CAWTHRON

REPORT NO. 3706

INT2017-03: IDENTIFICATION OF MARINE MAMMALS CAPTURED IN NEW ZEALAND FISHERIES 2019/20

INT2017-03: IDENTIFICATION OF MARINE MAMMALS CAPTURED IN NEW ZEALAND FISHERIES 2019/20

OLIVIA JOHNSTON, SIMON CHILDERHOUSE

Prepared for the Department of Conservation

CAWTHRON INSTITUTE
98 Halifax Street East, Nelson 7010 | Private Bag 2, Nelson 7042 | New Zealand
Ph. +64 3 548 2319 | Fax. +64 3 546 9464
www.cawthron.org.nz

REVIEWED BY:
Deanna Clement

APPROVED FOR RELEASE BY:
Grant Hopkins

ISSUE DATE: 26 October 2021

RECOMMENDED CITATION: Johnston O, Childerhouse S 2021. INT2017-03: Identification of marine mammals captured in New Zealand fisheries 2019/20. Prepared for the Department of Conservation. Cawthron Report No. 3706. 17 p. plus appendix.

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 INT2017-03. 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 2019 to 30 June 2020.

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. The CSP undertakes a review of all photographs obtained from marine mammal interactions to confirm important information. Cawthron is undertaking this expert review under contract to the CSP. 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.

Details on the date, time, location and fishery data (e.g., fishing method, fishery area and target species) linked to capture events are 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 114 marine mammal bycatch events reported between 1 July 2019 to 30 June 2020 (Table 1). Of these events, 67 (59%) had photos and 3 (3%) had videos that could be assessed to confirm taxa identification and other information. The remaining 44 (39%) events had no imagery associated with them and were therefore not able to be assessed. The following sections will report on the 70 events for which reasonable photos or video were available. There is some discussion of potential reasons for a lack of photos in Section 3.8.

Table 1. Summary of marine mammal bycatch events for the 2019/20 year as reported by observers. Note: Species codes are the official codes used by Fisheries New Zealand: FUR – New Zealand fur seal; HSL – New Zealand sea lion; DDO – dusky dolphin.

Species code (as identified by observer)	Common name	Species name	Photographic records?		All records
			No	Yes	
FUR	New Zealand fur seal	*Arctocephalus forsteri*	44	68	112
HSL	New Zealand sea lion	*Phocarctos hookeri*	0	1	1
DDO	Dusky dolphin	*Lagenorhynchus obscurus*	0	1	1
Total			44	70	114

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 2019/20 year for which photos or videos were available. Note: Species codes are the official codes used by Fisheries New Zealand: FUR – New Zealand fur seal; HSL – New Zealand sea lion; DDO – dusky dolphin.

Species code (as identified by expert)	No. of events with photos or videos	No. (%) correctly identified to taxa
FUR	68	68 (100%)
HSL	1	1 (100%)
DDO	1	1 (100%)
Total	70	70 (100%)

3.3. Sex identification

Of the 70 events where photos were available, all events had a sex assignment by the observer. Some of the sex identification categories assigned were reported numerically (1–4[1]) and some used letters (M, F, U and N[2]).This difference was due to an update in reporting from the non-fish bycatch form to the protected species interaction form during this reporting period.

Of the 70 photographed events, only 41 (59%) were able to have the animal's sex confirmed by the expert. In the remaining 29 (31%) events it was not possible for the

[1] Sex codes: 1 – male, 2 – female, 3 – sex unable to be determined, 4 – not sexed.
[2] Sex codes: M – male, F – female, U – sex unable to be determined, N – not sexed.

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 41 events where male or female sex could be assigned by the expert, 36 (88%) of expert results had the same sex determination as the observer (Table 3). There were a further 5 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 36 events where both the observer and expert had assigned sex, there was 100% agreement (blue box; Table 3). In the 5 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 complete agreement 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 2019/20 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.

Sex (as identified by observer)	**Sex (as confirmed by expert**				**Total**
	1(M)	**2(F)**	**3(U)**	**4(N)**	
1 (M)	35	0	1	14	50
2 (F)	0	1	3	6	10
3 (U)	3	0	0	4	7
4 (N)	2	0	0	1	3
No code	0	0	0	0	0
Total	40	1	4	25	70

[3] Male gender can often be established 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, 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 the 28 events where body profile photos included a tape measure (for scale) the majority (57%, n = 16) appear to have been measured nose to flipper-end, rather than nose to tail-end.

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 – 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 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 assign an age class who were familiar with most of the species appearing in these records to improve the accuracy of age class assignment.

Age class could be determined for 70 (100%) bycatch events (Table 4). Of the events where age could be assigned, 96% (n = 67) of events were estimated to be adults with low numbers of calves, pups and/or juveniles (n = 3). This is an interesting result and could be due a range of possible reasons, including:

- It can be challenging to accurately determine a juvenile from an adult from photos and 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 and 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 histopathology samples for examination by an expert.

Table 4. Summary of marine mammal age class data for bycatch events during 2019/20 for which photos were available. Note: Species codes are the official codes used by Fisheries New Zealand: FUR – New Zealand fur seal; HSL – New Zealand sea lion; DDO – dusky dolphin.

Species code (as identified by expert)	Age class assignment					Total
	Calf	Juvenile	Juvenile/Adult	Adult	Indeterminate	
FUR		2		66		68
HSL		1				1
DDO				1		1
Total	0	3	0	67	0	70

3.5. Dead before being caught

There are some events where a marine mammal is caught 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 have the field *decomposing* within the *life status* category that distinguishes between a marine mammal capture which was clearly dead before being caught vs a marine mammal that was likely killed in that fishery event. However, in one event in 2019/20, experts determined from photos that it was likely that the carcass had been dead prior to capture even though the observer had not noted that as such. It is suggested that the life status code be updated for this capture within the database.

In 2019/20, there was only one FUR bycatch event classed as decomposing by the observer. Lice and decomposition were evident in photos (where available), confirming the observer's findings/comments. As well as this, there was another FUR bycatch event (#5892) classed as *Dead* by the observer, that based on the images

provided, appeared to be in a state of decomposition, this record was classed by the expert as being *Dead before being caught*. This record needs to be corrected in the COD database. Given the state of decomposition in both examples, it is considered unlikely that the two specimens were killed in the fishery event where it was caught. Details of this event 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.

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[5] have been recorded in both columns, suggesting some uncertainty by observers of the correct data entry requirements.

There was a single reference to a potential flipper tag from one FUR bycatch event recorded within the *comments* column, with the observer noting that there was a hole in the flipper from a lost study tag (note, specimen was not considered to be *dead before capture,* so unlikely to be a recapture situation). There were no other mentions of provenance in the data set.

3.7. Fishery data

The following figures provide a brief summary of all bycatch events for which there were adequate photos from the 2019/20 year (n = 70) 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 2019/20 but that did not have adequate photos (n = 70).

Almost all (93%; n = 65) bycatch events with adequate photos (i.e., combined BT and TWL events; Table 5 (n = 70)) were captures in a trawl fishery. However, it is worth mentioning that there were a number (n = 37) 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

[5] 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.

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 CEE (Central East) Management Areas with 24% (n = 17) and 21% (n = 15), respectively (Table 6; Figure 1). Marine mammal bycatch events were recorded for 11 different target species with the main target species being hoki (HOK) and squid (SQU), comprising 36% (n = 25) and 33% (n = 23), respectively, of all events (Table 7).

Almost all (94%; n = 66) of the marine mammal bycatch events had the individual recorded as dead, but some (4%; n = 3) individuals were captured alive (Table 8). The number of live observer bycatch records with no associated photographs for identification verification, was higher (n = 38). This lack was most likely due to the fact it is difficult to take photographs of live marine mammals while efforts are focussed on safely returning them to sea or that some individuals are never brought aboard (e.g., longlines). Many (56%; n = 39) 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. The most prevalent being 'froth or foam present in mouth/nostrils,' which was used for 14 bycatch events. Of these, half were associated with 'bleeding from orifices', 'other', 'body in rigor', 'waterlogged' and 'no visible injuries'. The code for 'other' injuries often had associated comments in the notes column (Table 9). 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, with the most (49%; n = 34, Table 10) bycatch events occurring between July–September 2019, and an additional 34 bycatch events over this same period for which the photos were insufficient for identification purposes. Lower bycatch[6] occurred from November to December 2019 (3%, n = 2).

[6] No records without adequate photos during this time.

Table 5. Summary of all marine mammal bycatch events for the 2019/20 year that had adequate photos by fishing method. Species and fishing method codes are the official codes used by Fisheries New Zealand. FUR – New Zealand fur seal; HSL – New Zealand sea lion; DDO – dusky dolphin. Fishing method codes: SLL – Surface long line; SN – Set net; TWL – Trawl, BT – Bottom trawl.

Species code (as identified by observer)	Fishing method				
	BT	SLL	SN	TWL	Total
FUR	1	1	4	62	68
HSL				1	1
DDO				1	1
Total	1	1	4	64	70

Table 6. Summary of all marine mammal bycatch events for the 2019/20 year that had adequate photos by Fishery Management Area (FMA). Species and FMA codes are the official codes used by Fisheries New Zealand. FUR – New Zealand fur seal; HSL – New Zealand sea lion; DDO – dusky dolphin. Fishery Management Area codes: AKE (Auckland East), AKW (Auckland West), CEE (Central East), CHA (Challenger), SEC (Southeast Coast), SOE (Southeast), SOU (Southland), SOI (Sub-Antarctic Islands) and SUB (Sub-Antarctic).

Species code (as identified by expert)	FMA sub totals									
	AKE	AKW	CEE	CHA	SEC	SOE	SOI	SOU	SUB	Total
FUR	1	1	15[1]	8[2]	17	5[3]	11	3	7	68
HSL							1			1
DDO					1					1
Total	1	1	15	8	18	5	12	3	7	70

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.

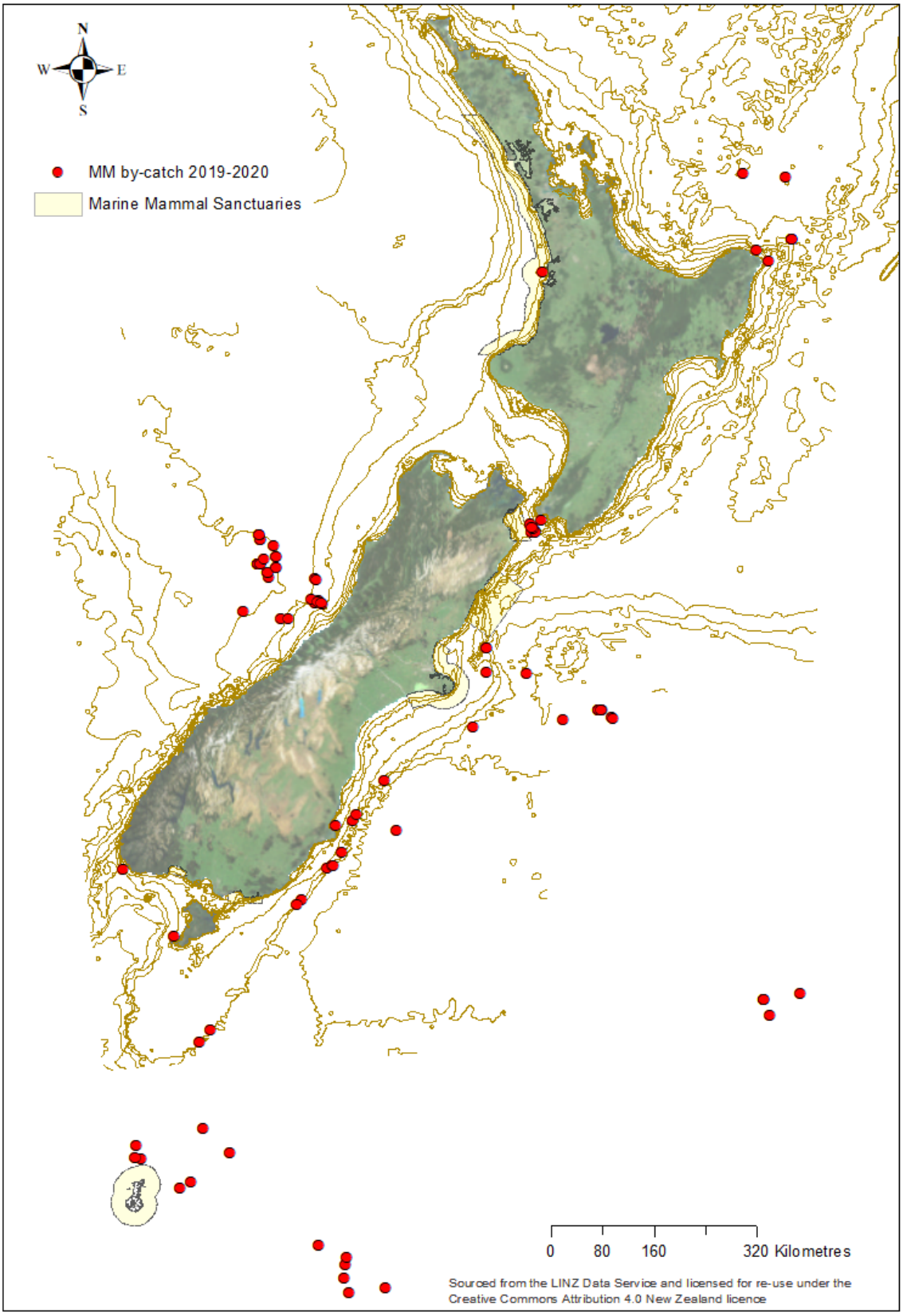

Figure 1. The location of all marine mammal bycatch events reported between 1 July 2019 and 30 June 2020.

Table 7. Summary of all marine mammal bycatch events for the 2019/20 year by Target species. Species codes are the official codes used by Fisheries New Zealand: FUR – New Zealand fur seal; HSL – New Zealand sea lion; DDO – dusky dolphin. Target Species codes: Definition of all codes are available at the following website: https://register.kupe.fishserve.co.nz/home/FindStock.

Target species	Species code (as identified by expert)			
	FUR	HSL	DDO	Total
BAR	1		1	2
GUR	1			1
HOK	25			25
LIN	2			2
SBW	11			11
SCH	3			3
SQU	21	1		23
STN	1			1
TAR	3			3
Total	68	1	1	70

Table 8. Summary of all marine mammal bycatch events for the 2019/20 year by life status. Species codes are the official codes used by Fisheries New Zealand: FUR – New Zealand fur seal; HSL – New Zealand sea lion; DDO – dusky dolphin.

Species code (as identified by observer)		FUR	HSL	DDO	Total
Species life status code	Alive	3			3
	Dead	64	1	1	66
	Killed by crew				0
	Decomposing	1			1
	Unknown				0
	Total	68	1	1	70

Table 9. Summary of all marine mammal bycatch events for the 2019/20 year by observer described injury status. Species and Injury codes are the official codes used by Fisheries New Zealand. FUR – New Zealand fur seal; HSL – New Zealand sea lion; DDO – dusky dolphin. Note: some events have more than one injury code associated as indicated by '&' between codes.

	Species code (as identified by expert)			
	DDO	**FUR**	**HSL**	**Total**
Injury status codes				
Open wound	1			1
Hook in mouth		1		1
Bleeding from orifices		2		2
Bleeding from orifices & waterlogged		1		1
N/A		1		1
Froth or foam present in mouth/nostrils		7	1	8
Froth or foam present in mouth/nostrils & bleeding from orifices		1		1
Froth or foam present in mouth/nostrils & other		2		2
Froth or foam present in mouth/nostrils & body in rigor		1		1
Froth or foam present in mouth/nostrils & waterlogged		1		1
Froth or foam present in mouth/nostrils & waterlogged & no visible injuries		2		2
Body in rigor		5		5
Unknown		2		2
Other		1		1
Waterlogged		1		1
No visible injuries		39		39
No visible injuries & froth or foam present in mouth/nostrils;		1		1
Total	1	68	1	70

Table 10. Summary of all marine mammal bycatch events for the 2019/20 year by month. Species codes are the official codes used by Fisheries New Zealand: FUR – New Zealand fur seal; HSL – New Zealand sea lion; DDO – dusky dolphin.

		Species code (as identified by expert)			
		FUR	HSL	DDO	Total
Year/Month					
2019	Jul	4	1		5
	Aug	12			12
	Sep	17			17
	Oct	4			4
	Nov	1			1
	Dec			1	1
2020	Jan	3			3
	Feb	6			6
	Mar	2			2
	Apr	4			4
	May	9			9
	Jun	6			6
	Total	68	1	1	70

3.8. Photos

As noted in Section 3.1, there were 70 (61%) bycatch events with photos that could be assessed to confirm taxa identification and other information. The remaining 44 (39%) 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, 35 were due to the mammal being alive and the observer making its return to sea the priority (over taking photos), or that the marine mammal was never brought aboard (e.g., longlining). Two other images had notes explaining that the images were missing due to accidental discard by the crew, or simply that the observer never got to see the bycatch. The remaining 7 events provided no explanation for the absence of photos.

Of the 70 events with photos, 6% (n = 4) were excellent quality, 40% (n = 28) were of good quality, 44% (n = 31) were of moderate quality and 10% (n = 7) were of poor quality. Overall, there were a mean of 5.9 (SD = 3) 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 70 events from the 2019/20 year where the observer had assigned sex, only 41% (n = 29) 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), the majority (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 sex assignments (male/female) that were able to be confirmed being correct. On the ten occasions where the observer could not or did not identify the sex, 50% were able to be confirmed as male by the expert. This was (commendably) due to the provision of accurate length measurements and clear genital images for these records.

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 amongst 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 caudal fin notch (DDO), and

  Yes – inaccurate = measurement clearly not measured nose to tail or nose to caudal fin 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, histopathology) 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 44 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 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.
- ***Sex field:*** Some of the sex identification categories assigned to *Observer sex* were reported numerically (1–4) and some used letters (M, F, N and U). It is recommended that a consistent coding approach is adopted.
- ***Sex identification:*** Observer male/female sex was able to be confirmed for 35 male FUR and 1 female DDO, the remaining 40% of observer male/female classifications were not able to be confirmed with the information and photos provided. This leaves a sizable gap in information, particularly around the number of female FUR bycatch, none of which could be verified. 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 48% 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. In addition, we recommend that the FUR bycatch event (#5892) classed as *Dead* by the observer is corrected in the COD database to decomposing as that is the opinion of the expert reviewers.
- ***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 sheets; 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. ACKNOWLDGEMENTS

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. APPENDICES

Appendix 1. Electronic data file to be sent separately.