Submitted in Support of the U.S. Navy's 2021 Annual Marine Species Monitoring Report for the Pacific

Pacific Marine Assessment Program for Protected Species

PacMAPPS 2021

Final Cruise Report

This project was completed under MIPR number N00070-21-MP-0E115, under the U.S. Navy Marine Species Monitoring Program and jointly funded by the U.S. Navy and NOAA National Marine Fisheries Service.

28 February 2022

Jessica Crance
Kim Goetz

Marine Mammal Laboratory
7600 Sand Point Way NE
Seattle, WA 98115

Citation for this report is as follows:
Crance, J.L., K.T. Goetz, R.P. Angliss. 2022. *Report for the Pacific Marine Assessment Program for Protected Species (PacMAPPS) 2021 field survey.* Submitted to the U.S. Navy Marine Species Monitoring Program, MIPR No. N00070-21-MP-0E115. Prepared by Alaska Fisheries Science Center, Seattle, Washington. February 2022. 21 pp.

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From - To)*
28-02-2022	Monitoring report	01 August 2021 - 26 August 2021

4. TITLE AND SUBTITLE
PACIFIC MARINE ASSESSMENT PROGRAM FOR PROTECTED SPECIES PACMAPPS 2021 FINAL CRUISE REPORT

5a. CONTRACT NUMBER
N62470-15-D-8006

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
Jessica L. Crance
Kim T. Goetz
Robin P. Angliss

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
National Marine Fisheries Service, Alaska Fisheries Science Center, Seattle, Washington

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Commander, U.S.Pacific Fleet, 250 Makalapa Dr. Pearl Harbor, HI

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSORING/MONITORING AGENCY REPORT NUMBER

12. DISTRIBUTION AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT
The Pacific Marine Assessment Program for Protected Species (PacMAPPS) survey occurred from 1 August to 26 August 2021, beginning and ending in Kodiak, AK. Over the course of the survey, a total of 2,330 km of on-effort tracklines were surveyed in suitable weather conditions, and a total of 667 sightings of marine mammals were documented (including duplicates and resights). Primary speciessighted include North Pacific right, fin, humpback, killer, and sperm whales, and Dall's and harborporpoise. Pinnipeds and rare birds (e.g., short-tailed albatross) were also recorded opportunistically. A total of 110 sonobuoys were deployed, of which 96 were successful deployments (i.e., sonobuoys transmitted correctly), for an overall success rate of 87.3%. Acoustically detected species were the same as those visually sighted. However, sonobouys also recorded seismic airguns and vessel noise. A long term bottom mounted passive acoustic recorder mooring in Barnabas Trough was retrieved and a new one deployed; the instrument recorded for a full year. A total of 20 CTD casts were conducted, and 119 nutrient and 8 salinity samples were collected. Additionally, sea surface temperature, fluorescencesalinity, and wind speed were sampled continuously along the survey track, and data on the prey field were collected when possible by the Acoustic Doppler Current Profiler (ADCP) and EK-80 echosounder.

15. SUBJECT TERMS					
Monitoring, marine mammals, passive acoustic monitoring, sonobuoys, Gulf of Alaska					
16. SECURITY CLASSIFICATION OF:			**17. LIMITATION OF ABSTRACT**	**18. NUMBER OF PAGES**	**19a. NAME OF RESPONSIBLE PERSON**
			UU	21	Department of the Navy
a. REPORT	**b. ABSTRACT**	**c. THIS PAGE**			**19b. TELEPONE NUMBER (*Include area code)***
Unclassified	Unclassified	Unclassified			808-471-6391

Executive Summary

The Pacific Marine Assessment Program for Protected Species (PacMAPPS) survey occurred from 1 August to 26 August 2021, beginning and ending in Kodiak, AK. Over the course of the survey, a total of 2,330 km of on-effort tracklines were surveyed in suitable weather conditions, and a total of 667 sightings of marine mammals were documented (including duplicates and resights). Primary species sighted include North Pacific right, fin, humpback, killer, and sperm whales, and Dall's and harbor porpoise. Pinnipeds and rare birds (e.g., short-tailed albatross) were also recorded opportunistically. A total of 110 sonobuoys were deployed, of which 96 were successful deployments (i.e., sonobuoys transmitted correctly), for an overall success rate of 87.3%. Acoustically detected species were the same as those visually sighted. However, sonobouys also recorded seismic airguns and vessel noise. A long-term bottom mounted passive acoustic recorder mooring in Barnabas Trough was retrieved and a new one deployed; the instrument recorded for a full year. A total of 20 CTD casts were conducted, and 119 nutrient and 8 salinity samples were collected. Additionally, sea surface temperature, fluorescence salinity, and wind speed were sampled continuously along the survey track, and data on the prey field were collected when possible by the Acoustic Doppler Current Profiler (ADCP) and EK-80 echosounder.

Background

The National Oceanic and Atmospheric Administration (NOAA) Fisheries is responsible for assessing and managing protected species within the waters of the U.S. Exclusive Economic Zone (EEZ) or where the U.S. has a vested interest to meet the requirements of the Marine Mammal Protection Act (MMPA) and the Endangered Species Act (ESA). To inform Stock Assessment Reports (SARs) and to address regulatory requirements, data on abundance, distribution, and habitat use of marine mammals are needed. Several agencies including the U.S. Navy, the Bureau of Ocean Energy Management (BOEM), and the United States Fish and Wildlife Service (USFWS) have shared overlapping interests in specific geographic areas within the U.S. EEZ. This mutual interest led to a partnership among Federal Agencies to conduct Multispecies Cetacean and Ecosystem Assessment Surveys (MCEAS) and the development of several successful marine assessment programs in the Atlantic Ocean (Atlantic Marine Assessment Program for Protected Species - AMAPPS), Gulf of Mexico (GoMMAPPS), and the Pacific Ocean (PacMAPPS).

The objectives of the MCEAS are to: (1) estimate cetacean abundance, trends, and delineate stock structure, and (2) develop habitat density models for generating predictions of cetacean density or occurrence and understand how these are changing with a changing environment. The outcomes from these objectives have proven valuable for NOAA, the Navy, and BOEM for addressing regulatory needs.

During the development process, PacMAPPS identified the U.S. California Current, the Hawaiian and Mariana Archipelagos, and the Gulf of Alaska (GOA) as three regions with multi-agency interest. The Gulf of Alaska provides important habitat for many endangered marine mammal species, both as a migratory thoroughfare and as an important feeding ground. Additionally, this area is of considerable importance for anthropogenic activities, mainly fishing, vessel traffic, and military exercises. The Navy has a Temporary Maritime Activity Area (TMAA) located in the Gulf of Alaska that is used for training purposes (Figure 1). Both the Navy and NOAA Fisheries require information on marine mammals in this area to understand numbers of marine mammals that may be incidentally taken during Navy operations. Although the Gulf of Alaska had been surveyed in 2009, 2013, and 2015 (Rone et al. 2017), key areas of the shelf and slope were not accessed during these surveys. As such, the PacMAPPS survey area was

specifically designed to cover the slope and shelf regions in addition to offshore areas.

Given the importance of the GOA as a diversity hotspot and the lack of data on the occurrence, distribution, and abundance of cetaceans, a large-scale ship-board survey was required to collect information urgently needed for preparing SARs as well as for meeting requirements of the ESA, MMPA, and the National Environmental Protection Act (NEPA). In order to implement the 2021 PacMAPPS cruise, NOAA provided the ship time, salaried scientists, and a portion of the travel support, and the Navy provided funding for hiring contractors to collect and analyze the data in conjunction with NOAA staff. To that end, a large-scale visual and passive acoustic line transect survey for marine mammals was conducted in the northern GOA to estimate current density and population abundance estimates for multiple species of cetaceans.

Objectives

The 2021 PacMAPPS survey was designed to improve the knowledge base of Federal agencies with protected species responsibilities by conducting a comprehensive marine mammal survey in an area of shared interest. Specifically, the objectives of the PacMAPPS survey were:

1. Survey the shelf and slope waters off Kodiak, AK and east/southeast of Prince William Sound, using visual and passive acoustic monitoring (survey area shown in Figure 1).
2. Conduct a double platform survey in passing mode in order to estimate g(0) for select species.
3. Collect images and biopsy samples of key species (in order of priority: right whale, humpback whale, fin whale, and killer whale) to help determine the stock structure of mixed stocks in the GOA.
4. Recover and redeploy a long-term bottom mounted passive acoustic mooring located in Barnabas Trough.
5. Collect oceanographic and active acoustic (i.e., prey field) data throughout the survey.

Methods

All operations were performed according to regulations and restrictions specified in the existing permits and Animal Care and Use Committee approval letter issued by the NMFS to the Marine Mammal Laboratory (permit #20465).

Visual observations

To estimate the proportion of whales missed on the trackline, g(0), visual effort was conducted from two independent platforms. Operations were conducted on pre-determined track lines during daylight hours and when weather and swell conditions allowed (Figure 1). The survey area consisted of two strata: coastal (30 m to 500 m isobath) and slope (500 m to 4000 m). An equal spacing zigzag trackline sampling design was used to ensure near uniform coverage throughout the survey area. Marine mammals were visually sighted and identified using 25x big eye binoculars to obtain distribution, density, and abundance information. Pinnipeds and rare birds were also recorded opportunistically but not assigned sighting numbers. Transect effort was defined as a visibility greater than 2 nautical miles (nm), Beaufort sea state ≤ 5, and survey speed of ~10 kts through the water. Occasionally, when weather forecasts showed no indication that conditions would improve and when returning to the area was unfeasible, effort was conducted during sub-optimal conditions, including conditions such as patchy fog, precipitation, Beaufort > 5 and high swell. When a sighting was detected, the visual observer reported the horizontal angle and number of reticles from the horizon of the initial sighting to the

recorder. The other observer on the same platform would then go off-effort to confirm species and independent group size estimates. Once independent group size estimates were obtained, both observers would go back on-effort. The computer program *VizSurvey* was used to record all sighting, effort, and environmental conditions (e.g., cloud cover, weather, glare, and sea conditions). In addition, photographs were collected when time and conditions allowed to better understand residency time and stock structure of some species (e.g., humpback whales). Biopsy sample collection was attempted for select sightings. Note, only biopsy samples can determine stock structure of fin whales (*Balaenoptera physalus*).

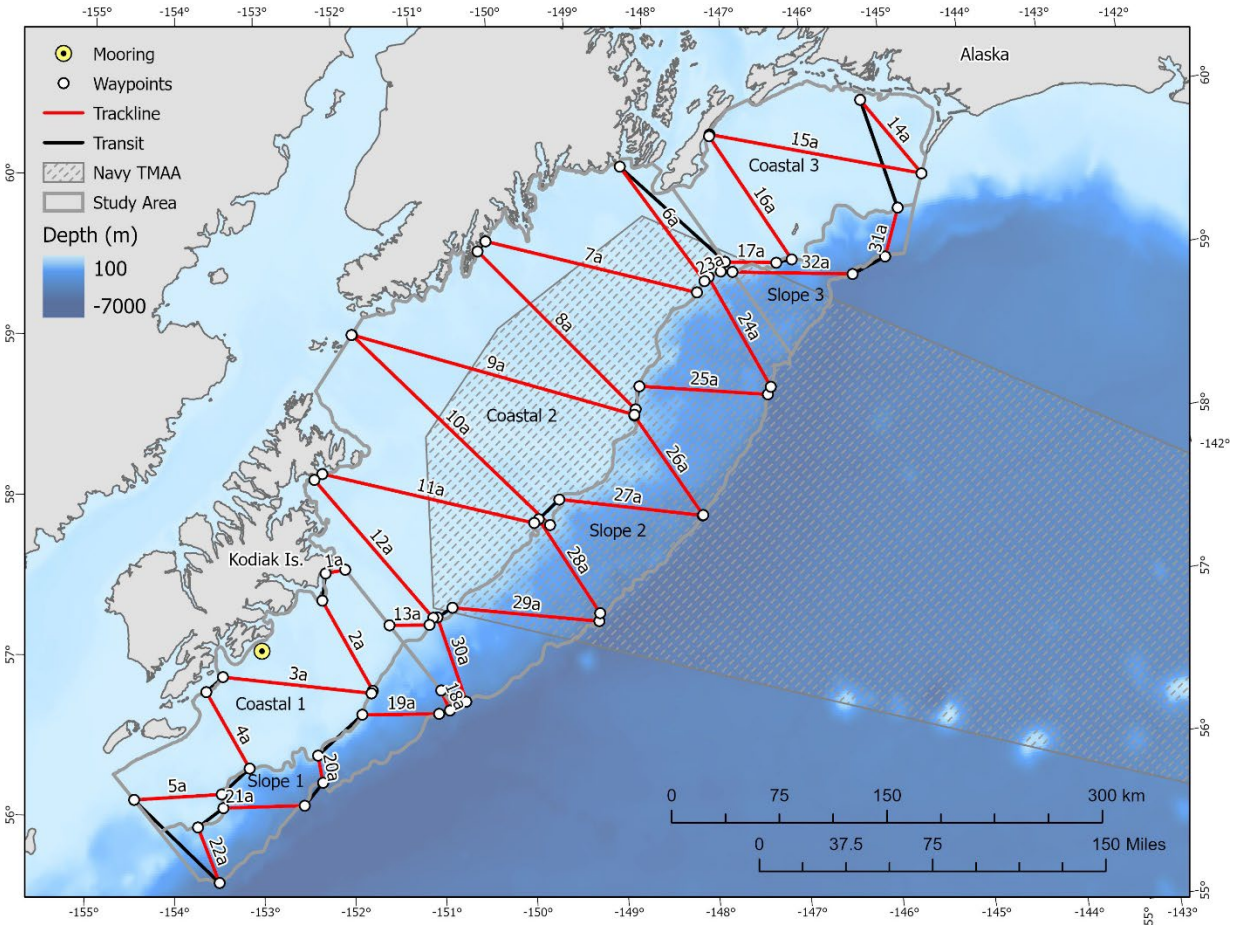

Figure 1. Survey area and predetermined transect lines (tracklines in red) and transit lines (black) for the 2021 PacMAPPS survey in the Gulf of Alaska. Strata and sub-strata are indicated by light gray lines. Hatched polygon marks the Navy TMAA.

Table 1: Proposed effort allocation for each sub-strata within the coastal and slope stratum for the 2021 PacMAPPS survey.

Strata	Area (km2)	Effort (km)	# lines	Effort/Area
Coastal 1	15,325	315	5	0.02
Coastal 2	51,381	1,113	8	0.02
Coastal 3	15,266	363	4	0.02
Slope 1	8,327	187	5	0.02
Slope 2	25,886	615	8	0.02
Slope 3	4,974	119	2	0.02

Passive acoustic monitoring

Sonobuoys were deployed approximately every 2-3 hours while transiting to obtain an evenly-sampled cross-survey census of marine mammal vocalizations. Four types of sonobuoy were used: 53F-GPS, 53G, 53D (all manufactured by either Sparton (SPW) or Ultra Electronics (UND)), and 57B (Magnavox). 53F-GPS, 53G, and 53D sonobuoys have either omnidirectional or DiFAR (Directional Frequency Analysis and Recording) capabilities (i.e., can obtain bearings, audio up to 2.5 kHz). 57B sonobuoys are omnidirectional only (i.e., no directional information, audio up to 24 kHz). Sonobuoys were primarily deployed in DiFAR mode to obtain bearings to calling animals. Exceptions were when in the presence of higher frequency species (e.g., killer whales) where higher frequency vocalizations could be recorded. In addition to real-time monitoring via sonobuoys, one long-term bottom mounted passive acoustic recorder mooring was retrieved and redeployed.

Oceanographic and prey field data collection

Oceanographic data (e.g., salinity, temperature, oxygen, chlorophyll) were collected using an underway water sampling system, as well as nightly Conductivity, Temperature, and Depth (CTD) casts. Nutrient samples were collected with every CTD, while salinity samples were collected every third cast. Active acoustics were used to collect data on the prey field using an ADCP and an EK80 echosounder.

The ability to link marine mammals to prey resources and oceanographic properties will enable us to better understand how these animals interact with their environment and the drivers behind their movement and distribution. Although endangered North Pacific right (*Eubalaena japonica*), fin, killer (*Orcinus orca*), and humpback (*Megaptera novaeangliae*) whales were the primary target species for the PacMAPPS survey, visual and acoustic data were collected on all marine mammal species as well as acoustic data for anthropogenic sound sources. The results from this survey will inform NOAA's SARs for many key Alaska species and provide contemporary data needed to meet the regulatory needs of the Navy, BOEM, and other agencies responsible for the management and conservation of protected species.

Results

Visual survey

A total of 2,330 km of on-effort tracklines were surveyed, with an additional 372 km of effort conducted during transits or in sub-optimal weather conditions (Figure 2; Table 2). Tracklines within the slope 2 and 3 sub-strata were completed successfully. However, due to adverse weather, only 8.6% of the tracklines in the slope 1 sub-strata were surveyed (Table 3). The majority of all survey tracklines were completed within the three coastal sub-strata (80.2-99.1%).

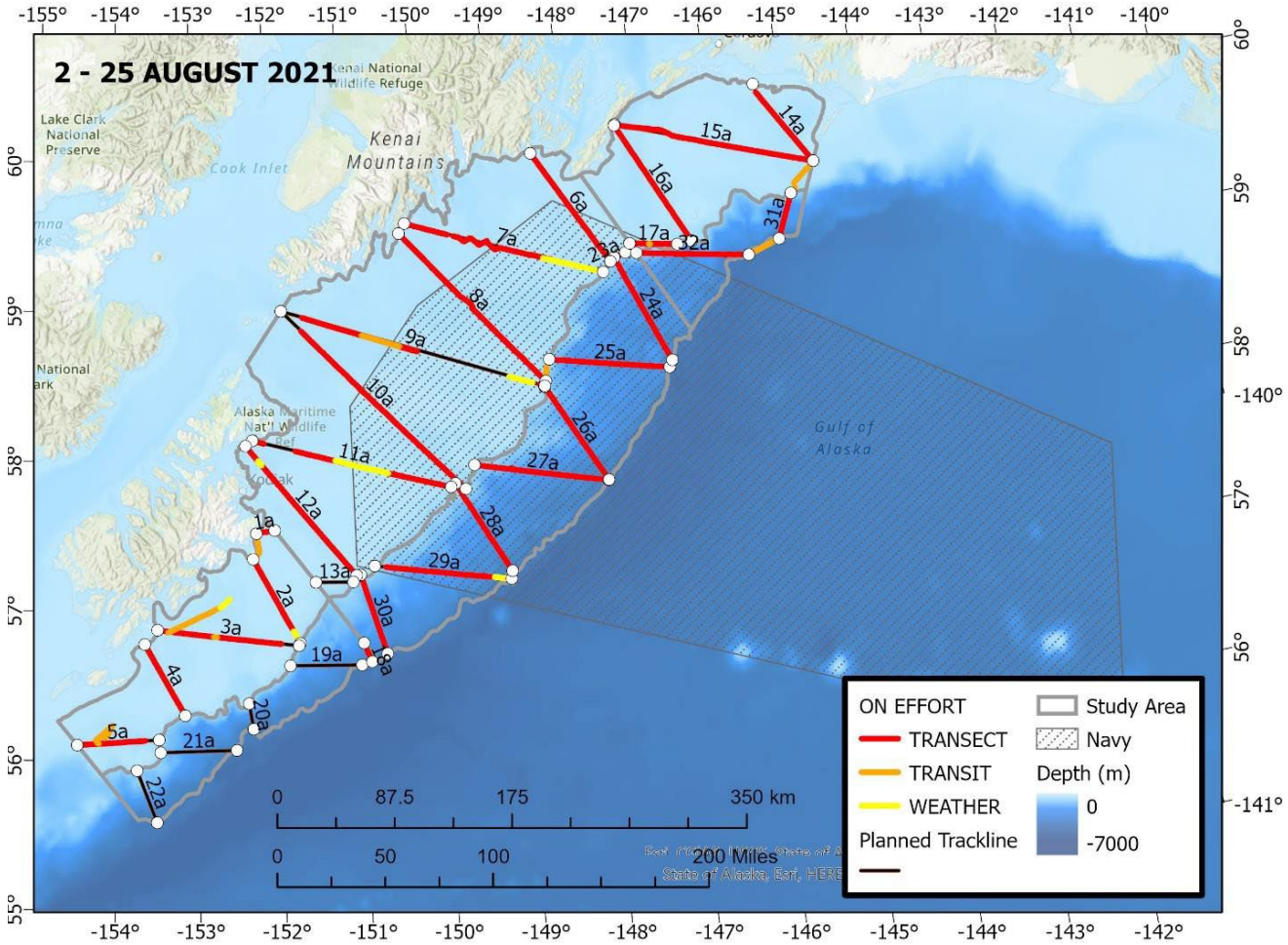

Figure 2. Map of survey area showing effort conducted during transect, transit, and in sub-optimal conditions during the 2021 PacMAPPS survey. Black lines indicate planned but un-surveyed transect lines. Hatched polygon marks the Navy TMAA.

Table 2. Summary of on-effort data collected during the 2021 PacMAPPS survey. Transect effort refers to effort on pre-determined tracklines, transit effort refers to effort conducted between pre-determined tracklines, and weather refers to effort performed in sub-optimal conditions.

Effort	Total length (km)	Total length (nm)
Transect	2,330.3	1258.3
Transit	221.4	119.5
Weather	150.8	150.8
Total	**2,702.5**	**1,459.2**

Table 3. Summary of on-effort data collected while on transect in each of the coastal and slope strata during the 2021 PacMAPPS survey. Note that effort conducted during sub-optimal conditions is not reflected in this table.

Stratum	Total length (km)	Total length (nm)	% Complete
Coastal 1	305.4	164.9	97.0
Coastal 2	892.5	481.9	80.2
Coastal 3	359.9	194.3	99.1
Slope 1	15.3	8.2	8.6
Slope 2	635.5	343.1	100
Slope 3	121.8	65.8	100
Total	**2330.3**	**1258.3**	**85.9**

A total of 667 sightings of cetaceans were recorded. Approximately 120 of these sightings are probable matches (the same sighting seen by both visual survey teams), bringing the number of unique sightings closer to 550. The distribution of cetacean sightings documented during the 2021 PacMAPPS survey is presented in Figure 3. The number of sightings per species and platform is shown in Table 4. Note that these data do not include number of individuals sighted (or group size), only the number of sightings. The total number of sightings on Table 4 also includes eight sightings of mixed groups. Fin, humpback, sperm (*Physeter macrocephalus*), and killer whales, as well as Dall's porpoise (*Phocoenoides dalli*) were the most commonly sighted species. Sightings for which species identification was not possible were labeled 'unidentified' for various categories (i.e., unid. baleen whale, unid. toothed whale) (Figure 4; Table 4). There were 39 unique killer whale sightings across platforms, including 18 resident sightings, 5 transient sightings, and 16 sightings that could not be identified to ecotype (Figure 5). For two of the killer whale sightings identified to ecotype, individual identity was determined based on photo identification. Members of the AJ13 matriline of resident killer whales (AJ13 (mother), four offspring (AJ83, AJ57, AJ62, AJ44) and AJ90 (the offspring of AJ44)) were seen on 5 August, survey line 14a (Figure 1). Additionally, two pods of resident killer whales (AX1 and AX27 pod) were seen on 17 August, survey line 11a. The AX1 matriline consisted of AX6 and her daughters (AX94, AX198, AX140) and daughter of AX96 (AX191) and individuals from the AX27 pod consisted of two males, AX89 and AX85.

Two North Pacific right whale (NPRW) sightings occurred during the survey, one of which was detected visually in Barnabas Trough on 21 August and one that was initially detected acoustically ~50 km south of Trinity Islands on 24 August (Figure 6). The sighting within Barnabas Trough (21 August) was inside the boundaries of the NPRW Critical Habitat. The first sighting (21 August) was of two individuals. One of the individuals was confirmed new and added to the MML NPRW catalog. The other animal was matched to an animal that was seen by Canada's Department of Fisheries and Oceans (DFO) off Haida Gwaii in British Columbia on 12 June earlier this year. This is the first time an animal from Haida Gwaii has been resighted. The second sighting (24 August) was also of two right whales. One animal was confirmed new and added to the MML NPRW catalog. The other animal was matched to a whale already in the catalog (MML #71), an individual first seen in Barnabas Trough in September 2006. This is the first time MML #71 has been resighted. The sex of all four animals is unknown; no biopsy samples were obtained in either sighting, although DFO obtained a biopsy sampleduring their sighting.

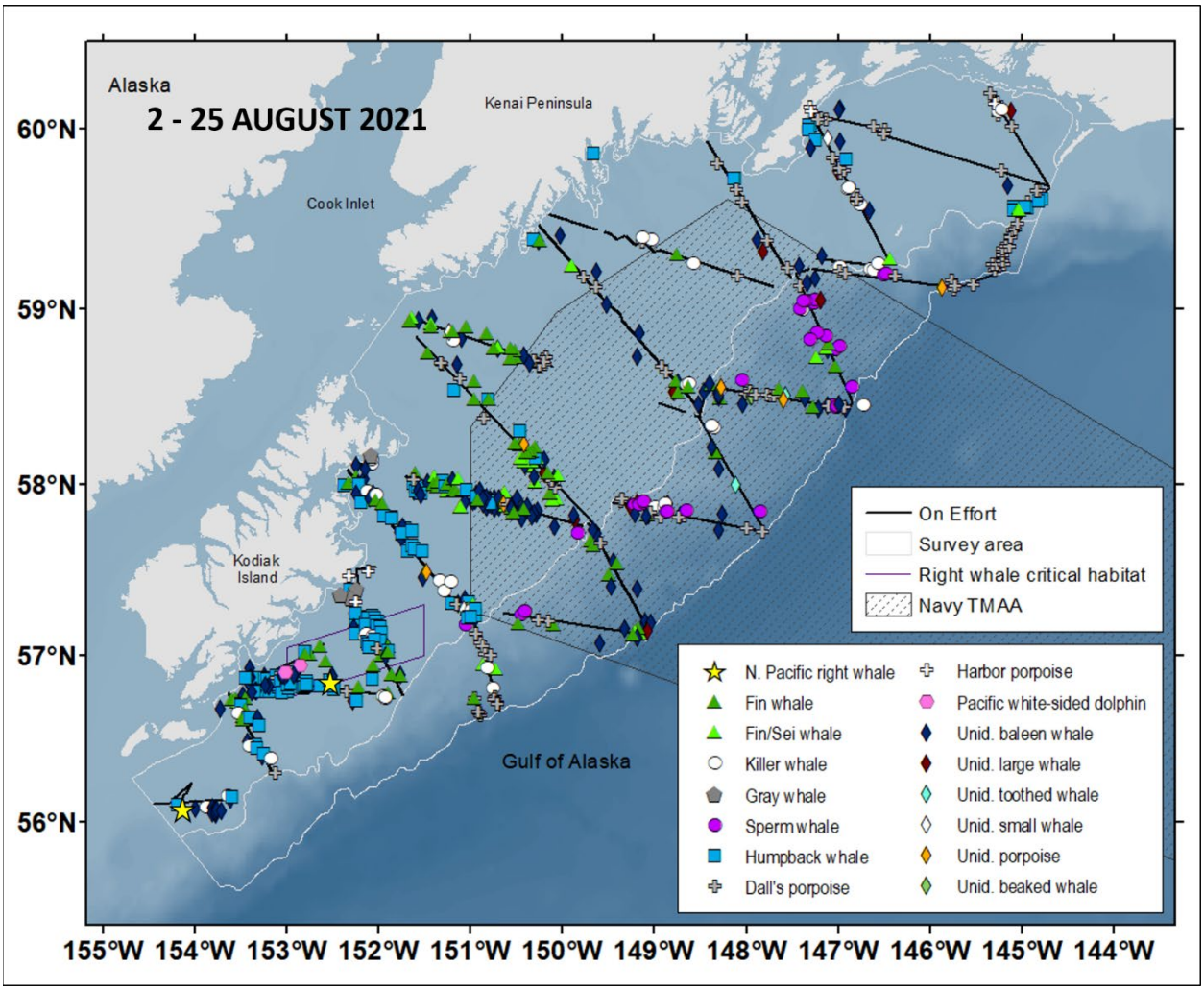

Figure 3. Distribution of cetacean sightings during the 2021 PacMAPPS survey, including duplicates and resights.

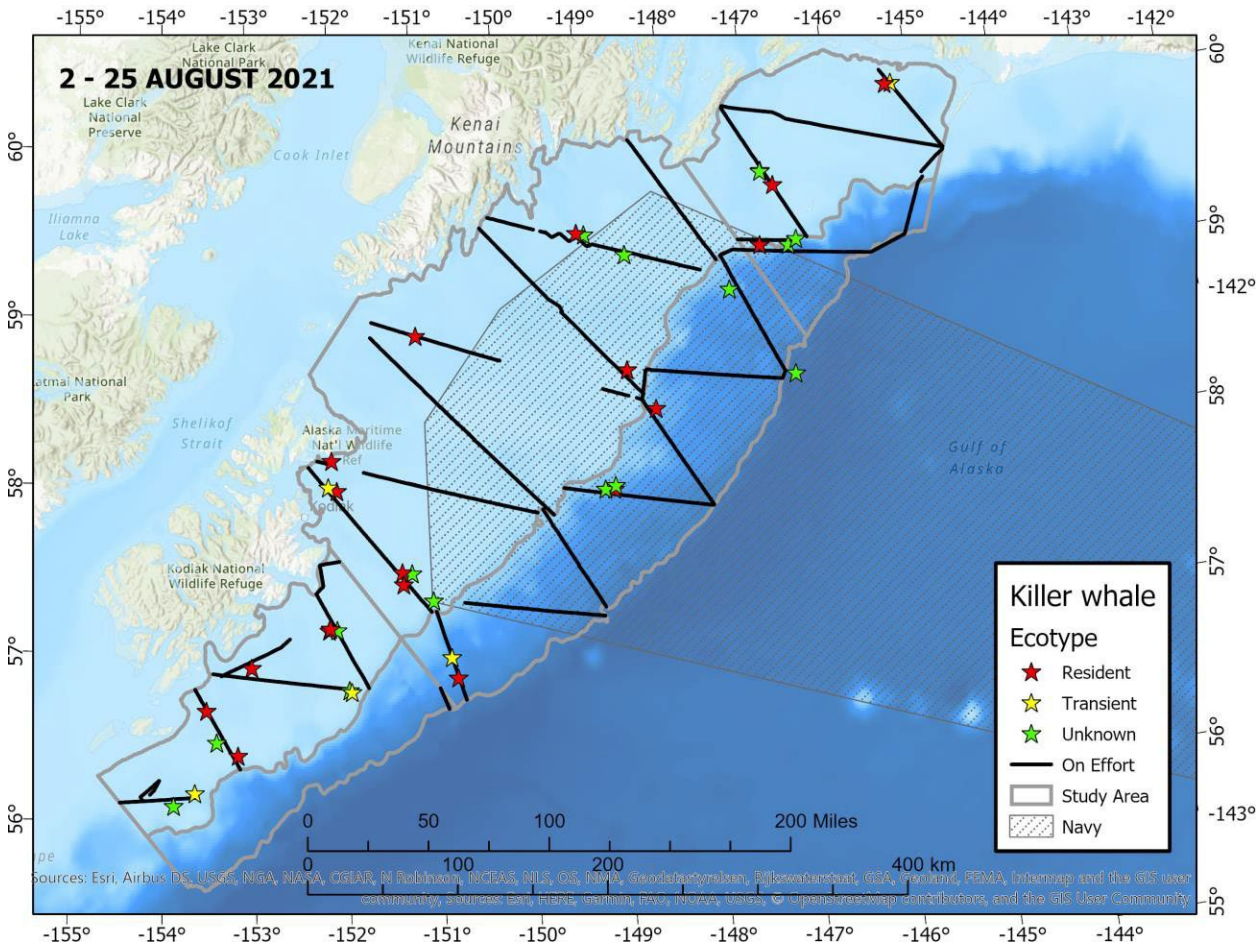

Figure 4. Distribution of unique killer whale sightings by ecotype during the 2021 PacMAPPS survey.

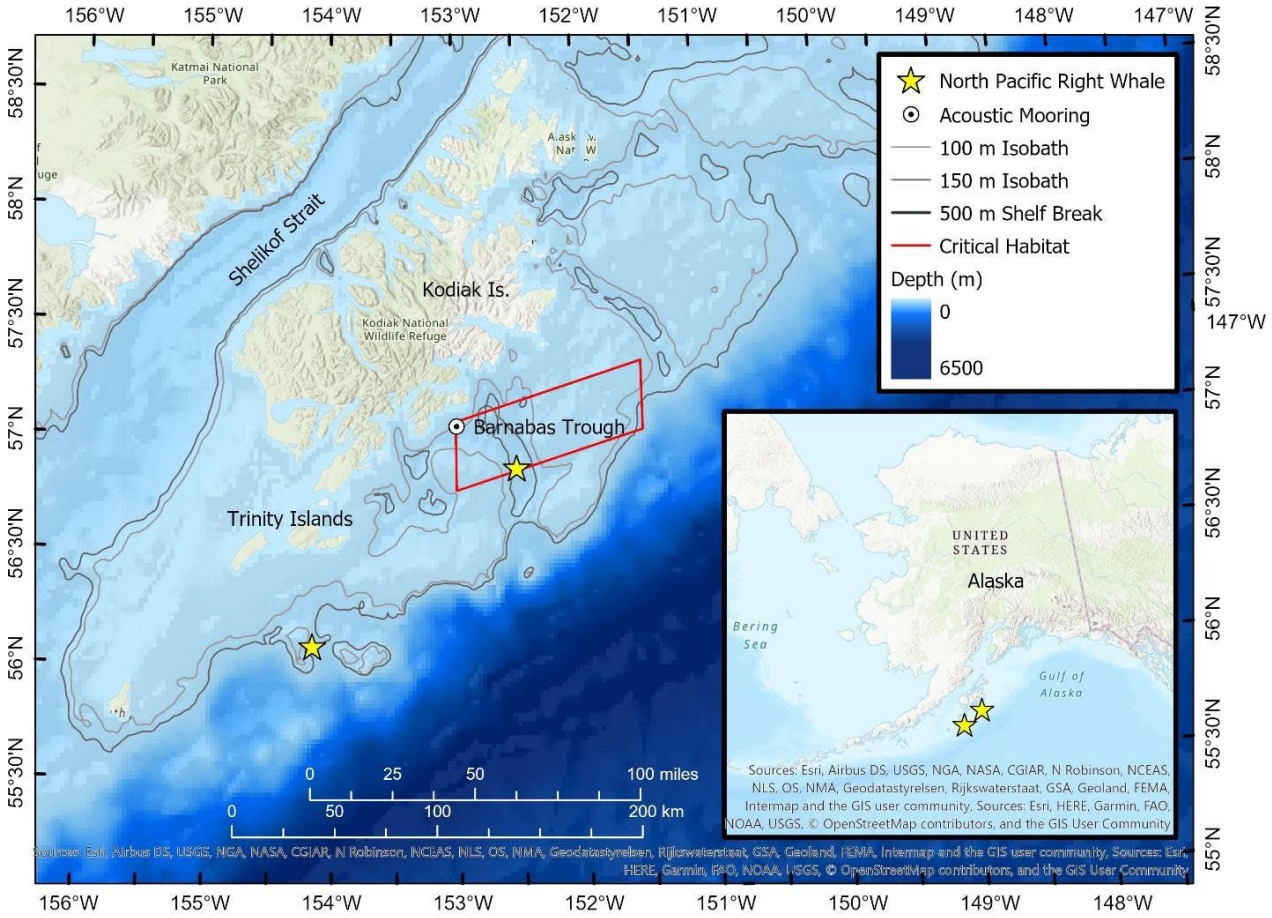

Figure 5. North Pacific right whale sightings during the 2021 PacMAPPS survey.

Table 4. Preliminary number of sightings per species by platform and stratum during the 2021PacMAPPS survey. Note: These numbers include duplicate sightings and possible resights.

Species	Platform 1	Platform 2	Total
Humpback whale	86	60	146
Fin whale	71	54	125
Fin/Sei whale	25	18	43
Grey whale	2	3	5
North Pacific right whale	1	1	2
Unid baleen whale	68	54	122
Killer whale	28	18	46
Sperm whale	17	18	35
Unid beaked whale	1	1	2
Unid toothed whale	1	2	3
Unid large whale	9	5	14
Unid small whale	3	1	4
Dall's porpoise	67	42	109
Harbor porpoise	6	3	9
Unid porpoise	4	3	7
Pacific white-sided dolphin	2	1	3
Total	**391**	**284**	**675***

*There were a total of 667 sightings (including probable duplicates), but 8 sightings of mixed species were counted twice, once for each species, bringing the total to 675.

Passive acoustic monitoring

A total of 110 sonobuoys were deployed, of which 96 were successful deployments (i.e., sonobuoys transmitted properly), for an overall success rate of 87.3% (Table 5). Sonobuoys included nine 57B units produced in 1990 and 101 53D, 53F-GPS and 53G manufactured between 2004 and 2019 (Table 5). The relatively lower overall success rate in the sonobuoy deployments occurred because all 57B units, which were more than 30 years old, failed. When excluding these buoys, the overall success rate of the newer sonobuoys was 95%. A total of 133.7 hours of acoustic monitoring occurred over 1700 km of survey trackline. Species or signals detected include fin (51 buoys, 53.1%), killer (42 buoys, 43.8%), sperm (36 buoys, 37.5%), humpback (22 buoys, 22.9%), and North Pacific right whales (8 buoys, 8.3%), fish (2 buoys, 2.1%), unknown sounds (2 buoys, 2.1%), and seismic airguns (45 buoys, 46.9%) (Figure 6). Details of sonobuoy deployments and species detected are provided in Appendix I. Detections were in good agreement with the visual survey results. The source of the seismic airguns was determined to be from the R/V Marcus Langseth, which was conducting a geophysical survey off the west coast of Canada and southeast Alaska during the same time period.

During the acoustic encounter with the North Pacific right whales, singing was detected. Crance et al. (2019) first documented singing by males of this critically endangered population, but prior to this survey, all detections of song were limited to the Bering Sea. The song detected during the 24 August detection was a variation of one of the documented Bering Sea songs. Detailed acoustic analyses are underway to compare this variant with the Bering Sea version. This detection suggests that at least one male right whale was present during the encounter. It remains unknown whether females also sing.

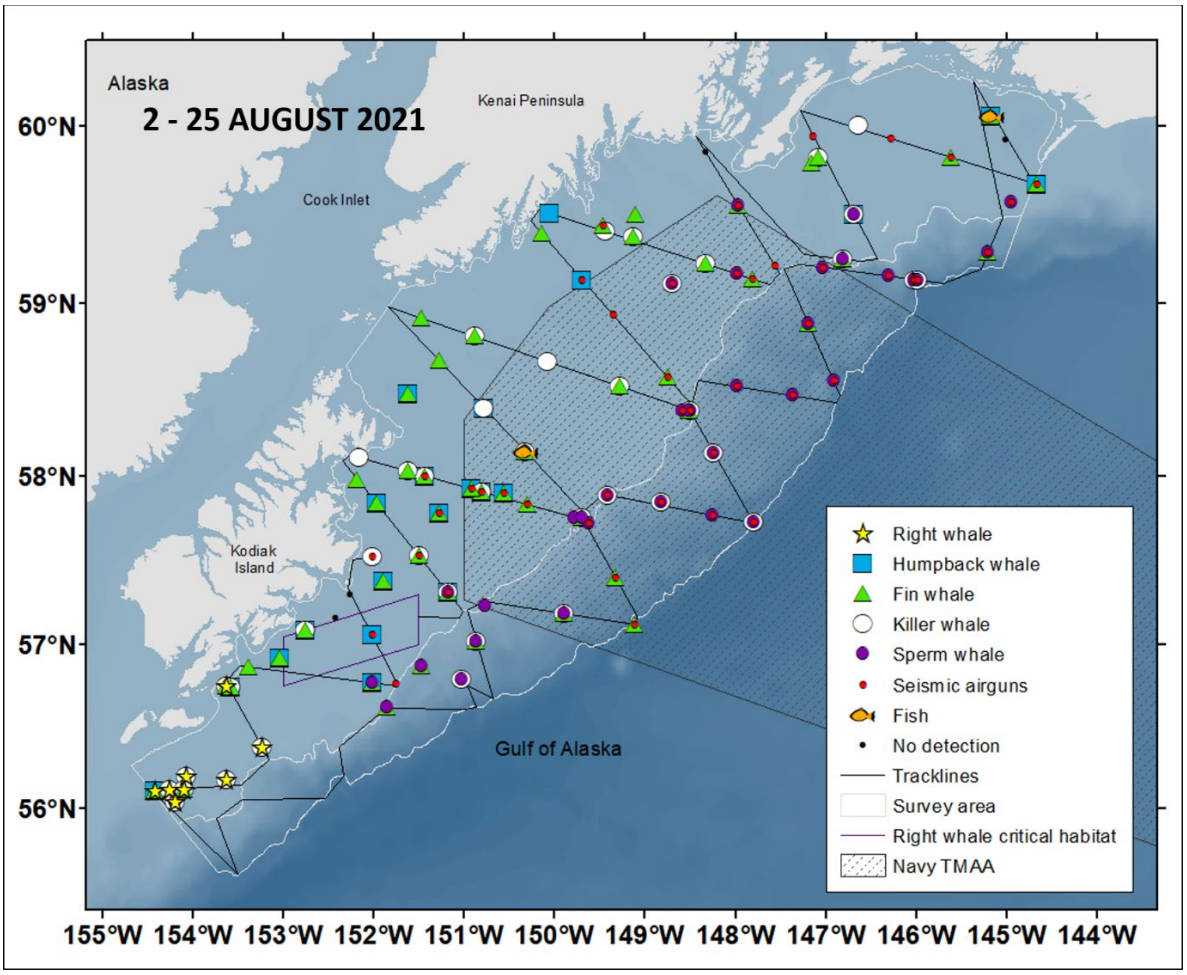

Figure 6. Sonobuoy deployments and species/signals detected during the 2021 PacMAPPS survey.

Table 5. Total number of sonobuoys deployed, number of successful deployments, and success rate for each manufacturer, type, and manufacturing year.

Manufacturer	Type	Year	# successful	Total # deployed	% success
UND	53F-GPS	2012	38	39	97.4%
		2013	27	30	90.0%
		2017	1	1	100.0%
	53D	2004	1	1	100.0%
SPW	53G	2019	29	30	96.7%
	57B	1990	0	9	0.0%
Total			**96**	**110**	**87.3%**

Long-term passive acoustic mooring

The long-term bottom mounted passive acoustic recorder located in Barnabas Trough and used to understand year-round occurrence of marine mammals, particularly NPRW, was successfully retrieved, and a new instrument redeployed in the same location (Figures 1, 7). The instrument recorded for a full year. These data will be analyzed at the Marine Mammal Laboratory in Seattle, WA.

Figure 7. Long-term bottom mounted passive acoustic recorder retrieval on the NOAA ship Oscar Dyson.

Oceanographic sampling

A total of 20 CTD casts were conducted, to depths ranging from 56 m to 2000 m. The North Pacific gyre that occurs annually and follows the slope to the southwest was also sampled (cast #17 in Figure 8). Nutrient samples were collected at every cast (119 samples in total), and salinity samples were collected at every third CTD cast (8 samples in total). Figure 8 and Table 6 show the locations and depths of all CTD casts conducted. These data were provided to PMEL to further their understanding of oceanographic processes in the Gulf. In addition, underway water sampling for oceanographic data was conducted. Figure 9 shows the average sea surface temperature measured along the trackline.

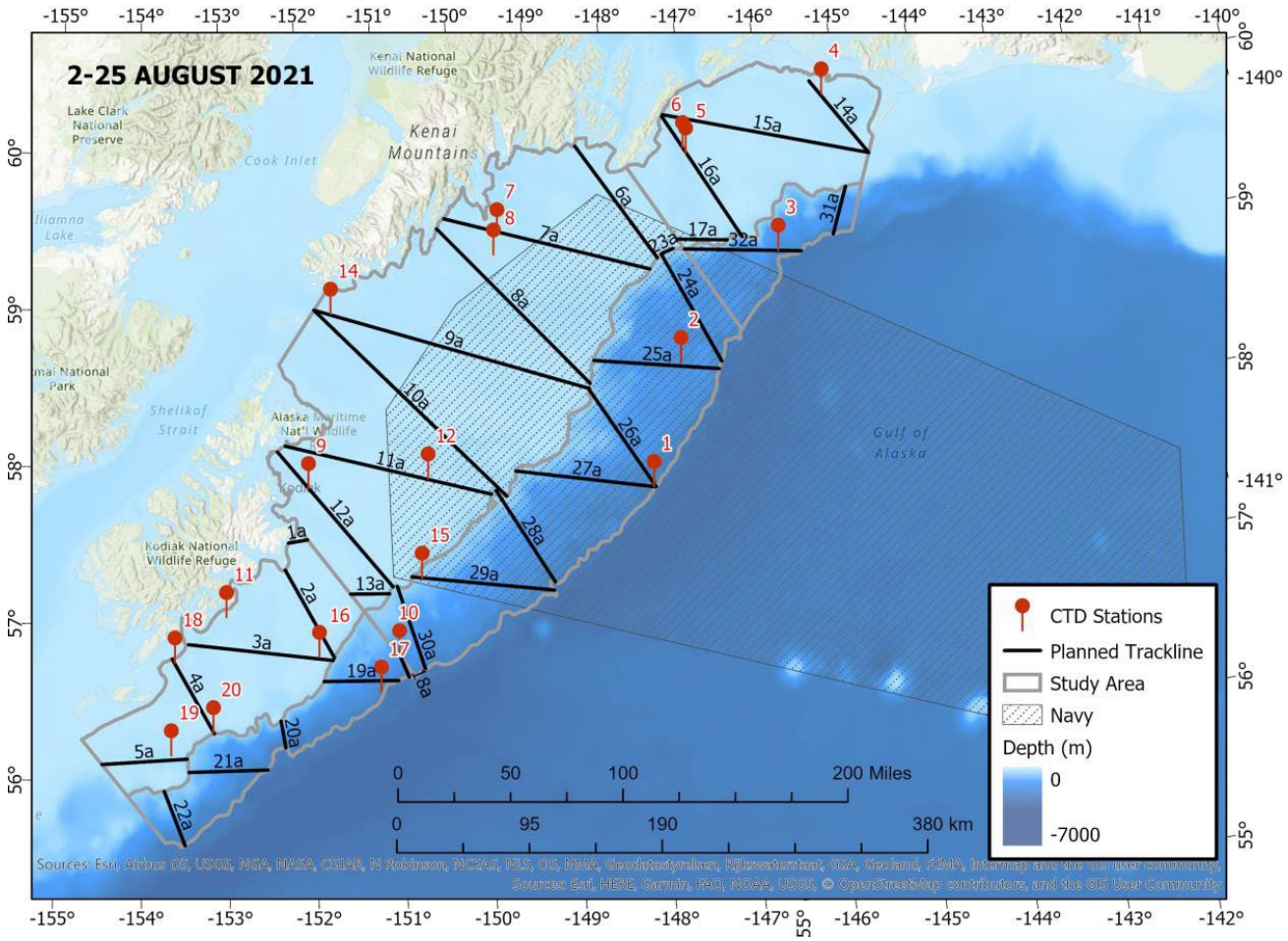

Figure 8. Location of all CTD casts conducted during the 2021 PacMAPPS survey.

Table 6. Location and maximum sampling depth of all CTD casts conducted during the 2021 PacMAPPS survey. Asterisk indicates those casts where salinity was collected.

Cast #	Date (UTC)	Time (UTC)	Latitude (°N)	Longitude (°W)	Bottom Depth (m)	Max Sampling Depth (m)
1*	8/3/2021	5:02	57.7193	-147.8160	3799	1000
2	8/4/2021	4:58	58.4885	-147.3453	2653	1000
3	8/5/2021	4:36	59.1320	-145.9918	3151	1000
4*	8/6/2021	4:36	60.0860	-145.2005	113	108
5	8/7/2021	3:39	59.8142	-147.0210	183	175
6	8/8/2021	5:31	59.8510	-147.0528	191	185
7*	8/11/2021	20:33	59.4003	-149.5010	105	100
8	8/13/2021	3:46	59.2725	-149.5620	104	100
9	8/14/2021	5:17	57.8422	-151.9803	95	90
10*	8/15/2021	5:36	56.7545	-150.9722	1616	1000
11	8/16/2021	4:11	57.0308	-152.9937	81	80
12	8/18/2021	4:32	57.8717	-150.5305	96	93
13*	8/19/2021	4:17	58.4097	-1478.4993	329	320
14	8/20/2021	5:40	58.9487	-151.6395	117	114
15	8/21/2021	5:15	57.2417	-150.6630	606	592
16*	8/22/2021	4:46	56.7632	-151.9113	69	63
17	8/22/2021	21:00	56.5272	-151.2015	3054	2000
18	8/24/2021	2:23	56.7450	-153.6057	144	138
19*	8/25/2021	5:10	56.1520	-153.6543	283	275
20	8/25/2021	22:02	56.2972	-153.1653	260	250

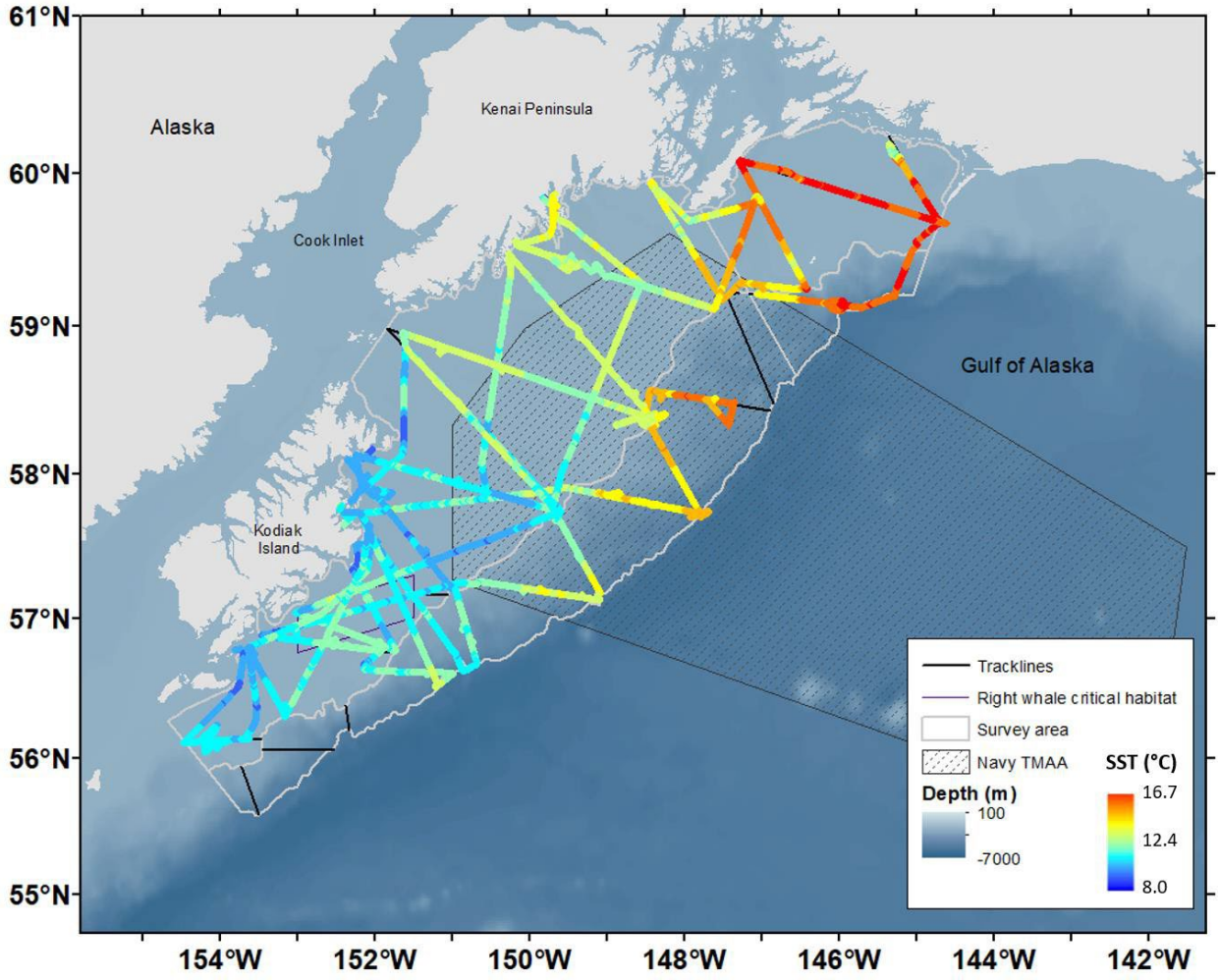

Figure 9. Sea surface temperatures measured from the underway water sampling system during the 2021 PacMAPPS survey.

Prey field sampling

Prey field data were collected while underway via the EK80 echosounder and Acoustic Doppler Current Profiler (ADCP). Data will be processed by staff in the AFSC Resource Assessment and Conservation Engineering (RACE) Division, and correlations between prey fields and animal occurrence will be analyzed as a joint project by researchers in both the MML and RACE Divisions.

Conclusions

Overall, the cruise provided valuable new data about the presence of marine mammals in the Gulf of Alaska during the summer on the shelf and slope areas adjacent and within the Navy TMAA. Analyses of the visual sighting data are underway; these results will provide abundance and density estimates for several species in this region. Photographic results provided new information on the presence of specific ecotypes and, in some cases, individual identification of killer whales in the study area. Four unique

North Pacific right whales were sighted, two of which were confirmed as new individuals. The inclusion of sonobuoys as a passive acoustic monitoring tool again proved successful during the survey. We were able to increase our understanding of the spatio-temporal distribution of many marine mammal species in the northern Gulf of Alaska, and obtain recordings of a variant of song that is produced by North Pacific right whales. Analyses on the similarities of this variant with the known Bering Sea version is ongoing.

Acknowledgments

The authors thank Andrea Balla-Holden (US Navy, Pacific Fleet) for her project support. The authors also thank PMA-264, NAVSUP GLS AMMO, and the LMR Program Office (J. Leonhard, T. Yost, T. Mequet, E. Rainey, E. Brown, A. Kumar, M. Shoemaker, R. Fitch, R. Gisiner) for their continued support and for providing sonobuoys. We also thank the Captain and crew of the NOAA ship Oscar Dyson and all field scientists (A. Ü, E. Vasquez-Morquecho, A. Ligon, C. Hoefer, A. Van Cise, M. Savoie, D. Ellifrit, D. Medley). Financial support provided by the U.S. Navy and NOAA Fisheries. The recommendations and general contents presented in this report do not necessarily represent the views or official position of the U.S. Department of Commerce, the National Oceanic and Atmospheric Administration or the National Marine Fisheries Service.

References

Crance, J.L., C.L. Berchok, D.L. Wright, A.M. Brewer, and D.F. Woodrich. 2019. Song production by the North Pacific right whale, *Eubalaena japonica*. *The Journal of the Acoustical Society of America*, 145(6): 3467-3479.

Rone, B.K., A.N. Zerbini, A.B. Douglas, D.W. Weller, and P.J. Clapham. 2017. Abundance and distribution of cetaceans in the Gulf of Alaska. *Marine Biology*, 164(1): 1-23.

Appendix I. List of all sonobuoy deployments and species/signals detected during the 2021 PacMAPPSsurvey. 1 = species was detected; 0 = not detected. Unknown = either sound was of unknown species/signal, or was too faint for definitive attribution.

Station #	Success?	Deploy Date	Deploy Time (ADT)	Latitude (°N)	Longitude (°W)	Water depth (m)	Right whale	Humpback whale	Fin whale	Killer whale	Airguns	Sperm whale	Fish	Unknown
1	1	01-Aug	18:13:31	57.786	-151.271	66	0	1	1	0	1	0	0	0
2	1	02-Aug	08:40:17	57.893	-149.413	489	0	0	0	1	1	1	0	0
3	1	02-Aug	14:11:53	57.849	-148.817	1445	0	0	0	1	1	1	0	0
4	1	02-Aug	18:13:54	57.773	-148.252	3300	0	0	0	0	1	1	0	0
5	1	03-Aug	08:09:18	57.732	-147.796	3892	0	0	0	1	1	1	0	0
6	0	03-Aug	10:48:52	58.126	-148.220	1615	0	0	0	0	0	0	0	0
7	1	03-Aug	10:53:35	58.138	-148.234	1600	0	0	0	1	1	1	0	0
8	0	03-Aug	13:53:01	58.370	-148.484	570	0	0	0	0	0	0	0	0
9	1	03-Aug	13:59:21	58.385	-148.502	303	0	0	0	1	1	1	0	0
10	1	03-Aug	18:11:02	58.527	-147.978	2114	0	0	0	0	1	1	0	0
11	1	04-Aug	07:22:32	58.476	-147.366	2532	0	0	0	0	1	1	0	0
12	1	04-Aug	09:44:11	58.560	-146.909	3013	0	0	0	0	1	1	0	0
13	1	04-Aug	12:39:14	58.889	-147.189	2385	0	0	1	0	1	1	0	0
14	1	04-Aug	16:02:57	59.208	-147.034	585	0	0	0	0	1	1	0	0
15	0	04-Aug	16:53:06	59.190	-146.766	428	0	0	0	0	0	0	0	0
16	1	04-Aug	19:03:19	59.160	-146.305	2074	0	0	0	0	1	1	0	0
17	1	04-Aug	21:42:29	59.137	-146.019	3061	0	0	0	1	1	1	0	0
18	1	05-Aug	07:21:04	59.138	-145.978	3100	0	0	0	1	1	1	0	0
19	0	05-Aug	10:10:59	59.282	-145.214	1945	0	0	0	0	0	0	0	0
20	1	05-Aug	10:16:03	59.296	-145.204	1908	0	0	1	0	1	1	0	0
21	1	05-Aug	13:05:10	59.576	-144.943	177	0	0	0	0	1	1	0	0
22	1	05-Aug	15:49:35	59.925	-145.001	183	0	0	0	0	0	0	0	0
23	0	05-Aug	21:17:52	60.068	-145.179	122	0	0	0	0	0	0	0	0
24	1	05-Aug	21:33:54	60.058	-145.166	124	0	1	1	0	0	0	1	1
25	1	06-Aug	07:09:21	59.680	-144.663	147	0	1	1	0	1	0	0	0
26	1	06-Aug	10:10:37	59.828	-145.615	102	0	0	1	0	1	0	0	0
27	0	06-Aug	12:52:37	59.924	-146.228	76	0	0	0	0	0	0	0	0
28	1	06-Aug	13:01:45	59.931	-146.278	74	0	0	0	0	1	0	0	0
29	1	06-Aug	14:10:52	60.005	-146.633	81	0	0	0	1	0	0	0	0
30	1	06-Aug	17:53:45	59.946	-147.142	206	0	0	0	0	1	0	0	0
31	1	06-Aug	20:40:25	59.798	-147.158	191	0	0	1	0	0	0	0	0
32	0	07-Aug	07:47:59	59.870	-148.346	66	0	0	0	0	0	0	0	0
33	1	07-Aug	07:53:35	59.857	-148.330	120	0	0	0	0	0	0	0	0
34	1	07-Aug	10:00:04	59.559	-147.967	116	0	0	1	0	1	1	0	0
35	1	07-Aug	13:07:29	59.219	-147.555	193	0	0	0	0	1	0	0	0

Station #	Success?	Deploy Date	Deploy Time (ADT)	Latitude (°N)	Longitude (°W)	Water depth (m)	Right whale	Humpback whale	Fin whale	Killer whale	Airguns	Sperm whale	Fish	Unknown
36	1	07-Aug	16:05:46	59.257	-146.810	192	0	0	1	1	0	1	0	0
37	1	07-Aug	19:02:54	59.510	-146.685	193	0	1	0	1	0	1	0	0
38	1	07-Aug	22:08:09	59.826	-147.084	205	0	0	1	1	0	0	0	0
39	1	08-Aug	07:50:31	59.143	-147.802	202	0	0	1	0	1	0	0	0
40	1	08-Aug	11:37:51	59.511	-149.103	198	0	0	1	0	0	0	0	0
41	1	11-Aug	07:42:03	59.514	-150.049	104	0	1	0	0	0	0	0	0
42	1	11-Aug	09:48:22	59.413	-149.433	123	0	0	0	1	0	0	0	0
43	1	12-Aug	07:38:53	59.449	-149.453	119	0	0	1	0	1	0	0	0
44	1	12-Aug	11:51:23	59.385	-149.120	210	0	0	1	1	0	0	0	0
45	1	12-Aug	14:33:31	59.229	-148.322	115	0	2	1	1	0	0	0	0
46	1	12-Aug	17:35:04	59.174	-147.977	197	0	0	0	0	1	1	0	0
47	1	12-Aug	21:02:38	59.116	-148.690	160	0	0	0	1	1	1	0	0
48	1	13-Aug	07:21:01	57.763	-149.782	383	0	0	0	0	0	1	0	0
49	1	13-Aug	09:30:14	57.840	-150.302	128	0	0	1	0	1	0	0	0
50	1	13-Aug	12:29:26	57.913	-150.801	94	0	1	1	1	1	0	0	0
51	1	13-Aug	14:32:29	58.005	-151.431	83	0	1	1	1	1	0	0	0
52	1	13-Aug	18:32:59	57.986	-152.185	167	0	0	1	0	0	0	0	0
53	1	14-Aug	07:21:33	57.843	-151.968	103	0	1	1	0	0	0	0	0
54	1	14-Aug	09:42:59	57.532	-151.499	126	0	0	1	1	1	0	0	0
55	1	14-Aug	13:12:14	57.313	-151.171	87	0	1	1	1	1	1	0	0
56	1	14-Aug	15:21:16	57.023	-150.863	1826	0	0	1	1	0	1	0	0
57	1	14-Aug	22:29:56	56.789	-151.027	1687	0	0	0	1	0	1	0	0
58	1	15-Aug	07:16:54	57.525	-152.011	54	0	0	0	1	1	0	0	0
59	1	15-Aug	09:29:05	57.304	-152.255	69	0	0	0	0	0	0	0	0
60	1	15-Aug	12:18:58	57.058	-152.015	78	0	1	0	0	1	0	0	0
61	1	15-Aug	14:21:12	56.765	-151.750	281	0	0	0	0	1	0	0	1
62	1	15-Aug	21:17:53	57.085	-152.751	156	0	1	1	1	0	0	0	0
63	1	16-Aug	07:12:07	57.728	-149.624	205	0	0	0	0	1	1	0	0
64	1	16-Aug	10:42:28	58.148	-150.319	165	0	0	1	1	1	1	1	0
65	0	16-Aug	13:18:14	58.375	-150.728	65	0	0	0	1	0	0	0	0
66	1	16-Aug	13:31:00	58.402	-150.775	77	0	1	0	1	0	0	0	0
67	1	16-Aug	16:02:42	58.677	-151.277	192	0	0	1	0	0	0	0	0
68	1	16-Aug	20:32:18	58.484	-151.620	171	0	1	1	0	0	0	0	0
69	0	17-Aug	10:06:14	58.103	-152.239	75	0	0	0	0	0	0	0	0
70	1	17-Aug	10:37:35	58.114	-152.165	195	0	0	0	1	0	0	0	0
71	1	17-Aug	13:39:08	58.034	-151.616	116	0	2	1	1	0	0	0	0
72	1	17-Aug	19:03:36	57.929	-150.913	87	0	1	1	0	1	0	0	0
73	1	17-Aug	20:59:36	57.904	-150.562	125	0	1	1	0	1	0	0	0

Station #	Success?	Deploy Date	Deploy Time (ADT)	Latitude (°N)	Longitude (°W)	Water depth (m)	Right whale	Humpback whale	Fin whale	Killer whale	Airguns	Sperm whale	Fish	Unknown
74	1	18-Aug	07:50:43	59.402	-150.140	156	0	0	1	0	0	0	0	0
75	1	18-Aug	10:10:45	59.137	-149.687	177	0	1	0	0	1	0	0	0
76	1	18-Aug	13:11:55	58.938	-149.350	243	0	0	0	0	1	0	0	0
77	1	18-Aug	16:19:53	58.580	-148.744	117	0	0	1	0	1	0	0	0
78	1	18-Aug	21:12:46	58.389	-148.586	145	0	0	0	0	1	1	0	0
79	1	19-Aug	07:18:21	58.390	-148.510	368	0	0	1	0	0	1	0	0
80	1	19-Aug	11:42:48	58.528	-149.279	126	0	0	1	1	0	0	0	0
81	1	19-Aug	14:07:04	58.673	-150.077	152	0	0	2	1	0	0	0	0
82	1	19-Aug	18:02:04	58.816	-150.874	182	0	0	1	1	0	0	0	0
83	1	19-Aug	20:51:37	58.921	-151.468	135	0	0	1	0	0	0	0	0
84	1	20-Aug	08:11:47	57.758	-149.692	506	0	0	1	1	0	1	0	0
85	0	20-Aug	11:53:11	57.418	-149.342	2500	0	0	0	0	0	0	0	0
86	1	20-Aug	11:58:38	57.405	-149.326	2500	0	0	1	0	1	0	0	0
87	1	20-Aug	14:08:51	57.125	-149.118	4000	0	0	1	0	1	2	0	0
88	1	20-Aug	17:50:19	57.189	-149.893	1838	0	0	1	1	0	1	0	0
89	1	20-Aug	21:58:47	57.237	-150.770	475	0	0	0	0	0	1	0	0
90	1	21-Aug	08:13:55	56.865	-153.378	188	0	0	1	0	0	0	0	0
91	1	21-Aug	14:55:10	56.827	152.558	167	0	1	1	1	0	0	0	0
92	1	21-Aug	18:54:55	56.768	-152.007	54	0	1	1	0	0	1	0	0
93	1	22-Aug	07:58:16	56.618	-151.855	380	0	0	1	0	0	1	0	0
94	1	22-Aug	15:44:47	56.870	-151.466	910	0	0	1	0	0	1	0	0
95	1	22-Aug	18:38:30	57.383	-151.892	69	0	1	1	0	0	0	0	0
96	1	23-Aug	12:07:01	57.160	-152.416	135	0	0	0	2	0	0	0	0
97	0	23-Aug	14:27:55	56.936	-153.035	140	0	0	0	0	0	0	0	0
98	1	23-Aug	14:35:16	56.921	-153.036	123	0	1	1	0	0	0	0	0
99	1	23-Aug	18:42:13	56.747	-153.631	142	0	0	1	1	0	0	0	0
100	0	24-Aug	08:03:53	56.106	-154.442	149	0	0	0	0	0	0	0	0
101	1	24-Aug	08:08:54	56.107	-154.419	138	1	1	1	0	0	0	0	0
102	1	24-Aug	08:40:29	56.112	-154.259	86	1	0	0	1	0	0	0	0
103	1	24-Aug	09:29:07	56.195	-154.068	166	1	0	0	1	0	0	0	0
104	1	24-Aug	11:44:18	56.041	-154.197	160	1	0	0	1	0	1	0	0
105	1	24-Aug	18:11:27	56.118	-154.090	134	1	0	1	1	0	0	0	0
106	1	24-Aug	21:50:34	56.179	-153.625	141	1	0	0	1	0	0	0	0
107	1	25-Aug	08:35:38	56.746	-153.577	127	0	1	1	1	0	0	0	0
108	0	25-Aug	12:18:19	56.397	-153.251	32	0	0	0	0	0	0	0	0
109	0	25-Aug	12:21:40	56.389	-153.243	34	0	0	0	0	0	0	0	0
110	1	25-Aug	12:26:25	56.378	-153.231	31	1	0	0	1	0	0	0	0