	Grey-backed storm petrel	*Garrodia nereis*	LC	RR
XGP	Grey petrel	*Procellaria cinerea*	NT	GD
XSH	Sooty shearwater	*Puffinus griseus*	NT	GD
XSP	Southern giant petrel	*Macronectes giganteus*	NT	M
XTS	Short-tailed shearwater	*Puffinus tenuirostris*	LC	M
XWC	White-chinned petrel	*Procellaria aequinoctialis*	V	RR
XWP	Westland petrel	*Procellaria westlandica*	V	RR
Other taxa reported by observers				
XWA	Wandering albatross	*Diomedea exulans*	V	M
XWF	White-faced storm petrel	*Pelagodroma marina*	LC	NT

* These codes give the current threat status of the listed taxa. IUCN 2007. *2007 IUCN Red List of Threatened Species.* www.iucnredlist.org, where CE is Critically Endangered, E is endangered, V is Vulnerable, NT is Near Threatened, LC is Least Concern. DoC status information is from Hitchmough et al. (2007), where NV is nationally vulnerable, GD is gradual decline, RR is range restricted, NT is not threatened, and M is migrant.

Captures were reported from Fishery Management Areas (FMAs) 1–7, including SQU 6T in FMA 6 (Table 2, Figure 1), with the highest diversity of taxa in FMAs 3, 4, 5, and SQU 6T. Some taxa were reported from one gear type (for example, Chatham albatross), whereas others were caught in both bottom and midwater trawl nets. Captures of southern Buller's albatross, Salvin's albatross, sooty shearwaters, white-chinned petrels, and white-capped albatrosses were recorded from tows in five or six FMAs. Species such as black petrels, flesh-footed shearwaters, and black-browed albatross were reported from trawl nets in northern waters only.

Table 2: Occurrence of each verified seabird taxa*caught, by gear type and Fishery Management Area (FMA). Note that numbers are not absolute, but reflect the seabirds identified as being captured in the trawl nets, 1999–2000 to 2006–07.

Code	FMA 1	FMA 2	FMA 3	FMA 4	FMA 5	FMA 6	FMA 7	SQU 6T	All
Bottom trawl									
XAN			1						1
XBM			1	4	2		1		8
XCI				1					1
XCM							1		1
XRA					1				1
XSA			7	3	1	1			12
XSM		1							1
XWM		1	2		62	4	7	17	93
XBP	1								1
XCC								1	1
XFS	14	1							15
XGB					1				1
XGP				1					1
XSH	1		130	5	149	3		32	320
XWC			3	2	10			16	31
XWP							1		1
Total	16	3	144	16	226	8	10	66	489
Midwater trawl									
XBM			4	2	9		1	1	17
XRA				1	1				2
XSA		3		1	1			1	6
XWM		1	3		97		8	97	206
XCC		1					4		5
XFP							5		5
XGP						1		3	4
XSH			50	4	141			29	224
XSP							1		1
XTS					21				21
XWC			2		78			51	131
Total		5	59	8	348	1	19	182	622

* Codes for seabirds are listed alphabetically for albatross then petrel taxa and are explained in Table 1. FMAs are shown in Figure 1. SQU 6T includes the scampi are around Auckland Islands (SCI 6A).

For many of these taxa the distribution at sea and foraging abilities are not very well understood. A summary of some relevant information about the main seabird taxa is provided in Appendix 1. The close proximity of breeding colonies to major fishing areas is particularly important when the fishing seasons and breeding seasons overlap; an example of this overlap is shown in Appendix 2 for the main squid and hoki fisheries. These target fisheries have accounted for most of the observed effort during the years covered in this summary. Most net captures were reported from these targets (Table 3).

Table 3: Target species of observed tows with net captures (of verified taxa)*.

Target	FMA 1	FMA 2	FMA 3	FMA 4	FMA 5	FMA 6	FMA 7	SQU 6T	All
Bottom trawl									
BAR			2						2
HAK				5			1		6
HOK			58	5	16	4	9		92
JDO	2								2
LIN			2						2
ORH				3					3
SCI	14	3	1	3				16	37
SQU			43		207	1		50	301
SWA			38		3	3			44
Total	16	3	144	16	226	8	10	66	489
Midwater trawl									
BAR			1		19		1	2	23
HAK							2		2
HOK		5	55	8	46		15		129
JMA					16		1		17
SBW						1		3	4
SQU			3		266			177	446
WAR					1				1
Total		5	59	8	348	1	19	182	622

* BAR, barracouta (*Thyrsites atun*); HAK, hake (*Merluccius australis*); HOK, hoki (*Macruronus novaezelandiae*); JDO, John dory (*Zeus faber*); JMA, jack mackerels (*Trachurus* spp.); LIN, ling (*Genypterus blacodes*); ORH, orange roughy (*Hoplostethus atlanticus*); SBW, southern blue whiting (*Micromesistius australis*); SCI, scampi (*Metanephrops challengeri*); SQU, arrow squid (*Nototodarus* spp.); SWA, silver warehou (*Seriolella punctata*); WAR, common warehou (*Seriolella brama*). FMAs are shown in Figure 1. SQU 6T for scampi is equivalent to SCI 6A.

3. Fishing fleets and gear types

Several fleets operate in the New Zealand waters and the main ones that are included in the observer information used for this report are from New Zealand (27 vessels), Japan (3), Korea (16), Poland (4), and Russia or Ukraine (14). Although vessels in one fleet may have some operational differences, there are some generalisations that can be made about the way in which the vessels of a fleet fish and process the product —

the main points of which are summarised below from observer information and some discussions with gear manufacturers and industry representatives.

New Zealand fishing trawlers range in size and processing capability from small vessels (< 28 m) that generally undertake short trips, store fish on ice, and fish inshore waters to large vessels (up to 105 m) that operate mainly in 200–1200 m, use sophisticated electronic gear, and process the product using a meal plant. Most observer coverage has been on these larger vessels operating in fisheries targeting squid, middle depths fisheries (particularly hoki), and deepwater fisheries for orange roughy and oreos. These vessels use bottom trawl nets, including twin-trawl rigs on some vessels, and midwater trawls (Figures 2 & 3). Most complete 2–4 tows a day. Vessels targeting scampi may use three codends per bottom trawl and retrieve only the codends on board at the end of a tow, rather than the whole net. A limited amount of observer coverage has taken place on inshore vessels, most of which has been in northern waters where species such as tarakihi, John dory, trevally, red gurnard, and snapper are targeted.

Korean vessels operating in New Zealand waters typically use bottom trawl nets and mainly target squid, hoki, and other middle depths species particularly barracouta. These vessels do not usually have a meal plant and when fishing for squid, the catch is packed whole and thus there is often very little offal or discards. As a general fishing strategy Korean vessels execute a turn, often to tow along the same path, before the net is hauled completely. One observer noted that the short deck on the Korean vessel he was aboard resulted in the net being hauled *in several pulls*. It is apparent, in recent years, that these vessels have changed their fishing strategy when targeting squid in the southern squid fisheries in SQU 6T in response to the limited number of tows designated under the MFish Operational Plan for SQU 6T. These vessels generally make one tow a day, starting at dawn, and finishing at the end of daylight, or when the catch is sufficient, or if the gear is found to be damaged. This behaviour requires that the net is hauled (to *doors up*) several times throughout the day to check on the catch and the state of the fishing gear.

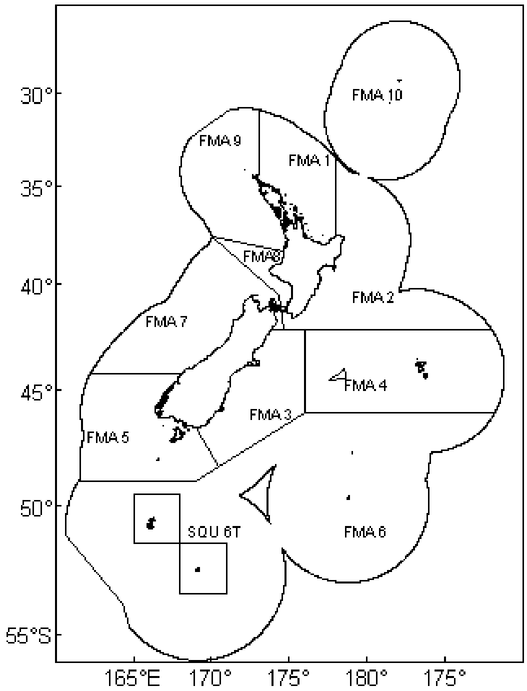

Figure 1: **Fishery Management Areas (FMAs) and SQU 6T within the 200 n. mile EEZ.**

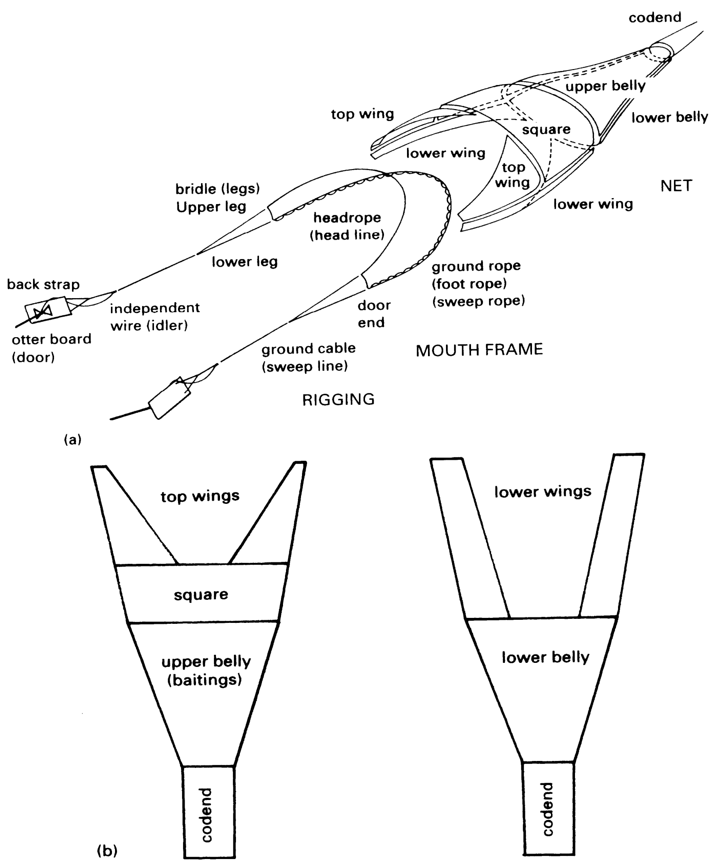

Figure 2: **Generalised diagram of bottom trawl gear (a) showing the net construction (b) (reproduced with permission, Sainsbury 1996).**

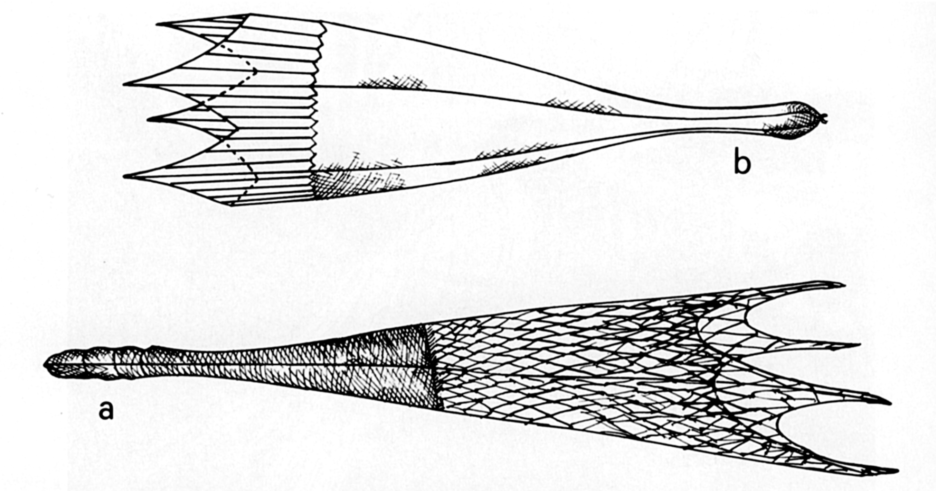

Figure 3: Generalised diagram of midwater trawl nets where the forward section is made from large mesh (a) and ropes (b) (reproduced with permission, Gabriel et al. 2005).

Large Polish, Russian, and Ukrainian vessels are equipped with meal plants and almost exclusively use large midwater nets when fishing in New Zealand waters, where they mainly target squid, hoki, and jack mackerels (Ukrainian vessels). These nets are made as four-seam nets, with two equal top and bottom panels and two smaller equal side panels (Figure 3).

The wings are shorter than on bottom trawl nets and on some midwater nets lengths of ropes (for example, about 28 m lengths) are used in the wings rather than large mesh. The mesh behind these ropes gets progressively smaller, with full mesh lengths dropping from 29 m (bar lengths of 14 and 15 m) to 12 m before the lengthener and codend. Various words are used to describe these net parts by observers and these names have been interpreted in this report as follows:

- *forward mesh* and *upper mesh* describe the large open meshes in the forward part of the net (that is, in front of the lengthener and codend)
- *light rope warps* describe the ropes in the wings and forward part of the net
- *mesh behind the headline* describes the smaller mesh (for example, with full mesh length of about 1.5 m) that is directly behind the headline
- *spaghetti lines*/*mesh* describe the ropes in the forward section.

4. Characteristics of captures in nets as described by MFish observers

Observer data that included the seabird incidental capture data, associated tow information, and comments made by observers on the Nonfish Bycatch Forms, from the MFish *obs* and *obs_lfs* databases for the 1999–2000 to 2006–07 fishing years provided the base information for this summary. The comments were used to isolate records where the seabird capture could be attributed to interaction with the trawl net. This information was then collated to provide summaries of the types of net interactions for each seabird species by fleet and gear type (for example, POL MW for Polish midwater nets).

For trips where there were larger numbers of net captures, the trip reports completed by the observers at the end of each trip were reviewed, as were the trip diaries for 2006–07 fishing year, because in this year vessels > 28 m were required to use mitigation devices during the tow to deter seabirds from the trawl warps. These devices are not in place during the shoot or haul. Vessels were also operating under a voluntary offal management plan, and this coupled with the type of seabird deterrent, or the use of the device, may result in different behaviours by seabirds when attempting to get food from behind the vessel. These measures may displace the feeding behaviour of the seabirds so that more attacks are made on the net, whether on the shoot or the haul.

The comments and remarks noted by observers, either in their logbooks or diaries, were not consistent in the type of information supplied. Thus, there is no attempt here to provide any quantitative summary. Observer comments in relation to net captures can be generalised into ten categories, some of which were nicely combined in some remarks, for example, for sooty shearwater captures, *daylight setting and codend not cleaned very well and very calm and lots of birds feeding*.

1. State of the bird

Comments on the state of the bird described the life status of the bird, any injury sustained (including *no obvious injury other than the bird was dead*), the likelihood of survival of an alive bird, the behaviour of a bird that was released, the entirety of the bird, and state of the feathers (for example, *caked in mud, full of sand, waterlogged, or wet feathers but dry body*). Sometimes observers noted that the bird may have been in the net as a result of a warp strike because of the injuries sustained, for example, *rust stains*, *wing torn off*, *feathers missing*.

2. Location of the bird in the net

These comments were varied in their detail, and the terminology used was often observer-specific (or perhaps vessel-specific). Generally, these comments referred to the part of the net where the bird was seen during the haul or recovered from when the net was actually hauled onto the vessel; for example, *in the forward meshes*, *codend*, *riding on the net*. Some comments referred to net meshes and others to net ropes. Occasionally these comments were associated with further descriptions, such as *caught by wing* or *tangled*.

3. Details such as existence of a photograph and/or specimen number

Occasionally, a photograph number or specimen number for the captured bird was recorded.

4. Considered opinion or observed (known) record of time of capture (shoot or haul)

An observer may state that the captured bird was *caught when the net was set*, particularly when the bird was *caked with mud*, *waterlogged*, or *full of sand*. A similar style of comment was recorded sometimes when the bird was either observed getting caught on the haul, or obviously caught on the haul because the feathers were not very wet, or the bird was alive. Some comments noted that it was not clear when a bird may have been captured. Others noted that the bird may have died from a warp strike (for example, had grease or rust on the feathers) and been “caught” by the net. For the latter comments, the record was used in this summary.

Seabird records were assigned a code, based on observers' comments, to identify whether the birds were caught when the net was shot, on the haul, during the tow when the net was partially raised (usually to doors up) or was on/near the surface for some reason; or if the time of capture (shoot or haul) was unknown. The latter category included dead birds only. Any live birds with no relevant comment for time of capture were assigned to the haul captures group.

5. Occurrence of a gear event at any stage of the fishing operation

Events that affected the performance of the gear or interrupted the normal fishing operation were recorded for some captures. These described either a gear breakdown, such as *starboard wire broke and the net was hauled on the port wire and the haul was 1 hour longer than usual*, or a fishing strategy, for example, *one turn was made with the doors up and the net near or at the surface*.

6. Fishing management

Most of these comments related to the timing, composition, and/or amount of offal discharge or discarding. These comments were more commonly made in the earlier years of the time period than in later years when offal management plans were in place. Examples include: *offal discharged at shoot*, *meal plant slurry and factory washings at haul*, or *no offal discharge at shoot or haul*.

Others noted the whether nets were cleaned properly before shooting or described the usual pattern of net use, for example, *one net was hauled on board, then the other net shot*.

7. The use of any mitigation devices

Occasionally these comments included remarks on the presence or use of warp mitigation devices, perhaps noting the efficacy or state of the chosen method.

8. The behaviour of the birds around the net

These comments generally described the numbers of birds around the net at the shoot or haul and the nature of their feeding behaviour, for example, if they *were aggressively feeding from the net*, or birds *were attacking squid meshed in the net* or *hoki stickers*.

9. Weather/environmental conditions

When included, these comments indicated *a full moon* or described the seabird activity: for example, *calm seas and little wind* ... or *extremely large swells and high winds affected the birds' feeding activity.*

10. Unknown capture cause

For some capture incidents the observers noted that there appeared to be no reason for the captures, including some multiple captures.

5. General summary of the net captures data

Any numbers of seabirds provided in this section are relative to the dataset constructed for this summary of net captures; thus, they are not directly comparable to the total numbers reported.

Similar numbers of albatrosses and petrels were recovered from Russian and Ukrainian midwater trawl nets as net captures, whereas seabirds caught in Polish midwater trawl nets and Korean and New Zealand bottom trawl nets were more likely to be petrels (Table 4). Albatrosses considered to be net captures were caught on the shoot and haul of bottom and midwater trawl nets. It appears that petrels are more likely to be recovered from the net after being caught during the haul, rather than the shoot, particularly on Korean vessels. However, the large number of records with an unknown capture time period precludes any real conclusion of when birds might be more vulnerable to capture.

Table 4: Numbers of albatrosses and petrels identified as being caught in the net, by fleet and gear type and time of capture*

			Capture time					
Fleet	Gear	Group	H	S	S/H	SH	U	All
CIS	BT	Alb		2			4	6
		Pet	10	3			17	30
	MW	Alb	53	84	1	6	69	213
		Pet	103	66	8		67	244
CIS Total			**166**	**155**	**9**	**6**	**157**	**493**
JAP	BT	Alb	4	1				5
		Pet	9	2			3	14
	MW	Pet	2					2
JAP Total			**15**	**3**			**3**	**21**
KOR	BT	Alb	39	26		9	34	108
		Pet	179	48	2	6	71	306
	MW	Alb	1				3	4
KOR Total			**219**	**74**	**2**	**15**	**109**	**419**
NOR	BT	Pet	2				6	8
	MW	Alb	1					1
NOR Total			**3**				**6**	**9**
NZL	BT	Alb	16	6	1		11	34
		Pet	81	33	3		47	164
	MW	Alb	1	1	1		6	9
		Pet	4	1		2	2	9
NZL Total			**102**	**41**	**5**	**2**	**66**	**216**
POL	BT	Alb	1					1
		Pet	1				1	2
	MW	Alb	16	11		6	27	60
		Pet	133	26	3	36	42	240
POL Total			**151**	**37**	**3**	**42**	**70**	**303**
All			644	312	19	65	412	1452

* Fleet is: CIS, Russia & Ukraine; JAP, Japan; KOR, Korea; NOR, Norway; NZL, New Zealand; POL, Poland. Gear is: BT, bottom trawl; MW, midwater trawl. Group is: Alb, albatross taxa; Pet, petrel and shearwater taxa. Capture times are: H, haul; S, shoot; S/H, shoot or haul; SH, when net is being shot or hauled during tow; U, unknown.

A summary of the life status of seabirds that were obviously caught on the haul suggests that more albatrosses and petrels are killed during the haul than are released alive in midwater trawl nets (Table 5). Similar numbers of albatrosses caught during the haul of bottom trawl nets were alive and dead. For petrels caught on the haul of bottom trawl nets, a higher proportion of petrels were released alive than dead from Korean vessels, whereas most petrels caught during New Zealand hauls were landed dead.

Although, the numbers of each taxon identified as being net captures are limited in their use, as discussed above, most of the taxa known to be caught on the haul were also caught during the shooting of the net. Captures of different taxa are discussed in the next section, relative to the observer comments.

Table 5: Numbers of alive and dead albatrosses and petrels identified as being caught in the net during the haul, by fleet and gear

		Albatrosses			Petrels		
Nation	Gear	Alive	Dead	Total	Alive	Dead	Total
CIS	BT				9	1	10
	MW	14	39	53	39	64	103
JAP	BT	4		4	2	7	9
	MW				1	1	2
KOR	BT	16	23	39	116	63	179
	MW	1		1			
NOR	BT					2	2
	MW		1	1			
NZL	BT	8	8	16	12	69	81
	MW		1	1	3	1	4
POL	BT	1		1	1		1
	MW	2	14	16	32	101	133

* Fleet is: CIS, Russia & Ukraine; JAP, Japan; KOR, Korea; NOR, Norway;, NZL, New Zealand; POL, Poland. Gear is: BT, bottom trawl; MW, midwater trawl.

6. Albatross captures in trawl nets

Most observer comments related to net captures of albatrosses were for white-capped albatrosses from the squid fisheries in FMA 5 and SQU 6T, and thus during January–May of any year. Few comments were provided for other albatross taxa, other than southern Buller’s albatross and Salvin’s albatross.

6.1 *Thalassarche* albatrosses

White-capped albatrosses were caught during midwater and bottom trawls for a variety of middle depths fish species and squid, throughout the year, and in FMAs 2–7, including SQU 6T (Table 6). Most net captures were from FMA 5 and SQU 6T (Tables 2 & 6) where the fishing season overlaps with the breeding season of the albatrosses that breed at the Auckland Islands (see Appendices 1 & 2).

Southern Buller's albatross captures were reported from bottom and midwater gear used to target middle depth fisheries for barracouta, hake, hoki, jack mackerels, and squid, as well as scampi and orange roughy in FMAs 3–7, including SQU 6T, with captures reported from most months of the year (Tables 2 & 7). Salvin's albatrosses were mainly caught by bottom trawl nets targeting hoki, hake, squid, and scampi, during effort in FMAs 2–6, including SQU 6T, during September to March (Table 8). This period is the breeding season for Salvin's albatross at the Bounty Islands.

A single Campbell albatross was recorded as being tangled in the bridles when the net was being hauled.

6.1.1 Captures in midwater nets

Captures that occurred when midwater nets were shot were recovered from trawl meshes from the codend through to the headline and wing meshes, light rope warps, and in the codend and the belly of the net. Comments describing these midwater trawl captures were related to:

- gear events which kept the net at the surface for longer than usual while the crew rectified the problem — mouth of net and lines were tangled; headline twist and net shot and retrieved twice; wire splice mended; several attempts at getting the gear down; during shoot net out to doors then vessel turned before setting; net still on surface and headline splayed out

- fishing management — net was not cleaned properly and birds actively feeding on 'stickers' in the mesh; tow set straight after haul and lots of birds around; factory processing and birds dived on offal that drifted into the shooting line and were tangled in the forward meshes.

Captures that occurred during the haul of midwater nets were recovered dead or alive from the meshes of the codend through to the wings (including headline meshes), light rope warps, and spaghetti mesh. Some were riding on the codend. Birds were tangled in the mesh or the rope lines, or caught by the wing, foot, neck, or beak. Haul comments related to:

- fishing strategy — turning while net at surface; hauled to doors up and in heavy swell birds were tangled in light ropes or mesh;
- fishing management — offal discharge during haul, sometimes because the meal plant had broken down, attracting large numbers of birds; haul stopped to clean weed from net
- gear event — net raised to change warp configuration; winch failure and net on surface; meal plant breakdown; damaged headline repaired mid haul and birds caught in twisted ropes on surface; net ropes/ warp repaired with net on surface

Table 6: Target fishery characteristics for observed tows with white-capped albatross in nets*.

Fleet	Gear: target	FMA 2	FMA 3	FMA 4	FMA 5	FMA 6	SQU 6T	FMA 7
CIS	BT: SQU				Mar		Mar-Apr	
	MW:BAR, HAK, JMA, SQU				Jan-May		Jan-Apr	Jun-Jul
JAP	BT: SQU				Feb		Mar	
KOR	BT: BAR, HOK, SQU, SWA		Feb-May	Feb-May	Jan-Jun		Feb-Apr, Jun	Jul-Sep
	MW: BAR, HOK, WAR		Jul					Aug-Sep
NOR	MW: HOK		Oct					
NZL	BT: HAK, HOK, OEO, SCI, SQU	Jun	Dec	Feb	Jan-Apr	May	Feb-Apr, Nov	Mar-Jun, Nov
	MW: HOK	Sep						Jul-Aug
POL	MW:HOK, SQU		Jun		Jan-Apr		Feb-Apr	Jun-Aug

* Fleet is: CIS, Russia & Ukraine; JAP, Japan; KOR, Korea; NOR, Norway; NZL, New Zealand; POL, Poland. Gear is: BT, bottom trawl; MW, midwater trawl. Target species codes are defined in Table 3. FMAs are shown in Figure 1.

Table 7: Target fishery characteristics for observed tows with southern Buller's albatross in nets*.

Fleet	Gear: target	FMA 3	FMA 4	FMA 5	SQU 6T	FMA 7
CIS	MW : BAR, JMA, SQU			Jan-May	Mar	
JAP	BT: HOK		Nov			
KOR	BT: BAR, HAK, HOK, SQU	May	Oct	Apr, Jun		Jul
NZL	BT: ORH, SCI,		May-Jun, Dec			
	MW: HOK			Aug		
POL	MW: HOK, SQU	Jun	Apr, Jun	Sep		Aug

* Fleet is: CIS, Russia & Ukraine; JAP, Japan; KOR, Korea; NOR, Norway; NZL, New Zealand; POL, Poland. Gear is: BT, bottom trawl; MW, midwater trawl. Target species codes are defined in Table 3. FMAs are shown in Figure 1.

Table 8: Target fishery characteristics for observed tows with Salvin's albatross in nets*.

Fleet	Gear: target	FMA 2	FMA 3	FMA 4	FMA 5	FMA 6	SQU 6T
CIS	MW : JMA, SQU				Mar		Feb
JAP	BT: HOK			Oct			
KOR	BT: HAK, SQU		Mar, Dec	Mar, Nov	Feb	Mar	
NOR	BT: HOK			Feb			
NZL	BT: HOK, SCI		Oct-Jan	Nov-Dec			
	MW: HOK	Sep					

* Fleet is: CIS, Russia & Ukraine; JAP, Japan; KOR, Korea; NOR, Norway; NZL, New Zealand; POL, Poland. Gear is: BT, bottom trawl; MW, midwater trawl. Target species codes are defined in Table 3. FMAs are shown in Figure 1.

- weather — birds on surface and light winds therefore limited mobility; swell direction pushing offal discharge into path of net being hauled
- bird behaviour — hundreds of birds around net; birds diving on codend and feeding from any area of net on surface; feeding on meshed fish or squid.

6.1.2 Captures in bottom trawl nets

Albatrosses caught on the shoot of bottom trawl nets were recovered from the codend and the net wings:

- fishing management — large catch of crab discarded at start of tow; squid or scampi nets not cleaned properly before net shot

Captures during the haul of bottom nets resulted in captures in the mesh, light rope warps, and bridles, when birds were tangled or caught by a body part, and one was caught by the neck on the chaffer gear trailing behind the codend. Comments were described in relation to:

- fishing strategy — several turns with net hauled to surface
- fishing management — offal discharge
- gear event — broken warp leading to very slow haul of scampi nets or spillage of catch, including fish, causing birds to feed frantically on escapees ; haul to surface after net came fast; net was badly ripped and spilling fish — birds dived on the net and were caught in the ripped wings; damaged net with broken headline;
- bird behaviour — many birds present; birds dived into net during turn when net at/near the surface; birds fighting over net; chasing stickers in the net; birds feeding when net is fleeted and the net folds up and creates a tunnel that traps the birds; more birds were around a vessels when few vessels were present
- weather — bright moonlit night.

6.2 Other albatrosses

There were few comments that related to the capture of the large albatrosses (Antipodean and southern royal albatrosses) other than that birds were found in the codend and that one capture could have occurred when there was a turn in the tow.

7. Petrel and shearwater captures

Sooty shearwaters and white-chinned petrels dominated the captures of smaller seabirds, particularly during squid fisheries in FMA 3, FMA 5, and SQU 6T during January–May.

7.1 Sooty shearwater ***Puffinus griseus***

Sooty shearwaters were caught during the shooting and hauling of both midwater and bottom trawl nets. Tows with multiple captures were a common characteristic of the sooty shearwater-trawl net interaction, and the causes for these events were mainly the net being on the surface for a prolonged time and the large numbers of birds feeding from the net. These birds form large migratory flocks during March–April before leaving New Zealand waters until their return in September–October.

Sooty shearwater captures in midwater nets were predominantly from Russian and Ukrainian midwater nets during the southern squid and multi-target fisheries during January–April and Polish nets in similar fisheries but also in FMAs 3 & 4 on the Chatham Rise during March–May (Table 9). Captures were reported from Korean, Japanese, and New Zealand bottom trawl nets in FMAs 1 & 3–6 and SQU 6T (equivalent to SCI 6A for scampi tows), during January–May and September–October. About 91% of sooty shearwater captures in nets were reported during January–May. The months of captures shown in Table 9 reflect the presence of breeding birds in New Zealand waters. The target fisheries with captures in bottom trawl nets were squid, scampi, hoki, barracouta, hake, ling, silver warehou, and white warehou.

7.1.1 Captures in midwater nets

Birds caught in midwater nets when the net was being shot were later discovered in the codend, the groundrope, net mesh, headline mesh, lengthener, and net wings. Birds were described as *tangled* — by a wing, body, or the neck. Comments describing these midwater trawl captures were related to:

- fishing management — offal discharge during the shoot
- gear event — repairs to the headline resulted in the net being just submerged for 3 hours; setting problems that required the headline and floats to be rehauled, straightened , and reset;
- bird behaviour — diving into the net as it was shot; hundreds of birds present
- weather — rough weather resulted several attempts to set the net.

Table 9: Target fishery characteristics for observed tows with sooty shearwaters in nets*

Fleet	Gear: target	FMA 1	FMA 3	FMA 4	FMA 5	FMA 6	SQU 6T	FMA 8
CIS	BT :SQU				Mar-Apr		Apr	
	MW : BAR, HOK, JMA, SQU				Jan-Apr		Feb-Apr	May
JAP	BT: HOK, SQU, WWA				Feb-Apr			
KOR	BT: BAR, HAK, HOK, SQU, SWA		Feb-May, Oct	Feb-May	Jan-May		Feb-Apr	
NOR	BT: HOK		Mar	Feb				
NZL	BT: HOK, LIN, SCI, SQU, SWA	Oct	Feb-May, Oct-Nov	Apr	Feb-May	Apr	Feb-Apr, Nov	
POL	BT: HOK		Mar					
	MW: HOK, SQU		Mar-Apr	Apr-May	Jan-Apr, Sep-Oct		Feb-Apr	

* Fleet is: CIS, Russia & Ukraine; JAP, Japan; KOR, Korea; NOR, Norway; NZL, New Zealand; POL, Poland. Gear is: BT, bottom trawl; MW, midwater trawl. Target species codes are defined in Table 3. FMAs are shown in Figure 1.

Captures that occurred during the haul of midwater nets were recovered dead or alive from the meshes of the codend through to the wings (including the lengthener, belly, and headline meshes), light rope warps, spaghetti lines, and spreaders. Some were riding on the codend. Birds were usually described as tangled, with the following comments:

- fishing strategy — several turns with net hauled to surface
- fishing management — discards throughout the fishing operation; offal or meal slurry discharged at haul
- gear event — slow haul because of break in net, break in groundline, or tangled gear; net at surface while light rope warps repaired; twisted chains in rough weather resulted in gear at surface
- bird behaviour — feeding on meshed fish or squid; flocks of birds diving into the net; diving for scraps amongst the net ropes; large amount of feeding activity around the vessel; birds flying into net when vessel turned with half the net on the vessel
- weather/environment — full moon; very calm weather; flocks of birds present; rough seas.

7.1.2 Captures in bottom trawl nets

Birds caught in bottom trawl nets when the net was being shot were recovered from the codend and the body of the net. Comments describing these captures were related to:

- fishing management — offal discharge during the shoot; offal discharge just before the net was shot and again just after it was submerged; the net was never completely clean when shot; whole fish were discarded when the scampi nets were shot
- gear event — repairs to the headline resulted in the net being just submerged for 3 hours; setting problems that required the headline and floats to be rehauled, straightened , and reset;
- bird behaviour — diving into the net as it was shot; hundreds of birds present
- weather — bad weather when the net was shot; daylight shot.

Sooty shearwaters caught during the haul of bottom trawl nets were trapped, tangled, or caught by a foot. Birds were recovered (alive and dead) from net and wing meshes and the codend. Some of these bottom tows were around the Mernoo Bank in February, March, and April and resulted in multiple captures, whether there was a gear event or not. On one tow with multiple captures, the birds had dived into the net mesh and the observer described them as like *stickers* in the mesh. Comments describing these captures were related to:

- fishing management — brief delay in haul because vessel has a short deck and therefore has to make many pulls to haul the net; meal slurry and factory wash discharged during the haul; more offal when targeting wetfish and more birds around the vessel; stopped fishing with the net hauled to midwater and hauled 7 hours later
- gear event — break in net when huge seas and winds; trailing damaged net; broken groundline and major net damage and codend on the surface for extended time; tear in wing mesh to groundline; net on surface while crew replaced faulty swivel; scampi gear on the surface for 1.5 hour with problems of a twisted chains and rough weather.
- bird behaviour — diving at the headline and mesh before the lengthener; feeding on meshed fish; hundreds of birds present; swim or fly into net; diving under and around the vessel; sooty shearwaters more at risk near codend when not displaced by larger birds; bird sitting on midsection of the net when large numbers around the vessel

- weather — on dusk (fewer albatrosses around) and the water was *boiling* with sooty shearwaters; very rough with 4–5 m swells; huge seas and winds; poor light conditions; following seas and moderate wind from the stern; sea swell was from behind the vessel which caused the net to be slack and open on the surface.

7.2 White-chinned petrel *Procellaria aequinoctialis*

Similar comments were provided for white-chinned petrels which were caught in bottom and midwater nets in FMAs 3–5 and SQU 6T particularly during squid trawls in January–May and in hoki or other middle depths fisheries in September–December (Table 10). About 98% of white-chinned petrel captures were from observed tows during January–May. This species breeds in New Zealand waters at a similar time to sooty shearwaters, between late September and April–May, and breeding birds migrate out of New Zealand waters outside the breeding season.

7.2.1 Captures in midwater nets

Captures attributed to the shoot of a midwater net were recovered from the lengthener and belly meshes, smaller mesh behind the headline, wings, body of the net (including forward of the sea lion exclusion device), and in the light rope warps. Multiple captures occurred when there was offal discarded at the shoot, the net was at the surface because of a gear event, and the vessel was in thick fog. Comments described:

- fishing management — offal discharge at shoot
- gear event — net repairs with gear on the surface; headline did not set properly and the net shot twice
- weather — very still misty night; hundreds of birds present.

White-chinned petrels caught during the haul of a midwater net were recovered from ropes and meshes along the length of the net, including the headline, wings, light rope warps, and spaghetti mesh. Comments described:

- fishing strategy — one or two turns in tow; usual pause in the haul when the headline is secured
- fishing management — offal discharge at haul; slow haul to ‘doors up’;
- gear event — net repairs with gear on the surface; broken rope net warp caused delay in haul; repair to broken ground chain and net hauled to surface then vessel executed a turn, whilst discharging offal; delay in haul to attach new bridle warp; gear failure and net submerged

- bird behaviour — diving into net; aggressively feeding on squid hanging from meshes.

Table 10: Target fishery characteristics for observed tows with white-chinned petrels in nets*

Fleet	Gear: target	FMA 3	FMA 4	FMA 5	SQU 6T	FMA 7
CIS	MW : BAR, SQU			Jan-Apr	Feb-Apr	
JAP	BT: SQU				Mar	
KOR	BT: SQU			Feb-May	Feb-Apr	
NOR	BT: HOK	Feb, Mar	Feb			
NZL	BT: HOK, SCI, SQU, SWA	Nov	Dec	Jan, Mar-Apr	Feb, Nov	
POL	MW: HOK, SQU	Apr	Jan-Apr, Sep-Oct	Jan-Apr, Sep-Oct	Feb-Apr	Jul

* Fleet is: CIS, Russia & Ukraine; JAP, Japan; KOR, Korea; NOR, Norway; NZL, New Zealand; POL, Poland. Gear is: BT, bottom trawl; MW, midwater trawl. Target species codes are defined in Table 3. FMAs are shown in Figure 1.

7.2.2 Captures in bottom trawl nets

White-chinned petrel captures during the shoot of bottom trawl nets were usually recovered from the net wings, belly, codend, groundline, and headline mesh. Few comments were provided for these captures:

- Gear event — scampi nets on the surface for about 3 hours before being shot away due to problem with starboard winch
- weather — poor light conditions during the shoot

Captures during the haul were from meshes along the length of the net including the wings and on the outside of the net (including the cover net of a Sea Lion Exclusion Device). Multiple captures occurred when hauling in poor light and net was hauled to check the catch. Comments were relevant to:

- fishing strategy — turn with net at the surface; net containing many stickers was hauled partially to check catch

- fishing management — whole barracouta discarded just before hauling and many birds were present;

- bird behaviour — birds were feeding aggressively from net

- weather/environment — net hauled in the dark and slowed when crew released birds; rough conditions; following sea of 2 m swell and moderate wind from the stern created a lot of water movement pushing the net around.

7.3 Other petrels and shearwaters

The other petrel and shearwater taxa reported as net captures are listed in Table 1. Generally taxa were infrequently reported and numbers were few. Multiple captures occurred in October in FMA 5 during scampi tows by two New Zealand vessels (flesh-footed shearwaters) and midwater tows by a Polish vessel (short-tailed shearwaters). These species were caught in different circumstances, when:

- the net was tangled on the surface and the flesh-footed shearwaters were caught on tows where the vessel left the last codend to be hauled in the water to clear the net of mud; the doors were on deck and the net wings were trailing behind the vessel above the water.
- whole fish were discarded as the net was being shot, and birds were diving under the headline when the net was on the surface
- the net was shot immediately after the haul and whole fish were being discarded.

Individuals from other taxa were caught in similar circumstances to those described for the sooty shearwaters and white-chinned petrels, for example:

- feeding from squid caught in a bottom trawl (black petrel, flesh-footed shearwater in John dory tows in FMA 1 in April)
- diving into mesh behind the headline (grey petrel in southern blue whiting tow in FMA 6 in August)
- feeding voraciously off the codend (southern cape petrel in a hoki tow in FMA 2 in September)
- caught when net at the surface when the headline was under repair during the haul (fairy prion in a jack mackerel tow in FMA 7 in June)
- tangled in the trawl (Westland petrel in a hoki tow in Aug in FMA 7; grey petrel during a southern blue whiting tow in Aug in SQU 6T)
- many birds feeding behind the vessel (southern cape petrels during hoki tows in Aug in FMA 7)
- meal plant and waste pumps running during shoot and haul of net (fairy prions during hoki tows in FMA 7).

Thus, seabirds in these taxa were more likely to be caught during hoki effort in FMA 7 during July–August and southern blue whiting tows in FMA 6 in August–September.

8. Notes from observer diaries

Often observer diaries are a rich source of information that is not easily captured on a form or transferred to a database. As with the comments discussed above, the fishing operation aspects covered and the amount written varies largely from one observer to another. It was hoped that the diaries for the trips with net captures that were undertaken in the 2006–07 fishing year, when vessels were working to voluntary offal management plans and were required to use seabird deterrents, would have some commentary on net captures.

There was little further description of the fishing operation with respect to seabird captures. Tori lines were used on most of the vessels, and where there was any detail, it focussed on the release of offal and the use of other warp mitigation methods. Other comments noted that the numbers of birds increased, and they were noisier and more aggressive with a new moon. On one trip with multiple captures of sooty shearwaters, the observer noted the large flocks of these birds were coming and going throughout the fishing operations (during March–April on the Chatham Rise).

On one scampi trip it was noted that birds fed aggressively on the codend and discards. When fishing in SQU 6T (SCI 6A) in summer, white-capped albatrosses were the most competitive at scavenging close to the net. The observer noted that the albatrosses tended to be in the air around the bow during the haul until the doors were hauled, after which all the birds were concentrated around the codends.

During squid trips, nets were well cleaned on one Russian vessel, a practice made easier by the use of two nets. On other vessels, the major attractant to the birds were the squid sticking to the lengthener mesh just past where the sea lion exclusion device was positioned. If the net was reused immediately, squid stuck to the meshes was a great attractant on the shoot. On a Japanese vessel in the fishery, white-chinned petrels were diving at the stern during the slow retrieval of gear on one tow; the observer reported that the birds were caught when the wings were ‘open’ and on the surface during the haul as they fed from squid and dived into the open water between the wings. When the net was hauled further the birds were trapped as the wings closed up.

As mentioned before the fishing activity of the Korean vessels in the squid fishery is geared towards maximising the length of the tow to minimise the number of tows made overall. This resulted in the net being partially hauled then reset several times throughout the day and thus there are more turns (at least one per haul, whether partial or not) and the net is at or near the surface to check on the size of the catch and the extent of any damage.

The fishing activity of the observed inshore vessels appeared to be of little interest to seabirds. Numbers of birds attending the vessel were not large and most tended to raft behind the vessels and any discards released during the tow were of little appeal to the shearwaters and petrels or the occasional albatross. On the haul there was some competition for escaped fish, but the birds kept a distance from the net itself.

9. Observer trip reports

In the entire dataset, certain trips appeared to have more net captures than others, and the trip reports (completed by observers on their return from sea) of these trips were checked to see if there were any further insights into net captures. These trips include years when there was no or little mitigation on the warps and no offal management plans in place.

One observer in the squid fishery noted that birds were always aggressive when feeding, but when the vessel used a 60 mm codend there was less feeding during the haul than when fishing was further north and a 100 mm codend was used.

Another listed multiple reasons for captures on a Korean vessel that participated in the recent wrap mitigation trial (Middleton & Abraham 2007): nets not cleaned properly before setting; setting in daylight hours; vessel would process, attract birds, then stop processing briefly before setting as normal procedure, but when the conveyor was left on through the shoot many sooty shearwaters were caught.

Other trip reports commented on the behaviour of Salvin’s albatrosses during southern blue whiting tows: these birds were feeding directly from the codend, pulling whole fish out and follow the net up the stern, walking on the codend. Once they had moved away grey petrels came in to feed. One observer noted that heavy seas sometimes caused the offal discharge to be distributed throughout the vessel wake.

10. Discussion of causes of net captures

Many factors determine the numbers and taxa of seabirds attending fishing vessels. Broad-scale factors include the time of day, year, and area: thus the overlap of the distribution of the fishing activity and of the seabirds (Baird 2004). The albatrosses, petrels, and shearwaters in the New Zealand region tend to forage over the continental shelf areas in waters of high productivity — waters that provide the best catches of the commercial fish species. This activity will be heightened during the breeding seasons when short, more local trips are undertaken by breeding seabirds, and during the months that migratory flocks move in and out of New Zealand waters.

Factors local to the interaction between seabirds and trawlers include the following.

- Environmental influences, including weather, including sea state, wind force, and wind direction; cloud cover; sea fog; sea surface temperature; and moonphase.
- Number of vessels in an area and their level of activity: more seabirds congregate around a vessel when there are few vessels in the immediate vicinity, and seabirds will move away from one vessel when the vessel is towing rather than shooting or hauling.
- Diversity of seabird taxa attending the vessels — large albatrosses tend to keep back from the fishing activity though show interest when smaller albatrosses and petrels and shearwaters have scavenged some food and often steal that themselves. The smaller albatrosses such as white-capped, southern Buller's, and Salvin's albatrosses may be particular aggressive in their feeding attempts when the net is on the surface. Along with the smaller petrels they will actively attempt to pull fish out of the mesh and scavenge any floating free. However, depending on the area, these albatrosses displace the smaller birds.

  The petrels and shearwaters also use their superior diving and swimming skills and will enter the net as it is being shot or hauled. Flocks of sooty shearwaters, particularly in FMA 3 during March-April seem to displace the activity of other species.
- Hunger level of the seabirds — one observer noted the large numbers of hungry seabirds feeding from the haul of hoki nets off Puysegur in August, but fewer birds and very little interest in food, including offal, when targeting southern blue whiting east of Campbell Rise during September.
- Type of trawl nets used — the behaviour of the nets in the water during setting and hauling.

Observers noted the increase in seabird activity at the time of the haul, in particular. Seabird numbers increased as the haul progressed and were greatest when the net reached the surface. At this time, any warp mitigation (mainly tori lines on the observed trips) has been stowed to allow the net to be hauled. Seabirds actively and aggressively fed from the net on most occasions, targeting fish or squid caught in the mesh or escapees from the net. As noted above, the species "pecking order" will affect how successful a bird is at getting close to the net.

Other birds swam, flew, or dived into the net, between any open meshes or ropes in an attempt to feed. Birds were caught when the net tension changed, either through the haul process or by the sea state, and became entangled, trapped, or injured. Any attempts at escape were often determined by the taxon it belonged to (and hence its size, manoeuvrability, and feeding style), the weather conditions, gear type, mesh size, injury status, and the length of the remainder of the haul. Some live birds were released by the crew as the net was hauled onto the deck (more often albatrosses), but others that were tangled among the ropes were killed when water pressure at the stern buffeted the net against the stern ramp.

Weather conditions can cause the net to be unpredictable in its movement and this effect will vary along the length of the net and with the amount of catch in the net. Midwater nets, especially the large mesh nets operated by the Russian, Ukrainian, and Polish vessels, have ropes or open mesh lying on the surface as the net is hauled and these easily trap seabirds attempting to feed. As these twist with water movement and the haul activity, birds may be drowned or injured. The smaller mesh on all nets behind the headline can be lethal in a different way: with the net movement, larger birds get their beaks or feet caught in these meshes and smaller birds dive into the open mesh and are unable to escape.

Weather conditions such as light winds, which restricted the seabirds' (generally albatrosses) mobility, were also considered to increase the potential for some captures when the net was at the surface.

Codend mesh size also seems to be important. Captures follow a similar pattern to that described above, but it appears that seabirds are less interested in trying to feed from the codend when the smaller 60 mm mesh is used targeting squid in waters south of 48° S compared to the 100 mm mesh used north of that latitude.

Any fishing practices that increase the number of times the net is close to the surface will increase the likelihood of seabirds being attracted to the gear. This is evident in the practices used by some vessels or fleets to execute a turn with the doors up either to then trawl back over the same path or to reposition before the net is fully hauled. The extreme of this is the one-tow-a-day practice used in the SQU 6T fishery when several partial hauls may be made.

On a normal haul, one vessel will vary from another in the time the net is hauled, depending on factors such as the vessel's power, winch power, presence of net rollers, fishing depth, sea state, and catch, and times to "doors up" reported by some observers varied from 8 minutes to 25 minutes. Vessels without net rollers need to fleet the net by hand which almost doubles the haul time (J. Cleal, pers. comm.). Unfortunately there were few records to describe the time taken to get the net on board.

All the above factors and circumstances are more likely to result in seabird captures, particularly multiple captures, when there is a gear breakdown or the haul is slow for some reason (perhaps the power of the winches) and the net is at the surface for an extended time. Gear breakdowns (including net repairs) were responsible for about half of the multiple capture events in which more than 5 seabirds were caught in the net. Other large capture events were mainly due to the large number of seabirds around the vessel at either the set or haul of the net.

With regard to the fishing operation, seabirds caught during the set of a net are more likely to be caught in nets that have not been completely cleaned, are shot immediately after a haul (when seabird activity is higher) or after there has been offal discharge, or nets that are at the surface for longer than usual due to a gear breakdown. The strategy used by some Russian and Ukrainian vessels preparing to shoot their large midwater nets also increases the time the net is on the surface: once the head of the net is in the water, the vessel tows it for some time to align the trawl to get the net monitor clear before turning and shooting (J. Cleal, pers. comm.).

In some fisheries such as the hoki fishery off the west coast of the South Island in July–September, the percent of observed tows with seabird captures has been about 1%, whereas in the squid fisheries in FMA 5 and SQU 6T 10–15% of observed tows resulted in net and warp strike captures (data pre the mitigation regulations) (Baird & Smith 2007). The ratio of net to warp captures is unknown, but more petrels and shearwaters are caught in the net than albatrosses, and the observer comments suggest that better management of the trawl operation — for example, reduce the time the net is on the surface, clean the net thoroughly, master the timing of any discharge — and changes to fishing strategy may provide some measures that enable fishers to manage the numbers of seabird captures in nets.

11. Acknowledgments

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APPENDIX 1: SEABIRD INFORMATION

NB: This summary was originally written for the HFMC and is included here as general information. Where possible some estimates have been updated. The reference list is in the original:

Baird, S.J.; Thompson, D. (2002). Seabirds and the hoki (*Macruronus novaezelandiae*) trawl fishery: a review of current knowledge. *NIWA Client Report WLG2005/2*. 44 p.

The population demography, distribution at sea, and foraging abilities of many of these species are not particularly well understood, but available information indicates that some albatross species (northern royal albatross (*Diomedea sanfordi*), Gibson's albatross (*D. gibsoni*), Buller's albatross (*Thalassarche bulleri*), Campbell albatross (*T. impavida*)), travel long distances from their breeding sites to forage (Nicholls *et al.* 1994, Walker *et al*. 1995, Sagar & Weimerskirch 1996, Waugh *et al.* 1999a). During the breeding season, these species generally forage along the continental shelf waters in areas of high productivity and, by association, of commercial fishing activity, including the hoki fishery.

For other wide-ranging foraging seabird taxa, such as grey petrel (*Procellaria cinerea*) and white-chinned petrel (*P. aequinoctialis*), there is little or no information about their ecology or population status in New Zealand waters. Recent work by Weimerskirch *et al.* (1999) reports on the global threats of fishing operations to white-chinned petrels and other pelagic seabirds with wide foraging abilities. Sooty shearwaters (*Puffinus griseus*) have suffered large losses in driftnet fisheries (De Gange *et al*. 1993) and may be vulnerable to climatic perturbations during their migration to the northern hemisphere (Veit *et al*. 1996, Lyver *et al*. 1999).

Many seabird species are known as ship-followers (Murray *et al*. 1993). Some seabird species are attracted to fishing activities of trawlers such that their distribution may be described by the locations of fishing effort (Ryan & Moloney 1988). Some species that were regular visitors to vessels in waters off southern Africa were not seen in previous transects of the area. These authors also noted that the species whose distributions were most affected by trawling (including black-browed albatross (*Thalassarche melanophris*) and white-chinned petrel) had large radii of attraction compared with those less affected by trawl activity (including sooty shearwater).

The scavenging of seabirds from fishing operations and the potential for resulting mortality has been documented for different fishing methods, including from those in

New Zealand waters for trawlers (Bartle 1991, Baird 2001a), longlines (Murray *et al*. 1993, Baird & Bradford 2000, Baird 2001a), and setnets (Lalas 1991, Taylor 1992). The seabird bycatch problem discussed by Bartle (1991) was related to the collision of seabirds, especially white-capped albatrosses (*Thalassarche steadi*), with the net-sonde monitor cable present on some vessels fishing in the southern squid (*Nototodarus* spp.) trawl fishery on the Stewart-Snares shelf and around the Auckland Islands. The use of this cable was banned from October 1992.

Seabirds caught during trawling operations often have food items in their stomach contents that indicate that before capture they were feeding on offal scraps and discarded fish. Robertson & Bell (in press a) noted that 60% of seabirds returned from fish trawlers operating in New Zealand waters (the majority of which would have targeted hoki) in 1999–2000 had offal and small fish (possibly associated with fish bycatch) in their stomachs. Another 22% had empty stomachs. However, the uptake of byproduct of fishing operations may differ depending on the seabird species.

Ryan & Moloney (1988) noted that white-chinned petrel stomachs comprised 50% trawl offal compared with 5% in sooty shearwater stomachs. Robertson & Bell (in press a) also suggested that declines in the subcutaneous fat scores of some seabird species represented in the returned seabirds may be related to food shortages. For other species such as white-capped albatrosses and white-chinned petrels there has been an improvement in fat scores in recent years.

Southern royal albatross *Diomedea epomophora*

An endemic species defined as ‘vulnerable’ by the IUCN based on its restricted range (fewer then five confirmed breeding locations) and falling in DoC’s conservation priority category B. The largest colony is at Campbell Island where ca. 7800, perhaps ca. 8000, pairs breed annually (see Taylor 2000). Elsewhere, a total of ca. 70 pairs breed in the Auckland Islands group, and a few southern royal-northern royal albatross hybrids breed with other hybrids or pure northern royal albatrosses at Taiaroa Head, Dunedin (Taylor 2000). Long-term population trends at Campbell Island are difficult to elucidate due to different census methodologies confounding any interpretation, but recent (since the mid 1980s) plot-counts indicate a population increase. There is little information about the at-sea distribution of this species during the breeding season, but Imber (1999) concluded that feeding was probably confined to relatively shallow coastal and inner slope waters based on analyses of regurgitated dietary samples from chicks at Campbell Island. This species is a biennial breeder as a result of the long breeding season: egg laying occurs in late November-December and fledging takes place by October-November (Heather & Robertson 1996).

White-capped albatross *Thalassarche steadi*

An endemic species defined as 'vulnerable' by the IUCN based on its restricted range (fewer then five confirmed breeding locations), and falling in DoC's conservation priority category C. The main colony (ca. 120 000 breeding pairs) is at Disappointment Island in the Auckland Islands group (B. Baker pers. comm., Taylor 2000), with far fewer pairs breeding at Auckland Island (ca. 3000 pairs) and Adams Island (ca. 100 pairs), Auckland Islands group (see Croxall & Gales 1998), Bollons Island (ca. 20 pairs), Antipodes Islands group (Tennyson *et al*. 1998) and Forty-Fours Island (1 pair during the 1990s), Chatham Islands group (see Taylor 2000). The total New Zealand breeding population numbers perhaps 80 000 pairs, which is stable or increasing slightly. This species begins breeding in November and fledging occurs in August (Heather & Robertson 1996).

Salvin's albatross *Thalassarche salvini*

Virtually an endemic species defined as 'vulnerable' by the IUCN based on its restricted range (fewer then five confirmed breeding locations), and falling in DoC's conservation priority category C. The largest population breeds at the Bounty Islands: a total of 30 752 pairs was recorded in the most recent population estimate, 1997 (see Taylor 2000). Elsewhere in New Zealand, less than 650 pairs were estimated to breed at the Western Chain of the Snares Islands group (Miskelly 1984) and two (empty) nests were occupied at The Pyramid, Chathams group in 1995 (see Croxall & Gales 1998). Four pairs were found at Penguin Island, Crozet group in the 1980s, the only records from outside New Zealand (Jouventin 1990). The total New Zealand population is perhaps 31 500 breeding pairs, but population trends are difficult to elucidate due to different census methodologies confounding any interpretation. The breeding season for Salvin's albatrosses at the Chatham Islands begins in September and fledging occurs in April (Robertson 1985).

Buller's albatross *Thalassarche bulleri bulleri*

An endemic species defined as 'vulnerable' by the IUCN based on its restricted range (fewer then five confirmed breeding locations), and falling in DoC's conservation priority category C. Breeds at only two locations in New Zealand: Sagar *et al*. (1999) estimated 8877 pairs at the Snares Islands in 1997 and 2625 pairs at the Solander Islands in 1996, indicating a total New Zealand breeding population of ca. 11 500 pairs, which has been increasing since at least the late 1960s (Sagar *et al*. 1994, 1999).

The at-sea distribution of this species during the breeding season (beginning in December) has been relatively well-studied. Sagar & Weimerskirch (1996), utilising satellite telemetry, reported that during the incubation period (February) birds from the Snares traveled north along the edge of the continental slope on both sides of the South Island, or over deep oceanic water to locations north-west of the Snares in the mid Tasman Sea. In a more comprehensive study, Stahl & Sagar (2000a) tracked the foraging of birds during different stages of the breeding season.

During incubation birds foraged mainly to the central or western Tasman Sea, or north-east from the Snares to the east coast of the South Island. During the guard stage (April-May) birds abandoned trips into the Tasman Sea and foraged mainly over the Stewart-Snares shelf and adjacent waters or northeastwards along the east coast of the South Island, as far north as Chatham Rise. During the post-guard stage (May-July) foraging trips were mainly to the east of the Snares, northwards up the east coast of the South Island and, in one individual female tracked, along the west coast of the South Island.

In a similar study of the foraging strategies of Buller's albatross breeding at the Solander Islands, Stahl & Sagar (2000b) noted that during incubation (February to early March) birds made trips to the Tasman Sea, the west coast of the South Island (all females) or the east coast of the South Island (one male). During the guard and post-guard stages (April-July), birds abandoned the Tasman Sea as a foraging location, males tended to travel eastwards and northeast from the Solander Islands and females tended to travel westwards from the islands. The results reported by Stahl & Sagar (2000a, b) using satellite telemetry confirm an earlier synthesis of at-sea distribution data for Buller's albatross provided by Stahl *et al*. (1998).

Campbell albatross *Thalassarche impavida*

An endemic species defined as 'vulnerable' by the IUCN based on its restricted range (fewer then five confirmed breeding locations) and a declining population (more than 20% over the last three generations), falling in DoC's conservation priority category B and considered 'at-risk' under the proposed DoC/MFish criteria. If the decline is shown, or inferred, to be continuing then this species would qualify as 'endangered'. A total of 19–26 000 pairs are estimated to breed at Campbell Island (see Taylor 2000), the only breeding site. Recent counts and population modeling indicate a modest recovery (ca. 1–2% per annum) of the population from a dramatic decline during the 1970s (Waugh *et al*. 1999b). Using satellite telemetry, Waugh *et al*. (1999a) determined that Campbell albatrosses exploited waters over the Campbell Plateau, relatively close to the island, and deeper oceanic waters as far south as the polar front at about 65^{o} S. Based on 11 foraging trips tracked, just over half were shorter in duration and confined to shelf waters relatively close to Campbell Island

(Waugh *et al*. 1999a). The breeding season for these birds is from the end of September-October until April (Heather & Robertson 1996).

Sooty shearwater *Puffinus griseus*

An indigenous species defined as 'lower risk – least concern' by the IUCN. No population estimate for New Zealand exists, but the number of breeding pairs is likely to be in the order of low millions. Although no population trend information for New Zealand is available, there is some evidence of a decline in numbers of sooty shearwaters migrating off California during the non-breeding season (Veit *et al*. 1997). Sooty shearwaters are present on their breeding grounds between late November-December to mid-April-May (Heather & Robertson 1996).

White-chinned petrel *Procellaria aequinoctialis*

An indigenous species defined as 'vulnerable' by the IUCN based on a declining population (more than 20% over the last 10 years or three generations), not listed by DoC but considered 'at-risk' under the proposed DoC/MFish criteria. There are very little accurate population data for this species in New Zealand. Recent estimates, summarised by Taylor (2000) put the entire New Zealand population in the order of hundreds of thousands of breeding pairs, with the largest colonies in the Auckland Islands group and Antipodes Islands group. Within New Zealand there is no information on population trends for this species. This petrel breeds from late November-early December until April-May (Heather & Robertson 1996).

Grey petrel *Procellaria cinerea*

An indigenous species defined as 'lower risk – near threatened' by the IUCN, falling in DoC's conservation priority category O and possibly considered 'at-risk' under the proposed DoC/MFish criteria. There is little information on the population size of this species in New Zealand, but estimates suggest a total number of pairs in the order of tens of thousands, with the bulk of these birds at Antipodes Island and perhaps a few hundreds of pairs at Campbell Island and associated offshore islands (see Taylor 2000). There is no information on population trends for this species in New Zealand. Grey petrels begin breeding in March-April and fledge in November (Marchant & Higgins 1990).

Southern cape pigeon *Daption capense capense*

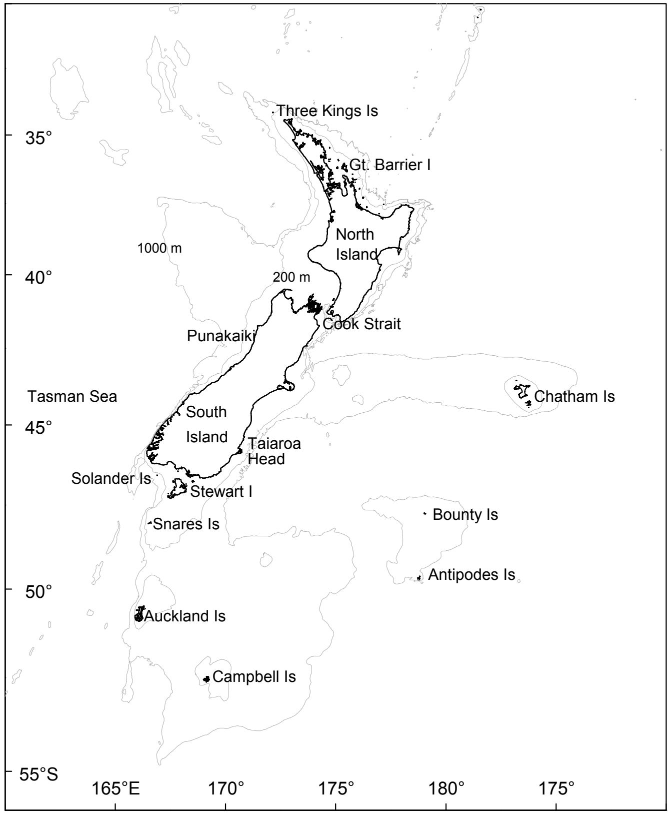
This indigenous sub-species of cape pigeon is defined as 'lower risk – least concern' by the IUCN. Within the New Zealand region it breeds at the Balleny Islands and at

Scott Island in the Antarctic. Southern cape pigeon was not included by Taylor (2000) in his recent ‘Action Plan’ for New Zealand seabirds, and population sizes and trends are unknown. Breeding takes place 2–3 weeks later than in the *australe* subspecies (Heather & Robertson 1996).

Fairy prion Pachyptila turtur

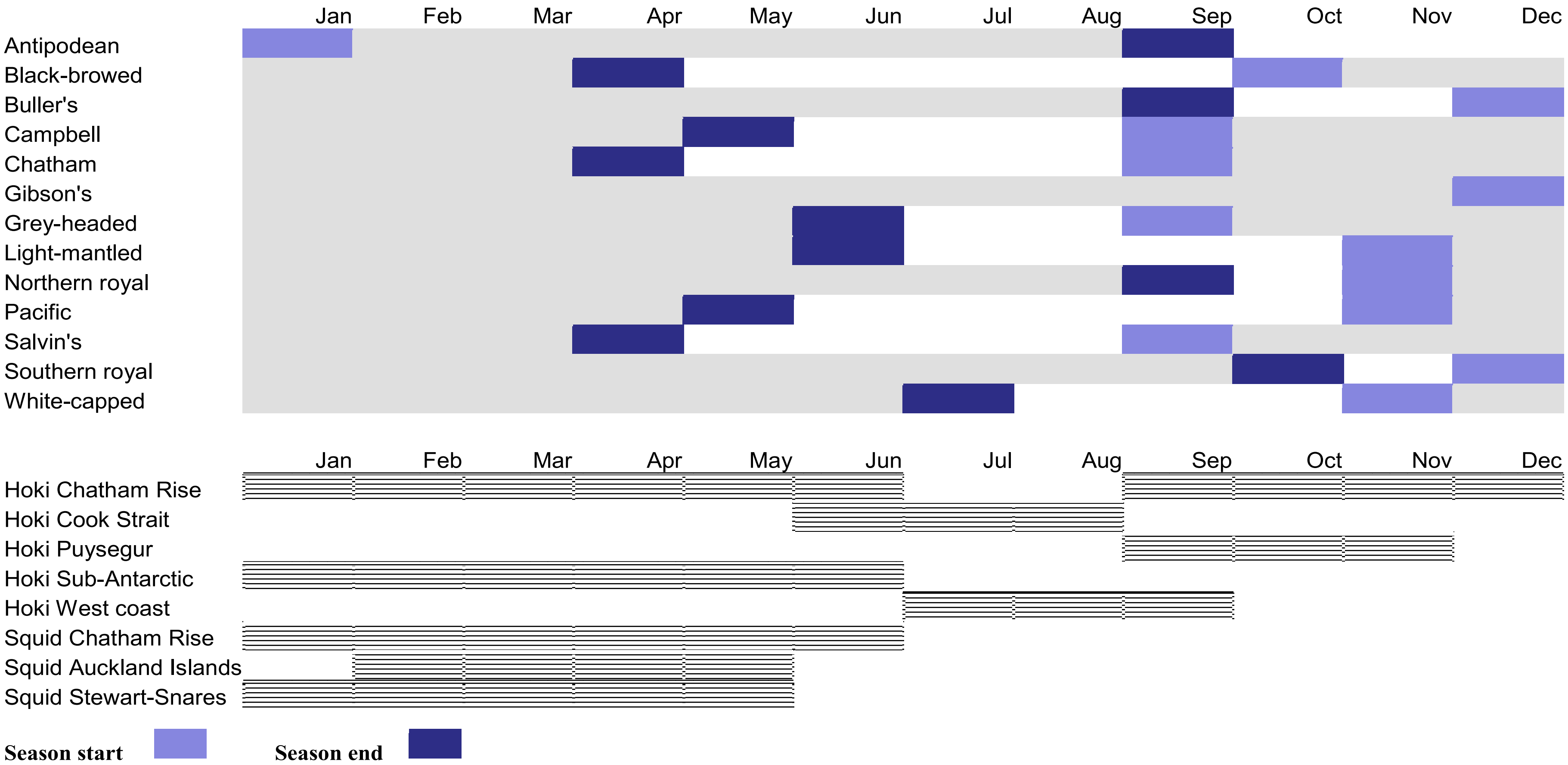
This indigenous species is defined as ‘lower risk – least concern’ by the IUCN. Fairy prions have a very widespread breeding distribution within New Zealand, on islands from the Poor Knights in the north to the Antipodes Islands and possibly islets off Campbell Island in the south. Although it is clear that large numbers of fairy prions breed in New Zealand, and Marchant & Higgins (1990) consider New Zealand to hold over 50% of the world population, accurate estimates of breeding population size are unavailable for most sites. The total New Zealand population is likely to exceed one million pairs (see Taylor 2000). Population trends are unknown. Breeding takes place from October-November to January-February depending on location (Heather & Robertson 1996).

APPENDIX 2: Distribution of seabird breeding colonies — adapted from Baird (2004)

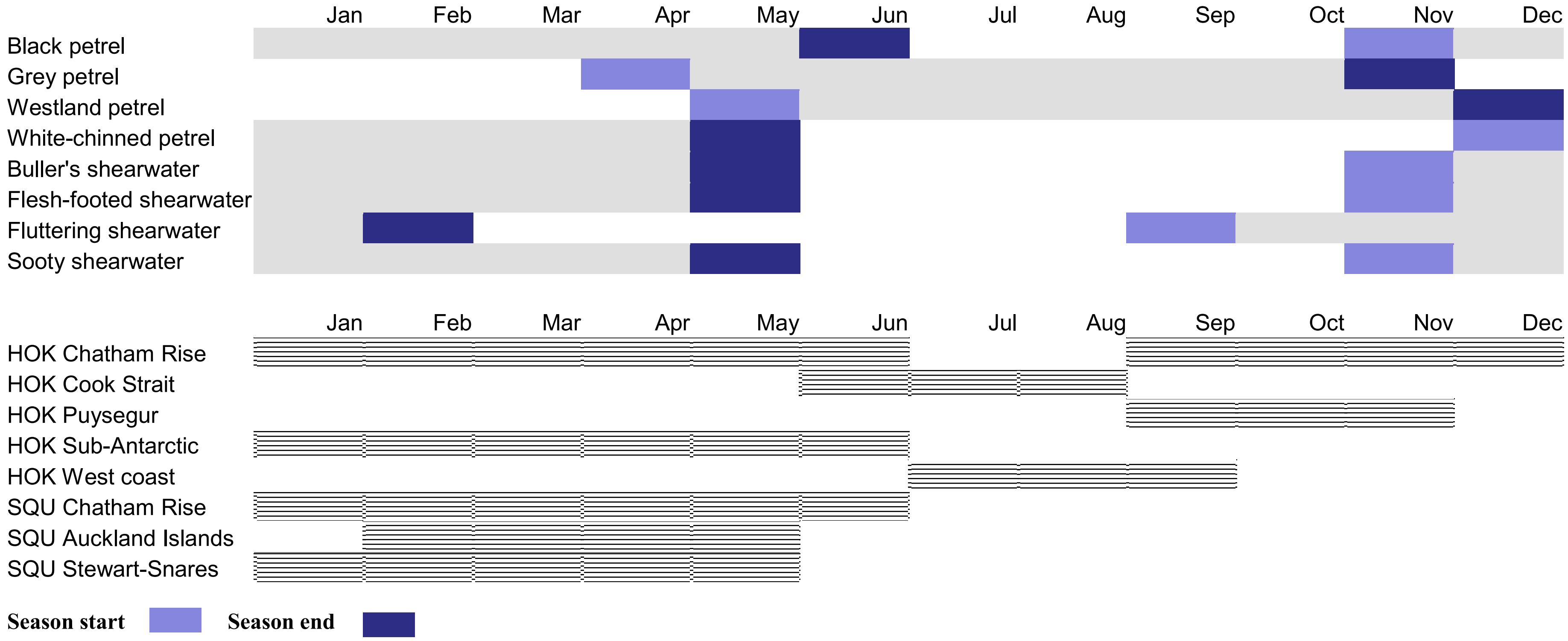


Breeding location	Seabird taxa
Three Kings Islands:	·Pacific albatross
	·grey-faced petrel, sooty shearwater
Poor Knights Islands	·Buller's shearwater
Little & Great Barrier Islands:	·Black petrel
North Island offshore (including Cook Strait):	·Fairy prions, flesh-footed shearwater, grey-faced petrel (north of 39º S), fluttering shearwater, sooty shearwater
Chathams Islands:	·Chatham, northern royal, Pacific, Salvin's?, and white-capped albatrosses
	·northern giant petrel, Snares cape pigeon, sooty shearwater
Bounty Islands:	·Salvin's albatross
Antipodes Islands:	·Antipodean, black-browed, light-mantled sooty, Salvin's, and white-capped albatrosses
	·black-bellied storm petrel, grey petrel, northern giant petrel, Snares cape pigeon, sooty shearwaters, white-chinned petrels
Campbell Island:	·Antipodean, black-browed, light-mantled sooty, and southern royal albatrosses
	·grey petrel, northern giant petrel, Snares cape pigeon, sooty shearwaters
Auckland Islands:	·Campbell, Gibson's, grey-headed, light-mantled sooty, northern royal, southern royal, and white-capped albatrosses
	·black-bellied storm petrel, northern giant petrel, Snares cape pigeon, sooty shearwaters, white-chinned petrels
Snares Islands:	·black-browed, Buller's, and Salvin's albatrosses
	·Snares cape pigeon
Solander Islands:	·Buller's albatross
South Island:	·northern royal and southern royal albatrosses (Taiaroa Head)
	·sooty shearwater (Stewart I.), Westland petrel (Punakaiki)

Temporal overlap of albatross breeding seasons and hoki and squid fisheries



Temporal overlap of petrel and shearwater breeding seasons and hoki and squid fisheries



APPENDIX 3: Summary of observed capture data with reference to net captures based on gear event records reported by MFish observers, 25 May 2007–2 May 2008

Introduction

Since mid 2007, MFish observers have collected data to describe more fully the interaction between commercial fishing activities and seabird captures. It was suggested that these data be reviewed, specifically the gear event data in relation to seabird captures, to see if there was any further information to inform potential mitigation method development or fishing operation management practices. This appendix describes the data available at mid July 2008.

Data description

MFish provided an extract of observed trawl trips based on the new observer logbook forms that provide tow-by-tow data on capture method (location of capture relative to the gear when the net is hauled) and gear events, such as breakages or partial hauls during a tow. This data set covered 108 trawl trips on 55 vessels between 25 May 2007 and 2 May 2008 to give a total of 7457 observed tows. Data were checked to ensure all fields used contained valid and sensible values, and amended where necessary. However, there are at least 5 seabirds included in this summary that were dead and decomposing and thus may have been previously caught and trawled up rather than 'caught' by the trawl gear. The short timeframe of this work meant that it was not possible to assign these deaths correctly. The verified species identification data were not included in the extract provided, so any reference to species groups is based on the observer identification.

Data relating to gear events were categorised into the following, based on the reported gear codes (given in parentheses) from the MFish observer trawl catch effort logbook:

- No events (Z)
- *Haul, turn, reshoot* — during a tow the vessel partially hauls the net, completes a turn, then reshoots the net (F)
- *Net damage* — where observer reported torn nets and nets that came fast (A,B)
- *Gear breakage* — where observer reported twisted warps, crossed doors, warp breakages, and lost gear (G, H, I)
- *Not at fishing depth* — where observer reported the net was deliberately towed for a long period at non fishing depth (E)
- *Winch failure at set* (C)
- *Winch failure at set* (D)
- *Other* — includes where observer has listed more than three (O, Y)
- Unknown (U)
- NULL — where the record is null

Only data for capture methods that related to captures by the trawl gear were included; thus, observed reports of seabirds landing on the deck or hitting the superstructure were not included. Capture method data were categorised as follows, based on the MFish observer non-fish bycatch form (codes are given in parentheses):

- No capture
- Net capture — caught in the net (N)
- Warp/door — caught on the door or warp (S)
- Tangled — tangled in line (but here taken to mean tangled in net ropes) (T)
- Unknown (U).

Results

In the total dataset of 7457 observed tows, from trips between 25 May 2007 and 5 May 2008, the main target species were hoki (20%), squid (20%), orange roughy (17%), oreo species (11%), Jack mackerel species (11%), scampi (5%), ling (4%), hake (3%), southern blue whiting (3%), barracouta (2%), and cardinal fish (2%).

New Zealand vessels accounted for 57% of the observed effort, with the remainder on Ukrainian vessels (29%), Korean vessel (8%), Polish vessels (4%), and Japanese vessels (2%). About 66% of observed tows used bottom trawl gear, and 82% of these were made by New Zealand vessels. Ukrainian vessels accounted for 77% of the midwater effort. About 27% of the observed effort was in FMA 6 (including SQU 6T), 17% in FMA 5, 14% in each of FMAs 4 & 7, 6% in each of FMAs 1, 3, 8, and 9, and 4% in FMA 2.

The dataset includes 225 seabird captures from 158 of the observed tows: 163 in bottom trawl gear (44 albatrosses and 119 petrels) and 62 in midwater trawl gear (23 albatrosses and 39 petrels). Almost 98% of observed tows had no seabird captures, 1.6% caught one seabird, and 0.4% caught more than one seabird per tow (maximum 14 birds per observed tow).

For all observed tows with seabird captures, those with no gear events accounted for nearly half the tows with 1 capture, half the tows with 2 seabirds, all the tows with 3 seabirds, and for one tow with 14 seabirds (Table 1). *Net damage* and *winch failure at set* were the categories recorded for the other multiple captures of 7 and 9 seabirds per tow.

Of the 4891 bottom tows, 70% had no gear events, 11% were in the *haul, turn, and reshoot* category and 9% in the *net damage* category (Table 2). For 5% of the observed bottom tows, there was no information on gear events. About 47% of the 163 seabird captures in bottom trawl gear occurred when there was no gear event, 36% on *haul, turn, and reshoot* tows, and 12% on *net damage* tows. Tows that targeted deepwater species such as orange roughy, oreo species, and cardinal fish, along with middle depth species such as hoki, hake, and ling targets accounted for most of the bottom trawl gear events involving net damage. Tows targeting squid, ling, hoki, hake, and oreo species had partial hauls and reshoots of the net.

Table 1: Number of observed tows, including those with seabird captures, based on 108 observed trips between 25 May 2007 and 2 May 2008.

	Number of seabirds per tow							
Gear event	0	1	2	3	7	9	14	Total
No gear event	5 062	55	13	4	0	0	1	5 135
Haul turn shoot	1 017	53	5	3	0	0	0	1 078
Net damage	468	8	4	0	0	1	0	481
Gear breakage	42	1	1	0	0	0	0	44
Not fishing depth	177	2	0	0	0	0	0	179
Other	157	2	3	0	0	0	0	162
Winch failure set	5	0	0	0	1	0	0	6
Winch failure haul	10	0	0	0	0	0	0	10
Unknown	359	1	0	0	0	0	0	360
No record	2	0	0	0	0	0	0	2
All	7 327	122	26	7	1	1	1	7 457
Number of seabirds	0	122	52	21	7	9	14	225

Table 2: Number and percentage of observed tows and seabird captures, based on 108 observed trips, by gear type and gear event.

Gear	Gear	Observed tows		Observed seabirds	
type	event	Number	%	Number	%
Bottom	No gear event	3 433	70.2	76	46.6
	Haul turn reshoot	523	10.7	59	36.2
	Net damage	447	9.1	20	12.3
	Gear breakage	30	0.6	1	0.6
	Not fishing depth	72	1.5	1	0.6
	Other	106	2.2	6	3.7
	Winch failure at set	3	0.1	0	0.0
	Winch failure at haul	9	0.2	0	0.0
	Unknown	266	5.4	0	0.0
	NULL	2	< 0.0	0	0.0
	Total	4 891	100.0	163	100.0
Midwater	No gear event	1 702	66.3	31	50.0
	Haul turn reshoot	555	21.6	13	21.0
	Net damage	34	1.3	5	8.1
	Gear breakage	14	0.5	2	3.2
	Not fishing depth	107	4.2	1	1.6
	Other	56	2.2	2	3.2
	Winch failure at set	3	0.1	7	11.3
	Winch failure at haul	1	< 0.0	0	0.0
	Unknown	94	3.7	1	1.6
	Total	2 566	100.0	62	100.0
Total		7 457		225	

Of the 2566 observed tows that used midwater trawl gear, 66% had no gear event, and 22% partially hauled, turned, then reshot the net. Half of the 62 seabirds caught in midwater gear were caught when there was no gear event. Partial hauls and turns with midwater gear occurred mainly in squid, jack mackerel, hoki, and hake observed tows, and tows with this event accounted for 21% of birds.

A summary of the bottom trawl gear event data by capture method and vessel nationality is given in Table 3. Net captures accounted for 88 of the 122 observed bottom tows with seabird captures, with 40 tows with net captures in the *haul, turn, and reshoot* category. About half the tows with captures were made by Korean vessels. There were no reported gear events for 42% of the observed bottom tows with seabird captures in the net.

Table 3: Number of observed tows using bottom trawl gear, for capture method and gear event categories, by nation.

Capture method	Gear event	Nation					
		JAP	KOR	NZL	POL	UKR	All
No captures	No gear event	24	253	2 939	97	72	3 385
	Haul turn reshoot	0	206	212	21	35	474
	Net damage	0	30	396	1	11	438
	Gear breakage	0	3	24	2	0	29
	Not fishing depth	0	4	61	6	0	71
	NULL	0	1	1	0	0	2
	Winch failure set	0	0	3	0	0	3
	Winch failure haul	0	0	8	0	1	9
	Other	0	9	87	3	3	102
	Unknown	0	10	244	0	12	266
	Total	24	516	3 975	130	134	4 779
Net	No gear event	0	17	15	4	1	37
	Haul turn reshoot	0	23	10	1	6	40
	Net damage	0	5	0	0	1	6
	Gear breakage	0	0	1	0	0	1
	Not fishing depth	0	1	0	0	0	1
	Other	0	2	1	0	0	3
	Total	0	48	27	5	8	88
Net/warp/door	Haul turn shoot	0	2	0	0	0	2
	Total	0	2	0	0	0	2
Warp/door	No gear event	0	0	8	0	0	8
	Haul turn reshoot	0	1	3	0	0	4
	Net damage	0	0	3	0	0	3
	Other	1	0	0	0	0	1
	Total	1	1	14	0	0	16
Tangled	Haul turn reshoot	0	1	0	0	0	1
	Total	0	1	0	0	0	1
Unknown	No gear event	0	1	1	0	1	3
	Haul turn reshoot	0	1	1	0	0	2
	Total	0	2	2	0	1	5
Bottom trawl total		25	570	4 018	135	143	4 891

For observed midwater tows, 1.8% (46 tows) had seabird captures (Table 4). About 55% of the 40 tows with captures had no gear event, and 28% were in the *haul, turn, and reshoot* category.

Of the net captures reported, 40 were albatross (90% dead) and 148 petrels (82% dead). Most captures released alive were net captured seabirds from tows with no gear events or with partial hauls, a turn, then reshoot, or some net damage. For two of the tows with more than 3 captures, live and dead birds were reported. The tow with 14 seabirds (and no gear event) had 8 alive and 6 dead petrels and the observer commented on the large number of birds feeding from the net during the haul. The tow with 9 captures had 2 alive and 7 dead petrels and the damaged net was hauled in foggy, rainy weather. The seabirds in the tow with 7 captures were all dead petrels.

Table 4: Number of observed tows using midwater trawl gear, for capture method and gear event categories, by nation.

Capture method	Gear event	JAP	KOR	NZL	POL	UKR	Nation All
No capture	No gear event	78	20	203	113	1263	1677
	Haul turn shoot	0	14	4	35	490	543
	Gear breakage	0	0	1	2	10	13
	Net damage	2	0	6	2	20	30
	Not fishing depth	14	4	0	20	68	106
	Winch failure set	0	2	0	0	0	2
	Winch failure haul	0	0	0	1	0	1
	Other	1	6	9	7	32	55
	Unknown	0	1	20	10	62	93
	Total	95	47	243	190	1945	2520
Net	No gear event	0	0	0	5	17	22
	Haul turn shoot	0	0	0	0	11	11
	Gear breakage	0	0	0	0	1	1
	Net damage	0	0	0	0	3	3
	Winch failure set	0	0	1	0	0	1
	Other	0	0	0	0	1	1
	Unknown	0	0	0	0	1	1
	Total	0	0	1	5	34	40
Warp/door	No gear event	0	0	0	1	1	2
	Haul turn shoot	0	0	0	0	1	1
	Net damage	0	0	0	0	1	1
	Not fishing depth	0	0	0	0	1	1
	Total	0	0	0	1	4	5
Unknown	No gear event	0	1	0	0	0	1
	Total	0	1	0	0	0	1
Midwater total		95	48	244	196	1983	2566

Albatross captures in nets were mainly from bottom trawl and midwater trawl squid tows in FMA 5 and SQU 6T, with 50% from tows with no gear event, 50% in *haul, turn, and reshoot* tows, and 11% in *net damage* tows (Table 5). Two albatrosses were caught in a midwater squid tow during the haul when the net was at the surface for a delayed time due to the kite being twisted.

Petrels caught singly in the net were mainly from squid bottom tows in FMA 5 and SQU 6T: 46% were tows with no gear event, 46% were *haul, turn, and reshoot* tows, and the remainder were in *net damage*, *gear breakage*, and *non-fishing depth tows* (Table 6). About 58% of observed tows with two petrel captures in the net were when there was no gear event, 21% were *haul, turn, and reshoot* tows, and 16% *net damage* or *gear breakage* tows.

Table 5: Number of observed tows, by recorded gear event and capture method, for observed tows with albatross captures (based on observer identification).

Capture method	Gear event	Number of observed tows with seabird captures identified as albatross				
		0	1	2	3	Total
Net	No gear event	42	17	0	0	59
	Haul turn shoot	36	15	0	0	51
	Net damage	5	4	0	0	9
	Gear breakage	2	0	0	0	2
	Not fishing depth	1	0	0	0	1
	Other	3	0	1	0	4
	Winch failure set	1	0	0	0	1
	Unknown	0	1	0	0	1
	All	90	37	1	0	128
Net/warp/door	Haul turn shoot	1	1	0	0	2
	All	1	1	0	0	2
Warp/door	No gear event	2	6	1	1	10
	Haul turn shoot	0	4	1	0	5
	Net damage	1	2	1	0	4
	Not fishing depth	1	0	0	0	1
	Other	0	0	1	0	1
	All	4	12	4	1	21
Tangled	Haul turn shoot	0	1	0	0	1
	All	0	1	0		1
Unknown	No gear event	2	2	0	0	4
	Haul turn shoot	1	1	0	0	2
	All	3	3	0	0	6
All		98	54	5	1	158

Table 6: Number of observed tows, by recorded gear event and capture method, for observed tows with petrel captures (based on observer identification).

Capture	Gear	Number of observed tows with seabird captures identified as petrels							
method	event	0	1	2	3	7	9	14	All
Net	No gear event	14	31	11	2	0	0	1	59
	Haul turn shoot	15	31	4	1	0	0	0	51
	Net damage	4	2	2	0	0	1	0	9
	Gear breakage	0	1	1	0	0	0	0	2
	Not fishing depth	0	1	0	0	0	0	0	1
	Other	1	2	1	0	0	0	0	4
	Winch failure set	0	0	0	0	1	0	0	1
	Unknown	1	0	0	0	0	0	0	1
	All	35	68	19	3	1	1	1	128
Net/warp/door	Haul turn shoot	0	0	1	1	0	0	0	2
	All	0	0	1	1	0	0	0	2
Warp/door	No gear event	8	2	0	0	0	0	0	10
	Haul turn shoot	5	0	0	0	0	0	0	5
	Net damage	3	0	1	0	0	0	0	4
	Not fishing depth	0	1	0	0	0	0	0	1
	Other	1	0	0	0	0	0	0	1
	All	17	3	1	0	0	0	0	21
Tangled	Haul turn shoot	1	0	0	0	0	0	0	1
	All	1	0	0	0	0	0	0	1
Unknown	No gear event	2	2	0	0	0	0	0	4
	Haul turn shoot	1	1	0	0	0	0	0	2
	All	3	3	0	0	0	0	0	6
All methods		56	74	21	4	1	1	1	158

Summary

A preliminary summary of observer data from May 2007 to May 2008 looked at several new data fields, specifically the “capture method” and “gear event” records, based on revised MFish observer forms. About 70% of the 4891 observed bottom trawl records and 66% of the 2566 observed midwater trawl records had no problems or “events” with the gear. The most common “gear event” was when a vessel made a partial haul, then turned, and reshot the net during a tow: this was the event recorded for 11% of observed bottom trawl records and 22% of midwater trawl records. Another 9% of bottom tows had some form of net damage, and 4.5% of midwater tows were recorded as being towed in “non-fishing depths”. Seabirds were caught on 158 observed tows, 73 of which had no gear event, 61 were tows with a partial haul, turn, and reshoot of the net, 13 had net damage, and the remainder were tows, either with another gear breakage, in non-fishing depths, with a winch failure at the set, or a mixture of these. For the three observed tows with more than 3 seabirds per tow, the largest capture event of 14 seabirds occurred on a tow with no gear problems, 9 were caught on a tow that had net damage, and 7 on a tow with winch failure during the set of the tow. These multiple capture events were of petrels.