U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE/NOAA FISHERIES

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CRUISE REPORT[1]

VESSEL: *Oscar Elton Sette*, Cruise SE-13-03

CRUISE PERIOD: 7 May – 5 June 2013

AREA OF OPERATION: Papahānaumokuākea Marine National Monument (PMNM)

TYPE OF OPERATION: Cetacean line-transect abundance survey in the PMNM

ITINERARY:

07 May	Embarked scientists Bradford, Yin, Breese, Ligon, Ü, Bendlin, Garver, Barkley, Coates, Trickey, Rex, Guiseffi, and LTjg Norris. Departed Pearl Harbor at 1330. Commenced transit to PMNM.
08 May – 19 May	Surveyed the PMNM. Conducted visual and acoustic observations during daylight hours along standard transect lines. Launched small boat for priority sightings in suitable weather conditions. Deployed CTD before and after daytime operations. Dropped XBT at 0900, 1200, 1500, and 1800.
20 May	Circumnavigated Pearl and Hermes Atoll by ship and small boat. Conducted visual and acoustic observations during daylight hours along non-standard transect line. Deployed CTD before daytime operations. Dropped XBT at 0900, 1200, 1500, and 1800. Retrieved previous HARP and deployed replacement HARP.
21 May – 28 May	Surveyed the PMNM. Conducted visual and acoustic observations during daylight hours along standard transect lines. Launched small boat for priority sightings in suitable weather conditions. Deployed CTD before and after daytime operations. Dropped XBT at 0900, 1200, 1500, and 1800.
29 May	Circumnavigated French Frigate Shoals by ship and small boat. Conducted visual and acoustic observations during daylight hours along non-standard transect line. Deployed CTD after daytime operations. Dropped XBT at 0900, 1200, 1500, and 1800.

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Issued 29 August 2013

30 May – 2 June	Surveyed the PMNM. Conducted visual and acoustic observations during daylight hours along standard transect lines. Launched small boat for priority sightings in suitable weather conditions. Deployed CTD before and after daytime operations. Dropped XBT at 0900, 1200, 1500, and 1800.
3 June	Circumnavigated Nihoa Island by ship. Conducted visual and acoustic observations during daylight hours along non-standard and standard transect lines. Deployed CTD after daytime operations. Dropped XBT at 0900, 1200, 1500, and 1800.
4 June	Surveyed the PMNM. Conducted visual and acoustic observations during daylight hours along standard transect line. Deployed CTD before daytime operations. Dropped XBT at 0900. Departed PMNM at 1030. Commenced transit to Pearl Harbor.
5 June	Returned to Pearl Harbor at 1030. Disembarked all scientific personnel.

MISSIONS AND RESULTS:

The goal of the Papahānaumokuākea Associated Cetacean Ecology Survey (PACES) was to collect data on the abundance, distribution, stock structure, and habitat of cetaceans in the Papahānaumokuākea Marine National Monument (PMNM) using 7 integrated operations. These operations included visual observations, passive acoustic monitoring, photo-identification, biopsy sampling, satellite tagging, small boat surveys, and oceanography.

A. Visual observations

1. Methods

Line-transect survey methods were used to collect cetacean sighting data for abundance estimation. Search effort began on a given trackline at the beginning of each day. The ship travelled at 10 knots along the designated trackline.

A daily watch for cetaceans was maintained by visual observers on the flying bridge during daylight hours (approximately 0600 to 2000) unless precluded by weather. The observers consisted of 6 scientists that rotated through 3 positions every 40 minutes and scanned for cetaceans using 25× and 7× binoculars and unaided eyes. Sighting information, watch effort, viewing conditions, and other required information were entered into a computer attached to the ship's GPS (for course, speed, and position information) using the program WinCruz.

The set of standard tracklines surveyed was established prior to the cruise and was intended to representatively sample cetacean habitat from the eastern boundary of the PMNM to Midway Atoll. Unanticipated mechanical difficulties and high cetacean sighting rates slowed trackline

progress. As a result, the two westernmost tracklines were removed, focusing the survey effort from the eastern PMNM boundary to Pearl and Hermes Atoll (Figure 1). Survey effort took place on circumnavigations of Pearl and Hermes Atoll, French Frigate Shoals, and Nihoa Island, which were considered non-standard tracklines. When weather precluded surveying, the Chief

Scientist decided whether to wait at a given position for better weather or to direct the ship to another location. The Chief Scientist monitored trackline progress and adjusted scientific activities to meet scientific and scheduling objectives.

Upon sighting a cetacean group or other feature of biological interest, the Chief Scientist or marine mammal observer team on watch requested that the ship be maneuvered to approach the group or feature for investigation. When the ship approached a group of cetaceans, the on-effort observers made independent estimates of group size. Photographic and biopsy sampling operations occasionally commenced from the bow based on directions from the Chief Scientist or Lead Mammal Observers.

When the observers completed scientific operations for a given sighting, the ship resumed the same course and speed as prior to the sighting. If pursuit of the sighting took the ship more than 5 nm from the trackline, the observers were notified. The Chief Scientist or Lead Mammal Observers sometimes requested that, rather than proceed directly toward the next waypoint, the ship take a heading of ≤ 20 degrees back toward the trackline.

It was occasionally necessary to divert the ship's course from the established trackline during regular effort because of glare or adverse sea conditions. Under these circumstances, the ship diverted from the established course until the ship was 5 nm from the trackline or otherwise directed by the observers, at which point the ship turned back toward the trackline at a heading of ≤ 20 degrees.

At times during the cruise, visual survey operations were not possible due to high wind or sea state. Survey operations were suspended at Beaufort Sea State 7 or higher. If rain made visibility one nautical mile or less, visual observations were also suspended until visibility increased. During these times, a single observer maintained a weather watch in order to notify the rest of the observer team when conditions improved.

2. Results

Twenty-eight days of on-effort surveying of both standard and non-standard transect lines were completed during PACES (Table 1), resulting in 88 ship-based visual sightings of at least 14 cetacean species (Table 2). A total of 2,073.6 nmi of standard effort trackline was covered, with 96% of this effort in Beaufort Sea States 3-6 (63% in Beaufort 3-4). Of the 88 sightings, 71 were made during standard effort, 7 during non-standard effort, and 10 while off effort. The geographic distribution of search effort and sightings within the PMNM is shown in Figures 2 and 3, respectively. The standard effort sighting data will be used to yield line-transect abundance estimates of observed species.

B. Passive acoustic monitoring

1. Methods

A new multi-node array consisting of two separate oil-filled hydrophone array sections (i.e., an inline and end array) was used to augment the visual survey effort during PACES. The inline array contained mid-frequency hydrophones, and the end array was made up of both mid-and high-frequency hydrophones. The array was towed at approximately 340 m behind the ship during daylight hours to collect data on cetacean vocalizations and assist with the localization of target species. The array was deployed each morning prior to the start of visual observations and normally retrieved each evening after search effort ended (and whenever increased maneuverability of the ship was required).

Signals received from the array were amplified and monitored by a team of 4 acoustic technicians. The technicians rotated through a primary, secondary, and off-effort position every 2 hours while the array was deployed. When cetacean sounds were detected audibly or on the spectogram display, incoming acoustic data was recorded to computer hard drives. A record was kept of acoustic effort, comments, and periodic acoustic updates using the program Logger. Real-time visual displays of sounds were monitored and localized using Ishmael and Whaltrak software. The localization angles created were plotted on the Whaltrak display and saved to corresponding files.

2. Results

A total of 120 cetacean groups were acoustically detected from the towed hydrophone array. While 37 of the visual detections were not detected acoustically, 69 acoustic detections (mostly sperm whales and unidentified dolphins) were not detected visually (Table 3), although the number of acoustic detections outside of the sighting range of the visual observers has not yet been determined. A group of minke whales was acoustically detected, but not seen, during the first week of the survey, bringing the PACES species total to at least 15. Additional processing of the acoustics data is ongoing.

C. Directed sampling and small boat surveys

1. Methods

Photographs and biopsy samples of cetaceans were taken from the ship on an opportunistic basis. The photographs were used to confirm species identification and, when possible, will be used to study the distribution of identified individuals, as well as intraspecific geographic variation in morphology and coloration. The biopsy samples will be used to examine stock structure and phylogenetic relationships within species. Photographed and sampled animals were either approached by the ship as a part of normal survey operations or approached the ship to bow ride.

A small boat was launched opportunistically during ship-based sightings, when time of day and weather conditions allowed, to photograph, biopsy sample, and satellite tag individuals of priority species. Satellite tag data will be used to assess the movement patterns and range of represented cetacean stocks.

The small boat was also launched on 2 days designated for the directed sampling of cetaceans in the nearshore waters of Pearl and Hermes Atoll and French Frigate Shoals. These days were

determined by transect scheduling and weather conditions. On these days, the small boat also assisted the ship, which was surveying more offshore waters, with sightings when deemed appropriate by the Chief Scientist. A third planned small boat survey of Nihoa Island was not conducted due to inclement weather conditions (high wind and sea state).

Photographs were taken with digital SLR cameras, and biopsy samples were collected using darts fired from a crossbow. Satellite tags were deployed using a pneumatic rifle. All directed sampling took place under permit. Necessary permits were present on the vessel.

2. Results

More than 2800 photographs of 12 cetacean species in 36 sightings were collected from the ship and small boat during PACES. Between the ship and small boat, a total of 23 samples were obtained from 6 species: 6 spinner dolphins, 7 bottlenose dolphins, 5 false killer whales, 2 pilot whales, 2 sperm whales, and 1 humpback whale (actually a sloughed skin sample). The small boat was launched 10 times during PACES and carried out over 34 hours and 180 nm of effort. The small boat operated in the nearshore waters of Pearl and Hermes Atoll on 20 May and of French Frigate Shoals on 29 May. The small boat worked with 14 sightings, including three sightings made near Pearl and Hermes Atoll that were not seen from the ship, bringing the total number of cetacean sightings for PACES to 91. Two satellite tags were deployed, both on false killer whales, one on 15 May off Laysan Island and the other on 26 May 40 nm SE of Maro Reef. A summary of small boat sightings is shown in Table 4.

D. Oceanography and HARP activities

Conductivity Temperature Depth tests (CTDs) were performed twice daily, at sunrise and sunset. On some days, a CTD was foregone if the CTD station would have overlapped in location with a prior station. Chlorophyll content was assessed from water samples from every morning CTD and from all surface water samples. Expendable Bathyothermographs (XBTs) were conducted in conjunction with surface samples at 0900, 1200, 1500, and, when sunset occurred after 1900, at 1800. During PACES, a total of 43 CTDs, 99 XBTs, and 95 surface samples were conducted.

On 29 May, a High-frequency Acoustic Recording Package (HARP) was recovered from its location at 27°43.509’N, 175°38.309’W (8 nm SE of Pearl and Hermes Atoll), where it has been recording acoustic data over the last year. A new HARP was deployed at 27°44.462'N, 175°33.588'W (12 nm SE of Pearl and Hermes Atoll).

SCIENTIFIC PERSONNEL:

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Attachments

Tables

Table 1. Visual line-transect effort during PACES.

	Survey	START			END			Distance	Average
Date	Activity	Time	Latitude	Longitude	Time	Latitude	Longitude	(nm)	Beaufort
05/08/13	Standard[1]	0600	N22°51.98	W160°24.32	1915	N22°31.53	W162°24.47	84.0	2.7
05/09/13	Standard	0639	N22°24.26	W162°46.36	1750	N24°06.51	W163°17.87	95.4	4.1
05/10/13	Standard	0619	N24°10.03	W163°21.40	1918	N23°21.84	W164°52.44	82.0	3.7
05/11/13	Standard[2]	0923	N23°40.34	W166°19.40	1915	N24°46.87	W166°10.94	91.9	5.5
05/12/13	Standard	0638	N24°45.96	W166°11.96	1920	N24°10.86	W168°16.43	114.5	5.3
05/13/13	Standard	0636	N24°12.65	W168°17.63	1940	N25°52.42	W168°47.22	97.2	4.7
05/14/13	Standard	0639	N25°57.42	W168°49.59	1905	N25°22.66	W170°04.95	64.5	3.6
05/15/13	Standard	0645	N24°46.08	W171°15.80	1527	N25°45.94	W171°29.96	55.4	4.3
05/16/13	Standard	0641	N26°35.27	W171°44.18	1756	N25°46.31	W173°16.85	91.1	4.3
05/17/13	Standard	1559	N25°16.39	W174°13.57	1839	N25°30.01	W173°47.70	27.1	5.8
05/18/13	Standard	0652	N25°17.17	W174°14.12	1950	N26°56.77	W174°21.64	95.2	4.9
05/19/13	Standard	0652	N27°39.44	W174°22.15	1758	N27°10.51	W176°21.12	110.0	4.1
05/20/13	P&H[3]	0810	N27°46.51	W175°50.25	1723	N27°49.42	W175°43.05	43.2	3.1
05/21/13	Standard	0649	N28°36.54	W175°25.59	1643	N27°33.32	W175°22.82	57.3	3.6
05/22/13	Standard	0700	N26°12.58	W175°17.98	2000	N26°45.99	W173°31.78	90.7	3.0
05/23/13	Standard	0832	N26°47.85	W173°22.51	2000	N25°10.03	W172°50.63	98.8	2.8
05/24/13	Standard	0648	N25°06.80	W172°48.81	2000	N25°35.19	W171°48.01	54.6	2.2
05/25/13	Standard	0652	N26°34.47	W171°44.54	1950	N26°13.12	W170°25.44	87.4	3.6
05/26/13	Standard	0635	N26°12.72	W170°25.24	1616	N24°53.90	W169°57.69	74.4	4.0
05/27/13	Standard	0644	N24°27.32	W169°45.56	1925	N25°24.37	W167°53.82	115.0	4.2
05/28/13	Standard	0627	N25°38.37	W167°26.06	1937	N24°09.85	W167°15.02	78.1	4.7
05/29/13	FFS[4]	0923	N23°49.74	W166°25.01	1919	N23°14.20	W165°53.04	35.0	3.1
05/30/13	Standard[5]	0631	N23°21.52	W167°08.03	1919	N24°08.85	W165°29.12	106.0	4.0
05/31/13	Standard	0632	N24°25.78	W164°50.60	1920	N22°42.61	W164°15.86	99.9	3.5
06/01/13	Standard[6]	0805	N22°52.33	W165°48.41	1833	N23°12.10	W164°30.29	64.6	2.9
06/02/13	Standard	0617	N22°38.54	W164°13.97	1920	N23°34.67	W162°33.33	107.0	5.5
06/03/13	Nihoa[7]	0620	N23°15.40	W161°47.27	1716	N23°53.69	W161°55.61	81.0	5.7
06/04/13	Standard	0617	N23°01.51	W161°39.94	1030	N22°19.05	W161°29.43	43.6	5.9
							Total	**2,243.9**	**4.1**

[1]Conducted non-standard effort while transiting to PMNM from 0600 to 0945.
[2]Conducted non-standard effort around French Frigate Shoals (FFS) from 0923 to 1146.
[3]Circumnavigated Pearl and Hermes Atoll (P&H) by ship and small boat.
[4]Circumnavigated FFS by ship and small boat.
[5]Conducted non-standard effort around FFS from 1102 to 1420.
[6]Conducted non-standard effort around Necker Island from 1559 to 1833.
[7]Circumnavigated Nihoa by ship from 0620 to 1141; remainder of day was standard effort.

Table 2. All visual sightings of cetacean species made while on standard (S) or non-standard (NS) transect lines and while off-effort (O). Locations of all visual sightings within the PACES study area are shown in Figure 3.

Code	Scientific Name	Common Name	No. Sightings	Effort Type
2	*Stenella attenuata*	Spotted dolphin	12	S
13	*Stenella coeruleoalba*	Striped dolphin	6	S
15	*Steno bredanensis*	Rough-toothed dolphin	1	S
18	*Tursiops truncatus*	Bottlenose dolphin	5	S
			1	O
33	*Pseudorca crassidens*	False killer whale	3	S
			2	O
36	*Globicephala macrorhynchus*	Short-finned pilot whale	5	S
			3	NS
			1	O
15/36	*S. bredanensis/G. macrorhychus*	Mixed rough-toothed/pilot	1	S
			1	NS
18/36	*T. truncatus/G. macrorhynchus*	Mixed bottlenose/pilot	2	S
37	*Orcinus orca*	Killer whale	1	S
46	*Physeter macrocephalus*	Sperm whale	14	S
			3	O
48	*Kogia sima*	Dwarf sperm whale	1	S
49	Ziphiid whale	Unidentified beaked whale	1	NS
51	*Mesoplodon* sp.	Unidentified *Mesoplodon*	3	S
61	*Ziphius cavirostris*	Cuvier's beaked whale	2	S
			1	O
76	*Megaptera novaeangliae*	Humpback whale	1	S
77	Delphinid	Unidentified dolphin	2	S
			1	NS
78	Small whale or large dolphin	Unidentified small whale	1	S
79	Large baleen or sperm whale	Unidentified large whale	3	S
80	*Kogia* sp.	Unidentified *Kogia*	1	O
99	*Balaenoptera borealis or edeni*	Sei or Bryde's whale	2	S
102	*Stenella longirostris*	Spinner dolphin	1	S
			1	NS
177	Small delphinid	Unidentified small dolphin	4	S
277	Medium delphinid	Unidentified medium dolphin	1	O
377	Large delphinid	Unidentified large dolphin	1	S
		Total	**88**	

Table 3. A comparison of the cetacean groups detected acoustically and visually during PACES.

Species	Visually Detected	Visual Sightings Acoustically Detected	Only Acoustically Detected
Spotted dolphin	7	5	-
Striped dolphin	3	3	-
Spinner dolphin	1	1	-
Rough-toothed dolphin	-	1	-
Bottlenose dolphin	3	3	-
False killer whale	-	5	4
Pilot whale	1	8	-
Mixed rough-toothed/pilot	-	2	-
Mixed bottlenose/pilot	-	2	-
Killer whale	-	1	-
Unidentified dolphin	6	3	28
Unidentified blackfish	-	-	3
Sperm whale	3	14	27
Dwarf sperm whale	1	-	-
Unidentified *Kogia*	1	-	-
Cuvier's beaked whale	1	2	-
Unidentified *Mesoplodon*	3	1	-
Unidentified beaked whale	1	-	-
Minke whale	-	-	1
Humpback whale	1	-	-
Sei or Bryde's whale	1	-	-
Unidentified whale	4	-	-
Unidentified cetacean	-	-	6
Total	**37**	**51**	**69**

Table 4. Summary of sightings made during PACES small boat launches. All sightings were first detected from the ship unless otherwise noted.

Date	PACES Sighting No.	Species	Group Size	No. Photographs	No. Biopsies	No. Tags
05/10/2013	8	Humpback whale	1	0	0	0
05/14/2013	16	Short-finned pilot whale	n/a[3]	0	0	0
05/14/2013	17	Bottlenose dolphin	21	380	2	0
05/15/2013	19	Short-finned pilot whale	23	33	0	0
05/15/2013	20	False killer whale	23	239	4	1
05/20/2013	31[1]	Unid. Dolphin	1	0	0	0
05/20/2013	32[1]	Bottlenose dolphin	8	50	0	0
05/20/2013	35[1]	Spinner dolphin	113	189	6	0
05/21/2013	40	Killer whale	4	55	0	0
05/24/2013	47	Cuvier's beaked whale	8	46	0	0
05/26/2013	59	False killer whale	15	175	1	1
05/29/2013	72	Short-finned pilot whale	31	19	0	0
05/29/2013	73	Short-finned pilot whale	64	107	2	0
06/01/2013	84[2]	Short-finned pilot whale	32	122	0	0
06/01/2013		Rough-toothed dolphin	30	13	0	0
			Total	**1,428**	**15**	**2**

[1]Sighting seen only from the small boat.
[2]Sighting was a mixed species group.
[3]Time spent with group was brief and inadequate for determining group size.

Figures

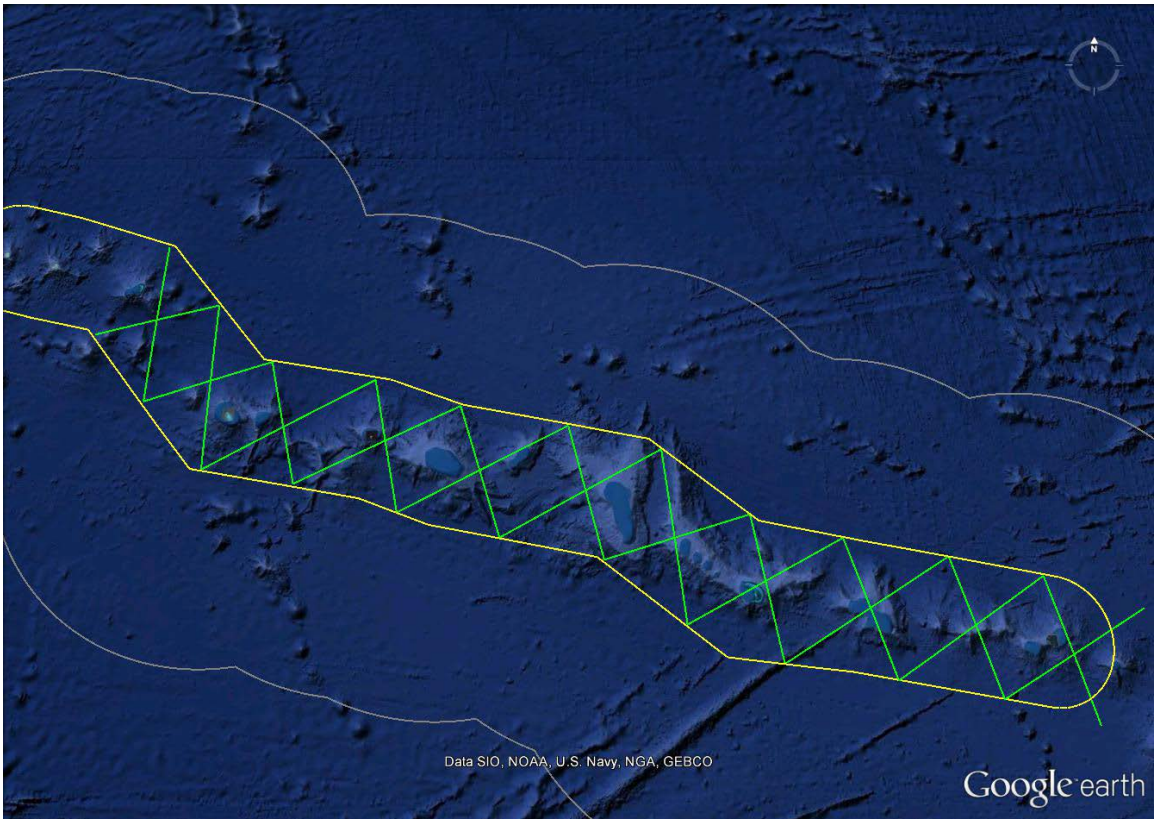

Figure 1. Revised PACES tracklines (green zigzags) within the PMNM (yellow boundary). The outer white line is the U.S. Exclusive Economic Zone (EEZ) around the Hawaiian Archipelago.

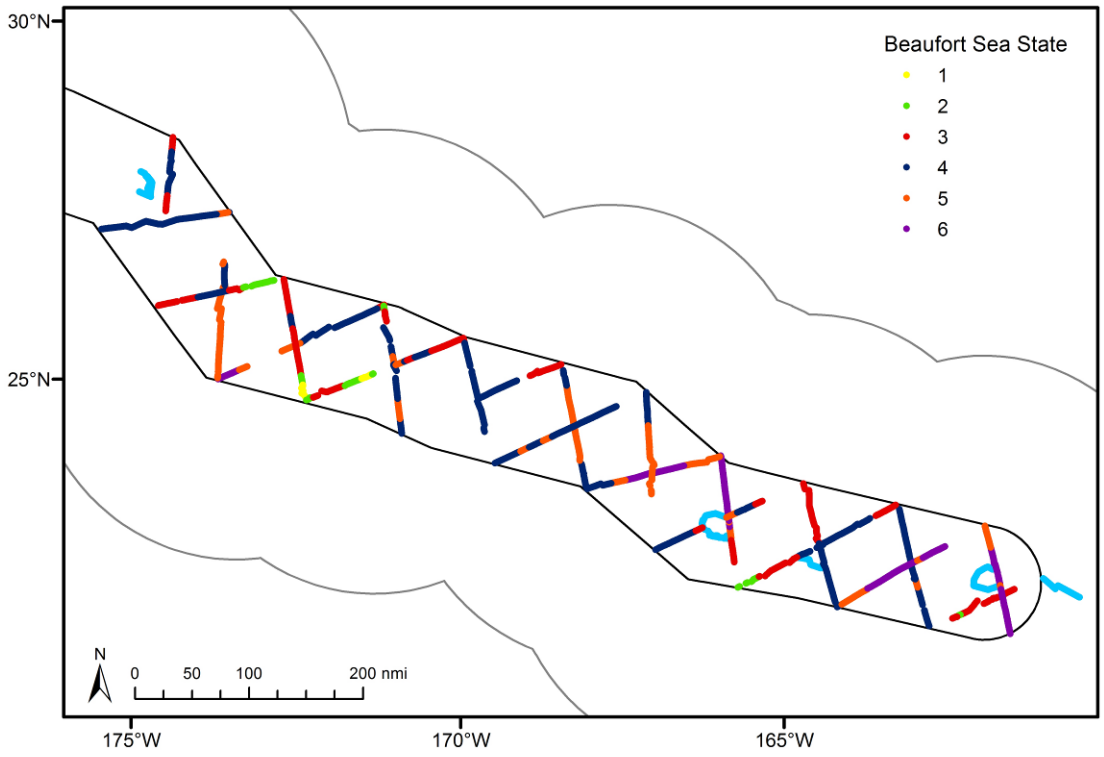

Figure 2. Survey effort (dotted colored lines) along standard tracklines by Beaufort Sea State within the PMNM (black outline). The sky blue lines show non-standard effort. The outer gray line is the U.S. EEZ around the Hawaiian Archipelago.

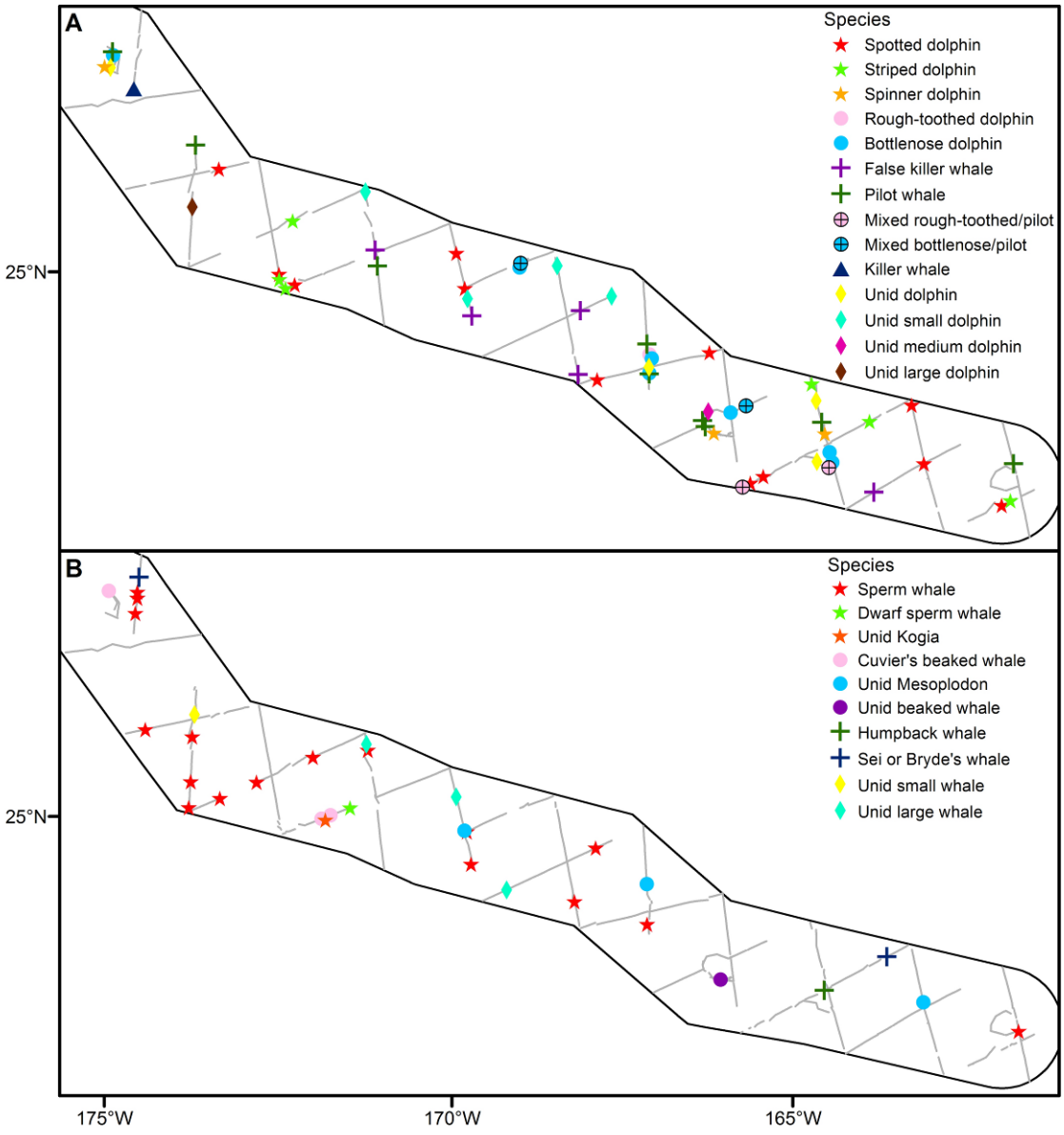

Figure 3. Visual sightings of dolphins (A) and all other whales (B) made while surveying standard and non-standard tracklines (gray lines) within the PMNM (black outline).