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

Contract #N62742-08-P-1942

Submitted to:

NAVFAC Pacific
EV2 Environmental Planning
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Pearl Harbor, HI 96860-3134

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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).

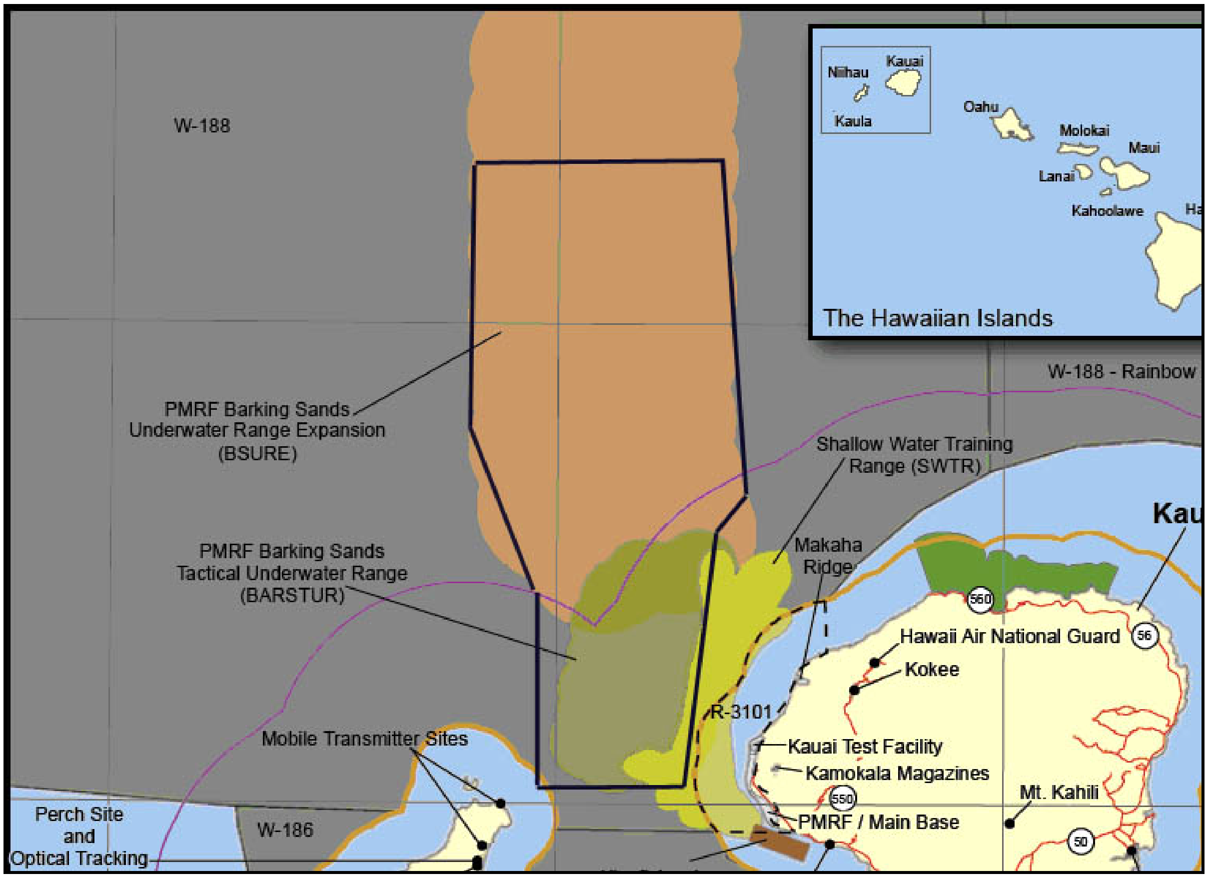

Figure 1. Location of the aerial survey monitoring area in and near the US Navy Pacific Missile Range Facility (PMRF) Range west and northwest of Kauai, Hawaii.

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

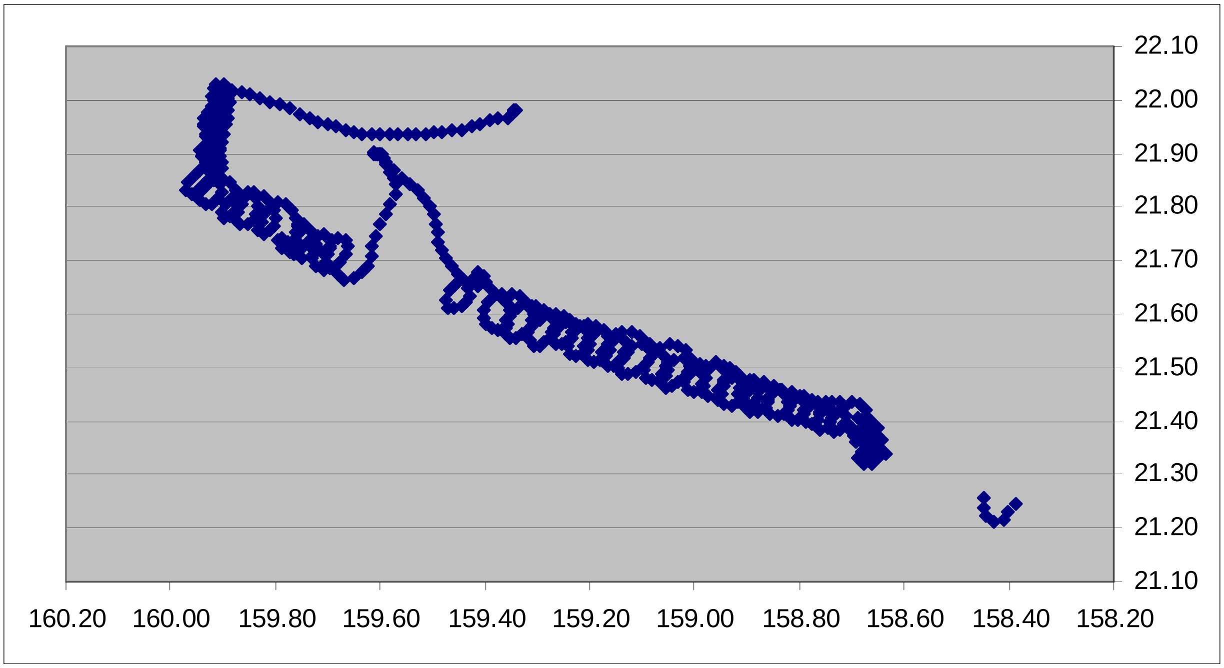

Figure 2. Actual flight path en route from near Pearl Harbor, Oahu, to Barking Sands, Kauai, on 18 August 2008 showing the typical elliptical-shaped flight pattern flown while searching for marine mammals and sea turtles in front of the USS *O'Kane*.

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

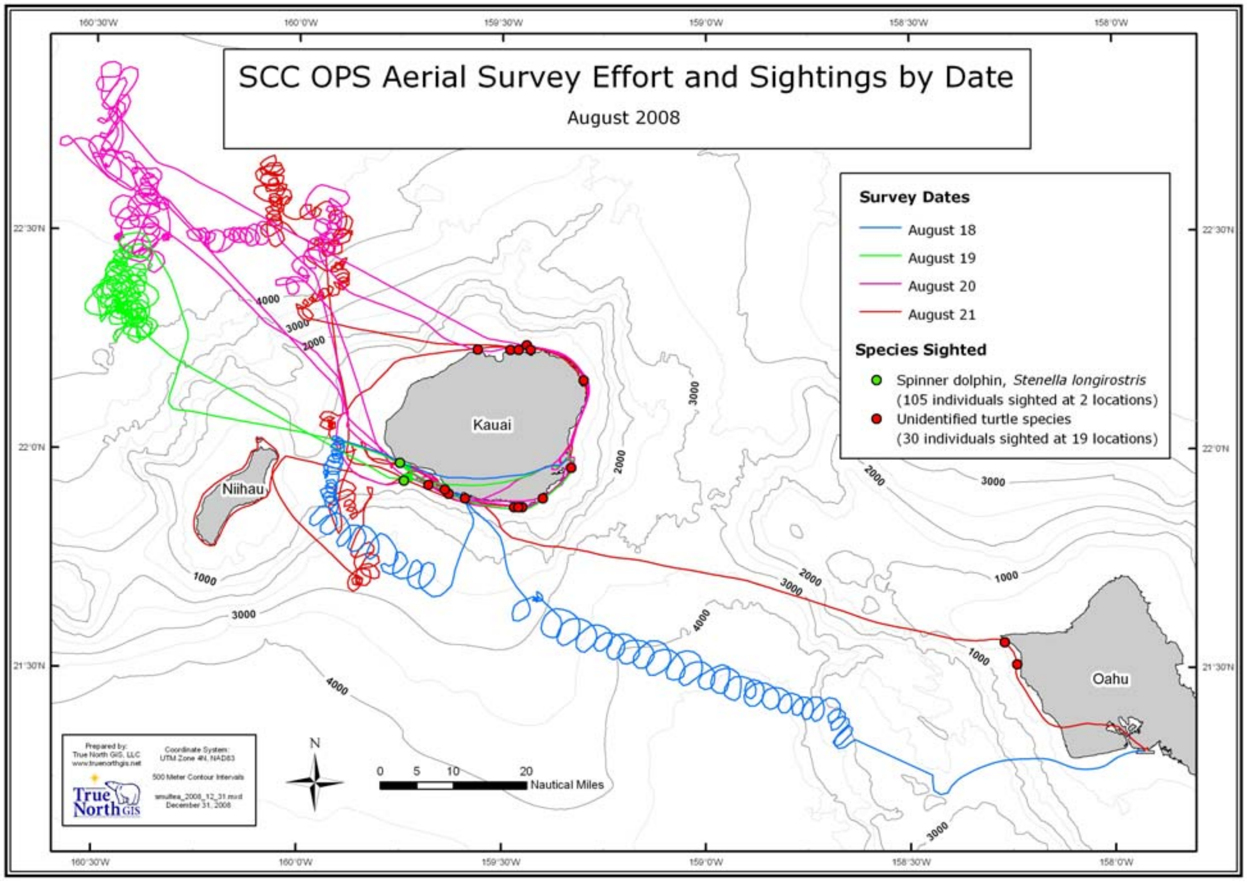

Figure 3. Aerial survey tracks during visual observations by survey date and locations of marine mammal and sea turtle sightings. Straight-line tracks indicate transit periods, some of which were conducted along the Kauai shoreline. Corkscrew-shaped tracks indicate when the aircraft was accompanying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

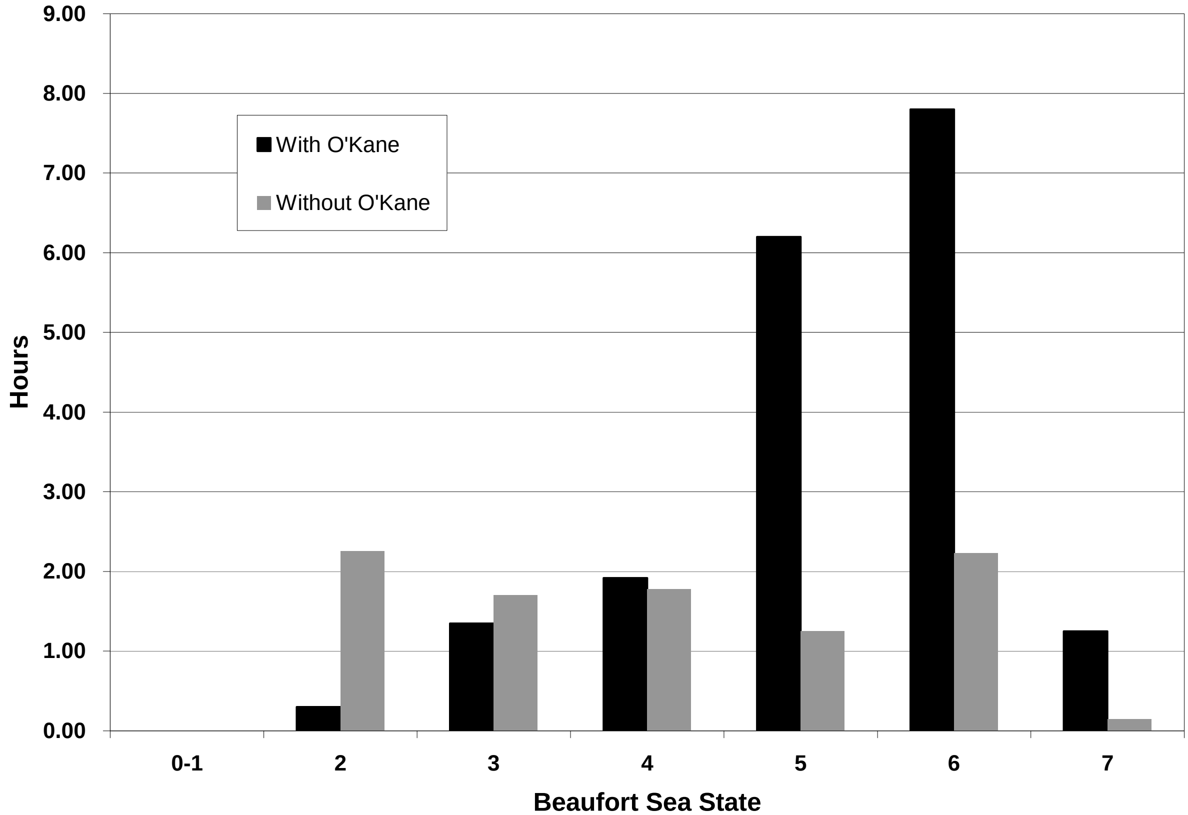

Figure 4. Beaufort sea state conditions during periods the observer aircraft was accompanying and not accompanying the *O'Kane*.

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.

Section 6 Acknowledgements

We are grateful to Navy NTR Lori Mazzuca for her support, coordination, and facilitation in the implementation of this project. Many thanks to the hard-working, dedicated and good-natured field observers and technical assistants Mark Deakos, Alexis Rudd, and Andrew Titmus. Mahalo to John Weiser for his superb piloting skills. Thanks also to Stasia Buffenbarger for the cover-page graphics, Stu Smith for GIS assistance and mapping, Jenelle Black for document formatting, and Suzanne Garrett and Cynthia Anderson for data entry and logistics assistance.

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