INT2019-02: IDENTIFICATION OF SEABIRDS CAPTURED IN NEW ZEALAND FISHERIES

1 July 2020 to 30 June 2021

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INT2019-02: Identification of seabirds captured in New Zealand fisheries, 1 July 2020 to 30 June 2021

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Cover image: Image of a flesh-footed shearwater (*Puffinus carneipes*) interaction (hook landing) provided by MPI/DOC Government Observer, 13 April 2021.

INT2019-02: IDENTIFICATION OF SEABIRDS CAPTURED IN NEW ZEALAND FISHERIES, 1 JULY 2020 TO 30 JUNE 2021

ABSTRACT

The New Zealand Exclusive Economic Zone (EEZ) supports a diverse range of seabird species. Much of the commercial fishing activity in the region overlaps with seabird foraging ranges. The accurate identification of bycatch seabirds interacting with New Zealand fisheries is vital for determining the impact of fisheries on these seabird populations. Between 1 July 2020 and 30 June 2021, a total of 651 seabirds were reported as incidental interactions with commercial fishing vessels by on-board New Zealand Government observers; of these 187 were returned for necropsy and 464 were interactions (photographed (*n* = 190) or non-photographed (*n* = 274)) as deceased or alive captures.

187 individual seabirds, grouped into 18 species, were incidentally killed as bycatch and returned for necropsy. Seabirds were returned from 52 individual vessels, comprised of 14 longline (n = 49 seabirds), 35 trawl (n = 133 seabirds), and three set net (n = 5 seabirds) vessels, and were dominated numerically by five bycatch species: white-chinned petrel (n = 48, 25.7%), New Zealand white-capped albatross (n = 34, 18.2%), sooty shearwater (n = 25, 13.4%), Salvin's albatross (n = 20, 10.7%) and Buller's albatross (n = 18, 9.6%). These five species accounted for 77.5% of all returns. All birds returned from longline fisheries had injuries consistent with being hooked in the bill, throat, or wing. Most birds returned from trawl fisheries were caught through entanglement in the net, cod-end, or pound (75.9%), with 16.5% likely to have specifically interacted with the warp. The cause of death for seven birds was deck strike on trawl vessels. Birds had a lower mean body fat score in comparison to birds from the previous two survey years. Discards, including offal, appear to continue to be an attractant for many seabirds.

In addition to the seabirds that were returned for necropsy, examination of the Ministry for Primary Industries (MPI) Central Observer Database (COD) and images provided by Government observers gave a total of a further 464 seabirds that were reported as interactions or photographed (as dead or alive captures) aboard 63 fishing vessels. The majority (64.9%) of the seabirds reported in these interactions and photographs were released alive. Out of these 464 records of seabird interactions, photographs were taken of 190 seabirds consisting of 18 species. Image quality varied widely, with poor images being particularly common for birds that were alive and seen on-board for short periods. Images of dead birds have improved with multiple images taken for each specimen. Recommendations are made to improve photo-identifications in the future.

Keywords: commercial fishing, seabirds, necropsy, photo-identification, incidental mortality, longline, trawl.

1. INTRODUCTION

New Zealand waters support a large and diverse range of seabird species. However, much of the commercial fishing activity within the New Zealand EEZ overlaps with the ranges of these seabirds (Robertson et al. 2003), and seabirds are regularly interacting with fishing vessels and gear. Therefore, the accurate identification of seabirds interacting with commercial fisheries operations is vital for determining the impact of fisheries on these seabird populations.

New Zealand Government observers have been placed on a subset of inshore and deep-water commercial vessels since 1989, partly to investigate interactions between fisheries and seabird species. However, observers are not always able to accurately identify seabirds to species level at sea. Consequently, a necropsy and morphometrics programme has been in place since 1996 to accurately determine the taxon (as well as

age, sex, diet, and provenance) of specimens recovered as deceased by observers. Observers present on fishing trips within New Zealand's EEZ are generally required to return all bycatch seabirds recovered during fishing operations for necropsy. Additional information such as vessel name, location of bycatch (latitude and longitude), and date of bycatch is also recorded. Specific bycatch locations and vessel names have not been provided in this report on the grounds of commercial sensitivity. All necropsies were performed for the Department of Conservation (DOC) as part of Conservation Services Programme (CSP) project INT2019-02.

In the past, observer identification of seabirds released alive was often of unknown accuracy, and was not confirmed by an expert. Consequently, a photography programme was developed to enable observers to record and return images of birds interacting with vessels (whether alive or dead), enabling the identification to be checked and verified.

This report provides a summary of the species of seabird identified as being captured in, or interacting with, New Zealand fisheries between 1 July 2020 and 30 June 2021. Species identification was made from specimens returned for necropsy, or from photographs or videos.

1.1 Objectives

The overall objective of the observer programme is to determine which protected species are captured in New Zealand commercial fisheries vessels and the mode of interaction.

The specific objectives of the necropsy programme are to:

1. Determine the taxon, sex and, where possible, age class, morphometrics, and provenance of seabirds killed in New Zealand fisheries (for returned dead specimens).
2. Describe the injuries, body condition and stomach contents and, where possible, the likely cause of mortality (for returned deceased specimens).
3. Report any changes in the protocol used for necropsy of seabirds (for returned deceased specimens).
4. Determine the species and, where possible, sex, age-class and provenance of bycatch seabirds in New Zealand fisheries through examination of photographs (for live interactions or deceased specimens discarded at sea).

2. METHODS

Common and scientific names of all species caught, photographed, or recorded in the COD extract are provided in Table 1. Nomenclature generally follows Marchant & Higgins (1990), but for the albatrosses for which current taxonomy and nomenclature is in a state of flux, it is based on a combination of Nunn et al. (1996) and Robertson & Nunn (1998) and is consistent with the taxonomy recognised by the Agreement on the Conservation of Albatrosses & Petrels (ACAP 2010).

2.1 Necropsy

The necropsy methods followed those described by Bartle (2000) and used in necropsies in subsequent fishing years (Robertson 2000, Robertson & Bell 2002a, Robertson & Bell 2002b, Robertson et al. 2003, Robertson et al. 2004, Conservation Services Programme 2008, Thompson 2009, Thompson 2010a, Thompson 2010b, Bell 2011, Bell 2012, Bell 2013, Bell & Mischler 2014, Bell & Mischler 2015, Bell & Bell 2016, Bell & Bell 2017, Bell & Bell 2018, Bell & Bell 2019).

During necropsy, all birds were sexed by internal examination, with the exception of birds that had been damaged by fishing gear, machinery, or sea lice. Feather moult and the condition of the brood patch were also recorded. Birds were characterised as either adult, breeding adult, non-breeding adult, sub-adult (pre-breeder), immature, or juvenile based on a combination of plumage, morphological (such as bill size and colour), gonadal and brood patch characteristics.

- *Adult* – adult morphology (e.g. body size, bill size, bill colour, plumage colour), but active breeding could not be confirmed.
- *Breeding adult* - considered to be actively breeding at the time of capture (e.g. bare brood patch, swollen ovaries or testes).
- *Non-breeding adult* - identified by feather moult (e.g. downy brood patch, body moult, wing moult) and gonadal evidence (i.e. regressed or small ovaries and testes).
- *Sub-adult (pre-breeder)* – non-adult or near-adult plumage and/or morphology (e.g. bill colour), but no gonadal evidence that they had obtained breeding condition.
- *Immature* – non-adult plumage, plumage indicates that individual is 1+ years from breeding age.
- *Juvenile* - juvenile plumage and/or morphology (e.g. bill colour, bill size, leg, and foot colour).

Body condition was determined by assigning a fat score based on the relative amount of subcutaneous fat and fat on and around organs: '1' = no fat, to '5' = extremely fat (where internal examination becomes difficult). In instances where the birds had been damaged by sea lice, the fat score was listed as unknown.

Stomach and gizzard contents were identified to broad dietary groupings (i.e. squid, fish, crustaceans, etc.) and any hard parts (squid beaks, otoliths) were retained for future identification where possible. In addition, any bait material, offal or discarded material, plastic, stones, algae, and goose barnacle plates were recorded. Photographs were taken of plastic debris in the gizzard or stomach.

For each bird, any injuries were recorded, and this information, together with observer comments on the necropsy label, was used to determine the likely cause of death.

Each specimen was allocated a unique necropsy number and photographed. This number, along with the information on the observer specimen tag and all other information collected during necropsy was entered into an Access database. Details relating to each specimen are available on request from the Manager, Conservation Services Programme, DOC (email: csp@doc.govt.nz).

2.2 Photo-identification

The photographs used in this analysis were of seabirds for which the records indicated that only observer identification had been made, rather than a confirmed identification following necropsy. This covered live specimens, mortalities where a specimen was not returned for necropsy (for whatever reason), images of birds that had no associated observer data (i.e. missing from MPI COD extracts) and reported interactions in the MPI COD extract with no corresponding image, including non-capture interactions.

Each bird or interaction was separated as follows:

- *Photo (Photo and Extract)*: seabird photographed by observer, image provided, and interaction recorded in MPI COD
- *Photo (Image not received to date)*: seabird apparently photographed by observer but not received to date and interaction recorded in MPI COD
- *Photo (Not in extract to date)*: image of seabird received but interaction not listed in MPI COD to date
- *Interaction*: seabird interaction with vessel (i.e., live or deceased capture, warp, or deck strike, etc.) listed in MPI COD, but no image taken by observer

Photographs were provided in electronic format with associated observer MPI COD extracted information (vessel name, type of fishery, date of bycatch, time of capture etc.) in an Excel spreadsheet.

Deceased specimens were generally photographed with a label that bore the trip, station, and sample number, making it easy to correlate to the MPI COD extract. However, photographs of live specimens often

contained no information on station or sample number, making it difficult to match the specimen to the extract unless the time and date stamp on the camera had been set correctly.

All photographed seabirds were identified to the lowest possible taxonomic level. Various seabird reference books (including Marchant & Higgins 1990, Bartle 2000, Shirihai 2002, Onley & Scofield 2007) were used to confirm identification when necessary.

Bill and head morphology and colour were usually sufficient to allow the identification of albatrosses and larger petrels to species level, but other key features (such as size, shape, foot colour and wing markings) were needed to identify smaller species. If key features were not visible in the photograph or the image was out of focus, identification to species level was not possible. Where possible, the age, sex and provenance of the photographed seabirds were also determined.

Each individual seabird was allocated a unique number. The photograph(s), the information from the observers, and any other information observed in the photograph or the MPI COD extract were entered into an Access database.

2.3 Statistical Analyses

Statistical analyses were conducted using Microsoft Excel. Descriptive statistics are presented. Means are given as values +/- standard error (SE).

Figures and tables were produced using Microsoft Excel and QGIS.

Table 1: *Common and scientific names of seabirds recorded by observers as interacting with fishing vessels between 1 July 2020 and 30 June 2021.*

COMMON NAME	SCIENTIFIC NAME
Albatross (unidentified)	
Australasian gannet	*Morus serrator*
Black (Parkinson's) petrel	*Procellaria parkinsoni*
Black-browed albatross (unidentified)	*Thalassarche spp.*
Buller's albatross	*Thalassarche bulleri bulleri*
Buller's and Pacific albatross	*Thalassarche bulleri*
Buller's shearwater	*Puffinus bulleri*
Campbell albatross	*Thalassarche impavida*
Cape petrels	*Daption spp.*
Common diving petrel	*Pelecanoides urinatrix*
Fairy prion	*Pachyptila turtur*
Flesh-footed shearwater	*Puffinus carneipes*
Foveaux shag	*Phalacrocorax stewarti*
Gibson's albatross	*Diomedea antipodensis gibsoni*
Great albatross (unidentified)	*Diomedea spp.*
Great-winged (Grey-faced) petrel	*Pterodroma macroptera*
Grey petrel	*Procellaria cinerea*
Grey-backed storm petrel	*Garrodia nereis*
New Zealand white-capped albatross	*Thalassarche steadi*
Northern giant petrel	*Macronectes halli*
Northern royal albatross	*Diomedea sanfordi*
Otago shag	*Phalacrocorax chalconotus*

COMMON NAME	SCIENTIFIC NAME
Petrel (unidentified)	
Petrels, prions, and shearwaters (unidentified)	
Prion (unidentified)	*Pachyptila spp.*
Procellaria petrel (unidentified)	*Procellaria spp.*
Pterodroma petrel (unidentified)	*Pterodroma spp.*
Red-billed gull	*Larus scopulinus*
Salvin's albatross	*Thalassarche salvini*
Seabird (small)	
Seabird (unidentified)	
Shearwater (unidentified)	*Puffinus spp.*
Small albatross (unidentified)	*Thalassarche spp.*
Snares Cape petrel	*Daption capense australe*
Sooty shearwater	*Puffinus griseus*
Southern giant petrel	*Macronectes giganteus*
Southern royal albatross	*Diomedea epomophora*
Storm petrel (unidentified)	
Wandering albatross (unidentified)	*Diomedea exulans spp.*
Westland petrel	*Procellaria westlandica*
White-chinned petrel	*Procellaria aequinoctialis*

3. RESULTS

3.1 Summary

Table 2 summarises all seabird interactions with vessels in New Zealand EEZ between 1 July 2020 and 30 June 2021; there were 187 seabirds returned for necropsy, 274 recorded as an interaction (245 released alive and 29 deceased) and 190 photographed interactions (56 released alive and 134 deceased).

Table 2: *Common and scientific names of seabirds recorded as interacting with fishing vessels between 1 July 2020 and 30 June 2021, grouped by end status (alive/dead). Records are classified as interactions (I) if no photograph was obtained, photographed (P) if a photograph was obtained, and necropsy (N) if the whole specimen was retained for necropsy.*

COMMON NAME	END STATUS							TOTAL
	ALIVE			DECEASED				
	I	P	Total	I	P	N	Total	
Albatross (unidentified)	10		10	3			3	**13**
Australasian gannet	2		2					**2**
Black (Parkinson's) petrel	8	1	9		1	4	5	**14**
Black-browed albatross (unidentified)	1		1					**1**
Buller's albatross	7	3	10		10	18	28	**38**
Buller's and Pacific albatross	4		4	1			1	**5**
Buller's shearwater	2		2					**2**

Campbell albatross						1	1	**1**
Cape petrels	7		7					**7**
Common diving petrel	9	7	16			3	3	**19**
Fairy prion	3	3	6			3	3	**9**
Flesh-footed shearwater	25	26	51		2	6	8	**59**
Foveaux shag						2	2	**2**
Gibson's albatross	1		1					**1**
Great albatross (unidentified)	2		2					**2**
Great-winged (Grey-faced) petrel	1		1					**1**
Grey petrel	2	1	3			4	4	**7**
Grey-backed storm petrel						2	2	**2**
NZ white-capped albatross	59	6	65	6	26	34	66	**131**
Northern giant petrel	2		2			1	1	**3**
Otago shag					2	3	5	**5**
Petrel (unidentified)	5		5					**5**
Petrels, prion, and shearwaters (unidentified)	6		6	4			4	**10**
Prion (unidentified)	3		3					**3**
Procellaria petrel (unidentified)	10		10					**10**
Pterodroma petrel (unidentified)	3		3					**3**
Red-billed gull	1		1					**1**
Salvin's albatross	13		13	2	5	20	27	**40**
Seabird (small)				1			1	**1**
Seabird (unidentified)	2		2					**2**
Shearwater (unidentified)	5		5	1			1	**6**
Small albatross (unidentified)	4		4	4			4	**8**
Snares cape petrel		1	1			2	2	**3**
Sooty shearwater	16	5	21	6	18	25	49	**70**
Southern royal albatross	2		2		2	1	3	**5**
Storm petrel (unidentified)	2	1	3					**3**
Wandering albatross (unidentified)	2		2					**2**
Westland petrel	6		6			10	10	**16**
White-chinned petrel	20	2	22	1	68	48	117	**139**
TOTAL	**245**	**56**	**301**	**29**	**134**	**187**	**350**	**651**

3.2 Necropsy

3.2.1 Returned seabirds

A total of 187 seabirds comprised of 18 species were returned from 52 vessels between 1 July 2020 and 30 June 2021. Seabirds returned were dominated by five species: white-chinned petrel (n = 48, 25.7%), New Zealand white-capped albatross (n = 34, 18.2%), sooty shearwater (n = 25, 13.4%), Salvin's albatross (n = 20,

10.7%) and Buller's albatross (n = 18, 9.6%) (Table 2). These five species accounted for 77.5% of all returned seabirds.

Two banded birds with uniquely numbered metal bands were within those captured and returned. One Westland petrel (L-34355) was recovered, but the banding information was not available through the DOC Banding Office; and one male Buller's albatross (M-90024) had been banded on North East Island, The Snares, as a 10+ year old on 3 March 2019. Banded specimens provide valuable longevity and survival data.

The monthly distribution of returned specimens was not evenly spread across the time period analysed in this study. Most returned birds were caught in April (n = 36, 19.3%), March (n = 33, 17.6%), May (n = 28, 15.0%), and February (n = 27, 14.4%) (Table 3).

The majority of birds were males (n = 129, 69.0%). All Foveaux shag, northern giant petrel, Otago shag, Snares cape petrel, and southern royal albatross returned were males (Figure 1). A single female Campbell albatross was returned (Figure 1). Sex ratios of returned black petrels, flesh-footed shearwaters, and grey-backed storm petrels were even (Figure 1). The sex of 14 birds (7.5%) was not able to be determined.

Most returned seabirds were adults (n = 171, 99.4%) (Figure 2). Of these, 67 (35.8%) were breeding and 14 (7.5%) were non-breeding birds (Figure 2). Twelve seabirds (6.4%) were pre-breeders (i.e. either sub-adult, immature, or juvenile birds) (Figure 2). The age group of four birds (2.1%) was not able to be determined.

Table 3: *Number of seabirds of each species returned for necropsy from observed fishing vessels between 1 July 2020 and 30 June 2021, by month of capture.*

SPECIES	MONTH												TOTAL	ANNUAL TOTAL (%)
	2020						2021							
	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun		
Black (Parkinson's) petrel								2		1	1		4	2.1
Buller's albatross	1		1		1		1		1	2	7	4	18	9.6
Campbell albatross											1		1	0.5
Common diving petrel				1				1		1			3	1.6
Fairy prion									1	2			3	1.6
Flesh-footed shearwater								2		1	3		6	3.2
Foveaux shag				1						1			2	1.1
Grey petrel		1	3										4	2.1
Grey-backed storm petrel	1	1											2	1.1
New Zealand white-capped albatross	3		2	1			2	12	9	3	2		34	18.2
Northern giant petrel						1							1	0.5
Otago shag	1						2						3	1.6
Salvin's albatross	1		3	2	4	3	2	4		1			20	10.7
Snares Cape petrel							1					1	2	1.1
Sooty shearwater					1			3	12	5	4		25	13.4
Southern royal albatross									1				1	0.5
Westland petrel		1	2	6						1			10	5.3
White-chinned petrel					1	1	6	3	9	18	10		48	25.7
TOTAL	**7**	**3**	**11**	**11**	**7**	**5**	**14**	**27**	**33**	**36**	**28**	**5**	**187**	
MONTHLY TOTAL (%)	**3.7**	**1.6**	**5.9**	**5.9**	**3.7**	**2.7**	**7.5**	**14.4**	**17.6**	**19.3**	**15**	**2.7**		

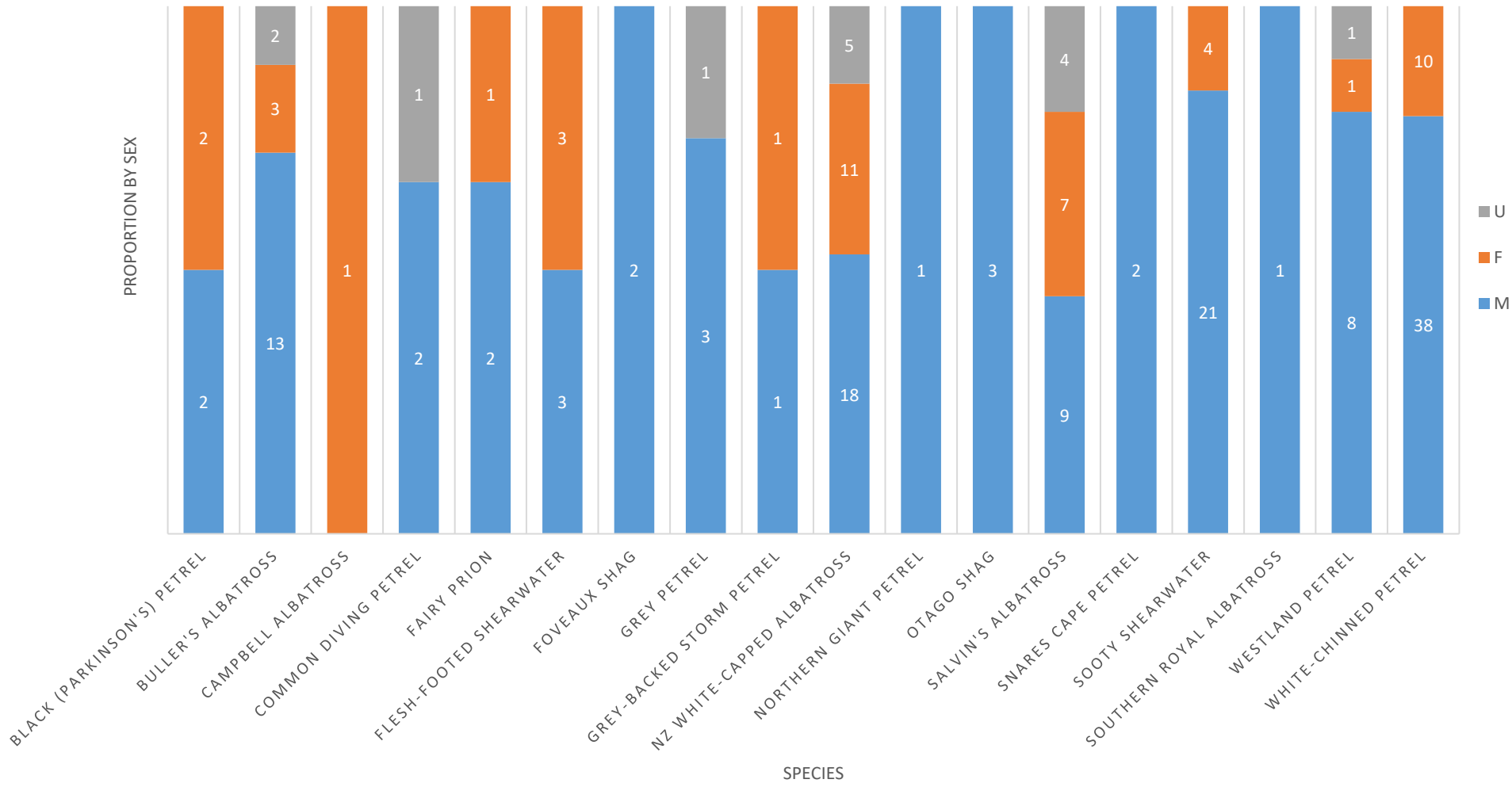

Figure 1: *Proportions of deceased seabirds returned from observed fishing vessels between 1 July 2020 and 30 June 2021, by species and sex (U = unknown, F = female, M = male). Total numbers returned for each category are shown inside the coloured bars.*

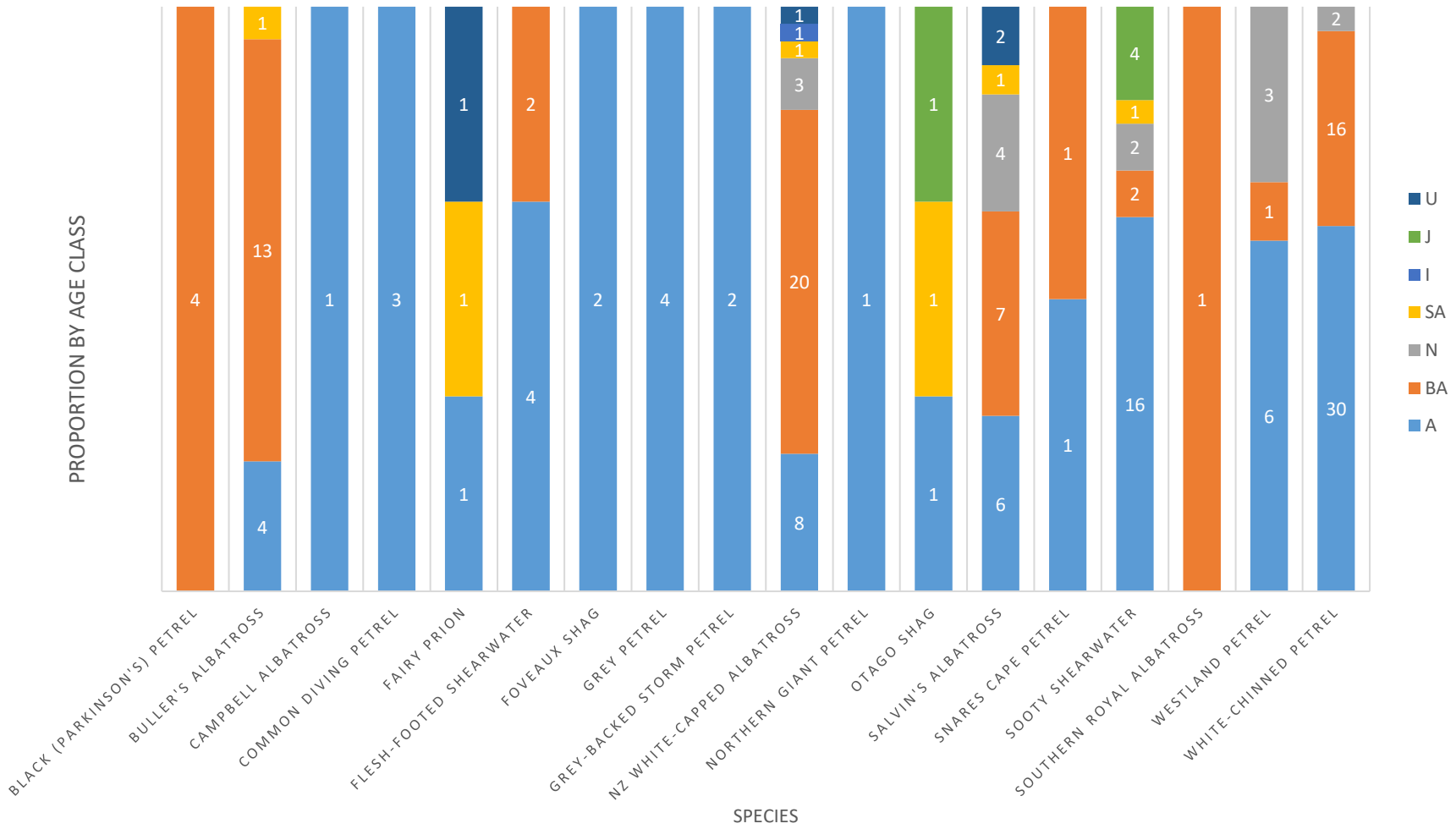

Figure 2: *Proportions of deceased seabirds returned from observed fishing vessels between 1 July 2020 and 30 June 2021, by species and age class (U = unknown, J = juvenile, I = immature, SA = sub-adult, N = non-breeder, BA = breeding adult, A = adult (not breeding adult or non-breeder). Total numbers returned for each category are shown inside the coloured bars.*

3.2.2 Vessel type and target fishery of necropsy seabirds

The bycatch seabirds returned for necropsy were caught in a range of Fishing Management Areas (FMAs) (1, 2, 3, 4, 5, 6, 7 and 9). General positions are show in Figure 3.

For the study period 1 July 2020 to 30 June 2021, there were 293 observed trips on 129 vessels (Observer data, unpublished). Fifty-two vessels (40.3%) returned seabirds for necropsy during this period from 129 observed trips (44.0%). Over 75% of these vessels returned relatively low numbers of birds (< 5 birds; n = 43, 82.7%). Three vessels caught ten or more birds; one bottom longline vessel returned 17 birds from one observed trip, one trawl vessel returned 14 birds over seven observed trips, and one trawl vessel returned ten birds over four observed trips. The remaining vessels returned between five and nine birds from between one and seven observed trips.

Of those vessels that returned seabirds, 15 were longline vessels (28.8%; 9 bottom and 6 surface), three were set-net vessels (5.8%) and 35 were trawl vessels (67.3%).

Bottom and midwater trawl fisheries combined returned 123 birds (67.2% of total returns), with trawlers targeting squid *Nototodarus* spp. accounting for 46.5% (n = 56) of all trawl returns, and those targeting hoki *Macruronus novaezelandiae* accounting for 34.1% (n = 42) of all trawl returns (Table 4).

Longline vessels returned a total of 49 seabirds (26.8% of total returns; bottom longline n = 39, and surface longline n = 10), with vessels targeting ling *Genypterus blacodes* accounting for 63.3% of longline specimens (n = 31) (Table 5).

Five seabirds were caught and killed on set net vessels (2.7% of total returns), with vessels targeting school shark *Galeorhinus galeus* and other shark species accounting for all set-net returns (Table 5).

The fishing method was not able to be determined for four seabird captures.

3.2.3 Injuries and likely cause of death of necropsied seabirds

Of the 133 birds returned from trawl vessels, most had been caught in the net or recovered in the pound or cod-end (i.e. had drowned, n = 101, 75.9%) and were very wet and sandy with crush injuries (Tables 6 and 7). Other birds had injuries suggesting entanglement and crush injuries from the trawl warp and blocks (n = 22, 16.5%), many with grease covering part, or all, of the body and multiple fractures or missing body parts. Non-albatross taxa were mostly recovered from the net (59.3%) while only albatross taxa were affected by warp strikes exhibiting serious wing injuries or lacerations (Tables 6 and 7). There were seven seabirds returned that had been killed by impacting the trawl vessel (5.3%) (Tables 6 and 7).

All five birds caught in setnets were caught in the net with occasional damage to legs or bills (Table 6).

The condition of the returned birds ranged from ‘no obvious or visible injury’, ‘waterlogged’, ‘greased’ or ‘hook present’ to ‘crushed’. As in previous years, birds caught and returned from trawl fisheries had different injuries from those caught by longline vessels.

Of the 49 birds returned from longline vessels, most were waterlogged and had hook injuries, and of these, 22 (44.9%) still had hooks present (eleven in the bill/throat/neck and eleven in the wing) (Tables 6 and 7).

Many birds had multiple injuries, resulting in the total number of injuries recorded being higher than the total number of seabirds returned (*n* = 187).

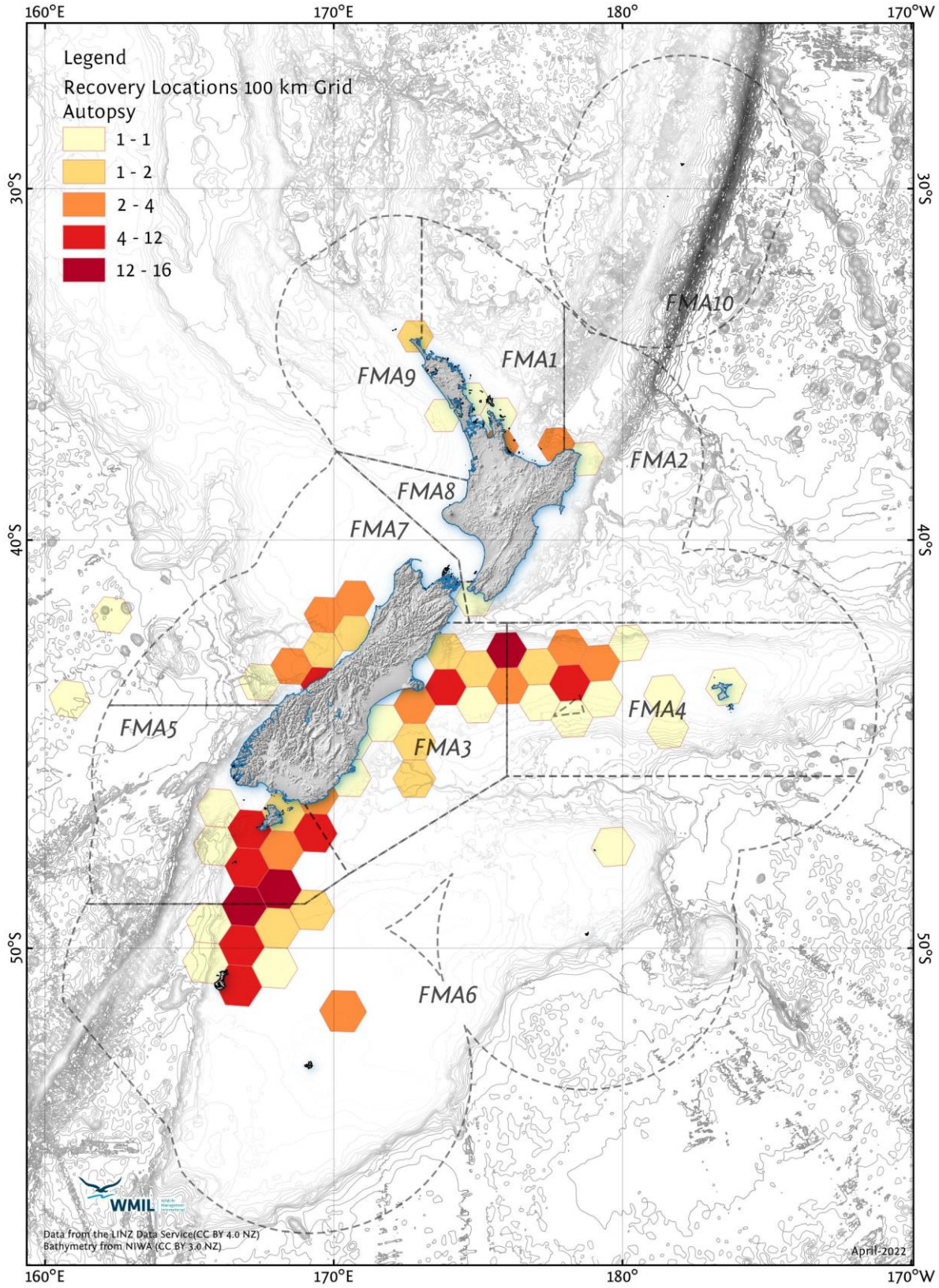

Figure 3: *Grouped catch locations of all bycatch seabirds returned in New Zealand fisheries for necropsy between 1 July 2020 and 30 June 2021.*

Table 4: *Number of seabirds of each species returned from observed fishing vessels between 1 July 2020 and 30 June 2021, by fishery type (Bottom Trawl and Bottom/Midwater Trawl).*

Species	Bottom Trawl		Bottom/Midwater Trawl											
	Barracouta	Trevally	Barracouta	Flatfish	Hoki	Jack Mackerel	Ling	Orange Roughy	Southern Blue Whiting	Scampi	Squid	Stargazer	Silver Warehou	Trevally
Black (Parkinson's) petrel														1
Buller's albatross			2		2					1	12			
Campbell Albatross					1									
Common diving petrel							1				1			
Fairy prion					1									
Flesh-footed shearwater			1											
Foveaux shag														
Grey petrel									3					
Grey-backed storm petrel								1						
NZ white-capped albatross	4	1	2		3	1	1			1	18			
Northern giant petrel					1									
Otago shag														
Salvin's albatross	1				16					1	1			
Snares/Cape petrel					1						1			
Sooty shearwater			1	3	5	1		1			10	1		
Southern royal albatross			1											
Westland petrel					1									
White-chinned petrel					11						13		1	
TOTAL	**5**	**1**	**7**	**3**	**42**	**2**	**2**	**2**	**3**	**3**	**56**	**1**	**1**	**1**
Total by fishery type	6		123											
% by fishery type	3.3		67.2											

Table 5: *Number of seabirds of each species returned from observed fishing vessels between 1 July 2020 and 30 June 2021, by fishery type (Setnet, Surface Longline and Bottom Longline).*

Species	Setnet	Surface Longline			Bottom Longline				
		Bigeye Tuna	Sturgeon	Swordfish	Ling	Red Snapper	School Shark	Snapper	Tarakihi
Black (Parkinson's) petrel		2				1			
Buller's albatross							1		
Campbell Albatross									
Common diving petrel									
Fairy prion									
Flesh-footed shearwater						1		4	1
Foveaux shag	2								
Grey petrel					1				
Grey-backed storm petrel					1				
NZ white-capped albatross			1	2					
Northern giant petrel									
Otago shag	3								
Salvin's albatross		1							
Snares/Cape petrel									
Sooty shearwater					1				
Southern royal albatross									
Westland petrel					9				
White-chinned petrel			4		19				
TOTAL	**5**	**3**	**5**	**2**	**31**	**2**	**1**	**4**	**1**
Total by fishery type	5	10			39				
% by fishery type	2.7	5.5			21.3				

Table 6: *Number of seabirds of each species returned from longline, trawl, and setnet fisheries between 1 July 2020 and 30 June 2021, by likely cause of death. The proportion of albatross and non-albatross species returned is also presented as a percentage.*

Species	Trawl					Longline					Setnet	Total
						Hook found in:						
	Warp	Net	Pound or Cod-end	Other	Vessel strike	Bill, neck, or throat	Wing	Drowned on line	Tangled	Vessel strike	Tangled	
Black (Parkinson's) petrel		1						2	1			**4**
Buller's albatross	4	9	3		1	1						**18**
Campbell albatross		1										**1**
Common diving petrel		2			1							**3**
Fairy prion			2		1							**3**
Flesh-footed shearwater						2	3	1				**6**
Foveaux shag											2	**2**
Grey petrel		3				1						**4**
Grey-backed storm petrel				1						1		**2**
NZ white-capped albatross	10	16	4	1		2	1					**34**
Northern giant petrel		1										**1**
Otago shag											3	**3**
Salvin's albatross	7	7	4	1			1					**20**
Snares Cape petrel		2										**2**
Sooty shearwater		18	2		4				1			**25**
Southern royal albatross	1											**1**
Westland petrel		1				1	5	3				**10**
White-chinned petrel		20	5			4	1	16	2			**48**
Total	**22**	**81**	**20**	**3**	**7**	**11**	**11**	**22**	**4**	**1**	**5**	**187**
Total (each type)	**133**					**49**					**5**	
% of total by fishery type (longline or trawl)	**16.5**	**60.9**	**15.0**	**2.3**	**5.3**	**22.4**	**22.4**	**44.9**	**8.2**	**2.0**		
Albatrosses (%)	100.0	40.7	55.0	66.7	14.3	27.3	18.2					
Non-albatross (%)		59.3	45.0	33.3	85.7	72.7	81.8	100.0	100.0	100.0		

WMIL: Bell & Larcombe 2022

Table 7: *Injury types recorded for seabird species returned from longline, set net, and trawl fisheries between 1 July 2020 and 30 June 2021 (n = 187). The proportion of albatross and non-albatross species returned is also presented as a percentage.*

Species	No visible injuries	Waterlogged	Broken wing	Broken legs or feet	Broken bill	Hook in bill or throat	Hook in wing	Tangled	Open wound or severed body part	Crushed, or more than 3 injuries	Greased	Liced	Total injury types
Black (Parkinson's) petrel		2						1	2				**5**
Buller's albatross		7	5	3	2				7	2	6	2	**34**
Campbell albatross			1	1									**2**
Common diving petrel	1									1	1		**3**
Fairy prion		1							3	1			**5**
Flesh-footed shearwater		2				2	3						**7**
Foveaux shag				1					1	1		1	**4**
Grey petrel	2	3							1	1	1		**8**
Grey-backed storm petrel	1		1										**2**
NZ white-capped albatross		7	10	6	1	3	1		22	4	11	5	**70**
Northern giant petrel	1	1	1										**3**
Otago shag		1			1								**2**
Salvin's albatross	3	4	9	1	1	1			8		3	1	**31**
Snares Cape petrel		2	1						1				**4**
Sooty shearwater	4	16	2	4	4			1	2		1		**34**
Southern royal albatross					1				1		1		**3**
Westland petrel	2			1			5		1			1	**10**
White-chinned petrel	6	34		8	3	1	1	2	2			1	**58**
Total	**20**	**80**	**30**	**25**	**13**	**7**	**10**	**4**	**51**	**10**	**24**	**11**	**285**
% of birds with this injury	**10.7**	**42.8**	**16.0**	**13.4**	**7.0**	**3.7**	**5.3**	**2.1**	**27.3**	**5.3**	**12.8**	**5.9**	
Albatrosses (%)	15.0	22.5	83.3	44.0	38.5	57.1	10.0	0.0	74.5	60.0	87.5	72.7	
Non-albatross (%)	85.0	77.5	16.7	56.0	61.5	42.9	90.0	100.0	25.5	40.0	12.5	27.3	

3.2.4 Body condition of necropsy seabirds

The mean fat scores of returned birds (2.09 ± SE 0.1) was lower than the previous two survey years (2019/2020 = 2.2 ± 0.1; 2018/2019 = 2.2 ± 0.1), but higher than the 2016-18 survey years (2017/18 (1.8 ± 0.1), 2016/17 (1.7 ± 0.1), 2015/16 (1.3 ± 0.0)) (Bell 2013, Bell & Mischler 2014, Bell & Mischler 2015, Bell & Bell 2016, Bell & Bell 2017, Bell & Bell 2018, Bell & Bell 2019; Bell 2021) (Table 8, Figure 5). Fat scores were not obtained from 18 birds due to damage.

Table 8: *Fat scores of bycatch seabirds returned from fishing vessels between 1 July 2020 and 30 June 2021 (1= no fat; 5 = extremely fat; U = unknown).*

SPECIES	FAT SCORE						Total No. Birds	Mean Fat Score	SE (±)
	1	2	3	4	5	U			
Black (Parkinson's) petrel	1	2				1	**4**	1.67	0.3
Buller's albatross	1	8	5	1		3	**18**	2.40	0.2
Campbell albatross		1					**1**	2.00	0.0
Common diving petrel	2	1					**3**	1.33	0.3
Fairy prion	1	1				1	**3**	1.50	0.0
Flesh-footed shearwater	3	3					**6**	1.50	0.2
Foveaux shag		2					**2**	2.00	0.0
Grey petrel	1	2				1	**4**	1.67	0.3
Grey-backed storm petrel			1	1			**2**	3.50	0.5
NZ white-capped albatross	11	6	7	4		6	**34**	2.14	0.2
Northern giant petrel	1						**1**	1.00	0.0
Otago shag			2	1			**3**	3.33	0.5
Salvin's albatross	5	8	1	1	1	4	**20**	2.06	0.3
Snares Cape petrel		1	1				**2**	2.50	0.5
Sooty shearwater	10	7	4		4		**25**	2.24	0.3
Southern royal albatross				1			**1**	4.00	0.0
Westland petrel	1	7	1			1	**10**	2.00	0.2
White-chinned petrel	13	24	7	2		2	**48**	1.96	0.1
TOTAL	**50**	**73**	**29**	**11**	**5**	**18**	**187**	2.09	0.1
% TOTAL	**26.7**	**39.0**	**15.5**	**5.9**	**2.7**	**9.6**			

The mean fat score has fluctuated over the past ten years (Figure 4), with mean fat scores steadily increasing over five survey years since the lowest fat score of 1.3 in 2015/16 to a mean fat score of 2.2 in 2018/19 and 2019/20 fishing years (Bell & Bell 2020; Figure 4).

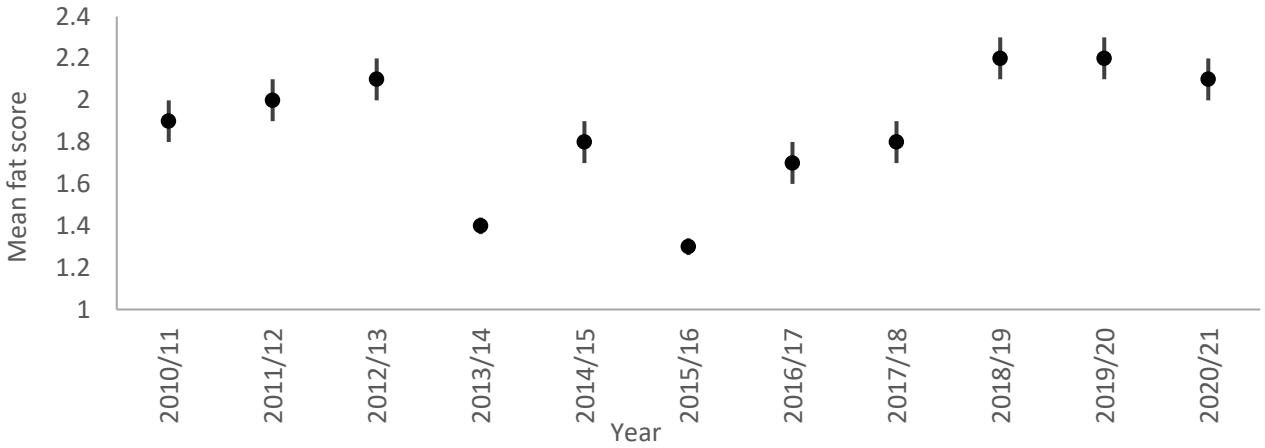

Figure 4: *Mean fat scores for all bycatch seabirds returned from New Zealand fisheries, per survey year, between 1 October 2010 and 30 June 2021 (1= no fat; 5 = extremely fat; U = unknown).*

Table 9: *Stomach contents of bycatch seabirds returned from fishing vessels between 1 July 2020 and 30 June 2021.*

SPECIES	EMPTY	MISSING	BAIT	OFFAL (OR DISCARDS)	NATURAL	BARNACLES OR SEAWEED	PLASTIC	PROVENTRICULAR OIL	WORMS
Black (Parkinson's) petrel	1			5				1	
Buller's albatross	5		1	8	1				
Campbell albatross				2					
Common diving petrel	2				2				
Fairy prion	1			1	2				
Flesh-footed shearwater	4			2					
Foveaux shag				1					1
Grey petrel	2	1		1					
Grey-backed storm petrel	1							1	
NZ white-capped albatross	8	2	1	32	4			1	
Northern giant petrel				1					
Otago shag				1					2
Salvin's albatross	3	2	3	12	2		1		
Snares Cape petrel	1							1	
Sooty shearwater	11			15	9			2	1
Southern royal albatross	1								
Westland petrel	3		6	3					
White-chinned petrel	8		11	36	4	1		14	
TOTAL no. birds	**51**	**5**	**22**	**120**	**24**	**1**	**1**	**20**	**4**
% of birds with status	**27.1%**	**2.7%**	**11.7%**	**63.8%**	**12.8%**	**0.5%**	**0.5%**	**10.6%**	**2.1%**

***Table 10**: Gizzard contents of bycatch seabirds returned from fishing vessels between 1 July 2020 and 30 June 2021.*

SPECIES	EMPTY	MISSING	SQUID BEAKS	OTOLITHS	FISH OR SQUID EYEBALLS	FISH BONES OR SKIN	PLASTIC, METAL OR STRING	SEEDS, STONES OR SHELL	WORMS	KRILL, FEATHERS, BARNACLES OR SEAWEED
Black (Parkinson's) petrel			4		2	1				
Buller's albatross	5		4	2	2	5			2	
Campbell albatross				1		1				
Common diving petrel	2									1
Fairy prion								1		2
Flesh-footed shearwater			6			1	1	2		
Foveaux shag						1			1	
Grey petrel			4	2		1			3	
Grey-backed storm petrel						2				
NZ white-capped albatross	10	3	8	4	4	12			2	3
Northern giant petrel				1						1
Otago shag						1				
Salvin's albatross		2	5	5	7	14		1	2	4
Snares Cape petrel					1	1			2	
Sooty shearwater	3		12	3		5	7	4	7	6
Southern royal albatross			1					1		
Westland petrel			10	6	3	5		1	2	
White-chinned petrel		1	46	18	7	32	4	1	26	
TOTAL no. birds	**20**	**6**	**100**	**42**	**26**	**82**	**12**	**11**	**47**	**17**
% of birds with status	**10.6%**	**3.2%**	**53.2%**	**22.3%**	**13.8%**	**43.6%**	**6.4%**	**5.9%**	**25.0%**	**9.0%**

3.2.5 Stomach and gizzard contents

There were 120 birds (63.8%) that had offal or discards in their stomachs and 22 birds (11.7%) that had bait in their stomachs (Table 9). In addition, 51 birds (27.1%) had empty stomachs. A further five birds (2.7%) had missing stomachs due to interaction with fishing gear or damage due to sea lice. One bird (a Salvin's albatross) had plastic in its stomach (Table 9).

Most of the gizzard contents were natural food items (squid beaks 53.2%, fish bones and skin 43.6%, squid or fish eyeballs 13.8%, and otoliths 22.3%), but 12 birds (6.4%) returned contained plastic, metal, or string and 11 (5.9%) contained stones or seeds (Table 10). Photographs and samples of plastics were taken.

In addition, 20 birds (10.6%) had empty gizzards and six birds (3.2%) had missing gizzards due to damage by fishing gear or sea lice. Samples (e.g. squid beaks and otoliths) have been collected for detailed identification to species level if required.

Birds could have multiple items in their stomachs and/or gizzards, resulting in higher stomach and gizzard contents figures than the total number of seabirds killed and returned (n = 187).

3.2.6 Identification of necropsied birds

Necropsy confirmed that the majority (75.0%) of the seabirds were identified correctly by on-board observers (based on the information provided by observers on the specimen tags) (Table 11).

Table 11: *Comparison of identifications (ID) recorded by on-board observers at sea compared with necropsy identification for seabirds returned from fishing boats between 1 July 2020 and 30 June 2021.*

Species	ID correct	ID to correct species group*	ID as seabird small, seabird large, or albatross*	ID wrong	ID not on label or code did not exist	Total
Black (Parkinson's) petrel	3				1	**4**
Buller's albatross	10	6		2		**18**
Campbell albatross					1	**1**
Common diving petrel	2			1		**3**
Fairy prion		2		1		**3**
Flesh-footed shearwater	6					**6**
Foveaux shag		2				**2**
Grey petrel	3	1				**4**
Grey-backed storm petrel	1	1				**2**
NZ white-capped albatross	32	1	1	1		**35**
Northern giant petrel		1				**1**
Otago shag		2		1		**3**
Salvin's albatross	12		3	5		**20**
Snares Cape petrel		2				**2**
Sooty shearwater	21	2		2		**25**
Southern royal albatross	1					**1**
Westland petrel	9			1		**10**
White-chinned petrel	41	3		3	1	**48**
Total	**141**	**22**	**4**	**17**	**3**	**187**
% Total	**75.0%**	**12.0%**	**2.2%**	**9.2%**	**1.6%**	

* Identified to correct group or size class but given the wrong species code.

Twenty-two seabirds (12.0%) were identified to the correct group or size class but were given the wrong species code (although this may relate to changes in the coding system). These species were Buller's albatross, fairy prion, Foveaux shag, grey petrel, grey-backed storm petrel, New Zealand white-capped albatross, northern giant petrel, Otago shag, Snares cape petrel, sooty shearwater, and white-chinned petrel. A further 17 seabirds (9.1%) were identified incorrectly: Buller's albatross, common diving petrel, fairy prion, New Zealand white-capped albatross, Otago shag, Salvin's albatross, sooty shearwater, Westland petrel, and white-chinned petrel. Three birds (1.6%) did not have an observer identification code on the return label or had a code that did not exist (Table 11).

3.3 Photographs and Interactions

3.2.1 Numbers of photographed seabirds or those listed as interactions

464 incidents involving seabirds and fishing vessels were reported in the MPI COD extract, either as 'photographed' records, or as 'interaction' records (if the seabird interacted with the fishing vessel but was not photographed). This total includes both live and deceased seabirds recorded (Table 12).

Of these, 274 records had no associated photographs taken. Most of the birds that were not photographed were released alive or left the vessel unaided (*n* = 245; Table 12). There were 190 seabird interactions that were photographed and had corresponding entries in the MPI COD extract (Table 12).

Similar to the seabirds caught and returned for necropsy, the photograph and interaction seabirds were dominated by four species: New Zealand white-capped albatross (n = 97, 20.9%), white-chinned petrel (n = 91, 19.6%), flesh-footed shearwater (n = 53, 11.4%), and sooty shearwater (n = 45, 9.7%) (Table 12). These four species accounted for 61.6% of all reported interactions and photographed birds.

The six species that were most frequently recorded as any interaction type with commercial fishing vessels are summarised in Table 13. White-chinned petrels made up the highest proportion of all interactions (21.4%), highest proportion of deceased birds across all interaction types (33.4%), and the highest proportion returned for necropsy (25.7%) (Table 12). A high proportion of all interactions were with New Zealand white-capped albatross (20.1%) but this species also made up a high proportion of the birds being released alive (21.6%).

As with records of seabird captures retained for necropsy, the distribution of photograph and interaction records was not evenly spread across the study time period. Most bird interactions were reported in April 2021 (n = 111, 23.9%), February 2021 (n = 90, 19.4%), March 2021 (n = 89, 19.2%), and May 2021 (n = 60, 12.9%) (Table 14). This pattern reflects the timing of presence of these seabird species within the New Zealand EEZ, timing and location of all observed fisheries, and observer coverage.

Table 12: *Number of seabirds of each species reported as photographed, or recorded as interacting with fishing vessels (not photographed), between 1 July 2020 and 30 June 2021.*

SPECIES	Photo			Interaction			TOTAL
	Alive	Dead	Total	Alive	Dead	Total	
Albatross (unidentified)				10	3	13	**13**
Australasian gannet				2		2	**2**
Black (Parkinson's) petrel	1	1	2	8		8	**10**
Black-browed albatross (unidentified)				1		1	**1**
Buller's albatross	3	10	13	7		7	**20**
Buller's and Pacific albatross				4	1	5	**5**
Buller's shearwater				2		2	**2**
Cape petrels				7		7	**7**

Common diving petrel	7		7	9		9	**16**
Fairy prion	3		3	3		3	**6**
Flesh-footed shearwater	26	2	28	25		25	**53**
Gibson's albatross				1		1	**1**
Great albatross (unidentified)				2		2	**2**
Great-winged (Grey-faced) petrel				1		1	**1**
Grey petrel	1		1	2		2	**3**
NZ white-capped albatross	6	26	32	59	6	65	**97**
Northern giant petrel				2		2	**2**
Otago shag		2	2				**2**
Petrel (unidentified)				5		5	**5**
Petrels, prion, and shearwaters (unidentified)				6	4	10	**10**
Prion (unidentified)				3		3	**3**
Procellaria petrel (unidentified)				10		10	**10**
Pterodroma petrel (unidentified)				3		3	**3**
Red-billed gull				1		1	**1**
Salvin's albatross		5	5	13	2	15	**20**
Seabird (small)					1	1	**1**
Seabird (unidentified)				2		2	**2**
Shearwater (unidentified)				5	1	6	**6**
Small albatross (unidentified)				4	4	8	**8**
Snares cape petrel	1		1				**1**
Sooty shearwater	5	18	23	16	6	22	**45**
Southern royal albatross		2	2	2		2	**4**
Storm petrel (unidentified)	1		1	2		2	**3**
Wandering albatross (unidentified)				2		2	**2**
Westland petrel				6		6	**6**
White-chinned petrel	2	68	70	20	1	21	**91**
TOTAL	**56**	**134**	**190**	**245**	**29**	**274**	**464**

Table 13: *Comparison of the six most frequently reported seabird species for different interaction types with commercial fishing vessels between 1 July 2020 and 30 June 2021.*

Species	Deceased, not photographed (n = 29)	Deceased, photographed non-retained (n = 134)	Deceased, retained for necropsy (n = 187)	Total Deceased (n = 350)	Released alive (n = 301)	Total all interactions (n = 651)
Buller's albatross		7.5%	9.6%	8.0%	3.3%	5.8%
Flesh-footed shearwater		1.5%	3.2%	2.3%	16.9%	9.1%
NZ white-capped albatross	20.7%	19.4%	18.2%	18.9%	21.6%	20.1%
Salvin's albatross	6.9%	3.7%	10.7%	7.7%	4.3%	6.1%
Sooty shearwater	20.7%	13.4%	13.4%	14.0%	7.0%	10.8%
White-chinned petrel	3.4%	50.7%	25.7%	33.4%	7.3%	21.4%

Table 14: *Number of seabirds recorded as interactions (photographed or non-photographed) with fishing vessels between 1 July 2020 and 30 June 2021, by month of incident.*

SPECIES	2020						2021						TOTAL	TOTAL %
	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	April	May	Jun		
Albatross (unidentified)	1			1				4		2	3	2	**13**	**2.8**
Australasian gannet							1				1		**2**	**0.4**
Black (Parkinson's) petrel				1		1	2	2	2	1	1		**10**	**2.2**
Black-browed albatross (unidentified)	1												**1**	**0.2**
Buller's albatross	2	1				2		1		1	3	10	**20**	**4.3**
Buller's and Pacific albatross		3						2					**5**	**1.1**
Buller's shearwater							1	1					**2**	**0.4**
Cape petrels			2							1		4	**7**	**1.5**
Common diving petrel	2			2	1	1	1		5	2	1	1	**16**	**3.4**
Fairy prion	1						1		2		2		**6**	**1.3**
Flesh-footed shearwater					2	1		9	6	34	1		**53**	**11.4**
Gibson's albatross								1					**1**	**0.2**
Great albatross (unidentified)									1		1		**2**	**0.4**
Great-winged (Grey-faced) petrel									1				**1**	**0.2**
Grey petrel			1								2		**3**	**0.6**
New Zealand white-capped albatross	6				3	1	2	24	23	8	24	6	**97**	**20.9**
Northern giant petrel		1										1	**2**	**0.4**
Otago shag						2							**2**	**0.4**
Petrel (unidentified)			1					1	3				**5**	**1.1**
Petrels, prion and shearwaters (unidentified)			1		1			2	2	2	2		**10**	**2.2**
Prion (unidentified)	1					1					1		**3**	**0.6**
Procellaria petrel (unidentified)								2	3	3	2		**10**	**2.2**
Pterodroma petrel (unidentified)										2	1		**3**	**0.6**

Red-billed gull					1								**1**	**0.2**
Salvin's albatross	2	2	5	3	6	1	1						**20**	**4.3**
Seabird (small)								1					**1**	**0.2**
Seabird (unidentified)	2												**2**	**0.4**
Shearwater (unidentified)					1				1		4		**6**	**1.3**
Small albatross (unidentified)	1				1		1	2		1		2	**8**	**1.7**
Snares Cape petrel												1	**1**	**0.2**
Sooty shearwater					2		1	6	18	16	2		**45**	**9.7**
Southern royal albatross									2		2		**4**	**0.9**
Storm petrel (unidentified)			1						1		1		**3**	**0.6**
Wandering albatross (unidentified)								1	1				**2**	**0.4**
Westland petrel					1				1		4		**6**	**1.3**
White-chinned petrel					1		2	31	17	38	2		**91**	**19.6**
TOTAL INTERACTIONS	**19**	**7**	**11**	**7**	**20**	**10**	**13**	**90**	**89**	**111**	**60**	**27**	**464**	
TOTAL INTERACTIONS (%)	**4.1**	**1.5**	**2.4**	**1.5**	**4.3**	**2.2**	**2.8**	**19.4**	**19.2**	**23.9**	**12.9**	**5.8**		

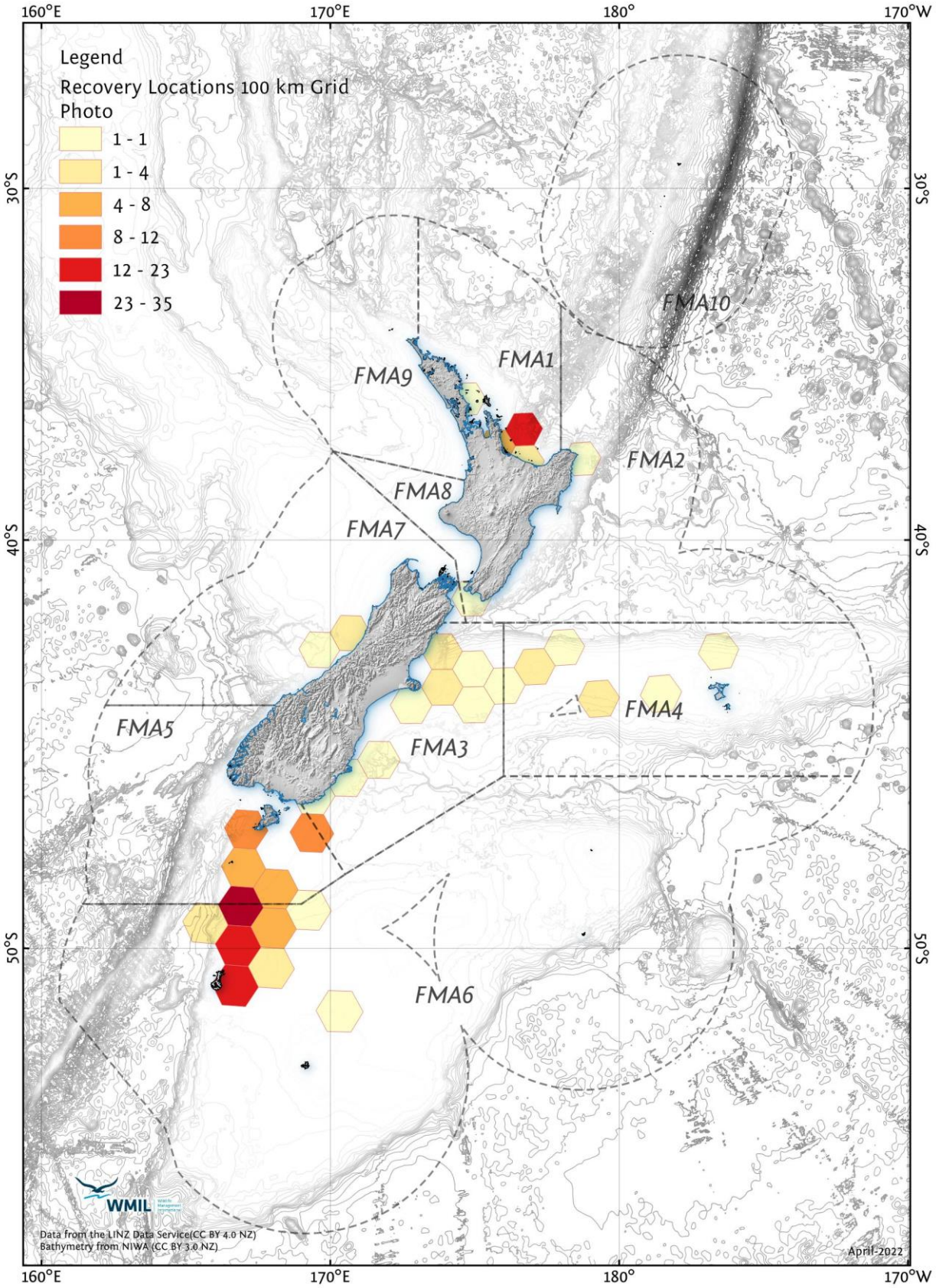

Figure 5: *Grouped catch locations of all seabirds caught and photographed in New Zealand fisheries between 1 July 2020 and 30 June 2021.*

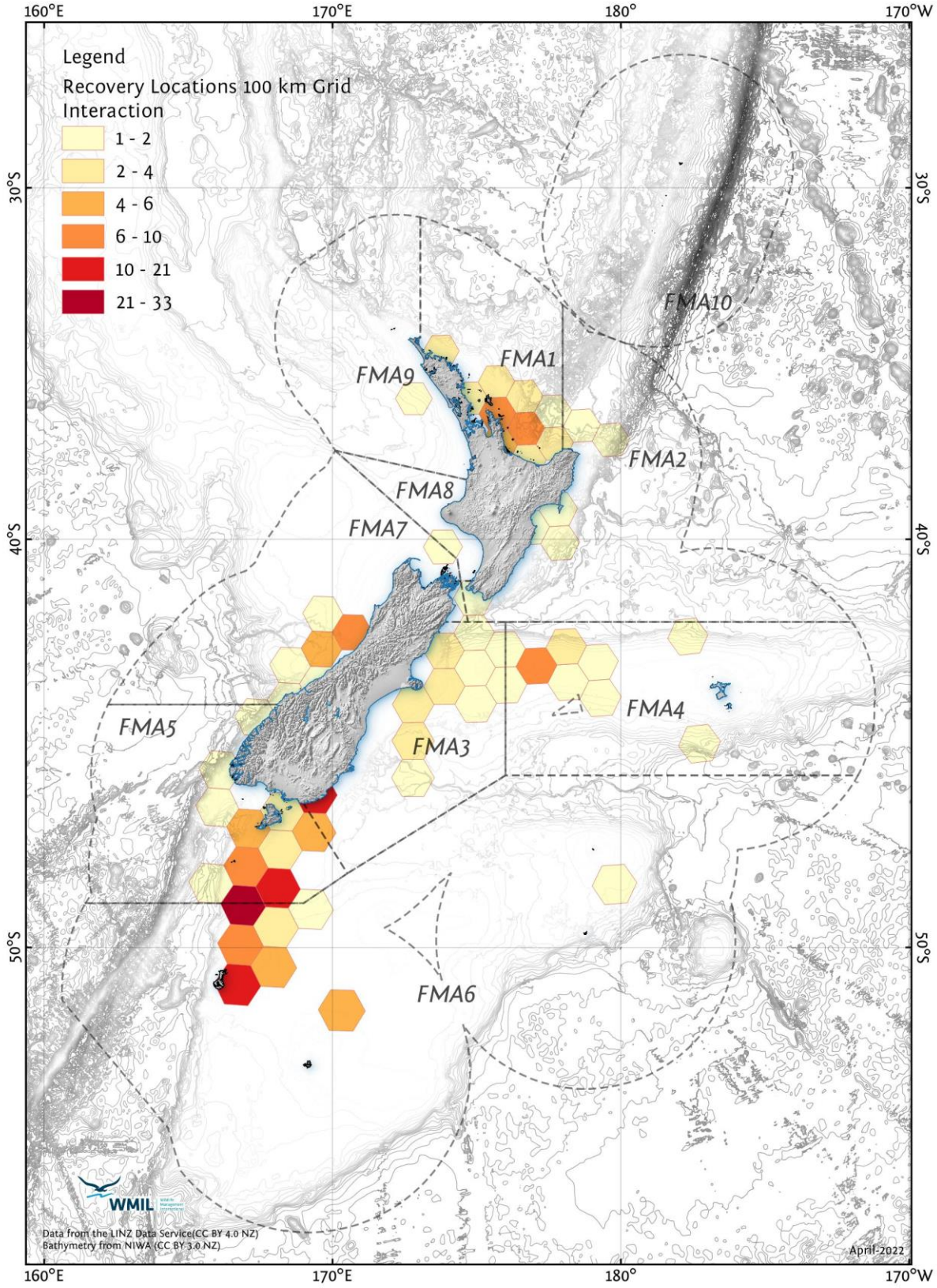

Figure 6: *Grouped catch locations of all seabirds reported as an interaction (and not photographed) in New Zealand fisheries between 1 July 2020 and 30 June 2021.*

3.2.2 Target fishery and vessels of photographed or interaction seabirds

The seabirds that were photographed and listed in the MPI COD extract and discarded or released alive were caught in a range of FMAs (FMA 1, 2, 3, 4, 5, 6, and 7). General positions are shown in Figure 5.

The seabirds that were reported as an interaction in the MPI COD extract but not photographed were caught in a range of FMAs (FMA 1, 2, 3, 4, 5, 6, 7, 8 and 9). General positions are shown in Figure 6.

The 464 seabirds that were either photographed or recorded as an interaction were from 63 individual vessels: 22 birds (4.7%) from three set net vessels, three birds (0.6%) from two purse seine vessels, 86 birds (17.5%) from 17 longline vessels, and 353 birds (76.1%) from 41 trawl vessels (Table 15).

Table 15: *Number of seabirds photographed or recorded as interactions from fisheries vessels between 1 July 2020 and 30 June 2021. The total number of unique vessels on which both photographed and non-photographed interactions were recorded is given.*

Fishery Type	Photograph		Interaction		Total	
	Seabirds	Vessels	Seabirds	Vessels	Seabirds	Vessels
Bottom Long Line	29	3	35	11	64	11
Surface Long Line	4	2	18	6	22	6
Bottom/Midwater Trawl	153	24	200	33	353	41
Set Net	3	1	19	3	22	3
Purse Seine	1	1	2	1	3	2
TOTAL	**190**	**31**	**274**	**54**	**464**	**63**

There were 293 observed trips on 129 vessels (Observer data, unpublished). Interactions with seabirds (photographed and non-photographed) were reported from 63 vessels (Table 15). Nearly half of these 63 vessels reported relatively low numbers of bird interactions (< 5 birds reported; n = 30, 47.6%). There were 12 vessels (19.0%) that had interactions with 10 or more birds.

The number of vessels that recorded any type of interaction with seabirds (photograph, interaction, retained for necropsy) was 75 (58.1% of vessels). Over half of these vessels reported low numbers of interactions or returned low numbers of seabirds (<5 birds; n = 40, 53.3%). Twenty vessels (26.7%) had interactions with or returned more than 10 seabirds.

3.2.3 Injuries of photographed or interaction seabirds

The majority of the 464 interaction or photographed birds represented live bird interactions (n = 300, 65.7%) (Table 16). Of the birds released alive, only 56 were photographed (18.6%) compared to 245 seabirds being recorded as interactions (Table 16). Most of these interaction-only birds were released by the crew prior to the observer being able to photograph them (as reported by the observer in the notes provided in the MPI COD extract), or left the vessel without requiring human assistance. Four reportedly deceased birds could not be recovered as they fell off the warp or hook before being transferred on-board, or were discarded by crew before the observer could view them (Table 16).

Table 16: *Number of seabirds recorded as interactions or photographed from fisheries vessels between 1 July 2019 and 30 June 2020.*

	Photograph seabirds	Interaction Seabirds	Total	Total %
Alive	56	245	**301**	64.9
Deceased	134	25	**159**	34.3
Not recovered (deceased)		4	**4**	0.9
Total	**190**	**274**	**464**	

Table 17: *Number of seabirds of each species that were photographed after vessel interaction with commercial fisheries between 1 July 2020 and 30 June 2021, by likely cause of death. The proportion of albatross and non-albatross species returned is also presented as a percentage.*

Species	LONGLINE		TRAWL						SET NET		PURSE SEINE	Total
	Hook		Warp	Net		Other	Vessel strike		Net		Vessel Strike	
	Alive	Deceased	Deceased	Alive	Deceased	Deceased	Alive	Deceased	Alive	Deceased	Alive	
Black (Parkinson's) petrel	1				1							2
Buller's albatross			3	3	7							13
Common diving petrel							6		1			7
Fairy prion							2				**1**	3
Flesh-footed shearwater	26		1		1							28
Grey petrel							1					1
NZ white-capped albatross		3	9	2	13	1	4					32
Otago shag										2		2
Salvin's albatross			1		4							5
Snares cape petrel							1					1
Sooty shearwater	1				18		4					23
Southern royal albatross			1					1				2
Storm petrel (unidentified)							1					1
White-chinned petrel				1	67	1	1					70
Total	**28**	**3**	**15**	**6**	**111**	**2**	**20**	**1**	**1**	**2**	**1**	**190**
% of total birds photographed	**14.7**	**1.6**	**7.9**	**3.2**	**58.4**	**1.1**	**10.5**	**0.5**	**0.5**	**1.1**	**0.5**	
Total (fishery type)	**31**		**155**						**3**		1	
Albatrosses (%)		100	93.3	83.3	21.6	50	20	100				
Non-albatross (%)	100		6.7	16.7	78.4	50	80		100	100	100	

WMIL: Bell & Larcombe 2022

Of the 190 seabirds that were photographed, 56 were released alive and 134 died for a range of reasons (Tables 16, 17, and 18).

There were a range of injury types recorded against the interaction-only and photographed birds, as shown in Table 18. Most of the birds had no visible injuries (n = 305, 65.7%) and most of these birds were released alive (n = 238, 78.0%). Of the 29 seabirds that were recorded as deceased following an interaction with the fishing vessel (but were not photographed), 16 (55.2%) were drowned in the trawl nets, six (20.7%) went through the warp, and two (6.9%) were drowned on longline hooks. Seven (24.1%) could not be recovered after falling off the warp or net prior to coming onboard the vessel, or were discarded by crew before the observer could assess them (Table 18).

Table 18: *Types of injuries recorded on seabirds that were photographed or recorded as interactions from fisheries vessels between 1 July 2020 and 30 June 2021.*

Injury Type	Photograph		Interaction		Total			% of birds with injury
	Alive	Deceased	Alive	Deceased	Alive	Deceased	All	
No visible injuries	33	62	205	5	**238**	**67**	**305**	65.7
Disorientated	1		2		**3**		**3**	0.6
Waterlogged	4	55	1	4	**5**	**59**	**64**	13.8
Greased	1	2			**1**	**2**	**3**	0.6
Broken or drooping wing		23	2	5	**2**	**28**	**30**	6.5
Hook in bill or throat		1	3	2	**3**	**3**	**6**	1.3
Hook in wing			2		**2**		**2**	0.4
Open wound	20	12	26	1	**46**	**13**	**59**	12.7
Severed body part		2		3		**5**	**5**	1.1
More than 3 injuries (crushed)		1				**1**	**1**	0.2
Liced				1		**1**	**1**	0.2
Unknown (unable to assess)		1	4	15	**4**	**16**	**20**	4.3
Total	**56**	**134**	**245**	**29**	**301**	**163**		
	190		**274**		**464**			

3.2.4 Identification of photographed seabirds

Examination of 188 photographed seabird interactions confirmed that observers had accurately identified 85.1% (n = 160) of seabirds (Table 19). One Buller's albatross, four common diving petrels, one fairy prion, one flesh-footed shearwater, four New Zealand white-capped albatross, four sooty shearwaters, and six white-chinned petrels were incorrectly identified (n= 21, 11.2%; Table 19).

Photographs of two seabirds recorded as 'photographed' interactions have not been received to date.

Table 19: *Comparison of 188 observer identifications with expert identifications for photographed captures listed in COD from fishing vessels between 1 July 2020 and 30 June 2021, by species. 'Confirmed' = identification confirmed the observer identification; 'new, consistent' = identification was to a lower taxonomic group, but consistent with the observer identification; and 'new, not consistent' = identification was not consistent with the observer identification (i.e. observer identified the species incorrectly).*

Species	Confirmed	New, consistent	New, not consistent	Total
Black (Parkinson's) petrel	1			**1**
Buller's albatross	9	3	1	**13**
Common diving petrel	3		4	**7**
Fairy prion	2		1	**3**
Flesh-footed shearwater	27		1	**28**
Grey petrel	1			**1**
NZ white-capped albatross	28		4	**32**
Otago shag		2		**2**
Salvin's albatross	5			**5**
Snares cape petrel		1		**1**
Sooty shearwater	17	1	4	**22**
Southern royal albatross	2			**2**
Storm petrel (unidentified)	1			**1**
White-chinned petrel	64		6	**70**
Total	**160**	**7**	**21**	**188**
% of total	**85.1%**	**3.7%**	**11.2%**	

3.2.5 Quality and number of photographs

The quality of the images obtained by observers continued to vary widely, particularly for live birds. Video footage is now being received as well as still imagery. Video footage was useful in determining species released alive in situations where photos may not have provided enough detail.

Photography of deceased birds continues to improve with a number of images being taken for most of the dead specimens.

Issues included only one photograph for some seabirds, not all key features being photographed, poor focus, labels being omitted from the photographs, and under- or over-exposure.

Poor images were particularly common for birds that were alive and seen on-board for short periods (particularly when photographs were taken from a long distance).

Some of the cameras used by observers had not been programmed with the current date and time, so that the metadata of each image did not match the data and time recorded in the COD. This was particularly unhelpful in situations where several seabirds were photographed in the same haul or set and labels were unclear.

3.2.6 Recommendations for photograph identification

It is recommended that:

1. Wherever possible, all seabird interactions are photographed and recorded. If possible, haul and sample information should be included in the image.
2. Images (with scale if possible) include the head and bill from the side and above, body (full body and side shots), wings (above and below) and shots of the feet whenever possible. This is particularly important for dead birds.
3. Photo logs are completed for all images (which can be correlated to date and time stamps from the camera). Cameras are programmed to show correct date and time. Descriptions of the interaction would also help with the identification and matching of images.
4. Photograph numbers are recorded on the observer non-fish bycatch form.
5. Photographs (and extracts from the MPI observer logbooks) are provided regularly throughout the fishing year for photo-identification.
6. Training and instruction on the use of the cameras and on how to take suitable photographs for identification use (i.e. number of images, type of images, date, and time stamps etc.) is provided for all observers.

4. DISCUSSION

The total number of seabirds retained for necropsy in the 2020/2021 survey year was lower than the previous three one-year reporting periods (Appendix 1: Figure 7). Furthermore, the total number of seabirds recorded as dead across all record types (necropsy, photograph, and interaction) in 2020/2021 was lower than the previous seven one-year reporting periods (Appendix 1: Figure 8). However, without knowing the total number of fishing trips undertaken within each reporting period, and more details with regard to observer coverage (e.g., total number of days observed within each fishery type), this apparent reduction in seabird bycatch remains inconclusive.

The five seabird species retained for necropsy most frequently in 2020/2021 (white-chinned petrel, New Zealand white-capped albatross, sooty shearwater, Salvin's albatross, and Buller's albatross) were the same as those reported in the preceding year, in similar proportions. These five species and flesh-footed shearwaters consistently comprise the vast majority of seabirds caught in New Zealand commercial fisheries.

Where the sex of seabirds retained in 2020/2021 could be identified, most of the birds (69.0%) were males. Twice as many males were retained as females. This proportion is consistent with observations in previous years. Sex-specific differences in foraging behaviour have been documented in a number of seabird species (Patrick & Weimerskirch 2014). Furthermore, the behaviour of seabirds around fishing vessels may vary by sex (Giménez et al. 2021).

White-chinned petrels made up over half of all 'photograph' (deceased, non-retained) records (50.7%, n = 68; Tables 12 & 13). This is likely attributable to observer requirements not necessitating that all specimens of white-chinned petrel be retained, and this species typically being caught in multiple numbers over short time spans. Observer requirements determining the frequency at which each species is retained must be considered when comparing necropsy figures over time.

5. ACKNOWLEDGMENTS

This work was funded through the Conservation Services Programme (INT2019-02), Department of Conservation. This necropsy and photo-identification work would not have been possible without the dedication of Ministry for Primary Industries Observers who retained the birds for necropsy, took the photographs, and completed logbooks (which contain important information on cause of death and other aspects of the interaction on-board). Shannon Weaver and Katie Clemens-Seely provided the link between Wildlife Management International Ltd, the Department of Conservation and the Ministry for Primary Industries Observer Programme and helped provide clarification on any discrepancies with necropsy tag data

and photograph records. Kelvin Floyd (WMIL) developed and maintained the WMIL necropsy and photo-identification database and produced all maps.

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7. APPENDIX 1

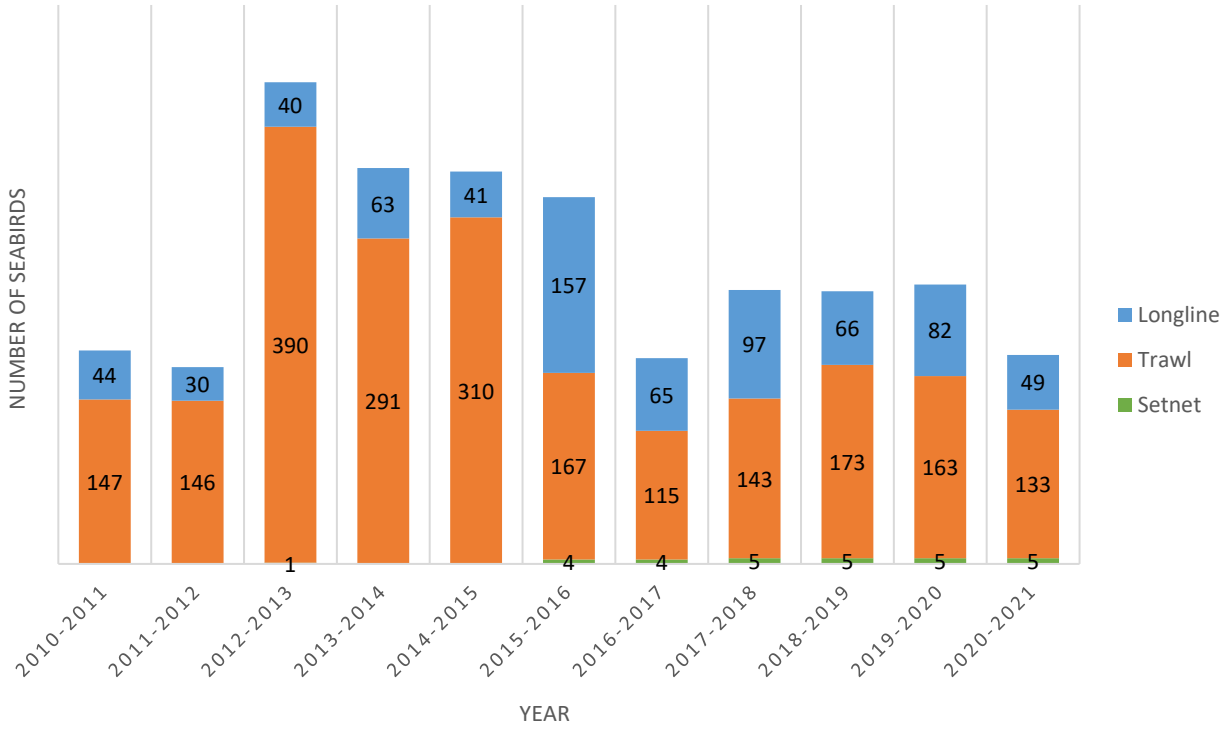

Figure 7: *Numbers of seabirds retained for necropsy by fishery type (longline, trawl, and setnet), 2010-2021.*

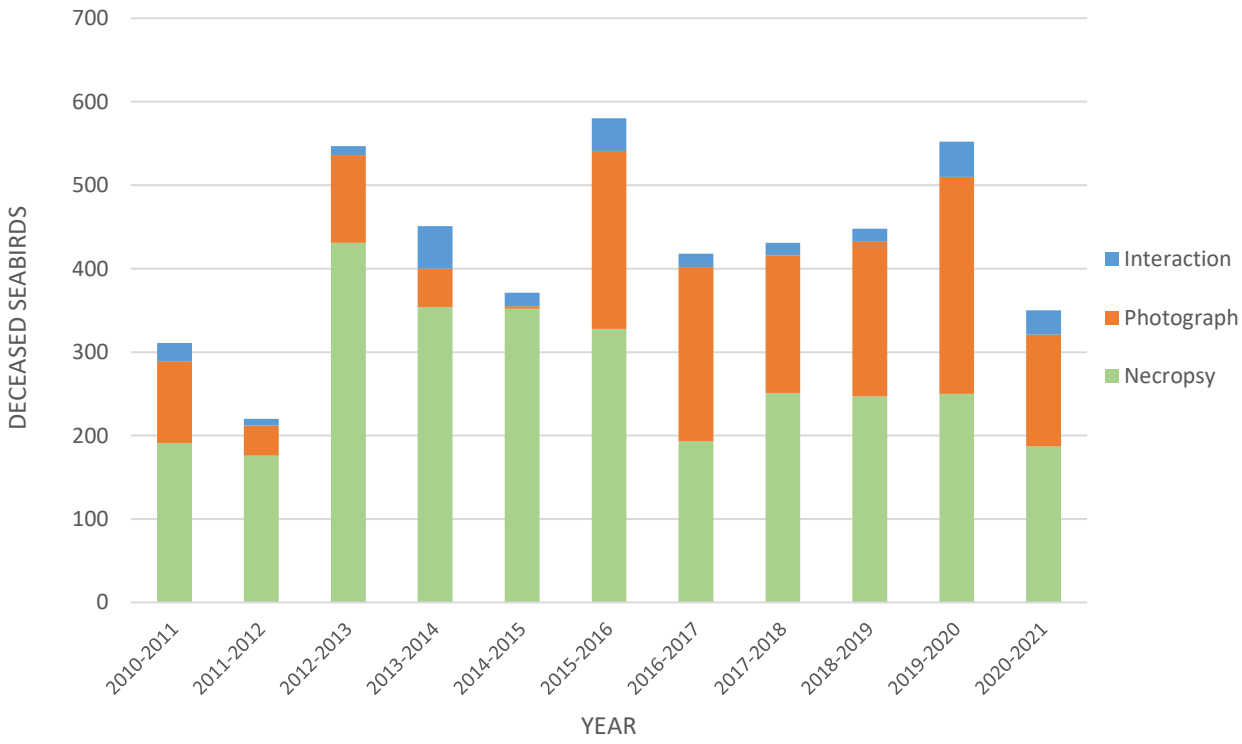

Figure 8: *Numbers of seabirds recorded as deceased by record type (interaction, photograph, or necropsy), 2010-2021.*