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INT2020-02: IDENTIFICATION OF MARINE MAMMALS CAPTURED IN NEW ZEALAND FISHERIES 2021–22

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Prepared for the Department of Conservation

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1. INTRODUCTION

Cawthron Institute (Cawthron) has been contracted by the Department of Conservation (DOC) to review Fisheries New Zealand (FNZ) observer identification records of incidental marine mammal captures (i.e. bycatch) in New Zealand fisheries as part of Project INT2020-02. This project forms part of a wider Conservation Services Programme (CSP) research project that also covers the identification of turtles and protected fish species caught as bycatch and is designed to complement the existing seabird identification project.

The accurate determination of the taxon of marine mammals captured in New Zealand fisheries is vital for examining the potential threats to population viability posed by incidental fisheries captures. Observers on commercial vessels are not always able to identify marine mammals with high precision, and the assessment of the age class may require expert knowledge. Information gained through this project will link to FNZ databases and will inform ongoing capture estimations, risk assessments, research and modelling of the effects of fisheries incidental bycatch on various marine mammal species.

The aims of this project were to determine, primarily through the examination of photographs, the taxa of marine mammals observed / captured in New Zealand fisheries (for live captures and dead specimens discarded at sea), and where possible, the sex, age class and provenance of the animals. The outputs from the project include: (i) a marine mammal identification spreadsheet; and (ii) a report summarising the photographs assessed. This report covers data collected from marine mammals captured from 1 July 2021 to 30 June 2022.

2. METHODS

When government observers aboard fishing vessels record an incidental capture of a dead or living marine mammal, they often take a photograph of the animal. Live interactions are also photographed wherever possible.[1] The CSP undertakes a review of all photographs obtained from marine mammal interactions to confirm important information. The objective of this research is to review all photographs of marine mammals and the subsequent identifications of the animals to determine the accuracy of the assignments made by FNZ observers in the field. This includes an assessment of the following assignments: species, sex, age and possible provenance.

[1] It may not always be possible to get imagery in all circumstances (e.g. when the individual is not brought aboard, or it exits the vessel before a photo can be taken). The welfare and release of the captured animal is the priority.

Details on the date, time, location and fishery data (e.g. fishing method, fishery area and target species) linked to capture events were provided to CSP by FNZ. The complete records (identification assignments and associated details) were then reviewed by Cawthron.

Where there was any uncertainty in assignment of taxa during the image cross-referencing process, a second experienced researcher did a blind review of the data. The final assessment was then made collectively by both researchers. If the taxon could not be determined (i.e. only a part of the body was recovered) or there was uncertainty (i.e. poor photograph quality), the event was identified and follow-up genetic analysis was recommended. Genetic samples of all marine mammals caught as bycatch are routinely collected by observers.

When a specimen was identified from a photograph, the identification features used were fully described. These data are categorised by taxon and fishery stratum (e.g. fishing method, fishery area and target species). All data were recorded in a spreadsheet, with each event linked to the original FNZ observer data through either a unique identifier (i.e. tag ID – unique to that event) or, if there was no unique identifier, using other event-specific data (e.g. trip number, date, time, specimen number, etc.).

3. RESULTS

3.1. Data summary

Between 1 July 2021 and 30 June 2022, 115 marine mammal bycatch events were reported (Table 1). Of these events, 72 (63%) had either photo or video records that could be assessed to confirm taxon identification and other information. The following sections report on the 72 events for which data records and imagery were available. There is some discussion of potential reasons for the lack of images and poor image quality in Section 3.8.

Table 1. Summary of marine mammal bycatch events for the 2021/22 year as reported by observers. Species code is the Fisheries New Zealand code used by observers in reporting.

Species code (as identified by observer)	Common name(s)	Scientific name	Photographic records?		All records
			No	Yes*	
BDO	Bottlenose dolphin / terehu	*Tursiops truncatus*		1	1
DDO	Dusky dolphin	*Lagenorhynchus*	2	4	6
FUR	New Zealand fur seal / kekeno	*Arctocephalus forsteri*	40	59	99
HSL	New Zealand sea lion / whakahao	*Phocarctos hookeri*	1	4	5
SEA	Seals and sea lions	N/A		1	1
WHU	Whale (unspecified)	N/A		2	2
ORC	Orca / maki	*Orcinus orca*		1	1
Total			**43**	**72**	**115**

3.2. Species identification

Taxon identification by observers was confirmed as correct in almost all events where reasonable quality photos were available (Table 2). The only exception to this was the expert identification of a WHT (dolphins and toothed whales [unidentified]), which was identified by the observer as WHU (whale unspecified).

Table 2. Summary of expert-identified marine mammal bycatch events for the 2021/22 year for which photos or videos were available, and those correctly identified by the observer.

Species code (as identified by expert)	Common species name(s)	No. of events with photos or videos	No. (%) correctly identified to taxa (by observer)
BDO	Bottlenose dolphin / terehu	1	1 (100%)
DDO	Dusky dolphin	4	4 (100%)
FUR	New Zealand fur seal / kekeno	59	59 (100%)
HSL	New Zealand sea lion / whakahao	4	4 (100%)
SEA	Seals and sea lions	1	1 (100%)
WHT	Dolphins and toothed whales (unidentified)	2	1 (50%)*
ORC	Orca / maki	1	1 (100%)
Total		**72**	**71**

* Identified by the observer as WHU (whale unspecified).

3.3. Sex identification

Of the 72 events where photos and data records were available, all but one had a sex assignment by the observer.[2] Of the same 72 events, only 25 (35%) could have the sex cross-referenced by the expert. Of the remaining 47 (65%) events, it was not possible for the expert to determine sex[3] due to poor photo quality, lack of genital imagery and / or low confidence in length measurements.[4]

Of the 25 events where sex could be assigned by the expert, 23 had the same sex determination as the observer, resulting in 96% agreement (the green squares within the blue box, Table 3). This left two incorrect sex records:

- one of the female sex assignments by observers was classed as male by the expert
- one individual assigned as ‘not sexed’ by the observer was assigned as male by the expert.

[2] Noting that for the purposes of this assessment an assignment of sex included assignment of 3 (‘U’, sex unable to be determined) or 4 (‘N’, not sexed).

[3] Males can often be determined with accurate size lengths, as there is typically a maximum female size (above which the animal is likely to be a male). However, this approach provides only a single line of evidence, relies on accurate observer measurements, is species specific and is biased to determining only large males, and therefore has been used here only as an additional line of evidence alongside clear sexually dimorphic characteristics (genitals, perpetual openings, fur manes, etc.) in photographs.

[4] There were no events where body profile photos included a tape measure (for scale), so it was not possible to determine whether the events were measured nose to flipper-end, rather than nose to tail-end. This demonstrates a need for better training.

There was also one observer blank entry for sex, which was classed as 'not sexed' by the expert.

Table 3. Cross-referencing of sex identification by observers and experts of marine mammals caught as bycatch during the 2021/22 year for which photos were available. Sex codes: 1(M) – male; 2(F) – female; 3(U) – sex unable to be determined; 4(N) – not sexed. Green squares show where observer identification of sex codes agreed with expert observation. The blue box shows where both observer and expert assigned M/F sex (but were not necessarily in agreement).

Sex (as identified by observer)	Sex (as confirmed by expert)				Total
	1(M)	2(F)	3(U)	4(N)	
1 (M)	18		19	2	39
2 (F)	1	5	11	1	18
3 (U)			4	3	7
4 (N)	1			6	7
No entry				1	1
Total	**20**	**5**	**34**	**13**	**72**

3.4. Age identification

The estimation of the age of a marine mammal is complicated and is best accomplished from the direct ageing of an individual through methods such as examining teeth cross sections, earwax plugs, sexual organs and stomach contents (e.g. for milk), and / or using DNA molecular methods. This information was not available for these bycatch individuals, and therefore general age categories were assigned based on visual criteria from photos.

Age class was determined using observer length records and the following generalised criteria:

- **Calf / pup** (e.g. age 0): dolphin / whale[5] – less than one-third of the length of an average adult female, sometimes with neonatal folds if very young; seal / sea lion – less than one-third of the length of an average adult female, pup pelage.
- **Juvenile** (e.g. age 1+): dolphin / whale – approximately one-half of the length of an average adult female, sexually immature; seal / sea lion – approximately one-half of the length of an average adult female, sexually immature, lack of pup pelage.
- **Adult** (e.g. variable age): dolphin / whale – greater than one-half the length of an average adult female, sexually mature; seal / sea lion – greater than one-half the

[5] This is species-dependent, e.g. some whale calves are closer to half the length of an adult female at birth.

length of an average adult female, sexually mature, secondary sexual characteristics (e.g. mane).

- **Indeterminate**: photos where age class could not be assigned.

We used experienced marine mammal researchers to improve the accuracy of age class assignment. These people, familiar with most of the species appearing in these records, assigned age classes where the generalised criteria (listed above) could be ascertained. Despite this, age class classification using only photos and observer size-length records is likely to be inaccurate for individuals transitioning between these categories. Potential identification inaccuracies are especially possible for the juvenile category as there is considerable variation around when individuals attain a specific size and sexual maturity. The method is likely to be more accurate for very young individuals and fully mature individuals that fit clearly into a single category.

Age class could be assigned for 48 (67%) bycatch events (Table 4). Of the events where age could be assigned, 63% (*n* = 45) were estimated to be adults. Three (4%) were assigned as juveniles (leaving 33% classed as indeterminate). This prevalence of adults could be due a range of possible reasons, including:

- It can be challenging to accurately determine a juvenile from an adult from photos and uncertain[6] size-length records alone. Generally, the criteria are based on reproductive maturity, which cannot be easily assessed from external characteristics and is generally confirmed by examination of reproductive organs. This may mean that the number of actual juveniles is underestimated.
- In many species different age classes have different foraging behaviours and ranges. Therefore, some fisheries may have a genuinely higher proportion of adults as bycatch, as juveniles are foraging elsewhere.

It is not possible to distinguish between these two reasons without reliable data on actual reproductive maturity status, which would require the direct examination of reproductive organs and, potentially, the collection of histology samples for examination by an expert.

[6] A tape measure was not included in the body profile photos, so it was not possible to quality-check measurement approaches (e.g. was the measurement taken nose to flipper-end, rather than nose to tail-end).

Table 4. Summary of marine mammal age class data for bycatch events during 2021/22 for which photo data records were available. Species codes are the official codes used by Fisheries New Zealand: BDO – bottlenose dolphin / terehu; DDO – dusky dolphin; FUR – New Zealand fur seal / kekeno; HSL – New Zealand sea lion / whakahao; ORC – orca / maki; SEA – seals and sea lions; WHT – dolphins and toothed whales (unidentified).

Species code (as identified by expert)	Age class assignment					Total
	Calf	Juvenile	Juvenile / adult	Adult	Indeterminate	
BDO					1	1
DDO				4		4
FUR		2		39	18	59
HSL		1		2	1	4
ORC					1	1
SEA					1	1
WHT					2	2
Total	**0**	**3**	**0**	**45**	**24**	**72**

3.5. Dead before being caught

In some instances a marine mammal is brought aboard but was clearly not killed as part of that specific fishing event. For example, if a very decomposed marine mammal or a skull with no flesh and signs of extensive weathering appears in the catch, it was clearly not killed in that fishing event (e.g. tow or set). In this case, while the event is technically recorded as a dead marine mammal capture, the death is not attributed to that specific fishing event.

The observer reporting forms include the field ‘decomposing’ within the ‘life status’ category, which distinguishes between a marine mammal that was clearly dead before being caught, versus a marine mammal that was likely killed in that fishery event. Five events were recorded by observers as ‘decomposing’ (life status code 4), these being three FUR (New Zealand fur seals / kekeno), one SEA (seals and sea lions), and one WHT (dolphins and toothed whales, unidentified). All but one of these mammals were confirmed by the expert as being likely to have already been dead before they were caught, and therefore they should not be counted towards bycatch totals. The one exception to this was the New Zealand fur seal / kekeno with CSP tag 12940, which did not appear to be decomposing from the imagery and had no record of a preexisting tag. This record should be counted towards the bycatch totals.

In two additional events observers had assigned the bycatch code 2 (‘dead’) and the expert subsequently determined that the event should be coded 4 (‘decomposing’). These two events (one FUR and one WHU) could not be identified[7] from their CSP

[7] Details of these events have not been reported here due to privacy issues, but details are available from DOC upon request.

tag numbers as none of these were recorded. Since the CSP tag number was not recorded / visible, it was not possible to know when, where or if the animals had been previously caught. We suggest that the life status code be updated to code 4 ('decomposing') for these captures within the observer database.

3.6. Provenance

Provenance is the likely origin of a bycatch individual. It is possible to determine the provenance of an individual only if it has been previously marked (e.g. tagged, branded, biopsied) and those marking data are available. Genetic / biopsy samples were not collected or examined by observers; thus, it was not possible to tie individuals to a distinct population using genetic markers.

With respect to data recording, there was no clear designation of a column specifically for provenance-related tags, brands or biopsy marks. There are three observer columns for tag entry, labelled individually: csp_tag_number, tag_ID and tag_capture. There were no entries in the tag_ID column, and two tag disposal numbers[8] were recorded in both the csp_tag_number and tag_capture columns. There was also one record in the tag-capture column (10995) that did not match the entry in the csp_tag_number column (10998). It is probable that this is a typographical error, as the capture was not recorded as 'decomposing' by the observer, or as 'dead before being caught' by the expert. The data records suggest some uncertainty on the part of observers around the correct data entry requirements.

There were no observer data records of a previously tagged individual, and nor was there any evidence of tagged individuals in the images provided to the expert.

3.7. Fisheries data

The following figures provide a brief summary of all bycatch events for which there were photos and records from the 2021/22 year (*n* = 72) in relation to fishing areas, injury status, month of event and fishing methods.

Most (93%, *n* = 67) bycatch events with adequate photos / records were captures in a trawl fishery (TWL events; Table 5) with the remainder captures from surface longlining (6%; SLL) or attributable to set-netting (1%; SN). We note that a number of observer SLL bycatch records had no associated photographs for identification verification (*n* = 26). The lack of imagery here likely relates to the focus of the

[8] A disposal number is the number of the tag that is placed in a bycatch individual by the observer prior to the carcase being disposed of at sea. The aim of this is to allow for re-identification of this already dead individual if it happens to be caught again.

observer on returning the animal safely to sea, or that some individuals were never brought aboard (e.g. when longlining).

Of the bycatch events, there was a reasonable geographic spread of captures around Aotearoa New Zealand, with almost 70% of bycatch occurring within the South-East Coast (SEC, 18%), Challenger (CHA, 18%). Central (East) (CEE, 17%), and Southland / Fiordland (SOU, 17%) Fisheries Management Areas (Table 6).

Marine mammal bycatch events were recorded for eight different target species, with two of the main target species, squid (SQU; 35%, *n* = 25) and hoki (HOK; 32%, *n* = 23), comprising 65% of all events (Table 7).

Six bycatch events[9] occurred within marine mammal sanctuaries (Figure 1). All six were in Te Rohe o Te Whānau Puha / Kaikōura Whale Sanctuary within the SEC Fisheries Management Area (Figure 1):

- The closest captures to shore were two New Zealand fur seals / kekeno (FUR), captured (dead) on 24–27 July 2021 and 23–24 July 2021. The fishing method used for both was set-netting (SN). The 23–24 July capture was also within the set-netting prohibition area.
- Another New Zealand fur seal / kekeno (FUR) was captured (dead) further to the southeast (cf. the two fur seals above) on 20–21 July 2021. The fishing method used during the capture was set-netting (SN).
- Near the centre of the sanctuary, a dusky dolphin (DDO) was caught (dead) on 14–16 August 2021. The fishing method used during the capture was set-netting (SN).
- To the southwest of the sanctuary, one dusky dolphin (DDO) was captured alive and returned to the water. It was caught on 24–27 July 2021. The fishing method used during the capture was set-netting (SN).
- To the southeast of the sanctuary another New Zealand fur seal / kekeno (FUR) was captured (dead) on 1–2 May 2022. The fishing method used during the capture was set-netting (SN).

In almost all (86%, *n* = 62) of the marine mammal bycatch events the individual was recorded as dead, but some (7%, *n* = 5) individuals were captured alive and the remainder were classed as decomposing (7%, *n* = 5; Table 8). The number of live observer bycatch records with no associated photographs for identification verification was higher (*n* = 34). It would be valuable to collect photos of live animals; however, the focus of the observer is on returning the animal safely to sea and in other cases (e.g. when longlining) some individuals are never brought aboard.

[9] 114 of the 115 original observer records could be mapped in Figure 1. However, a single entry had no start or end location records, and consequently could not be included in Figure 1.

Many (60%, *n* = 43) animals caught as bycatch were recorded as having no visible injuries (Z) in the relevant data column; however, there were a range of (sometimes multiple) injury codes reported by observers (Table 9). The most prevalent injury was 'Froth or foam present in mouth / nostrils' (Q), which was recorded in 12 bycatch events. Other injuries were also noted but there were no obvious consistent patterns. The code for 'other' or 'unknown' injuries typically had an associated comment in the 'notes' column (see Table 9). Review of these comments suggests some injury-coding inconsistencies, as many of these events could have been coded J ('hook in mouth') as opposed to O ('other') or U ('unknown'). It is also noted that the 'decaying' (V) code (Table 9) was recorded in five bycatch events; interestingly, four of these had corresponding life status (Table 8) 'decomposing' codes assigned (as would be expected), but one was recorded as 'dead' (life status code 2). Irregularities between the 'decaying' injury code and 'decomposing' life status data entries also suggest some coding inconsistencies.

Bycatch events were recorded in all months of the year, with the exception of November 2021 (Table 10). The greatest bycatch in a single month occurred during August 2021 and April 2022 (predominantly FUR, with one ORC and one WHU), when each month accounted for 18% of the recorded annual bycatch events (*n* = 13). This was followed closely by March 2022, which accounted for 17% (*n* = 12; Table 10). Most of the bycatch in August 2021 occurred primarily when targeting hoki (HOK) and southern blue whiting (SBW), while in March and April 2022 bycatch occurred primarily during fishing events targeting squid (SQU).

Table 5. Summary of all marine mammal bycatch events for the 2021/22 year that had adequate photos by fishing method. Species and fishing method codes are the official codes used by Fisheries New Zealand. Species codes: BDO – bottlenose dolphin / terehu; DDO – dusky dolphin; FUR – New Zealand fur seal / kekeno; HSL – New Zealand sea lion / whakahao; ORC – orca / maki; SEA – seals and sea lions; WHT – dolphins and toothed whales (unidentified). Fishing method codes: SLL – surface longline; SN – set-net; TWL – trawl.

Species code	**Fishing method**			
(as identified by expert)	SLL	SN	TWL	**Total**
BDO	1			1
DDO			4	4
FUR	2	1	56	59
HSL			4	4
ORC	1			1
SEA			1	1
WHT			2	2
Total	**4**	**1**	**67**	**72**

Table 6. Summary of all marine mammal bycatch events for the 2021/22 year that had adequate photos by Fishery Management Area (FMA). Species and FMA codes are the official codes used by Fisheries New Zealand. Where start and end FMAs differed in a record, the end FMA location was used for the sub-total calculation. Species codes: BDO – bottlenose dolphin / terehu; DDO – dusky dolphin; FUR – New Zealand fur seal / kekeno; HSL – New Zealand sea lion / whakahao; ORC – orca / maki; SEA – seals and sea lions, WHT – dolphins and toothed whales (unidentified). Fishery Management Area codes: AKE (Auckland [East]), CEE (Central [East]), CEW (Central [West]), CHA (Challenger), SEC (South-East Coast), SOE (Southeast), SOI (Sub-Antarctic Islands), SOU (Southland) and SUB (Sub-Antarctic).

Species code (as identified by expert)	FMA sub-totals									Total
	AKE	CEE[a]	CEW	CHA[b]	SEC[c]	SOE[d]	SOI	SOU	SUB	
BDO	1									1
DDO					4					4
FUR		12	1	13	8	7	3	12	3	59
HSL							2		2	4
ORC					1					1
SEA							1			1
WHT						1	1			2
Total	**1**	**12**	**1**	**13**	**13**	**8**	**7**	**12**	**5**	**72**

(a) One of the confirmed bycatch trawls started in CHA and finished in CEE.
(b) One of the confirmed bycatch trawls started in CEE and finished in CHA.
(c) One of the confirmed bycatch setnet records had no entry for where it started (finished in the SEC).
(d) Three of the confirmed bycatch fishing trawls started in SEC and finished in SOE.

Table 7. Summary of all marine mammal bycatch events for the 2021/22 year by target species. Species codes are the official codes used by Fisheries New Zealand: BDO – bottlenose dolphin / terehu; DDO – dusky dolphin; FUR – New Zealand fur seal / kekeno; HSL – New Zealand sea lion / whakahao; ORC – orca / maki; SEA – seals and sea lions; WHT – dolphins and toothed whales (unidentified). Target species codes: definitions of all codes are available at https://register.kupe.fishserve.co.nz/home/FindStock

Species code	Target species								Total
(as identified by expert)	BAR	HOK	JMA	SBW	SCI	SPO	SQU	STN	
BDO								1	1
DDO	4								4
FUR	6	23	2	3		1	22	2	59
HSL				3			1		4
ORC								1	1
SEA					1				1
WHT							2		2
Total	**10**	**23**	**2**	**6**	**1**	**1**	**25**	**4**	**72**

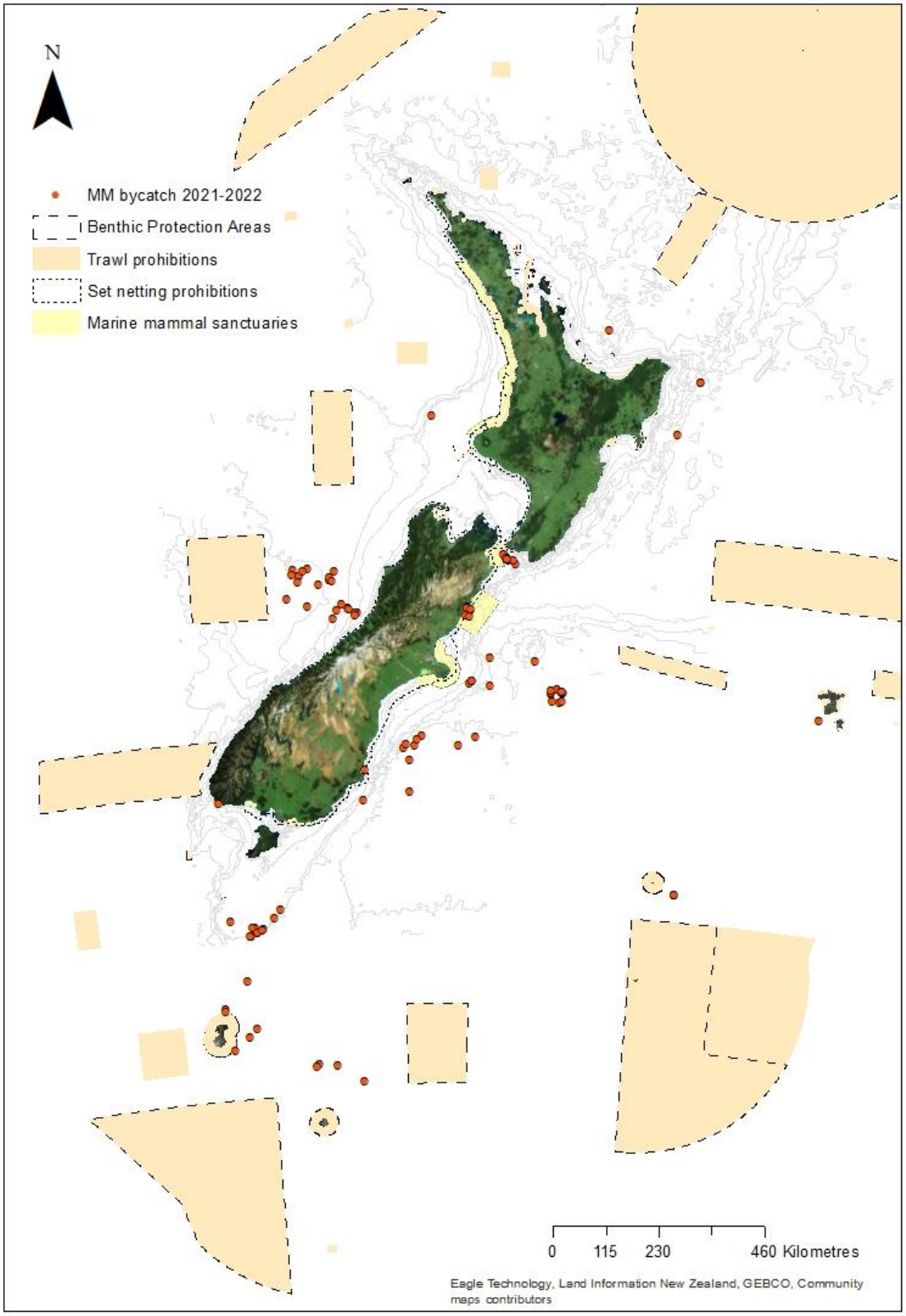

Figure 1. The location of all marine mammal bycatch events reported by observers between 1 July 2021 and 30 June 2022, noting that a single bycatch event had no start or end location records and was therefore not included here (114 of 115 reported events included). Source: map created from the Fisheries New Zealand observer bycatch records using ArcMap 10.8.2.

Table 8. Summary of all marine mammal bycatch events as identified by the expert for the 2021/22 year by life status. Species codes are the official codes used by Fisheries New Zealand: BDO – bottlenose dolphin / terehu; DDO – dusky dolphin; FUR – New Zealand fur seal / kekeno; HSL – New Zealand sea lion / whakahao; ORC – orca / maki; SEA – seals and sea lions; WHT – dolphins and toothed whales (unidentified).

Species code (as identified by expert)	**Species life status code**					
	Alive	Dead	Killed by crew	Decomposing	Unknown	**Total**
BDO	1					1
DDO		4				4
FUR	2	54		3		59
HSL	1	3				4
ORC	1					1
SEA				1		1
WHT		1		1		2
Total	**5**	**62**	**0**	**5**	**0**	**72**

Table 9. Summary of all marine mammal bycatch events for the 2021/22 year by observer-described injury status. Species are the official codes used by Fisheries New Zealand: BDO – bottlenose dolphin / terehu; DDO – dusky dolphin; FUR – New Zealand fur seal / kekeno; HSL – New Zealand sea lion / whakahao; ORC – orca / maki; SEA – seals and sea lions; WHT – dolphins and toothed whales (unidentified). Note: some events have more than associated one injury code, as indicated by multiple code letters (in parentheses). Italicised text = direct quotes from the observers' comments.

		Species codes (as identified by expert)							
Injury status (codes)		**BDO**	**DDO**	**FUR**	**HSL**	**ORC**	**SEA**	**WHT**	**Total**
Open wound (F)	(F)	1							1
Open wounds (FF)	(FF)			1					1
Open wound (F) Predated (S) Decaying (V)	(FSV)			1					1
Open wound (F) More than three injuries (Y) Waterlogged (W)	(FYW)			1					1
Other (O) specified in comments (hook in mouth, *could have been called J*)	(O)			2					2
Other (O) specified in comments (dead, nothing about injuries noted) Froth or foam present in mouth / nostrils (Q)	(OQ)			1					1
Froth or foam present in mouth / nostrils (Q)	(Q)			7					7
Froth or foam present in mouth / nostrils (Q) Other (O) specified in comments (*small hole in left rear flipper with some scarring, likely from a DOC or other tagging programme*)	(QO)				1				1
Froth or foam present in mouth / nostrils (Q) Body in rigor (R)	(QR)			1					1
Froth or foam present in mouth / nostrils (Q) Waterlogged (W)	(QW)			1					1
Froth or foam present in mouth / nostrils (Q) No visible injuries (Z)	(QZ)				1				1
Body in rigor (R)	(R)			3					3
Body in rigor (R) No visible injuries (Z)	(RZ)			1					1
Unknown (U)	(U)			1					1
Decaying (V)	(V)			1			1	2	4
Waterlogged (W)	(W)			2					2
No visible injuries (Z)	(Z)		4	36	2	1			43
Total		**1**	**4**	**59**	**4**	**1**	**1**	**2**	**72**

Table 10. Summary of all marine mammal bycatch events for the 2021/22 year by month. Species codes are the official codes used by Fisheries New Zealand: BDO – bottlenose dolphin / terehu; DDO – dusky dolphin; FUR – New Zealand fur seal / kekeno; HSL – New Zealand sea lion / whakahao; ORC – orca / maki; SEA – seals and sea lions; WHU – whales and dolphins.

		Species Code							
Year and month		BDO	DDO	FUR	HSL	ORC	SEA	WHU / WHT	**Total**
2021	Jul	1		6					7
	Aug			13					13
	Sep			1	3				4
	Oct			1					1
	Nov								0
	Dec			1					1
2022	Jan		4	1					5
	Feb			1	1				2
	Mar			12					12
	Apr			11		1		1	13
	May			5				1	6
	Jun			7			1		8
Total		**1**	**4**	**59**	**4**	**1**	**1**	**2**	**72**

3.8. Photos

As noted in Section 3.1, 72 (62%) events had either records and / or imagery that could be assessed to confirm taxon identification and other information. The remaining 44 (38%) events had no associated photos or had photos but no associated records (there were four missing records), and therefore could not be assessed. Of the events that were missing photos, 30 (68%) were due to the mammal being alive and the observer making it the priority to return the animal to the sea over taking photos, or because the marine mammal was never brought aboard (e.g. during longlining). Where the bycatch was listed as dead, the observer's comments suggest that either the individual was lost (from the set-net or longline), or conditions were not amenable to taking photographs (the weather conditions were bad, or the records were being taken in the very early hours of the morning).

Of the 72 events with photos (and records), 1% (*n* = 1) were excellent quality, 11% (*n* = 8) were good quality, 42% (*n* = 30) were moderate quality and 46% (*n* = 33) were poor quality. Overall, there was a mean of 7.5 (SE = 0.9) photos taken per event.[10] It is important to note that a photo group was deemed to be good quality overall if at least one photo was of good quality even if the remainder were of moderate or poor quality. There were many examples where multiple photos were taken but only a single photo was of useful quality. Bycatch photo records were considered 'excellent'

[10] Zero values (i.e. no still image records) were assigned by the expert when only videos were provided rather than still images (a total of four events had video only). Video records were excluded from the mean number of photos calculation.

quality if they included clear images of the genitals, head and body (with tape measure for scale), had good lighting and the images were in focus.

Of the 72 events from the 2021/22 year where the observer had assigned sex (and where photos and data records were available), only 33% (n = 24) had genital photos of adequate quality so that sex could be confirmed by the expert (noting that the remaining assignments were confirmed by size and other sexually dimorphic characteristics visible in the photos). In most cases, no photos were taken of the genital region, or if they were taken, they were of insufficient quality for the expert to confirm the sex.

Some general comments:

- The FNZ observer protocols for the collection of photos should be reviewed to ensure that observers have sufficient instructions on what photos to collect, the purpose of the photos and how to collect high-quality images.
- We appreciate that the working environment is particularly challenging for the collection of photos by observers, but there is little use in collecting photos for subsequent expert identification unless they are of good quality.
- Multiple photos should be taken for each research question (e.g. species identification, sex, age, injuries) to maximise the chance of collecting a good photo.
- One of the consistent challenges seen in photos was adequate lighting. In many situations, lighting was inadequate, which in turn frequently appeared to lead to loss of focus and lack of contrast. Adequate lighting is very important and should be considered when taking photos.
- Camera quality is also important, as is ensuring that an observer is trained to use it. For example, adjusting the ISO setting to a higher value or making sure the automatic flash setting is on can help when there is inadequate lighting.
- Accurate observer length measurements are a useful line of evidence for sex and age identification. However, no images included a tape measure for scale, and therefore the accuracy of the measurements could not be checked (e.g. for the expert to be able to determine whether the measurements were taken nose to tail rather than nose to flipper). As this has been identified as an issue in previous years, and may still be, the FNZ observer protocols for the collection of length measurements should be reviewed to ensure consistency, and body profile photos should include a tape measure to confirm measurement accuracy.

4. SUMMARY AND RECOMMENDATIONS

Overall, the observers did an excellent job of identifying marine mammal species caught as bycatch. The only potential improvements would be to identify individuals to a higher phenotypic resolution when good taxonomic resolution is not possible (e.g. a toothed whale vs a whale in general), and to provide photographic evidence of length measurement and genitals. Although only a limited number of photos were available to identify sex as recorded by observers, these photos were extremely valuable in confirming that almost all sex assignments were made correctly, with only two corrections made by the expert.

The provision of accurate length measurements and clear genital images is important for confirming sex and age assessments and, while it is appreciated that it is difficult to collect good-quality photos on a working fishing vessel, it makes a big difference to collecting accurate biological data. Another option that should be considered for reviewing the accuracy of observer records is genetic testing of observer-collected tissue samples (Peters et al. 2022; Robeck et al. 2023). The benefit of taking genetic samples is that they would verify all of the identification, sex and age data.

Some recommendations from the review of observer data are given below.

Age estimation

Accurately determining age class from photos and ancillary data (e.g. body length) is challenging given the natural variation seen among individuals, meaning that there is no single measurement that can be used to reliably confirm either age class or actual age. While it is not clear if the estimated age class is used in any analysis, it could be informative and potentially beneficial in understanding any interaction. However, to achieve a high degree of confidence in assessing age class, additional work would be required from observers (e.g. direct assessment and genetic sampling and / or reproductive organ sampling), and it would also likely include a follow-up assessment by a trained biologist or vet. At present, the collection of an accurate total length (i.e. nose to tip of tail for seals) and good-quality photos is probably sufficient to provide an approximate age class for any bycatch individual. To partly address this, the field ‘length measurement accuracy’ was added to the dataset, whereby:

- No = not able to assess, no tape measure included in photo
- Yes – accurate = measurement able to be confirmed as nose to tail (FUR / HSL) and nose to fluke notch[11] (DDO)
- Yes – inaccurate = measurement clearly not measured nose to tail or nose to fluke notch.

[11] Noting that some cetaceans do not have a fluke notch (e.g. most beaked whales).

Because of these inaccuracies, further investigation into genetic ageing is recommended.

Data records

Where images or data were not available (or were incomplete), the accuracy of marine mammal identifications could not be evaluated. It is important that records collected from observers are managed appropriately to ensure that all data are available for review. Some form of quality assurance may be useful to ensure that all records are present and stored appropriately. Of the 43 bycatch events where taxon could not be determined (due to lack of photographs), follow-up genetic analysis of routinely collected genetic marine mammal samples is recommended.

Photographic quality

It would be useful to review the observer protocols for the collection of photos to ensure they are up to date and provide the required information. Photos serve a range of purposes (e.g. providing additional information on species, sex, age class and injuries), and practical descriptions of what photos are required for each research question need to be clearly provided. While most events had at least one good-quality photo, many photos were of poor quality and not useful in providing any additional information. There is room for improvement in the collection of good-quality photos (e.g. better lighting), but we note that the environment is a particularly challenging one for collecting photos. Further photographic training and solutions to the limitations that exist aboard vessels should be sought (e.g. addressing lighting conditions, shiny surfaces / glare).

Sex identification

Observer assignments of male / female sex could be confirmed for 33% (n = 24) of events with photos, which means that 67% (n = 48) of sex assignments could not be confirmed by the expert. Combining the latter figure with the 43 records that did not have any photos or records indicates that in 91 events, or 79% of all bycatch, the observer-assigned sex was not confirmed. This is very low compared to previous years (e.g. 59% in 2020–21, 40% in 2019–22).

As only 34% of events had photos of sufficient quality to confirm / reject sex assignments, it is important that observers are provided with clear descriptions of the photos needed to confirm the sex of an individual so that this can be done independently. Any notes and descriptions of sex identification methods should be reviewed and updated where necessary, especially for female sex determination. Because of these inaccuracies, further investigation into genetic sexing is recommended.

Dead before being caught

During some events a marine mammal is brought aboard but was clearly not killed as part of that specific fishing event. For example, if a very decomposed marine mammal

or a skull with no flesh and signs of extensive weathering appears in the catch, it was clearly not killed in that fishing event (e.g. tow or set). In this case, while the event is technically recorded as a dead marine mammal capture, the death is not attributed to that specific fishing event. We added a new field, 'Dead before being caught', to try to address this issue as these records should not be attributed to the fishery as mortality events. We recommend that a similar field is added to the observer reporting forms to distinguish between a marine mammal capture that was clearly dead before being caught vs a marine mammal that was likely killed during that fishery event.

The expert confirmed four events where the bycatch individual was assessed as being dead prior to capture. However, one of the events classed as 'decomposing' by the observer was not confirmed as 'dead before being caught' by the expert, and this record will need to be amended in the FNZ database (it should be counted towards the bycatch totals). In addition, there were two events where observers had assigned the bycatch code 2 ('dead') but the expert determined they should be code 4 ('decomposing'). We suggest that the life status code be updated to code 4 ('decomposing') for these captures within the observer database.

Flipper tags or other identifying marks

To determine the provenance of a bycatch individual, the animal must have been marked previously (e.g. tagged, branded, microchipped, biopsied). With respect to the 2021–22 data recording, there was no clear designation of a column specifically for provenance-related tags, brands or biopsy marks. There were no data records where an observer recorded a previously tagged individual, and nor was there any evidence of tagged individuals in the images provided (to the expert). The data records suggest that there was some uncertainty by observers around the correct data entry requirements.

If a marked individual is caught, it is essential that details of the mark are recorded. We recommend the following: (i) the observer takes several high-quality photos of the mark, and if there is more than one mark (e.g. two tags or a tag and a brand) then they should take separate photos of both marks; (ii) the observer attempts to read and confirm the mark and then records that on their data sheet; and (iii) ideally, provenance flipper tags are removed from the individual (and replaced with a capture tag) and returned ashore for confirmation.

4.1. Database amendments

- Change the record WHU (whale unspecified) to WHT (dolphins and toothed whales [unidentified]).
- Change incorrect sex assignments. One individual assigned as female by the observer was classed as male by the expert, and one individual assigned as 'not sexed' by the observer was assigned as male by the expert. There was also one observer blank entry for sex, which was classed as 'not sexed' by the expert.
- Change the 'life status' / 'dead before being caught' assignments:
    - One of the events classed as 'decomposing' by the observer was not confirmed as 'dead before being caught' by the expert and should be counted towards the bycatch totals.
    - In addition, there were two events where observers had assigned the bycatch code 2 ('dead') but the expert determined that the event should be code 4 ('decomposing'). We suggest that the life status code be updated to code 4 ('decomposing') for these two captures within the database.
- Of the 43 bycatch events where taxon could not be determined (due to lack of photographic evidence), we recommend follow-up genetic analysis of routinely collected genetic marine mammal samples.
- Due to the inaccuracies identified and the limited photographic records available to assess the majority of the observer bycatch ageing and sexing records, routine testing of bycatch tissue samples collected for genetics should be considered. Testing genetic samples would verify all of the species identification, sex and age data.

5. APPENDIX

Appendix 1. Electronic data file to be sent separately.

6. ACKNOWLEDGEMENTS

We would like to acknowledge the dedication and hard work of the observers in collecting this information to a high standard. We fully appreciate the complexities and challenges of the role (the authors have worked as observers previously) and hope that our suggestions can help them in the work they do. We would also like to thank Hollie McGovern and the Conservation Services Programme of the Department of Conservation for supporting this work. This research was funded by levies on the commercial fishing industry.

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