Small-boat surveys and satellite tagging of odontocetes on the Pacific Missile Range Facility, Kaua‘i, in August 2021

Field survey report to U.S. Pacific Fleet by HDR, under Federal contract number N6247020D0016, Task Order No. N6274221F0107.

Prepared by

Robin W. Baird, Colin J. Cornforth, Kimberly A. Wood, Shannon E. Vasquez, Annette E. Harnish, and Michaela A. Kratofil

Cascadia Research Collective
218 ½ W. 4th Avenue
Olympia, WA 98501

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Executive Summary

As part of the long-term United States (U.S.) Navy-funded Marine Species Monitoring Program, from 1-14 August 2021, a combination of boat-based field effort and passive acoustic monitoring was carried out on and around the underwater hydrophone ranges of the Pacific Missile Range Facility (PMRF). The effort was timed to occur immediately prior to the start of Phase B of a Submarine Command Course, to allow for collection of movement and dive data that could be used to examine exposure and response of cetaceans to Navy mid-frequency active sonar (see Henderson et al. 2021). This interim field survey report provides a summary of boat-based survey methodology (Appendix 1), survey effort, encounters, and satellite tags deployed. Thirteen days of field effort were funded by the U.S. Navy, and an additional day was funded by NOAA Fisheries. Over the 14 days the research vessel covered 1,252 km of trackline over 82.2 survey hours. Access to PMRF was limited on three of 14 days due to live fire exercises. Survey effort was broadly spread across the southern one-third of PMRF, to the south of PMRF, and off the south shore of Kaua‘i (Figure 1). There were 35 encounters with nine species of marine mammals (Table 1). A group of approximately 24 Fraser’s dolphins (*Lagenodelphis hosei*) were encountered, the first sighting of this species off Kaua‘i or Ni‘ihau in Cascadia Research Collective’s (CRC’s) field effort off these islands over 13 prior years and 24,224 km of effort (Baird 2016; Baird et al. 2021). There was a sighting of a group of seven Blainville’s beaked whales (*Mesoplodon densirostris*), only the seventh sighting of this species in CRC’s prior work off of Kaua‘i or Ni‘ihau. In addition, there was one sighting each of false killer whales (*Pseudorca crassidens*), and a Hawaiian monk seal (*Neomonachus schauinslandi*), three sightings of spinner dolphins (*Stenella longirostris*), four sightings of short-finned pilot whales (*Globicephala macrorhynchus*), five sightings of melon-headed whales (*Peponocephala electra*), six sightings of common bottlenose dolphins (*Tursiops truncatus*), and 13 sightings of rough-toothed dolphins (*Steno bredanensis*). Thirteen of the sightings (37%) were cued by acoustic detections from the Navy’s hydrophone range, including the one sighting of Blainville’s

beaked whales and four sightings of melon-headed whales. In total, four genetic samples were obtained (one each from a Blainville's beaked whale and a melon-headed whale, and two from false killer whales), and 40,161 photographs were taken for individual and species identification, although individual photo-identification matching has not been undertaken. Fourteen satellite tags were deployed on six different species, including 12 depth-transmitting SPLASH10-F (Fastloc®-Global Positioning System (GPS)) tags, one location-only SPOT6 tag, and one depth-transmitting SPLASH10 tag (Table 2). One of the SPLASH10-F tags failed upon impact, but location data were received from the other 13 tags (Figures 2 through 14), and dive data were obtained from 11 of the 12 remaining depth-transmitting tags (e.g., Figure 15). Data from all of the tagged individuals overlapped temporally with Phase A of the SCC, and 11 of them overlapped temporally with Phase B of the SCC. Some of the tagged individuals remained on or close to PMRF during the duration of the tag deployments (e.g., see Figures 2, 3, 8, 9, 10).

Acknowledgements

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Table 1. Details of sightings of marine mammals during the August 2021 Kauaʻi field effort, sorted by species and date.

Species	Date	Group size (best)	Start latitude (ºN)	Start longitude (ºW)	# photos
Blainville's beaked whale	11-Aug-21	7	22.13344	159.935	2,465
Bottlenose dolphin	03-Aug-21	40	22.14787	159.769	1,278
Bottlenose dolphin	04-Aug-21	5	22.02264	159.819	520
Bottlenose dolphin	10-Aug-21	2	21.96745	159.755	137
Bottlenose dolphin	12-Aug-21	4	22.12076	159.814	2,702
Bottlenose dolphin	14-Aug-21	20	22.10404	159.798	1,502
Bottlenose dolphin	14-Aug-21	2	21.97435	159.775	289
False killer whale	08-Aug-21	30	21.91938	159.708	3,631
Fraser's dolphin	01-Aug-21	24	21.98482	159.896	460
Hawaiian monk seal	02-Aug-21	1	22.07941	159.784	168
Melon headed whale	01-Aug-21	250	22.07716	159.896	3,592
Melon headed whale	09-Aug-21	225	22.13350	159.937	2,238
Melon headed whale	11-Aug-21	150	22.20936	159.820	3,434
Melon headed whale	12-Aug-21	140	22.14080	159.883	777
Melon headed whale	13-Aug-21	125	21.91612	159.770	1,557
Rough-toothed dolphin	04-Aug-21	2	22.01992	159.908	54
Rough-toothed dolphin	04-Aug-21	2	22.07758	159.903	112
Rough-toothed dolphin	04-Aug-21	5	22.00657	159.848	407
Rough-toothed dolphin	05-Aug-21	2	22.01798	159.928	84
Rough-toothed dolphin	06-Aug-21	8	22.14257	159.926	809
Rough-toothed dolphin	09-Aug-21	7	22.14618	159.934	247
Rough-toothed dolphin	09-Aug-21	18	22.13782	159.848	3,495
Rough-toothed dolphin	11-Aug-21	8	21.94317	159.843	0
Rough-toothed dolphin	12-Aug-21	18	22.12076	159.814	2,702
Rough-toothed dolphin	12-Aug-21	3	22.10362	159.834	26
Rough-toothed dolphin	13-Aug-21	5	21.96967	159.823	77
Rough-toothed dolphin	13-Aug-21	4	22.07085	159.879	46
Rough-toothed dolphin	13-Aug-21	3	21.91394	159.778	0
Short-finned pilot whale	07-Aug-21	35	21.91614	159.795	1,710
Short-finned pilot whale	08-Aug-21	8	21.88207	159.665	1,969
Short-finned pilot whale	10-Aug-21	22	21.92261	159.822	2,568
Short-finned pilot whale	11-Aug-21	8	21.96551	159.874	146
Spinner dolphin	02-Aug-21	100	22.10698	159.745	702
Spinner dolphin	02-Aug-21	45	21.95757	159.721	0
Spinner dolphin	04-Aug-21	70	21.98340	159.768	257

Table 2. Details of satellite tag deployments during the August 2021 Kauaʻi field effort, sorted by species and date.

Species	Date	Tag type	Tag ID	# days location data	Comments
Blainville's beaked whale	11-Aug-21	SPLASH10-F	MdTag020	13.3	
Blainville's beaked whale	11-Aug-21	SPLASH10-F	MdTag021	9.0	
Bottlenose dolphin	12-Aug-21	SPLASH10-F	TtTag039	12.8	
Bottlenose dolphin	14-Aug-21	SPLASH10-F	TtTag040	15.9	No dive data
False killer whale	08-Aug-21	SPLASH10-F	PcTag074	12.0	
Melon headed whale	01-Aug-21	SPLASH10-F	PeTag029	12.6	
Melon headed whale	09-Aug-21	SPLASH10-F	PeTag030	0.0	Tag failed
Melon headed whale	11-Aug-21	SPLASH10-F	PeTag031	20.6	
Melon headed whale	13-Aug-21	SPLASH10-F	PeTag032	16.4	
Rough-toothed dolphin	09-Aug-21	SPLASH10	SbTag023	13.0	
Rough-toothed dolphin	09-Aug-21	SPOT6	SbTag024	4.5	
Short-finned pilot whale	08-Aug-21	SPLASH10-F	GmTag232	14.0	
Short-finned pilot whale	10-Aug-21	SPLASH10-F	GmTag233	16.1	
Short-finned pilot whale	10-Aug-21	SPLASH10-F	GmTag234	24.1	

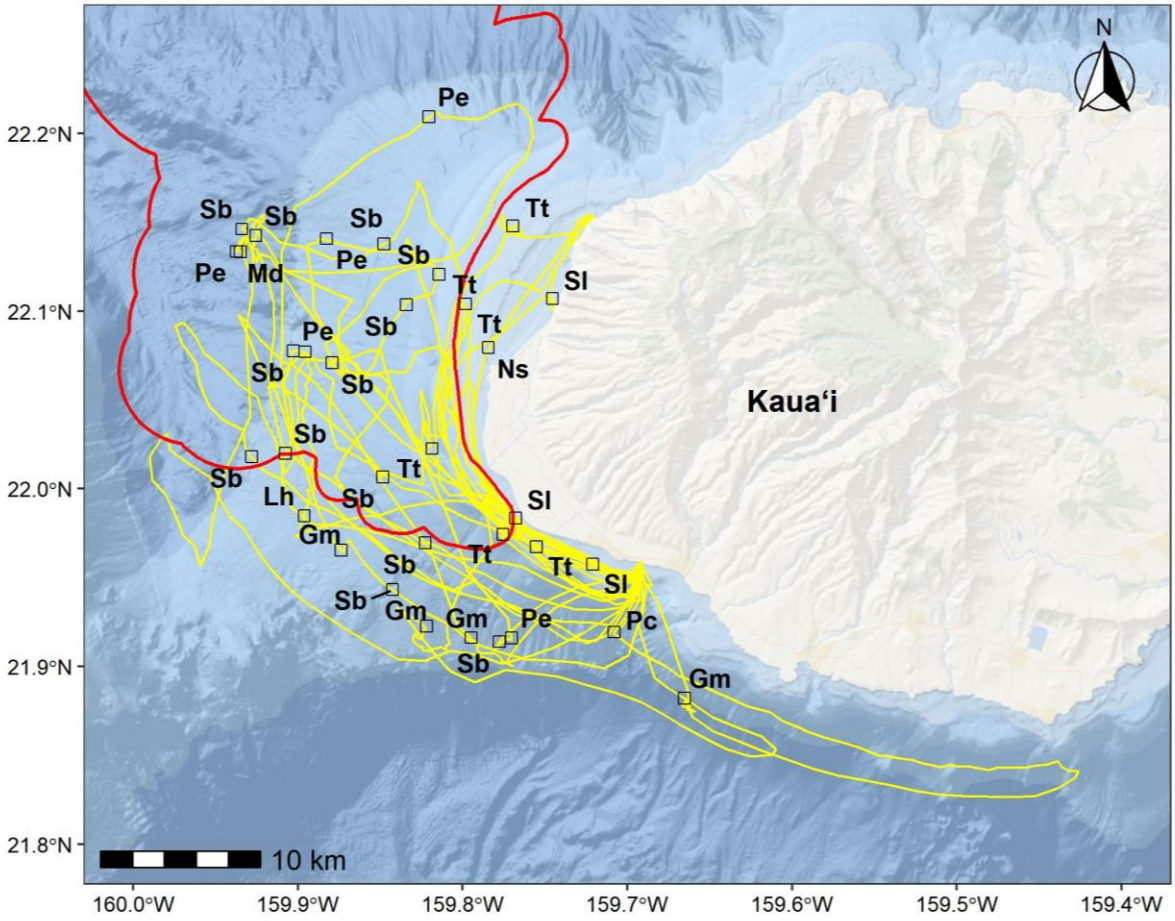

Figure 1. Search effort (yellow lines) and odontocete sightings (open squares) over 14 days from 1-14 August 2021. Species are indicated by two-letter codes (Sb = *Steno bredanensis*, Tt = *Tursiops truncatus*, Gm = *Globicephala macrorhynchus*, Sl = *Stenella longirostris*, Pe = *Peponocephala electra*, Pc = *Pseudorca crassidens*, Md = *Mesoplodon densirostris,* Lh = *Lagenodelphis hosei*, Ns = *Neomonachus schauinslandi*). The PMRF outer boundary is indicated in red.

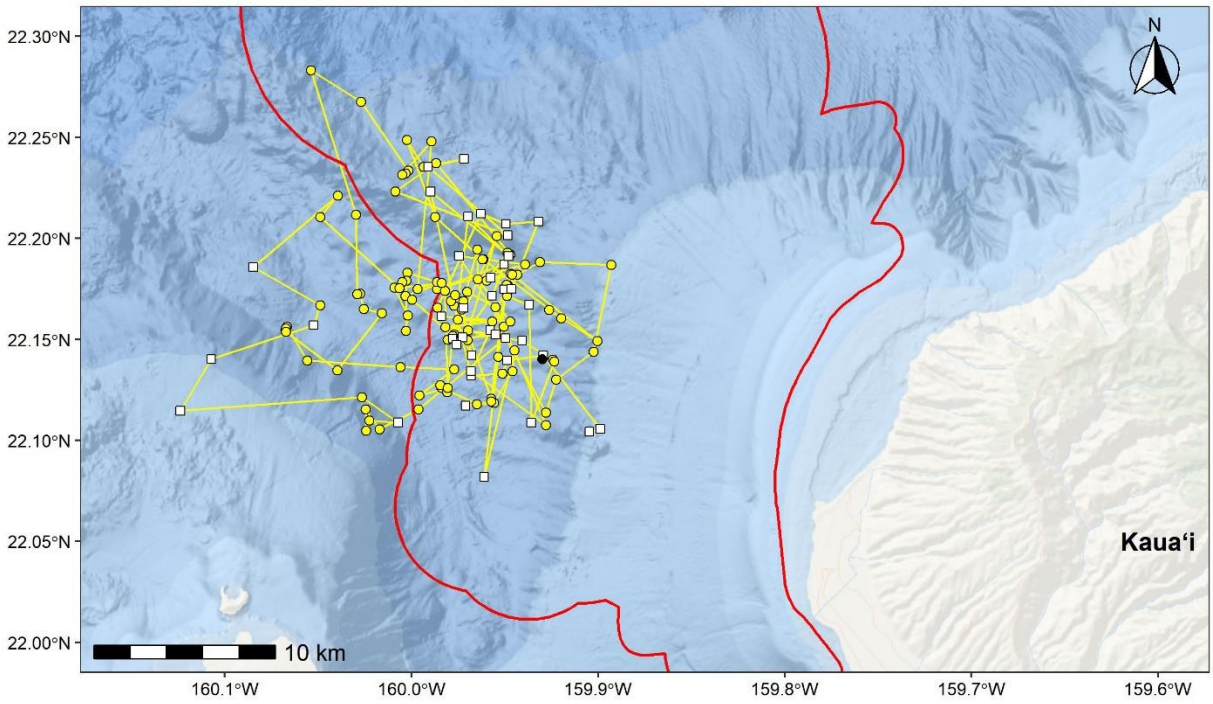

Figure 2. Filtered locations from a satellite-tagged Blainville's beaked whale (MdTag020) over a nine-day period from 11 August 2021 to 20 August 2021. Fastloc®-GPS locations are shown as white squares while Argos locations are shown as yellow circles. Temporally consecutive locations (regardless of location type) are joined by a yellow line. The location where the individual was tagged is indicated by a filled black circle, and the PMRF boundary is shown as a red line.

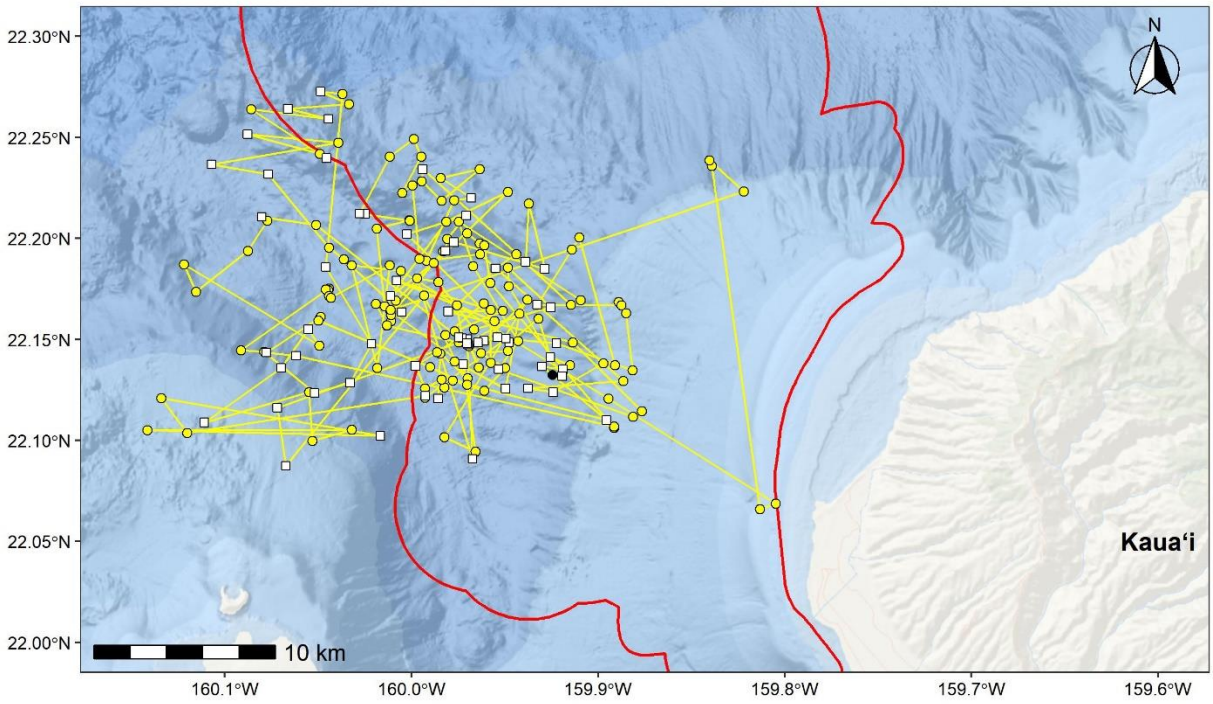

Figure 3. Filtered locations from a satellite-tagged Blainville's beaked whale (MdTag021) over a 13.3-day period from 11 August 2021 to 25 August 2021. Fastloc®-GPS locations are shown as white squares while Argos locations are shown as yellow circles. Temporally consecutive locations (regardless of location type) are joined by a yellow line. The location where the individual was tagged is indicated by a filled black circle, and the PMRF boundary is shown as a red line.

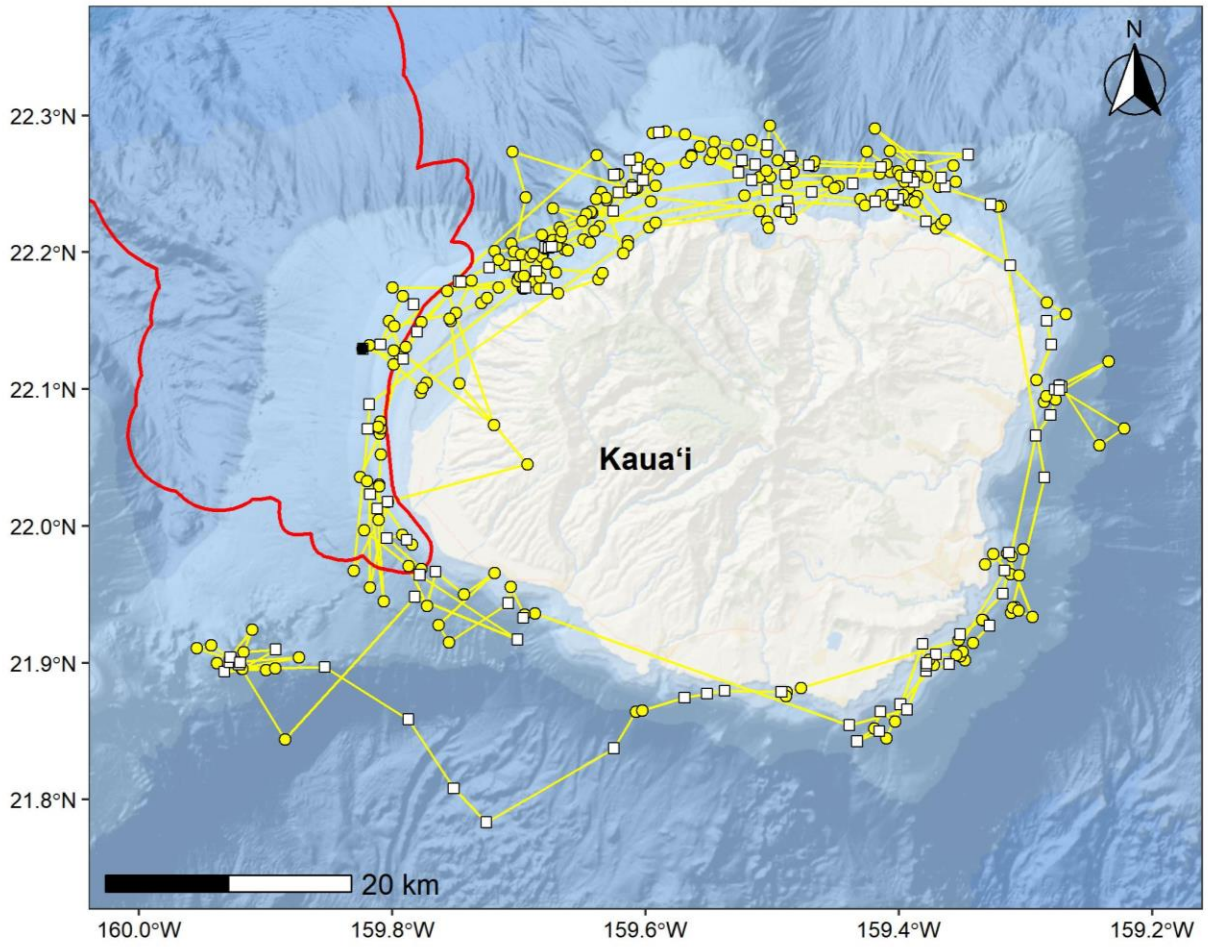

Figure 4. Filtered locations from a satellite-tagged bottlenose dolphin (TtTag039) over a 12.8-day period from 12 August 2021 to 25 August 2021. Fastloc®-GPS locations are shown as white squares while Argos locations are shown as yellow circles. Temporally consecutive locations (regardless of location type) are joined by a yellow line. The location where the individual was tagged is indicated by a filled black circle, and the PMRF boundary is shown as a red line.

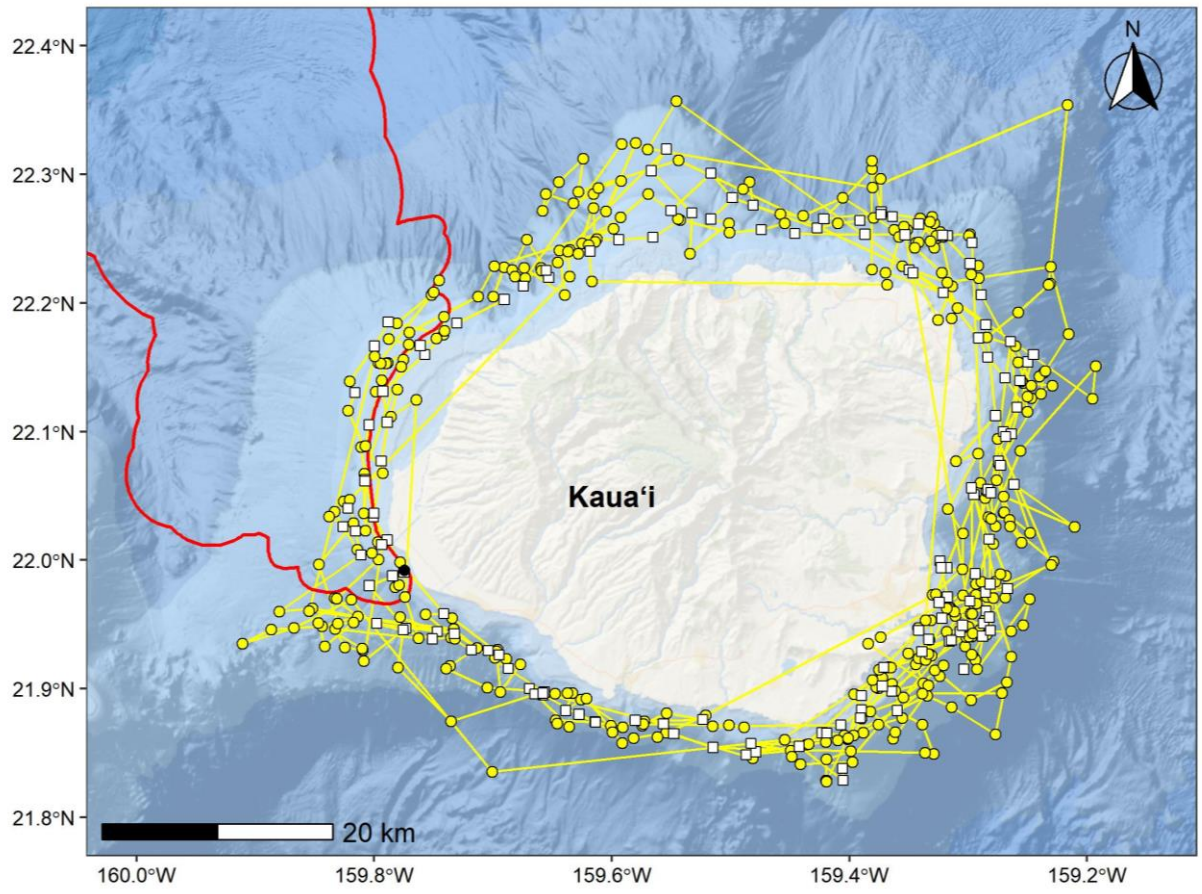

Figure 5. Filtered locations from a satellite-tagged bottlenose dolphin (TtTag040) over a 15.9-day period from 14 August 2021 to 30 August 2021. Fastloc®-GPS locations are shown as white squares while Argos locations are shown as yellow circles. Temporally consecutive locations (regardless of location type) are joined by a yellow line. The location where the individual was tagged is indicated by a filled black circle, and the PMRF boundary is shown as a red line.

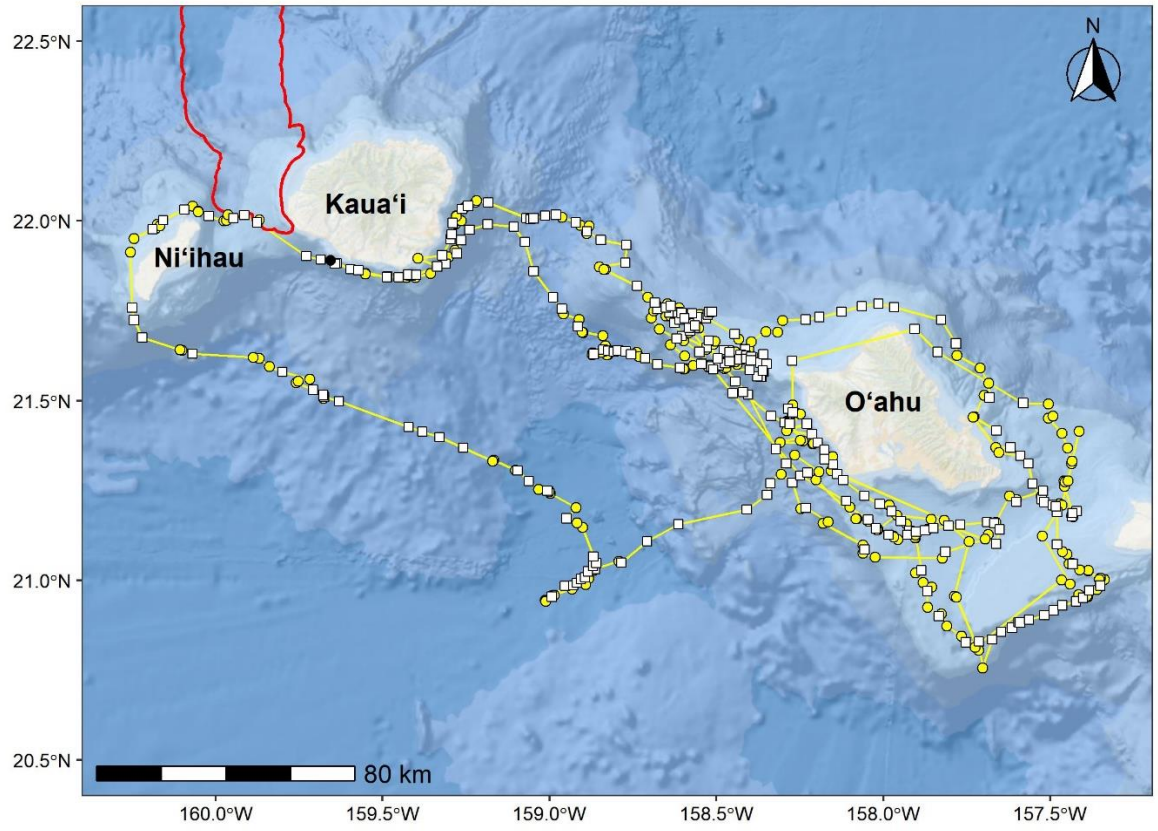

Figure 6. Filtered locations from a satellite-tagged false killer whale (PcTag074) over a 12.0-day period from 8 August 2021 to 20 August 2021. Fastloc®-GPS locations are shown as white squares while Argos locations are shown as yellow circles. Temporally consecutive locations (regardless of location type) are joined by a yellow line. The location where the individual was tagged is indicated by a filled black circle, and the PMRF boundary is shown as a red line.

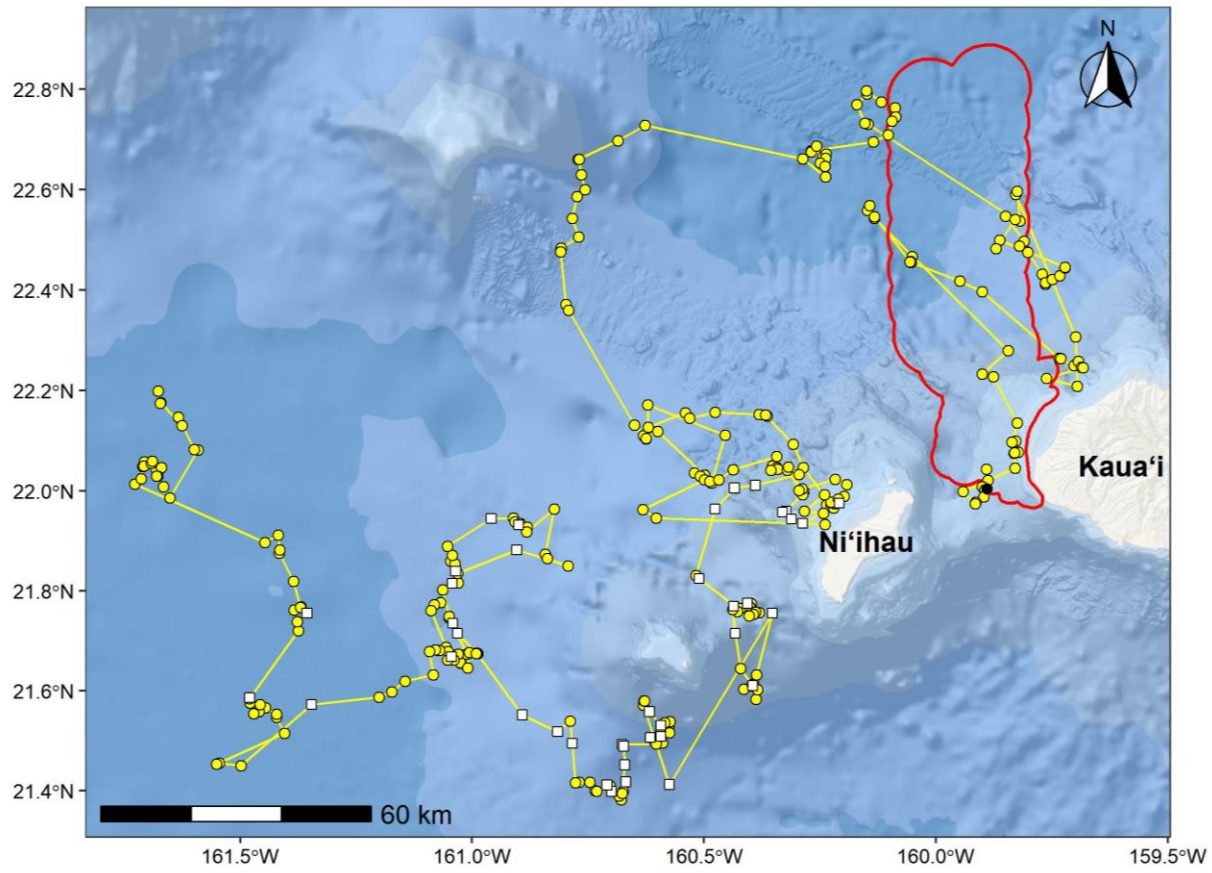

Figure 7. Filtered locations from a satellite-tagged melon-headed whale (PeTag029) over a 12.6-day period from 1 August 2021 to 13 August 2021. Fastloc®-GPS locations are shown as white squares while Argos locations are shown as yellow circles. Temporally consecutive locations (regardless of location type) are joined by a yellow line. The location where the individual was tagged is indicated by a filled black circle, and the PMRF boundary is shown as a red line.

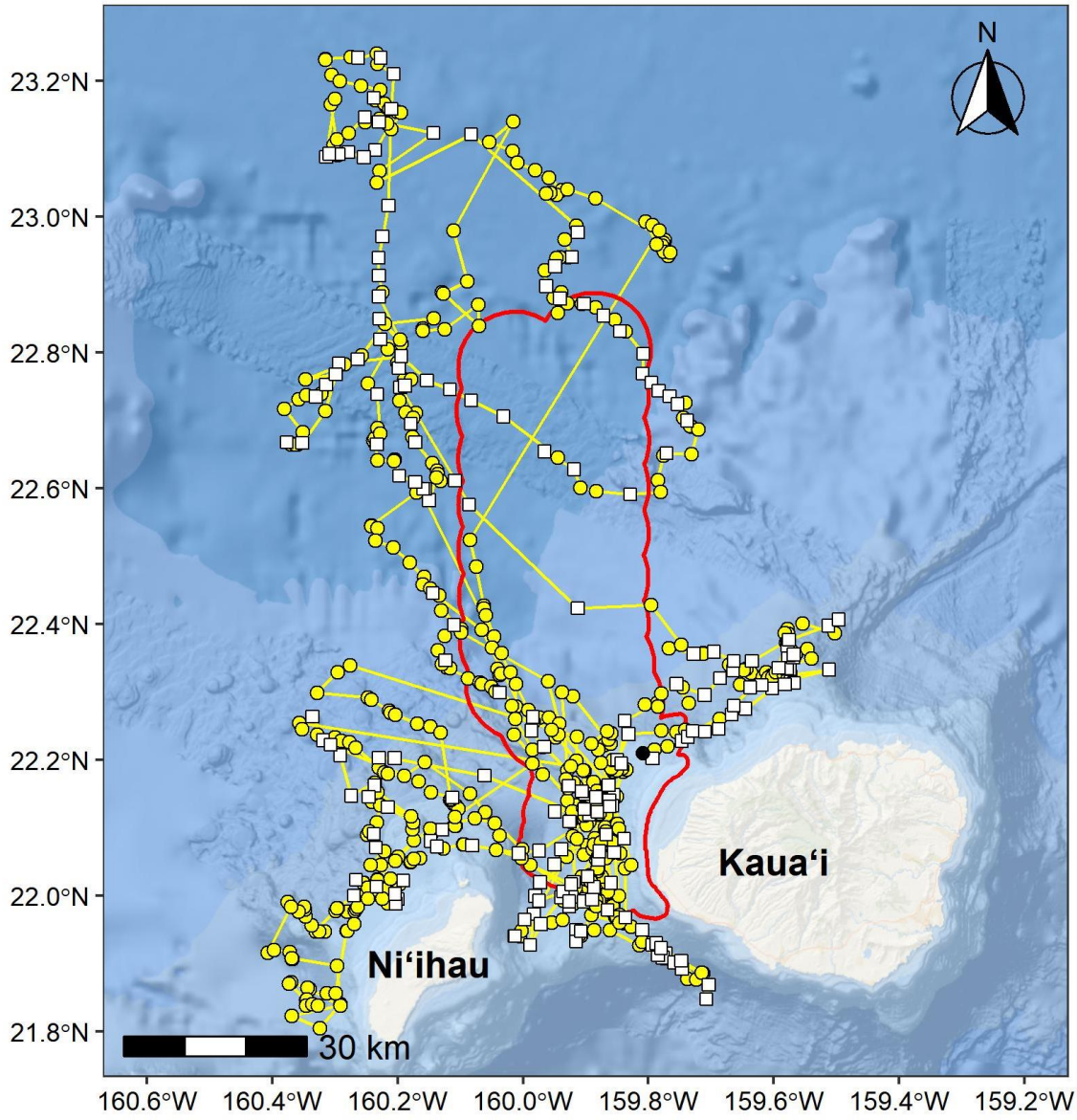

Figure 8. Filtered locations from a satellite-tagged melon-headed whale (PeTag031) over a 20.6-day period from 11 August 2021 to 31 August 2021. Fastloc®-GPS locations are shown as white squares while Argos locations are shown as yellow circles. Temporally consecutive locations (regardless of location type) are joined by a yellow line. The location where the individual was tagged is indicated by a filled black circle, and the PMRF boundary is shown as a red line.

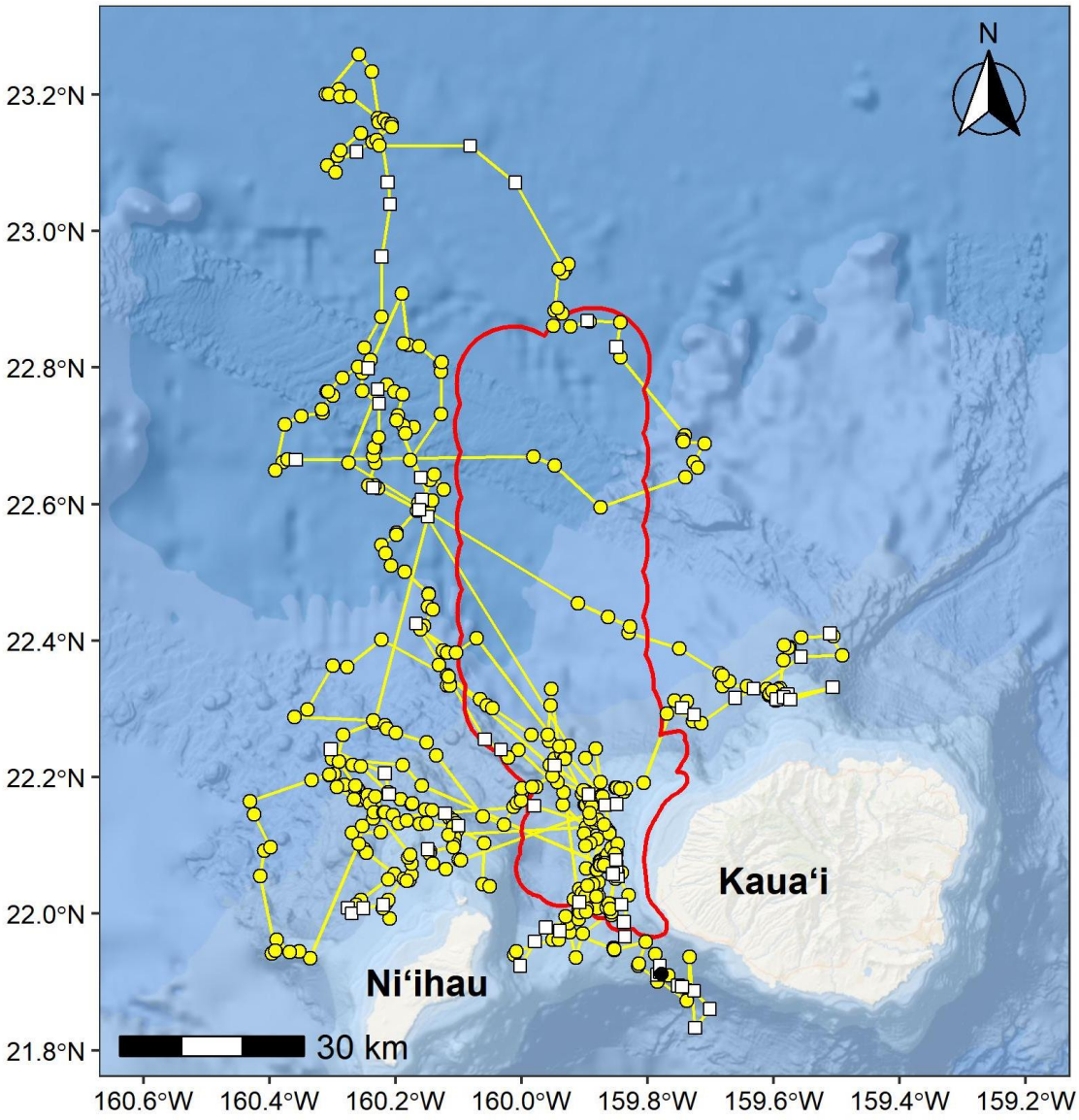

Figure 9. Filtered locations from a satellite-tagged melon-headed whale (PeTag032) over a 16.4-day period from 13 August 2021 to 29 August 2021. Fastloc®-GPS locations are shown as white squares while Argos locations are shown as yellow circles. Temporally consecutive locations (regardless of location type) are joined by a yellow line. The location where the individual was tagged is indicated by a filled black circle, and the PMRF boundary is shown as a red line.

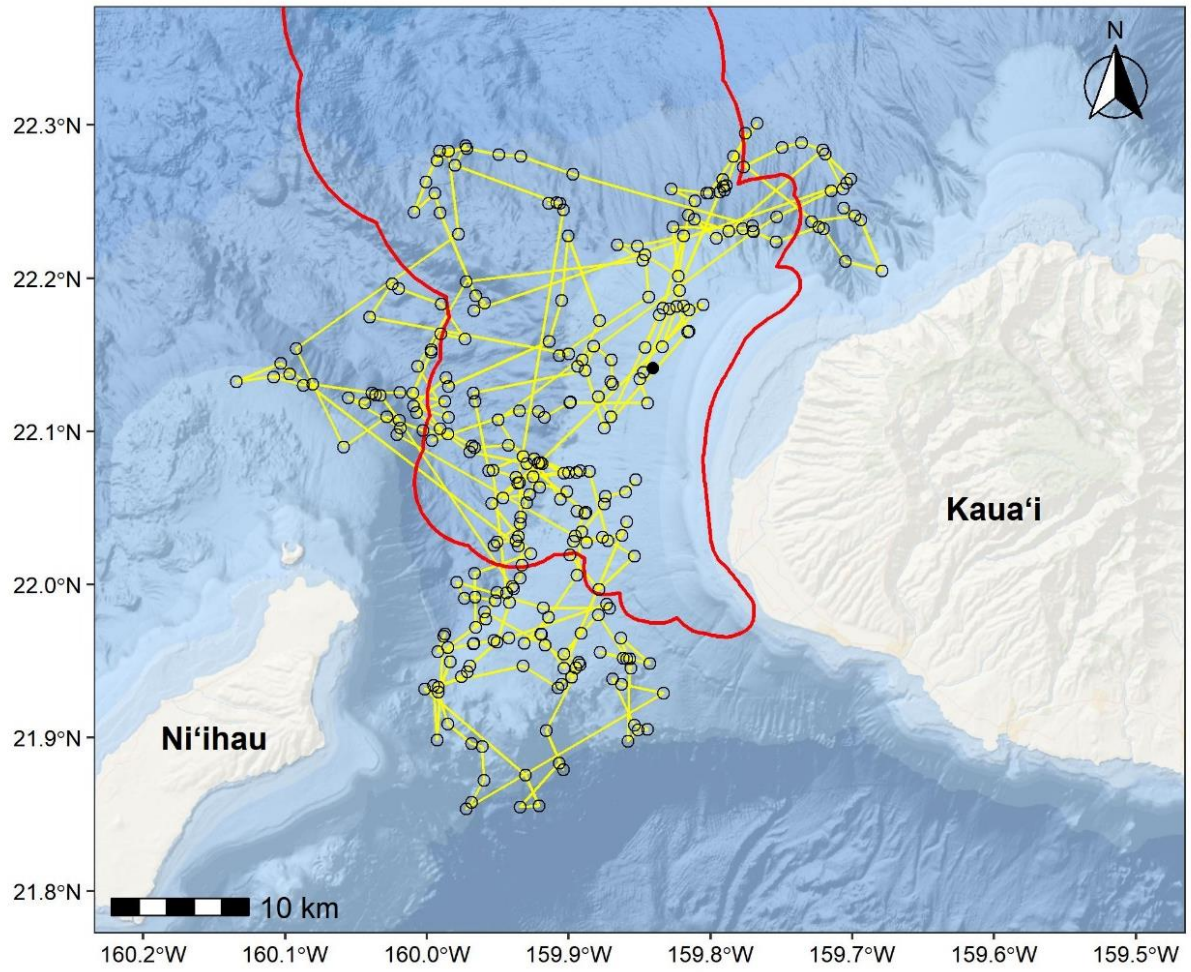

Figure 10. Filtered locations from a satellite-tagged rough-toothed dolphin (SbTag023; Argos location-only tag) over a 13.0-day period from 9 August 2021 to 22 August 2021. The location where the individual was tagged is indicated by a filled black circle, and the PMRF boundary is shown as a red line.

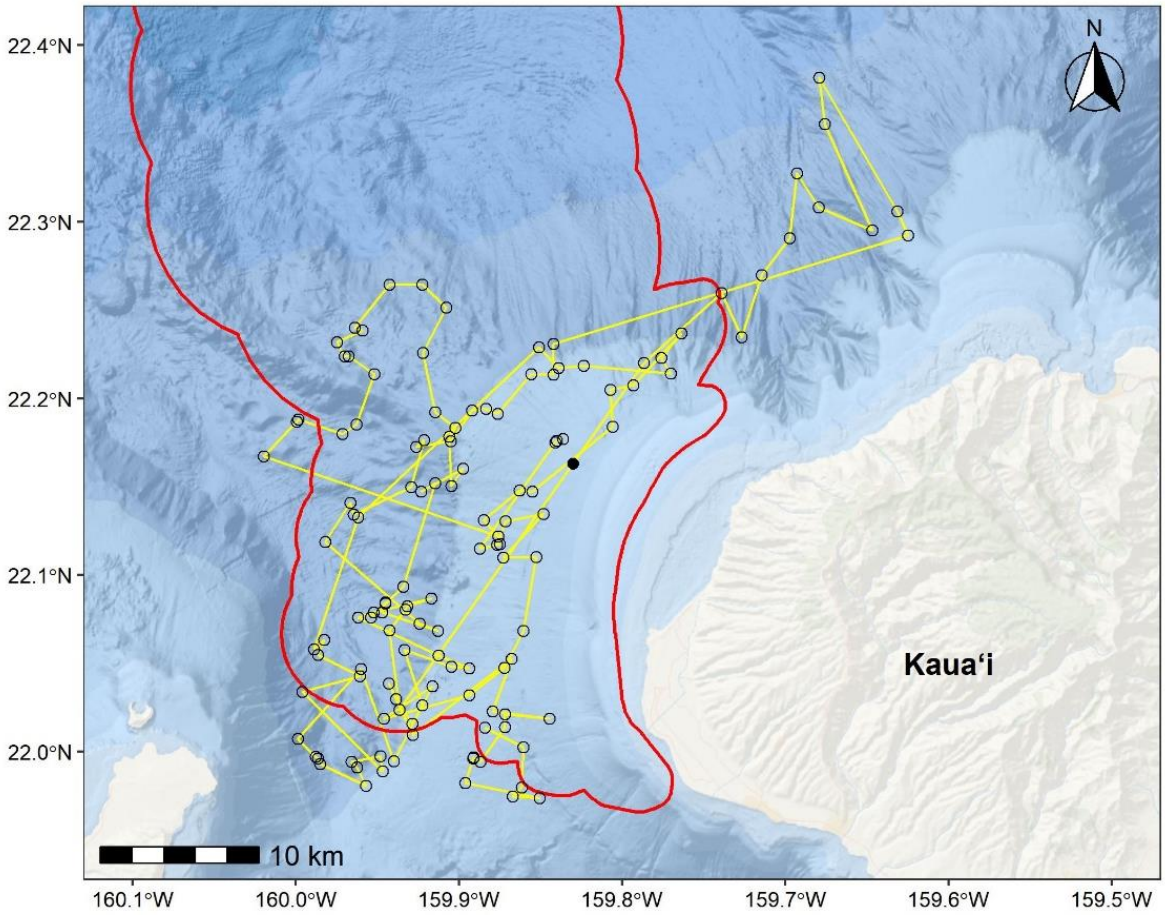

Figure 11. Filtered locations from a satellite-tagged rough-toothed dolphin (SbTag024; Argos location-only tag) over a 4.5-day period from 9 August 2021 to 14 August 2021. The location where the individual was tagged is indicated by a filled black circle, and the PMRF boundary is shown as a red line.

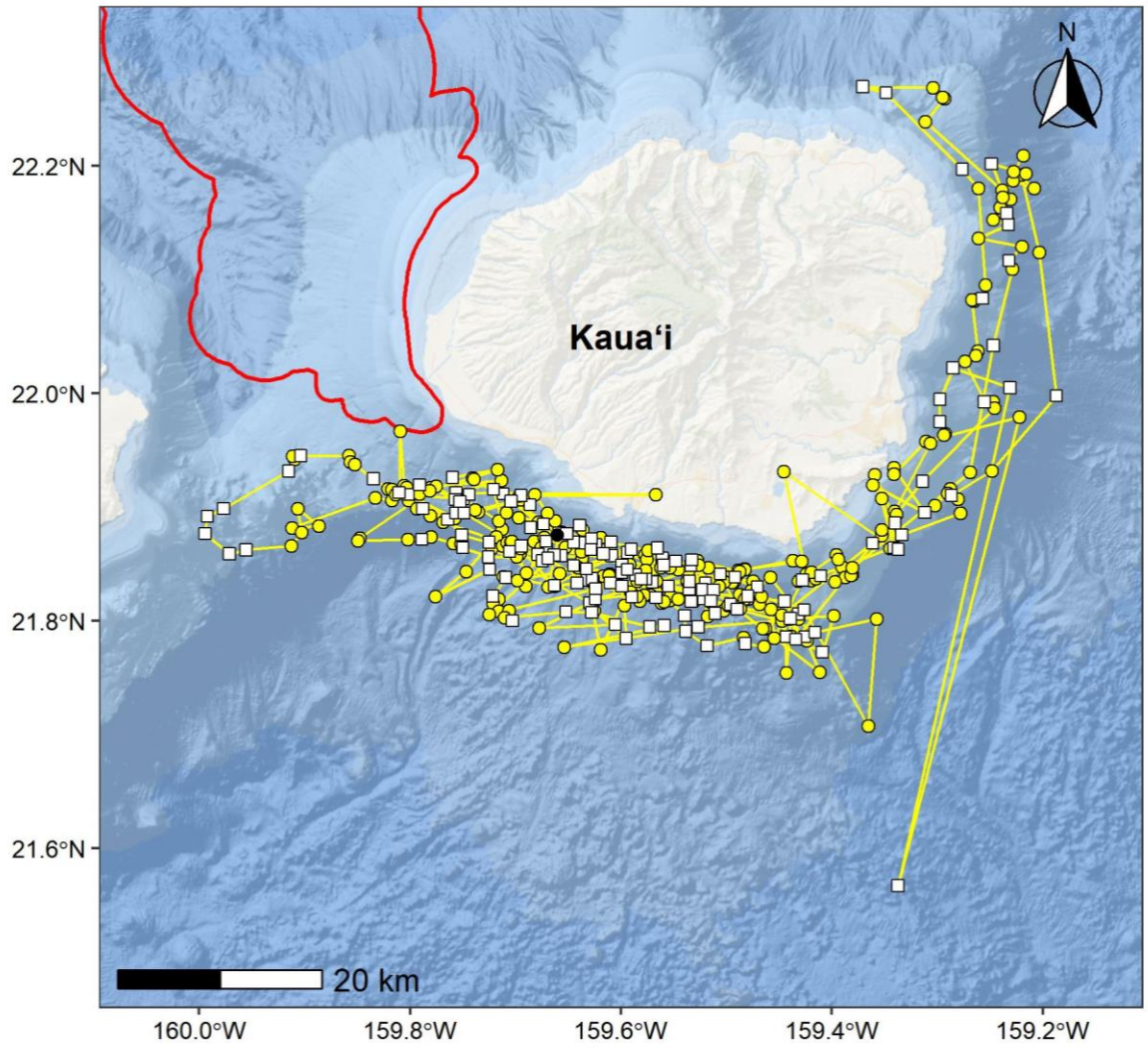

Figure 12. Filtered locations from a satellite-tagged short-finned pilot whale (GmTag232) over a 14.0-day period from 8 August 2021 to 22 August 2021. Fastloc®-GPS locations are shown as white squares while Argos locations are shown as yellow circles. Temporally consecutive locations (regardless of location type) are joined by a yellow line. The location where the individual was tagged is indicated by a filled black circle, and the PMRF boundary is shown as a red line.

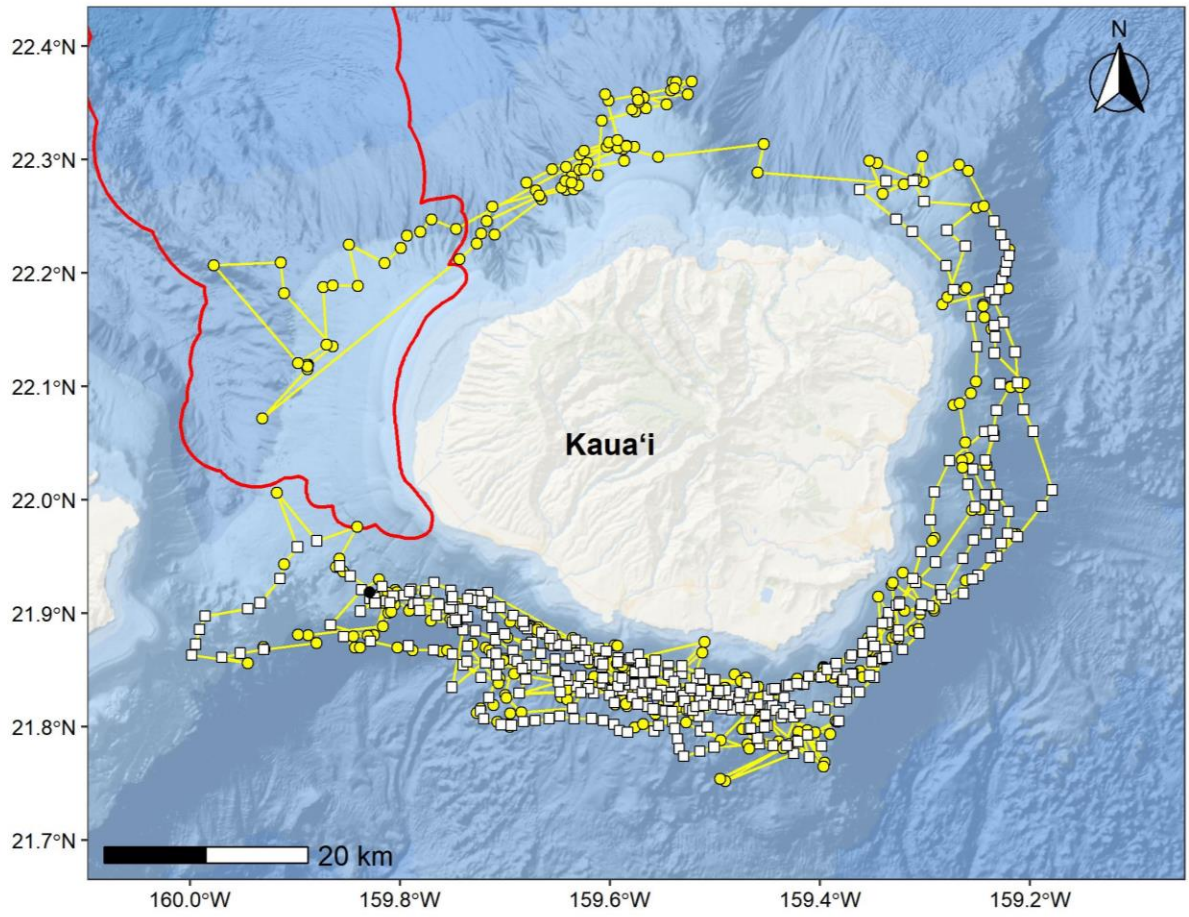

Figure 13. Filtered locations from a satellite-tagged short-finned pilot whale (GmTag233) over a 16.1-day period from 10 August 2021 to 26 August 2021. Fastloc®-GPS locations are shown as white squares while Argos locations are shown as yellow circles. Temporally consecutive locations (regardless of location type) are joined by a yellow line. The location where the individual was tagged is indicated by a filled black circle, and the PMRF boundary is shown as a red line.

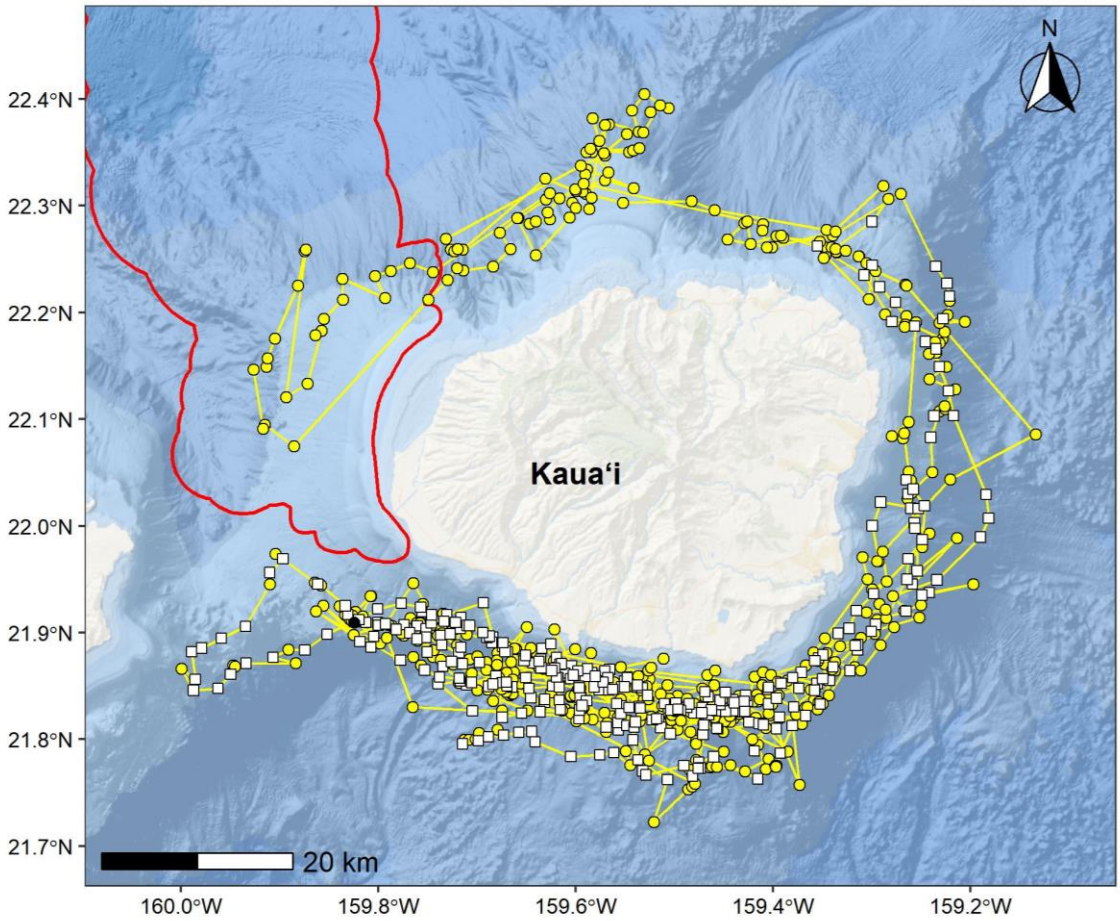

Figure 14. Locations from a satellite-tagged short-finned pilot whale (GmTag234) over a 14.0-day period from 10 August 2021 to 3 September 2021. Fastloc®-GPS locations are shown as white squares while Argos locations are shown as yellow circles. Temporally consecutive locations (regardless of location type) are joined by a yellow line. The location where the individual was tagged is indicated by a filled black circle, and the PMRF boundary is shown as a red line.

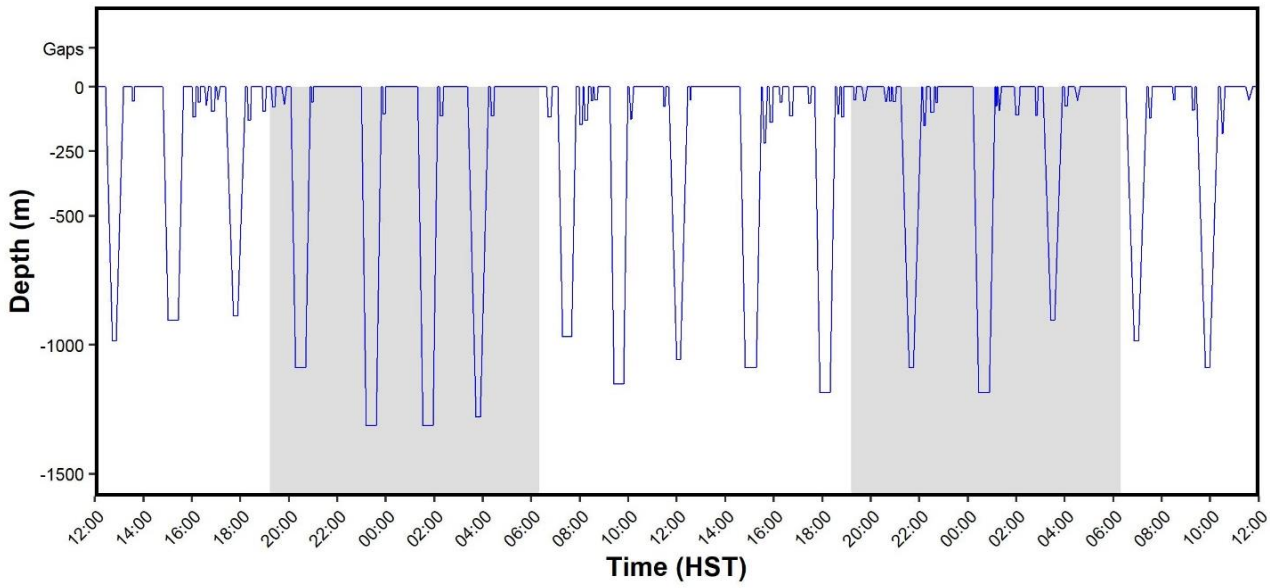

Figure 15. An example of behavior data obtained from a Blainville's beaked whale (MdTag021) over a two-day period, from 1200 hrs HST on 15 August 2021 through 1200 hrs HST on 17 August 2021. Night time periods are shaded. For any dives shallower than 50 m a line at the 0 m depth is shown. No data gaps were present during this period.

Appendix 1. Field survey methods

The field project was timed to occur over a 14-day span immediately prior to Phase B of a Submarine Command Course (SCC) scheduled to occur in August 2021. Thirteen days of funding were provided by the U.S. Navy and an additional day was funded by a grant from the Pacific Islands Fisheries Science Center. The vessel used was a 24-foot (7.3 m) rigid-hulled inflatable, powered by twin Yamaha 150 horsepower outboard engines, and with a custom-built bow pulpit for tagging and biopsy operations. The vessel was launched each morning at or prior to sunrise, and operations continued during daylight hours as long as weather conditions were suitable, with a team of five to seven observers scanning 360 degrees around the vessel. Vessel locations were recorded on a GPS unit at 5-minute intervals.

When weather conditions permitted and there were no range access constraints, the primary area of operations was the PMRF instrumented hydrophone range, with a focus on deep-water areas to increase the likelihood of encountering high-priority species (see below). Coordination with M3R was undertaken for all days when weather conditions allowed access to the range or areas near the range. When positions from the M3R system were available, the vessel would transit to specific locations in response to the positions and would survey areas for visual detection of groups. Positions of probable bottlenose dolphins or rough-toothed dolphins, as determined by M3R analysts, were not responded to unless no high-priority species were detected in areas that were accessible. When conditions on PMRF were sub-optimal and there were better conditions elsewhere, or if there was no vocal activity on the range from priority species, or if the range was closed because of Navy activity, the vessel team worked in areas off the range. The vessel team communicated each morning with the PMRF Range Control prior to entering the range and remained in regular contact with Range Control throughout the day as needed to determine range access limitations.

Research was undertaken under NMFS MMPA/ESA Scientific Research Permit No. 20605. Each group of odontocetes encountered was approached for positive species identification. Humpback whales were generally not approached unless they were associated with odontocetes, or in cases when weather conditions precluded working with other higher-priority species. When more than one species was present in a group they were recorded as separate sightings, and details were noted on spacing and interactions among the species. Decisions on how long to stay with each group and the type of sampling (e.g., photographic, tagging, biopsy) depended on a variety of factors, including current weather conditions and weather outlook, information on other potentially higher-priority species in the area (typically provided by M3R), and the relative encounter rates. Species encountered infrequently (melon-headed whales, false killer whales, short-finned pilot whales) were given higher priority than frequently encountered species (bottlenose dolphins, rough-toothed dolphins, spinner dolphins). Extended work with frequently encountered species was typically only undertaken when no other higher-priority species were in areas suitable for working.

In general, species were photographed for species confirmation and individual identification. For each encounter, information was recorded on start and end time and location of encounter, group size (minimum, best, and maximum estimates), sighting cue (e.g., acoustic detection from M3R, splash, radio call from another vessel), start and end behavior and direction of travel, the group envelope (i.e., the spatial spread of the group in two dimensions), the estimated percentage of the group observed closely enough to determine the number of calves and neonates in the group, the number of individuals bowriding, and information necessary for permit requirements.

For infrequently encountered species (e.g., false killer whales, short-finned pilot whales, melon-headed whales, Blainville's beaked whales), if conditions were suitable we attempted to deploy at least one satellite tag per group. Tags for these species were depth transmitting SPLASH10F (Fastloc®-GPS) tags. For bottlenose dolphins, at the direction of the Navy, tagging (with SPLASH10F tags) was only attempted in the latter half of the field effort. Rough-toothed dolphins were considered low priority species by the Navy, and thus a SPLASH10 tag or a location-only SPOT6 tag (the latter provided by a non-Navy grant) were used. When more than one tag deployment was attempted within a single group, the second individual to be tagged was not closely associated with the first.

Skin/blubber biopsy samples were collected with a crossbow, using an 8-millimeter diameter dart tip with a stop that prevented penetration greater than approximately 15 millimeters. Species targeted for biopsy samples were those where samples could be used to assess stock identity (e.g., false killer whale, see Martien et al. 2014), or when behavior of the group and conditions facilitated sample collection. In encounters where tagging was going to be undertaken, biopsy sampling was only undertaken after the cessation of tagging operations. Biopsy samples were sub-sampled for a number of ongoing studies through the Southwest Fisheries Science Center and the University of Hawai‘i.

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