Māui dolphin photo-identification using artificial intelligence: Progress Report

Rochelle Constantine & Tane van der Boon

MAUI63

Correspondence: tane@maui63.org

Overview

The long-term photo-identification (photo-ID) catalogue of Māui dolphins is curated at the University of Auckland – Waipapa Taumata Rau (UoA). In recent years, this catalogue has been used in the early development of Artificial Intelligence (AI) tools to identify individual dolphins via the MAUI63 drone. In 2022, the Department of Conservation – Te Papa Atawhai (DOC) undertook boat-based photo-ID surveys providing an opportunity to further develop the AI and test whether individual dolphins could be identified from the high-resolution imagery collected via the drone-mounted camera.

This project has the following objectives:

1. Update the Māui dolphin photo-ID catalogue & records of individual sightings
2. Inform further development of the unique fin ID models
3. Improve AI accuracy of the models
4. Incorporate these into a new marine mammal sightings app under development

Results & Discussion

Here, we provide a summary of the DOC and MAUI63 collaboration and a summary of some of the objectives of this work. The MAUI63 drone was deployed from Hamilton's Gap, just south of the Manukau Harbour, which was a core location for the dolphins, on three of the boat-based surveys, 18th February, 1st March and 7th March. There were some challenges with weather conditions and communications between the vessel and the land-based drone pilots, but the communications were quickly resolved.

These flights were a proof of concept to determine whether the AI automatic detection algorithm was able to detect Māui dolphins when we knew dolphins were present as they were observed from by the boat-based researchers. On two days, dolphins were detected with the drone and during one of these, dolphins were detected by the drone but not the boat-based observers. We have high confidence in the AI detector to accurately identify dolphins during drone flights.

1. Māui dolphin photo-ID catalogue

A total of seven boat-based surveys were conducted from 18 February – 7 March 2022, six out of the Manukau Harbour and one out of Whaingaroa – Raglan Harbour. Māui dolphins were sighted on six of those surveys (Figures 1 & 2). A total of 573 images containing parts of or complete Māui dorsal fins were taken throughout these surveys. There were 19 photo-identifications of 13 individual dolphins, no new dolphins were added to the catalogue.

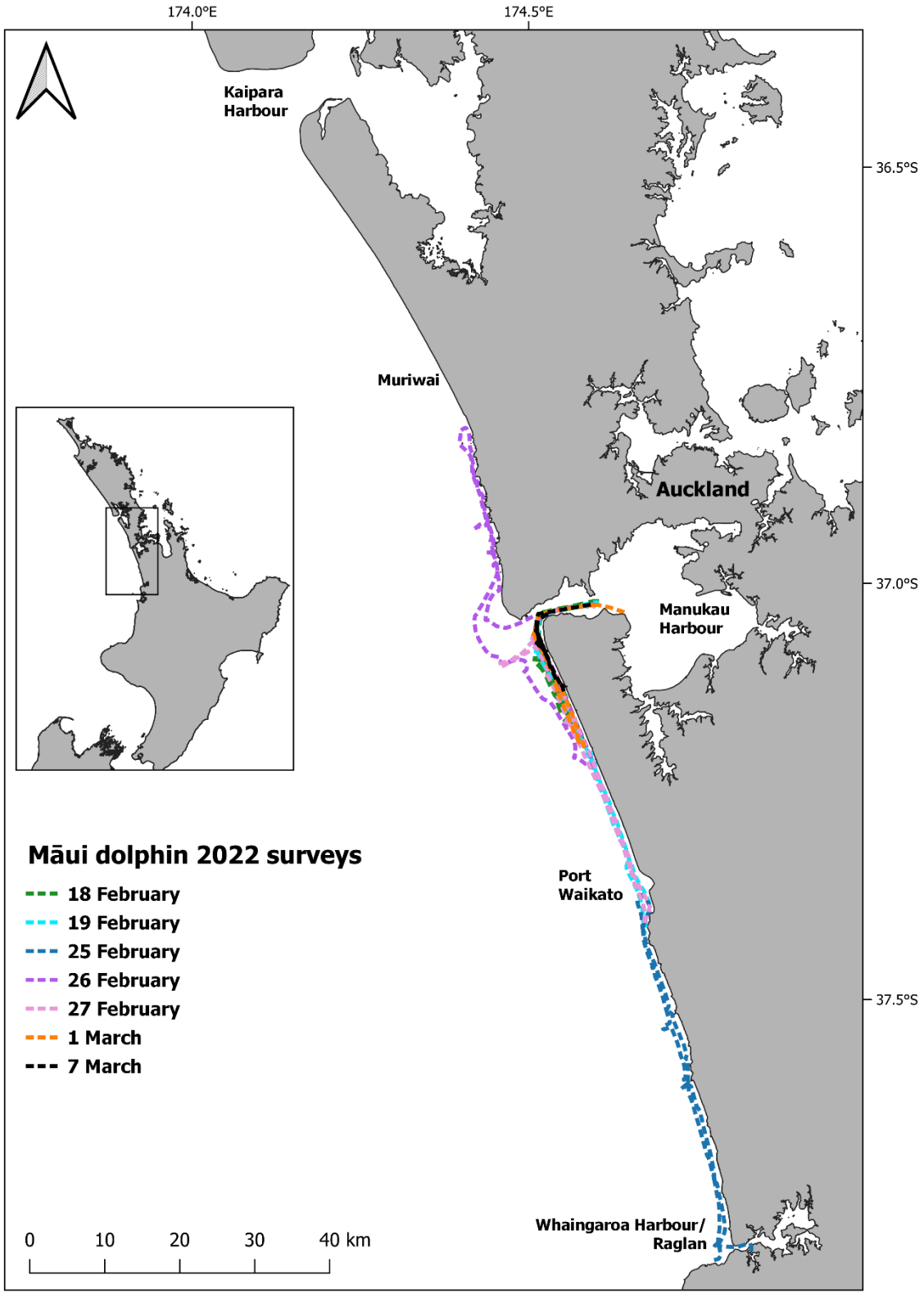

Figure 1. Map of the boat-based surveys undertaken between 18th February and 7th March 2022. Drone flights were conducted on 18 February, 1st and 7th March near Hamilton's Gap.

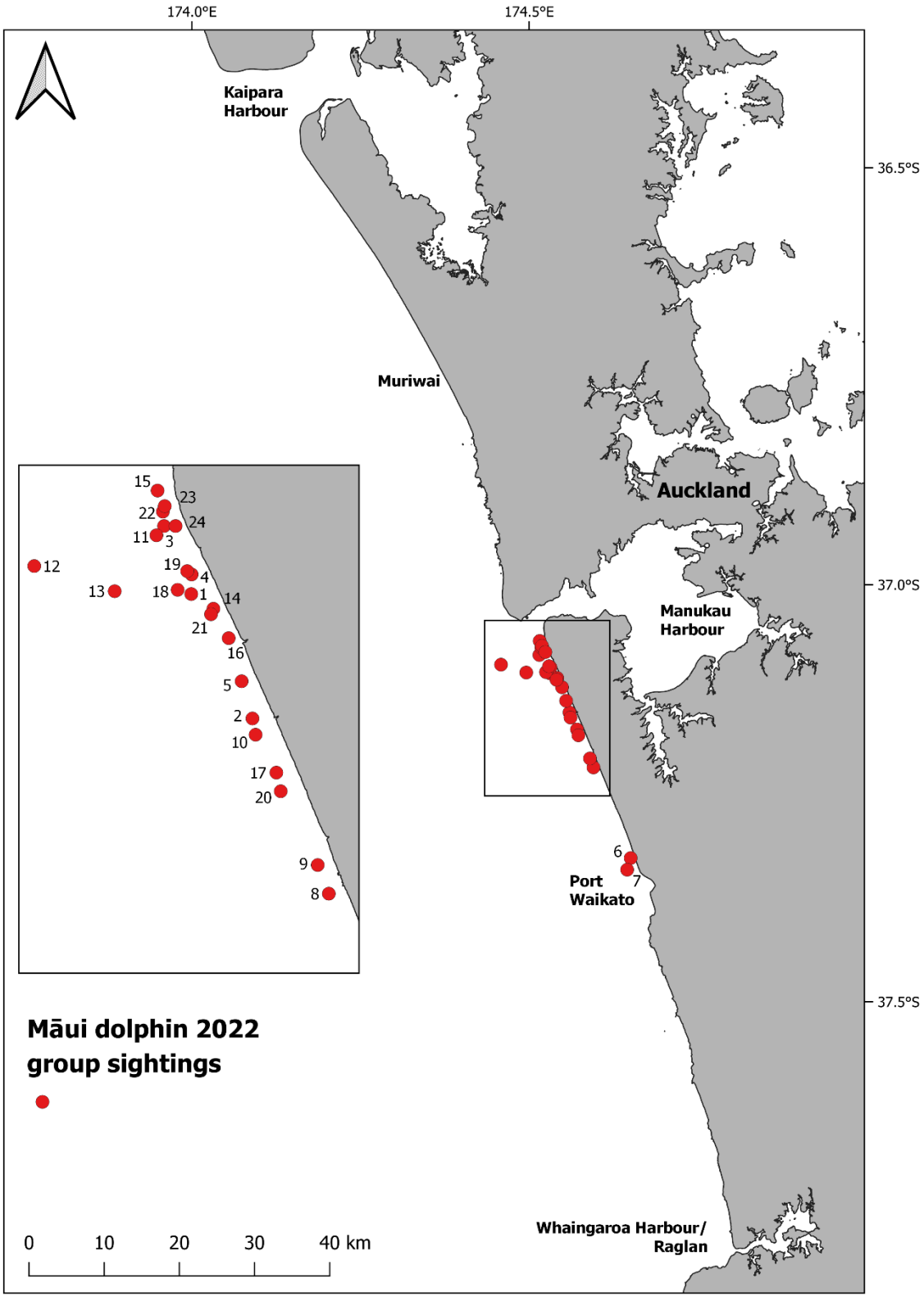

Figure 2. Location of the 24 groups sighted during the boat-based surveys undertaken between 18th February and 7th March 2022.

We have updated the database of sightings for the 13 photo-IDed individual dolphins. These dolphins have been seen on average 6.7 times (range = 3 – 17) between 2005 (ID 118,

M063) and 2022. Two individuals (ID 63, M012 and ID 84, M027) have been sampled and genetically sexed as females (see Appendix 1 for all data).

2. Inform development of the fin ID models

A total of 62 Māui dolphin dorsal fin images were annotated and used in the ongoing improvements in modelling AI accuracy. These include multiple images of individual dolphins to train the algorithm (Table 1).

Table 1. Survey dates when Māui dolphins were photographed in 2022. Of the 573 images taken, 63 were annotated for developing the AI algorithm and there was a cumulative total of 19 matches of 13 individuals in the photo-ID catalogue.

Date	Number of images annotated	Number of matches to catalogue
18 Feb	3	3
19 Feb	22	5
26 Feb	3	1
27 Feb	20	6
1 Mar	14	4
7 Mar	0	0
Total	63	19 (13 individuals)

3. Improve AI accuracy of the models

The AI models for unique fin identification were retrained with the additional data collated and annotated. The model has improved its accuracy (mAP) by ~4% with the addition of new data to 92.7% (Figure 3). Note this accuracy is a comparison to the human against the annotated and catalogued data.

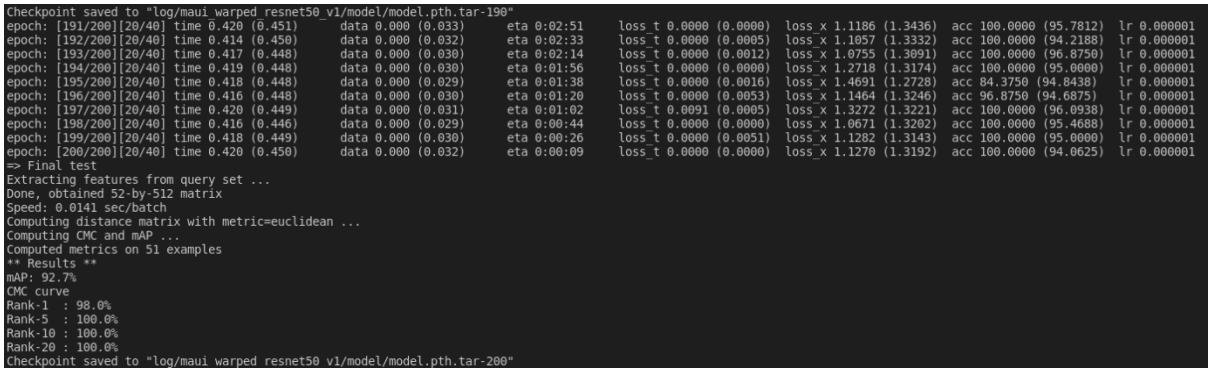

Figure 3. Screenshot of retraining of model completed showing the new accuracy calculation.

The AI model is working and will continue to be refined with ongoing training. Figure 4 shows the comparison between the first image and the following set of images and looking for a match (green) or no match (red).

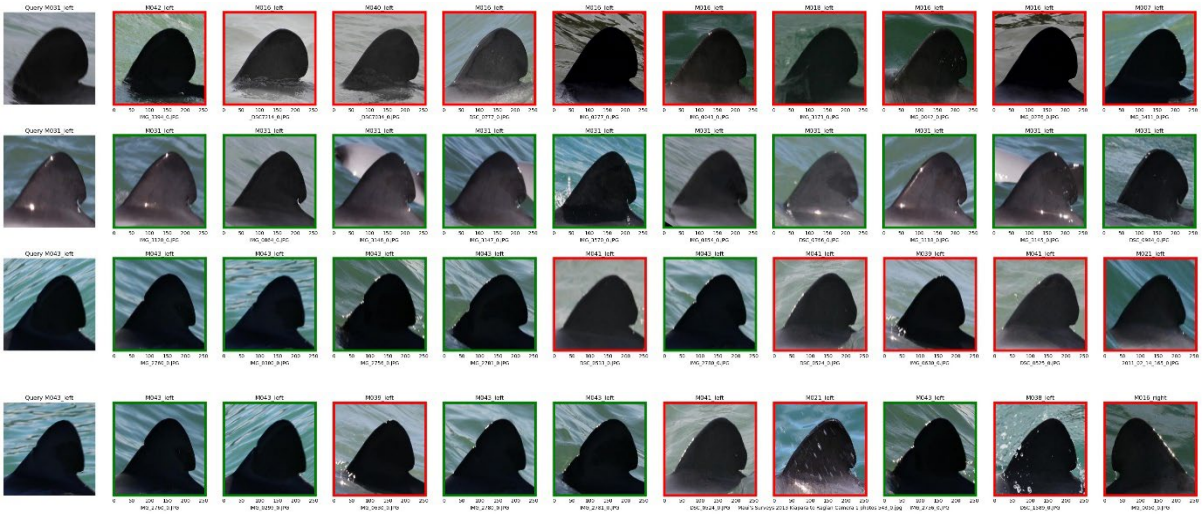

Figure 4. A single Māui dolphin dorsal fin compared to other fins with the AI model determining a match or no match. The names at the top represent the animal ID and the red / green represent correct or incorrect. The figures show how accurate the model is.

4. Incorporate these into a new marine mammal sightings app under development

The above retrained model will primarily be utilised by the new SeaSpotter app with the intention of improving the quality of the data collected and adding the ability to determine which dolphin was spotted, if there is a good quality photo taken. The SeaSpotter app isn't complete yet, but we have completed the deployment of the programmatic API in which you can send a fin image and get an identification result response.

As this is currently only programmatic the below diagram shows the function returning a result for a fin identification in the http response content. In this case we correctly identified M016 and returned a 200 OK.

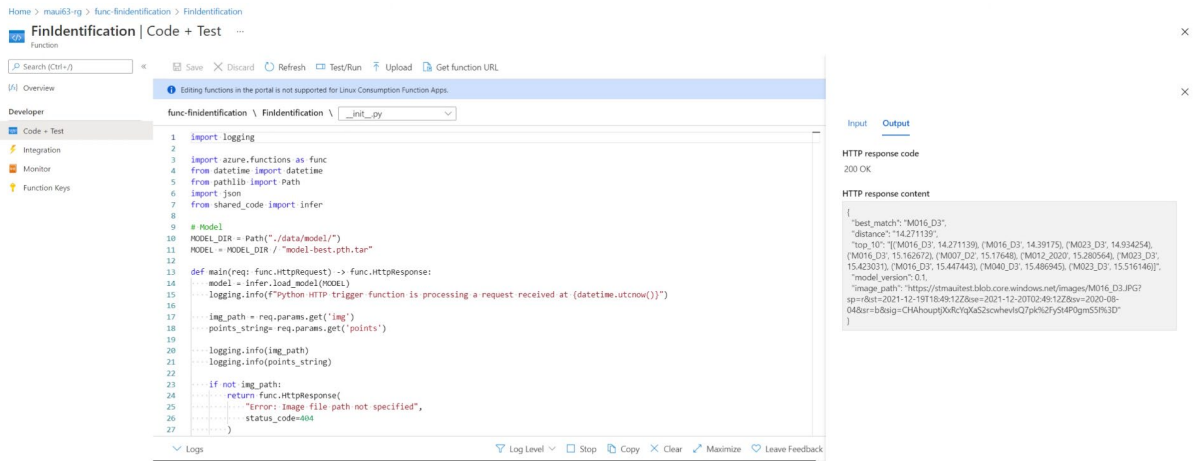

Figure 5. Screen shot of the function returning a dorsal fin identification from the cloud hosted application that the mobile app will consume.

We would like to note we do not expect to see accuracy of ~92% for users of the app. We will need to continue to train the model as real data from real users comes in. It will not be as well-captured as the data the team collects from the research boat. These data are crucial for building a base we can develop on as we collate more data such as angles, distance and lighting conditions.

Acknowledgements

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APPENDIX

Table 1. Sightings data on 13 individual Māui dolphins identified in 2022 as confirmed by genetics (Chem codes) or photo-ID (M codes). The Unique ID and M-codes correspond to the individual number in the photo-identification catalogue provided. Where sex is noted, that has been genetically confirmed. Animals seen in close association with a calf are denoted as F/C (female/calf) and are highly likely females given Māui behaviour. Calves are individuals < half the size of an adult and consistently associated with an adult (presumably the mother), juveniles are smaller than adults but not consistently associated with an adult.

Unique ID	Genetic sex - Male/Female or Female/Calf	Date	Time	Group number	Sample code Chem=DNA; M=Photo-ID	Latitude (S)	Longitude (E)	Group size min	Group size max	Calves	Juveniles
63	F	7-Feb-10	10:05	10	ChemNI10-13/M012	-37.1813	174.5923	10	12	0	2
63	F	14-Feb-11	9:35	2	ChemNI11-02	-37.1762	174.5848	5	6	0	1
63	F	10-Mar-11	10:23	28	M012	-36.5764	174.2237	4	4	0	0
63	F	13-Mar-13	15:39	11	M012	-37.1898	174.5888	6	6	1	1
63	F	11-Feb-10	13:51	28	M012	-37.2480	174.6220	10	15	1	2
63	F	17-Feb-15	9:09	16	Chem15NZ27	-37.1230	174.5613	10	12	1	0
63	F	27-Feb-15	16:30	27	M012	-37.1278	174.5616	9	9	0	0
63	F	28-Feb-15	15:05	34	M012	-37.1292	174.5597	7	7	1	0
63	F	22-Feb-17	10:08	29	M012	-37.1004	174.5424	6	8	0	0
63	F	23-Feb-17	9:20	31	M012	-37.1201	174.5570	12	16	0	1
63	F	24-Feb-17	11:04	X	M012	n/a	n/a	n/a	n/a	n/a	n/a
63	F	31-Jan-18	14:11	7	M012	-37.1380	174.3682	8	12	2	0
63	F	12-Feb-19	13:46	8	M012	-37.0958	174.3482	9	9	2	0
63	F	20-Feb-19	14:21	17	M012	-37.0949	174.3405	7	8	1	0
63	F	13-Feb-20	12:34	6	M012	-36.5054	174.1754	4	4	0	0
63	F	18-Feb-20	16:24	17	M012	-37.1350	174.5607	6	6	0	2
63	F	1-Mar-22	11:02	20	M012	-37.18715	174.5903	4	4	0	0
84	F	21-Feb-11	13:16	19	ChemNI11-25	-37.2581	174.6325	8	8	0	unknown
84	F	21-Feb-11	13:09	19	M027	-37.2595	174.6344	8	8	0	unknown
84	F	27-Feb-15	14:38	25	M027	-37.2122	174.6032	6	12	0	0
84	F	27-Feb-16	13:16	45	Chem16NZ38/M027	-37.1436	174.5729	3	5	0	0

84	F	27-Feb-16	14:20	46	M027	-37.1258	174.5605	8	9	0	0
84	F	5-Mar-16	12:51	65	M027	-37.1160	174.5575	9	12	2	0
84	F	24-Feb-17	13:31	X	M027	n/a	n/a	n/a	n/a	n/a	n/a
84	F	17-Feb-20	12:06	12	M027	-37.1455	174.5700	8	8	1	3
84	F	19-Feb-22	14:48	8	M027	-37.22539	174.6137	4	4	0	0
117		13-Mar-13	12:12	4	M002	-37.2045	174.6009	3	3	0	1
117		1-Mar-15	8:59	36	M002	-37.1060	174.5476	4	4	0	0
117		31-Jan-18	11:59	6	M002	37.0962	174.3474	3	5	0	0
117		12-Feb-19	13:46	8	M002	-37.3122	174.7931	9	9	2	0
117		26-Feb-22	14:11	14	M002	-37.11890	174.5572	5	5	0	0
118	F/C	12-Jan-05			M003	n/a	n/a	n/a	n/a	n/a	n/a
118		13-Feb-15	16:19	9	M003	-37.1348	174.5647	6	7	0	2
118		1-Mar-15	8:59	36	M003	-37.1060	174.5476	4	4	0	0
118		10-Feb-16	9:30	1	M003	-37.1290	174.5630	4	6	0	0
118		12-Feb-16	13:53	10	M003	-37.1835	174.5886	5	7	1	0
118		18-Feb-22	11:32	2	M003	-37.15995	174.5764	3	4	1	0
126		8-Feb-10	11:04	17	M015	-36.7465	174.3635	4	5	0	1
126		19-Feb-22	14:48	8	M015	-37.22539	174.6137	4	4	0	0
131		14-Feb-11	12:46	4	M021	-37.1332	174.5686	8	8	0	2
131		9-Apr-13	13:48	16	M021	-36.5750	174.2326	4	4	0	1
131		17-Feb-15	9:09	16	M021	-37.0998	174.5476	10	12	1	0
131		28-Feb-15	15:05	34	M021	-37.1292	174.5597	7	7	1	0
131		19-Feb-19	12:05	11	M021	-37.2559	174.4183	5	5	1	0
133		18-Feb-11	8:33	8	M023	-37.4726	174.7152	4	4	0	0
133		21-Feb-11	13:09	19	M023	-37.2595	174.6344	8	8	0	unknown
133		28-Feb-11	11:24	21	M023	-37.4334	174.6946	4	4	0	0
133		9-Mar-11	11:32	25	M023	-37.4589	174.7072	3	3	0	1
133		9-Mar-11	11:52	26	M023	-37.4596	174.7098	1	1	0	0
133		1-Mar-15	12:32	42	M023	-37.1375	174.5684	6	8	0	0
133		19-Feb-17	16:54	19	M023	-37.1732	174.5820	n/a	n/a	n/a	n/a
133		30-Jan-18	13:35	1	M023	-37.2397	174.4192	5	5	0	0
133		19-Feb-22	15:18	9	M023	-37.21468	174.6083	8	8	2	0

133		1-Mar-22	11:02	20	M023	-37.18715	174.5903	4	4	0	0
135		21-Feb-11	11:28	18	M025	-37.2146	174.6116	6	6	0	1
135		18-Feb-17	14:55	16	M025	-36.7475	174.3651	4	4	2	0
135		14-Feb-20	10:34	8	M025	-36.5396	174.2029	3	3	0	1
135		27-Feb-22	10:18	17	M025	-37.18017	174.5881	8	8	3	0
140		14-Feb-15	9:24	11	M031	-37.1439	174.5679	8	9	0	2
140		27-Feb-15	11:55	23	M031	-37.1816	174.5899	6	6	0	0
140		27-Feb-15	14:38	25	M031	-37.2122	174.6032	6	12	0	0
140		1-Mar-15	10:45	39	M031	-37.1493	174.5752	5	8	0	0
140		1-Mar-15	12:08	40	M031	-37.1656	174.5825	4	4	0	0
140	F/C	14-Feb-16	10:17	21	M031	-37.1694	174.5779	12	15	1	0
140		14-Feb-16	14:38	25	M031	-37.1663	174.5825	9	10	0	0
140		24-Feb-16	12:21	37	M031	-37.4065	174.6936	5	7	1	0
140		3-Mar-16	10:33	50	M031	-37.1363	174.5607	3	3	0	0
140		5-Mar-16	11:36	64	M031	-37.1485	174.5746	5	8	0	0
140		19-Feb-17	13:37	17	M031	-37.1669	174.5759	7	12	0	0
140		19-Feb-17	16:50	19	M031	-37.1732	174.5820	n/a	n/a	n/a	n/a
140		22-Feb-17	11:36	29	M031	-37.1004	174.5424	6	8	0	0
140		22-Feb-17	13:21	30	M031	-37.1572	174.5763	12	18	0	0
140		11-Feb-19	14:49	4	M031	-37.0902	174.3477	7	8	1	0
140		17-Feb-20	14:19	14	M031	-37.2458	174.6255	4	4	0	0
140		19-Feb-22	14:48	8	M031	-37.22539	174.6137	4	4	0	0
140		27-Feb-22	10:18	17	M031	-37.18017	174.5881	8	8	3	0
142		19-Feb-11	14:00	12	M033	-37.2456	174.6278	4	5	0	1
142	F/C	21-Feb-11	13:09	19	M033	-37.2595	174.6344	8	8	0	unknown
142		1-Mar-15	11:15	28	M033	-37.2471	174.6268	2	2	0	0
142		14-Feb-16	12:12	23	M033	-37.1717	174.5693	4	15	0	some
142		14-Feb-16	16:08	27	M033	-37.1717	174.5693	9	9	0	some
142		18-Feb-17	14:54	16	M033	-36.7475	174.3651	4	4	2	0
142		30-Jan-18	17:22	5	M033	-37.0769	174.3362	2	2	0	0
142		31-Jan-18	12:03	6	M033	-37.0962	174.3474	3	5	0	0
142		13-Feb-20	13:05	7	M033	-36.5064	174.1748	6	7	0	0

142	14-Feb-20	11:49	9+10	M033	-36.5265	174.1939	6	8	0	0
142	18-Feb-22	14:51	3	M033	-37.08807	174.5334	8	10	1	0
149	16-Feb-17	13:12	6	M040	-37.1281	174.5553	9	11	0	2
149	11-Feb-19	14:49	4	M040	-37.0902	174.3477	7	8	1	0
149	1-Mar-22	11:02	20	M040	-37.18715	174.5903	4	4	0	0
150	22-Feb-17	11:36	29	M041	-37.1004	174.5424	6	8	0	0
150	22-Feb-17	12:28	30	M041	-37.1572	174.5763	12	18	0	0
150	21-Feb-20	11:36	19	M041	-37.4575	174.7091	4	4	0	0
150	27-Feb-22	10:18	17	M041	-37.18017	174.5881	8	8	3	0
155	20-Feb-17	17:18	23	M046	-37.1686	174.5825	5	5	0	0
155	30-Jan-18	13:08	1	M046	-37.2547	174.4160	5	5	0	0
155	19-Feb-19	12:05	11	M046	-37.2559	174.4183	5	5	1	0
155	18-Feb-22	14:51	3	M046	-37.08807	174.5334	8	10	1	0