



Preparation of data on observed protected species captures, 2002–03 to 2014–15

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EXECUTIVE SUMMARY

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Incidental captures of protected species in New Zealand waters are recorded by fisheries observers when they are on-board commercial fishing vessels. As observer coverage varies across fisheries, statistical models are used to estimate the total number of incidental captures across New Zealand fisheries. These bycatch assessments rely on the linking of observer records to fisher-reported effort data. Preparation of the data also requires corrections to errors in the capture records (e.g., misidentifications of species), and the inclusion of capture records from other sources, such as seabird necropsies and examination of photographs taken by observers.

This report documents the data preparation process used for observer records of protected species captures for the period between the 2002–03 and 2014–15 fishing years. The data preparation process included the linking of observer and fishing effort data, the expanding of multiple capture events that were reported as single captures, and updates to capture records and species identifications, following expert reviews through necropsies and photograph examinations. Other updates to the dataset included the omission of records such as data that were not consistent with the definition of incidental captures or were from waters outside New Zealand’s Exclusive Economic Zone. Some seabird captures that were only identified by fisheries observers also had their identifications modified through an imputation process. The imputation used information from other captures that were formally identified, from necropsy or photograph, to infer the likely identification.

The final dataset consisted of 8921 protected species captures for the fishing years between 2002–03 and 2014–15. Included in this dataset were 6621 captures of seabirds.

Three substantive issues were found with the data used for estimating marine mammal and seabird bycatch to the end of the 2013–14 fishing year. These issues were missing observer trip records, inclusion of seabird deck captures, and the incorrect matching of photograph identifications to the observer capture data. Addressing these issues with resulting changes to the data will lead to changes in the number of estimated captures, especially of seabirds. When the seabird bycatch estimation is updated to the end of the 2014–15 fishing year, estimates for all previous years will also be updated.

This report highlights several areas where improvement in the processes would help with more timely (and potentially more accurate) records of bycatch data. Multiple organisations work with the observer capture data, and depend on them for their reporting. Developing collaborative working methods would help to develop a consistent, reliable, and timely view of protected species bycatch information.

1. INTRODUCTION

Protected non-fish species, including seabirds and marine mammals, are caught in New Zealand fisheries. These captures are recorded by government fisheries observers when they are on-board commercial vessels fishing in New Zealand waters. As observers are not present at all fishing events, bycatch assessments use statistical models to estimate the total number of incidental captures of protected species in New Zealand commercial trawl and longline fisheries each year (e.g., Abraham & Thompson 2011, Richard & Abraham 2013, Thompson et al. 2013). These estimations are based on observer records and on fishing effort data.

Observers document each capture event on non-fish bycatch paper forms, and these data are subsequently entered into the Centralised Observer Database (COD), managed by the National Institute of Water and Atmospheric Research (NIWA). Observer records include information on whether the animals were alive (and subsequently released), or dead. In addition, observers regularly take digital photographs to document the captures, and a number of fatal captures are retained for subsequent necropsy by experts. The photographs and necropsies allow confirmation or correction of species identifications by experts, while necropsies also provide additional information such as the sex, age and body condition of the animal, and the cause of death.

For bycatch estimation, each capture needs to be linked to a fishing event to determine the location, time, and other characteristics of the fishing. The captures are associated with a fishing event reported by the observer, and this observed fishing effort is then linked to the fisher-reported fishing event. Fisher-reported data on fishing events are extracted from the *warehouse* database administered by Ministry for Primary Industries (MPI), which centralises all data related to the fishing activities for each fishing event, including fishing effort, target species, gear, location, and catch information.

The linking of captures to observer-reported data is sometimes hampered by errors during the recording of information on paper forms, during data entry from paper forms to digital databases, or through the lack of some records. To address these shortfalls and maximise the number of captures that can be used in bycatch estimation analyses, data are assessed and prepared in a number of steps. This document describes these data preparation steps, and provides a summary of the changes to the initial raw protected species capture data that were made in the process. The data considered here include all data on observed captures between the fishing years 2002–03 and 2014–15 inclusive (a fishing year starts on 1 October and ends on 30 September the following year). The data do not include any information from video monitoring of fisheries. Fishers are also required to report the captures of protected species, but fisher-reported captures are not discussed here.

2. METHODS

2.1 Observer fishing effort data

A full extract of observer fishing effort data from the COD was made on 8 April 2016. The extract included data from October 1992 until the end of the 2014–15 fishing year (i.e., ending 30 September 2015). Observer fishing effort data were included from trips using trawl, surface-longline, bottom-longline, set-net, or purse-seine fishing methods on at least one fishing event. In preparing the final dataset, data were restricted to fishing trips with at least one fishing event within the outer boundary of New Zealand's Exclusive Economic Zone (EEZ).

The fisheries' observers are managed by the observer programme at MPI, which assigns observers to fishing trips. The observer trip record tables give information on the status of each observer trip. These tables were reconciled with observer fishing effort data to assess the completeness of the observer effort data included in this study. Effort data from observer trips were included in the study unless they:

- were cancelled,
- operated exclusively outside the EEZ,

- were research trips,
- did not record any fishing effort, or
- were not using the fishing methods included here (trawl, surface and bottom longline, set net, or purse seine).

Protected captures estimation requires data on the fishing effort. Observed fishing effort is included in the COD, when it is available. When these data are not available, but the trip was observed, the observed effort was reconstructed from the fisher-reported catch effort, assuming that all effort on the observed days was observed. This process involved the linking of the vessel key and the fishing dates.

2.2 Protected species captures

All records of protected species captures (as recorded by observers on the non-fish bycatch form) were extracted from the COD. These included records of animals that were caught during fishing by methods not included in the extract of the fishing effort data. In instructions given to observers, a protected species capture was defined as a seabird, marine mammal, turtle, or other protected species becoming fixed, entangled, or trapped, preventing it from moving freely or freeing itself. In particular, the definition of capture excluded the following:

- sightings at sea,
- animals interacting with fishing gear, unless they were caught,
- birds that hit the superstructure of the vessel or landed on it, unless they fell to the deck injured or dead, and were unable to move freely,
- marine mammals climbing onboard the vessel,
- animals that were snagged momentarily, but then managed to free themselves because they have not been caught,
- traces of individuals (such as feathers or fur caught in a trawl warp splice) as it is unclear whether an animal was caught,
- individuals that appear to have been caught but are lost before being brought onboard the vessel, unless they were confirmed as being caught but could not be recovered safely to the deck of the vessel.

The data preparation also identified observer records that were not consistent with the definition of incidental captures. The remarks associated with each capture were reviewed, where a keyword search of the remarks indicated that they may be relevant (the remarks are at the fishing event level, and some are unrelated to the capture). Some observers had recorded animals that climbed on-board the vessel, or landed on it (such as a pair of swallows perched on the railings of the vessel). Others had recorded animals that were seen dead in the water, where that fatality was not clearly associated with the fishing. These captures did not meet the definition of a capture. Particular care was taken to identify seabirds that had been caught on trawl warps, but that had fallen off into the water before being brought on-board the vessel. These incidents were excluded from the final dataset, on the basis that their reporting would be inconsistent (observers do not watch the warps for the duration of the haul). An exception was made for a small number of dead birds that had been deliberately knocked off the warps into the water by the crew. These were included as captures.

The remarks associated with each capture were also used to classify the capture methods. Since 2006–07, this information has been coded by the observer on the form, however the remarks provide additional

information on the captures. In particular, deck captures of seabirds (e.g., birds that hit the superstructure of the vessel, or were found dead on the deck) were identified in the data. These deck captures were not included in the final dataset, even though they may meet the identification of captures. There are a wide range of circumstances leading to birds being found on the deck. In many cases, there was not sufficient information to make a clear decision on whether a recorded deck capture meets the definition of a capture incident. In addition, the remarks were reviewed to detect records of animals that were caught in bycatch mitigation devices (such as streamer lines or bird bafflers) and animals that hit the paravane cable. This review of the observer's remarks was carried out by searching for relevant keywords in the remarks, and reviewing the associated capture method. In addition to the keyword-based search, all remarks associated with seabird captures in trawl fisheries between 2002–03 and 2014–15 were reviewed. This latter review was carried out to allow determination of any changes in the ratio of warp captures and net captures.

Any decomposing animals that may not have been caught by the fishing were also omitted from the dataset. This decomposition was generally indicated by the observer on the form. In some cases, however, decomposed animals were identified by review of the observers' remarks. Captures during fishing trips that involved research into the efficacy of mitigation methods were excluded. These research trips required modifying the vessel's usual practice, and a condition for use of the vessel for this purpose was that any captures that occurred were not recorded. The analysis was restricted to captures from within New Zealand's EEZ, and any captures from outside New Zealand's EEZ were excluded from the dataset.

The COD records protected species captures in non-fish bycatch tables. All captures of seabirds, turtles, and marine mammals that were reported by observers should be recorded in this database. The database also includes some records of captures of spine-tailed devil ray (*Mobula japonica*), basking shark (*Cetorhinus maximus*), white pointer shark (*Carcharodon carcharias*), and Porbeagle shark (*Lamna nasus*). Observers have also recorded captures of sharks on fish catch forms. Fish catch data were not examined here to identify these records. While the shark bycatch data from the COD were included, they should not be regarded as complete, or used for estimation of total shark bycatch. In addition, any land birds recorded by observers were excluded, to restrict the dataset to seabirds.

2.3 Expert identification

Observers were instructed to retain all seabirds fatally caught for subsequent examination and identification via necropsy (by seabird experts contracted to Department of Conservation; e.g., Thompson 2010, Bell 2015). Each of these specimens was accompanied by a tag that includes the observer trip and fishing event numbers, so that the captures could be associated with the fishing effort data recorded by the observer. Some sea lion captures have also been retained for necropsy.

In addition to necropsies, experts also assessed photographs taken by observers to identify the species interacting with fishing activities, including fatal captures or captures of live animals that were subsequently released. Most of the photographs included a time stamp (recorded by the camera), and information on the fishing event (recorded on a note placed in the frame), allowing the linking of captures to the associated record in the COD.

Information from the expert reviews was used to assess the identifications recorded by the observer. Captures recorded in the COD were updated to incorporate additional information from the necropsies that had not already been included. These updates included corrections of species identifications, and the addition of any additional captures that were identified from necropsy records and from the expert review of photographs taken by observers.

Updates to the bycatch data were also made by expanding any multiple capture events that were mistakenly reported as single captures. Although observers were required to fill in separate rows of the non-fish bycatch forms for each individual animal observed caught, sometimes a single row was used for multiple capture events. This discrepancy was detected by reviewing observer comments that indicated more than one individual was caught, or when photographs or necropsies documented more than one individual in a capture event. Data from these multiple capture events were expanded to obtain the

number of individual captures.

Department of Conservation reviewed all cetacean captures, seeking an expert opinion on the identity of the captured animals when there was uncertainty. During the review of the observer remarks, species identifications were also changed if the remarks indicated a more specific identification than had been coded by the observer.

2.4 Imputation of seabird identifications

The data preparation used an imputation process to improve the identifications of seabird captures that were not necropsied or identified via photographs. The imputation was carried out to minimise the proportion of captures that were identified with generic codes (instead of species or sub-species specific codes). Generic codes describe a group of seabirds (e.g., “petrel”, “albatross”, “small albatross”, “large seabird”, “seabird”) instead of identifying a single taxon, and are used when observers are unsure about species identifications. Although generic codes avoid errors introduced by observers guessing species identifications, they limit the use of the data when estimating bycatch numbers at the species level.

The imputation worked as follows. First, a key was generated for each capture event, based on observer data. On the first pass, the key was a composite of the following identifiers: trip number, fishing year, observers’ names, target fishery, fishing method, area, and observed species code. For each bird capture that had not been necropsied, all capture events with the same key were selected. From the matching observed captures where a necropsy had been made, a record was chosen at random, and this identification was the imputed identification. If no matching capture events were found, or if none of the matching captures had been necropsied, then no imputation was made at that level, and the observers’ species identification was retained.

The imputation process was repeated, in a total of four passes. At each pass, the key was made more general, dropping the requirement that the trip number matched, then that the fishing year matched, then that the observers’ names matched, and then that the target fishery matched. On the final pass, the observed captures used for imputation were required to match on the fishing method, area, and the species code recorded by the observer.

3. RESULTS

3.1 Observer fishing effort data

The reconciliation resulted in a number of observer trips that were not included or had missing information (Table 1). Trips that were entirely outside New Zealand’s EEZ were not included. In addition, there were many observer trips that had records in the observer trip record but that had no fishing associated with them. This mismatch may have been because the trip was cancelled, or because no fishing was observed. A number of trips had missing information, such as missing fishing effort data. Following preparation of the data during 2015, it was found that there were observer trips that were included in the observer trip record, but that had no associated effort or capture data. A review of all these trips was undertaken by MPI staff. Where possible, the missing paper forms or data were located and the COD was updated. The impact of this update was evident in data from the 2013–14 fishing year, with the number of protected species capture trips increasing from 289 to 298 (an increase of 3%). Missing trips from previous years were also located.

There was one trip in 2014–15 that was classified as a research trip of seabird bycatch mitigation (Goad & Williamson 2015). This trip did not involve the collection of fishing effort data or observations of non-fish bycatch and so is not included in the COD.

Occasionally, the effort data collected by observers is not entered into the COD. Where possible, these records were reconstructed using fisher-reported effort from the *warehouse* database by linking the *warehouse* data to vessel and trip dates from the observer trip record database (Table 2). This linking allows some

Table 1: Number of trips reconciled from the observer trip record database in the data preparation of protected species captures. The number of trips with records in the protected species captures (PSC) database, in the current extract and in 2015. Trips were classified according to reasons for not including them or for missing information. Cancelled: observer trip did not occur; extra-territorial: observer trip was entirely outside New Zealand’s Exclusive Economic Zone; no sea days: the observer was unable to get time onboard the vessel; research trip: observer trips that involved research activities and did not report protected species captures; other method: the fishing method was not included (i.e., no trawl, longline, set net, or purse seine on the trip); in the COD (Centralised Observer Database): data in loading tables but not in the main COD; not in COD: data missing from the database; no vessel assoc.: fishing vessel not known; no catch effort: missing effort data.

	Observer trip record	Not included							Missing			
		PSC	PSC (2015)	Cancelled	Extra-territorial	No sea days	Research trip	Other method	In COD loading	Not in COD	No vessel assoc.	No catch effort
2002–03	122	107	107		13					2		
2003–04	164	154	154		7		1			2		
2004–05	155	146	146		6			1		1	1	
2005–06	134	124	124		10							
2006–07	181	172	171		6			2				1
2007–08	176	162	162		11		1	1		1		
2008–09	233	214	213	2	14	1		2				
2009–10	222	198	197	2	16			6				
2010–11	186	162	162	4	16			4				
2011–12	184	167	163	3	11	2		1				
2012–13	274	245	243		14	6	3	6				
2013–14	326	298	289	7	13	4		4				
2014–15	270	251		1	14	2	1		1			

Table 2: Summary of 11 observer trips from the observer trip record where effort data were missing from the Centralised Observer Database, but could be reconstructed from fishing effort data in the *warehouse* database. Fishing methods included set-net (SN), bottom-longline (BLL), and trawl fisheries (DoC, Department of Conservation).

Trip start	Stations	Events	Method	Target	Observer trip record note
03 Nov 2006	1–20	20	SN		
12 May 2009	1–3	3	BLL	Snapper	Nomad data missing-email from CL to CD and DF 23Nov11
12 Apr 2010	1–19	19	BLL	Snapper	Nomad data missing-email from CL to CD and DF 23Nov11
17 Jan 2012	1–46	46	Trawl	Flatfish	Issues with transferring data from NOMAD to PC, data unavailable
13 Feb 2012	1–54	54	Trawl	Flatfish	Issues with transferring data from NOMAD to PC, data unavailable
22 Mar 2012	1–12	12	Trawl	Inshore	Issues with transferring data from NOMAD to PC, data unavailable
19 May 2012	1–44	44	Trawl	Middle depths	Issues with transferring data from ODEAS to PC, data unavailable
02 Jul 2012	1–124	124	Trawl	Hoki	Issues with transferring data from ODEAS to PC, data unavailable
06 Aug 2012	1–106	106	Trawl	Hake	Issues with transferring data from ODEAS to PC, data unavailable
31 Jan 2013	1–73	73	BLL	Minor targets	BLL experimental trip for DoC, looking at bycatch mitigation
22 Mar 2013	1–41	41	BLL	Snapper	BLL experimental trip for DoC, looking at bycatch mitigation

captures without observer-reported effort data to be assigned a position and date. All but two of these trips were trips where the data were collected on electronic devices, and the data were either lost or were corrupted in some way. The remaining two trips were not regular observer trips, but were trips researching seabird bycatch mitigation (Goad & Williamson 2015). No fishing effort data from these trips were collected by the observer.

For one trip in the 2014–15 fishing year, there was no documentation available. As this trip left port on 30 September 2015, and all captures on this trip occurred in the 2015–16 fishing year, they were not included in the current study. There were eight other trips with missing data, including the most recent one in 2007–08 (Table 1).

3.2 Protected species captures

3.2.1 Expanding of observed captures

The rows on non-fish bycatch forms are intended to record individual animals that were observed caught, but there were 22 instances where a single row was used for multiple seabird capture events. These multiple capture events were entered as single captures into the COD, but observer comments (e.g., “white-chinned petrel x 15”) or photographs taken by observers indicated that more than one bird was caught (see Table 3). Identification of these multiple captures increased the number of 22 grouped captures entered into the COD to 213 individual captures.

3.2.2 Missing captures

There were some errors between the recording of observed captures and the database record, including errors during the reporting of data on paper forms and during data entry in digital format. For example, transcription errors may occur, paper forms may get lost, or forms may get missed in the data entry process. For this reason, photographed and necropsied specimens provide valuable information relating to fishing events, revealing missing corresponding records in the non-fish bycatch forms and in the COD.

Using information from necropsy records or from examination of photographs, this data preparation found 125 observed captures that were not recorded in the COD. These captures were added to the list of observed captures extracted from the COD (Table 4). For 48 of these captures, the associated non-fish bycatch paper form was available in the COD’s loading tables (the z tables in the COD), providing additional information on the capture events. For the remaining 77 records, no associated form was found, and some information about the captures is, therefore, missing. This missing information includes

Table 3: Details of 22 multiple seabird capture events in different fisheries that were entered as individual captures into the Centralised Observer Database (COD), but were identified as involving more than one individual in the current data preparation. The multiple captures were considered single captures in the COD as they were entered on a single row of the non-fish bycatch form. Fishing methods included trawl, bottom-longline (BLL), and surface-longline (SLL) fisheries.

Date	Method	Target species	Area	Captured species	No. birds
20 Jan 2010	Trawl	Inshore	Stewart Snares Shelf	Fairy prion	10
20 Jan 2010	Trawl	Inshore	Stewart Snares Shelf	Sooty shearwater	30
20 Jan 2010	Trawl	Inshore	Stewart Snares Shelf	Petrels, prions, and shearwaters	40
07 Oct 2010	Trawl	Hoki	Stewart Snares Shelf	Common diving petrel	5
19 Oct 2010	Trawl	Middle depths	Fiordland	Sooty shearwater	3
13 Feb 2011	Trawl	Scampi	Auckland Islands	White-chinned petrel	15
26 Feb 2011	Trawl	Scampi	Auckland Islands	White-chinned petrel	10
09 Feb 2012	Trawl	Squid	Stewart Snares Shelf	White-chinned petrel	3
05 May 2012	SLL	Southern bluefin	Fiordland	Southern Buller's albatross	2
19 Sep 2012	Trawl	Southern blue whiting	Subantarctic	Seabirds	38
09 Nov 2012	Trawl	Hoki	Chatham Rise	White-chinned petrel	2
19 Jan 2013	Trawl	Squid	Stewart Snares Shelf	Sooty shearwater	2
18 Feb 2013	Trawl	Middle depths	Stewart Snares Shelf	NZ white-capped albatross	2
23 Feb 2013	Trawl	Middle depths	Stewart Snares Shelf	White-chinned petrel	3
13 Mar 2013	Trawl	Mackerel	Stewart Snares Shelf	White-chinned petrel	3
18 Mar 2013	Trawl	Mackerel	East Coast South Island	Fairy prion	3
10 Feb 2014	BLL	Snapper	Northland and Hauraki	Flesh-footed shearwater	25
10 Feb 2014	BLL	Snapper	Northland and Hauraki	Shearwaters	2
01 Mar 2014	Trawl	Squid	Stewart Snares Shelf	Sooty shearwater	2
22 Sep 2014	Trawl	Southern blue whiting	Subantarctic	Grey petrel	2
11 Oct 2014	Trawl	Hoki	Stewart Snares Shelf	Common diving petrel	2
27 Jan 2015	Trawl	Mackerel	Taranaki	Fairy prion	9

the capture method (e.g., capture in net, on warps, or hooked), which is used in other studies such as the estimation of cryptic mortality in seabird risk assessments (Richard & Abraham 2013).

Improved scrutiny of photographs and of capture records made the detection of captures missing from the COD more likely in recent years. Some missing or grouped captures prior to 2006–07 may remain undetected, as the captures added to the list from the COD only occurred between 2006–07 and 2014–15 (Table 5). It is possible that the apparent capture rate might be slightly higher during these years due to these additional captures, without reflecting a change in fisheries practices. Nevertheless, the small number of additional captures in comparison to the total number of captures means that this effect is likely to be small.

In 2014–15, there were no records that needed to be expanded because multiple capture events were recorded in a single field on the non-fish bycatch forms (at least those forms in the reporting part of the COD). There were 30 captures recorded from one observed squid jigger trip that are in the COD loading tables. These captures were not included in the final dataset, however, as no squid jiggering observer effort was available.

Overall, MPI's data reconciliation processes identified that less than 2% of observed protected species captures between 2002 and 2015 were not recorded in the COD (N. Walker, pers. comm.).

3.2.3 Capture method

Observers' remarks were reviewed to identify deck captures, warp strikes, and birds that were struck by the warps but not recovered on-board the vessel (these were recorded as "warp lost") (see examples of the classification of the capture method from the remarks in Table 6). The review of the remarks also identified captures associated with mitigation devices, and with the paravane wire. Incidents recorded by observers on the non-fish bycatch form, but which did not meet the definition of a capture were also identified (for example, one observer recorded two swallows perched on the railings on the non-fish bycatch form).

The distinction between deck captures and records that were not considered captures was somewhat arbitrary, as observers often provide only limited information in the remarks. Where birds are recorded as landing on the deck, they are recorded as deck captures, unless the remarks indicate that the birds left unharmed, or were assisted off the vessel by crew or observers. Deck captures are excluded from summaries of seabird bycatch and from estimation of total bycatch. Many of the captures that were assigned to a capture method of "other" were birds that had been struck by a gaff while fish were being retrieved on-board the vessel. There were occasional unusual captures that also had a capture method of "other"; for example, one bird got caught in fish-processing equipment in the factory. Records that are classified as "not a capture" are not considered further in the reporting here. These records included animals that climbed on-board the vessel, rode on-board on fishing gear, were seen dead in the water, and that surfaced in the moonpool (or hauling well) of longline vessels.

Most changes to capture methods following review of the remarks involved net and deck captures in trawl fisheries (Table 7). There was also a large number of records that were set to a capture method of "unknown". These records were typically where information was insufficient to determine the capture method from the remarks. The capture method of "line" was used on older surface-longline forms, and included animals that had been both hooked and tangled. New capture methods that were created as part of the analysis of observer remarks included "warp lost", "mitigation device", and "paravane". The latter two methods were associated with a relatively small number of captures. The captures on mitigation devices are recorded, as they may indicate potential shortcomings in the design of the mitigation devices. In addition, paravane captures were included, as this capture method used to be a main source of mortality in trawl fisheries (Bartle 1991).

All capture records of seabirds in trawl fisheries between 2002–03 and 2014–15 with a missing capture method were reviewed (Table 8). There was a marked change in the number of captures by each method,

Table 4: Summary of captures (by species) that were added to captures in the Centralised Observer Database (COD) during the current data preparation. These additional captures resulted from the expanding of multiple capture events that were initially recorded as single captures (Expanded), from non-fish bycatch forms that were available in the COD loading tables (COD load tables), and from necropsy or photograph identifications that had no corresponding record in the COD.

Species	Expanded	COD load tables	Identifications		Total
			Necropsy	Photographs	
Sooty shearwater	37	26	2	4	69
White-chinned petrel	35	2		7	44
Petrels, prions, and shearwaters	40				40
Fairy prion	22	1		7	30
Snares Cape petrel	27				27
Flesh-footed shearwater	22		1		23
NZ white-capped albatross	2	1	2	16	21
Antarctic prion				18	18
Grey petrel	13				13
Common diving petrel	7			4	11
Southern Buller's albatross	2	2	1	1	6
Buller's shearwater	2	3			5
Salvin's albatross			3	1	4
Southern black-backed gull		3			3
Black petrel		2		1	3
Fluttering shearwater	3				3
Black-bellied storm petrel		1		2	3
NZ fur seal		2			2
NZ white-faced storm petrel		1		1	2
White-headed petrel				2	2
Cape petrels		1			1
Grey-backed storm petrel				1	1
Grey-faced petrel				1	1
Cook's Petrel		1			1
Fulmars, petrels, prions and shearwaters	1				1
Prions				1	1
Spotted shag				1	1
Shearwaters		1			1
Westland petrel		1			1
All species	213	48	9	68	338

Table 5: Summary of captures (by fishing year) that were added to captures in the Centralised Observer Database (COD) during the current data preparation. These additional captures resulted from the expanding of multiple capture events that were initially recorded as single captures (Expanded), from non-fish bycatch forms that were available in the COD loading tables (COD load tables), and from necropsy or photograph identifications that had no corresponding record in the COD.

Fishing year	Expanded	COD load tables	Identifications		Total
			Necropsy	Photographs	
2006–07	0	2	0	0	2
2007–08	0	0	0	1	1
2008–09	0	4	0	0	4
2009–10	80	0	0	0	80
2010–11	33	0	0	25	58
2011–12	43	6	1	2	52
2012–13	15	2	5	30	52
2013–14	31	4	2	3	40
2014–15	11	30	1	7	49
All years	213	48	9	68	338

with a decrease in the proportion of warp captures following the introduction of mandatory warp mitigation devices on trawl vessels longer than 28 m in January 2006 (Department of Internal Affairs 2006). In 2004–05, 26.3% of observed seabird captures in trawl fisheries were on trawl warps, compared with 3.7% in 2014–15. There was a high proportion of captures with an unknown capture method in earlier years, because observers were not formally recording the capture method. There were many remarks indicating that captured seabirds were first seen in the pounds (where the fish are tipped from the trawl before processing). These remarks are likely to be net captures; however, without more detailed information, it was not always clear whether the birds were caught in the net or the warps. For this reason, these captures were assigned to the capture method of “unknown”.

3.2.4 Exclusion of records

Following the preparation of the observer effort data and the classification of the capture method, some captures recorded by observers were excluded from the dataset (Table 9). In particular, a total of 1226 captures that occurred between 2002–03 and 2014–15 were animals that landed on deck, or collided with the vessel structure, and these records were removed from the final dataset. Additionally, a number of fishing events were part of research experiments, for example, testing the efficacy of bycatch mitigation devices. As these fishing events do not reflect standard fishing practices, 198 captures that occurred during these experiments were also excluded from the dataset. Captures involving animals that were caught in a decomposed state were considered to be dead before fishing occurred, and were also excluded (87 captures). Birds that were observed to have struck the trawl warps, but were not recovered on-board the vessel were also excluded (78), even if they had clearly been killed. These observations were excluded because observers do not routinely watch the warps during the haul, and so the recording of these captures was no consistent. A number of animals (60 records) were considered not to be bycatch events. These exclusions were animals that surfaced in the moonpool or hauling well of surface-longline vessels, animals that climbed on-board the vessel, and animals that were seen dead in the water without a capture event being observed. There were 29 captures that were excluded because they could not be linked to a station, and so could not be associated with fishing effort; 9 captures of land birds were excluded; and 5 captures that were outside New Zealand’s EEZ.

In total, 1728 captures were excluded from the captures that occurred between 2002–03 and 2014–15. The resulting final dataset included 8921 captures for the fishing years between 2002–03 and 2014–15.

While some captures have been recorded by observers on vessels using other fishing methods, many of these have been deck captures. For example, six seabird captures were reported from a single observer trip that included cod potting. All these captures, however, were deck captures with the birds being

Table 6: Classification of protected species capture methods based on the remarks of fisheries observers. For each of the selected capture methods, the table includes a sample of five of the remarks that were associated with that method (verbatim, but long remarks are truncated).

Capture method	Remarks
Deck	<ul style="list-style-type: none"> - LANDING ON DECK. - VESSEL DISCARDING OFFAL, SEVERAL THOUSAND BIRDS FOLLOWING. 4 OF THE BIRDS FOUND THEIR WAY INTO THE PROCESSING AREA. THE BIRDS HAD FOUND THEIR WAY ... - XST = WHITE FACED STORM PETREL. ALL BIRDS APPEARED TO STRUGGLE WITH FLIGHT OVER THE VESSEL. SOME LANDED ON TRAWL DECK OR FLEW INTO SUPER STRUCTURE ... - THE BIRD LANDED ON TOP OF CODEND AS IT WAS BEING HAULED ALONG THE DECK PRIOR TO TIPPING. - RELEASED ALIVE - CONFUSED, DISORIENTATED BUT UNHARMED. - LANDING ON DECK.
Mitigation device	<ul style="list-style-type: none"> - JUVENILE XAL CAUGHT ON TORI LINE AND DRAGGED UNDER, RELEASED ALIVE. LTS. SEEN BY OBSERVER DURING WARP STRIKE OBS. - BIRD TANGLED IN TORI LINE - RETRIEVED AND RELEASED UNHARMED. - CAUGHT IN TORI LINE. - TORI LINE ENTANGLEMENT, RELEASED BY CREW. - XWC DRAGGED UNDER BY TORI LINE FOR APPROX 30 SECONDS, RELEASED ALIVE, LTS. XCP DRAGGED UNDER BY TORI LINE FOR APPROX 7 MINUTES. RELEASED ALIVE WIT ...
Other	<ul style="list-style-type: none"> - 1. ACCIDENTLY STRUCK XKM WITH POLE GAFF FROM HAUL DOOR. XKM WAS PICKING AT LOST LIN ON WATER. XKM SAT ON WATER BRIEFLY THEN FLEW OFF. FISH WAS ABA ... - GIANT PETREL WAS WITHIN 4M RADIUS OF LONG-LINE EXIT POINT, WHEN CREW MEMBER REACHED DOWN WITH LONG-GAFF TO RETRIEVE LOST LING. PETREL WAS GAFFED O ... - AN XCP WAS HIT BY A GAFF WHILE CREW MEMBER WAS ATTEMPTING TO RETRIEVE A FLOATER. IT WAS KILLED INSTANTLY. - WHILE ATTEMPTING TO RETRIEVE A FISH, AN XSA WAS STRUCK BY A THROWING GAFF. THE BIRD WAS HIT ON THE WING WHICH APPEARED TO BE BROKEN. IT WAS UNABLE ... - BIRD WAS HOOKED ACCIDENTLY BY THROWING GAFF WHILST RETRIVEING A LINE. BIRD DID NOT APPEAR TO SUFFER LIFE THREATING INJURIES. IT WAS SEEN TO FLY AWAY.
Paravane	<ul style="list-style-type: none"> - CAUGHT ON PARAVANE 0245HRS 45 21'S; 176 08'W. - CAUGHT ON PARAVANE, LOST OVERBOARD. - REPORTED BY MATE - CAUGHT ON PARAVANE. - CAUGHT ON PARAVANE. - TANGLED IN PAREVANE CABLES PHOTO 55 56.
Warp lost	<ul style="list-style-type: none"> - CAUGHT ON WARP ONE. THEN DROWNED. NOT RECOVERED. - BIRD CAUGHT ON DOOR FELL OFF AS NET WAS HAULED. - BOTH BIRDS OBSERVED DROWNED ON SPRAG ON PORT TRAWL WIRE. FELL OFF ON LEAVING THE WATER SO NOT LANDED. XWM1 - OBSERVED ON PORT HAUL DURING VESSEL T ... - XWM1 OBSERVED DROWNED ON PORT WARP DURING WARP - STRIKE OBS. CAME FREE AFTER SMALL ADJUSTMENT TO TRAWL DEPTH BROUGHT IT TO THE SURFACE. NOT LANDED ... - BOTH BIRDS KILLED AS A RESULT OF WARP STRIKE. BIRDS WERE LOCATED AROUND EYERING AT BASE OF WARP, HOWEVER WHEN PORT DOOR SURFACED BOTH FELL OFF AND ...
Warp or door	<ul style="list-style-type: none"> - XSB IS LABELED AS 08 AS A MISTAKE, WAS ROUGH AND DARK, WITH ALOT TO DEAL WITH. DID MY BEST, SORRY. SOME OF XSL ARE IN PIECES, BUT TRIED TO PLACE A ... - BIRD CAUGHT ON PORTSIDE WRAP. CAME THROUGH THE BLOCK. BIRD SCARIER NOT DOWN THIS SIDE. BROKEN. - FOUND ON STARBOARD WARP DURING IN-HAUL. VERY FOGGY AT HAUL TIME. SET TOOK PLACE AT NIGHT 0540 NZST. PHOTO 27 + RETAINED. - BOTH XSY CAUGHT ON SPRAGS ON STBD WARP. VESSEL DISCHARGING OFFAL DURING THE TOW. 1 XSH, CAUGHT IN THE NET, DEAD. - XWM 1 CAUGHT ON WARP DURING TURN, RETAINED BY CREW. XWM 2 PROBABLY CAUGHT DURING HAULING AT 2135HRS 48 50.6S 166 42.2E.
Unknown	<ul style="list-style-type: none"> - FOUND BY CHIEF TRAWLMASTER, GIVEN TO OBS. RELEASED INTO THE NIGHT. - OBSERVED ON DECK DURING HAULING. HAD A CABLE DROPPED ON IT, MOST LIKELY INJURING IT. RELEASED OVERBOARD ALIVE. CHANCES OF SURVIVAL UNKNOWN. - ALL THAT WAS LEFT OF THIS BIRD WAS ONE GREY FOOT, MOST LIKELY THAT OF A MOLLYMAWK, A BRESTBONE, SOME WING BONES AND SOME BLACK AND WHITE FEATHERS ... - FOUND DEAD ON DECK BY CREW. SAMPLE #1. - SMALL AMOUNTS OFFAL GOING OVERBOARD WHILST HAULING. MAINLY JUST DECK WASH FROM OVERBOARD PUMPS VSH HAS MEAL PLANT SO NOT MUCH GOING OVER. MAY HAVE ...
Not a capture	<ul style="list-style-type: none"> - FLOATING IN WATER, UNABLE TO RETAIN. - RELEASED ALIVE. RODE CODEND ABOARD. - BIRD SWAM UP THRU MOONPOOL - NETTED AND RELEASED ALIVE. - BIRD SURFACED IN MOONPOOL. CAUGHT WITH A NET. WAS RELEASED UNHARMED. - DEAD IN WATER. GAFFED ON BOARD. (BLUE PENGUIN).

Table 7: Number of protected species captures by capture method for different fishing methods between 2002–03 and 2014–15. Also shown is the numbers of captures for which the capture method changed following review of the remarks of the fisheries observers. Data include records that had no information of the capture method (Missing), and where the capture method was recorded by the observer as unknown. Fishing methods included trawl, bottom-longline (BLL), surface-longline (SLL), set-net (SN), purse-seine (PS), and other fisheries.

Capture method	Total captures	Changed method	Captures by fishing method					
			Trawl	BLL	SLL	SN	PS	Other
Net	5 183	916	5 045	0	0	112	26	0
Deck	1 234	649	988	214	7	10	7	8
Hook	1 040	72	0	396	642	0	0	2
Missing	954	0	583	343	0	12	16	0
Warp or door	688	321	688	0	0	0	0	0
Line	608	0	0	0	608	0	0	0
Unknown	490	402	451	32	4	0	3	0
Warp lost	78	78	78	0	0	0	0	0
Tangled	59	4	0	18	41	0	0	0
Other	49	12	33	15	0	1	0	0
Mitigation device	37	37	33	4	0	0	0	0
Paravane	22	22	22	0	0	0	0	0

Table 8: Number of seabird captures associated with different capture methods in trawl fisheries, by fishing year between 2002–03 and 2014–15. Data are shown as included or excluded from the current data preparation of protected species captures.

Fishing year						Included		Excluded	
	Net	Warp or door	Paravane	Mitigation	Other	Unknown	Deck	Warp lost	
2002–03	131	59	3			68	40	5	
2003–04	127	71	1			54	41	8	
2004–05	224	131		2		142	89	31	
2005–06	251	48	2	4		41	52	6	
2006–07	171	18		1		20	35	3	
2007–08	195	23	2	5	4	11	75	4	
2008–09	391	59		7	2	6	53	9	
2009–10	189	48	9	1	1	18	189	1	
2010–11	330	16		1		18	60	1	
2011–12	176	62	1	1	2	7	69		
2012–13	614	63	2	3	1	26	95		
2013–14	393	66	1	1	1	19	111	8	
2014–15	570	23	1	7	4	16	77	2	

Table 9: Records of observed protected species captures in New Zealand commercial fisheries that were excluded from the final dataset during data preparation, by fishing year between 2002–03 and 2014–15. Exclusions included records of seabirds landing on the deck or colliding with vessel structures (Deck), captures recorded during mitigation research trips (Research), animals in a decomposed state at the time of capture (Decomposed), seabirds caught on trawl warps but not brought on-board the vessel (Warp lost), records that were determined from observer remarks to not be bycatch events (Not bycatch), records that could not be linked to fishing effort (No station), records of land birds (Land birds), and captures in extra-territorial waters (ET). For each fishing year, the table also indicates the number of protected species captures remaining in the database.

Fishing year	Exclusions								Final
	Deck	Research	Decomposed	Warp lost	Not bycatch	No station	Land birds	ET	
2002–03	176	0	1	5	41	0	1	1	795
2003–04	58	58	5	8	1	0	1	0	552
2004–05	106	61	8	31	1	0	1	2	770
2005–06	63	75	3	6	3	0	3	0	608
2006–07	42	0	6	3	0	0	0	0	578
2007–08	76	4	11	4	1	0	0	0	506
2008–09	71	0	10	9	5	0	0	0	703
2009–10	206	0	5	1	2	0	0	0	597
2010–11	66	0	15	1	0	1	0	1	566
2011–12	69	0	2	0	2	1	2	0	451
2012–13	95	0	11	0	2	16	1	0	974
2013–14	118	0	7	8	1	4	0	0	889
2014–15	80	0	3	2	1	7	0	1	932
All years	1 226	198	87	78	60	29	9	5	8 921

recorded as landing on the vessel and being assisted off alive and uninjured. In the two most recent fishing years, 2013–14 and 2014–15, there were five observer trips on two Japanese squid jiggers. To date, there are no effort data from these trips available, but non-fish bycatch records have been added into the COD’s loading tables for three of these trips. These data record incidental captures of 32 seabirds (black-bellied storm petrel, unidentified shearwaters (2), fairy prion, New Zealand white-faced storm petrel, sooty shearwater (25), Cook’s petrel, and New Zealand white-capped albatross). Only the captured Cook’s petrel was identified by an autopsy. There were four other captures that were not deck captures and that had a different fishing method (other than trawl, longlining, purse seine, or set net). These were all seabird captures, and included a gadfly petrel and an unidentified petrel caught while fishing with dropper or Dan lines in 1996–97 and 1997–98, respectively, and an Australasian gannet and a flesh-footed shearwater caught during 2013–14 while trolling for albacore. The 2013–14 trolling captures were included in the final dataset, as the vessel also carried out bottom longlining and set-net fishing on the same trip.

3.3 Expert identification

3.3.1 Identifications via necropsy and photographs

The identification of captured species can be challenging for observers, especially for seabirds, due to the diversity of species and the visual similarities between some of them. Expert identification from necropsies and the examination of photographs reduces errors in the identifications.

In addition to the 3468 expert identifications already included in the COD, more recent expert seabird identifications (carried out by Wildlife Management International; WMIL) from both necropsies and photographs were also added to the dataset (see summary in Table 10). These recent identifications consisted of 1532 necropsies of captured seabirds that occurred between 2010–11 and 2014–15, and examinations of 776 photographs taken between 2004–05 and 2014–15. The COD extract used for making this dataset (date 8 April 2016) had no WMIL seabird identification data from the 2013–14 or 2014–15 fishing years, and few expert identifications based on photographs were included in the COD extract.

Table 10: Summary of identifications carried out by Wildlife Management International (WMIL) of seabird captures, by fishing year between 2002–03 and 2014–15. Included are the total number of seabird captures identified by WMIL, the number of seabird captures for which the WMIL identification was included in the extract of the Centralised Observer Database (COD), the total number of WMIL seabird identifications (some captures have multiple identifications), the number of identifications from necropsy and from photographs, and the number of identifications that could not be linked to (or used to create) a capture record.

Year	Captures		WMIL identifications			
	WMIL	In COD	Total	Necropsy	Photo	Unlinked
2002–03						
2003–04						
2004–05	3		3		3	
2005–06	18		18		18	
2006–07	100	39	100		100	
2007–08	52	29	53		53	1
2008–09	48	6	48		48	
2009–10						
2010–11	381	199	384	206	178	2
2011–12	277	164	281	196	85	
2012–13	512	332	576	448	128	2
2013–14	411		469	346	123	3
2014–15	364		376	336	40	1
All years	2 166	769	2 308	1 532	776	9

Table 11: Summary of methods used to link Wildlife Management International seabird identifications (from necropsies or photographs) to capture records. Included are the number of records that were directly linked as they matched (Full), partially matched (Partial), matched apart from a date discrepancy of one day (Full, date out by one), were matched after expanding multiple capture events reported as single captures or that were otherwise created (Created from identification data), were matched after manual corrections of observer records (Manually linked), or could not be linked to (or used to create) a capture record.

Linking	Captures
Full	1 368
Partial	397
Full, date out by one	235
Created from identification data	182
Manually linked	117
Unlinked	9
Total	2 308

Of the 2308 recent seabird expert identifications, 1368 could be directly linked to the corresponding capture record in the COD. For these records, the trip number, the station number, the specimen number, the capture date, the species identification (by the observer), and the live status all matched (Table 11). In 235 other cases, all fields matched, but the capture date was different by one day. This discrepancy can occur when the dates of the start and the end of the fishing event are different. An additional 397 identifications were linked through partial matching, i.e., the trip and station numbers matched, with various combinations of other fields. A total of 182 captures were detected in the recent expert identifications, when observer records indicated a single capture, but the number of animals returned for necropsy or evident in photographs highlighted that more than one individual was caught. These identifications were linked using the original single capture record. For another 117 identifications, the linking involved manual corrections of the observer record, mostly of the specimen number, but also of errors in capture dates, trip, or station numbers. Despite the effort to link identifications to observed fishing effort and observed captures recorded in the COD, nine identifications could not be linked. These unlinked captures all involved seabirds, and lacked crucial information such as trip or station numbers, or they were allocated to fishing events that were not recorded in the COD.

The linked identifications provided information about 2166 unique captures (some captures were identi-

Table 12: Summary of protected species capture records (by fishing year) from the current data preparation, including records added to existing data held in the Centralised Observer Database (COD), species identifications by experts that were initially included in the COD or added in the present study, the percentage of identifications confirmed by experts, and changes to identifications made by observers following expert review.

Fishing year	Capture records			Species identifications from experts				Changes in identification	
	COD	Added	Total	COD	Added	Total	%	Total	%
2002–03	1 020	0	1 020	493	0	493	48.3	95	19.3
2003–04	683	0	683	348	0	348	51.0	109	31.3
2004–05	980	0	980	360	3	363	37.0	111	30.6
2005–06	764	0	764	371	18	389	50.9	88	22.6
2006–07	626	2	628	287	61	348	55.4	89	25.6
2007–08	602	1	603	249	23	272	45.1	72	26.5
2008–09	794	4	798	382	43	425	53.3	134	31.5
2009–10	844	0	844	274	0	274	32.5	109	39.8
2010–11	625	25	650	203	180	383	58.9	73	19.1
2011–12	518	9	527	170	109	279	52.9	104	37.3
2012–13	1 062	37	1 099	336	236	572	52.0	114	19.9
2013–14	1 020	9	1 029	2	463	465	45.2	90	19.4
2014–15	1 018	38	1 056	0	372	372	35.2	92	24.7
All years	10 556	125	10 681	3 475	1 508	4 983	46.7	1 280	25.7

fied by both necropsies and photographs). For these captures, the observer identifications were updated with the subsequent identifications by experts, with the final identification from the necropsy if possible, or from photograph examination otherwise. The identification made by the observer was confirmed by experts in 1704 cases, with corrections involving 462 cases. This finding indicates that 21.3% of identifications by observers were incorrect, highlighting the importance of necropsies and photographs.

The species identifications of the corresponding captures in the COD were updated from the recent expert identifications (see summary of these updates in Table 12). Of the 10 681 captures that occurred between 2002–03 and 2014–15, 1508 expert identifications were added to the 3475 expert identifications already included in the COD (including expanded captures; see section 3.2.1). This update resulted in a total of 4983 captures for which species identifications were reviewed by experts, representing 46.7% of all captures between 2002–03 and 2014–15. Between 2005–06 and 2013–14, around 50% of all captures have been reviewed in each year by experts; however, in 2014–15, this percentage fell to 35.5% of all captures. These updates (Table 12) included marine mammal captures (which are not routinely necropsied), and live captures. Further investigation of the data showed that, for seabirds, over 93% of dead captures had an expert identification in each fishing year since 2010–11, with 96.5% of dead seabird captures being identified by experts in 2014–15. In 2010–11, over 30% of live seabird captures were identified from photographs; however, in 2014–15, only 12 live bird captures (3.5% of all live bird captures) were identified from photographs.

In total, 25.7% of the captures that were identified by experts resulted in a change to the identification made by observers. Most of the captures that were identified by experts were seabirds. For example, of a total of 4097 captures in the final dataset for the period between 2002–03 and 2014–15 that were necropsied, all but five captures were seabirds. Of a total of 574 captures in the final dataset for the period between 2002–03 and 2014–15 that had a photographic identification, 483 were seabirds.

3.3.2 Manual changes to identifications

In addition to the routine review carried out as part of the necropsy work, the identification of all cetacean and sea lion captures since 1998–99 has been reviewed by Department of Conservation and MPI. A total of 10 marine mammals had their identifications changed as a result of this review (Table 13). In addition to these changes, one observer recorded a “decomposed dolphin” and a “decomposed dolphin head” on

Table 13: Changes to the identification of marine mammal capture records in the Centralised Observer Database (COD), following review by Department of Conservation and Ministry for Primary Industries staff.

Fishing method	Target	Date	Number of captures	Observer species	Correct species
Trawl	Jack mackerel	01/05/2003	1	Porpoise	Common dolphin
Trawl	Jack mackerel	09/11/2004	1	Bottlenose dolphin	Common dolphin
Trawl	Jack mackerel	02/12/2004	6	Risso's dolphin	Pilot whale long-finned
Trawl	Jack mackerel	23/11/2010	1	Dolphin (Unidentified)	Common dolphin
Trawl	Hake	19/05/2011	1	New Zealand sea lion	New Zealand fur seal

tows targeting squid during April 2013. These captures were both excluded from the analysis as the animals were decomposed, and review of the photographs identified them as southern bluefin tuna and not dolphins.

A total of nine seabirds had their identifications manually changed. In one case, this change involved a black petrel that was reported by the observer in the hoki trawl fishery in the Stewart-Snares shelf area. This capture was not necropsied. On the subsequent tow of the same trip, the vessel targeted silver warehou in the east coast South Island area, and the observer also reported a black petrel caught at that station. This capture was identified at necropsy as a white-chinned petrel. On this basis, the identification of the reported black petrel capture in the Stewart-Snares shelf area was changed to white-chinned petrel. The other seabird captures whose identifications were manually changed were birds that had not been necropsied or identified from a photograph, but where the observers' remarks indicated a more accurate identification than was indicated by the formal species code.

3.4 Imputation of seabird identifications

Among the 8921 captures in the fishing years between 2002–03 and 2014–15, 6621 captures were of seabirds. Only 4499 (68%) species identifications of these seabird captures were reviewed by experts. Based on the challenge for observers to correctly identify seabirds, evident in the finding that 1009 (22.4%) of species identifications were corrected following expert review, there is a considerable chance that seabird species involved in these incidental captures were misidentified.

To minimise the number of incorrect observer identifications and the proportion of captures that are identified with generic codes, an imputation process was carried out. This imputation aimed to improve the species identifications for captures of seabirds that were not necropsied or identified via photographs. The imputation process was repeated, in a total of five passes. At each pass, the key used to match observer identified captures with expert identified captures was made more general, dropping the requirement that the trip number matched, then that the fishing year matched, then that the observers' names matched, and then that the target fishery matched. On the final pass, the observed captures used for imputation were required to match on the fishing method, area, and the species code recorded by the observer (Table 14).

The most common species imputed were white-chinned petrel, New Zealand white-capped albatross, and sooty shearwater. This finding reflected the seabird captures that were most commonly observed (Table 15).

A total of 579 seabird capture identifications changed as a result of the imputation (Table 16). The changes involved mostly the captures that occurred prior to 2009–10, as there were only 12 changes in identification between 2010–11 and 2014–15. The proportion of captures with a generic code decreased from 9.7% after expert review to 2.7% following the imputation process (Table 16).

Table 14: Imputation rules applied by fishing year. The “best” matches agree on trip number, fishing year, observer identification, fishery, method, area, and observer-recorded species code. On each pass, the imputation loosens one criterion for matching observer-identified captures with expert-identified captures, in turn.

Fishing year	Match type					Total
	Best	- trip	- year	- observer	- fishery	
2002–03	16	1	1	18	9	45
2003–04	4	1	1	11	1	18
2004–05	17			18	3	38
2005–06	3		4	7	3	17
2006–07	2		1	6	3	12
2007–08	4			11	5	20
2008–09	48	1	3	15	5	72
2009–10	34		1	23	5	63
2010–11	9		5	13	2	29
2011–12	3	1	2	16	2	24
2012–13	17		2	64	5	88
2013–14	40		2	29	4	75
2014–15	23	16	7	29	8	83
All years	220	20	29	260	55	584

3.5 Comparison with previous data

The final dataset includes captures of a diverse range of seabird, marine mammal, shark and ray, and turtle taxa (Table 17). During the 2014–15 fishing year, the highest numbers of observed captures were of white-chinned petrel (295 captures), and New Zealand fur seal (176 captures).

Several substantial corrections were made during the process of preparing the current dataset, which identified errors in the previous dataset (which was used by Ministry for Primary Industries 2015 in summaries of interactions between protected species and fisheries). First, missing observer trips were identified. This correction caused some increases in the reported number of captures. For example, in 2013–14, there were two additional common dolphin captures that were on trips that had not been previously included in the data. Second, while preparing the previous dataset, seabird deck captures were inadvertently included in the final data, whereas they had been excluded in prior data preparations. In some cases, this correction led to fewer captures in the current dataset. For example, there were three additional black petrel captures in the 2013–14 fishing year in the dataset used by Abraham and Richard (2017). These three captures were all deck captures on a scampi trawl vessel, with the observer making the remark “returned alive by crew, no visible injuries, no photo”. Similarly, the decrease in the number of fairy prion captures in 2013–14 is due to the exclusion of deck captures. The third major change between the datasets involved corrections to the records from Wildlife Management International. In the previous dataset, these records were misinterpreted, and many records of seabird captures were assumed to have had their identification confirmed by photo identifications, when this assumption was not correct. In 2013–14, 99% of the seabird captures that were not necropsied were considered to have had their identity confirmed from photographs. In the current dataset, with the photograph identification records correctly applied, only 19% of the seabirds that were not necropsied had their identifications confirmed from photographs. Since their identifications were not confirmed, many of these records had their identifications changed by the imputation process. This process led to the largest changes in the dataset. For example, in 2013–14, the current dataset included 42 white-chinned petrel captures whose identification had changed to white-chinned petrel (29 captures changed from the Fulmars, petrels, prions and shearwaters group; six captures from the *Procellaria* petrels group; five captures from sooty shearwater; and two captures from the wandering albatrosses group). The change from wandering albatrosses to white-chinned petrel was likely owing to the similarity of the codes used by observers for the two species (XWA and XWC, respectively), which means that white-chinned petrel captures are occasionally entered into the COD as wandering albatross captures. As the imputation was applied to more capture records, there was a decrease in the number of captures associated with generic codes.

Table 15: Final identification for all seabird captures between 2002–03 and 2014–15. Included are the number of records updated by expert or imputed identifications, and the initial observer codes (with the number of records in parentheses).

Species	Code	Identifications		
		Expert	Imputed	Observer codes
White-chinned petrel	XWC	1 113	160	XPE(116), XPC(16), XXP(10), XSH(9), XBP(2), XWP(2), XWA(2), XSB(2), XSP(1)
Sooty shearwater	XSH	979	112	XPE(60), XXP(25), XSW(10), XBP(4), XST(3), XWP(2), XAL(2), XSS(2), XWC(1), XDP(1), XBM(1), XPM(1)
NZ white-capped albatross	XWM	952	103	XAL(32), XSY(26), XKM(14), XMA(7), XSA(6), XGA(5), XSL(5), XWC(4), XBP(2), XBM(1), XSH(1)
Cape petrel	XCC	32	42	XCP(42)
Salvin's albatross	XSA	295	35	XAL(22), XWM(6), XMA(3), XBM(2), XCI(1), XSL(1)
Southern Buller's albatross	XBM	439	23	XMA(6), XPB(4), XKM(4), XWM(3), XAL(3), XGM(1), XNB(1), XSL(1)
Campbell black-browed albatross	XCM	54	13	XKM(7), XMA(2), XSL(1), XSA(1), XWM(1), XGM(1)
Westland petrel	XWP	22	10	XPE(7), XWC(3)
Gibson's albatross	XAU	36	8	XWA(4), XAN(1), XRA(1), XAS(1), XAL(1)
Fairy prion	XFP	5	7	XPN(7)
Northern giant petrel	XNP	4	6	XTP(4), XSA(2)
Grey petrel	XGP	152	5	XPE(4), XSB(1)
Black petrel	XBP	48	5	XFS(2), XPE(2), XSH(1)
Grey-backed storm petrel	XGB	4	5	XST(4), XPE(1)
Flesh-footed shearwater	XFS	91	5	XSH(3), XBP(2)
Grey-faced petrel	XGF	26	4	XSH(3), XPE(1)
Antarctic prion	XPR	20	4	XPE(4)
Chatham Island albatross	XCI	24	4	XSY(2), XGM(1), XSA(1)
Snares Cape petrel	XCA	2	3	XCP(2), XBM(1)
Southern royal albatross	XRA	14	3	XWA(2), XAL(1)
Short-tailed shearwater	XTS	4	3	XPE(2), XSH(1)
Fluttering shearwater	XFL	6	2	XPE(1), XFS(1)
Prions	XPN	2	2	XFP(1), XDP(1)
Antipodean albatross	XAN	28	2	XWA(1), XSY(1)
Wandering albatrosses	XWA	2	2	XAL(2)
Fulmars, petrels, prions and shearwaters	XPE	9	1	XWC(1)
Black-browed albatross	XSM	6	1	XWM(1)
Common diving petrel	XDP	11	1	XPN(1)
NZ white-faced storm petrel	XWF	8	1	XST(1)
Albatrosses	XAL	12	1	XBM(1)
Large seabirds	XSL	1	1	XBM(1)
Small seabirds	XSS	1	1	XCP(1)

Table 16: Summary of seabird captures (by fishing year) after imputation of species identifications. The imputation process was applied to capture records that were not assessed by experts. Total number of observed captures, the number of identifications confirmed by experts, the number of captures for which a generic (species group) or specific (single species or sub-species) code was used for species identifications, and the type of seabird.

Fishing year	Total	Confirmed	Specificity		Species class			Identification changes
			Generic	Specific	Albatross	Other pelagic	Other	
2002–03	633	480	11	622	205	425	3	45
2003–04	379	292	7	372	230	145	4	18
2004–05	505	355	10	495	312	190	3	38
2005–06	427	323	25	402	117	307	3	17
2006–07	466	338	58	408	262	197	7	12
2007–08	317	243	13	304	113	200	4	20
2008–09	577	399	16	561	199	338	40	72
2009–10	477	267	9	468	228	241	8	63
2010–11	452	341	5	447	125	326	1	29
2011–12	322	233	3	319	203	119	0	22
2012–13	755	487	5	750	279	474	2	86
2013–14	623	395	5	618	210	408	5	73
2014–15	688	346	14	674	191	496	1	84
All years	6 621	4 499	181	6 440	2 674	3 866	81	579

Table 17: Summary of number of protected species captures by taxon for the 2014–15 and 2013–14 fishing years. Captures for the 2014–15 fishing year are from the current dataset, whereas the 2013–14 captures include the current dataset and the previous version (prepared in 2015, and used by Ministry for Primary Industries 2015). Also shown is the change in the number of captures of each taxon between the two datasets for 2013–14.

Taxon	Scientific name	2014–15	2013–14		
			Curr.	Prev.	Change
White-chinned petrel	<i>Procellaria aequinoctialis</i>	295	182	140	42
Sooty shearwater	<i>Puffinus griseus</i>	136	124	125	-1
New Zealand white-capped albatross	<i>Thalassarche cauta steadi</i>	81	81	77	4
Southern Buller's albatross	<i>Thalassarche bulleri bulleri</i>	55	60	60	
Salvin's albatross	<i>Thalassarche salvini</i>	46	57	51	6
Flesh-footed shearwater	<i>Puffinus carneipes</i>	17	41	50	-9
Grey petrel	<i>Procellaria cinerea</i>	8	14	13	1
Fulmars, petrels, prions and shearwaters	Procellariidae			40	-40
Black petrel	<i>Procellaria parkinsoni</i>	3	12	15	-3
Westland petrel	<i>Procellaria westlandica</i>	5	8	9	-1
Albatrosses	Diomedidae		2	15	-13
Buller's shearwater	<i>Puffinus bulleri</i>		7	7	
Common diving petrel	<i>Pelecanoides urinatrix</i>	5	1	3	-2
Mid-sized petrels & shearwaters	<i>Pterodroma, Procellaria & Puffinus</i> spp.	6		1	-1
Northern giant petrel	<i>Macronectes halli</i>	4	2	2	
Fairy prion	<i>Pachyptila turtur</i>	2	1	6	-5
Fluttering shearwater	<i>Puffinus gavia</i>		6	5	1
Giant petrels	<i>Macronectes</i> spp.	5			
Antarctic prion	<i>Pachyptila desolata</i>	2	3	1	2
Campbell black-browed albatross	<i>Thalassarche impavida</i>	2	2	1	1
Cape petrel	<i>Daption capense</i>	2	2	1	1
Gibson's albatross	<i>Diomedea antipodensis gibsoni</i>	2	2	1	1
Prions	<i>Pachyptila</i> spp.			7	-7
Black-browed albatross	<i>Thalassarche melanophris</i>	3			
Grey-faced petrel	<i>Pterodroma macroptera gouldi</i>	3			
Short-tailed shearwater	<i>Puffinus tenuirostris</i>		3	3	
Southern black-backed gull	<i>Larus dominicanus dominicanus</i>		4	2	2
Smaller albatrosses	<i>Thalassarche</i> spp.		1	4	-3
New Zealand white-faced storm petrel	<i>Pelagodroma marina maoriana</i>	2			
Procellaria petrels	<i>Procellaria</i> spp.			4	-4
Southern royal albatross	<i>Diomedea epomophora</i>		2	2	
Buller's albatross	<i>Thalassarche bulleri</i>	1		1	-1
Shearwaters	<i>Puffinus</i> spp.	1		1	-1
Australasian gannet	<i>Morus serrator</i>		1	1	
Chatham Island albatross	<i>Thalassarche eremita</i>		1	1	
Cormorants and shags	Phalacrocoracidae	1			
Great albatrosses	<i>Diomedea</i> spp.		1	1	
Grey-backed storm petrel	<i>Garrodia nereis</i>		1	1	
Northern Buller's albatross	<i>Thalassarche bulleri platei</i>		1	1	
Petrels, prions, and shearwaters	Hydrobatidae, Procellariidae & Pelecanoididae		1	1	
Royal albatrosses	<i>Diomedea sanfordi & D. epomophora</i>	1			
Storm petrels	Hydrobatidae			2	-2
Wandering albatrosses	<i>Diomedea exulans & D. antipodensis</i> spp.			2	-2
Cape petrels	<i>Daption</i> spp.			1	-1
Black-browed albatrosses	<i>Thalassarche melanophris & T. impavida</i>			1	-1
New Zealand fur seal	<i>Arctocephalus forsteri</i>	176	220	218	2
New Zealand sea lion	<i>Phocarctos hookeri</i>	8	4	4	
Spine-tailed devil ray	<i>Mobula japanica</i>	24	2	1	1
Basking shark	<i>Cetorhinus maximus</i>	5	5	5	
Porbeagle shark	<i>Lamna nasus</i>	2			
White pointer shark	<i>Carcharodon carcharias</i>		2		2
Common dolphin	<i>Delphinus delphis</i>	24	32	30	2
Dusky dolphin	<i>Lagenorhynchus obscurus</i>	2			
Bottlenose dolphin	<i>Tursiops truncatus</i>	1			
Hector's dolphin	<i>Cephalorhynchus hectori</i>		1	1	
Green turtle	<i>Chelonia mydas</i>	1			
Leatherback turtle	<i>Dermochelys coriacea</i>	1			

4. DISCUSSION

This report is a detailed summary of the preparation of protected species bycatch data, which is the main source of information on the impacts of New Zealand fisheries on protected species. These data are made openly available online (currently through <http://data.dragonfly.co.nz/psc>). The data are released under a creative commons license, allowing anyone to explore and carry out their own analysis of the dataset.

In the context of bycatch assessments, the data will be used for estimations of the total capture of seabirds, New Zealand fur seal, New Zealand sea lion, and common dolphin in commercial trawl and longline fisheries. In addition, the seabird bycatch data underpin the assessment of the risk of fisheries-related mortalities to seabirds in New Zealand waters (Richard & Abraham 2015), which supports the “National Plan of Action – 2013 to reduce the incidental catch of seabirds in New Zealand fisheries” (NPOA) (Ministry for Primary Industries 2013). The data will also be used for assessing the risk of New Zealand fisheries to marine mammals.

The data summarise observer records of protected species bycatch. Information from video monitoring was not included, nor were fisher-reported data of protected species captures. Furthermore, data from observations that were not part of the fisheries observer programme (such as the observations of Hector’s dolphin bycatch made in 1997–98; Baird & Bradford 2000) were also omitted from the current dataset.

Necropsies and observer photographs provide an independent source of information about bycatch data from observers’ records. After linking the expert identifications to the COD data, a further 125 captures were identified and added to the COD records. Although some of these added captures were recorded on bycatch forms that had not yet been incorporated into the COD, some captures had no associated paperwork. The only records of these captures were the observers’ photographs, or the animals that were returned for necropsy.

In contrast, for some captures that were recorded during the necropsy process, there was insufficient information to link them to the dataset (9 captures). Improving the processes around the briefing of observers and transfer of the data into the observer database would help reduce these discrepancies, improving the accuracy of the protected species capture data. Furthermore, at the time data were extracted for the current analysis (8 April 2016), no expert identifications of seabirds had been incorporated into the COD for either the 2013–14 or the 2014–15 fishing years.

Observers are required to identify protected species in the field, and this identification can be challenging. The difficulty in correctly identifying captured animals was illustrated in the present study, which showed that subsequent expert identifications corrected nine of the initial observers’ identifications. Although there are inherent difficulties in identifying protected species on-board fishing vessels, observer training to improve species identification remains important. While over 96% of dead seabirds were necropsied or identified from photographs in 2014–15, only 3% of seabirds that were captured but released alive were identified from photographs. Improving the photographing and subsequent identification of seabirds that are captured alive would help to improve the integrity of bycatch estimation processes. The seabird risk assessment (Richard & Abraham 2015) uses species-level bycatch data, and considers live-released captures as fatalities (on the assumption that the post-release survival of the birds is unknown). Misidentified birds may affect the estimation of seabird risk. For example, of 138 captures of black petrel (the seabird species at highest risk) in the final dataset, 45.6% were live captures that were not photographed and had no expert identification.

Furthermore, observer photographs are not lodged in the COD. Storing the photographs in the database would help resolve issues with linking the identifications to the capture records. While all recent cetacean and sea lion captures were reviewed to ensure that they were accurate, not all pinniped captures are routinely reviewed. For example, it is possible that there are New Zealand sea lion captures that are recorded by observers as fur seals. To ensure that species identifications are correct, providing access to observer photographs through the database would help improve the integrity of the process.

Three substantive issues were found with the data used to estimate marine mammal and seabird bycatch

to the end of the 2013–14 fishing year (Abraham & Richard 2017, Ministry for Primary Industries 2015). These issues were missing observer trip records, the inclusion of seabird deck captures, and the incorrect matching of photograph identifications to the observer capture data. Identification of these issues and resulting changes to the data will result in changes to the number of estimated captures, especially of seabirds. When the seabird bycatch estimation is updated to the end of the 2014–15 fishing year, estimates for all previous years will also be updated and made available.

This report highlights several areas where improvement in the processes would help with more timely (and potentially more accurate) records of bycatch data. Multiple organisations work with the observer capture data, and depend on it for their reporting. Developing collaborative working methods would help to develop a consistent, reliable, and timely view of protected species bycatch information.

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