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INT2020-02: Identification of marine mammals captured in New Zealand fisheries 2022–23

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INT2020-02: Identification of marine mammals captured in New Zealand fisheries 2022-23

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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 2022 to 30 June 2023.

2. Method

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. 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.

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 2022 and 30 June 2023, 109 marine mammal bycatch events were reported (Table 1). Of these events, 88 (81%) had either photo or video records that could be assessed to confirm taxon identification and other information. The following sections report on the 88 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 2022/23 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	
CDD	Common dolphin / aihe	*Delphinus delphis*		1	1
DDO	Dusky dolphin	*Lagenorhynchus obscurus*		1	1
FUR	New Zealand fur seal / kekeno	*Arctocephalus forsteri*	20	82	102
HDO	Hector's dolphin / tutumairekurai	*Cephalorhynchus hectori*		2	2
HSL	New Zealand sea lion / whakahao	*Phocarctos hookeri*		2	2
ORC	Orca / maki	*Orcinus orca*	1		1
Total			**21**	**88**	**109**

3.2 Species identification

Taxon identification by observers was confirmed as correct in all events where reasonable quality photos were available (Table 2).

Table 2. Summary of expert-identified marine mammal bycatch events for the 2022/23 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)
CDD	Common dolphin / aihe	1	1 (100%)
DDO	Dusky dolphin	1	1 (100%)
FUR	New Zealand fur seal / kekeno	82	82 (100%)
HDO	Hector's dolphin / tutumairekurai	2	2 (100%)
HSL	New Zealand sea lion / whakahao	2	2 (100%)
Total		**88**	**88 (100%)**

3.3 Sex identification

Of the 88 events where photos and data records were available, all events had a sex assignment entry recorded by the observer.[1] Of the same 88 events, only 22 (25%) could have the sex cross-referenced by the expert. Of the remaining 66 (75%) events, it was not possible for the expert to determine sex[2] due to poor photo quality, lack of genital imagery and / or low confidence in length measurements.[3]

Of the 24 events where sex could be assigned by the expert, 16 had the same sex determination as the observer, resulting in 67% agreement (the green squares within the blue box, Table 3). This resulted in six incorrect sex records:

- one of the male sex assignments by observers was classed as female by the expert.
- three of the female sex assignments by observers were classed as male by the expert.
- one individual assigned as 'unable to be sexed' by the observer was assigned as male by the expert.
- one individual assigned as 'not sexed' by the observer was assigned as female by the expert.

Table 3. Cross-referencing of sex identification by observers and experts of marine mammals caught as bycatch during the 2022/23 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)	16	1	24	13	54
2 (F)	3		16	6	25
3 (U)	1		2	3	6
4 (N)		1		2	3
Total	**20**	**2**	**42**	**24**	**88**

[1] 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).

[2] 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.

[3] There were events where body profile photos included a tape measure (for scale); however, many of the images (for species code FUR) appear to have been measured incorrectly using nose to flipper-end, rather than nose to tail-end. This demonstrates a need for better training.

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[4] – 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 (fur).
- **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 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 67 (76%) bycatch events (Table 4), leaving 21 (24%) classed as indeterminate. Of the events where age could be assigned, 93% (n = 62) were estimated to be adults. Five (7%) were assigned as juveniles. This prevalence of adults could be due to a range of possible reasons, including:

- It can be challenging to accurately determine a juvenile from an adult from photos and uncertain[5] 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.

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

- 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.

Table 4. Summary of marine mammal age class data for bycatch events during 2022/23 for which photo data records were available. Species codes are the official codes used by Fisheries New Zealand: CDD – Common dolphin / aihe, DDO – Dusky dolphin, FUR – New Zealand fur seal / kekeno, HDO – Hector's dolphin / tutumairekurai, HSL – New Zealand sea lion / whakahao.

Species code (as identified by expert)	Age class assignment					Total
	Calf	Juvenile	Juvenile / adult	Adult	Indeterminate	
CDD				1		1
DDO					1	1
FUR		5		58	19	82
HDO				1	1	2
HSL				2		2
Total		**5**		**62**	**21**	**88**

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. Two events were recorded by observers as 'decomposing' (life status code 4), both of which were FUR (New Zealand fur seals / kekeno). While these mammals had no record of a pre-existing tag (that would link them to another catch event), an expert confirmed that both mammals were likely already dead before they were caught, and therefore they should not be counted towards bycatch totals.

3.6 Provenance

Provenance is the likely origin of a bycatch individual. It is only possible to determine the provenance of an individual 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 seven tag disposal numbers[6] were recorded in both the csp_tag_number and tag_capture columns. There was also text occasionally recorded in the tag-capture column (twine, rope, CSP, non and no), it was unclear what these related to. 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 previously 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 2022/23 year (n = 88) in relation to fishing areas, injury status, month of event and fishing methods.

Most (92%, n = 81) bycatch events with adequate photos / records were captures in a trawl fishery (TWL events; Table 5) with the remainder captures from set-netting (5%; SN) or attributable to bottom long lining (1%; BLL). We note that the BLL bycatch record had no associated photograph for identification verification (instead including a video recording), and two of the SN records were missing any imagery. The lack of still imagery here related to the focus of the crew on returning the animal safely to sea, and / or that some individuals were not brought aboard (e.g. released by crew before observations could be made).

Of the bycatch events, there was a reasonable geographic spread of captures around Aotearoa New Zealand, with almost 82% of bycatch occurring within the South-East Coast (SEC, 28%), Challenger (CHA, 25%) and Central East (CEE, 28%) Fisheries Management Areas together (Table 6).

Marine mammal bycatch events were recorded for 10 different target species, with two of the main target species, hoki (HOK; 60%, n = 53) and squid (SQU; 14%, n = 12), comprising 74% of all events (Table 7).

6. A disposal number is the number of the tag that is placed on 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.

Five bycatch events[7] occurred within marine mammal sanctuaries (Figure 1). Three were in Te Rohe o Te Whānau Puha / Kaikōura Whale Sanctuary, and two were in the Banks Peninsula Marine Mammal Sanctuary, both of which are within the SEC Fisheries Management Area (Figure 1):

- The three captures in the Te Rohe o Te Whānau Puha / Kaikōura Whale Sanctuary included two New Zealand fur seals / kekeno (FUR), captured (dead) on 7 June 2023 and 13 June 2023, and one Dusky dolphin (DDO), captured (dead) on 25 June 2023. The fishing method used for all three events was set-netting (SN).
- The two captures in the Banks Peninsula Marine Mammal Sanctuary included one Hector's dolphin (HDO), captured (dead) on the 3 June 2023, and one New Zealand fur seal / kekeno (FUR), captured (dead) on 9 February 2023. The fishing method used during the capture was trawling (TWL).

In almost all (97%, *n* = 85) of the marine mammal bycatch events, the individuals were recorded as dead, with one individual captured alive and the remainder (*n* = 2) classed as decomposing (Table 8). The number of live observer bycatch records with no associated photographs for identification verification was higher (*n* = 13). 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.

Many (41%, *n* = 36) animals caught as bycatch were recorded as having no visible injuries (Z) or simply as 'body in rigour' (22%, *n* = 19) in the relevant data column. However, there were a range of other injury codes (sometimes multiple) reported by observers (Table 9). The most prevalent injury was 'Froth or foam present in mouth / nostrils' (Q), which was recorded in 15 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 that the injury-coding was reasonably consistent, as many of these events could not have been coded differently, with the exception of one event, which could have used code M ('bleeding from orifices'). It is also noted that the 'decaying' (V) code (Table 9) was recorded in two bycatch events; these had corresponding life status (Table 8) 'decomposing' codes assigned (as would be expected) and were confirmed by the expert as 'dead before being caught'.

Bycatch events were recorded in all months of the year, with the exception of November 2022 (Table 10). The greatest number of bycatch (all FUR) occurred during July (22%, *n* = 19) and August 2022 (39%, *n* = 34) primarily when targeting hoki (HOK). All other months had less than five bycatch events reported.

[7] 107 of the 109 original observer records could be mapped in Figure 1. However, two entries had no start or end location records, and consequently could not be included in Figure 1.

Table 5. Summary of all marine mammal bycatch events by fishing method for the 2022/23 year that had adequate photos. Species and fishing method codes are the official codes used by Fisheries New Zealand. Species codes: CDD – Common dolphin / aihe, DDO – Dusky dolphin, FUR – New Zealand fur seal / kekeno, HDO – Hector's dolphin / tutumairekurai, HSL – New Zealand sea lion / whakahao. Fishing method codes: BLL – bottom longline; SN – set-net; TWL – trawl; Blank – no entry from observer.

Species code (as identified by expert)	Fishing method (as identified by observer)				Total
	BLL	SN	TWL	Blank	
CDD				1	1
DDO		1			1
FUR	1	2	78	1	82
HDO		1	1		2
HSL			2		2
Total	**1**	**4**	**81**	**2**	**88**

Table 6. Summary of all marine mammal bycatch events by Fishery Management Area (FMA) for the 2022/23 year that had adequate photos. 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: CDD – Common dolphin / aihe, DDO – Dusky dolphin, FUR – New Zealand fur seal / kekeno, HDO – Hector's dolphin / tutumairekurai, HSL – New Zealand sea lion / whakahao. Fishery Management Area codes: CEE (Central East), CHA (Challenger), SEC (South-East Coast), SOE (Southeast), SOI (Sub-Antarctic Islands), SOU (Southland) and Blank (no entry from observer).

Species code (as identified by expert)	Fisheries Management Area (as identified by observer)							Total
	CEE	CHA	SEC*	SOE*	SOI*	SOU	Blank	
CDD							1	1
DDO			1					1
FUR	25	22	22	5	4	3	1	82
HDO			2					2
HSL					2			2
Total	**25**	**22**	**25**	**5**	**6**	**3**	**2**	**88**

* Three of the confirmed bycatch fishing trawls started in SOE and finished in SEC.

Table 7. Summary of all marine mammal bycatch events by target species for the 2022/23 year. Species codes: CDD – Common dolphin / aihe, DDO – Dusky dolphin, FUR – New Zealand fur seal / kekeno, HDO – Hector's dolphin / tutumairekurai, HSL – New Zealand sea lion / whakahao. Target species codes: definitions of all codes are available at https://register.kupe.fishserve.co.nz/home/FindStock

Species code (as identified by expert)	Target species (as identified by observer)											Total
	BAR	BYX	ELE	HOK	JMA	LIN	RCO	SBW	SQU	TAR	Blank	
CDD											1	1
DDO										1		1
FUR	6	3	1	53	5	1			11	1	1	82
HDO			1				1					2
HSL								1	1			2
Total	**6**	**3**	**2**	**53**	**5**	**1**	**1**	**1**	**12**	**2**	**2**	**88**

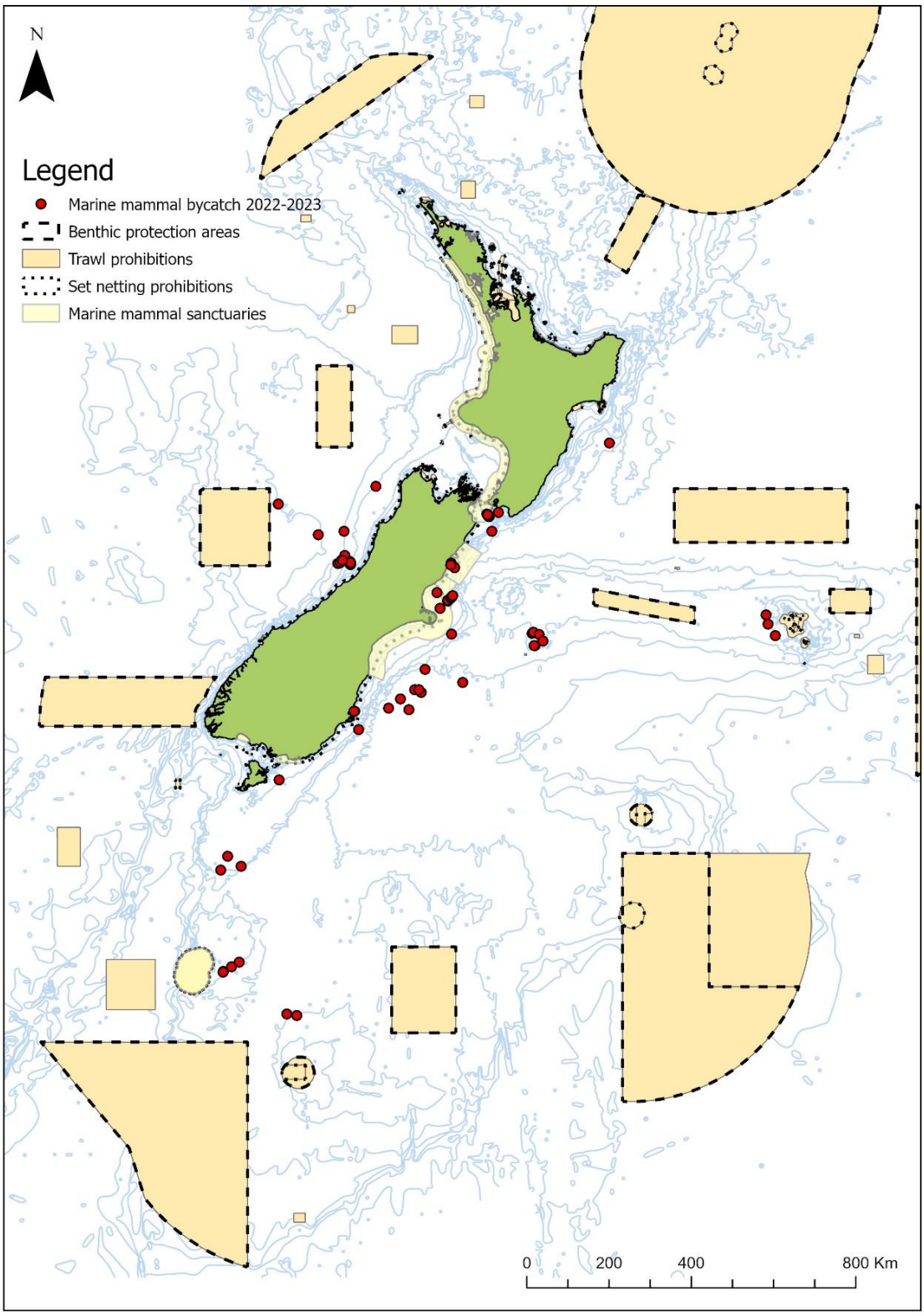

Figure 1. The location of all marine mammal bycatch events reported by observers between 1 July 2022 and 30 June 2023, noting that two bycatch events had no start or end location records and were therefore not included here (107 of 109 reported events included). Source: map created from the Fisheries New Zealand observer bycatch records using ArcGIS Pro 3.1.2 ©Esri Inc.

Table 8. Summary of all marine mammal bycatch events by life status for the 2022/23 year Species codes: CDD – Common dolphin / aihe, DDO – Dusky dolphin, FUR – New Zealand fur seal / kekeno, HDO – Hector's dolphin / tutumairekurai, HSL – New Zealand sea lion / whakahao.

Species code (as identified by expert)	Species life status code					Total
	Alive (1)	Dead (2)	Killed by crew (3)	Decomposing (4)	Unknown (5)	
CDD		1				1
DDO		1				1
FUR	1	79		2		82
HDO		2				2
HSL		2				2
Total	**1**	**85**	**0**	**2**	**0**	**88**

Table 9. Summary of all marine mammal bycatch events by injury status as for the 2022/23 year. Species codes are the official codes used by Fisheries New Zealand: CDD – Common dolphin / aihe, DDO – Dusky dolphin, FUR – New Zealand fur seal / kekeno, HDO – Hector's dolphin / tutumairekurai, HSL – New Zealand sea lion / whakahao. Note: some events have more than one associated injury code, as indicated by multiple code letters (in parentheses). Italicised text = direct quotes from the observers' comments.

Injury status (codes) (as identified by observer)		Species codes (as identified by expert)					Total
		CDD	DDO	FUR	HDO	HSL	
Injured by crew (2)	**(2)**			1			1
Other (O)	**(O)**	1		3	1		5
Froth or foam present in mouth / nostrils (Q)	**(Q)**			12		1	13
Froth or foam present in mouth / nostrils (Q)	**(QR)**			2			2
Body in rigor (R)							
Body in rigor (R)	**(R)**			19			19
Unknown (U)	**(U)**			1			1
Decaying (V)	**(V)**			1			1
Decaying (V)	**(VS)**			1			1
Predated (S)							
Waterlogged (W)	**(W)**		1	4			5
Waterlogged (W)	**(WQ)**			3			
Froth or foam present in mouth / nostrils (Q)							
No visible injuries (Z)	**(Z)**			34	1	1	36
Waterlogged (W)	**(ZW)**			1			1
No visible injuries (Z)							
Total		**1**	**1**	**82**	**2**	**2**	**88**

Table 10. Summary of all marine mammal bycatch events by month for the 2022/23 year. Species codes are the official codes used by Fisheries New Zealand: CDD – Common dolphin / aihe, DDO – Dusky dolphin, FUR – New Zealand fur seal / kekeno, HDO – Hector's dolphin / tutumairekurai, HSL – New Zealand sea lion / whakahao.

Year and month		Species code					Total
		CDD	DDO	FUR	HDO	HSL	
2022	**July**			19			19
	Aug			34			34
	Sept			4		1	5
	Oct			3			3
	Nov						0
	Dec	1		3		1	5
2023	**Jan**			2			2
	Feb			3			3
	Mar			4			4
	Apr			5	1		6
	May			4			4
	June		1	1	1		3
Total		**1**	**1**	**82**	**2**	**2**	**88**

3.8 Photos

Only 88 (81%) of the total events had either photo or video records that could be assessed to confirm taxon identification and other information. The following sections report on the 88 events for which data records and imagery were available.

The remaining 21 (19%) events had no associated photos and therefore could not be assessed. Of the events that were missing photos, 15 (71%) were due to the mammal being alive (and returned to sea either uninjured or injured), the observer making it a priority to return the animal to the sea over taking photos, or because the marine mammal was never brought aboard (e.g. during longlining). Two bycatch entries were coded V, 'tagged / banded and released alive injured'; however, the observer comments described the FUR as dead. This suggests some inconsistencies in the codes being used by the observer.

Where the bycatch was listed as D, 'dead and unmarked', or L, 'not recovered', the observer's comments suggest that either the individual was lost (from the set-net or longline), the individual was too decomposed to tag, or the individual was cut out of the net or line by the crew and discarded overboard before the observer could photograph it.

Of the 88 events with photos (and records), none were described as excellent quality, 9% (n = 8) were good quality, 48% (n = 42) were moderate quality and 43% (n = 38) were poor quality. Overall, there

was a mean of 4.6 (SD = 2.5) photos taken per event. 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' 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 88 events from the 2022/23 year where the observer had assigned sex (and where photos and data records were available), only 16% (*n* = 14) 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, only 17 images included a tape measure for scale, and of these images, the majority appear to have been measured nose to flipper-end (rather than nose to tail-end). This has also been identified as an issue in previous years. 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 provide photographic evidence of length measurements 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 sex assignments were made correctly, with only five corrections made by the expert.

The provision of accurate length measurements and clear genital images is important for confirming sex and age assessments. 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 is genetic testing of observer-collected tissue samples for reviewing the accuracy of observer records (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[8] (DDO)
- Yes – inaccurate = measurement clearly not measured nose to tail or nose to fluke notch.

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

It may also be useful to provide observers with a longer tape measure with clearer numerical divisions (which would be easier to discern in poorly lit or blurred images) and to ensure that at least two measurement verification images are taken: 1) a full body shot with tape measure, and 2) a clear close-up of the final measurement number.

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

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 21 bycatch events where taxon could not be determined (due to lack of photographs), follow-up genetic analysis of routinely collected genetic samples from marine mammals is recommended.

Data entry errors could potentially be reduced if the image sample label headings and database record headings were consistent. For example, the images from 2022–23, had a combination of image sample label headings being used to represent the database 'station_number' heading, such as 'tow/set no.' or 'haul/set no.' or 'fishing event no.' Similarly, the 'Interaction number' is sometimes referred to as the 'interaction number' or the 'sample no.' Consistency between the data record headings and the image label headings could help to reduce data transcribing errors.

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 did not provide 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

As very few 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

The expert confirmed two events where the bycatch individual was assessed as being dead prior to capture. Both events were correctly assigned the bycatch code 4 ('decomposing').

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 2022–23 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, 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

- Of the 21 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.
- Change incorrect sex assignments. Three individuals assigned as female by the observer were classed as male by the expert (6601, 6761, 6761), and one individual assigned as male by the observer was assigned as female by the expert (6613). There was also one observer 'unidentified' entry for sex, which was classed as 'male' by the expert (6626), and one 'not sexed' entry by the observer, which was classed as 'female' by the expert (6820).
- Change incorrect coding. Two bycatch entries were incorrectly coded V, 'tagged/banded and released alive injured', (6739/39/5 & 4). Change to M, 'returned dead and unmarked'.
- Remove the two 'dead prior to capture' bycatch records (6724, 6810).
- Due to the inaccuracies identified and the limited photographic records available to assess most 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.
- Ensure measurement units are recorded as either cm or mm (e.g. 6714/59).
- Other minor inconsistencies in the database are provided in Table 11.

Table 11. Minor database inconsistencies for consideration.

Trip / station / interaction	Database inconsistencies
6610/65	The station number record (65) doesn't match the image 'tow/haul no.' label (66).
6610	The record interaction numbers (2, 3) don't match the images 'sample no.' labels (01, 02).
6610	Remove comma from 'tag_capture' record.
6610	The record csp_tag_number is 6402, but is 6042 in the image.
6645	The record csp_tag_number is 9529, but is 9568 in the image.
6644/10/4	The record interaction number (4) doesn't match the image 'sample no.' label (2).
6645/8/4	The station number record (8) doesn't match the image 'tow/haul no.' label (7).
6645 (all)	Size measurement in mm, change to cm.
6656/08/06	The station number record (8) doesn't match the image 'haul/set no.' label (6).
6714/59	Missing FMA, Start times/end times, fishing method, target species etc.
6714/65	Missing FMA, Start times/end times, fishing method, target species etc.
6720	There was one image from trip 6717 in the 6720 folder.
6734	CSP number not in records or images for HSL and FUR records.
6759	Missing CSP number for HDO.

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6. References

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