

**2009 Report to PACFLT:  
Data collection and Preliminary Results from the Main Hawaiian Islands  
Cetacean Assessment Survey  
& Cetacean Monitoring Associated with Explosives Training off Oahu<sup>1</sup>**

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This report covers two separate activities carried out by the Cetacean Research Program at the Pacific Islands Fisheries Science Center from February to June 2009. A cetacean assessment survey of the main Hawaiian Islands was conducted by NMFS in February 2009. The survey was designed to conform to the 2002 NMFS HICEAS survey (Hawaiian Islands Cetacean Ecosystem Assessment Survey) so that abundance and distribution estimates would be comparable. Following a request from the Navy, additional survey lines were added to assess the region east and north of Kauai, and these lines were surveyed to the extent possible. The data collection methodology and preliminary results are summarized here. No formal support was provided for this survey effort by PACFLT, though partial data analysis support was provided. In addition, protected species presence was monitored prior to and during two days of explosives training off Pearl Harbor, Oahu, to fulfill the Navy's Hawaii Range Complex monitoring plan under the MMPA and ESA. Full support for this activity was provided by PACFLT. Detailed analyses of the explosive events and the acoustic data collected during the cetacean assessment survey in February are still underway. A post-doctoral researcher and acoustic analysis technician were hired in late-July to analyze the cetacean assessment cruise data.

**Main Hawaiian Islands Cetacean Assessment Survey- February, 2009**

The Pacific Islands Fisheries Science Center Cetacean Research Program conducted a visual and acoustic line-transect assessment survey of cetacean populations within the inner waters of the main Hawaiian Islands (MHI) EEZ. The survey was carried out using the NOAA Ship *Oscar Elton Sette* (Cruise OES-09-01). The inner waters of the MHI were last surveyed in the summer and fall of 2002, yielding abundance estimates for most cetacean species found in those waters. Our intention in the February 2009 survey was to collect the distributional and presence data needed to develop updated abundance estimates for the same species to look at the potential of seasonal movements and population trends since 2002. During this survey, sighted groups of cetaceans were photographically identified to evaluate individual movements and estimate population size. Some individuals were also biopsied to collect tissue samples for genetic analyses of stock structure. The cruise was to be conducted February 5 to March 2; however, mechanical problems with the *Sette*'s engines forced us to return to port on February 27.

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<sup>1</sup> PIFSC Internal Report IR-09-029  
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## Methods- Visual Survey

Line-transect survey methods were used to collect abundance data. At the beginning of each day search effort began on the trackline. The ship travelled at 9–10 knots (through the water) along the designated trackline.

A daily watch for cetaceans was maintained by scientific observers on the flying bridge during daylight hours (approximately 0700 to 1830), except when the ship stopped to conduct sampling operations or when precluded by weather. Two teams of three observers worked in 2-hour rotations, scanning for cetaceans using 25x and, 7x magnification binoculars, and unaided eyes. Sighting conditions, watch effort, sightings, and other required information were entered into a computer attached to the ship's Global Positioning System (for course, speed, and position information).

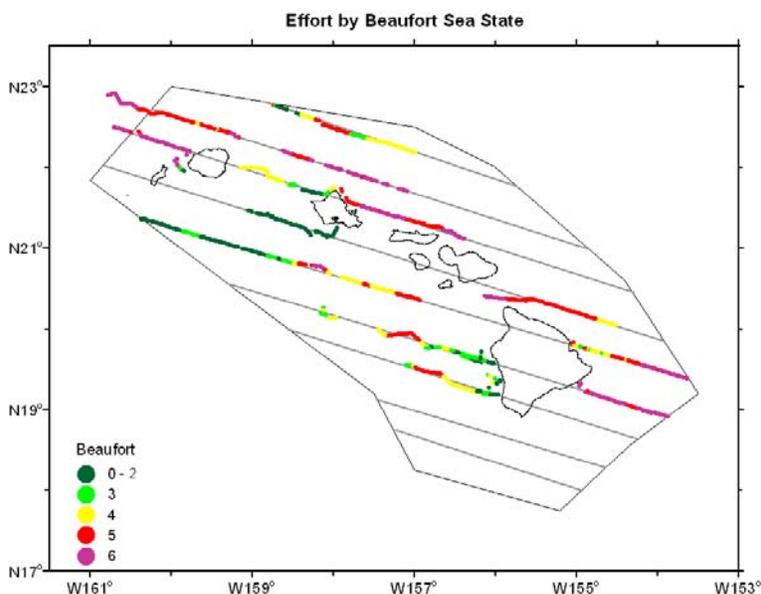


Figure 1. Main Hawaiian Islands inner exclusive economic zone survey region. Gray lines are the predetermined transect lines used to systematically survey the region. The colored lines indicate the region we've surveyed so far, by Beaufort sea state.

The grid of tracklines covered during the survey was established prior to the cruise and was intended to replicate the "Main Islands" stratum of the Southwest Fisheries Science Center 2002 HICEAS survey. The actual tracklines covered are shown in Figure 1. The entire grid was intended to be covered during the 28-day survey; however, some sections were not surveyed due to inclement weather or mechanical problems with the ship requiring an early return to Honolulu. On sighting a cetacean group or other feature of biological interest, the marine mammal observer team on watch requested that the vessel be maneuvered to approach the group or feature for investigation. When the ship approached a group of cetaceans, the observers made independent estimates of group size. Photographic operations occasionally commenced from the bow. In some instances, a small boat was deployed for biopsy, photographic, or other operations.

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

At times during the cruise, visual survey operations were not possible because of high winds or seas. Usually, survey operations were suspended at Beaufort Sea State 7 or higher. Also, if rain made visibility 1 nautical mile or less, visual observations were 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.

### ***Methods- Acoustic Survey***

Acoustic operations during this survey included passive listening for marine mammals and active acoustic measurement of backscatter and oceanographic currents.

Table 1. Visual and acoustic survey effort.

<b>Date</b>	<b>Start time</b>	<b>Start latitude</b>	<b>Start longitude</b>	<b>End time</b>	<b>End latitude</b>	<b>End longitude</b>	<b>Distance surveyed (nmi)</b>	<b>Average Beaufort</b>
2/5/2009	1751	N21:13.00	W158:14.01	1832	N21:15.26	W158:21.05	6.9	4
2/6/2009	733	N21:59.89	W159:08.92	1819	N21:33.29	W157:45.14	74.4	3.9
2/7/2009	723	N20:38.58	W157:54.09	1414	N20:21.82	W156:56.14	54.9	4.5
2/8/2009	914	N19:34.40	W156:01.36	1811	N19:45.47	W156:37.15	34.9	3
2/9/2009	818	N19:34.48	W156:01.66	1820	N20:00.00	W157:26.76	84.0	3.6
2/10/2009	834	N21:15.60	W157:57.40	1818	N21:28.25	W159:03.06	56.0	1.8
2/11/2009	711	N21:21.13	W160:20.19	1833	N21:00.80	W159:10.84	63.7	2.1
2/12/2009	708	N21:00.07	W159:07.70	1828	N20:08.35	W157:57.84	92.0	3.5
2/13/2009	702	N19:33.39	W157:05.82	1701	N19:12.28	W156:03.97	62.1	4
2/14/2009	655	N19:13.45	W156:09.44	1752	N19:43.62	W156:10.75	55.7	2.3
2/15/2009	1225	N19:42.22	W156:05.12	1805	N19:25.53	W156:04.18	32.7	3.6
2/16/2009	713	N19:51.96	W155:02.03	1812	N19:23.11	W153:37.71	85.3	4.8
2/17/2009	659	N18:55.00	W153:51.95	1802	N19:14.25	W154:51.94	64.4	5.8
2/18/2009	648	N20:03.02	W154:30.71	1816	N20:24.51	W156:07.73	89.3	5.1
2/19/2009	No effort						0	7+
2/20/2009	745	N21:07.10	W156:22.65	1800	N21:33.22	W157:44.68	93.4	5.7
2/21/2009	710	N22:22.48	W159:09.80	1814	N22:53.77	W160:46.95	89.8	5.2
2/22/2009	728	N22:30.17	W160:42.44	1803	N21:57.69	W159:50.76	61.6	5.7
2/23/2009	721	N22:46.54	W158:44.60	1827	N22:11.03	W156:59.34	94.2	3.8
2/24/2009	716	N22:12.17	W158:37.66	1720	N21:42.67	W157:05.51	61.9	5.9
2/25/2009	No effort						0	7+
2/26/2009	No effort						0	7+
<b>Total</b>							<b>1257.2</b>	

- **Passive Acoustics**

Two hydrophone arrays were available for use during this survey, a 6-element array towed 300 m behind the vessel and a 4-element array towed 350 m behind the vessel. One or the other array was towed 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 was required).

The 6-element array contained two elements with a high-frequency response up to 250kHz. The high-frequency data was recorded opportunistically when cetacean vocalizations were heard on the other lower frequency elements. On 20 February, the 6-element array, provided by Scripps Institution of Oceanography, suffered a break in the tubing that houses the hydrophone elements. The 4-element array was used for the remainder of the cruise.

Signals received from the array were amplified and monitored by an acoustic technician. Two acoustic technicians rotated on 3-hour shifts during daylight hours. When cetacean sounds were detected either audibly or on the spectrogram display, incoming acoustic data was recorded to the computer's hard drive. A record was kept of acoustic effort, comments and 5-minute acoustic updates using the program WHALTRAK 2. Real-time visual displays of sounds were monitored using *Ishmael* software, which also allows for localization of vocalizing animals via beamforming and phone-pair (cross-correlation) algorithms. These angles could then be plotted on the WHALTRAK display and saved to file.

Sonobuoys were deployed periodically from either the *Sette* or a small boat on an opportunistic basis. Sonobuoys transmit acoustic data over a radio carrier frequency received by a VHF radio on the ship. A VHF antenna was mounted on the trawl house on the 01 deck for reception of the sonobuoy signals. Incoming signals were monitored using a scrolling spectrogram display in *Ishmael*, and cetacean sounds were noted.

- **Active Acoustics**

The scientific EK-60 depth sounder was operated continuously at 38 and 120 KHz and was interfaced to a data acquisition system to estimate micronekton biomass between 0 and 500 m. The vessel's navigational depth sounder was also used at the discretion of the Commanding Officer, but was generally secured while underway in deep waters. The ship's acoustic Doppler current profiler (ADCP) also ran continuously and was logged to a data acquisition system.

## ***Results***

Eighteen days of on-effort survey were completed during the cruise (Table 1), resulting in 117 sightings of 12 cetacean species, in addition to a number of unidentified cetaceans (Table 2). Over 1250 nmi of trackline were visually and acoustically surveyed. The geographic distribution of search effort and sightings is shown in Figures 1 and 2, respectively. Sighting data are currently being analyzed to yield new abundance estimates for all observed species. In addition, photo-ID and biopsy samples were collected on several occasions. Limited survey effort was

completed with the Navy's PMRF range and north of Kauai. An active training event in that region prevented dedication of additional effort there, though at least 20 on- and off-sightings were logged in the area north of Kauai alone.

Table 2. All on- and off-effort visual sightings. Sighting locations are shown on the maps in Figure 2.

<b>CODE</b>	<b>SPECIES</b>	<b>Common name</b>	<b>Total</b>
2	<i>Stenella attenuata</i> (offshore)	Spotted dolphin	3
13	<i>Stenella coeruleoalba</i>	Striped dolphin	4
15	<i>Steno bredanensis</i>	Rough-toothed dolphin	3
18	<i>Tursiops truncatus</i>	Bottlenose dolphin	3
31	<i>Peponocephala electra</i>	Melon-headed whale	1
32	<i>Feresa attenuata</i>	Pygmy killer whale	2
33	<i>Pseudorca crassidens</i>	False killer whale	6
36	<i>Globicephala macrorhynchus</i>	Short-finned pilot whale	9
61	<i>Ziphius cavirostris</i>	Cuvier's beaked whale	2
70	<i>Balaenoptera</i> sp.	Rorqual	14
71	<i>Balaenoptera acutorostrata</i>	Minke whale	2
72	<i>Balaenoptera edeni</i>	Bryde's whale	1
76	<i>Megaptera novaeangliae</i>	Humpback whale	56
77	unid. Dolphin		5
79	unid. large whale		1
99	<i>Balaenoptera borealis/edeni</i>	Sei whale/Bryde's whale	3
177	unid. small delphinid		1
277	unid. medium delphinid		1
<b>TOTAL</b>			<b>117</b>

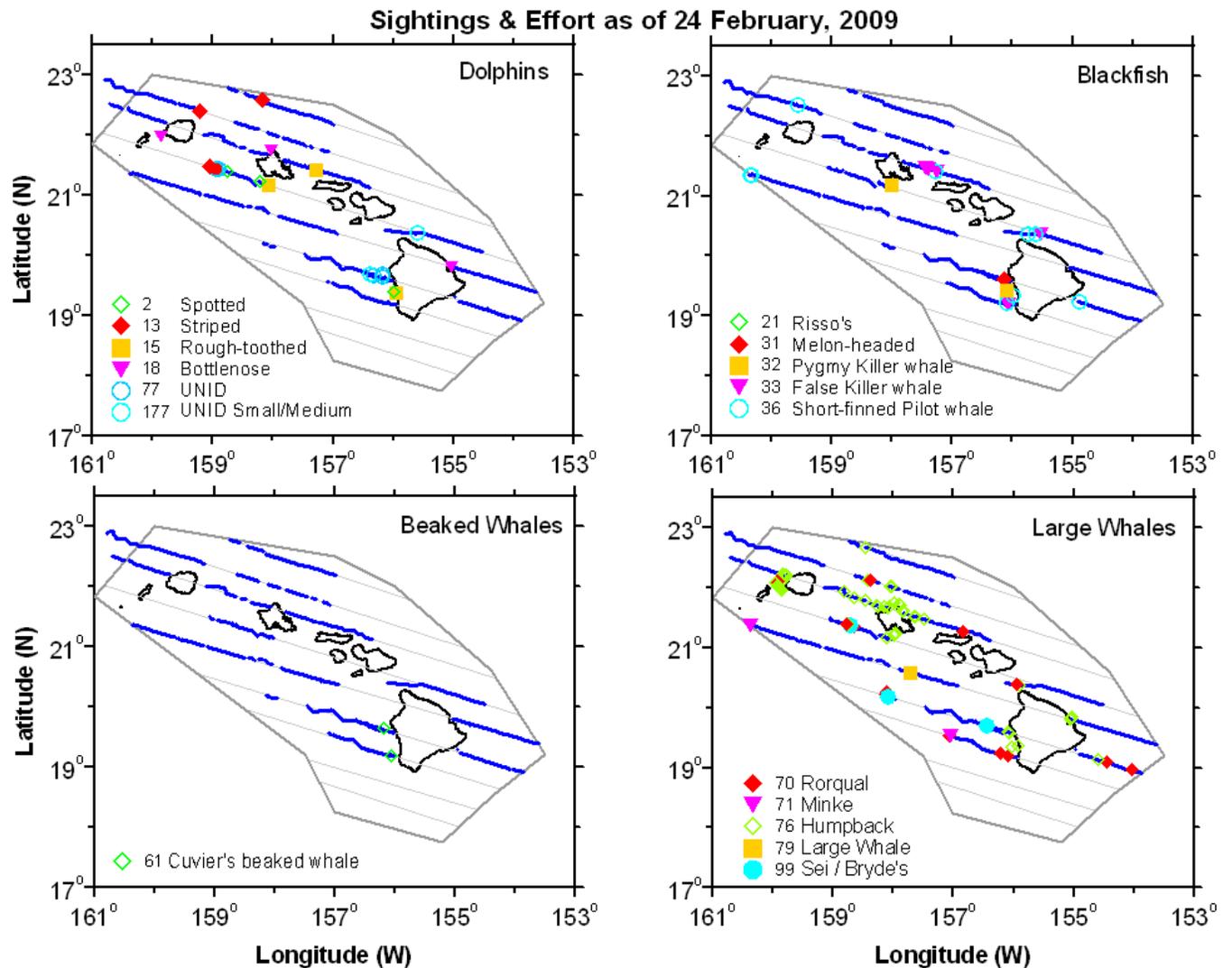


Figure 2. Visual and acoustic survey effort (blue lines) and cetacean visual sightings during the cruise.

- **Passive Acoustics**

A towed array was deployed each day to augment visual survey effort. A number of cetacean schools were detected both visually and with the towed array, including pilot whales, false killer whales, spotted dolphins, and bottlenose dolphins. A significant number of unidentified cetacean schools were also detected, but were determined to be outside of the ship's 3 nmi search radius so were not pursued for species-ID.

Localization of cetacean vocalizations was hampered during the first part of the cruise as the spacing of the individual hydrophone elements within the 6-element array was too close together for robust determination of bearing angle to the sound source. Bearing angles were successfully computed during use of the 4-element array, as the elements are spaced more appropriately for lower frequency dolphin whistles.

Table 3. Number of acoustic detections on the towed array or sonobuoys.

<b>SPECIES</b>	<b>Sighted schools acoustically detected</b>	<b>Acoustic detection- no visuals</b>
Spotted dolphin	2	0
Striped dolphin	2	0
Rough-toothed dolphin	2	0
Bottlenose dolphin	2	0
Melon-headed whale	1	0
False killer whale	5	3
Short-finned pilot whale	4	0
Minke whale	0	Almost continuous
Bryde's whale	1	1
Fin whale	0	8
Humpback whale	?	Almost continuous
unid. Dolphin	1	15

A total of 42 sighted cetacean groups were acoustically detected with the hydrophone array (Table 3). In addition, another 20 cetacean groups were detected only with the acoustic array; however, in most cases we were unable to locate these groups visually so many are considered unidentified dolphins. There was also nearly continuous acoustic detection of humpback and minke whales during the later part of the cruise while using the 4-element array. A total of 48 sonobuoys were deployed during the survey, of which 32 provided high-quality acoustic data. Nearly all sonobuoy deployments include humpback and minke whale calls, while a smaller portion contain fin whales or sounds from unidentified whales. A sonobuoy was deployed on a sighting of a Bryde's whale and does contain new sounds; however, further processing will be required before conclusive assignment of those sounds to Bryde's whales can be made. No anthropogenic sounds, including military roar, were detected on the acoustic array during the course of this survey. A complete list of all acoustic detections on the towed arrays and sonobuoys can be found in Appendix I.

- **Active Acoustics**

ADCP and multi-frequency echosounder data were recorded during the entire cruise, except during short periods when the pings produced by those instruments interfered with recordings of nearby cetaceans on the towed array.

Table 5. Cruise personnel during two legs February 5-19, and February 19-24..

**Leg 1: 5-19 February**

<b>Name</b>	<b>Position</b>	<b>Affiliation</b>
Erin Oleson	Chief Scientist	NMFS-Pacific Islands Fisheries Science Center (PIFSC)
Karin Forney	Co-Chief / Mammal Observer	NMFS-Southwest Fisheries Science Center (SWFSC)
Suzanne Yin	Lead Mammal Observer	NMFS-SWFSC
Allan Ligon	Lead Mammal Observer	Independent Contractor
Marie Hill	Mammal Observer	Joint Institute for Marine and Atmospheric Research (JIMAR)- University of Hawaii (UH)
Andrea Bendlin	Mammal Observer	JIMAR-UH
John Henderson	Mammal Observer	NMFS-PIFSC
Hannah Bassett	Acoustician	University of California San Diego (UCSD)- Scripps Institution of Oceanography (SIO)
Ali Bayless	Acoustician	UCSD-SIO

**Leg 2: 19-24 February**

<b>Name</b>	<b>Position</b>	<b>Affiliation</b>
Erin Oleson	Chief Scientist	NMFS-PIFSC
Suzanne Yin	Lead Mammal Observer	NMFS-SWFSC
Allan Ligon	Lead Mammal Observer	Independent Contractor
Marie Hill	Mammal Observer	JIMAR-UH
Andrea Bendlin	Mammal Observer	JIMAR-UH
Mark Deakos	Mammal Observer	Independent Contractor
Alexis Rudd	Mammal Observer	Hawaii Institute of Marine Biology (HIMB)-UH
Hannah Bassett	Acoustician	UCSD-SIO
Ali Bayless	Acoustician	UCSD-SIO

Appendix I. -- Table I. Acoustic detections on the towed hydrophone array. A large increase in detections at toward the later part of the cruise can be attributed in part to the use of a different towed array with a more gain at the low frequencies. Call types are identified as C = echolocation clicks, W = whistles, and BP = pulsed sounds.

Recording ID	Date (Local)	Time (Local)	Sighting #	Species	Call Types (C, W, BP)
TA02d	2/6/2009	14:07		unid dolphin	C, W
TA02f	2/6/2009	15:11	11	Bottlenose dolphin	C, W
TA04a	2/8/2009	10:08	20	Melon-headed whale	C, W
TA06b	2/10/2009	10:11	29	Rough-toothed dolphin	C, W, BP
TA06c	2/10/2009	11:57	31	Spotted dolphin	C, W, BP
TA06e	2/10/2009	17:31	37	Striped dolphin	C, W, BP
TA06f	2/10/2009	17:46	37	Striped dolphin	C, W, BP
TA08b	2/12/2009	8:52		UNID	W
TA08d	2/12/2009	10:39		UNID	W
TA09a	2/13/2009	11:36		UNID	W
TA09b	2/13/2009	12:43	49	False killer whale	W
TA09c	2/13/2009	13:43	49	UNID	W
TA09e	2/13/2009	15:06		False killer whale	C, W
TA09f	2/13/2009	17:00	52	Pilot whale	C, W
TA10a	2/14/2009	8:11		UNID	C
TA10b	2/14/2009	10:34	54	Pilot whale	C
TA10c	2/14/2009	11:20	57	Spotted dolphin	C, W, BP
TA10d	2/14/2009	13:01	58	Pygmy killer whale	
TA13h	2/17/2009	16:50		UNID	C
TA14b	2/18/2009	12:33		False killer whale + UNID	C, W, BP
TA14c	2/18/2009	15:13		Pilot whale	W
TA15a	2/19/2009	12:08		False killer whale	C,W
TA15b	2/19/2009	13:15		False killer whale	C,W
TA15d	2/19/2009	17:51		UNID	W
TA15e	2/19/2009	18:05		UNID	W
TA15f	2/19/2009	18:26		UNID	C, W
TA16c	2/20/2009	11:11		UNID	W
TA16e	2/20/2009	13:18		False killer whale	C
TA16f	2/20/2009	13:30	79, 80	False killer whale, Pilot whale, spotted dolphin	C, W, BP
TA16g	2/20/2009	15:23	81	False killer whale	C,W
TA16h	2/20/2009	17:00	82	False killer whale	W
TA16i	2/20/2009	17:28		False killer whale	W
TA17a	2/21/2009	9:50	87	Pilot whale	
TA17d	2/21/2009	12:42		Humpback + UNID	C
TA17e	2/21/2009	13:08		Humpback, minke + UNID	C
TA17f	2/21/2009	14:11		Humpback, minke + UNID	C
TA17g	2/21/2009	14:26		Humpback, minke + UNID	C
TA17h	2/21/2009	16:03		Humpback, minke + UNID	C, W
TA18a	2/22/2009	9:42	88	Humpback, minke + UNID	W
TA18b	2/22/2009	13:49		UNID	C, W
TA18c	2/22/2009	14:32	89-92	Humpback, minke + UNID	C, W

Table I (continued).

<b>Recording ID</b>	<b>Date (Local)</b>	<b>Time (Local)</b>	<b>Sighting #</b>	<b>Species</b>	<b>Call Types (C, W, BP)</b>
TA18d	2/22/2009	14:50	89-92	Humpback, minke	
TA18e	2/22/2009	15:58	93-96	Humpback, minke + UNID	C, W
TA18f	2/22/2009	16:58	93-96	Humpback, UNID	W
TA18g	2/22/2009	17:13	97-107	Bottlenose, humpback, minke Bottlenose, humpback, minke +	C,W
TA18h	2/22/2009	18:06	97-107	UNID	C, W
TA19a	2/23/2009	7:39		Minke	
TA19b	2/23/2009	8:19	108, 109	Humpback, minke, striped dolphin	C, W
TA19c	2/23/2009	13:54		Humpback, minke	
TA19e	2/23/2009	16:42		Minke, UNID	W
TA20a	2/24/2009	7:13		Humpback, minke + UNID	C
TA20b	2/24/2009	8:27	110-113	Humpback, minke	
TA20c	2/24/2009	10:16	114, 115	Humpback, minke	
TA20d	2/24/2009	14:07		Humpback, minke	

--Table II. Operable sonobuoy deployment locations and species that have been detected in the incoming acoustic data.

Recording ID	Date	Time (Local)	Latitude	Longitude	Sighting #	Species Heard			
						Humpback	Minke	Fin	Other
SB02	2/6/2009	10:20	21 52.90	158 47.29		x	x		
SB03	2/7/2009	7:32	20 38.1	157 52.6					
SB04	2/7/2009	10:07	20 31.30	157 29.53					Unidentified
SB05	2/8/2009	12:34	19 40.33	156 24.82			x	x	
SB06	2/8/2009	14:01	19 42.31	156 26.53	21 (Sei / Bryde's)				
SB08	2/9/2009	13:28	19 46.54	156 45.25		x	x	x	
SB12	2/10/2009	14:19	21 19.12	158 33.93		x	x		
SB14	2/10/2009	15:34	21 21.27	158 44.97	33 (Sei / Bryde's)	x	x		
SB16	2/11/2009	15:06	21 10.43	159 43.68		x	x		
SB18	2/11/2009	18:04	21 03.32	159 15.68		x	x		
SB21	2/12/2009	16:24	20 15.03	158 07.36	45, 46 (Sei / Bryde's)			x	?
SB22	2/13/2009	7:31	19 33.10	157 02 20	47, 48 (Minke)	x	x	x	
SB23	2/13/2009	11:25	19 29.45	156 55.45					
SB25	2/14/2009	8:02	19 12.13	156 06.77		x	x		
SB26	2/14/2009	12:01	19 23.25	156 00.60	58 (Pygmy killer whale)				Unidentified
SB28	2/15/2009	15:12	19 24.19	156 13.24		x	x		?
SB29	2/15/2009	17:13	19 20.49	156 03.93	62 (Humpback)	x			
SB30	2/16/2009	9:21	19 45.87	154 53.63		x			
SB31	2/16/2009	16:25	19 27.85	153 52.87		x	x	x	Unidentified dolphin
SB32	2/17/2009	8:28	18 57.853	154 05.173	67 (Rorqual)	x	x	x	
SB33	2/17/2009	12:20				x	x		
SB35	2/18/2009	8:09	20 07.01	154 44.52		x	x		
SB37	2/19/2009	11:49	21 03.43	157 43.84		x			
SB38	2/19/2009	14:42	20 55.73	157 18.74		x			
SB39	2/20/2009	10:45	21 16.4	156 47.7	78	x			
SB40	2/20/2009	16:32	21 28.67	157 30.79	83	x	x		False killer whale
SB42	2/21/2009	13:08	22 39.61	160 00.48		x	x		UNID
SB43	2/22/2009	9:12	22 25.29	160 26.90	88	x	x		Bryde's whale

Table II. continued.

Recording ID	Date	Time (Local)	Latitude	Longitude	Sighting #	Species Heard			
						Humpback	Minke	Fin	Other
SB45	2/23/2009	10:00	22 37.6	158 18.91	108, 109	x	x		Striped dolphin
SB46	2/23/2009	15:36	22 19.73	157 26.26		x	x	x	
SB47	2/24/2009	8:33	22 08.2	158 25.8	110-113	x	x		
SB48	2/24/2009	15:52	21 46.65	157 18.14		x	x	x	

## Cetacean Monitoring Associated with Explosives Training



The Pacific Islands Fisheries Science Center Cetacean Research Program conducted at-sea occurrence and behavioral observations of cetaceans in association with 6 explosive events (~4 days of monitoring) off of Pearl Harbor. Three explosive events were carried out on each of two days, June 18 and 19. The region surrounding the events was surveyed for cetaceans on the day prior to the events (June 17) in order to assess whether large-scale movement could be observed pre- and post-event, which could possibly be associated with the explosive detonations. High winds and large swells created poor sighting conditions, such that we cannot assess whether such movements may have occurred.

### *Planned Operation*

A survey of 4 gridded-transect lines covering a 2.5 nmi x 2.5 nmi area was conducted (Fig. 1) using the Program's 23' fiberglass boat during June 17-19 (Cruise SB-09-01). Four experienced observers kept watch for marine mammals, two from an observation tower approximately 6' above the water when conditions permitted, and two from inside the boat. Photographs and biopsy samples were collected of sighted schools when possible in addition to cetacean occurrence and general behavioral information. The occurrence of monk seals and turtles was also noted; however, no biological sampling was carried out of these species.

The following information was collected at each cetacean sighting:

- 1) Location of sighting (GPS)
- 2) Species identification
- 3) Group size estimate and/or pod composition
- 4) Number of calves, if present

- 5) Duration of sighting
- 6) Detailed, as best as possible, behavior, disposition and reaction/no reaction to vessels or aircraft in the area
- 7) Direction of travel
- 8) Photographs and/or video, when possible
- 9) Environmental information associated with sighting event (Beaufort Sea State, wave height, swell direction, wind direction, wind speed, glare, percentage of glare, percentage of cloud cover, etc.)
- 10) If/when in proximity of Navy event, did the sighting occur (before, during or after detonations/event)

**Results**

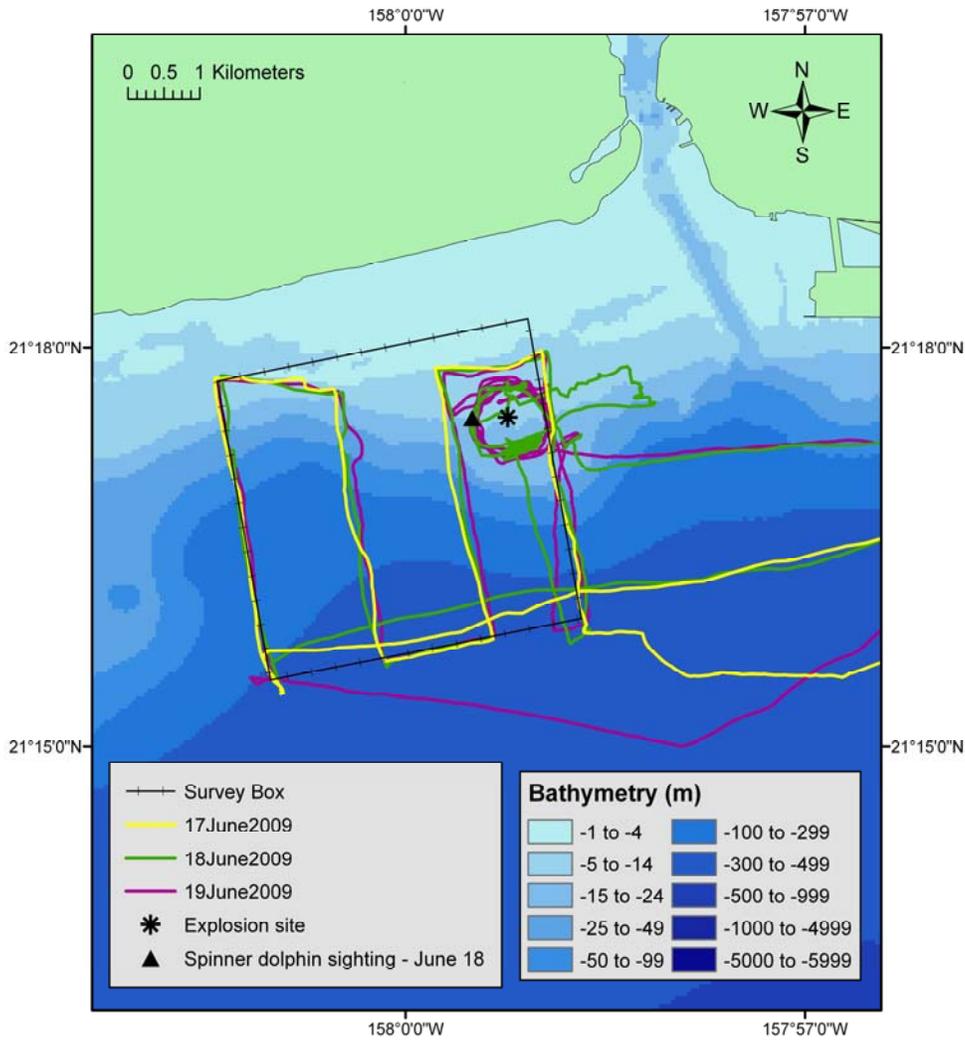


Figure 1. Map of survey effort prior to and during explosive detonations. A general survey was conducted on June 17, one day prior to explosives operations (yellow). Additional gridded surveyed were conducted on June 18 (green) and June 19 (purple) prior to explosive events on each of those days. No survey was conducted following explosives events or on June 20 due to very poor weather conditions.

Table 1. Summary of survey, detonation, and sighting events for pre- and during- explosive detonations.

Date	Time (HST)	Event	Latitude	Longitude	Notes/Weather
17-Jun-09	8:56	Begin transect survey	21.258	-158.017	Beaufort 3
17-Jun-09	10:02	End transect survey	21.266	-157.978	Beaufort 4
18-Jun-09	8:23	Begin transect survey	21.258	-158.017	Beaufort 4
18-Jun-09	9:52	End transect survey	21.266	-157.978	Beaufort 4
18-Jun-09	11:16	Explosive detonation #1	21.291	-157.987	Seen by Navy whaler within proximity of explosion site; detonation of explosives postponed for 15 min.
18-Jun-09	12:08	Turtle sighting	n/a	n/a	
18-Jun-09	12:26	Explosive detonation #2	21.291	-157.987	Seen by Navy Whaler within proximity of explosion site; PIFSC boat moved in to take photos and monitor movements
18-Jun-09	13:06	Begin spinner dolphin sighting	21.291	-157.992	
18-Jun-09	14:02	End spinner dolphin sighting	21.293	-157.975	Spinners moved out of area Beaufort 5
18-Jun-09	14:15	Explosive detonation #3	21.291	-157.987	No sightings
18-Jun-09	14:22	Survey 800 foot perimeter of detonation site	n/a	n/a	
18-Jun-09	14:57	End monitoring effort	21.291	-157.981	Beaufort 5
19-Jun-09	8:37	Begin transect survey	21.258	-158.017	Beaufort 4
19-Jun-09	10:00	End transect survey	21.266	-157.978	Beaufort 5
19-Jun-09	11:31	Explosive detonation #1	21.291	-157.987	
19-Jun-09	12:14	Explosive detonation #2	21.291	-157.987	
19-Jun-09	12:52	Explosive detonation #3	21.291	-157.987	No sightings
19-Jun-09	12:57	Survey 800 foot perimeter of detonation site	n/a	n/a	
19-Jun-09	13:06	End monitoring effort	21.287	-157.981	Beaufort 5
20-Jun-09	6:30	Survey cancelled			Beaufort 6

Surveys were conducted one day prior to explosives training (June 17), and prior to 3 explosive events on June 18 and June 19. Post-exposure surveys were planned for June 20; however, this survey was cancelled on the morning of the 20<sup>th</sup> due to very high winds and small craft advisory conditions. The survey track lines were modified slightly once on site due to exposure to breaking waves on the inshore legs of 3 of the transect lines (Fig. 1). In addition to pre-exposure surveys June 17-19, we monitored the region around the explosives site during and between explosive events for the occurrence of cetaceans (Table 1). The Navy explosives team

observed a group of spinner dolphins prior to the last explosion on June 18. We proceeded to monitor this group (group size minimum, best, maximum: 23, 25, 30), collecting behavioral observations as they transited east through the explosives area until they had moved beyond 2 mi from the explosion site. At least one animal in the group was always at the surface and we were unable to track individuals to measure surfacing rates. The group was tracked traveling east northeast at roughly 2-3 kts until they were 2nmi from the detonation site. No significant changes in travel direction or speed, or any abnormal behavior was observed during the 45-minute follow. High winds often made it difficult to closely track the animals so fine-scale changes in behavior could not be evaluated. Photo-identification pictures were obtained from several animals in the group. There were no other cetacean sightings during the three days of monitoring effort. Acoustic recordings were made of each explosion (Fig. 2), though these have not yet been analyzed to determine sound pressure levels at various distances from the explosive site.

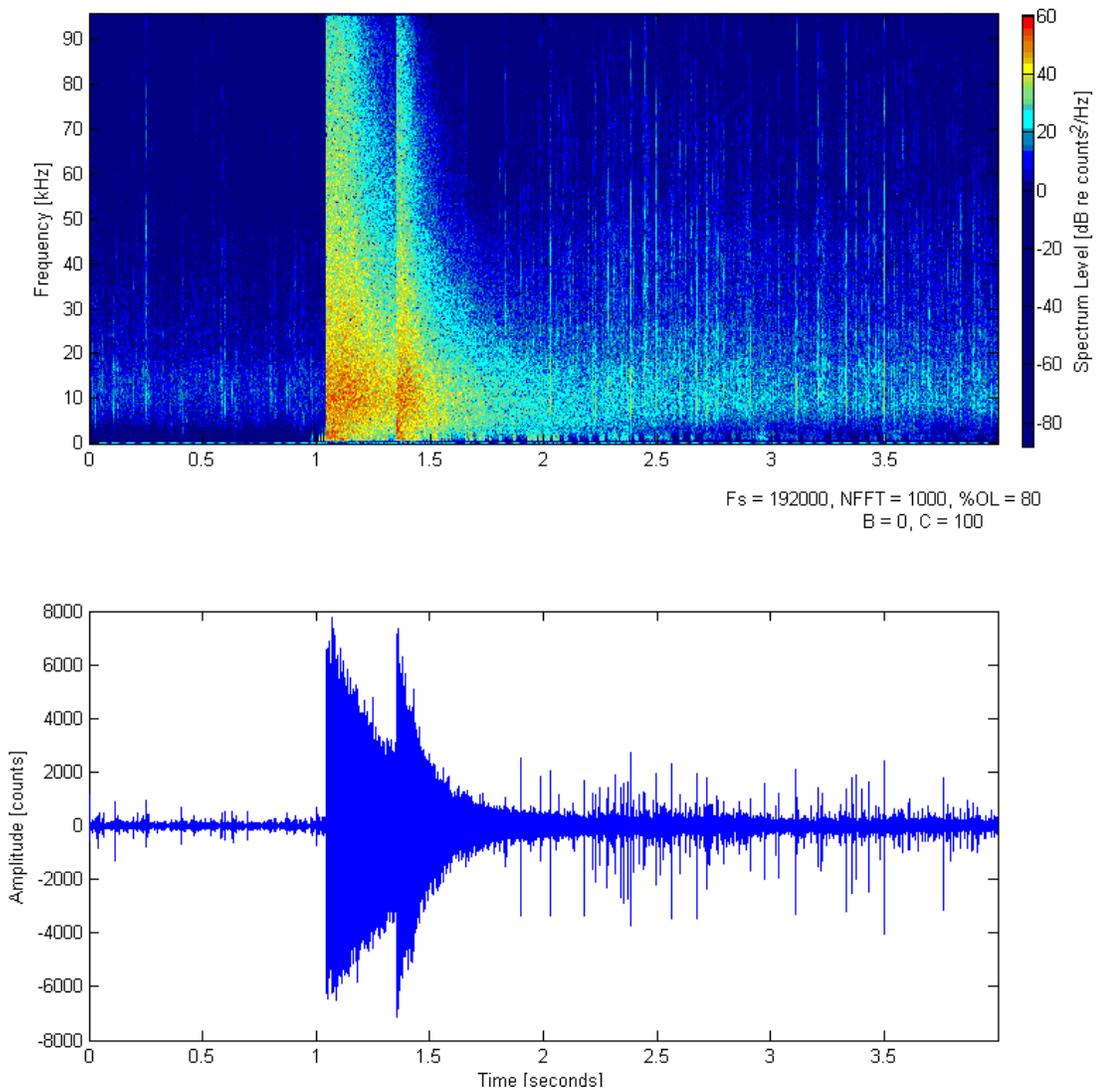


Figure 2. Spectrogram of first explosive event recorded on June 18 at a distance of approximately 400m from the explosive site.