U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE/NOAA FISHERIES
Pacific Islands Fisheries Science Center
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CRUISE REPORT[1]

VESSEL: *Oscar Elton Sette*, Cruise 09-01 (SE-69)

CRUISE PERIOD: 4–27 February 2009

AREA OF OPERATION: Main Hawaiian Islands

TYPE OF OPERATION: Conducted cetacean line-transect abundance surveys in the Hawaiian inner exclusive economic zone in support of a Pacific Islands Fisheries Science Center research project.

ITINERARY:

4 Feb	At sea, tested new shipboard instrumentation. Returned to port.
5 Feb	Embarked scientists Oleson, Forney, Yin, Ligon, Hill, Bendlin, Henderson, Bassett, Bayless. Departed Honolulu at 1000. Transited to nearest transect line and began line transect survey. Conducted conductivity-temperature-depth (CTD) cast at dusk.
6–18 Feb	Conducted daytime line-transect visual and acoustic survey for cetaceans within the defined study area. CTD casts occurred at dawn and dusk and an XBT drop at noon each day. The towed array may be redeployed following the evening CTD cast for nighttime acoustic monitoring.
19 Feb	Arrived Kewalo Basin, Oahu 0800 for transfer of scientific personnel. Disembarked Forney, Henderson. Embarked Deakos, Rudd. Following personnel transfer, resumed cetacean line-transect survey at nearest new transect line.

[1] PIFSC Cruise Report CR-09-008
Issued 30 June 2009

20–27 Feb Conducted daytime line-transect visual and acoustic survey for cetaceans within the defined study area. CTD casts occured at dawn and dusk and an XBT drop at noon each day. The towed array was permitted to be redeployed following the evening CTD cast for nighttime acoustic monitoring.

27 Feb Returned to Honolulu due to mechanical problems. Disembarked all scientists.

3 Mar Planned return to Honolulu.

MISSIONS AND RESULTS:

1. Cetacean Line-transect Survey

Methods

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 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).

The grid of tracklines to be 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 Hawaiian Islands Cetacean Ecosystem Assessment 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. When weather precluded survey, the Chief Scientist decided whether to wait at that position for better weather, direct the ship to another location on the grid based on weather forecasts, or to direct the ship to conduct localized surveys in the lee of the islands. The Chief Scientist adjusted the scientific activities and length of the nighttime travel to meet scientific and scheduling objectives.

On sighting a cetacean group or other feature of biological interest, the Chief Scientist or 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, based on directions from the Chief Scientist or Senior Marine Mammal Observers. In some instances, the Chief Scientist requested the deployment of a small boat for biopsy, photographic, or other operations.

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 3 nmi from the trackline, at which point the ship turned back toward the trackline.

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.

Results

Eighteen days of on-effort survey were completed during the cruise (Table 1), resulting in 116 sightings of 12 cetacean species, in addition to a number of unidentified cetaceans (Table 2). 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.

2. Photo-ID and Biopsy Sampling

Methods

A small boat was occasionally launched from the *Sette* for biopsy sampling and photography of sighted animals. Deployment was requested by the Chief Scientist on an opportunistic basis, possibly multiple times in a single day, providing the Commanding Officer concurred that operating conditions were safe. The small boat remained within radar and radio contact at all times while deployed. Both the *Sette's* Safe Boat and the Science Party's rigid hull inflatable boat were used for small boat operations during the survey.

Biopsy samples for genetic analyses of cetaceans were collected on an opportunistic basis. Necessary permits were present on the vessel. The sampled animals were either approached by the research vessel during normal survey operations, approached the vessel on their own, or were approached by a small boat. Samples were collected from animals using a dart fired from a crossbow.

Photographs of cetaceans were taken on an opportunistic basis. These will be used to study social behavior and movement patterns of identified individuals and to study geographic variation. Necessary permits were present on the vessel. The photographed animals were either approached by the research vessel during normal survey operations, approached the vessel on their own, or were approached by a small boat.

Results
Photographs and biopsy samples were collected from the *Sette* during periods of rough weather, limited time, or when animals were thought to be unapproachable with a small boat. The small boat was also launched for photographs and biopsy sampling on several occasions. The number of photo-ID encounters and the number of biopsy samples collected are summarized in Table 3.

3. Acoustics

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

Passive Acoustics
Two hydrophone arrays were available for use during this survey, one 6-element array towed 300 m behind the vessel, and one 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 at the discretion of the Chief Scientist. 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

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.

A total of 42 sighted cetacean groups were acoustically detected with the hydrophone array (Table 4). 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. A total of 48 sonobuoys were deployed during the survey, of which 32 provided high-quality acoustic data. Nearly all sonobnuoy 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.

Active Acoustics
ADCP and multifrequency 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.

4. High-frequency Acoustic Recording Package (HARP) Deployment

On 8 February, a High-frequency Acoustic Recording Package was recovered from positions lat. 19.5791^0 N, long. 156.0146^0 W off the Kona coast of the Island of Hawaii. The HARP release was triggered by acoustic command from a transducer lowered over the side of the *Sette*. Once aboard and secure the Acoustic team and Chief Scientist refurbished the HARP with new batteries and hard drives and readied it for redeployment. The HARP was redeployed near the original recovery position on 9 February. The data collected by the HARP is being analyzed for cetacean sounds.

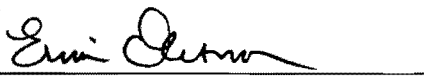
SCIENTIFIC PERSONNEL:

Leg 1: 4-19 February 2009

Erin Oleson, Chief Scientist, Pacific Islands Fisheries Science Center (PIFSC), National Marine Fisheries Service (NMFS)
Karin Forney, Co-chief Scientist/Mammal Observer, Southwest Fisheries Science Center (SWFSC), NMFS
Suzanne Yin, Lead Mammal Observer, SWFSC, NMFS
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, PIFSC, NMFS
Hannah Bassett, Acoustician, University of California San Diego (UCSD), Scripps Institution of Oceanography (SIO)
Ali Bayless, Acoustician, UCSD-SIO

Leg 2: 19-27 February 2009

Erin Oleson, Chief, Scientist, PIFSC, NMFS
Suzanne Yin, Lead Mammal Observer, SWFSC, NMFS
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, UH
Hannah Bassett, Acoustician, UCSD-SIO
Ali Bayless, Acoustician, UCSD-SIO

Submitted by: 
Erin M. Oleson
Chief Scientist

Approved by: 
Samuel G. Pooley
Science Director
Pacific Islands Fisheries Science Center

Attachments

TABLES

Table 1.--Visual and acoustic survey effort.

Date	Start time	Start latitude	Start longitude	End time	End latitude	End longitude	Distance surveyed (nmi)	Average Beaufort
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+
						Total	1257.2	

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

CODE	SPECIES	Common name	Total
2	*Stenella attenuata* (offshore)	Spotted dolphin	3
13	*Stenella coeruleoalba*	Striped dolphin	4
15	*Steno bredanensis*	Rough-toothed dolphin	3
18	*Tursiops truncatus*	Bottlenose dolphin	3
31	*Peponocephala electra*	Melon-headed whale	1
32	*Feresa attenuata*	Pygmy killer whale	2
33	*Pseudorca crassidens*	False killer whale	5
36	*Globicephala macrorhynchus*	Short-finned pilot whale	9
61	*Ziphius cavirostris*	Cuvier's beaked whale	2
70	*Balaenoptera* sp.	Rorqual	14
71	*Balaenoptera acutorostrata*	Minke whale	2
72	*Balaenoptera edeni*	Bryde's whale	1
76	*Megaptera novaeangliae*	Humpback whale	56
77	unid. Dolphin		5
79	unid. large whale		1
99	*Balaenoptera borealis/edeni*	Sei whale/Bryde's whale	3
177	unid. small delphinid		1
277	unid. medium delphinid		1
	TOTAL		116

Table 3.--Number of photo-ID encounters and biopsy samples collected during the cruise.

Species	Photo-ID encounters	Biopsy samples
Spotted dolphin	1	1
Rough-toothed dolphin	3	0
Bottlenose dolphin	2	2
Melon-headed whale	1	5
Pygmy killer whale	2	1
False killer whale	4	0
Pilot whale	5	1
Minke whale	1	0
Bryde's/Sei whale	3	0

Table 4. Number of acoustic detections on the towed array or sonobuoys.

SPECIES	Sighted schools acoustically detected	Acoustic detection-no visuals
Stenella attenuata (offshore)	2	0
Stenella coeruleoalba	2	0
Steno bredanensis	2	0
Tursiops truncatus	2	0
Peponocephala electra	1	0
Feresa attenuata	0	0
Pseudorca crassidens	5	3
Globicephala macrorhynchus	4	0
Ziphius cavirostris	0	0
Balaenoptera acutorostrata	0	Almost continuous
Balaenoptera edeni	1	1
Balaenoptera physalus	0	8
Megaptera novaeangliae	?	Almost continuous
unid. Dolphin	1	15

FIGURES

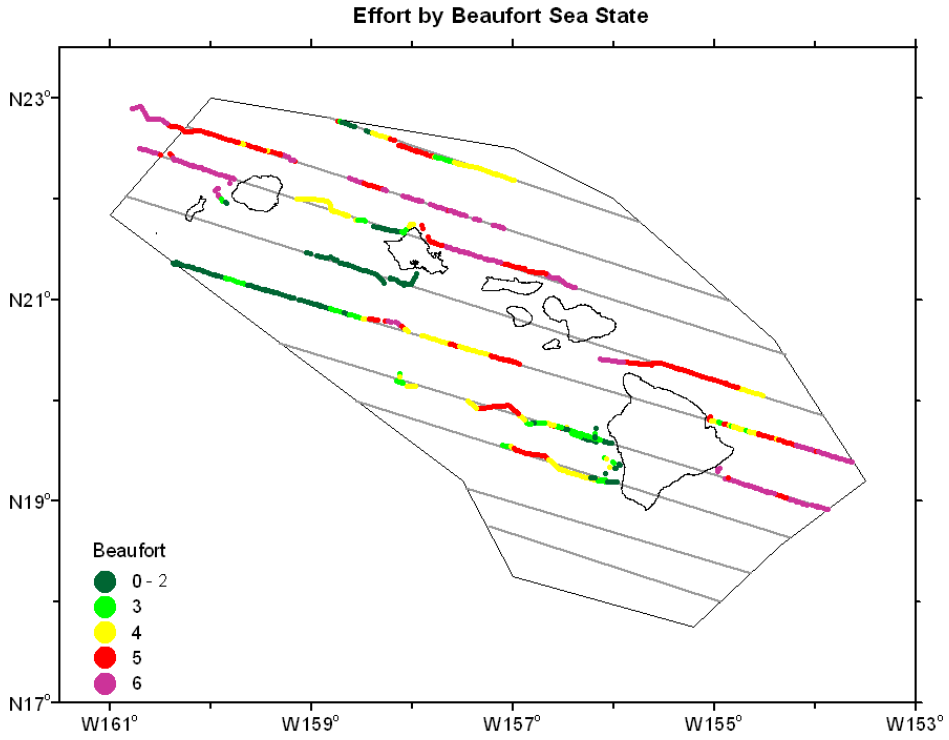


Figure 1.--Main Hawaiian Islands inner exclusive economic zone survey region. Gray lines are the predetermined transect lines used to systematically survey the region. The colored lines indicate the region we've surveyed so far, by Beaufort sea state.

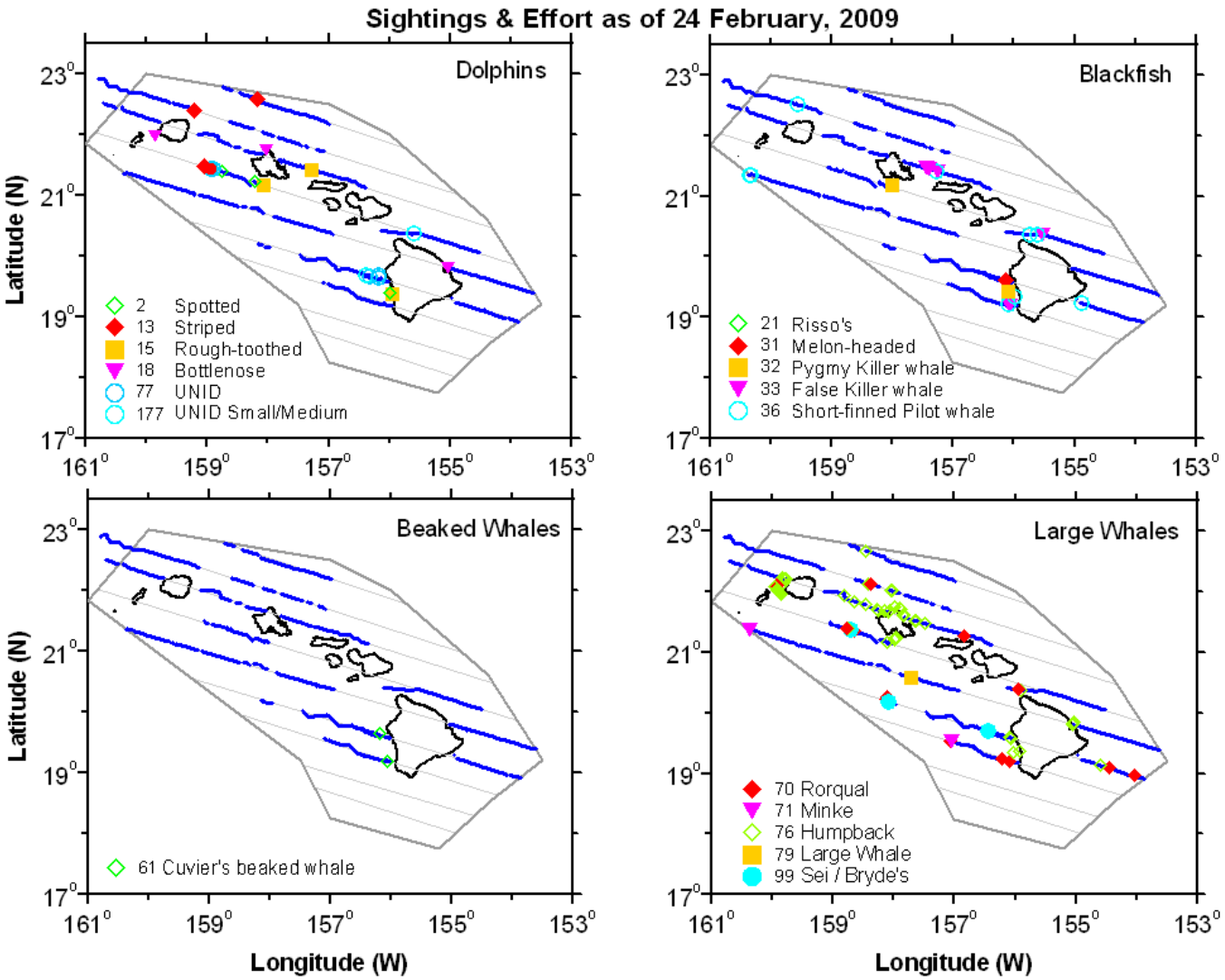


Figure 2.--Visual and acoustic survey effort (blue lines) and cetacean visual sightings during the cruise.