<u>Final Report</u>: Aerial Surveys of Marine Mammals

Performed in Support of USWEX Exercises

Nov. 11-17, 2007

Photo by J. Mobley, NOAA Permit No. 810

Submitted to:

Environmental Division

Commander, U.S. Pacific Fleet

Submitted by:

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Summary

Aerial surveys were performed in support of the US Navy Undersea Warfare Exercise (USWEX) on November 11-12 and 15-17, 2007. The mission was to detect, locate and identify all marine mammal and sea turtle species observed within a specified 6,174 km^2 grid (Figure 1) and during circumnavigation of the islands of Oahu and Molokai. For marine mammal species, additional observation time was spent characterizing behavior at the time of sighting. Target species were observed on two of the five survey days, primarily corresponding to those days with more favorable seastate conditions and the greater visibility of some species (e.g., sea turtles) during circumnavigation (Table 1). Effort comprised 17.15 hrs of survey time, involving a linear distance of approximately 3,150 km. A total of 26 sightings were recorded involving five identified species (Green sea turtles, short-finned pilot whales, Hawaiian spinner dolphins, bottlenose dolphins and Hawaiian monk seals) and four unidentified species (*Stenella* species, unidentified turtle, dolphin and whale) (Tables 2-3). Based on behavioral observation of the marine mammal species, no indications of distressed or unusual behavior were seen. The circumnavigation survey (Nov. 15) yielded no evidence of stranded or near stranded animals.

Background

The US Navy Undersea Warfare Exercise (USWEX) was proposed as an advanced Anti-Submarine Warfare Exercise to be conducted by U.S. Navy Carrier Strike Groups (CSGs) and Expeditionary Strike Groups (ESGs) within the Hawaii Range Complex. Since the exercise involved deployment of mid-frequency active sonar, concerns over possible impacts on protected marine species dictated that a parallel monitoring program be conducted. For the Nov. 07 USWEX, this monitoring involved systematic surveys using both shipboard as well as aerial platforms. This report is specific to the aerial monitoring portion only. Aerial surveys of a pre-determined 56 x 111 km grid as well as coastal areas of the islands of Oahu and Molokai were conducted on five days during the period November 11-12 and 15-17, 2007. The mission was to document incidence, location, and species identity of all marine mammal and sea turtle species within those regions. Additionally, for marine mammal species, additional observation time was spent characterizing behavior at time of sighting.

Method

Three aircraft were utilized. For the transect grid surveys a twin-engine Partenavia Observer (P68) (Nov. 11-12) and Britten Norman Islander (Nov. 16-17) were used. For the circumnavigation portion (Nov. 15), a Robinson 44 helicopter was used. The transect surveys utilized design and methods prescribed by accepted distance sampling theory (Buckland et al., 2001). Survey crew and pilot were not informed as to the status or location of navy exercises to minimize observational bias. Six north-south transect lines 111 km long were placed 9 km apart to cover the 6,174 sq km target area (Figure 1). Random longitudinal startpoints were used so that the exact trackline configuration varied on each survey. Aircraft flew at 100 knots ground speed and altitude of 244 m (800 ft). Survey crew consisted of two experienced observers, one on each side of the plane, and a data recorder. When target species were detected, an angle was taken to the sighting using hand-held Suunto clinometers, typically followed by orbiting to identify species and in the case of marine mammals, to characterize behavior. Environmental data (Beaufort seastate, glare, visibility) were taken at the start of each transect leg or when conditions changed. Positional data via GPS were automatically recorded every 30-sec and manually when sightings occurred.

Table 1. Summary of USWEX aerial surveys

Date	Survey Type	Hrs Effort	No. Sightings	Mean Seastate
Nov. 11	Transect grid	3.85	0	3.7
Nov. 12	Transect grid	4.15	7	2.7
Nov. 15	Circumnavigate Oahu & Molokai	2.53	19	3.7
Nov. 16	Transect grid	2.92	0	5.5
Nov. 17	Transect grid	3.70	0	4.1
	Totals:	17.15	26	3.84

Results and Discussion

The five days of aerial surveys consisted of a total of 17.15 hrs effort, comprising approximately 3,150 km of linear distance. Target species were observed on two of the five days surveyed (Table 2), corresponding to days with more favorable seastate conditions as well as the greater visibility of some species (sea turtles) during circumnavigation of inshore waters (Tables 1 & 2). The total of 26 sightings included three identified species of odontocetes (Hawaiian spinner dolphin, short-finned pilot whale, and bottlenose dolphin), one pinniped species (Hawaiian monk seal) and one sea turtle species (green sea turtle) (Table 3). The only baleen whale sighting was an unidentified species sighting on Nov. 12 that occurred in the eastern portion of the grid (Figure 1). The animal was seen diving but from the body outline it did not appear to be a humpback whale. The three positively identified odontocete species represent ubiquitous species that are among the top five most commonly seen in Hawaiian waters based on the 1993-03 Hawaii survey results (Appendix). The two Hawaiian monk seal sightings included one of a single seal swimming in the waters off Barbers Pt as well as two seals observed resting on a southwestern Molokai beach. These two sightings are noteworthy since sightings of monk seals in the main Hawaiian Islands are relatively rare.

The total of 7 odontocete species observed across the 3,150 km of linear effort corresponded to an average encounter rate of .002 sightings/km. This is considerably less than noted in previous surveys of Hawaiian waters. For the 2005 summer RIMPAC exercises, odontocetes were seen at a rate of .004 sightings/km (Mobley, 2006) and during the 1993-03 Hawaii statewide surveys (period Feb-Apr) they were observed at a rate of .005 sightings/km (Mobley, 2004). The lower encounter rate observed during the USWEX surveys is likely attributable to two factors: a) the average seastate conditions during the present surveys were less favorable than prevailing conditions during the other series mentioned; and b) a greater portion of effort during the

USWEX surveys was spent in deep water greater than 1829 m (1000 fathoms) where odontocetes may be less abundant.

Notes regarding the general behavior of the marine mammal sightings are summarized in Table 2. None of the behavioral descriptions indicated the presence of unusual or distressed behavior (e.g., tight or unusual aggregations, strandings or near strandings).

Overall there were no indications of any deleterious effects of the USWEX exercise on the indigenous marine species observed. It should be noted of course that the absence of such indications does not necessarily imply the absence of any negative effects, merely that no overt indications of such effects were detected.

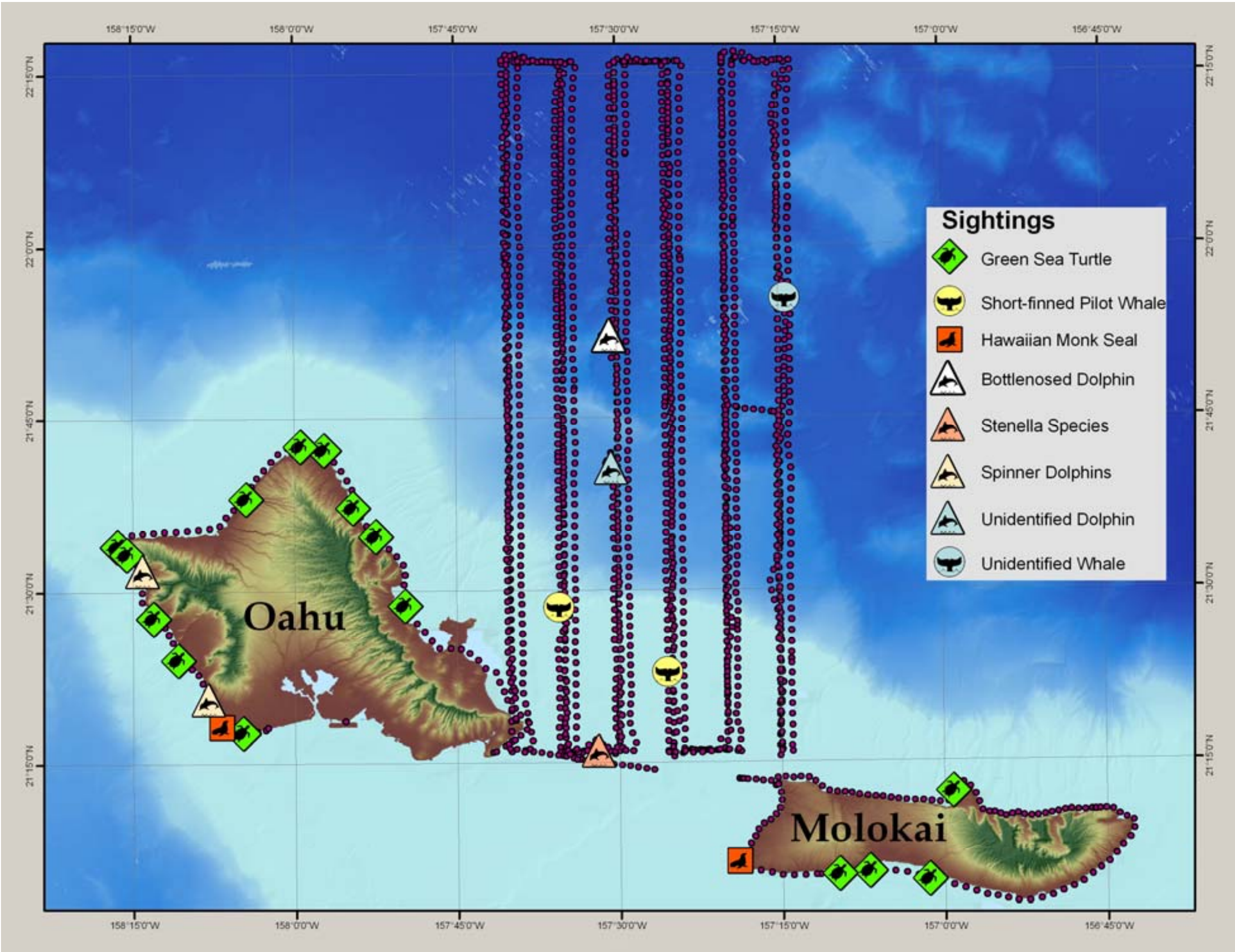

Figure 1. Summary of Effort and Species Sightings. Based on GPS data. For transect grid, random longitude start points were used so the exact trackline varied on each survey date. Note: South shore of Oahu not covered due to Class B airspace restrictions.

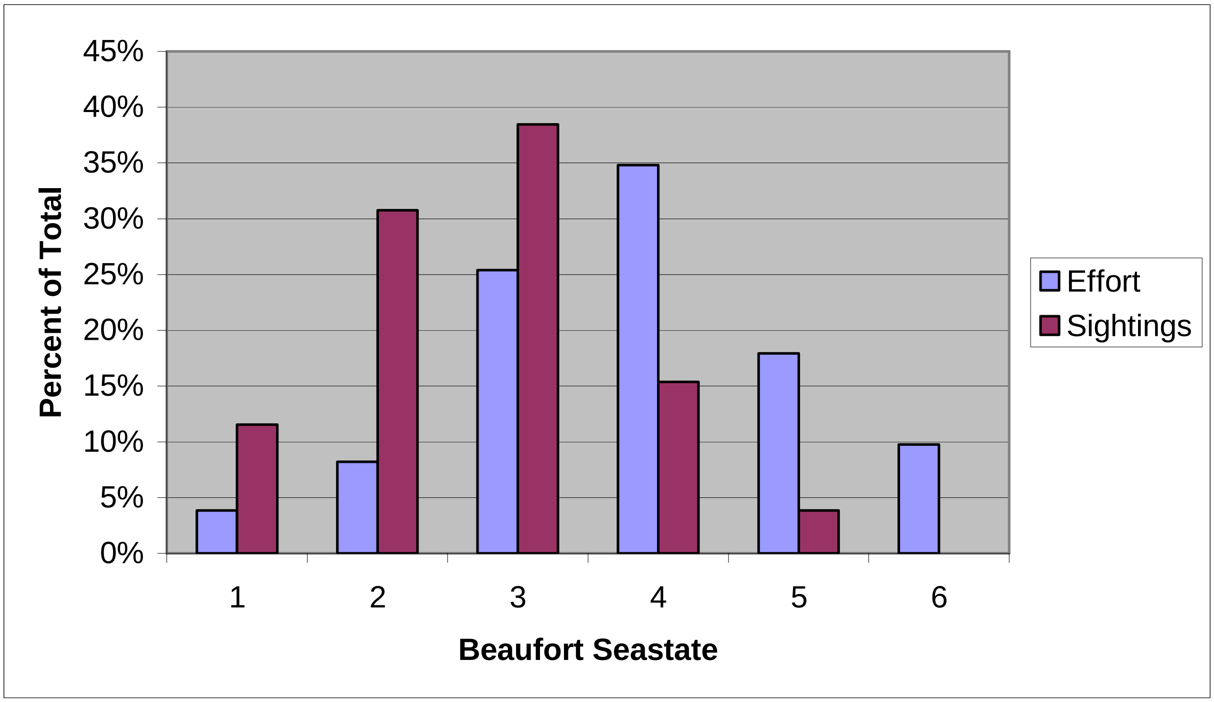

Figure 2. Summary of Beaufort Seastate. As shown, the majority of effort was spent in Beaufort seastate greater than 3 (63%) whereas the majority of sightings occurred in Beaufort seastate 3 or less (81%). Seastate is the primary factor affecting sighting probability of free-ranging marine mammals.

Table 2. Summary of individual sightings

Date	Number	Spp	Time	Seast	Londec	Latdec	Behavioral Description
11/15/2007	14	CM	9:49:31	3	157.8291	21.4781	
11/15/2007	6	CM	9:55:52	3	157.8741	21.5792	
11/15/2007	1	CM	9:57:31	3	157.9093	21.6202	
11/15/2007	1	CM	10:00:43	3	157.9536	21.7047	
11/15/2007	1	CM	10:01:53	3	157.9898	21.7104	
11/15/2007	2	CM	10:05:45	3	158.0747	21.6336	
11/15/2007	3	CM	10:13:02	2	158.2733	21.5659	
11/15/2007	2	CM	10:13:49	2	158.2590	21.5542	
11/15/2007	1	CM	10:24:06	2	158.2176	21.4611	
11/15/2007	1	CM	10:27:04	2	158.1800	21.4006	
11/15/2007	1	CM	10:39:42	3	158.0800	21.2950	
11/15/2007	1	CM	13:05:03	5	156.9861	21.2047	
11/15/2007	1	CM	13:33:24	4	157.0240	21.0772	
11/15/2007	2	CM	13:36:01	4	157.1159	21.0898	
11/15/2007	1	CM	13:37:21	4	157.1626	21.0857	
11/12/2007	1	UT	12:21:44	1	157.4183	21.3762	
11/12/2007	12	GM	10:37:50	1	157.5927	21.4753	scattered; milling
11/12/2007	19	GM	12:19:12	1	157.4252	21.3810	slow travel
11/15/2007	1	MS	10:35:33	3	158.1111	21.3031	slow swimming
11/15/2007	2	MS	13:44:24	4	157.3142	21.1048	sunning on beach
11/15/2007	24	SL	10:15:19	2	158.2321	21.5304	slow swimming
11/15/2007	60	SL	10:30:02	2	158.1310	21.3440	milling; slow swimming
11/12/2007	31	SS	10:55:42	2	157.5298	21.2667	scattered; milling
11/12/2007	5	TT	11:27:12	3	157.5087	21.8691	fast swimming
11/12/2007	1	UD	11:17:38	2	157.5071	21.6769	Dove
11/12/2007	1	UW *	15:56:27	3	157.2400	21.9230	submerged swimming

Species code: CM = green sea turtle; UT = unidentified turtle; GM = short-finned pilot whale; MS = Hawaiian monk seal; SL = spinner dolphin; SS = unidentified *Stenella* species; TT = bottlenose dolphin; UD = unidentified dolphin; UW = unidentified whale

Table 3. Summary of sightings by species

Species	No. Sightings	No. Individuals
Green sea turtle (*Chelonia mydas*)	15	38
Short-finned pilot whale (*Globicephala macrorhynchus*)	2	31
Hawaiian spinner dolphin (*Stenella longirostris*)	2	84
Bottlenose dolphin (*Tursiops truncatus*)	1	5
Stenella species	1	31
Hawaiian monk seal (*Monachus schauinslandi*)	2	3
Unidentified turtle	1	1
Unidentified dolphin	1	1
Unidentified whale	1	1

Acknowledgements

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http://socrates.uhwo.hawaii.edu/SocialSci/jmobley/2006RIMPAC.pdf

Appendix:
Summary of 1993 - 2003 Hawaiian Islands Aerial Survey Results

Species Name	No. pods	No. indiv.
Humpback whale (*Megaptera novaeangliae*)	2352	3907
Spinner dolphin (*Stenella longirostris*)	52	1825
Spotted dolphin (*Stenella attenuata*)	31	1021
Short-finned pilot whale (*Globicephala macrorhynchus*)	73	769
Melon-headed whale (*Peponocephala electra*)	6	770
Bottlenose dolphin (*Tursiops truncatus*)	54	492
False killer whale (*Pseudorca crassidens*)	18	293
Sperm whale (*Physeter macrocephalus*)	23	106
Rough-toothed dolphin (*Steno bredanensis*)	8	90
Blainville's beaked whale (*Mesoplodon densirostris*)	9	32
Pygmy or dwarf sperm whale (*Kogia* spp.)	4	28
Striped dolphin (*Stenella coeruleoalba*)	1	20
Pygmy killer whale (*Feresa attenuata*)	2	16
Cuvier's beaked whale (*Ziphius cavirostris*)	7	13
Risso's dolphin (*Grampus griseus*)	1	8
Killer whale (*Orcinus orca*)	1	4
Fin whale (*Balaenoptera physalus*)	1	3
Unid. Dolphin	96	452
Unid. Stenella spp.	11	196
Unid. Whale	28	39
Unid. beaked whale	9	23
Unid. Cetacean	14	27
Totals:	2801	10134

Aerial Surveys of Marine Mammals and Sea Turtles

in Conjunction with RIMPAC 2008 Exercises
near Kauai and Niihau, Hawaii
July 13-17, 2008

Field Summary Report

October 2008
FINAL REPORT

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Executive Summary

Aerial surveys were performed in support of the 21st multi-national "Rim of the Pacific" (RIMPAC) naval exercises on July 13-17, 2008. The mission was to detect, locate and identify all marine mammal and sea turtle species. Also, for marine mammal species, additional observation time was spent characterizing behavior and direction of travel at the time of sighting. The surveys covered an area of approximately 2600 nm^2 (8,880 km^2) lying primarily south of the island of Kauai. Transects followed a pre-specified grid for the first four days (July 13-16) followed by circumnavigation of Kauai and Niihau on the fifth day (July 17). All surveys were flown in a twin-engine Partenavia Observer (P68) aircraft, specifically designed for search-and-rescue as well as biological surveys. The transect surveys utilized design and methods prescribed by accepted distance sampling theory (Buckland et al., 2001). Survey crew and pilot were not informed as to the status or location of navy exercises to minimize observational bias. A total of 24 sightings were recorded either during transects or during circumnavigation of the islands. These sightings involved eight identified species (bottlenose dolphin, Blainville's beaked whale, Cuvier's beaked whale, Hawaiian monk seal, rough-toothed dolphin, Short-finned pilot whale, spinner dolphin, striped dolphin) and two unidentified species (unidentified dolphin species, unidentified turtle species) (Tables 2-3). Based on behavioral observation of the marine mammal species, no indications of distressed or unusual behavior were seen. The circumnavigation survey (July 17) yielded no evidence of stranded or near stranded animals.

Section 1 Introduction

The 21st multi-national Rim of the Pacific (RIMPAC) Exercise spanned a month-long period from June 29 through July 31, 2008

Over the past several years, the Navy has been further developing its marine species monitoring in conjunction with major training exercises. Monitoring during RIMPAC08 included aerial surveys focused in waters of the Pacific Missile Range Facility (PMRF) off Barking Sands, Kauai. The aerial surveys were designed based on current accepted distance sampling theory (Buckland et al, 2001) using methods consistent with those used in previously as part of RIMPAC 2006 (Mobley, 2006). Results of those surveys are reported here.

Section 2 Methods

Aerial surveys were performed over a five-day period, consisting of four days (July 13-16) of transect-based surveys that followed a pre-specified grid followed by a one-day circumnavigation of Kauai and Niihau on the fifth day (July 17) (Table 1; Figure 1). All surveys were flown in a twin-engine Partenavia Observer (P68) aircraft outfitted with bubble windows to permit unobstructed downward views. The transect surveys utilized design and methods prescribed by accepted distance sampling theory (Buckland et al., 2001).

Table 1. Description of surveys

Date	**Survey Type**	**Hrs Effort--Transect**	**Transit Hrs**	**No. Sightings***	**Mean Beaufort**	**Range Beaufort**
July 13	Transect grid	3.45	1.62	1	4.69	3-6
July 14	Transect grid	3.50	1.67	2	3.26	2-6
July 15	Transect grid	4.35	2.22	7	3.35	1-5
July 16	Transect grid	2.92	1.93	2	5.13	2-6
July 17	Circumnavigate Kauai/Niihau	1.23	1.73	12	4.57	2-7
	Totals:	**15.45**	**9.17**	**24**	**4.20**	**1-7**

Transect grids were designed for maximum coverage within range limits of the aircraft. Six north-south transect lines were placed approximately 7 nmi (14 km) apart to cover the approximate 2600 sq nmi (8,880 sq km) target area (Figure 1). The circumnavigation portion (July 17) involved flying along the coasts of Kauai and Niihau with the mission of identifying any stranded or near stranded cetaceans.

Aircraft flew at an average 100 knots ground speed and altitude of 244 m (800 ft). Survey crew consisted of two observers, one on each side of the plane, and a data recorder. Survey crew and pilot were not informed as to the status or location of navy exercises to minimize observational bias. When target species were detected, an angle was taken to the sighting using hand-held Suunto clinometers, typically followed by orbiting to identify species and in the case of marine mammals, to characterize behavior and direction of travel. Photographs were taken opportunistically by the data recorder to assist in species identification. Environmental data (Beaufort seastate, glare, visibility) were taken at the start of each transect leg or when conditions changed. Positional data via GPS were automatically recorded every 30-sec and manually when sightings occurred.

Total flight time consisted of a total of approximately 25 hrs, including 9 hrs of transiting to and from the survey grid, and approximately 16 hrs of survey "effort" (i.e., trackline or coastal coverage) (Table 1). Observers were told to monitor continuously during both transiting and transect portions.

Section 3 Results and Discussion

A total of 24 sightings were recorded during the five days of aerial surveys (Table 2) consisting of eight identified species. Nineteen of these sightings occurred during survey effort (either during transects or circumnavigation) and five occurred during transits between Oahu and Kauai (Figure 1). Positively identified species included six sightings of Hawaiian monk seals (*Monachus schauinslandi*), two of rough-toothed dolphins (*Steno bredanensis*) and one sighting each of Blainville's beaked whales (*Mesoplodon densirostris*), bottlenose dolphins (*Tursiops truncatus*), Cuvier's beaked whales (*Ziphius cavirostris*), short-finned pilot whales (*Globicephala macrorhynchus*), spinner dolphins (*Stenella longirostris*) and striped dolphins (*Stenella coeruleoalba*) (Table 3). Unidentified species consisted of seven sightings of delphinid species and three sightings of turtle species.

Sighting probability is primarily dependent on Beaufort seastate (Buckland et al., 2001) which is in turn controlled by wind speed. Survey conditions ranged from calm seas (Beaufort 1) to near gale force winds (Beaufort 7) with 50% of total effort spent in Beaufort 5 or higher (Figure 2). Sightings tended to occur in lower Beaufort seastate conditions with the majority (70%) occurring in Beaufort 2-3.

Since the status of sonar transmissions (i.e., whether on or off) was not known during these surveys, it was not possible to address the issue of species' reactions to mid-frequency sonar. Here we limit our report to the incidence and location of the target species, with brief descriptions of the behavior of cetacean species sighted.

The presence of Cuvier's and Blainville's beaked whales in the study area is of interest due to their involvement in previous stranding incidents involving mid-frequency sonar (e.g., Balcomb & Claridge, 2001). The Cuvier's sighting occurred outside of the study area during transit from

Oahu to Kauai in deep water (> 1000 fathoms) consistent with known dive depths reported from tagged specimens (Schorr et al. 2008). The pod of Blainville's beaked whales was sighted within the study area between Kauai and Niihau in depths between 100 and 1000 fathoms. Behavioral observations did not reveal unusual or distressed behavior (e.g., unusually tight aggregations of pod members).

The six sightings of Hawaiian monk seals hauled-out on the island of Niihau were also noteworthy. Though the primary habitat of Hawaiian monk seals is the Northwestern Hawaiian Islands, sightings in the main Hawaiian Islands have increased in recent years (Baker & Johanos, 2004). The seals tend to prefer haul-out areas like Niihau that are low in human population density.

Table 2. Summary of Sightings, Positions and Behavior

Date	Species	No. Indiv.	Time	Latitude	Longitude	Direction of travel	Behavioral Summary
7/13/2008	ZC	3	14:23	22 04.05	159 9.07	--	surface resting for 3 orbits then dove
7/14/2008	UD	3	10:19	21 35.59	159 20.90	--	(not resighted)
7/14/2008	SB	5	13:30	21 58.62	159 56.21	NW	fast swimming, porpoising (photos available)
7/15/2008	UD	5	10:15	21 27.01	158 17.25	--	(not resighted)
7/15/2008	UD	3	10:46	21 51.91	159 21.67	--	(not resighted)
7/15/2008	MD	6	14:07	21 51.51	159 58.37	SE	swimming staggered line abreast formation; dove (photos available)
7/15/2008	SB	1	14:23	22 05.49	159 54.22	S	
7/15/2008	UD	4	14:48	22 11.88	159 18.53	--	(not resighted)
7/15/2008	GM	2	14:54	22 10.51	159 15.86	--	resting at surface
7/15/2008	SC	75	15:10	22 01.51	159 3.32	SE	fast swimming, porpoising; spread-out, no clear formation (photos available)
7/16/2008	TT	2	10:25	21 28.34	158 22.63	NE	UW swimming; visible for only 2 orbits
7/16/2008	UD	1	10:58	21 49.15	159 8.65	N	observed UW swimming belly-up
7/17/2008	UT	1	10:50	22 13.61	159 26.47	--	
7/17/2008	UT	1	10:53	22 13.11	159 31.52	--	
7/17/2008	UT	1	11:03	22 03.74	159 47.47	--	
7/17/2008	UD	3	11:10	21 58.41	159 58.98	SW	(not resighted)
7/17/2008	UD	1	11:14	21 58.39	160 1.68	SE	(not resighted)
7/17/2008	SL	70	11:21	22 01.64	160 5.66	NW	milling; moving away from Lehua Rock

7/17/2008	MS	2	11:27	22 0.25	160 5.32	--	beached monk seals
7/17/2008	MS	3	11:32	21 55.07	160 11.75	--	beached monk seals
7/17/2008	MS	1	11:34	21 51.29	160 14.42	--	beached monk seal
7/17/2008	MS	1	11:35	21 50.55	160 14.89	--	beached monk seal
7/17/2008	MS	1	11:38	21 46.86	160 12.01	--	beached monk seal
7/17/2008	MS	1	11:39	21 47.74	160 12.01	--	beached monk seal

Species Code: SC = striped dolphin; SL = spinner dolphin; UD = unidentified dolphin species; UT = unidentified turtle species

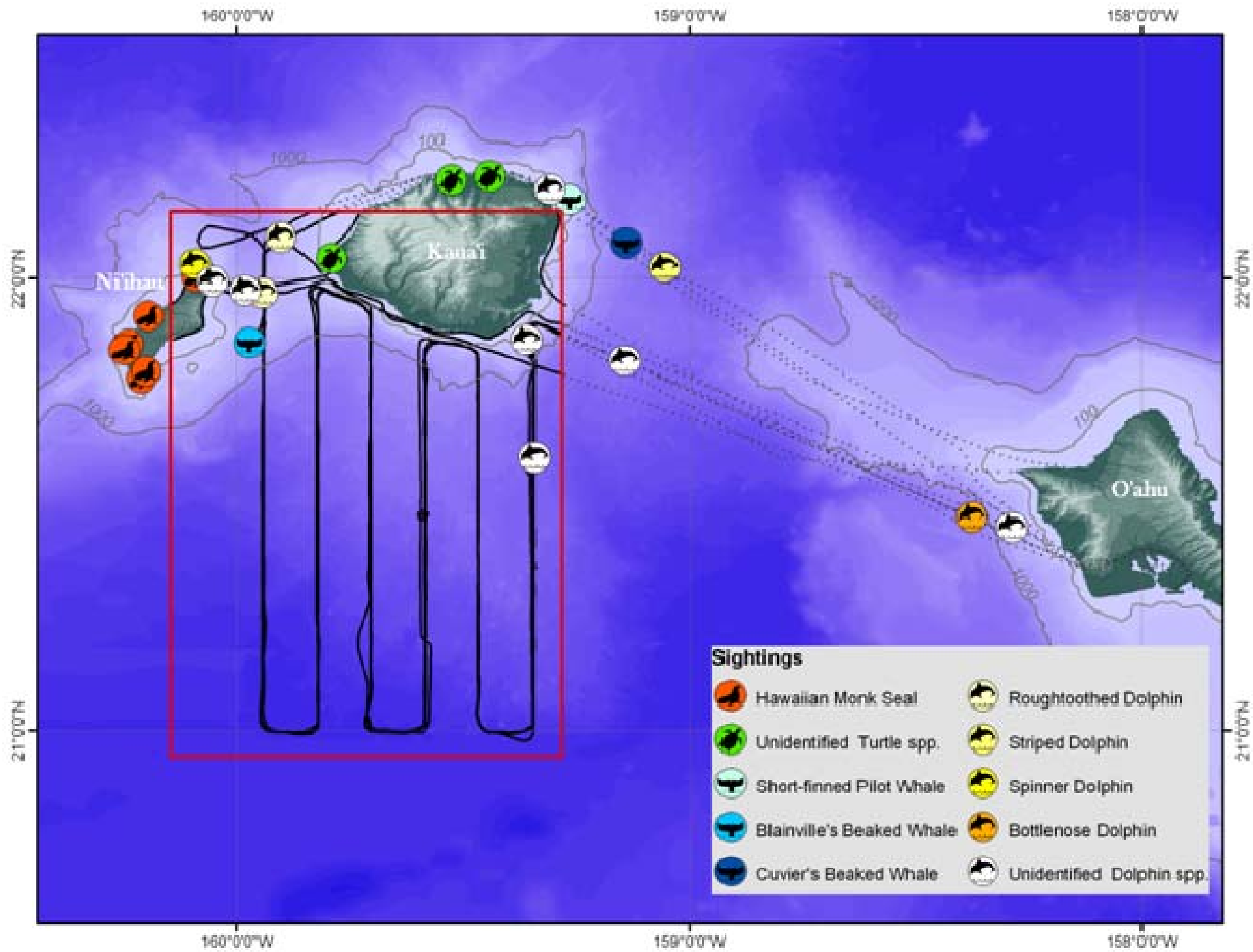

Figure 1. **Survey effort and species locations**--Survey effort based on GPS location data. Red lines indicate the boundaries of the survey area. Surveys were constructed around north-south systematic lines approximately 8 nmi (15 km) apart. Circles with silhouettes indicate locations of sightings. Inner and outer bathymetry lines refer to 100- and 1000-fathom contours respectively.

The remaining species sighted, including bottlenose, rough-toothed, spinner, and striped dolphins, as well as short-finned pilot whales, are fairly common in Hawaiian waters based on previous surveys (Barlow, 2006; Mobley, 2004; Mobley et al., 2000).

In summary, the results of aerial surveys conducted during the 2008 RIMPAC exercises in the waters south of Kauai did not reveal any obvious indications of disturbance on the part of resident marine mammals and sea turtles. Observations revealed no unusual behavior or signs of distress. The coastal survey produced no evidence of stranded or near stranded cetaceans. That being said, it is important to note that the absence of evidence in this case should not be construed as demonstrating the absence of any effect of the exercises. Merely that no obvious effect was discernible.

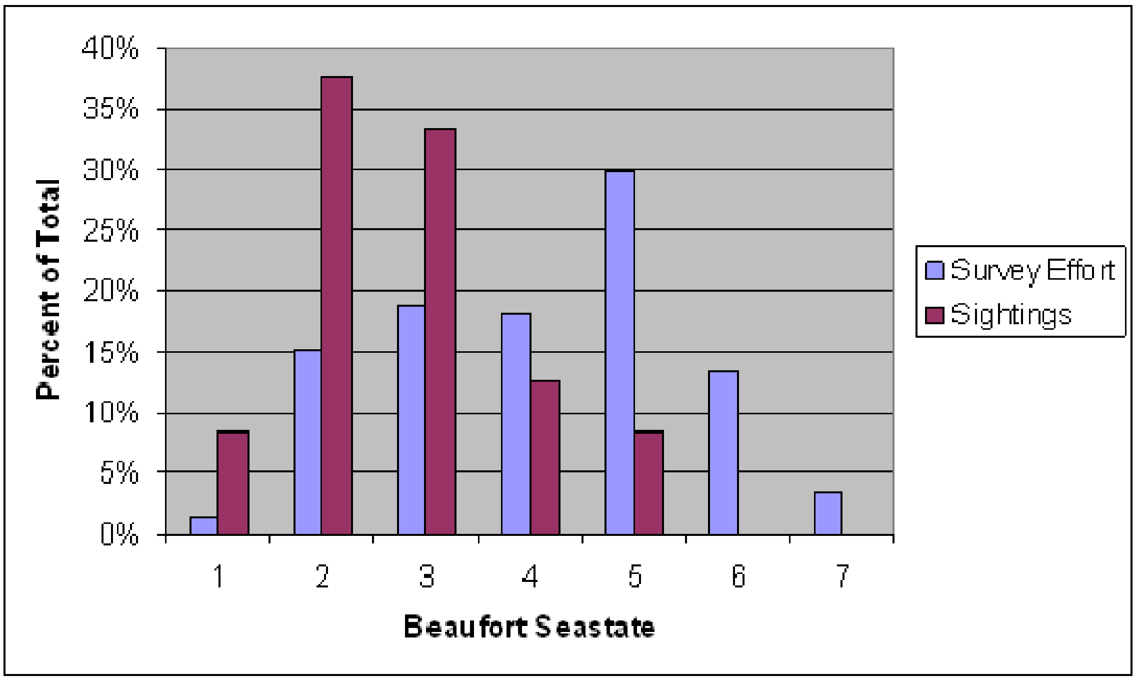

Figure 2. Beaufort seastate conditions—Effort occurred in Beaufort seastate conditions spanning from nearly flat seas (Beaufort 1) to near gale conditions (Beaufort 7). As shown, the majority of sightings occurred in more favorable seastate, with the majority (70%) occurring in Beaufort 2-3.

Table 3. Summary of Sightings by Species

Species	No. Sightings	No. Individuals
Blainville’s beaked whale (*Mesoplodon densirostris*)	1	6
Bottlenose dolphins (*Tursiops truncatus*)	1	2
Cuvier’s beaked whale (*Ziphius cavirostris*)	1	3
Hawaiian monk seals (*Monachus schauinslandi*)	6	9

Rough-toothed dolphin (*Steno bredanensis*)	2	6
Short-finned pilot whale (Globicephala macrocephalus)	1	2
Spinner dolphins (*Stenella longirostris*)	1	70
Striped dolphins (*Stenella coeruleoalba*)	1	75
Unidentified dolphin species	7	20
Unidentified turtle species	3	3

Section 4 Acknowledgements

I would like to thank our observers Julie Oswald and Robert Uyeyama for their excellent work. Mahalo also to our pilot John Weiser for his usual superb piloting. These data were obtained under NOAA permit no. 642-1536-03 issued to the author (JRM).

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Aerial Survey Monitoring of Marine Mammals and Sea Turtles
in Conjunction with SCC OPS 08 Training Exercises off Kauai and Niihau, Hawaii
August 18-21, 2008

Field Summary Report

FINAL REPORT
May 2009

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Executive Summary

Aerial surveys to monitor for marine mammals and sea turtles (MM/ST) were conducted in conjunction with the August 2008 US Navy Submarine Commanders Course (SCC OPS) 08 training event in the Hawaii Range Complex on the Pacific Missile Range Facility Barking Sands Range off Kauai and Niihau, Hawaii, on four consecutive days from 18-21 August 2008. The purpose of the survey was to monitor potential effects of the training event on these species. This effort involved assessing the feasibility of conducting searches for MM/ST in front of an Arleigh Burke class naval destroyer, the *USS O'Kane* DDG 77 (*O'Kane*). During monitoring, the *O'Kane* was underway following a non-systematic course and speed and intermittently transmitting mid-frequency active sonar (MFAS). The goal was to monitor for any changes in the near-surface behavior, orientation, occurrence, and location of animals relative to the vessel's activities using a focal follow method. This included monitoring for any potentially dead, injured, distressed and/or unusually behaving animals. The approach involved flying elliptical-shaped patterns in advance of the *O'Kane* that extended from the front of the ship (~200 yards [yd]) out to ~2500 yd) over a width of ~2 nm. When range safety conditions precluded accompanying the *O'Kane*, "practice focal follows" were conducted opportunistically when target species were sighted off range.

Surveys were conducted with a small fixed-wing Partenavia P68 Observer flying at 100 knots (kt) groundspeed and an altitude of 800 ft (244 m). Observations from the monitoring aircraft involved four personnel including the pilot and three professionally trained marine mammal biologists, at least two with >10 years of related experience. One biologist was the data recorder/video camera operator and the other two were observers. Behavioral observation methods followed protocols previously implemented from small fixed-wing aircraft to monitor baseline behavior and reactions of whales and dolphins to various anthropogenic stimuli. Observers were not informed of the times and types of underwater transmissions during Navy activities, nor the course of the *O'Kane*.

The survey aircraft was able to accompany the *O'Kane* during 19.0 (67%) of the 28.5 hours (hr) of flight time; the remaining 9.5 hr (33%) while not with the *O'Kane* involved primarily transit time to and from the offshore location of the vessel. No sightings were recorded while escorting the *O'Kane*, although observation conditions were predominantly poor near the *O'Kane* (Beaufort >4 during 80% of 19 hr). In general, previous reported densities of MM/ST are very low in the deep offshore waters where the *O'Kane* operated compared to near-shore Hawaiian waters (reviewed in Smultea 2008). During the 9.5 hr away from the *O'Kane*, 20 sightings were recorded, all in nearshore waters of Kauai (18 sea turtle and 2 spinner dolphin groups). Two <10-min opportunistic focal follows were conducted on the two groups of spinner dolphins while flying at an altitude of ~1200-1500 ft and included digital video recordings of their behavior. These focal sessions demonstrated the feasibility of the behavioral observation method from a circling aircraft. Video was also obtained of a non-target species (whale shark) as it swam >10 yd below the surface in Bf 6 sea conditions, demonstrating that a large marine species could be tracked underwater in the clear tropical water conditions in the *O'Kane*'s vicinity.

Overall, the monitoring survey effort demonstrated the feasibility of performing search and behavioral observations of target species without interfering with at-sea naval training involving multiple large vessels, aircraft (both fixed-wing and helicopters), and submarines. This information can be used to continue developing effective monitoring approaches and to gather behavioral data, including baseline data, on the potential effects of Navy activities on marine resources as required under the Navy's marine species monitoring plan for the Hawaii Range Complex. Recommendations for marine mammal monitoring during future similar Navy activities have been presented.

Citation for this report is as follows:

Smultea, M.A. and J.R. Mobley, Jr. 2009. Aerial Survey for Marine Mammals and Sea Turtles in Conjunction with SCC OPS Navy Exercises off Kauai, 18-21 August 2008, Final Report, May 2009. Prepared by Marine Mammal Research Consultants, Honolulu, HI, and Smultea Environmental Sciences, LLC., Issaquah, WA, under Contract No. N62742-08-P-1942 for Naval Facilities Engineering Command Pacific, EV2 Environmental Planning, Pearl Harbor, HI.

Photo Credits on Cover: Partenavia P68 Observer aircraft used during the survey, photo courtesy of Lori Mazzuca; Hawaiian spinner dolphin (*Stenella longirostris*) observed near Kauai during RIMPAC July 08 vessel survey, photo courtesy of Thomas Jefferson. Cetacean photo taken under NOAA Permit No. 642-1536-03 issued to Joseph R Mobley, Jr. Cover Page Graphics: Stasia Buffenbarger.

Section 1 Introduction

In support of the U.S. Navy's (Navy) marine species monitoring plan in the Hawaii Range Complex (HRC), Marine Mammal Research Consultants (MMRC), Honolulu, HI, was contracted by the Navy to conduct an aerial survey to monitor marine mammals and sea turtles (MM/ST) in conjunction with the SCC OPS 08 Navy training event involving mid-frequency-active sonar (MFAS) off Kauai and Niihau in the main Hawaiian Islands (Fig. 1). MMRC attended pre-planning sessions with the Navy Technical Representative (NTR) and other Navy staff at Pearl Harbor, Honolulu, Oahu, Hawaii, to coordinate survey efforts with the SCC 08 operations. These meetings were required given the complexity of multiple naval aircraft and vessel operations involved with the training event. The goal of the meetings was to ensure safety and open communication between the Navy and the aerial monitoring team during the survey.

The approach implemented for monitoring was to search for and follow MM/ST in front of the Arleigh Burke class naval destroyer, the *USS O'Kane* DDG 77 (O*'Kane*), while it was underway and intermittently transmitting MFAS. Observations by experienced marine mammal observers occurred from a small, fixed-wing Partenavia P68 Observer aircraft on four days from 18-21 August 2008. This included one day of transit from Oahu to Kauai; poor weather conditions precluded effort during the return transit to Oahu on 21 August.

The primary monitoring goals were as follows.

1. Monitor MM/ST to identify potential changes in behavior, orientation, location, distribution, and relative abundance relative to MFAS and other SCC OPS 08 activities. This included monitoring for any potentially dead, injured, distressed and/or unusually behaving animals.
2. Facilitate real-time communication between Navy biological observers on the *O'Kane* and those in the survey aircraft, as well as those between naval and observer aircrafts in order to communicate (a) animal sighting locations relative to the *O'Kane*'s location, and (b) observer aircraft altitude changes to allow safe monitoring relative to naval aircraft and vessel operations.
3. Obtain locations of animals so that received MFAS sound levels could be calculated and estimated by Navy personnel in post-survey analyses.
4. Assess the feasibility and capabilities of monitoring near- and sub-surface tracking and behavior of MM/ST from the survey plane near the *O'Kane*.
5. Evaluate effectiveness and feasibility of monitoring approaches during SCC OPS 08 and provide recommendations for future such efforts.

Accompanying a naval destroyer actively engaged in training events from a small aircraft to search for MM/ST for extended periods had not been previously implemented; thus, the project was considered a feasibility study. Additionally, *O'Kane* crew lookouts and professional Navy marine mammal biologists maintained watch for MM/ST during all daylight hours; lookouts also maintained watch during darkness hours.

Herein we describe the methods and results of our aerial monitoring survey in the context of other similar surveys and methodologies. We also evaluate the feasibility of the survey approach and provide recommendations for future efforts designed to monitor MM/ST during naval events and exercises. These topics are discussed in the context of short- and long-term monitoring goals summarized in the Hawaii Range Complex Final Monitoring Plan (Navy 2008) and the Southern California Range Complex Final Monitoring Plan (Navy 2009).

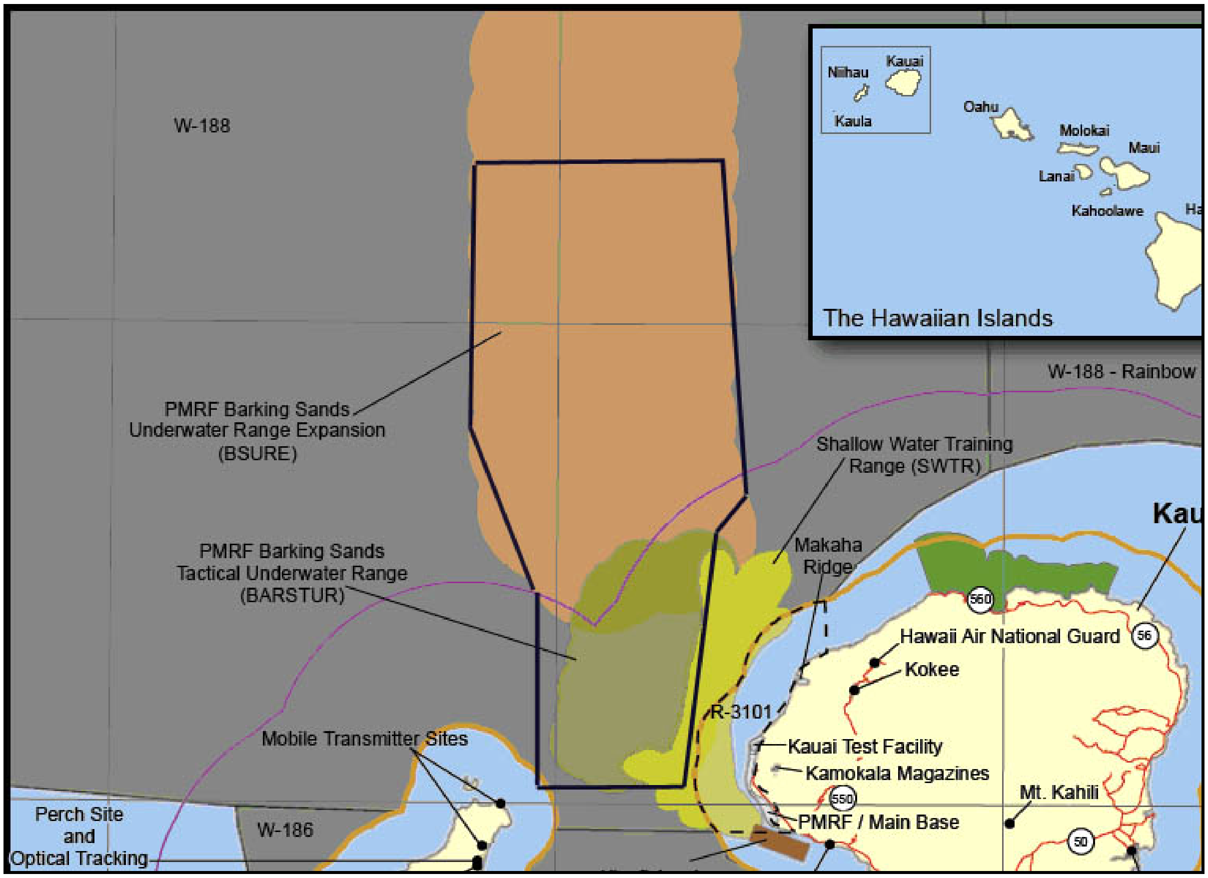

Figure 1. Location of the aerial survey monitoring area in and near the US Navy Pacific Missile Range Facility (PMRF) Range west and northwest of Kauai, Hawaii.

Section 2 Methods

Survey protocols were designed to meet the Navy goals outlined in the Statement of Work (SOW) while remaining adaptable to both *in-situ* and predicted weather conditions, as well as to naval activities. The survey methodology and sampling design were submitted and approved in advance, per the SOW, to the NTR. Per the SOW and NTR communications, the primary goals of this project were to locate and identify MM/ST during the training event, and to monitor and report observations of their behavior focusing on any changes potentially resulting from exposure to MFAS. This included monitoring for any potentially injured or harmed MM/ST and any unusual behavior or changes in behavior, distribution, numbers, and species associations of animals observed during the training event. Post-event analysis will be conducted by Navy personnel to correlate observed animal locations with estimated received sounds levels of MFAS. Current Navy policy does not allow civilian monitoring scientists access to MFAS transmission schedules.

The survey was undertaken from a twin-engine, fixed-wing Partenavia P68 Observer previously used to conduct numerous aerial surveys for MM/ST on behalf of the Navy in Hawaii and elsewhere (e.g., Mobley 2004, 2008a,b). The survey occurred from 18-21 August 2008. This included one full day accompanying the *O'Kane* on 18 August as it transited from Pearl Harbor in Honolulu, Oahu, to the training area off Kauai and Niihau, followed by three days within the training area (Fig. 1).

The SCC OPS 08 event involved several large naval vessels, submarines, and both fixed-wing and helicopter aircraft. Thus, daily survey periods were generally limited to relatively short time windows that did not conflict with naval airspace operations for logistical and safety reasons. These flight windows had to be identified and coordinated with the NTR and/or the air controller at Barking Sands each morning prior to take off and updated throughout the flight via cell phone, Inmarsat satellite phone, and/or the aircraft radio. Each morning after the flight window had been identified through communications with Navy personnel, the *O'Kane*'s position was communicated to the crew on the aircraft and the plane was flown to that location. This location was expected to be within the BSURE or BARSTUR ranges of the training event area located at minimum ~15 nm WNW of Kauai's Lihue Airport where the survey aircraft was located.

Observations were conducted en route to the *O'Kane*'s location following established line-transect survey protocol (see Mobley 2004, 2008a,b). Upon locating the *O'Kane* visual observations for MM/ST were conducted using two approaches (i.e., modes): search mode and focal follow mode (Table 1). The purpose of the first mode was to systematically search for animals by flying elliptical, "race track" shaped patterns in front of the *O'Kane*. The goal of this flight pattern was to cover a swath extending from ~200 yd in front of the ship out to ~2500 yd and ~2 nm wide. The pilot manually flew this pattern and frequently had to adjust the pattern to non-systematic and unpredictable changes in speed and headings of the *O'Kane* as it conducted training maneuvers. The resulting extended flight pattern was corkscrew-shaped (Fig. 2). This mode was to be maintained until a MM/ST sighting was made either by the aircraft or the vessel-based observers, or until there was a potential conflict with naval airspace. In addition, passive acousticians aboard the *O'Kane* occasionally alerted the aircraft observers to the presence of vocalizing cetaceans and communicated approximate bearings to these acoustic detections.

When a sighting was made, the aircraft was to cease the flight search pattern and begin circling the sighting following focal follow behavior mode (Table 1). The latter protocol has been successfully implemented during previous aerial studies monitoring the behavior of cetaceans, including near anthropogenic stimuli (e.g., oil and gas exploration activities and sounds, oil spills) (e.g., Richardson et al. 1985a,b, 1986, 1990; Würsig et al. 1985, 1989; Smultea and Würsig 1995; Patenaude et al. 2002). The objective was to circle the sighting at an altitude of 1200-1500 ft and a radial distance of ~1 km and record detailed behavioral observations using a digital video camera and paper data forms (Tables 2 and 3). Previous studies indicate that bowhead and adult humpback whales show few or no detectable reactions to a small aircraft circling at these altitudes and radial distance (e.g., Richardson et al. 1985a,b; Smultea et al. 1995; Patenaude et al. 2002; also see review in Richardson et al. 1995). These parameters are well outside the theoretical range of air-to-water sound transmission angle associated with over-flying aircraft (i.e., Snell's Cone -- see Urick 1972 and Richardson et al. 1995). Thus, these parameters were anticipated to avoid the potential for the aircraft to affect the behavior of the observed animals. However, very few studies on the effects of over-flying aircraft on cetaceans have been made, and no studies of the underwater received levels of an overflying Partenavia P68 Observer are known to exist to our knowledge.

Observations from the monitoring aircraft involved four personnel including the pilot and three professionally trained marine mammal observers, at least two with >10 years of related experience. Roles and responsibilities of the four positions on the aircraft during the search and focal follow modes are depicted in Table 2**.** During focal follows, one observer used a Canon Vixia HF10 digital video camera with a built-in optical image stabilizer and 12x optical zoom to record behaviors in real time as indicated by a time stamp on the viewfinder screen. The microphone of the video camera was connected to the audio system of the aircraft so that all vocal input (e.g., behavioral descriptions) was recorded into the video camera data stream. Observers used Steiner 7 X 25 or Swarovski 10 X 32 binoculars as needed to identify species, group size, behaviors, etc. A Suunto handheld clinometer was used to measure declination angles to sightings when the aircraft was level and the sighting was perpendicular to the aircraft (see Mobley et al. 2000).

Scan-sampling and zero-one sampling approaches (Altmann 1974; Shane 1990; Smultea 1994, 2008; Mann 2000) were used to record the following information on the focal group approximately once per circling of the aircraft (e.g., at 1-2 min intervals) or when the parameter changed, as possible: (1) behavior state, (2) occurrence/non-occurrence and type of "conspicuous" individual behaviors, (3) estimated speed of travel (slow – 1-3 kt, medium – 4-6 kt, fast – >6 kt), (4) distance (declination angle) and magnetic bearing (range) relative to the *O'Kane* or other potential disturbance, (5) minimum and maximum spacing between individuals (i.e., dispersal distance) estimated in body lengths, and (6) aircraft altitude and estimated distance of the aircraft to the focal group (using a clinometer while the aircraft was level) (Table 2). For whales, continuous behavioral sampling (Altmann 1974) was to be used to record surface, dive, and respiration times (see Würsig et al. 1985, 1989). *Ad libitum* (Altmann 1974) detailed notes were also taken in the comments column of the form on school configuration, unusual behaviors or circumstances (e.g., birds feeding nearby, description of Navy activity), and/or any observed reactions to the vessel. Post-field analysis of video tape was to supplement these data and provide more detailed information on behaviors, inter-animal spacing, etc. Geographical Positioning System (GPS) locations were automatically recorded at 30-sec intervals and manually when a sighting was made. Environmental data including Beaufort sea state (Bf) and observation conditions (involving various glare and visibility conditions) were manually recorded at the start of each transect leg and when conditions changed. These methods are described in further detail in Green et al. (1993) and Mobley (2004, 2008a,b).

Table 1. Description of the two primary study approach modes designed to address monitoring goals of the aerial survey.

Mode	Aircraft Speed	Aircraft Altitude	Flight Pattern	Duration	Data Collected
Search	~100 kt	~800 ft	Elliptical shape ~200-2500 yd ahead of *O'Kane*'s bow and ~2 nm wide	Until MM or ST seen, then switch to Focal Follow Mode	Alert *O'Kane* of all MM/ST locations Species, group size & composition Time Lat/long location (automatic GPS) Bearing & declination angle to sighting Behavior state & individual aerial behaviors Reaction (yes or no & description)
Focal Follow	~65 kt	~1200-1500 ft	Circling at ~0.5 nm radius	≥30 – 60 min goal	In order of priority: Time Focal group heading (magnetic) Lat/long (automatic GPS) Behavior state Inter-animal dispersal distance (min & max in body lengths) Aircraft altitude (ft) Distance of aircraft to MM (angle) Reaction? Individual aerial behavior events Bearing & distance to *O'Kane* from MM (angle) Other nearby activity Surface & dive times Individual respirations

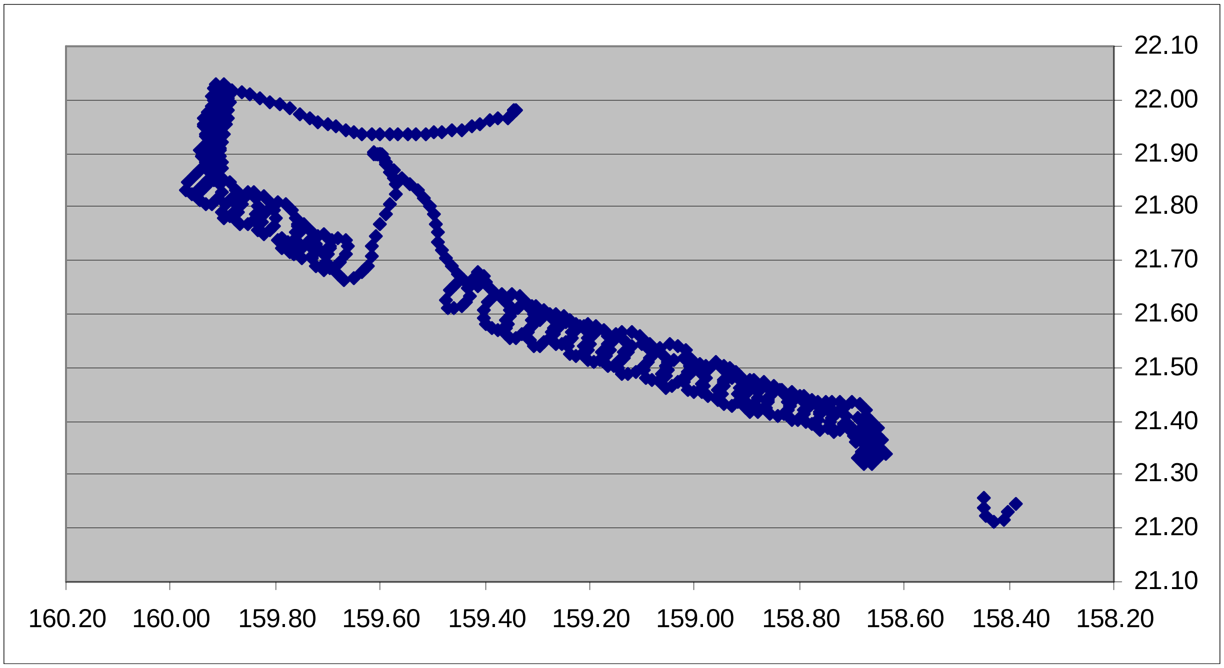

Figure 2. Actual flight path en route from near Pearl Harbor, Oahu, to Barking Sands, Kauai, on 18 August 2008 showing the typical elliptical-shaped flight pattern flown while searching for marine mammals and sea turtles in front of the USS *O'Kane*.

Table 2. Roles and responsibilities of the four personnel aboard the monitoring aircraft during the search mode and the focal behavior follow mode.[1/]

Aircraft Seat Position	Role during SEARCH Mode (~800 ft Altitude)	SEARCH Mode Responsibilities	Role during FOCAL Mode (Circling) (~1500 ft Alt & ~0.5 nm radial distance)	FOCAL Mode Responsibilities
Pilot (Left front)	Pilot	Fly elliptical-shaped pattern ~2 nm wide and ~200-2500 yd ahead of *O'Kane*. Maintain 800 ft altitude Communicate w/ PMRF & Range Director before entering range and when first approaching <2nm *O'Kane*	Pilot	Circle focal group clockwise @ 0.5 nm radius & 1200-1500 ft altitude as directed by behavior observer Keep animal(s) in middle of circle Avoid flying directly overhead animal(s) Keep track of sighting location
Right front	Recorder/ Back-up Observer	Record data Search for MM/ST Keep "big picture" track of relative position of *O'Kane*(s) & aircraft Communicate w/ *O'Kane* observers Monitor hand-held GPS Guide pilot to MM/ST location(s) Photograph to verify/identify spp.	Videographer	Videotape focal group through open window
Left center	Observer	Search for MM/ST	Notetaker	Fill out manual behavior data form and record with time: • orientation of MM when parallel w/ plane heading • *O'Kane* relative location • aircraft altitude & distance to MM (w/ clinometer) once per circling as possible when plane level Call out overall big picture description when behavior observer not talking (e.g., *O'Kane* & other activity, etc.)
Right center	Observer	Search for MM/ST	Primary Behavioral Observer	Keep track of focal group Call out 1x/circle as possible/when changes: focal behavior & other data (see Table 1)

[1/] MM = marine mammal; ST = sea turtle; PMRF = Pacific Missile Range Facility; w/ = with

Table 3. Definitions of behavior states and individual behaviors (events) used during focal animal/group follows. Behavior states are determined based on what >50% of the group is doing.

Behavior State	Code	Definition
REST	rest	>50% of group exhibiting little or no forward movement (<1 km/hr) remaining at the surface in the same location or drifting
MILL	mill	>50% of group swimming with no obvious consistent orientation (non-directional) characterized by asynchronous headings, circling, changes in speed, and no surface activity
TRAVEL	trav	>50% of group swimming with an obvious consistent orientation (directional) and speed, no surface activity
SURFACE-ACTIVE MILL	sac mill	While milling, occurrence of aerial behavior that creates a conspicuous splash (includes all head, tail, pectoral fin, and leaping behavior events—see below)
SURFACE-ACTIVE TRAVEL	sac trav	While traveling, occurrence of aerial behavior that creates a conspicuous splash (include all head, tail, pectoral fin, and leaping behavior events—see below)
Individual Behavior Event		
Breach	BR	Leap out of water with a twisting motion at >45º landing on water surface with large splash
Porpoise	PO	Leap fast out of water in forward “leap” motion at <45º creating splashes
Spin	SP	Leap clear of water and spin horizontally >1 time (dolphins only)
Bowride	BOW	Swims in front of vessel riding bow wave
Head Slap	HS	Leap out of water with forward thrust at >45º and slap ventral surface on water creating large splash
Feeding	FE	Seen chasing fish or prey and/or zig-zag pursuit swimming
Social	SOC	Two or more animals in physical contact
Tail Slap	TS	Slap water surface with ventral or dorsal side of tail flukes
Pectoral Fin Slap	PS	Slap water surface with pectoral fin
Other Behavior	OB	Behavior not listed above: describe
Whales Only		
Blow	BL	Visible respiration
No Blow Rise	NB	Surface with no visible blow/respiration
Peduncle Arch	PA	Arching of back without lifting tail/flukes
Fluke up	FU	Arching of back followed by lifting tail flukes into air (fluke facing up or down) usually before an extended dive
Unidentified Large Splash	US	Large splash associated with an unidentified/unseen behavior

Section 3 Results

Results are described below in the following four sections: effort, sightings, focal follows, and communications. Table 4 summarizes observation effort by date and by periods that the aircraft was accompanying and not accompanying the *O'Kane*. Figure 3 displays aerial survey tracks during visual observations by survey date and shows the locations of marine mammal and sea turtle sightings.

Effort

Aerial survey effort occurred on all four days of the survey period from August 18-21. The first day on 18 August was spent accompanying the *O'Kane* from near Honolulu to Kauai (Table 4). Portions of the next three days were spent with the *O'Kane* ~20-60 nm off the NW shore of Kauai when there were no airspace conflicts and when the *O'Kane* moved off range (i.e., outside the training event range--see below) as depicted in Table 4. About ~40-60 min of transit time one-way was required to reach the *O'Kane* from the Kauai Lihue airport. The aircraft usually returned to shore once per day then made a second flight on the same day, either to refuel or to avoid conflicts with periods of naval aircraft operations (Table 4). On August 19 and 20, the *O'Kane* went off range, away from the scheduled training event to conduct drills and unit-level training. This allowed the civilian observer aircraft to accompany the *O'Kane* for more hours than originally anticipated, with minimal maneuvering to avoid airspace conflicts. On the last survey day (August 21), the civilian aircraft spent the morning with the *O'Kane* as the Beaufort sea state (Bf) steadily deteriorated from Bf 2 to Bf 7 by ~14:00. The NTR and aircraft observers decided to seek calmer waters in leeward areas (near Niihau and within the Kaulakahi Channel between Niihau and Kauai) to attempt opportunistic sighting and behavioral observation of MM/ST. However, the strong wind quickly mounted to Bf 7 conditions in the channel by ~15:00. Thus, observations ceased and the aircraft returned to Oahu; no observations were conducted during the transit due to Bf >6.

A total of 28.5 hr of aerial monitoring effort was conducted over the four-day survey period from 18-21 August. This included 19.0 hr accompanying the *O'Kane* in offshore waters of Kauai and Niihau, representing 67% of the total flight time (Table 4). The remaining 9.5 hr of flight time was spent in transit or conducting opportunistic searches or focal follows for MM/ST. For example, when range safety or Bf conditions precluded accompanying the *O'Kane*, opportunistic survey effort was expended searching for cetaceans in order to conduct "practice focal follows" off range.

Observation conditions offshore where the *O'Kane* was located consisted largely of strong high wind and thus high (poor) Beaufort conditions that severely limited the ability of observers to sight MM/ST. Of the total ~19 hr spent with the *O'Kane*, most (80%) was a Bf 5, 6 or 7; the remaining ~9.5 hr (20%) was Bf 2-4 (Fig. 4). In comparison, only 38% of the 9.5 hr of survey effort while not accompanying the *O'Kane* was Bf 5-7 and occurred predominantly during transits in offshore areas. Calmer conditions of Bf 2-3 (42%) were typically found in lees along the west shore of Kauai during transits.

Sightings

No MM/ST were seen from the observer aircraft during the 19.5 hr while surveying in conjunction with the *O'Kane*. However, two groups of spinner dolphins and 18 sightings of unidentified sea turtles were recorded during the nearly 10 hr of transit and opportunistic survey time (Table 5). The spinner dolphins were seen in the lee off the NW shore of Kauai during the initial and return transits from the *O'Kane* on August 19 (Fig. 3, Table 5). All 18 sea turtle sightings were also made during transits, all close to the coastline within the protected lees of mainly Kauai but also Oahu (Fig. 3).

On August 19 at ~13:35 the aircraft observers received a satellite phone call from the Navy biologist (NTR) reporting that a group of pilot whales had been initially seen ~5 min earlier from the *O'Kane*. The

Table 4. Summary of survey times by date and periods when observer aircraft was accompanying and not accompanying the *O'Kane*.

Date 2008	Flight Times	Total Flight Time	Time not with *O'Kane*	Time with *O'Kane*	No. Sightings Near *O'Kane*	No. Sightings Away from *O'Kane*
18 August	13:10-17:06 17:20-19:29	6.1 hr	13:10-13:31 17:01-17:06 17:20-17:27 19:08-19:29 (0.9 hr)	13:32-17:00 17:28-19:07 (5.1 hr)	0	0
19 August	09:23-15:00	5.6 hr	09:23-10:19 14:06-15:00 (1.8 hr)	10:20-14:05 (3.8 hr)	0	4
20 August	06:19-08:25 09:45-14:00 15:09-18:10	9.4 hr	06:19-06:52 07:57-08:25 09:45-10:04 13:01-14:00 15:09-15:49 17:31-18:10 (3.7 hr)	06:53-07:56 10:05-13:00 15:50-17:30 (5.7 hr)	0	13
21 August	06:45-10:25 12:00-15:47	7.4 hr	06:45-07:15 10:01-10:25 12:00-12:20 14:01-15:47 (3.1)	07:16-10:00 12:21-14:00 (4.4 hr)	0	3
TOTALS:		28.5 hr	9.5 hr	19.0 hr	0	20

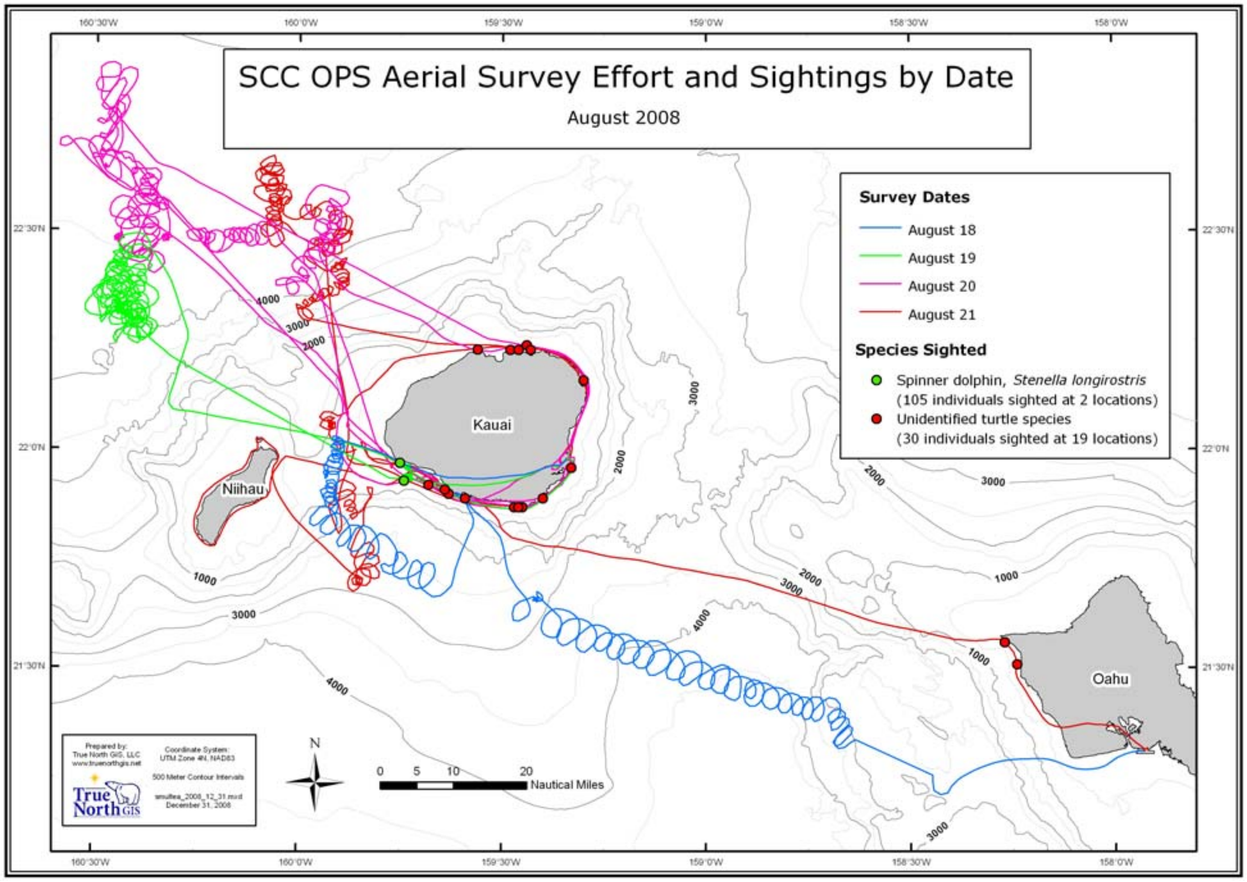

Figure 3. Aerial survey tracks during visual observations by survey date and locations of marine mammal and sea turtle sightings. Straight-line tracks indicate transit periods, some of which were conducted along the Kauai shoreline. Corkscrew-shaped tracks indicate when the aircraft was accompanying the O'Kane or conducting an opportunistic focal follow.

NTR informed the aircraft personnel that it was not until the ~9th satellite phone dialing attempt that she was able to successfully reach the aircraft observers. At the time of this communication, all the animals had dived. Thus, the NTR suggested that the observer aircraft search for the animals behind the *O'Kane*. Although the aircraft observers circled the last known location of the pilot whales for ~30 min, they were unable to re-sight the animals. Overall, the civilian aircraft observers did not see the animals probably due to several factors including: 1) the elapsed time (~5 min) it took Navy Biologists to make initial communication due to INMRSAT failure; 2) the elapsed time (another ~5 min) it took to subsequently reach the presumed location of the animals yet remain outside the minimum required radar safety guidelines aft of the *O'Kane* (in this instance >1 nm), and 3) a Beaufort sea state 6.

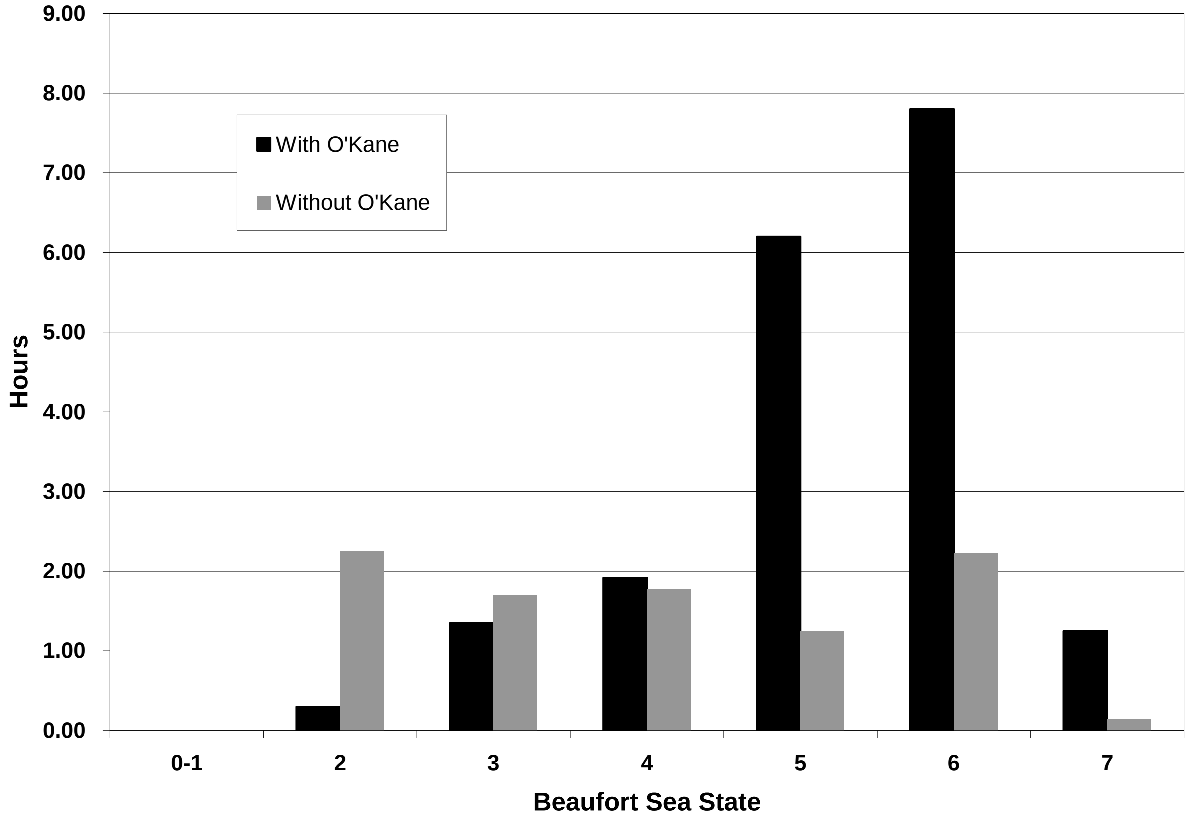

Figure 4. Beaufort sea state conditions during periods the observer aircraft was accompanying and not accompanying the *O'Kane*.

On several occasions, the NTR Navy Biologist aboard the *O'Kane* alerted the aircraft observers that the contracted Navy acoustician aboard the *O'Kane* for the survey was detecting cetacean vocalizations, including sperm whales and delphinids. The rough approximate bearing and distance (in nm) to the detection from the *O'Kane* were communicated to the aircraft observers. Aircraft observers searched these general locations for up to 10-20 min each time, but no sightings were made and observation conditions were marginal (i.e., high Bf). On one of these occasions on August 20, a whale shark was sighted from the aircraft during a Bf 6 and video was taken of it for several minutes as it swam ~30 ft below the surface.

In addition, submarines were observed from the aircraft several times and tracked for a few minutes while they were ~60 ft below the water surface. This was done to opportunistically assess the feasibility of tracking a large cetacean underwater near this depth.

Focal Follows

Two opportunistic focal follows were conducted during transits on two groups of spinner dolphins sighted off NW Kauai on August 19. The two groups were circled for ~10 min each, respectively, and video tape was taken on both groups.

The first focal follow was a group of ~80 spinner dolphins seen at 9:41 near (<1 nm) the west-central coast of Kauai as the aircraft transited to the *O'Kane*'s location (Figure 3, Table 5). The aircraft initially flew over the group at an altitude of ~800 ft when the dolphins were first seen during "search mode" (see Table 1). The aircraft then turned and began circling the dolphins, gradually increasing altitude to ~1200 ft and radial distance to ~0.5 nm over the next few minutes. The group was engaged in surface-active milling behavior throughout the encounter, with some individuals intermittently displaying spins and leaps. The overall movement of the group was to the northwest along the Kauai shoreline. Video was taken by the front right observer.

The second focal follow was a group of ~25 spinner dolphins seen at 14:30 approximately 2 nm off the central-west coast of Kauai as the aircraft transited at 800 ft altitude back to Lihue to refuel after leaving the *O'Kane*'s location (Figure 3, Table 5). The aircraft turned, increase its altitude to ~1200 ft, and began circling the dolphins at a radial distance of ~0.3 nm, gradually increasing its altitude to ~1500 ft over the next few minutes. Throughout the observations, the dolphins were engaged in fast travel to the north (toward the coastline) in close formation with <0.5 body length between individuals. Video tape was taken although Bf 4 and heavy glare made it difficult to track the dolphins. The aircraft departed after ~10 min in order to refuel.

No "harassment" due to the civilian observation aircraft as defined under the MMPA and/or ESA occurred during the survey based on observations made by the experienced observers aboard this aircraft. No obvious changes in headings or behavior states were observed among the two spinner dolphin groups during the short time durations that they were circled by the civilian observer aircraft.

Communications

Part of the survey goal was to assess the best method and means of communicating information between biological observers aboard the *O'Kane* and research aircraft observers. In previous surveys devoid of Navy platform involvement, cell phone calls and/or text messaging was determined to be the most reliable form of communication if within cell tower range, up to ~5 nm or more offshore in some instances (e.g., see Smultea 2008). However, for National security reasons, Navy platforms did not allow cell phone use at anytime when underway. Hence, cell phone use between Navy biologists on the *O'Kane* and civilian biologists aboard the observer aircraft was not an option during this survey. Prior to taking off and after landing, however, cell phones were used to communicate information between land-based Navy personnel and aircraft observers while they were still on Kauai. While at sea, however, cell phones aboard the civilian observer aircraft did not work reliably while in the air as it was difficult to hear and the *O'Kane* was far offshore during most of the survey where there was no cell phone service.

The most convenient and reliable means of communications between the *O'Kane* and aircraft observers *in situ* was usually satellite phone, although connection errors were often experienced (see *Sightings* sub-section above). In addition, communications between the observer aircraft pilot and the NTR aboard the *O'Kane* were sometimes facilitated through radio communications with PMRF. However, the marine VHF radio used by the NTR aboard the *O'Kane* and the aircraft UHF radios could not be used to directly communicate given the differences in maritime versus aviation radio frequency sensitivities. In addition, the *O'Kane* was short one radio communication device as it was in need of repair, and they did not have frequencies available for use on either side of the narrow band that the civilian aircraft had available.

Table 5. Summary of marine mammal and sea turtle sightings seen from the observer aircraft by species and date.

Date 2008	Group Size	Species	Time	Latitude (º N)	Longitude (º W)
19 August	1	Unident. sea turtle.	9:29	21.96	159.33
19 August	1	Unident. sea turtle	9:37	21.89	159.59
19 August	1	Unident. sea turtle	9:38	21.90	159.63
19 August	80	Spinner dolphin (*Stenella longirostris*)	9:41	21.97	159.75
19 August	25	Spinner dolphin	14:30	21.93	159.74
20 August	4	Unident. sea turtle	6:30	21.89	159.40
20 August	2	Unident. sea turtle.	6:36	21.91	159.64
20 August	2	Unident. sea turtle	6:37	21.92	159.68
20 August	1	Unident. sea turtle	8:10	22.23	159.56
20 August	3	Unident. sea turtle	8:12	22.23	159.48
20 August	2	Unident. sea turtle	8:13	22.23	159.46
20 August	2	Unident. sea turtle	8:13	22.24	159.44
20 August	3	Unident. sea turtle	8:14	22.23	159.43
20 August	1	Unident. sea turtle	8:19	22.16	159.30
20 August	1	Unident. sea turtle	9:50	21.87	159.46
20 August	1	Unident. sea turtle	15:16	21.87	159.45
20 August	1	Unident. sea turtle	15:16	21.87	159.47
20 August	1	Unident. sea turtle	15:20	21.91	159.64
21 August	1	Unident. sea turtle	6:51	21.87	159.46
21 August	1	Unident. sea turtle	15:32	21.56	158.27
21 August	1	Unident. sea turtle	15:34	21.51	158.24

Section 4 Discussion

The following discussion begins with a general assessment of the feasibility and success of the implemented approach for aerial monitoring of MM/ST in front of the *O'Kane*. This is followed by a general review of past data from the survey area to provide a relative context for the contribution of this and future monitoring surveys in the HRC. Recommendations for future similar aerial monitoring programs are discussed in the subsequent Section 5.

Feasibility of Approach

The primary goal of our aerial monitoring survey was to assess the feasibility of searching for and conducting focal follows of MM/ST from a small civilian aircraft while accompanying a Navy destroyer actively engaged in training involving intermittent transmissions of MFAS. Survey results successfully demonstrated that the destroyer could be accompanied by the aircraft while it flew elliptical-shaped patterns ~200-2500 yd in front of the vessel. Although no MM/ST were seen by aircraft observers near the *O'Kane*, two opportunistic focal follows of spinner dolphins including videotaping of behaviors were successfully conducted in lee-protected waters away from the *O'Kane*. Results indicate that these are feasible methods that can be used to monitor cetaceans near an active Navy vessel.

Another survey goal was to assess the feasibility of seeing and tracking cetaceans below the water surface from the civilian aircraft. Although no whales were seen by the aircraft observers, they successfully sighted, tracked and obtained video of the dolphins described above as well as a whale shark as it swam >30 ft below the surface in Bf 6 sea conditions. In addition, submarines were observed from the aircraft several times and tracked for a few minutes while they were ~60 ft below the water surface. Also, in Bf 5 conditions, a large flattened cardboard box (~5 ft X 5 ft) was tracked and videotaped as it floated ~1 yd below the water surface. The latter non-cetacean trackings were done to opportunistically assess the feasibility of tracking a large cetacean underwater at various depths. These efforts demonstrated that small to large marine species could be tracked underwater in the clear tropical water conditions in the *O'Kane*'s vicinity, including in Bf 6 conditions. However, under poor Bf conditions, the ability to continuously track objects was compromised by the rough sea-surface conditions.

One limitation of the usefulness of the implemented approach specifically for waters offshore of Kauai/Niihau (and other similar regions) is that the predominant Bf 5-6+ sea conditions severely limited the ability of aircraft observers to sight MM/ST; this was expected based on previous studies and documented typical sea conditions in this region (e.g., Buckland et al. 2001, Barlow 2006, see review in Smultea 2008).

Another serious limitation of this approach with respect to Navy monitoring is the potential for airspace conflict with naval aircraft operations. At least for the SCC OPS 08 training event, windows within which the observer aircraft could fly without potential airspace conflict were limited to relatively short periods and could be interrupted on short notice. However, effective communications between the aircraft pilot and the PMRF air tower allowed observers to maximize the periods they could fly safely. In addition, the aircraft observer team operated on standby as practicable, and could adapt to short-notice changes in airspace schedules. This was particularly useful on two days when the *O'Kane* left the range for drills and unit level training. This allowed the aircraft to accompany the *O'Kane* for many more hours than originally anticipated prior to the actual training event.

In general, the approach described herein is optimally suited to conditions where predominant expected sea states are <5-6 and where MM/ST densities are scientifically documented to be higher. Further recommendations are summarized in Section 5 *Recommendations*.

Past Cetacean Studies Near Kauai and Niihau

Few intensive systematic data are available on cetaceans in the Kauai-Niihau project area, particularly during summer. A review of these data was provided in the final field report summarizing the results of vessel-based monitoring of MM/ST in conjunction with Navy RIMPAC July 2008 exercises near Kauai and Niihau (Smultea 2008). The latter survey was concentrated in the waters between Kauai and Niihau primarily within the Kaualakahi Channel, although there was some overlap with the survey reported herein in waters northwest of Kauai. In general, available data suggest that relatively few cetaceans, mostly odontocetes, occur in the offshore windward waters of Kauai and Niihau throughout the year (e.g., Mobley 2004, 2008a,b; Mobley et al. 2000; Barlow 2006; reviewed in Smultea 2008). As noted by Barlow (2006): "The overall density of cetaceans in Hawaiian waters is lower than in most areas that have been previously surveyed" (p. 454). Barlow attributed this low density to the relative low productivity of subtropical waters. Additionally the poor sighting conditions described here likely contributed to lower-than-average sighting rates of target species.

Of most relevance to the SCC OPS 08 survey is that few if any MM/ST were anticipated to be observed in the deep offshore waters where the *O'Kane* occurred, even without the presence of the *O'Kane*. This was based on effort during a small number of previous aerial and vessel surveys conducted during summer in these waters as well as the anticipated high wind and rough sea conditions in this region (Smultea 2008). The predominant, strong NE summer tradewind and wave conditions with Bf >4-5+ typically preclude effective visual observations in the northern offshore waters of Kauai and Niihau and sighting rates/densities there are generally low (e.g., Au et al. 2000; Mobley et al. 2000; Norris et al. 2005; Mobley 2005, 2007; Barlow 2006; Baird et al. 2008c). Such conditions reduce sighting effectiveness (e.g., Barlow et al. 2001; Buckland et al. 2001; Barlow and Gisiner 2006). Thus, even if the aircraft had not been accompanying the *O'Kane*, given the predominantly high Bf conditions experienced, few if any sightings were expected in the offshore survey waters. However, observers aboard the *O'Kane* briefly sighted one group of pilot whales off the bow during Bf 6 while the aircraft circled nearby. In addition, the aircraft observers sighted a whale shark while circling near the *O'Kane* in a Bf 6.

Mobley (2004) reported a summer/fall (July-November) sighting rate of 0.006 sightings/km (0.011 sightings/nm) in 2002 in the BARSTUR and BSURE Navy ranges where the August 2008 SCC OPS survey occurred; this figure was based on 2815 km (1520 nm) of systematic aerial survey effort during 10 surveys and a total of nine odontocete sightings. However, our data cannot be directly compared because ~67% of all our survey effort was spent circling the small area in front of the *O'Kane* as opposed to the systematic line-transect effort conducted by Mobley (2004).

Summary and Relevance of Survey Results

This study contributes the following information relevant to the goals identified in the SOW and the Navy's Marine Species Monitoring Plans for the Hawaiian Islands and Southern California (Navy 2008, 2009).

- It is feasible to fly an elliptical-shaped search pattern in front of a non-systematically traveling Navy destroyer when there are no potential naval airspace conflicts.

- Focal follows of delphinids including videotaping can successfully be conducted from a circling aircraft similar to previous studies of dolphins (e.g., Smultea and Würsig 1991), bowhead whales (e.g., Richardson et al. 1985a,b, 1986, 1990, Würsig et al. 1985, 1989), and humpback whales (e.g., Smultea et al. 1995).

- Focal follows should be conducted at altitudes of at least ~1200-1500 ft and radial distances of at least ~0.5 nm to avoid and minimize the potential for focal animals to react to the aircraft. This is based on results of the limited available studies of a few cetacean species (mostly whales) as well as preliminary observations during this study. We recommend that the latter protocol be followed unless it can be statistically demonstrated that particular species do not exhibit detectable reactions to the aircraft at closer distances.

- It is not possible to assess whether the lack of sightings by aircraft observers while with the *O'Kane* in offshore deep waters was associated with the *O'Kane*'s presence and/or activities. Available studies indicate that baseline density in this region is very low. Furthermore, sighting conditions were predominantly poor. These factors suggest that aircraft observers were unlikely to sight MM/ST near the *O'Kane* whether or not the *O'Kane* was present.
- In general, the predominant environmental conditions and estimated MM/ST densities in the project area are not conducive to effective monitoring for these species.
- The sample size (*n* = two dolphin groups) collected during this study is too small to allow meaningful quantification and interpretation of potential baseline behavior of spinner dolphins as observed from a circling aircraft. However, some general observations follow.
    - As expected, sightings of MM (*n* = 2) and ST (*n* = 18) from the aircraft were higher with Bf <4 in lees close to the Kauai and Oahu coast than in deep, offshore waters where Bf was >4 (*n* = 0).
    - Data collected during this study contribute to baseline data important in developing and implementing effective marine mammal monitoring for future planned Navy activities identified for the HRC and the SOCAL Range Complex in the Navy's associated monitoring plans (Navy 2008, 2009).
- This survey helped to identify both limitations of and recommendations for future SCC OPS and other monitoring-related efforts as discussed in the following section.

Section 5 Recommendations

As requested in the SOW, this section provides recommendations for future monitoring efforts relative to what was learned during this survey. Recommendations focus on experiences during this survey and those from recent similar past monitoring surveys in the HRC (e.g., Norris et al. 2005; Mobley 2008a,b; Smultea et al. 2007, 2008), as well as other relevant professional experience. The recommendations are briefly summarized below.

- Continue to assess the feasibility of the approach described herein to conduct focal follows while accompanying a Navy vessel that intermittently transmits MFAS. Where SCC OPS or other similar training events or exercises occur, this approach would be most useful in areas where expected baseline densities of MM/ST are higher, where the expected predominant observation conditions are better (i.e., Bf <5), and where potential naval airspace conflicts are minimal. In Hawaii, this could be during the winter humpback season in areas near the 100-fathom isobath.

- Apply this approach to facilitate collection of multiple before-during-after (i.e., A-B-A) exposure conditions ideally from the same group for at least 10 different groups for at least 30-60 min each (e.g., see Mobley et al. 1988; Smultea et al. 1995). This study approach allows for pair-wise comparisons to control for inter-group/individual variability, which in turn typically requires a much smaller sample size and provides greater statistical power to determine significance (e.g., Zar 1984; Mobley et al. 1988; Maybaum 1990, 1993; Frankel and Herman 1993; Smultea et al. 1995).

- Conduct pre- and post-exercise aerial surveys in the area to address potential presence/absence and distribution/redistribution effects relative to the MFAS exercise activities. The post-exercise/event survey could also serve to identify any potential stressed, injured, or dead floating MM/ST. Post-exercise surveys including island coastlines were implemented during several USWEX and RIMPAC training events in Hawaii (Mobley 2008a,b) with no detections of injured or stranded animals. Additionally, during aerial monitoring surveys conducted by MMRC in November 2008 within several days after the cessation of the 2008 JTFEX and COMPTUEX Navy exercises off southern California, trained aerial observers twice spotted a dead pinniped and a dead blue whale (the latter >10 nm away) floating at the water surface (Smultea and Mobley in prep.). The latter two sightings were reported by the Navy to the National Marine Fisheries Service.

- Conduct a-priori power analyses of available baseline behavioral data from species of concern to determine the sample size required to identify a statistically significant change in behavioral parameters proposed to be monitored relative to potential effects of Navy activities (e.g., MFAS). For example, there are considerable existing baseline behavior data available for humpbacks and a few other cetacean species from which these analyses could be run. It is prudent to conduct power analyses prior to committing to the resources required to conduct monitoring to determine whether the monitoring goals can be addressed given the limited resources (e.g., plane or vessel time, etc.).

- Continue feasibility studies using recently developed software (e.g., Noldus or BioObserver for the iPhone) to collect focal follow behavioral data as narrated in the field as well as to analyze behavioral data collected on videotape. These types of programs allow efficient, accurate, and standardized transcription of behaviors including while observing video tapes post-field collection. The program should also be capable of conducting desired statistical tests and descriptions, including power analyses, tests of significance, etc.

- Continue to collect video of the behavior of animals during focal follows. We successfully collected video footage of two groups of spinner dolphins that contributes to baseline focal follow data for this species as observed from a small fixed-wing Partenavia aircraft in the HRC. These data may be useful for comparison with future monitoring assessments. Detailed transcription of video-taped behavior provides a more-detailed database on the behavior of delphinids in this area for which there are very few previous data. The greater detail and accuracy facilitated by recording behavior to videotape may reveal subtle changes in behavior that are not evident during *in situ* observations and from associated field notes, as found in studies of other cetaceans relative to anthropogenic activities (e.g., Malme et al. 1983, 1984; reviewed in Richardson et al. 1995). Videotape also reduces the potential for observer error during field behavioral observations, as taped sessions can be reviewed repeatedly. Examination of videotape also allows for more accurate measure and quantification of some behavioral variables that can be indicative of stress, including inter-individual body lengths and respiration rates; the former variable can be measured relatively from the video tape using calipers (Smultea and Würsig 1995).

- <u>Design and conduct studies to assess potential effects of the observer aircraft on focal follow species.</u> Based on limited studies of some cetacean species, flying a small aircraft at altitudes of 1200-1500 ft and radial distances of 500-1500 yd is highly unlikely to affect behavior of observed animals in a statistically detectable way (e.g., see Richardson et al. 1985a,b, 1986, 1990, 1995; Würsig et al. 1985, 1989; Smultea and Würsig 1991; Patenaude et al. 2002). At these parameters, the aircraft is calculated to be well outside the theoretical air-through-water transmission cone (i.e., "Snell's Cone") of sound from an over-flying aircraft (Urick 1972; reviewed in Richardson et al. 1995). However, it is prudent and strongly suggested that studies be conducted to assess the potential effects of the specific Partenavia observer aircraft on species of concern and other species in the HRC. This would serve to validate/evaluate the aforementioned assumptions, particularly since they are mostly based on bowhead whales in cold temperate and polar waters. Assessing potential effects of the circling observer aircraft could be done a number of ways.
    - The aircraft could begin circling at a large radial distance (e.g., 2-3 nm) and at a select altitude, gradually closing in on the focal group until a reaction is observed and/or until the aircraft is directly overhead. This could be repeated at different altitudes and for different species, etc.
    - The ideal non-intrusive approach would be to track animals from land using a theodolite before, during and after an aircraft circled overhead (e.g., see Smultea et al. 1995). This approach uses the A-B-A study method and thus typically requires a relatively small sample size to detect a statistically significant effect and/or sufficient statistical power to conclude no effect.
    - Controlled overflights of an underwater hydrophone such as a sonobuoy (at various pre-selected water depths) should be conducted at pre-selected altitudes and radial distances as well as various flight patterns (e.g., straight-line passbys and circling) and during different Bf sea states to record associated underwater sounds, as all these factors influence received sound levels. This will allow measurement of received underwater sound levels of the aircraft at various frequencies and distances relative to the known frequencies used by marine mammals of concern. These data can then be used to estimate received levels of underwater aircraft sounds near marine mammal sightings. Similar studies have been conducted in the Arctic relative to bowhead whales though with very different aircraft (e.g., a Twin Otter and a Bell 212 helicopter) and in very different water conditions and temperatures, which affect the transmission of underwater sounds (e.g., reviewed in Urick 1972; Richardson et al. 1995).
- <u>Conduct a literature review and short summary paper of parameters successfully used to identify and quantify significant behavioral and stress reactions in MM/ST in response to stimuli.</u> Considerable literature is available on the reactions of MM/ST to various anthropogenic stimuli such as underwater sounds, predators, etc. Quantifying behavioral data and collecting sufficient such data to measure significant changes in various behavioral parameters (e.g., respiration and dive patterns,

inter-individual spacing, orientation, etc.) is challenging. Selecting and using parameters that have been shown in past studies to be indicative of stress and/or that result in what could be considered MMPA/ESA level B take is critical to solid protocol development. Given the size of the related literature database available, a thorough up-to-date review of this literature is important to support the choice of behavioral parameters used to study and quantify potential effects of Navy activities on MM/ST.

- Review Data on Navy Activities and Strandings. Compilations and analyses of data on marine mammal strandings in Hawaii and other Navy ranges are limited (e.g., Mazzuca et al. 1998, 1999; Maldini et al. 2003; Ligon et al. 2007; Mobley 2007). There are even fewer available reports comparing locations and the nature of Navy activities concurrent to strandings in the Pacific (e.g., NOAA and Secretary of the Navy 2001; NMFS 2005; Southall et al. 2006). Given the elevated public, regulatory, and conservation concerns regarding this issue surrounding many stranding events, it is prudent to examine historical data to better understand the evidence or lack thereof for correlating strandings with Navy activities. It is known that many cetaceans strand due to natural causes (e.g., Perrin and Geraci 2002; Geraci and Lounsbury 2005), while other publications show a correlation with military actions at sea (e.g., Balcomb and Claridge 2001; Brownell et al. 2004; Fernández et al. 2005).

- Conduct a cost-effectiveness and safety analysis of monitoring approaches. This type of analysis would objectively evaluate, quantify, and qualify the cost-effectiveness, contribution value of results, and observer safety of various monitoring techniques to address the Navy's monitoring objectives/questions related to training events. For example, the utility vs. cost as well as complimentary value of photo-ID vs. various tagging techniques vs. vessel surveys vs. aerial surveys vs. acoustic monitoring, etc., could be evaluated. This would help to assess which approaches and in what combination would be most cost-effective but could also feasibly and reasonably address Navy monitoring goals. This analysis should include assessing the resulting expected sample sizes and significance of contributing results obtained.

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<u>Final Report</u>: Aerial Surveys of Marine Mammals

Performed in Support of USWEX Exercises

Mar. 23-30, 2008

Photo by J. Mobley, NOAA Permit No. 810

Submitted to:

Environmental Division

Commander, U.S. Pacific Fleet

Submitted by:

Joseph R. Mobley, Jr., PhD

dba: Marine Mammal Research Consultants

Date: May 28, 2008

Summary

Aerial surveys were performed in support of the US Navy Undersea Warfare Exercise (USWEX) exercises on March 23-24 and 28-30, 2008. The mission was to detect, locate and identify all marine mammal and sea turtle species. Also, for marine mammal species, additional observation time was spent characterizing behavior and direction of travel at the time of sighting. The circumnavigation portion (March 28) involved flying along the west coast of the island of Hawaii, and circumnavigating the islands of Kahoolawe and Lanai with the mission of identifying any stranded or near stranded cetaceans. Aircraft flew at 100 knots ground speed and altitude of 244 m (800 ft). Survey crew consisted of two observers, one on each side of the plane, and a data recorder. Effort comprised 22 hrs of survey time. No sightings occurred in the primary (larger) survey grid (Figure 1). A total of 47 sightings (40 on-effort; 7 off-effort) were recorded either in the secondary (smaller) survey grid (on-effort), or during transits to and from the islands (off-effort). These sightings involved three identified species (humpback whales, spotted dolphins and bottlenose dolphins) and two unidentified species (*Stenella* species, unidentified turtle species) (Tables 2-3). Based on behavioral observation of the marine mammal species, no indications of distressed or unusual behavior were seen. The circumnavigation survey (March 28) yielded no evidence of stranded or near stranded animals.

Background

The US Navy Undersea Warfare Exercise (USWEX) was proposed as an advanced Anti-Submarine Warfare Exercise to be conducted by U.S. Navy Carrier Strike Groups (CSGs) and Expeditionary Strike Groups (ESGs) within the Hawaii Range Complex. Since the exercise involved deployment of mid-frequency active sonar, concerns over possible impacts on protected marine species dictated that a parallel monitoring program be conducted. This report is specific to the aerial monitoring portion of the March 2008 USWEX monitoring effort. Aerial surveys of a pre-determined 64,853 sq km (18,908 sq nmi) grid (Figure 1) as well as coastal areas of the islands of Oahu and Molokai were conducted on five days during the period March 23-24 and 28-30, 2008. The mission was to document incidence, location, and species identity of all marine mammal and sea turtle species within those regions. Additionally, for marine mammal species, additional observation time was spent characterizing behavior at time of sighting.

Method

Two aircraft were utilized. For the transect grid surveys (March 23-24, 29-30) a twin-engine Partenavia Observer (P68) fixed wing aircraft was used. For the circumnavigation portion (March 28), a Robinson 44 helicopter was used. The transect surveys utilized design and methods prescribed by accepted distance sampling theory (Buckland et al., 2001). Survey crew and pilot were not informed as to the status or location of navy exercises to minimize observational bias. Transect grids were designed for maximum coverage within range limits of the aircraft. Three north-south transect lines were placed approximately 65-85 km apart to cover the 64,853 sq km target area (Figure 1). Aircraft flew at an average 100 knot ground speed and altitude of 244 m (800 ft). Survey crew consisted of two experienced observers, one on each side of the plane, and a data recorder. When target species were detected, an angle was taken to the sighting using hand-held Suunto clinometers, typically followed by orbiting to identify species and in the case of marine mammals, to characterize behavior. Environmental data (Beaufort seastate, glare, visibility) were taken at the start of each transect leg or when conditions changed. Positional data via GPS were automatically recorded every 30-sec onto a laptop computer and manually when sightings occurred. The resultant datasets were later merged into an Excel spreadsheet and converted to GIS to develop maps.

Table 1. Description of surveys

Date	Survey Type	Hrs Effort	On-Effort Sightings	Off-Effort Sightings	Mean Beaufort	Range Beaufort
Mar. 23	Transect grid	4.01	4	2	4.71	2-6
Mar. 24	Transect grid	4.85	12	2	4.24	2-6
Mar. 28	Circumnavigate Oahu & Molokai	3.75	15	1	3.20	2-6
Mar. 29	Transect grid	4.75	1	2	5.22	2-7
Mar. 30	Transect grid	4.63	8	0	5.05	3-7
	Totals:	**21.99**	**40**	**7**	**4.56**	**2-7**

Results and Discussion

The five days of aerial surveys consisted of a total of 22 hrs effort, comprising approximately 3,715 km of linear distance. Target species were observed on each of the five days surveyed (Table 1 & 2). The total of 47 sightings consisted of three identified cetacean species including one mysticete species (humpback whales) and two odontocete species (spotted dolphins and bottlenose dolphins) (Table 3). The balance of sightings consisted of an unidentified *Stenella* species (either spinner, spotted or striped dolphins) and two sightings of an unidentified turtle species, likely green sea turtles (*Chelonia mydas*) based on their prevalence in Hawaiian waters. None of the on-effort sightings occurred in the primary target area (larger grid in Figure 1); all occurred in either the secondary target area (smaller grid in Figure 1) or the shoreline areas during the circumnavigation portion (Mar 28).

The majority of sightings (85%) were of humpback whales which are seasonally present in Hawaiian waters during their wintering season (Jan-Apr). All of the on-effort sightings of humpbacks occurred in the Penguin Bank region, a shallow water shoal that extends southwest of Molokai (Figure 2). Penguin Bank typically shows the highest densities of humpbacks during the winter months (Mobley, Bauer & Herman 1999; Mobley 2004).

The two identified odontocete species (spotted and bottlenose dolphins) represent ubiquitous species that are among the top five most commonly seen in Hawaiian waters based on the 1993-03 Hawaii survey results (Appendix). The total of 5 odontocete sightings across the 3,715 km of linear effort corresponded to an average encounter rate of .001 sightings/km. This is considerably less than noted in previous surveys of Hawaiian waters. For the 2005 summer RIMPAC exercises, odontocetes were seen at a rate of .004 sightings/km (Mobley, 2006) and during the

1993-03 Hawaii statewide surveys (period Feb-Apr) they were observed at a rate of .005 sightings/km (Mobley, 2004). The lower encounter rate observed during the USWEX surveys is likely attributable to two factors: a) the average seastate conditions during the present surveys were less favorable than prevailing conditions during the other series mentioned; and b) a greater portion of effort during the USWEX surveys was spent in deep water greater than 1829 m (1000 fathoms) where odontocetes may be less abundant.

Notes regarding the general behavior of the marine mammal sightings are summarized in Table 2. None of the behavioral descriptions indicated the presence of unusual or distressed behavior (e.g., tight or unusual aggregations, strandings or near strandings).

Overall there were no indications of any deleterious effects of the USWEX exercise on the indigenous marine species observed. It should be noted of course that the absence of such indications does not necessarily imply the absence of any negative effects, merely that no overt indications of such effects were detected.

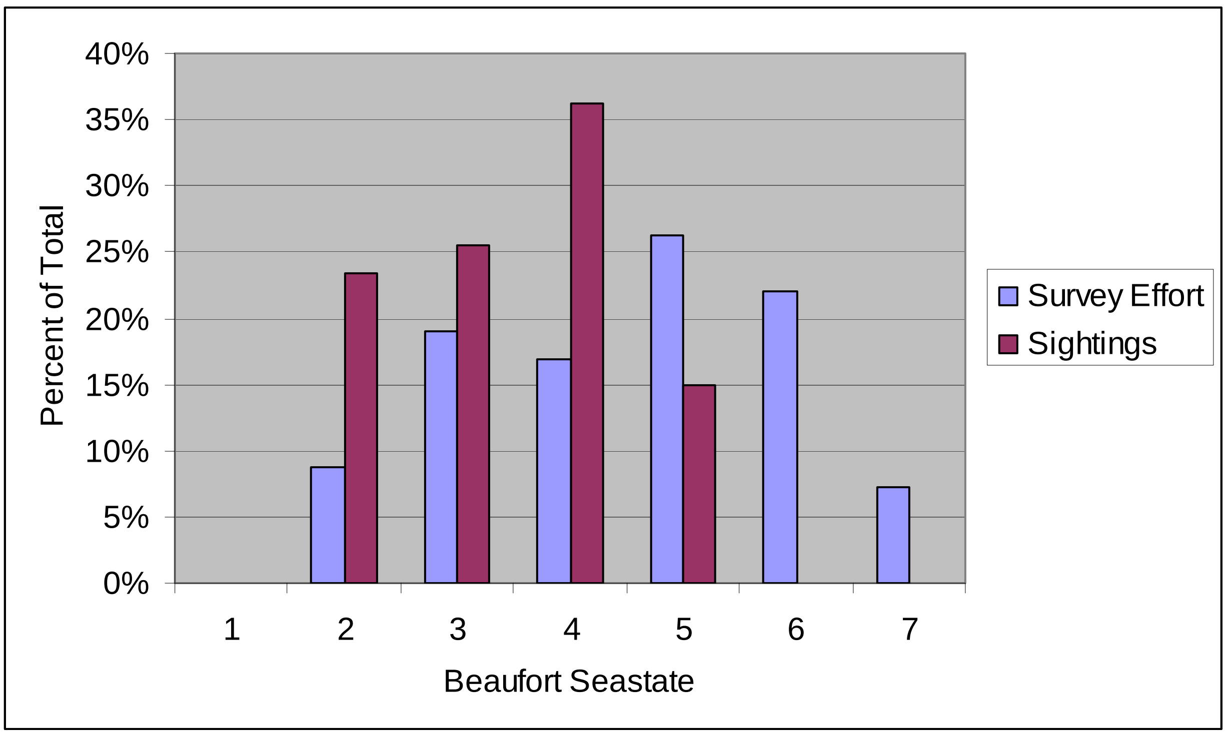

Table 2. Summary of individual sightings and positions

On-Effort Sightings (sighted during transect or shoreline surveys):

Date	Number	Calf	Spp	Time	Longitude	Latitude	Behavior
3/23/2008	5		MN	9:24:27	157.7288	21.0438	rapid swim; surface active; SE
3/23/2008	3		MN	9:29:08	157.7242	21.0050	slow swim; N
3/23/2008	2		MN	9:31:47	157.7291	20.9257	slow swim; NE
3/23/2008	2		MN	9:32:35	157.7311	20.9006	both dove
3/24/2008	1		MN	9:29:20	157.7385	21.0215	slow swim; E
3/24/2008	2		MN	9:29:30	157.7384	21.0169	slow swim; pec slap; SE
3/24/2008	1		MN	9:29:38	157.7383	21.0129	slow swim N; dove
3/24/2008	3		MN	9:30:09	157.7382	20.9973	Dove
3/24/2008	1		MN	9:30:47	157.7380	20.9777	mod. Swim; SE
3/24/2008	3		MN	9:31:15	157.7378	20.9637	below surface
3/24/2008	1		MN	9:31:26	157.7378	20.9584	Dove
3/24/2008	1		MN	9:33:02	157.7382	20.9110	Blow only
3/24/2008	1		MN	9:33:13	157.7378	20.9057	slow swim; E
3/24/2008	1		MN	9:33:25	157.7374	20.8998	slow swim; NW
3/24/2008	1		MN	9:33:45	157.7370	20.8899	slow swim SW; dove
3/24/2008	1		MN	9:34:35	157.7383	20.8647	slow swim NW
3/28/2008	1		MN	11:45:10	156.992	20.806	stationary SW
3/28/2008	1		MN	11:47:11	156.991	20.761	slow swim SW
3/28/2008	3		MN	11:56:16	156.795	20.744	Milling
3/28/2008	1		MN	12:06:52	156.527	20.638	pec-slapping
3/28/2008	3		MN	12:40:16	155.879	20.278	slow swim: W
3/28/2008	2	1	MN	12:50:46	155.865	20.075	slow swim NE
3/28/2008	3	1	MN	12:52:10	155.840	20.045	pec-slap NE
3/28/2008	2		MN	12:57:30	155.889	19.932	slow swim N
3/28/2008	1		MN	12:59:22	155.914	19.887	mod swim NE
3/28/2008	2		MN	13:26:01	155.951	19.493	slow swim; no clear formation; S
3/28/2008	1		MN	15:59:48	156.561	20.611	slow swim N
3/28/2008	1		MN	16:03:38	156.650	20.564	porpoising; dispersed; fast swimming
3/28/2008	2		MN	16:05:07	156.685	20.548	breach; pec slap
3/28/2008	2		TT	13:06:30	156.053	19.767	slow swim NW
3/28/2008	1		UT	16:34:43	156.808	20.799	
3/29/2008	1	1	MN	16:52:57	157.5340	21.2023	Calf breaching
3/30/2008	1		MN	9:51:50	157.7115	20.9566	Breaching
3/30/2008	2		MN	9:52:20	157.7114	20.9381	Slow swim; SW
3/30/2008	1		MN	9:52:42	157.7114	20.9244	fluke-up dive
3/30/2008	2		MN	9:53:13	157.7116	20.9059	slow parallel swim; W
3/30/2008	3	1	MN	9:53:53	157.7124	20.8809	surface active
3/30/2008	1		MN	9:54:13	157.7128	20.8687	slow swim; SE
3/30/2008	1		MN	9:54:33	157.7131	20.8566	slow swim; E
3/30/2008	2		MN	16:38:29	157.6130	20.9797	Slow swim; west

Off-Effort Sightings (sighted outside of transect area or during transits):

3/23/2008	75	SS	12:24:31	156.3588	19.7692	porpoising; rapid swim; SW
3/23/2008	1	UT	12:30:25	156.2025	19.7552	
3/24/2008	1	TT	12:28:27	156.2580	19.7620	porpoising; swimming south
3/24/2008	12	TT	12:17:47	156.5293	19.7887	fast swim; south
3/28/2008	32	SA	14:02:53	156.185	19.904	slow swim NE
3/29/2008	1	MN	16:46:07	157.3522	21.0687	slow swimming; SW
3/29/2008	1	MN	16:47:32	157.3271	21.1085	slow swimming; SW

Species Code: MN = humpback whale; TT = bottlenose dolphin; SA = spotted dolphin;
SS = *Stenella* species; UT = unidentified turtle species

Table 3. Summary of Sightings by Species

Species	No. Sightings	No. Individuals
Humpback whales (*Megaptera novaeanglaie*)	40	68
Bottlenose dolphins (*Tursiops truncatus*)	3	15
Spotted dolphins (*Stenella attenuata*)	1	32
Stenella species	1	75
Unidentified turtle species	2	2

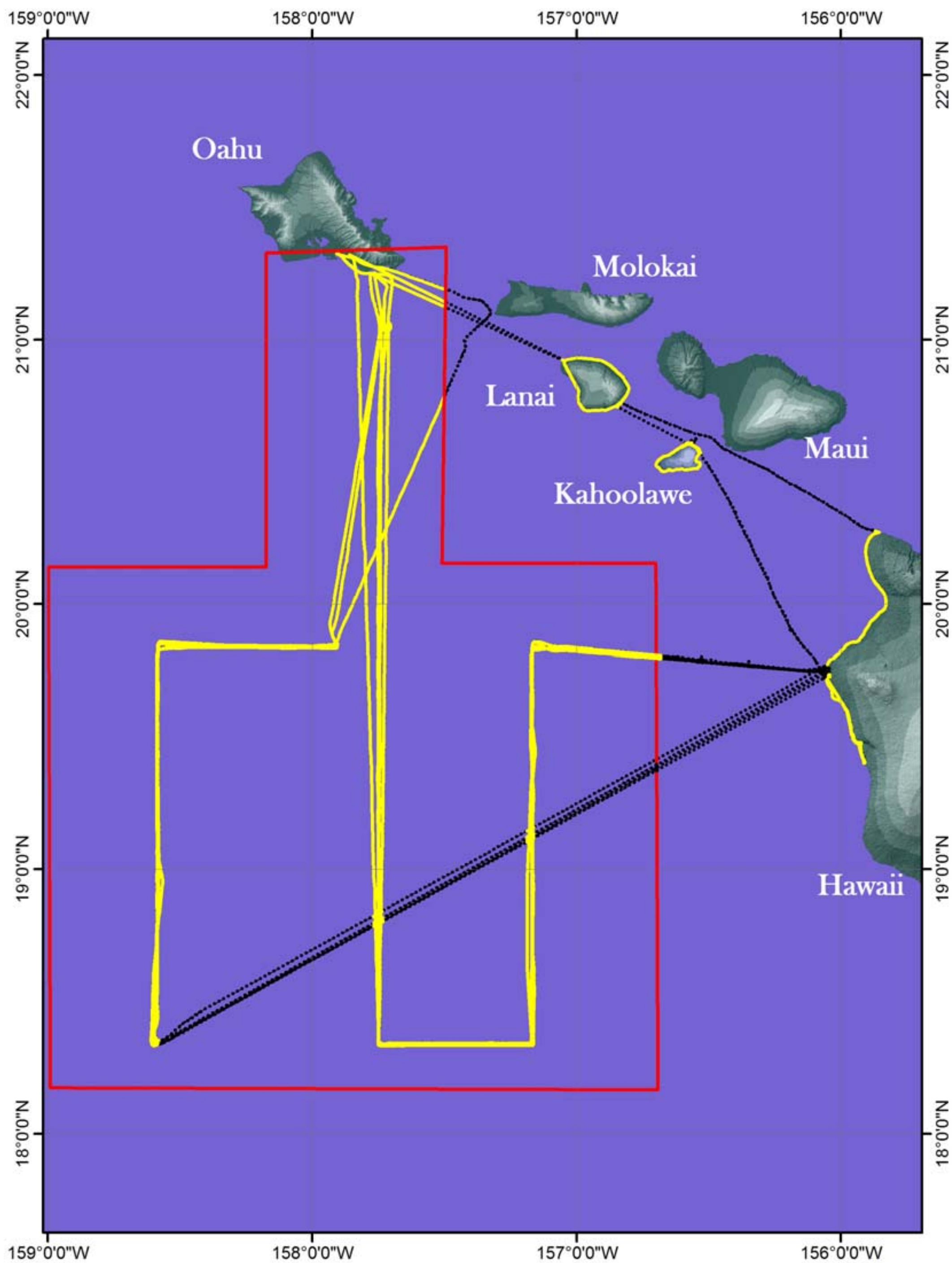

Figure 1. Survey effort (yellow lines) based on GPS location data. Red lines indicate the boundaries of the primary (larger) and secondary (smaller) survey grids. Black dotted lines indicate off-effort flight paths.

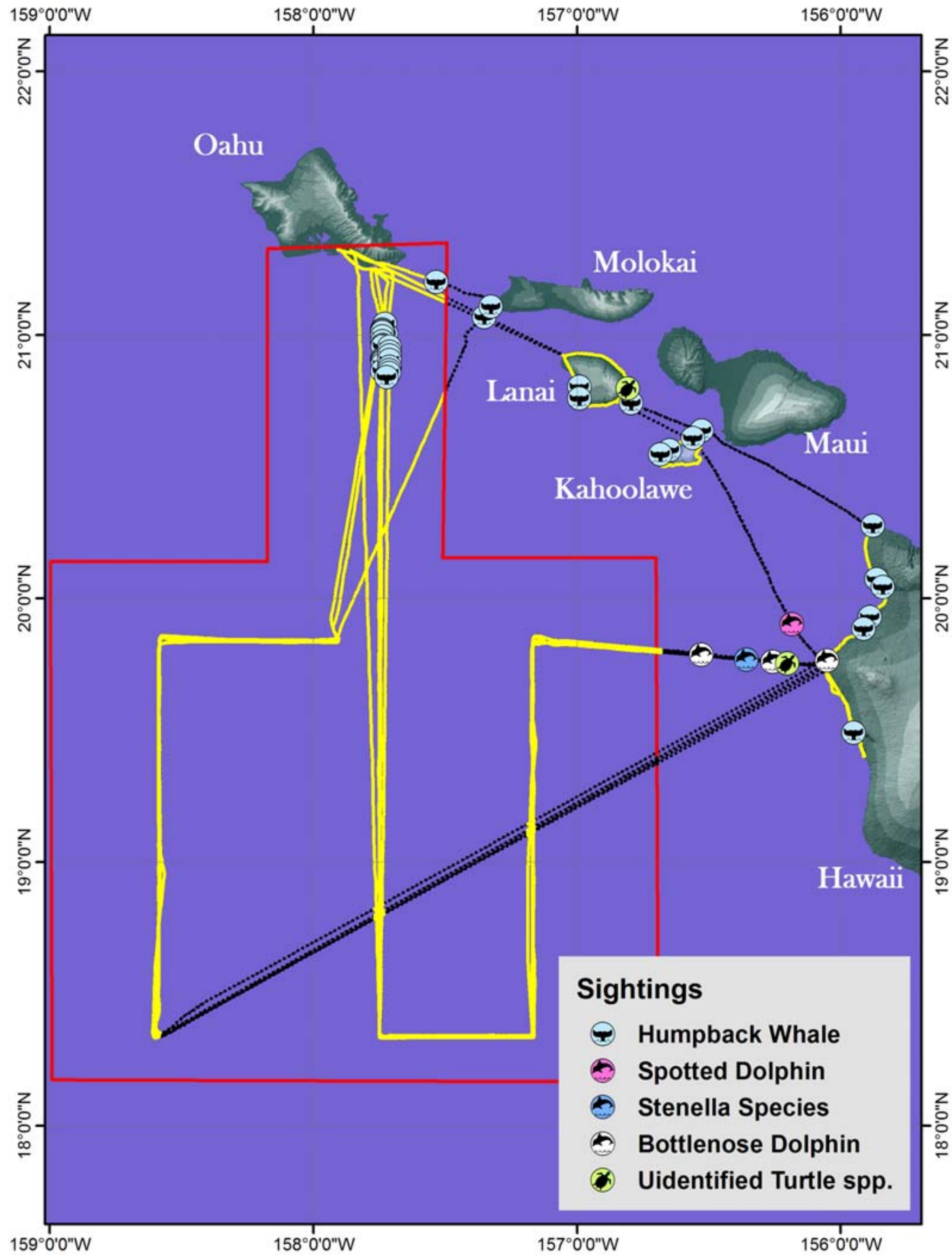

Figure 2. Locations of Sightings. Sightings noted on yellow lines were recorded as "on effort." Those sighted on black lines are "off-effort."

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Appendix:
Summary of 1993 - 2003 Hawaiian Islands Aerial Survey Results

Species Name	No. pods	No. indiv.
Humpback whale (*Megaptera novaeangliae*)	2352	3907
Spinner dolphin (*Stenella longirostris*)	52	1825
Spotted dolphin (*Stenella attenuata*)	31	1021
Short-finned pilot whale (*Globicephala macrorhynchus*)	73	769
Melon-headed whale (*Peponocephala electra*)	6	770
Bottlenosed dolphin (*Tursiops truncatus*)	54	492
False killer whale (*Pseudorca crassidens*)	18	293
Sperm whale (*Physeter macrocephalus*)	23	106
Rough-toothed dolphin (*Steno bredanensis*)	8	90
Blainville's beaked whale (*Mesoplodon densirostris*)	9	32
Pygmy or dwarf sperm whale (*Kogia* spp.)	4	28
Striped dolphin (*Stenella coeruleoalba*)	1	20
Pygmy killer whale (*Feresa attenuata*)	2	16
Cuvier's beaked whale (*Ziphius cavirostris*)	7	13
Risso's dolphin (*Grampus griseus*)	1	8
Killer whale (*Orcinus orca*)	1	4
Fin whale (*Balaenoptera physalus*)	1	3
Unid. Dolphin	96	452
Unid. Stenella spp.	11	196
Unid. Whale	28	39
Unid. beaked whale	9	23
Unid. Cetacean	14	27
Totals:	2801	10134

Aerial Surveys of Marine Mammals

Performed in Support of USWEX Exercises

May 26-27 & June 2-4, 2008

Photo by J. Mobley, NOAA Permit No. 810

Submitted to:

Environmental Division

Commander, U.S. Pacific Fleet

Submitted by:

Joseph R. Mobley, Jr., PhD

dba: Marine Mammal Research Consultants

Date: September 22, 2008

Summary

Aerial surveys were performed in support of the US Navy Undersea Warfare Exercise (USWEX) exercises on May 26-27 and June 2-4, 2008. The mission was to detect, locate and identify all marine mammal and sea turtle species. Also, for marine mammal species, additional observation time was spent characterizing behavior and direction of travel at the time of sighting. Two aircraft were utilized: A twin-engine Partenavia Observer (P68) (May 26-27 and June 3-4) was used for the transect grid and a Robinson 44 helicopter was used for the circumnavigation portion (June 2). The transect surveys utilized design and methods prescribed by accepted distance sampling theory (Buckland et al., 2001). Survey crew and pilot were not informed as to the status or location of navy exercises to minimize observational bias. Transect grids were designed for maximum coverage within range limits of the aircraft. Three north-south transect lines were placed 56 km (30 nmi) apart to cover the approximate 35,116 km^2 (10,238 nmi^2) target area (Figure 1). The circumnavigation portion (June 2) involved flying along the west coast of the island of Hawaii, and circumnavigating the islands of Kahoolawe and Lanai with the mission of identifying any stranded or near stranded cetaceans. Both survey aircraft flew at 100 knots ground speed and altitude of 244 m (800 ft). A total of 15 sightings were recorded during the transect surveys and during circumnavigation of the islands (Note: sighting conditions on the final two days, June 3-4, were hampered due to thick volcanic haze). These sightings involved two identified species (spinner and striped dolphins) and two unidentified species (unidentified dolphin species, unidentified turtle species) (Tables 2-3). Based on behavioral observation of the marine mammal species, no indications of distressed or unusual behavior were seen. The circumnavigation survey (June 2) yielded no evidence of stranded or near stranded animals.

Background

The US Navy Undersea Warfare Exercise (USWEX) was proposed as an advanced Anti-Submarine Warfare Exercise to be conducted by U.S. Navy Carrier Strike Groups (CSGs) and Expeditionary Strike Groups (ESGs) within the Hawaii Range Complex. Since the exercise involved deployment of mid-frequency active sonar, concerns over possible impacts on protected marine species dictated that a parallel monitoring program be conducted. This report is specific to the aerial monitoring portion of the May-June 2008 USWEX monitoring effort. Aerial surveys of a pre-determined 35,116 sq km (10,238 sq nmi) grid (Figure 1) as well as coastal areas of the islands of Hawaii (western coastline), Lanai and Kahoolawe were conducted on five days during the period May 26 to June 4, 2008. The mission was to document incidence, location, and species identity of all marine mammal and sea turtle species within those regions. Additionally, for marine mammal species, additional observation time was spent characterizing behavior at time of sighting.

Method

Two aircraft were utilized. For the transect grid surveys (May 26-27, June 3-4) a twin-engine Partenavia Observer (P68) fixed wing aircraft was used. For the circumnavigation portion (June 2), a Robinson 44 helicopter was used. Both aircraft flew at an average 100 knot ground speed and altitude of 244 m (800 ft). The transect surveys utilized design and methods prescribed by accepted distance sampling theory (Buckland et al., 2001). Transect grids were designed for maximum coverage within range limits of the aircraft. Three north-south transect lines were placed approximately 56 km (30 nmi) apart with random lines connecting endpoints to cover the 35,116 km target area (Figure 1). Survey crew consisted of two observers, one on each side of the plane, and a data recorder. When target species were detected, an angle was taken to the sighting using hand-held Suunto clinometers, typically followed by orbiting to identify species and in the case of marine mammals, to characterize behavior. Environmental data (Beaufort seastate, glare, visibility) were taken at the start of each transect leg or when conditions changed. Positional data via GPS were automatically recorded every 30-sec and manually when sightings occurred. The resultant datasets were later merged into an Excel spreadsheet and converted to GIS to develop maps. Total flight time consisted of approximately 27 hrs, 20 hrs of which were "on-effort" (Table 1). Survey crew and pilot were not informed as to the status or location of navy exercises to minimize observational bias.

Table 1. Description of surveys

Date	**Survey Type**	**Hrs Effort**	**Hrs Off-Effort**	**No. Sightings**	**Mean Beaufort**	**Range Beaufort**
May 26	Transect grid	4.79	1.43	3	4.0	2-6
May 27	Transect grid	4.28	0.95	2	4.1	2-6
June 2	Circumnavigate Lanai, Kahoolawe and west Hawaii	4.49	1.69	10	3.7	2-5
June 3	Transect grid	4.21	1.34	0	4.8	2-6
June 4	Transect grid	2.77	1.26	0	4.4	2-6
	Totals:	**20.36**	**6.68**	**15**	**4.3**	**2-6**

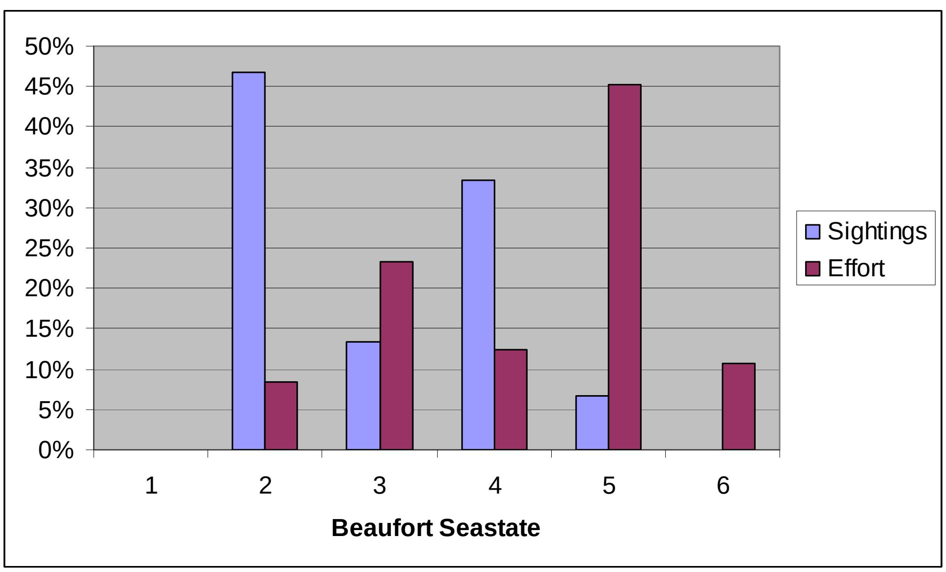

Figure 1. Effort and Sightings by Seastate. As shown, sightings tended to occur in better seastate conditions whereas 68% of total survey effort was spent in Beaufort 4 or higher.

Results and Discussion

The five days of aerial surveys consisted of a total of nearly 21 hrs effort, comprising approximately 3,889 km of linear distance. Target species were observed on each of the five days surveyed (Table 1 & 2). The total of 15 sightings included five identified cetacean species (four pods of spinner dolphins and 1 pod of striped dolphins) (Table 3). The remaining sightings consisted of three unidentified dolphin species and seven sightings of an unidentified turtle species, likely green sea turtles (*Chelonia mydas*) based on their prevalence in Hawaiian waters. The majority of sightings 10 out of 15 (67%) occurred during the circumnavigation portion of the survey (June 2), including 8 sightings of unidentified turtle species and two sightings of spinner dolphins. There was no evidence of stranded or near stranded animals during that survey.

Casual comparison of the present results against those observed during the previous USWEX exercises during March 23-30, 2008 (Mobley, 2008) reveal a striking difference in numbers of sightings (15 present sightings vs 47 sightings during March surveys). However, it should be noted that, of those 47 sightings, 40 of these (85%) were of humpback whales since the March USWEX exercises occurred during the Hawaii humpback whale wintering season (Jan-Apr). Comparison of odontocete species only yields nearly identical numbers of sightings in both cases (four in March vs five in May-June). Both the March and May-June series were also hampered by poor seastate conditions (Figure 1; Mobley, 2008, p. 4) as well as volcanic haze during the present series which likely suppressed numbers of sightings in both cases.

Notes regarding the general behavior of the marine mammal sightings are summarized in Table 2. None of the behavioral descriptions indicated the presence of unusual or distressed behavior (e.g., tight or unusual aggregations, strandings or near strandings).

Overall there were no indications of any deleterious effects of the USWEX exercise on the indigenous marine species observed. It should be noted of course that the absence of such indications does not necessarily imply the absence of any negative effects, merely that no overt indications of such effects were detected.

Table 2. Summary of sightings, positions and behavior

Summary Table--Sightings Only:						
Date	Number	Spp	Time	Longitude	Latitude	Behavior
5/26/2008	9	SC	16:37:45	157.5862	20.7167	underwater line abreast; 2 groups slow swimming NE
5/26/2008	6	SL	12:25:07	156.0503	19.7837	resting beh; milling & spinning
6/2/2008	48	SL	11:26:17	156.8953	20.7363	Manele Bay--milling & swimming with snorkelers; no directionality
6/2/2008	51	SL	12:50:08	156.0392	19.7933	Large group resting; 1 spinning leap; no directionality
6/2/2008	28	SL	1:02:00	155.9905	19.6249	fast swimming underwater; NE direction
5/26/2008	15	UD	16:53:56	157.7047	20.8548	3 separate groups slow swimming underwater
5/27/2008	1	UD	4:38:35	157.6182	20.7642	sighted underwater; unable to resight
5/27/2008	7	UD	4:47:35	157.7504	20.9195	milling; balled-up; no directionality
6/2/2008	1	UT	11:15:44	157.0617	20.8985	
6/2/2008	1	UT	3:34:07	156.8046	20.8120	
6/2/2008	1	UT	3:36:14	156.8400	20.8650	
6/2/2008	1	UT	3:37:37	156.8577	20.8832	
6/2/2008	2	UT	3:38:07	156.8674	20.8918	
6/2/2008	1	UT	3:38:37	156.8774	20.9001	
6/2/2008	1	UT	3:41:07	156.9453	20.9238	

Species Code: SC = striped dolphin; SL = spinner dolphin; UD = unidentified dolphin species; UT = unidentified turtle species

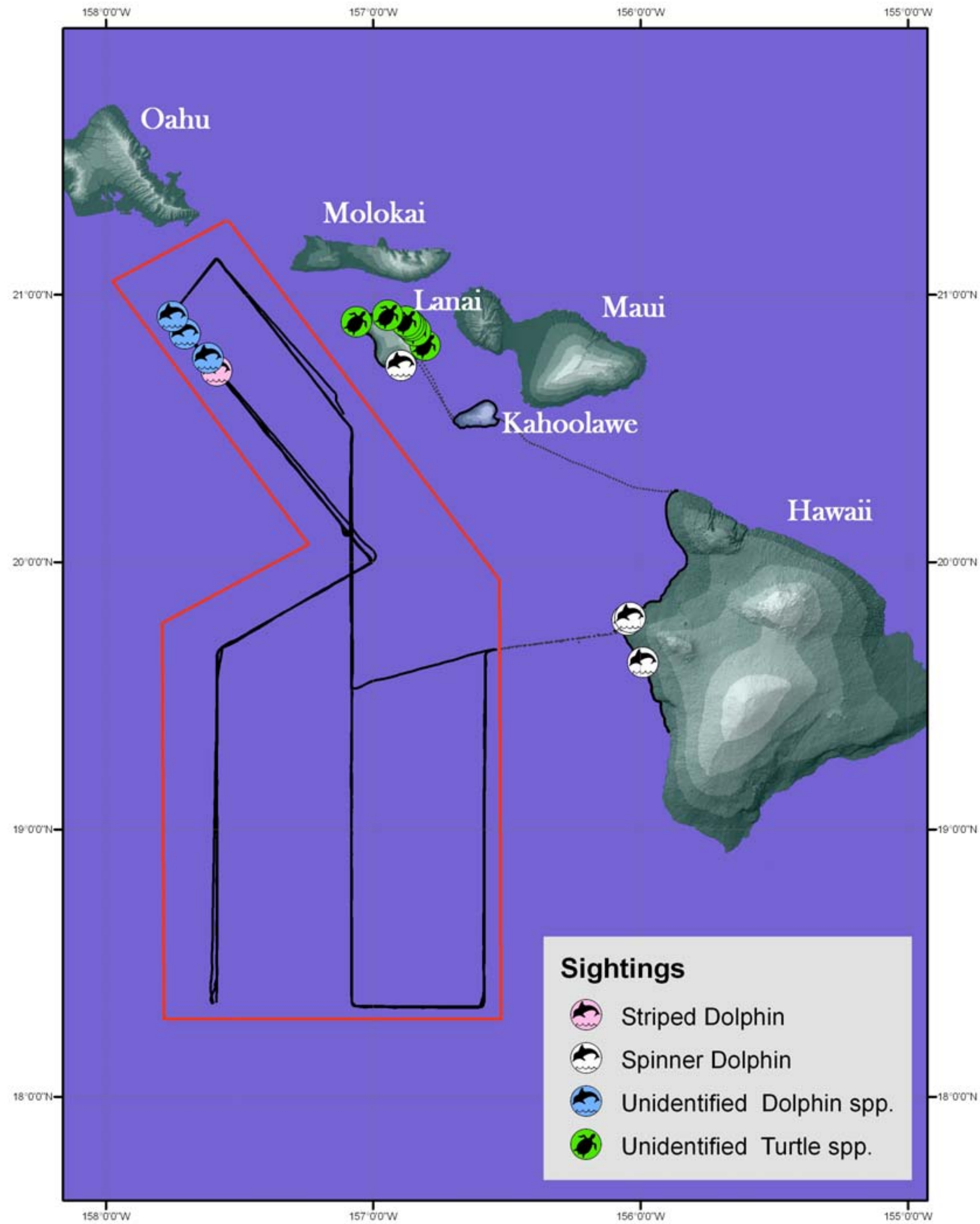

Figure 2. Survey effort based on GPS location data. Red lines indicate the boundaries of the primary (larger) and secondary (smaller) survey grids. Black solid lines indicate survey effort; black dotted lines indicate off-effort transits.

Table 3. Summary of Sightings by Species

Species	No. Sightings	No. Individuals
Spinner dolphins (*Stenella longirostris*)	4	133
Striped dolphins (*Stenella coeruleoalba*)	1	9
Unidentified dolphin species	3	23
Unidentified turtle species	7	8

Acknowledgements

I would like to thank our observers Alexis Rudd, Julie Oswald and Robert Uyeyama for their excellent work. Mahalo also to our pilot John Weiser for his usual superb piloting and to Susan Vogt for her GIS graphics work. These data were obtained under NOAA permit no. 642-1536-03 issued to the author (JRM).

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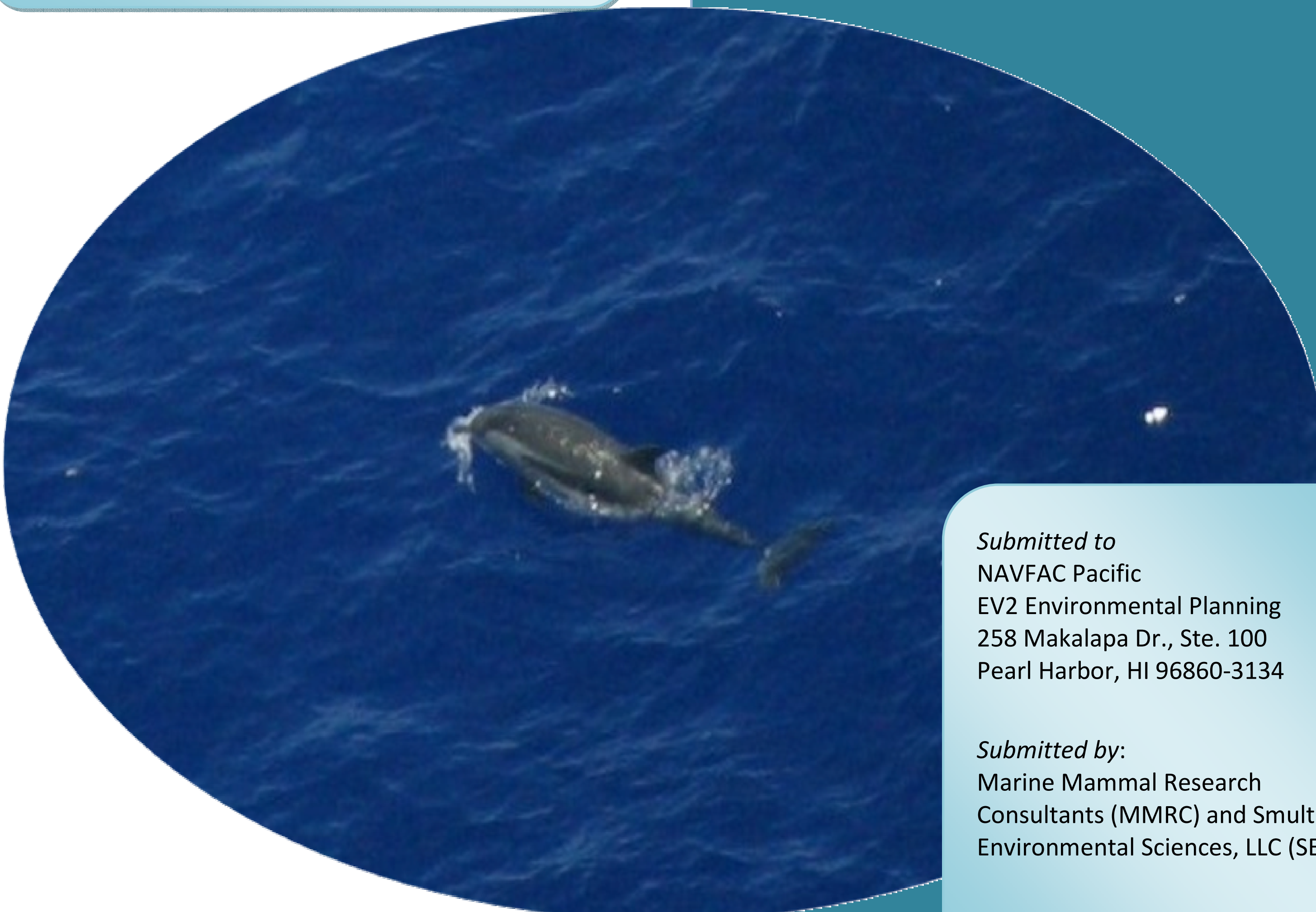
Mobley, Jr., J. R. (2008).Aerial surveys of marine mammals performed in support of USWEX exercises: March 23-30, 2008. Final report submitted to Environmental Division, Commander, U.S. Pacific Fleet, 10 pp. http://socrates.uhwo.hawaii.edu/SocialSci/jmobley/08USWEX-March.pdf

Hawaii Range Complex

June 17-25, 2009

Final Field Report

Aerial Survey Monitoring for Marine Mammals and Sea Turtles off Oahu, Hawaii, in Conjunction with a Unit Level Training Event and Underwater Detonations



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Cover Photo: A striped dolphin (*Stenella coeruleoalba*) photographed with a telephoto lens from the aircraft during the HRC June 09 aerial monitoring survey. Photo by Mark Deakos

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Executive Summary

A total of 44.96 hr of aerial surveys for marine mammals and sea turtles (MM/ST) was conducted on the Hawaii Range Complex (HRC) on eight of the nine-day survey period from 17-25 June 2009 in conjunction with a unit level training event (ULT) and six underwater detonations (UNDET). The surveys consisted of three parts: (a) observations near the Navy warship *USS Hopper* during a ULT (June 17-18); (b) observations before, during and after UNDET activities (June 19); and (c) systematic line-transect surveys in warning areas south of Oahu after the *Hopper* had finished training in that area (June 20-25). Beaufort sea state (Bf) conditions were generally high (modal Bf = 6) due to unusually strong prevailing trade winds for all but the final survey day. During the first two days with the *Hopper*, observations were conducted from a fixed-wing aircraft flying elliptical-shaped orbits to search for MM/ST near the *Hopper* for a total of 12.8 hr of observation. A single sighting of two unidentified dolphins was recorded on the first day at a minimum estimated distance of 1.4 km from the *Hopper*. For the subsequent single day of UNDET activities, 6.4 hr of observations were conducted from a helicopter flying pre-set line transects in a 5.75 x 5.75-km box. A total of 38 sightings of sea turtles were recorded during this effort; no marine mammals were observed. Over the last six days of transect surveys in the warning areas south of Oahu, a total of 25.7 hr of observations were conducted from a fixed-wing plane. On the last day of surveys (June. 25) a total of three cetacean species were sighted, consisting of one sighting each of Risso's dolphins, spotted dolphins, and striped dolphins. The clustering of sightings on the final day was likely due to improved sea state conditions compared to previous survey days.

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Section 1 Introduction

Marine Mammal Research Consultants (MMRC), in collaboration with Smultea Environmental Sciences, LLC. (SES), was contracted by the US Navy to perform aerial surveys for marine mammals and sea turtles (MM/ST) in support of the Navy Hawaii Range Complex (HRC) marine monitoring plan (Navy 2008) over a nine-day period from June 17-25, 2009. These surveys were planned in conjunction with a unit level training event (ULT) in the region of the island of Oahu, Hawaii. The ULT involved the Navy vessel *USS Hopper* (*Hopper*), employing mid-frequency active sonar (MFAS) with MM/ST observers blind as to MFAS deployment status, as well as underwater detonations (UNDET) at Puuloa Underwater Range in an inshore area. For observations associated with the *Hopper*, surveys were conducted directly with the *Hopper* while it was underway (June 17-18) and subsequently in an area where the *Hopper* had operated but after the *Hopper* had returned to port (June 20-25).

The overall monitoring objective was to detect, identify and observe all MM/ST given their protected status under the Endangered Species Act (1973) and/or the Marine Mammal Protection Act (1972). This included recording the time, location, and species identity (as possible) and observing the behavior of all target species.

Section 2 Methods

General Approach

Surveys were generally flown at a speed of ~100 kt and altitude of ~244 m (800 ft) as stipulated under the terms of NOAA permit no. 642-1536 issued to the co-Principal Investigator (JM), unless the pilot was directed to fly at alternate altitudes by flight controllers for safety reasons. Three observation aircraft were used: (1) a twin-engine, high fixed-wing Partenavia Observer (P68) equipped with two bubble windows and a camera porthole in the co-pilot window; (2) a twin-engine, high fixed-wing Aerocommander, and (3) a Robinson 44 helicopter (Table 1). Flight dates are summarized in Table 1.

Crew consisted of two experienced observers and an experienced data recorder/photographer/ videographer in addition to the pilot. Location data from a WAAS-enabled global positioning system (GPS) receiver were recorded automatically at 30-sec intervals or whenever a sighting was made. Suunto clinometers were used to obtain declination angles of sightings when the sighting was perpendicular to the aircraft using standard line-transect methodology (e.g., Buckland et al. 2001). Environmental data including Beaufort sea state (Bf), glare and visibility, were taken at the start of each survey leg or when conditions changed, as was information on effort type (see Mobley 2008, Mobley et al. 2000, Smultea and Mobley 2009, Smultea et al. 2009 for further methodology details).

When a sighting occurred, the declination angle to the sighting was called out by the observer as was species identity (if readily identifiable), group size/composition (including presence/absence of calf), general behavior, and any observed potential reactions (defined as a change in heading or behavior or a behavior deemed unusual by the experienced observers). Following the initial sighting, the aircraft typically broke from the transect line and orbited the sighting to confirm species identification, obtain more detailed behavioral observations, and take photographs. Species determination of cetaceans was often made possible via photographs taken with a Canon EOS 5D camera equipped with a 400-mm telephoto lens. A Canon Vixia HF10 high-definition video camera with an internal stabilization feature was available to obtain detailed behavioral data as feasible (though it ended up not being used during this survey).

Table 1. Hawaii Range Complex (HRC) Aerial Survey Flight Log 17-25 June 2009.

Date	Platform	Training Event Monitored	Time Wheels Up	Time Wheels Down	Total Hours
6/17/2009	Fixed-Wing, Twin-Engine Partenavia P68 Observer (FW OBS)	Anti-submarine Warfare Training (ASW)	10:21 15:28	13:55 18:30	*3:34* *3:02*
6/18/2009	FW OBS	ASW	10:55 12:35	11:13 18:30	*0:18* *5:55*
6/19/2009	Robinson 44 Helicopter	Underwater Ordnance Detonation	8:30 9:15 12:50	8:45 11:50 16:30	*0:15* *2:35* *3:40*
6/20/2009	FW OBS	ASW	10:30 14:53	13:46 18:35	*3:16* *3:42*
6/21/2009	FW OBS	ASW	9:54	13:13	*3:19*
6/22/2009	No survey due to poor weather (Bf>6)		-	-	*0*
6/23/2009	Fixed-Wing Aerocommander (FW AC)	ASW	10:05	12:17	*2:12*
6/24/2009	FW AC	ASW	8:32 12:41	11:34 15:40	*3:02* *2:59*
6/25/2009	FW AC	ASW	7:00 11:12	10:29 14:52	*3:29* *3:40*
TOTAL					**44:58 (44.96)**

Observations during ULT with *USS Hopper*

During the first two days of the surveys (June 17-18), observations were conducted from a fixed-wing Partenavia Observer (P68) aircraft while traveling in front of the *Hopper* which was conducting unit level training (Figure 1 and Figure). The aircraft flew elliptical orbits in front of the *Hopper* over waters ~20-35 km south of Oahu. The survey protocol involved two modes: (a) search mode—searching for target species while accompanying the *Hopper*; and (b) focal follow mode—following a sighting (see Smultea and Mobley 2009 and Smultea et al. 2009 for detailed methodology). In focal follow mode, the aircraft was to break off and orbit the sighting to obtain detailed behavioral observations for as long as the sighting was visible/trackable.

Communications were maintained between the observation aircraft and *Hopper* personnel via use of a hand-held aviation-band VHF radio operated by *Hopper* crew. Communications were initiated in the event of a sighting or prior to joining or leaving the *Hopper*.

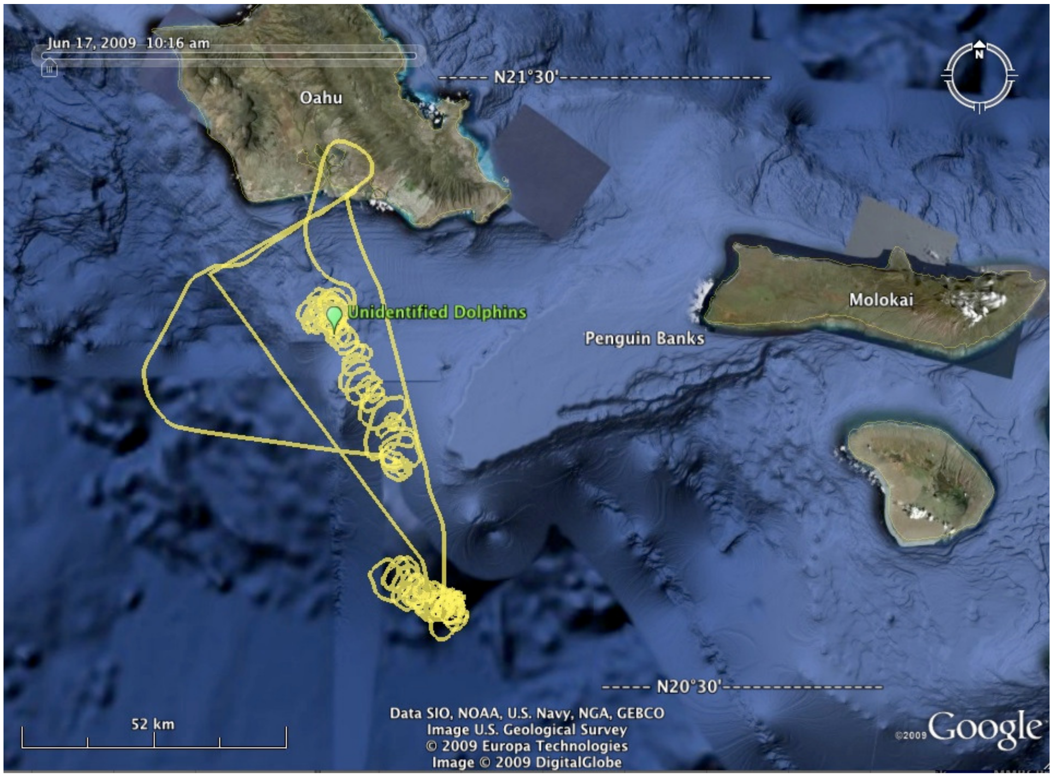

Figure 1. Map of Survey Route June 17, 2009

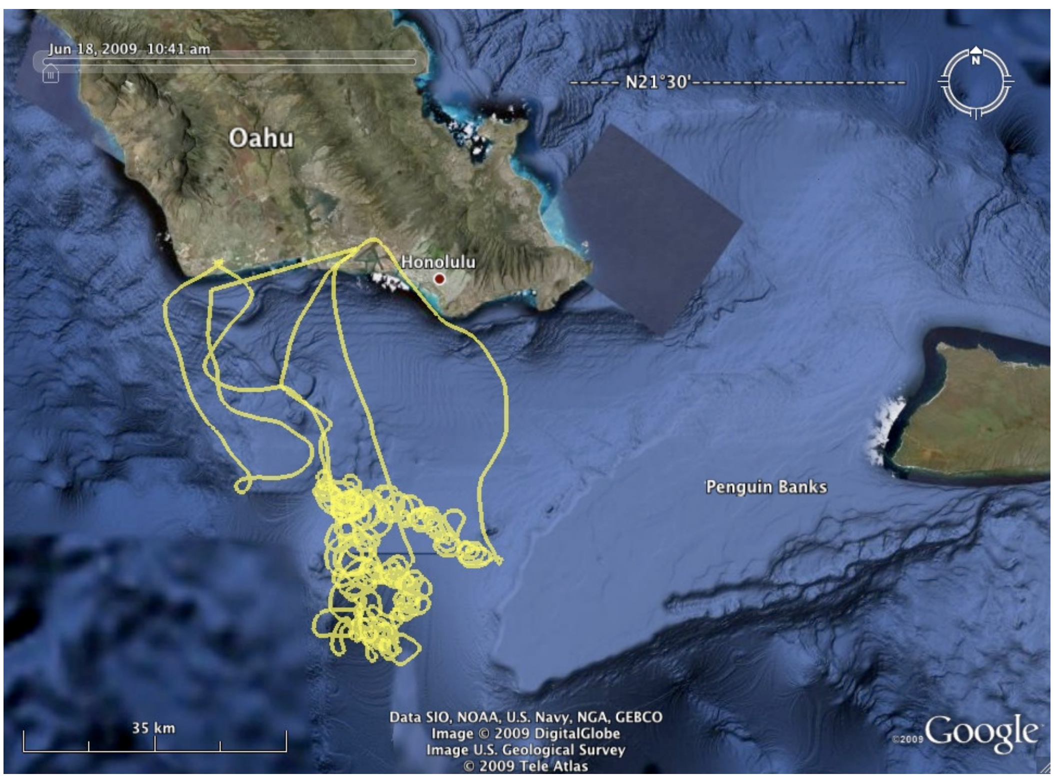

Figure 2. Map of Survey Route June 18, 2009

Observations During UNDET Activity

On the third day of the survey series (June 19), observations were conducted from a Robinson 44 helicopter flying transects in a 5.75 x 5.75-km grid immediately west of the entrance to Pearl Harbor (Figure). Since the grid was located in the final flight approach area to Honolulu International Airport, all survey operations were closely controlled by FAA flight controllers. Systematic observations occurred in the survey grid during two sessions from 9:15-11:50 and from 12:50-16:30 with a break to return to Honolulu Airport to fuel in-between the sessions (Table 1). Three underwater detonations occurred this day in the center portion of the survey grid. The observation helicopter was present during the first of these three detonation events at ~11:30. The two subsequent detonations occurred between ~11:40 - 13:00 while the helicopter was off-site refueling. Post-detonation observations from the helicopter occurred at the survey grid from ~12:55 – 16:25. Communications were maintained with naval personnel from the Mobile Dive and Salvage Unit One (MDSU) via cell phone and texting given the close proximity to shore. Professional biological observers were aboard the MDSU vessels as well as monitoring for MM/ST in and near the survey grid from a small NOAA-contracted vessel.

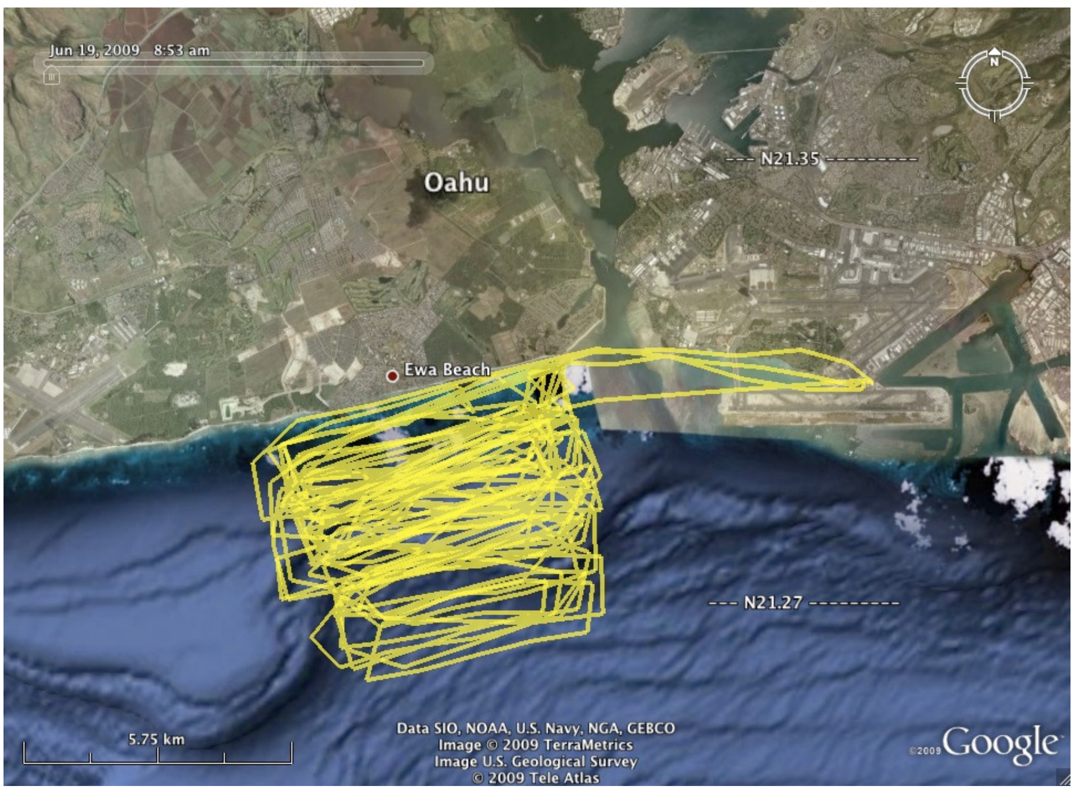

Figure 3. Map of Survey Route June 19, 2009

Survey Transect Observations

For five of the six final five days of the survey series, surveys were flown following pre-set north-south oriented transect lines in the general area where *Hopper* training had been conducted (~15-35 km south of Oahu)(Figure - Figure 8). Surveys followed north-south systematic transect lines connected at the endpoints by random lines. However, on day three (June 22) of the final six survey days, tradewinds were so strong and widespread that observations could not be conducted by the observation aircraft due to unfavorable and unsafe wind and wave conditions (Table 1).

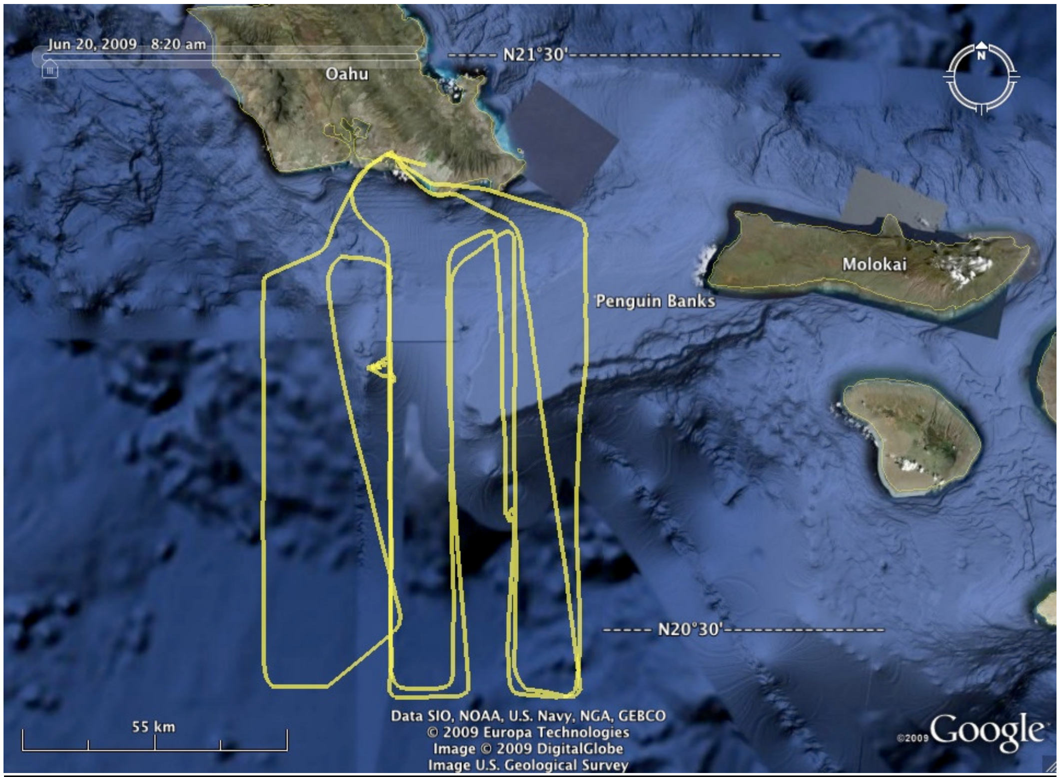

Figure 4. Map of Survey Route June 20, 2009

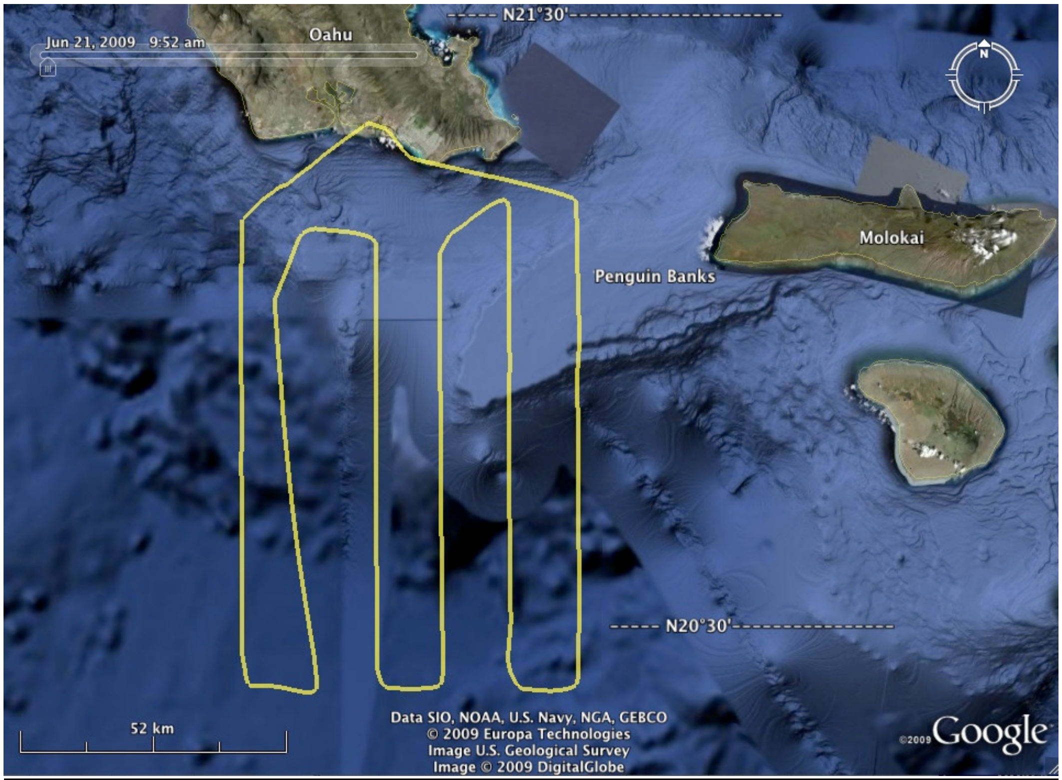

Figure 2. Map of Survey Route June 21, 2009

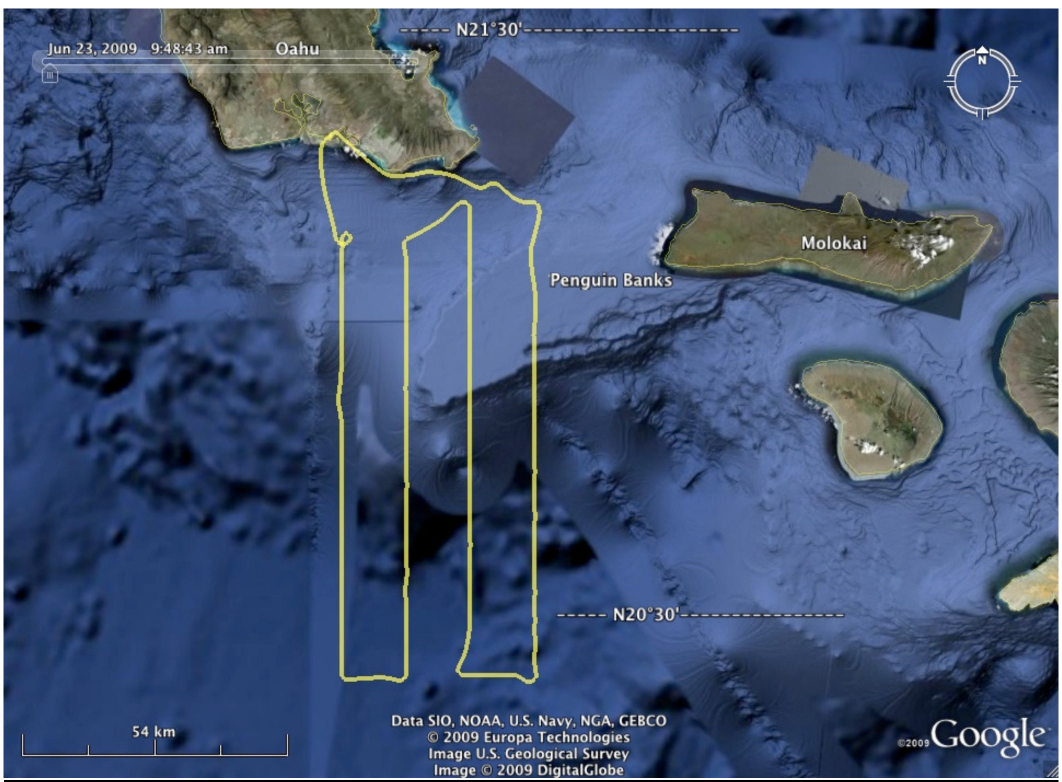

Figure 3. Map of Survey Route June 23, 2009

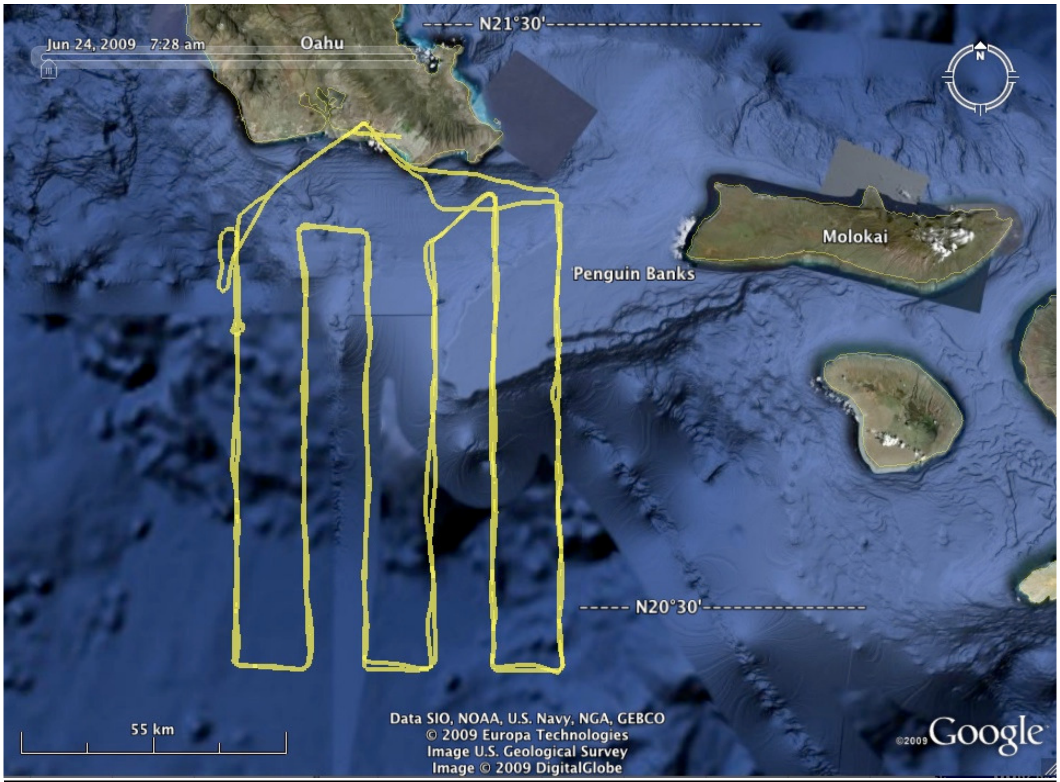

Figure 4. Map of Survey Route June 24, 2009

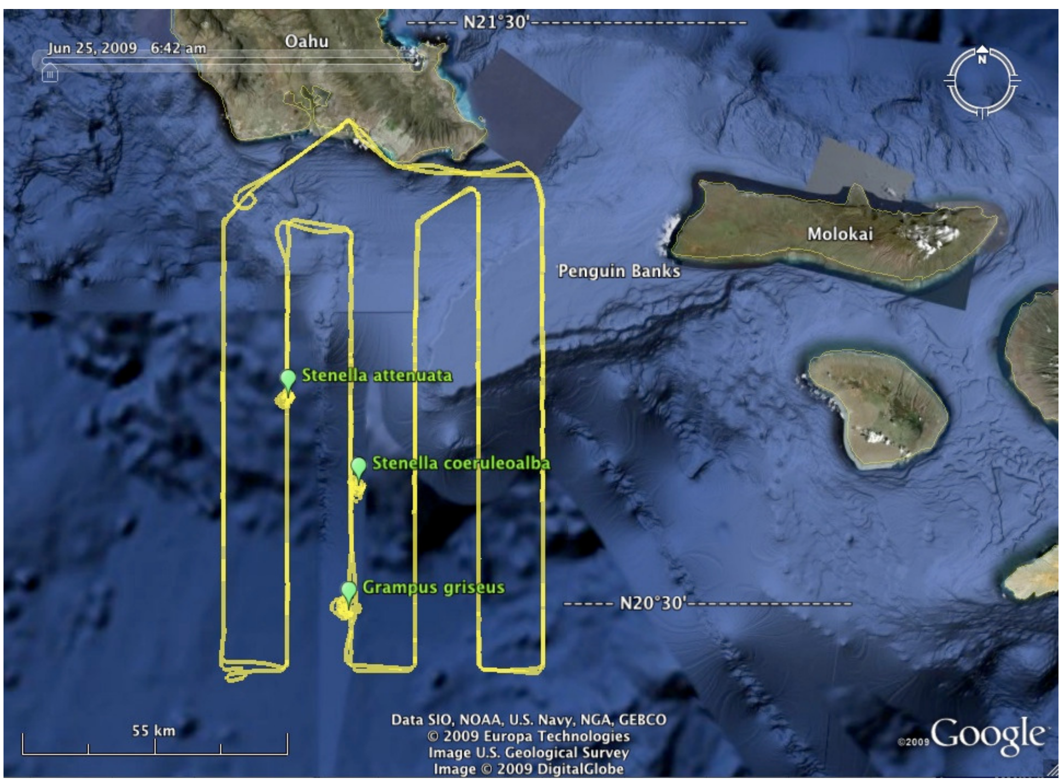

Figure 8. Map of Survey Route June 25, 2009

Section 3 Results and Discussion

Survey conditions were generally hampered by poor Bf conditions due to the exceptionally strong tradewinds that prevailed during all but the final day (Table 2 and Figure 5). The modal Bf value was 6, corresponding to winds in excess of 21 knots. Bf is an important factor affecting visibility during marine surveys: as Bf increases above 2, detectability of marine mammals decreases (Buckland et al. 2001).

Sightings were recorded on only three of the nine survey dates: June 17, 19 and 25 (Table 3 and Appendix A). A single sighting of a group of two unidentified dolphins was made within the first hour of surveying with the *Hopper* on the first day (June 17) at 12:07. Based on analysis of GPS tracklines, the two dolphins were sighted at a minimum distance of 1.4 km from the *Hopper*. Since observers were blind to the status of MFAS transmissions, it was not known whether the dolphins were exposed to MFAS. The dolphins were sighted briefly as they traveled away from the *Hopper* toward a bearing of ~260° magnetic. The observation plane circled for several minutes where the dolphins had first been seen but observers were unable to relocate the dolphins in the Bf 5 conditions to obtain species identification photos or any further behavior information. No reactions/changes in behavior and no unusual behaviors were noted during the brief period of this sighting.

All sightings on June 19, during monitoring of the UNDET activities, were comprised of unidentified sea turtles (likely green sea turtles, *Chelonia mydas*). These were highly visible due to the backlighting reflecting from the sand bottom in that area. No marine mammal species were seen likely due to the shallow water in that area (< 15 m). No unusual behaviors, reactions/changes in behavior were noted among any of the sea turtles seen.

A total of three cetacean sightings occurred on the final survey date (June 25) when sea state conditions improved (Bf modal =4, range = 2 to 6). Those sightings included a group of Risso's dolphins, a group of striped dolphins, and a group of spotted dolphins (Table 3 and Appendix A). All three sightings were seen during a Bf 3 and were circled to obtain photographs to verify species and composition. No video was taken as photos were considered higher priority to confirm species. Short descriptions of these encounters are provided below.

1. A group of ~9 Risso's dolphins (including one calf) was first seen at 8:40 traveling toward ~300° (magnetic). No apparent reactions/changes in behavior were noted among these dolphins. Nearest-neighbor dispersal distance ranged from ~1 to 30 body lengths. The dolphins were circled by the plane for ~23 min during which time 23 photos were taken.
2. A group of ~12 striped dolphins was first observed at 13:02 while they were surface-active milling (a behavior state that includes individual behaviors creating conspicuous splashes, e.g., porpoising, leaps). One calf was seen in the group. Dispersal distance between individuals ranged from 1 to 10 body lengths. The plane circled the striped dolphins for ~15 min during which time 79 photos were taken (see photo on report cover page).
3. A group of ~30 spotted dolphins was sighted at 13:44 engaged in surface-active milling. The dolphins appeared to be feeding and were associated with birds. Dispersal distance between dolphins ranged from 1 to 15 body lengths. The plane circled the dolphins for ~17 min during which time 63 photos were taken. One possible reaction was noted and consisted of diving (sounding) quickly below the surface.

Low rates of sightings are typical for Hawaiian waters during the months outside of the Hawaiian humpback whale wintering season (Jan-April), particularly in offshore waters deeper than ~200 m (reviewed in Smultea 2008). This is likely due to the low productivity of tropical waters (Barlow 2006). The three cetacean species sighted during the survey (Risso's, striped, and spotted dolphins) typically occur in waters surrounding the main Hawaiian Islands (Balcomb 1979; Mobley et al. 2000). The normally low sighting rates were further suppressed in this case due to the strong trade wind conditions extant during the study period.

Table 2. Aerial Survey Effort Hours by Beaufort Sea State and Leg Type

	BEAUFORT SEA STATE								
LEG TYPE	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	***Totals***
Random	0:00	0:00	0:00	0:11	0:21	0:25	0:50	0:10	*1:56*
Systematic	0:00	0:00	0:21	2:44	3:29	3:32	7:42	1:32	*19:20*
Transiting	0:00	0:00	2:39	1:31	1:13	3:29	9:28	3:22	*21:43*
Totals	***0:00***	***0:00***	***3:01***	***4:26***	***5:03***	***7:26***	***18:00***	***5:04***	***43:00***

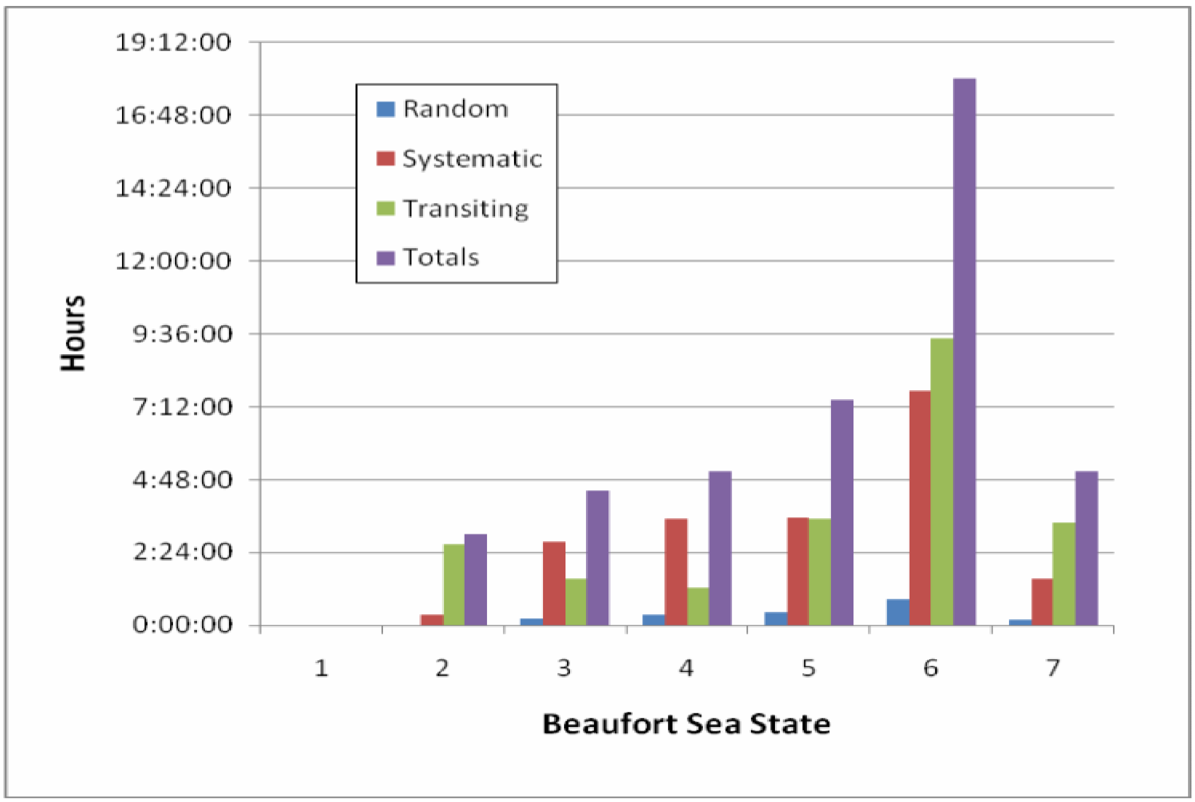

Figure 5. Beaufort sea state conditions during periods the observer aircraft was conducting Random, Systematic and Transiting observations during the HRC June 2009 aerial survey monitoring off Oahu, Hawaii.

Table 3. Marine Mammal and Sea Turtle Sighting Summary by Species. Asterisk (*) indicates species verified by photographs.

Species	Scientific Name	Total No. of Sightings	Best Estimate of Group Size
Risso's Dolphin*	*Grampus griseus*	1	9
Striped Dolphin*	*Stenella coeruleoalba*	1	12
Spotted Dolphin*	*S. attenuata*	1	30
Unidentified Dolphin	*Delphinidae* sp.	1	2
Unidentified Sea Turtle	*Chelonia* sp.	38	38
TOTAL		**42**	**91**

Section 4 Recommendations

As requested in the SOW, this section provides recommendations for future monitoring efforts relative to what was learned during this survey. Recommendations focus on experiences during this survey and those from recent similar past monitoring surveys we have conducted in the HRC (e.g., Mobley 2008; Smultea et al. 2009; Smultea and Mobley 2009), as well as other relevant professional experience. The recommendations are briefly summarized below.

- <u>When aerial monitoring is desired, consider scheduling for training events that occur away from protected airspace near major airports. The UNDET event described here occurred immediately outside Class B airspace of Honolulu International Airport on a final approach path. As a result, our aerial monitoring activities created issues with air traffic controllers.</u>
- <u>When activities are planned requiring coordination with naval warships, designate on-land POC with knowledge of ship location</u>. During the observation exercise with warship *Hopper*, refueling requirements required re-establishing the ship's location with as much as 1-2 hr intervening. In this case, approx 1-2 hr of potential observation time was lost during attempts to relocate ship.
- <u>During training events involving civilian aircraft traveling into active warning areas, need to clarify which agency (FAA or military) is to provide air support</u>. In this case, our aircraft was asked to broadcast different transponder codes by each agency which produced confusion.

Section 5 Acknowledgements

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Appendix A List of All Sightings

Appendix A. List of all marine mammal and sea turtle sightings observed in the Hawaii Range Complex during the 17-25 June 2009 aerial monitoring survey off Oahu.

Date 2009	Estimated Group Size	Species	Scientific Name	Sighting Time	Location
17-Jun	2	Unidentified Dolphin	*Delphinidae* sp.	12:07:01	N21.07749 W157.96041
19-Jun	1	Unidentified Turtle	*Chelonia* sp.	9:20:58	N21.28776 W158.03354
19-Jun	1	Unidentified Turtle	*Chelonia sp.*	9:27:19	N21.29398 W158.03253
19-Jun	1	Unidentified Turtle	*Chelonia* sp.	9:41:30	N21.29071 W158.01986
19-Jun	1	Unidentified Turtle	*Chelonia* sp.	9:42:13	N21.29000 W158.03074
19-Jun	1	Unidentified Turtle	*Chelonia* sp.	9:45:07	N21.30770 W157.98311
19-Jun	1	Unidentified Turtle	*Chelonia* sp.	9:46:22	N21.30742 W158.00365
19-Jun	1	Unidentified Turtle	*Chelonia* sp.	9:50:11	N21.29615 W157.98074
19-Jun	1	Unidentified Turtle	*Chelonia* sp.	10:03:23	N21.29283 W158.01391
19-Jun	1	Unidentified Turtle	*Chelonia sp.*	10:06:59	N21.29182 W158.02692
19-Jun	1	Unidentified Turtle	*Chelonia* sp.	10:07:56	N21.30066 W158.03008
19-Jun	1	Unidentified Turtle	*Chelonia* sp.	10:09:48	N21.30662 W157.99561
19-Jun	1	Unidentified Turtle	*Chelonia* sp.	10:38:06	N21.29333 W158.01343
19-Jun	1	Unidentified Turtle	*Chelonia* sp.	10:39:51	N21.30238 W157.98674
19-Jun	1	Unidentified Turtle	*Chelonia sp.*	10:43:00	N21.28709 W158.02345
19-Jun	1	Unidentified Turtle	*Chelonia* sp.	10:58:04	N21.29191 W158.02732
19-Jun	1	Unidentified Turtle	*Chelonia* sp.	11:02:08	N21.29840 W158.00345
19-Jun	1	Unidentified Turtle	*Chelonia* sp.	11:03:05	N21.29033 W158.02877
19-Jun	1	Unidentified Turtle	*Chelonia* sp.	11:06:35	N21.30696 W157.97880
19-Jun	1	Unidentified Turtle	*Chelonia* sp.	11:24:32	N21.28817 W158.02780
19-Jun	1	Unidentified Turtle	*Chelonia* sp.	11:24:59	N21.29472 W158.02454
19-Jun	1	Unidentified Turtle	*Chelonia* sp.	11:28:25	N21.30505 W157.97605
19-Jun	1	Unidentified Turtle	*Chelonia* sp...	11:39:49	N21.31326 W157.97845
19-Jun	1	Unidentified Turtle	*Chelonia* sp.	12:56:06	N21.31650 W157.97288
19-Jun	1	Unidentified Turtle	*Chelonia* sp...	12:59:54	N21.29943 W158.03273
19-Jun	1	Unidentified Turtle	*Chelonia* sp.	13:03:01	N21.30210 W157.98285
19-Jun	1	Unidentified Turtle	*Chelonia* sp.	13:38:43	N21.30504 W157.97661
19-Jun	1	Unidentified Turtle	*Chelonia* sp.	13:39:00	N21.30504 W157.97661
19-Jun	1	Unidentified Turtle	*Chelonia* sp...	13:39:17	N21.31428 W157.97902

Date 2009	Estimated Group Size	Species	Scientific Name	Sighting Time	Location
19-Jun	1	Unidentified Turtle	*Chelonia* sp.	13:41:24	N21.29723 W158.02922
19-Jun	1	Unidentified Turtle	*Chelonia* sp.	13:44:43	N21.29800 W157.97873
19-Jun	1	Unidentified Turtle	*Chelonia* sp...	14:02:54	N21.29495 W157.98046
19-Jun	1	Unidentified Turtle	*Chelonia* sp.	14:04:45	N21.28636 W158.02722
19-Jun	1	Unidentified Turtle	*Chelonia* sp.	14:28:44	N21.28504 W158.03185
19-Jun	1	Unidentified Turtle	*Chelonia* sp.	14:29:26	N21.29282 W158.03057
19-Jun	1	Unidentified Turtle	*Chelonia* sp.	14:34:06	N21.29119 W158.02997
19-Jun	1	Unidentified Turtle	*Chelonia* sp.	14:34:21	N21.29119 W158.02997
19-Jun	1	Unidentified Turtle	*Chelonia* sp...	14:40:40	N21.30073 W158.03009
19-Jun	1	Unidentified Turtle	*Chelonia* sp.	14:44:14	N21.31459 W157.97699
25-Jun	9	Risso's Dolphin	*Grampus griseus*	8:40:08	N20.48307 W157.90188
25-Jun	12	Stripped Dolphin	*Stenella coeruleoalba*	13:02:10	N20.70843 W157.88485
25-Jun	30	Spotted Dolphin	*Stenella attenuata*	13:44:37	N20.85654 W158.01728
TOTAL	**91**				