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INT2020-02: IDENTIFICATION OF MARINE MAMMALS CAPTURED IN NEW ZEALAND FISHERIES 2020-21

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Prepared for the Department of Conservation

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1. INTRODUCTION

The 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 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 bycaught turtles and protected fish species 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 capture (i.e., bycatch) on various marine mammal species.

The aims of this project were to determine, primarily through examination of photographs, the taxon 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 for upload to FNZ; and (ii) a report summarising the photographs assessed. This report covers data collected from marine mammals captured from 1 July 2020 to 30 June 2021.

2. METHODS

When government observers aboard fishing vessels record an incidental capture of a dead or living marine mammal, a photographic record is often collected. 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 for all marine mammal photographs and their subsequent identification to be examined 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 provenance.

[1] It may not always possible to get imagery in all circumstances (e.g., when the individual isn't bought aboard, or it exits the vessel before a photo can be taken) and 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 was unable to 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 by-caught marine mammals 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 being 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, it was linked to the specific event using other event-specific data (e.g., trip number, date, time, specimen number, etc.).

3. RESULTS

3.1. Data summary

There were 116 marine mammal bycatch events reported between 1 July 2020 to 30 June 2021 (Table 1). Of these events, 94 (81%) had either photos or videos that could be assessed to confirm taxon identification and other information. The remaining 22 (19%) events had no imagery associated with them and were therefore not able to be assessed. The following sections will report on the 94 events for which reasonable photos or video were available. There is some discussion of potential reasons for a lack of photos and / or video in Section 3.8.

Table 1. Summary of marine mammal bycatch events for the 2020/21 year as reported by observers. Species code is the Ministry of Fisheries code used by observers in reporting.

Species code (as identified by observer)	Common name	Species name	Photographic records?		All records
			No	Yes	
BDO	Bottlenose dolphin	*Tursiops truncatus*		1	1
CDD	Common dolphin	*Delphinus delphis*	4	3	7
DDO	Dusky dolphin	*Lagenorhynchus obscurus*		1	1
FUR	New Zealand fur seal	*Arctocephalus forsteri*	17	82	99
HSL	New Zealand sea lion	*Phocarctos hookeri*	1	5	6
ORC	Killer whale	*Orcinus orca*		1	1
PIW	Pilot whale	*Globicephala melas*		1	1
Total			22	94	116

3.2. Species identification

Taxa 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 2020/21 year for which photos or videos were available.

Species code (as identified by expert)	Common species name	No. of events with photos or videos	No. (%) correctly identified to taxa
BDO	Bottlenose dolphin	1	1 (100%)
CDD	Common dolphin	3	3 (100%)
DDO	Dusky dolphin	1	1 (100%)
FUR	New Zealand fur seal	82	82 (100%)
HSL	New Zealand sea lion	5	5 (100%)
ORC	Killer whale	1	1 (100%)
PIW	Pilot whale	1	1 (100%)
Total		94	94 (100%)

3.3. Sex identification

Of the 94 events where photos were available, all events had a sex assignment by the observer[2]. Of the 94 photographed events, only 58 (62%) were able to have the

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

animal's sex confirmed by the expert. In the remaining 36 (38%) events it was not possible for the expert to determine sex[3]. The inability of the expert to identify sex was due to poor photo quality and / or lack of genital imagery, as well as low confidence in length measurements[4].

Of the 58 events where sex could be assigned by the expert, 41 (71%) of expert results had the same sex determination as the observer (Table 3). There were a further 11 events where the expert had assigned sex as either female or male, but the observer had assigned the event as either *sex unable to be determined* or *not sexed* (Table 3). Of the 47 events where both the observer and expert had assigned sex, there was 87% agreement (blue box; Table 3). Of these, all male sex assignments by observers were correct. However, of the 13 individuals assigned as female, only 7 (54%) were assigned as female by the expert.

In the 11 events where the expert was able to assign sex, but the observer did not, sex assignments should have been able to be completed by the observer, given they had access to the same photos and measurements as the expert. In some of these cases, the lengths of the bycaught individuals were considerably longer than the maximum length of a female fur seal and therefore, it should have been possible for the observer to assign sex. This suggests that some additional training and information may be useful to aid observers' sex determination although it is important to note that there was still a relatively high agreement (i.e., 87%) between observer and expert sex assignment where both were able to assign sex.

Table 3. Cross-reference of sex identification of bycaught marine mammals by observer and experts during the 2020/21 year for which photos were available. Note: 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 agreed with expert observation. The blue box shows where both observer and expert assigned sex.

Sex (as identified by observer)	**Sex (as confirmed by expert)**				**Total**
	1(M)	**2(F)**	**3(U)**	**4(N)**	
1 (M)	34		15	3	52
2 (F)	6	7	7	2	22
3 (U)	9		7	1	17
4 (N)	2		1		3
Total	51	7	30	6	94

[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 only provides a single line of evidence, relies on accurate observer measurements, is species-specific and is biased to determining only large males, therefore it has only been used here as an additional line of evidence, alongside clear sexually dimorphic characteristics (genitals, perpetual openings, fur manes, etc) in photographs.

[4] Based on events where body profile photos included a tape measure (for scale) the majority appear to have been measured 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 cross sections of teeth, earwax plugs, examination of sexual organs and stomach contents (e.g., for milk) and / or DNA molecular methods. This information was not available for these bycaught individuals and therefore general age categories were assigned to individuals 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 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.
- ***Adults*** *(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.

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 those in the juvenile category as there is considerable variation when individuals attain a specific size and sexual maturity. It is likely to be more accurate for very young individuals and fully mature individuals that fit clearly into a single category. We also used experienced marine mammal researchers to improve the accuracy of age class assignment. These people, were familiar with most of the species appearing in these records, assigned age classes where the generalised criteria (listed above) could be ascertained.

Age class could be assigned for 89 (95%) bycatch events (Table 4). Of the events where age could be assigned, 80% (n = 71) of events were estimated to be adults. Thirteen (14%) were assigned as juveniles and a further 5 (6%) as either juveniles or adults. This is an interesting result and could be due a range of possible reasons, including:

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

- 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 from examination of reproductive organs. This may mean that the number of actual number of juveniles is underestimated; and / or
- Many species have different foraging behaviour and ranges between different age classes. Therefore, the fisheries which have most of the bycatch may have a genuinely higher proportion of adults with juveniles foraging elsewhere.

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

Table 4. Summary of marine mammal age class data for bycatch events during 2020/21 for which photos were available. Note: Species codes are the official codes used by Fisheries New Zealand: BDO – bottlenose dolphin; CDD – common dolphin; DDO – dusky dolphin; FUR – New Zealand fur seal; HSL – New Zealand sea lion; ORC – killer whale; PIW – pilot whale.

Species code (as identified by expert)	Age class assignment					Total
	Calf	Juvenile	Juvenile/Adult	Adult	Indeterminate	
BDO		1				1
CDD		1	1	1		3
DDO				1		1
FUR		9	2	66	5	82
HSL		2	1	2		5
ORC			1			1
PIW				1		1
	0	13	5	71	5	94

3.5. Dead before being caught

There are some events where 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,

[6] Based on events where body profile photos included a tape measure (for scale) most of the observer size length records for FUR appear to have been measured nose to flipper-end, rather than nose to tail-end.

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 have the field *decomposing* within the *life status* category that distinguishes between a marine mammal capture which was clearly dead before being caught versus a marine mammal that was likely killed in that fishery event. There were three events recorded by observers as life status 4 (*decomposing*), comprising 2 fur seals and 1 bottlenose dolphin. All three events were confirmed by experts as being likely to have already been dead before they were caught and therefore, they should not be counted towards bycatch totals.

However, there were three additional events where observers had assigned the bycatch code 2 (dead) and experts determined that the event should be code 4 (decomposing). These three events can be identified as CSP tag numbers 8134, 6464 and 10291. Animal 10291 had been caught dead five days previously and tagged, therefore the second record for this event should be removed but the first record retained. It is suggested that the life status code be updated for this capture within the database. Details of these events have not been reported here due to privacy issues, but details are available from DOC upon request.

3.6. Provenance

Provenance is the likely origin of a bycaught individual. It is only possible to determine the provenance of an individual if it has been previously marked (e.g., tagged, branded, biopsied) and that marking data are available. Genetic / biopsy samples were not collected or examined here, thus it was not possible to tie the individual 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 / biopsy marks in the data provided. There are two observer columns for tag entry, one labelled *csp_tag_number* and the other *tag_capture*. A number of tag disposal numbers[7] have been recorded in both columns, suggesting some uncertainty by observers of the correct data entry requirements.

There were two events where a previously tagged individual was caught including:

- Tag H501 – a New Zealand sea lion. This was a female tagged as a pup in January 2015 at Dundas Island in the Auckland Islands. This would make her

[7] A disposal number is the number of the tag that is placed in a bycaught 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.

approximately 7 years old. She was also previously seen in January 2018 at Sandy Bay on Enderby Island in the Auckland Islands.

- Tag V112 – a New Zealand sea lion. This was a female also tagged as a pup in January 2015 at Dundas Island in the Auckland Islands. This would make her approximately 7 years old. She was also previously seen in February 2018 at Teal Lake on Enderby Island in the Auckland Islands.

Both events should be added into the DOC New Zealand sea lion data base to record the deaths of these individuals.

3.7. Fishery data

The following figures provide a brief summary of all bycatch events for which there were adequate photos from the 2020/21 year (n = 94) in relation to fishing areas, injury status, month of event and fishing methods. It is important to note that this report does not include those bycatch events in 2020/21 that did not have adequate photos (n = 22).

Most (82%; n = 78) bycatch events with adequate photos were captures in a trawl fishery (i.e., combined BT and TWL events; Table 5). However, it is worth mentioning that there were a number (n = 16) of observer bycatch events recorded in the surface longline fishery as well, but these events were not able to be confirmed due to lack of photographic evidence (e.g., often bycaught individuals are not brought aboard but are released alive when the line is cut) and therefore have not been included further in this report.

Of the bycatch events, there was a reasonable geographic spread of captures around New Zealand, but most events were recorded in the SEC (Southeast Coast) and SOU (Southland) Management Areas (27% (n = 25) and 17% (n = 16), respectively) (Table 6; Figure 1). Marine mammal bycatch events were recorded for 16 different target species with the main target species being squid (SQU) and hoki (HOK), comprising 34% (n = 32) and 21% (n = 20), respectively, of all events (Table 7).

Five bycatch events occurred within marine mammal sanctuaries (Figure 1). Of these, there were three captures within the West Coast North Island (WCNI) Marine Mammal Sanctuary of the Central West Fisheries Management Area (CEW, Figure 1) and two were within Te Rohe o Te Whānau Puha / the Kaikōura Whale Sanctuary of the South East Coast (SEC) Fisheries Management Area (Figure 1):

- The northern most WCNI sanctuary capture was a bottlenose dolphin (BDO), caught during 7 February 2020. The BDO was captured 4.1 nautical miles (7.6 km) from the nearest coastline (Kawhia Harbour Heads). The fishing method used during the capture was bottom trawling (BT). The capture was

outside the trawling prohibition boundary and occurred prior to the trawling prohibition measures coming into effect (MPI 2020[8])[9].

- The other two WCNI captures were New Zealand fur seals (FUR). The fishing method used during both captures was set netting (SN). The captures occurred on separate sets during the same vessel trip, on 5 and 6 of August 2020. The FUR captures were both approximately 5 nautical miles (9.3 km) from the nearest coastline (Taranaki Harbour break wall). At the time, the captures were outside the set net prohibition boundary (captures were prior to the set net prohibition measures coming into effect[10]).
- Two FUR were also captured within the Kaikōura Whale Sanctuary. The individuals were from two separate set net (SN) events, from two different vessels (on 20 January and 25 June 2021). Both were outside of the set net prohibition area (Figure 1).

Almost all (91%; n = 86) of the marine mammal bycatch events had the individual recorded as dead, but some (2%; n = 2) individuals were captured alive (Table 8). The number of live observer bycatch records with no associated photographs for identification verification, was higher (n = 20). It would be valuable to collect photos of live animals; however, it is understood that the focus is on returning the animal safely to sea and that some individuals are never brought aboard (e.g., when longlining).

Many (56%; n = 53) bycaught animals were recorded as having no visible injuries in the relevant data column; however, there were a range of (sometimes multiple) injury codes reported by the observer (Table 9). The most prevalent injury was ‘waterlogged’, which was used for 9 bycatch events. Other injuries were also noted but there were no consistent patterns obvious. The code for ‘other’ injuries often had associated comments in the ‘notes’ column. Review of the comments suggests some injury coding inconsistencies, as many of these events could have been coded J (hook in mouth), O (other) or U (unknown).

There were bycatch events in all months of the year. The most bycatch in a single month was April 2021 with 21% (n = 20) of the annual bycatch events occurring (Table 10). Most of the bycatch during April 2021 was from fishing events targeting squid (SQU). The next highest months for bycatch were August 2020 (15%, n = 14)

[8] MPI 2020. Ministry for Primary Industries. Fisheries New Zealand. New fisheries measures to support the Threat Management Plan for Hector’s and Maui Dolphins - Factsheet. 2 pgs. Note: measure came into effect 1 October 2020.

[9] An extension to commercial trawl closures between Maunganui Bluff and Pariokariwa Point was put in place on the 1 October 2020 (MPI 2020), extending south to the Waiwhakaiho River (New Plymouth) and to 4 nautical miles offshore. This falls within the central Māui dolphin habitat zone (MPI 2020).

[10] New fisheries measures to support Threat Management Plan for Hector’s and Maui dolphins came into effect on 1 October 2020 (MPI 2020). Set-net closures were extended between Maunganui Bluff and the Waiwhakaiho River (New Plymouth) from 7 nautical miles to 12 nautical miles offshore, as well as between the Waiwhakaiho River and Hawera from 2 nautical miles to 7 nautical miles offshore (MPI 2020).

and September 2020 (13%, n = 12). These events occurred primarily when targeting hoki (HOK) and southern blue whiting (SBW).

Table 5. Summary of all marine mammal bycatch events for the 2020/21 year that had adequate photos by fishing method. Species and fishing method codes are the official codes used by Fisheries New Zealand. BDO – bottlenose dolphin; CDD – common dolphin; DDO – dusky dolphin; FUR – New Zealand fur seal; HSL – New Zealand sea lion; ORC – killer whale; PIW – pilot whale. Fishing method codes: BLL – Bottom long line; BT – Bottom trawl; SLL – Surface long line; SN – Set net; TWL – Trawl.

Species code	**Fishing method**					
(as identified by expert)	BLL	BT	SLL	SN	TWL	**Total**
BDO		1				1
CDD	1		1		1	3
DDO					1	1
FUR		4	1	12	65	82
HSL					5	5
ORC			1			1
PIW					1	1
Total	1	5	3	12	73	94

Table 6. Summary of all marine mammal bycatch events for the 2020/21 year that had adequate photos by Fishery Management Area (FMA). Species and FMA codes are the official codes used by Fisheries New Zealand. BDO – bottlenose dolphin; CDD – common dolphin; DDO – dusky dolphin; FUR – New Zealand fur seal; HSL – New Zealand sea lion; ORC – killer whale; PIW – pilot whale. Fishery Management Area codes: AKE (Auckland East), AKW (Auckland West), CEE (Central East), CHA (Challenger), SEC (Southeast Coast), SOE (Southeast), SOI (Sub-Antarctic Islands), SOU (Southland) and SUB (Sub-Antarctic).

Species code	**FMA sub totals**										**Total**
(as identified by expert)	AKE	AKW	CEE	CEW	CHA	SEC	SOE	SOI	SOU	SUB	
BDO		1									1
CDD	1		1		1						3
DDO						1					1
FUR		1	8	3	12	24	4	5	16	9	82
HSL								5			5
ORC			1								1
PIW					1						1
Total	1	2	10	3	14	25	4	10	16	9	

1. One of the confirmed bycatch fishing trawls started in the CEE and finished in the CHA FMA.
2. One of the unconfirmed bycatch fishing trawls started in CHA and finished in the CEE FMA.
3. Three of the confirmed bycatch fishing trawls started in the SOE and finished in the SEC FMA.

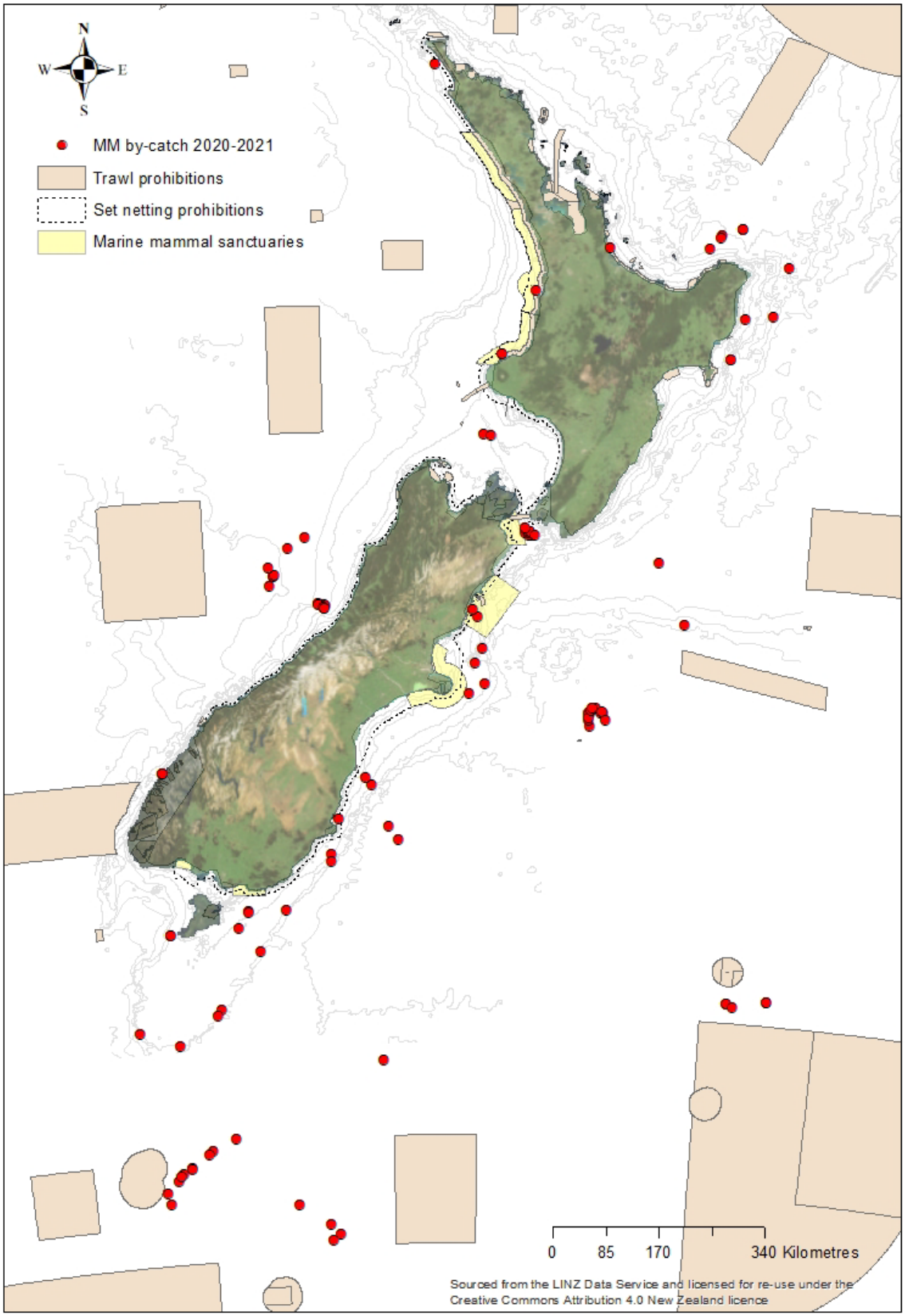

Figure 1. The location of all marine mammal bycatch events reported between 1 July 2020 and 30 June 2021.

Table 7. Summary of all marine mammal bycatch events for the 2020/21 year by target species. Species codes are the official codes used by Fisheries New Zealand: BDO – bottlenose dolphin; CDD – common dolphin; DDO – dusky dolphin; FUR – New Zealand fur seal; HSL – New Zealand sea lion; ORC – killer whale; PIW – pilot whale. Target Species codes: Definition of all codes are available at the following website: https://register.kupe.fishserve.co.nz/home/FindStock.

Species code (as identified by expert)	**Target species**																**Total**
	BAR	GUR	HAK	HOK	JMA	LIN	SBW	SCH	SCI	SNA	SQU	STN	SWA	SWO	TAR	WAR	
BDO		1															1
CDD		1								1		1					3
DDO				1													1
FUR	7	1		19	2	1	8	8	1		27	1	1		3	3	82
HSL											5						5
ORC														1			1
PIW			1														1
Total	7	3	1	20	2	1	8	8	1	1	32	2	1	1	3	3	94

Table 8. Summary of all marine mammal bycatch events for the 2020/21 year by life status. Species codes are the official codes used by Fisheries New Zealand: BDO – bottlenose dolphin; CDD – common dolphin; DDO – dusky dolphin; FUR – New Zealand fur seal; HSL – New Zealand sea lion; ORC – killer whale; PIW – pilot whale.

Species code (as identified by expert)	**Species life status code**					
	Alive	Dead	Killed by crew	Decomposing	Unknown	**Total**
BDO				1		1
CDD	1	2				3
DDO		1				1
FUR		78		4		82
HSL		5				5
ORC	1					1
PIW				1		1
Total	2	86	0	6	0	94

Table 9. Summary of all marine mammal bycatch events for the 2020/21 year by observer described injury status. Species are the official codes used by Fisheries New Zealand: BDO – bottlenose dolphin; CDD – common dolphin; DDO – dusky dolphin; FUR – New Zealand fur seal; HSL – New Zealand sea lion; ORC – killer whale; PIW – pilot whale. Note: some events have more than one injury code associated as indicated by '&' between codes.

	Species codes (as identified by expert)							**Total**
Injury status codes	BDO	CDD	DDO	FUR	HSL	ORC	PIW	
Open wound				2			1	3
Bleeding from orifices		1						1
N/A						1		1
Froth or foam present in mouth/nostrils				4	1			5
Froth or foam present in mouth/nostrils & waterlogged				2				2
Broken flipper & open wound & severed body part				1				1
Body in rigor				9	1			10
Body in rigor & waterlogged				2				2
Body in rigor & waterlogged & bleeding from orifices		1						1
Unknown		1		2				3
Other				8				8
Other & severed body part	1							1
Waterlogged				2				2
Waterlogged & open wound				1				1
Waterlogged & no visible injuries				2				2
No visible injuries			1	47	2			50
No visible injuries & body in rigor					1			1
Total	1	3	1	82	5	1	1	94

Table 10. Summary of all marine mammal bycatch events for the 2020/21 year by month. Species codes are the official codes used by Fisheries New Zealand: BDO – bottlenose dolphin; CDD – common dolphin; DDO – dusky dolphin; FUR – New Zealand fur seal; HSL – New Zealand sea lion; ORC – killer whale; PIW – pilot whale.

		Species Code							
Year and month		BDO	CDD	DDO	FUR	HSL	ORC	PIW	**Total**
2020	Jul		1		4			1	6
	Aug				14				14
	Sep			1	11				12
	Oct								0
	Nov				1				1
	Dec				2	1			3
2021	Jan				5	2			7
	Feb	1	1		2	1			5
	Mar		1		5	1			7
	Apr				20				20
	May				8		1		9
	Jun				10				10
Total		1	3	1	82	5	1	1	94

3.8. Photos

As noted in Section 3.1, there were 94 (81%) bycatch events with photos that could be assessed to confirm taxon identification and other information. The remaining 22 (19%) events had either no photos associated with them or had poor quality photos and therefore were not able to be assessed. Of the events that were missing photos, 20 (91%) were due to the mammal being alive and either the observer made the priority to return it to the sea (over taking photos), or that the marine mammal was never brought aboard (e.g., longlining).

Of the 94 events with photos, 6% (n = 6) were excellent quality, 6% (n = 6) were of good quality, 79% (n = 74) were of moderate quality and 9% (n = 8) were of poor quality. Overall, there were a mean of 5.1 (SE = 0.4) photos taken per event. It is important to note that a photo group was deemed to be good quality 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, body (with tape measure for scale), had good lighting and images were in focus.

Of the 94 events from the 2020/21 year where the observer had assigned sex, only 37% (n = 35) 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, there were no photos 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 in what photos to collect, for what purpose and how to collect high quality photos.
- 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 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 photos. 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 can help when there is inadequate lighting.
- Accurate observer length measurements are a useful line of evidence for sex and age identification. However, based on the 28 events where body profile photos included a tape measure (for scale), over half (57%, n = 16) appear to have been measured nose to flipper-end, rather than nose to tail-end. 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. DISCUSSION AND RECOMMENDATIONS

Overall, the observers did an excellent job in identifying species of marine mammals. The only potential improvement would be more consistent length measurement. Although there were only a limited number of photos to confirm the identification of

sex by observers, they performed well, with all male sex assignments made correctly but less than half of female sex assignments. The provision of accurate length measurements and clear genital images is essentials 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.

There are some recommendations from the review of observer data:

- ***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 sampling of reproductive organs) 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 bycaught individual. To partly address this, the field *length measurement accuracy* was added to the data set, 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), and
  - Yes – inaccurate = measurement clearly not measured nose to tail or nose to fluke notch.

  If additional detail and a higher level of accuracy is required (e.g., actual age in years or reproductive status), then additional sampling (e.g., collection of teeth and reproductive organs) and analysis (e.g., tooth reading, histology, genetic aging) will be required.
- ***Data records:*** Where images or data were not available (or were incomplete) the accuracy of marine mammal identifications was not able to be evaluated. It is important that data collected from observers are managed appropriately to ensure that all records and 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 22 by-catch events where taxon was unable to be determined (due to lack of photographic records), 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

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

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 it is noted that it is a particularly challenging environment to try and collect photos. Further photographic training and solutions into 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 was able to be confirmed for 50% of events with photos, which means that 50% of sex assignments could not be confirmed by the expert. Combining this with the 22 records which didn't have any photos or useable images, that means the 69 events or 59% of all bycatch could not have the observer-assigned sex confirmed. This is pretty low. Any notes and descriptions of sex identification methods should be reviewed and updated where necessary especially for female sex determination. It is also important to provide clear descriptions of the photos necessary to confirm the sex of an individual so that they can be confirmed independently as only 41% of events had photos of sufficient quality to confirm sex.
- ***Dead before being caught:*** There are some events where a marine mammal is brought aboard but which 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 and address this issue as these events should not be attributed to the fishery as a mortality event. We recommend that a similar field is added to the observer reporting forms to distinguish between a marine mammal capture which was clearly dead before being caught vs a marine mammal that was likely killed in that fishery event. The experts identified three additional events where the bycaught individual was assessed as being dead prior to capture which will need to be amended in the Ministry of Fisheries database.
- ***Flipper tags or other identifying marks:*** To determine the provenance of a bycaught individual it is necessary for that individual to have been previously marked (e.g., tagged, branded, microchipped, biopsied). If a marked individual is caught it is essential that details of the mark are recorded. We recommend the following: (i) several high-quality photos are taken of the mark. If there is more than one mark (e.g., two tags or a tag and a brand), independent photos should be taken of both marks; (ii) the observer should attempt to read and confirm the mark and record that on their data sheet; and (iii) ideally, flipper tags would be removed from the individual and returned ashore for confirmation.

With respect to data recording, there was no clear designation of a column specifically for provenance-related tags / brands / biopsy marks in the data provided. There are two observer columns for tag entry, one labelled *csp_tag_number* and the other *tag_capture*. A number of tag disposal numbers were recorded in both columns, and a single tag note was provided in the observer *comments* column, suggesting some uncertainty by observers of the correct data entry requirements. It is recommended that there is clear designation of a column specifically for provenance related tags and marks.

5. 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 that they do. We would also like to thank Shannon Weaver 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.

6. APPENDIX

Appendix 1. Electronic data file to be sent separately.