
Aerial Survey Monitoring for Marine Mammals and Sea Turtles in the Hawaii Range Complex in Conjunction with two Navy Training Events

SCC and USWEX February 16 – March 5, 2011

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**ACRONYMS AND ABBREVIATIONS**

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>DDG</td>
<td>missile destroyer</td>
</tr>
<tr>
<td>HD</td>
<td>high-definition</td>
</tr>
<tr>
<td>HRC</td>
<td>Hawaii Range Complex</td>
</tr>
<tr>
<td>km</td>
<td>kilometer</td>
</tr>
<tr>
<td>kt</td>
<td>knots</td>
</tr>
<tr>
<td>MFAS</td>
<td>Mid-frequency Active Sonar</td>
</tr>
<tr>
<td>MM/ST</td>
<td>Marine mammals and sea turtles</td>
</tr>
<tr>
<td>NM</td>
<td>Nautical Miles</td>
</tr>
<tr>
<td>NPAL</td>
<td>North Pacific Acoustics Laboratory</td>
</tr>
<tr>
<td>NTR</td>
<td>Navy Technical Representative</td>
</tr>
<tr>
<td>PMRF</td>
<td>Pacific Missile Range Facility</td>
</tr>
<tr>
<td>SCC</td>
<td>Submarine Commander’s Course</td>
</tr>
<tr>
<td>SOW</td>
<td>statement of work</td>
</tr>
<tr>
<td>USWEX</td>
<td>Undersea Warfare Exercise</td>
</tr>
</tbody>
</table>
SECTION 1 INTRODUCTION

Aerial surveys to monitor marine mammals and sea turtles (MM/ST) were conducted in conjunction with two training events during the period February 16 to March 5, 2011, including (a) U.S. Navy Submarine Commander’s Course (SCC) naval training event in the Hawaii Range Complex (HRC) on the Pacific Missile Range Facility (PMRF) instrumented range between Kauai and Niihau, Hawaii; and (b) Undersea Warfare Exercise (USWEX) training event south of Oahu and Molokai (Figure 1). Surveys in support of the SCC event occurred on 4 consecutive days from February 16 to 19, 2011, in waters adjoining Kauai and Niihau where the missile destroyer (DDG) and other ships were operating, followed by shoreline surveys of Kauai and Niihau on 2 separate days thereafter: February 24 and 26, 2011. This was followed by shoreline surveys of the Four Islands region in support of the USWEX event on 2 separate days, February 28 and March 5, 2011. The survey methods and sampling design were submitted and approved in advance, per the statement of work (SOW), to the Navy Technical Representative (NTR) and followed previously established protocol (Mobley and Milette 2010; Smultea et al. 2009a,b).

Figure 20. Location of the aerial survey monitoring area in and near the U.S. Navy PMRF Range west and northwest of Kauai, Hawaii.

Prior to the training event, the Principal Investigator (Joe Mobley) and pilot (John Sharkey) attended pre-planning sessions with the NTR and other Navy staff at Pearl Harbor, Honolulu,
Oahu, Hawaii, to coordinate survey efforts with the SCC February 2011 operations. Per the SOW, the goal of the aerial survey was to monitor and report the presence/absence, distribution/redistribution, reaction/no reaction, injury, and mortality of MM/ST before, during and after the training event. This involved monitoring and reporting the surface behavior of MM/ST. In particular, we were to monitor for any changes in the near-surface behavior, orientation, occurrence, and location of animals relative to the DDG’s activities using a systematic search and focal follow method.

Since mid-frequency active sonar (MFAS) locations and transmission times were unknown to the observers during this field survey effort, no effort was made to determine types or level of response of MM/ST to these transmissions. Rather, as stated in the SOW, survey data collected during this monitoring effort will be compiled with previous (Mobley and Milette 2010) and subsequent data, and analyzed by the Navy.

Survey effort during this training event was of three types (Table 1): (a) ship follows (February 16–18): flying elliptical orbits in front of the DDG per previous training events (Mobley and Milette 2010; Smultea et al. 2009a,b), (b) transects (February 19): flying in sawtooth pattern north of Kauai during the tagging support portion of effort, and (c) circumnavigation of islands: flying along the coastlines of Kauai and Niihau (February 24 and 26) and Four Island Region and Kona coast (February 28 and March 5) to search for stranded or near-stranded MM/STs. In all cases the mission was to document the presence of MM/STs including species identity, group composition, behavior, and any obvious reactions.

Table 1. Summary of Effort Type, Hours, and Seastate by Date.

<table>
<thead>
<tr>
<th>Date</th>
<th>Type of Effort</th>
<th>No. Hrs Effort</th>
<th>Mean Beaufort Sea State</th>
</tr>
</thead>
<tbody>
<tr>
<td>2/16/11</td>
<td>With DDG</td>
<td>7.8 hrs</td>
<td>4.4</td>
</tr>
<tr>
<td>2/17/11</td>
<td>With DDG</td>
<td>5.4 hrs</td>
<td>5.2</td>
</tr>
<tr>
<td>2/18/11</td>
<td>With DDG*</td>
<td>4.9 hrs</td>
<td>3.6</td>
</tr>
<tr>
<td>2/19/11</td>
<td>Transects--tag support (Cascadia)</td>
<td>6.4 hrs</td>
<td>2.9</td>
</tr>
<tr>
<td>2/24/11</td>
<td>Shoreline survey—Kauai/Niihau</td>
<td>4.2 hrs</td>
<td>4.0</td>
</tr>
<tr>
<td>2/26/11</td>
<td>Shoreline survey—Kauai/Niihau</td>
<td>3.8 hrs</td>
<td>2.4</td>
</tr>
<tr>
<td>2/28/11</td>
<td>Shoreline survey—Four island region and Kona coast</td>
<td>6.7 hrs</td>
<td>2.9</td>
</tr>
<tr>
<td>3/5/11</td>
<td>Shoreline survey—Four island region and Kona coast</td>
<td>4.4 hrs</td>
<td>2.6</td>
</tr>
<tr>
<td>TOTAL:</td>
<td></td>
<td>46.1 hrs</td>
<td></td>
</tr>
</tbody>
</table>

Note: * afternoon leg on 2/18/11 cancelled due to IFR conditions (low visibility)

SECTION 2 METHODS

Monitoring effort followed protocol implemented in previous SCC training events (Mobley and Milette 2010). The approach involved flying elliptical-shaped patterns in advance of the Navy vessel (DDG) that extended from the front of the ship (~200 meters) out to ~2,500 meters) over a width of ~4 kilometers (km).
Surveys were conducted from a small fixed-wing Aero Commander flying at 100 knots groundspeed and an altitude of ~305 meters (1,000 feet), unless the pilot was directed to fly at alternate altitudes by flight controllers for safety reasons. Observations from the monitoring aircraft involved four personnel including the pilot and copilot, plus two biologist observers with one also acting as data recorder/videographer. Survey crew and pilot were not informed as to the status of MFAS transmissions, which minimized potential for observational bias. When animals were detected, the angle to the sighting was recorded 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 using a Canon 5D digital camera with Canon 100-400mm telephoto lens with image stabilizer. Environmental data (Beaufort seastate, glare, visibility) were recorded at the start of effort and when conditions changed. Positional data via GPS were automatically recorded every 5 seconds and manually when sightings occurred.

When pods were suitable (i.e., were visible at the surface for extended periods) focal follows were performed using accepted methods (Altmann 1974). The aircraft ascended to 457 meters (1,500 feet), an altitude shown to minimize reactivity to fixed-wing aircraft (Smultea et al. 1995), and the pod was orbited and behavior videotaped for as long as possible. A high-definition (HD) Canon Vixia HF10 camcorder with 12-power optical zoom was used to videotape focal follows. The intercom system of the aircraft inputted to the audio port of the digital camcorder so that all behavioral observations could be recorded with a minimum of ambient noise. Time stamps on the Canon camcorder were synchronized with those from the Garmin GPS receiver. The resultant digital audio/video file and digital photos will be made available to the Navy for subsequent behavioral analysis.

Overall survey effort was divided into four parts as summarized below:

(a) **Ship follows, SCC event** (February 16–18, 2011): involved flying elliptical orbits in front of the DDG (*Figure 2*) with the goal of finding target species in the vicinity of the DDG and observing and recording their behavior using focal follow methods (Altmann 1974)

(b) **Transect surveys** (February 19, 2011): to search for marine mammals in support of tagging effort by Cascadia Research Collective (*Figure 3*). Note: More detailed description of tagging effort provided in Baird et al. (2011)

(c) **Circumnavigation surveys, post-SCC event** (February 24 and 26, 2011): following the SCC event, the aircraft flew along the coastlines of Kauai, Ni‘ihau, and Ka‘ula islands (*Figure 3*) looking for target species along the shoreline and any stranded or near-stranded marine mammals

(d) **Circumnavigation surveys, post-USWEX event** (February 28 and March 5, 2011): following the USWEX training event, the aircraft flew along the coastlines of Oahu, the Four Island Region (Maui, Molokai, Lanai, and Kahoolawe), and the Kona coast of the island of Hawaii (*Figure 4*).

Most sightings during the 3-day SCC event occurred during transits between Lihue, Kauai, and the ship’s position (*Figure 2*). Four sightings of humpback whales occurred in the vicinity of the DDG (four squares shown in elliptical plots), one of which became the target of a focal follow session with videotape.
Aerial support of the tagging effort followed a sawtooth transect pattern north of Kauai (Figure 3). The shoreline survey effort involved circumnavigating the islands of Kauai and Niihau approximately 1 to 2 km offshore.

**Communications**

Communications were reliably established between the survey aircraft and the DDG using aviation-band VHF radios broadcasting on 123.45 MHz. Observers onboard the DDG used a handheld aviation VHF radio while on the bridge wing of the DDG. This system proved to be reliable whenever the aircraft was in the vicinity of the ship (i.e., < 10 km); whereas communications at greater distances were possible via radio communications with PMRF Range Control or Outrider Bravo. Daily locations of the DDG were usually communicated via onboard VHF radio once in the air via PMRF Range Control or Outrider Bravo.

**Range Control Interventions**

Range safety during training events is of paramount importance. Range control interventions during the SCC training event occurred more frequently than in past SCC observation missions (Table 2).
Figure 3. Post-SCC event. Effort and sighting locations during spotting assist for tagging effort (Feb. 19) and circumnavigation of Kauai and Niihau (February 24 and 26, 2011). Marine mammal sightings are shown in (a) and sea turtle sightings are shown in (b).
Figure 4. Post USWEX event. Effort and sighting locations during shoreline surveys of Oahu, Molokai, Maui, Lanai, Kahoolawe, and Kona coasts. Marine mammal sightings are shown in (a) and sea turtle sightings are shown in (b).
Table 2. Summary of Range Control Interventions

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Instruction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feb 16</td>
<td>15:06</td>
<td>Directed away from DDG by Range Control; returned 26 minutes later at 15:32.</td>
</tr>
<tr>
<td>Feb 17</td>
<td>08:02</td>
<td>Instructed to stay within 2 Nautical Miles (NM) of DDG location at all times. This did not permit focal follows since they frequently requires moving more than 2 NM away from DDG.</td>
</tr>
<tr>
<td>Feb 17</td>
<td>09:15</td>
<td>Instructed to orbit south of DDG location; allowed to return 1 hour 20 minutes later (called twice during intervening period but no reply).</td>
</tr>
<tr>
<td>Feb 18</td>
<td>11:00</td>
<td>Instructed to stay south of 22°26’ latitude which required leaving DDG. Were able to return to DDG at 11:33 and remained in contact until 14:18.</td>
</tr>
</tbody>
</table>

SECTION 3 RESULTS

Effort

During the SCC event (February 16–18), the survey aircraft accompanied the DDG for 13.25 hours (66%) of the total 19.95 hrs of SCC-related flight time (Table 3). The remaining 6.7 hours (34%) while not with the DDG primarily involved transiting between the DDG’s location and Lihue, Kauai, and maintaining a holding pattern per the instructions of PMRF Range Control (Figure 2). The aircraft was considered “with the DDG” upon commencement of elliptical orbits around the ship’s location (Figure 2).

On February 19, the mission was to provide aerial spotting services to support a tagging operation (Cascadia Research Collective aboard the M/V Searcher) north of Kauai. Effort followed a sawtooth transect pattern (Figure 3) Note: More detail of tagging effort is provided in Baird et al. (2011).

Shoreline surveys were conducted as part of the SCC event in the waters surrounding Kauai/Niihau (February 24 and 26) (Figure 3) and in conjunction with the USWEX event in waters south of the eastern portion of the main Hawaiian Island chain (February 28 and March 5) (Figure 4).

Sea State

The majority of overall effort (70%) was spent in good sea state conditions (i.e., Beaufort 1-3) (Figure 5). The majority of sightings (57%) occurred in these more favorable conditions, with most in Beaufort 2. This pattern is consistent with known effects of sea state on sighting probabilities (Buckland et al. 2001).
### Table 3. Survey Effort (with and not with DDG).

<table>
<thead>
<tr>
<th>Date</th>
<th>Time Wheels Up</th>
<th>Time Wheels Down</th>
<th>Total Flight Hours</th>
<th>Period not with DDG</th>
<th>Total Hours not with DDG</th>
<th>Period with DDG</th>
<th>Total Hours with DDG</th>
<th>No. Sightings With DDG</th>
<th>No. Sightings Away from DDG</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>16:00–16:25</td>
<td></td>
<td>15:32–16:00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>11:30–11:55</td>
<td></td>
<td>13:45–16:15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>13:32–13:45</td>
<td></td>
<td></td>
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<td></td>
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<td>16:15–16:44</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>11:00–11:33</td>
<td></td>
<td>11:33–14:18</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>14:18–14:48</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2/19/2011</td>
<td>7:47</td>
<td>11:50</td>
<td>4:03</td>
<td>7:47–11:50</td>
<td>6:36</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>18</td>
</tr>
<tr>
<td>2/24/2011</td>
<td>8:07</td>
<td>11:32</td>
<td>3:25</td>
<td>8:07–11:32</td>
<td>4:19</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>41</td>
</tr>
<tr>
<td></td>
<td>12:10</td>
<td>13:04</td>
<td>0:54</td>
<td>12:10–13:04</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2/26/2011</td>
<td>7:50</td>
<td>10:34</td>
<td>2:44</td>
<td>7:50–10:34</td>
<td>3:40</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>12:04</td>
<td>13:00</td>
<td>0:56</td>
<td>12:04–13:00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2/28/2011</td>
<td>7:54</td>
<td>12:22</td>
<td>4:28</td>
<td>7:54–12:22</td>
<td>6:34</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>91</td>
</tr>
<tr>
<td></td>
<td>13:34</td>
<td>15:40</td>
<td>2:06</td>
<td>13:34–15:40</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3/5/2011</td>
<td>7:37</td>
<td>10:45</td>
<td>3:08</td>
<td>7:37–10:45</td>
<td>5:01</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>63</td>
</tr>
<tr>
<td></td>
<td>12:00</td>
<td>13:53</td>
<td>1:53</td>
<td>12:00–13:53</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Total** | 46:07 | 32:52 | 13:15 | 4 | 301
Figure 5. Beaufort sea state conditions for total effort and for sightings.

Sightings

There were 305 sightings made during the 8 days of surveys (Table 4). The majority (74%) of these sightings were of humpback whales observed in shallow areas (< 1,000 fathoms), known to be preferred habitat of humpbacks based on past survey results (Mobley 2004). Of the 227 sightings of humpback whales, 195 were seen during the transect and shoreline surveys (i.e., not including those seen during ship follows). When converted to sighting rates, the result is 0.040 humpback sightings/km effort. This represents twice the sighting rate for humpbacks seen north of Kauai during the 2006 North Pacific Acoustics Laboratory (NPAL) surveys—0.020 humpback sightings/km effort (Mobley 2006). The greater rate of humpback whale sightings recorded during the present surveys is consistent with previous reports of increases in the Hawaii wintering population (Mobley et al. 1999, Mobley 2004, Calambokidis et al. 2008).

The remaining sightings with confirmed species identifications consisted of odontocete species, specifically spinner dolphins, bottlenose dolphins, short-finned pilot whales, and sperm whales. All of these are typically found in Hawaiian waters (Mobley et al. 2000, Barlow 2006). Twenty-nine odontocete sightings were recorded during all of the non-ship follow surveys combined and this converts to a sighting rate of 0.004 odontocete sightings/km effort. This is less than the sighting rate of 0.006 odontocetes/km effort reported for transect surveys of the main Hawaiian Islands conducted in 2000 (Mobley 2004). However, when restricted to the 22 odontocete sightings that occurred during non-ship follow surveys in the Kauai/Niihau area (February 19, 24, and 26), this results in a sighting rate of 0.008 odontocete sightings/km effort. This is more than the 0.006 sightings/km effort reported for the Kauai region during 2002 surveys on the PMRF instrumented range (Mobley 2004).
Table 4. Summary of Sightings for Kauai-Niihau Shoreline surveys (Feb. 19, 24, 26).

<table>
<thead>
<tr>
<th>Species</th>
<th>Region</th>
<th>No. Groups</th>
<th>No. indiv's</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green sea turtles</td>
<td>Kauai</td>
<td>20</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>Niihau</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Humpback whales</td>
<td>Kauai</td>
<td>37</td>
<td>71</td>
</tr>
<tr>
<td></td>
<td>Niihau</td>
<td>39</td>
<td>60</td>
</tr>
<tr>
<td>Short-finned pilot whales</td>
<td>Kauai</td>
<td>4</td>
<td>35</td>
</tr>
<tr>
<td>Sperm whales</td>
<td>Kauai</td>
<td>4</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>Channel</td>
<td>1</td>
<td>33</td>
</tr>
<tr>
<td>Spinner dolphins</td>
<td>Kauai</td>
<td>3</td>
<td>132</td>
</tr>
<tr>
<td></td>
<td>Niihau</td>
<td>4</td>
<td>360</td>
</tr>
<tr>
<td>Unid. delphinid spp.</td>
<td>Kauai</td>
<td>5</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td>Niihau</td>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td>Unid. whale spp.</td>
<td>Channel</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td><strong>119</strong></td>
<td><strong>755</strong></td>
<td></td>
</tr>
</tbody>
</table>

We recorded 48 sightings of green sea turtles, all of which were observed in the shallow coastal waters where the animals were highlighted against the light sandy bottom (Figures 3 and 4). Thus, these numbers are likely an undercount of sea turtle species given the limited range of conditions under which they were observed. The 48 sightings of sea turtles recorded during the non-ship follow surveys produces a sighting rate of 0.010 sea turtle sightings/km effort. Since this is the first encounter rate estimate for this species as part of HRC monitoring, there is no basis for comparison.

Although Hawaiian monk seals were recorded on previous surveys in this region (Smultea et al. 2009a), no monk seals were seen during this survey series either swimming or hauled out onshore. Given the relatively low numbers of monk seals in the main Hawaiian Islands (Baker and Thompson 2007), the absence of this species likely reflects a random sampling artifact rather than a systematic effect.

Observations across the 8 days of survey effort revealed no evidence of injury or mortality among target species before, during, and after the event. There were no behavioral indications of distress (e.g., tight aggregations of pod members) or unusual nearshore aggregations of marine mammals. The circumnavigation of islands (February 24, 26, and 28; and March 5) similarly revealed no stranded or near-stranded animals. Evidence regarding possible effects is further summarized in the next section.

Four sightings of humpback whales occurred in the vicinity of the DDG (Table 5; Figure 1). One of these pods became the subject of a focal follow session described in the next section.
Table 5. Summary of Sightings for Post-USWEX Event Shoreline Surveys (Feb 28, Mar 5)—No. Groups (No. Indiv’s).

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Oahu</td>
<td>11 (20)</td>
<td></td>
<td>3 (7)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Penguin Bank</td>
<td></td>
<td>10 (14)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Molokai</td>
<td>14 (37)</td>
<td></td>
<td>17 (31)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lanai</td>
<td></td>
<td></td>
<td>26 (38)</td>
<td>1 (50)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kahoolawe</td>
<td></td>
<td></td>
<td>14 (21)</td>
<td>3 (92)</td>
<td>1 (3)</td>
<td></td>
</tr>
<tr>
<td>Maui</td>
<td>2 (2)</td>
<td>1 (5)</td>
<td>26 (36)</td>
<td>1 (2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Big Island</td>
<td></td>
<td></td>
<td>24 (40)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td><strong>154 (398)</strong></td>
<td><strong>27 (59)</strong></td>
<td><strong>120 (187)</strong></td>
<td><strong>1 (2)</strong></td>
<td><strong>4 (142)</strong></td>
<td><strong>1 (3)</strong></td>
</tr>
</tbody>
</table>

Behavioral Focal Follows

Behavioral focal follows were conducted during the SCC event (February 16–18) while circling at an altitude of ~1,400 to 1,500 feet and a lateral distance of ~1 km (summarized in Table 6). The higher altitude for focal follows was designed to reduce the potential for reactivity to plane engine noise, thereby permitting naturalistic observation of whales in the vicinity of the DDG (Smultea et al. 1995).

Humpback whale pods were seen within the vicinity of the DDG (≤ 5 km) on four occasions during the SCC event (Table 6) but a focal follow was initiated in only one instance. In two of the other three instances the target pod was not resighted after initial detection and in one instance, the observation plane was directed away from the sighting by Outrider Bravo control to deconflict aircraft operations in the area.

The one behavioral focal follow session conducted while monitoring near the DDG (February 18; Appendix C) involved a pod of two humpback whales. At closest proximity, the pod was found within 1 to 2 km of the ship, and was observed for a total period of approximately 32 minutes; however, the whales were not in view the entire time due to the orientation of the plane or when the pod was traveling underwater. During surface observations, no obvious indications of stress were seen, i.e., the animals did not assume a defensive posture nor did they dive quickly, though, as noted earlier, any specific response to MFAS could not be determined since the observers were unaware of sonar transmission status throughout the event. However, the animals remained within 2 to 4 km of the DDG for most of the 32-minute observation period, suggesting that the activities and presence of the ship were not overly disturbing.

During the focal follow, behavior was called out in real time and recorded onto the audio of the digital videocam. The digital video files and the still photos will be made available to the Navy for subsequent behavioral analysis.
Table 6. Summary of Sightings by Species—All Surveys Combined.

<table>
<thead>
<tr>
<th>Species</th>
<th>No. Groups</th>
<th>No. Indiv.</th>
<th>Ave. Pod Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Humpback Whales (<em>Megaptera novaeangliae</em>)</td>
<td>227</td>
<td>370</td>
<td>1.63</td>
</tr>
<tr>
<td>Green Sea Turtle (<em>Chelonia mydas</em>)</td>
<td>48</td>
<td>95</td>
<td>1.98</td>
</tr>
<tr>
<td>Spinner Dolphins (<em>Stenella longirostris</em>)</td>
<td>11</td>
<td>634</td>
<td>57.64</td>
</tr>
<tr>
<td>Unidentified Dolphin</td>
<td>8</td>
<td>54</td>
<td>6.75</td>
</tr>
<tr>
<td>Short-finned Pilot Whale (<em>Globicephala macrorhynchus</em>)</td>
<td>5</td>
<td>37</td>
<td>7.40</td>
</tr>
<tr>
<td>Sperm Whale (<em>Physeter macrocephalus</em>)</td>
<td>4</td>
<td>14</td>
<td>3.50</td>
</tr>
<tr>
<td>Unidentified Whale</td>
<td>1</td>
<td>3</td>
<td>3.00</td>
</tr>
<tr>
<td>Bottlenose Dolphin (<em>Tursiops truncatus</em>)</td>
<td>1</td>
<td>5</td>
<td>5.00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>305</strong></td>
<td><strong>1,212</strong></td>
<td></td>
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Table 7. Summary of sightings with and away from the DDG—All Surveys Combined.

<table>
<thead>
<tr>
<th>Species</th>
<th>With the DDG</th>
<th>Away from the DDG</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Humpback Whale (<em>Megaptera novaeangliae</em>)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bottlenose Dolphin (<em>Tursiops truncatus</em>)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Short-finned Pilot Whale (<em>Globicephala macrorhynchus</em>)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spinner Dolphin (<em>Stenella longirostris</em>)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sperm whale (<em>Physeter macrocephalus</em>)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unidentified Dolphin (Delphinidae)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unidentified Whale</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Green Sea Turtle (<em>Chelonia mydas</em>)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>4</strong></td>
<td><strong>5</strong></td>
<td><strong>301</strong></td>
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</table>
Table 8. Summary of Pods Observed within 5 km of DDG (February 16–18)

<table>
<thead>
<tr>
<th>Date</th>
<th>Time Sighted</th>
<th>Species</th>
<th>No. Individuals</th>
<th>Video? (Y/N)</th>
<th>If No, Reason Video not Initiated</th>
</tr>
</thead>
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<tr>
<td>Feb 16</td>
<td>14:05</td>
<td>Humpback Whale (MN)</td>
<td>1</td>
<td>N</td>
<td>Not resighted*</td>
</tr>
<tr>
<td>Feb 16</td>
<td>14:12</td>
<td>MN</td>
<td>1</td>
<td>N</td>
<td>Not resighted*</td>
</tr>
<tr>
<td>Feb 17</td>
<td>08:11</td>
<td>MN</td>
<td>1</td>
<td>N</td>
<td>Directed away from location by Outrider Bravo</td>
</tr>
<tr>
<td>Feb 18</td>
<td>13:14</td>
<td>MN</td>
<td>2</td>
<td>Y</td>
<td></td>
</tr>
</tbody>
</table>

Note: *Also sighted by observers onboard DDG.

SECTION 4 DISCUSSION

As stated in the SOW, the survey mission was to “monitor and report the presence/absence, distribution/redistribution, reaction/no reaction, injury, and/or mortality of marine mammals and sea turtles before, during and after the event.” Evidence regarding each of these points is summarized below:

(a) **Presence/absence.** This category is best assessed using an aggregate index such as “overall sightings per km” reported earlier. The observed sighting rates for humpbacks (0.040 sightings/km) suggest that humpbacks were present in the target area at higher densities than previously reported for this area (0.020 sightings/km) (Mobley 2006 for period mid-Feb through late-March), consistent with reports of an increasing winter population (Calambokidis et al. 2008, Mobley 2004). The overall sighting rate for odontocetes (0.004 sightings/km) for all non-ship-follow surveys was lower than that reported earlier from transect surveys of the main Hawaiian Islands in 2000 (0.006 sightings/km) with no training events ongoing (Mobley 2004). However, when the analysis was restricted to the Kauai/Niihau region where training events were closer to the surveyed regions involved, the sighting rate for odontocetes (0.008 sightings/km) was higher than that seen earlier during 2002 surveys of the same region with no training events ongoing (0.006 sightings/km) (Mobley 2004). This suggests that the training events did not result in the evacuation of the area on the part of odontocetes.

(b) **Distribution/redistribution.** The same principle described in (a) applies to assessing changes in distribution, i.e., changes in distribution can only be reliably detected for the most abundant species, e.g., seasonally present humpbacks via comparisons across consecutive seasons (e.g., Mobley 2005). If one examines the locations of humpbacks observed in this survey series (Figures 2 through 4), it is clear that they were seen throughout their normal preferred habitat of shallow, coastal regions as shown in previous surveys (e.g., Mobley 2004). In contrast, since the distribution of odontocetes is typically sparse, particularly for tropical waters such as Hawaii (Barlow 2006), discerning distribution change is made difficult. Sea turtles are also sparsely distributed, and only seen occasionally along primarily sand-bottom coastal regions (see Recommendations), so it is similarly difficult to discern changes in distribution for these species.
(c) **Reaction/no reaction.** For this category one must be able to distinguish reactions to the observation platform (survey aircraft in this case) from reactions related to the training event (e.g., MFAS). For that reason, the best source of data would be to aggregate the focal follow observations across multiple trials based on observations from non-reactive platforms (e.g., aircraft altitude ≥ 457 meters). That way one can discern changes in respiration rates, dive times, and other factors that might correlate with MFAS transmissions with little or no reactivity to the platform itself. To that end, we will continue to provide Navy sponsors with videotaped results of focal follows and detailed behavioral logs (Appendix C).

(d) **Injury and mortality.** Injury and mortality are readily discernible for each of the target species due to marked reduction or cessation of locomotion and by other cues, such as visible wounds or blood. As such, it is arguably the most detectible of the four categories listed here. There was no evidence of injury or mortality for any of the target species observed before, during, or after either of the two training events.

Given the caveats noted, overall there were no direct observations of adverse effects of the training event. As for the effects of sonar, since the status of MFAS transmissions throughout the survey period was unknown, any specific response of the animals observed to such transmissions would require more detailed behavioral analyses by the Navy with knowledge of the time/duration of MFAS. The time-stamped audio/video files from the focal follows will be provided to the Navy to enable such detailed analyses. Per the SOW, the data obtained in this study are meant to contribute to a growing baseline of information on the distribution, occurrence, and behavior of MM/ST near Navy training events in the HRC per the HRC marine species monitoring plan (DoN 2008) and as revised in the Pacific Fleet Annual Monitoring Report (DoN 2009).

**SECTION 5 RECOMMENDATIONS**

In light of the issues summarized in this report, the following recommendations are offered:

1. **Promote development of baseline behavior and density database for more abundant species** (e.g., humpback whales, spinner dolphins). Discerning effects of MFAS or any other training event-related stimulus requires comparisons with baseline behavior and densities particularly for the more abundant species where sufficient statistical power can be more readily obtained. For the HRC, the more abundant species include the seasonally present humpbacks and the spinner dolphins that are present year-round (Mobley 2004). It is recommended that the Navy consider promoting the development of these databases to facilitate such comparisons.

2. **Consider limiting sea turtles as target species for coastal surveys only** since they can only be reliably detected along coastlines with primarily sandy bottoms. Sea turtles are rarely observed during open ocean surveys.

3. **Consider revising goal of detecting “presence/absence” to focus primarily on aggregate indices such as sighting rates (e.g., sightings/km) of highly abundant species (e.g., humpback whales) or combined sightings of remaining species (e.g., odontocetes).** For reasons noted previously, applying a presence/absence criterion on a species by species basis, except for the most abundant species, is not a defendable approach.
(4) Consider revising goal of detecting “redistribution” to focus similarly on more abundant species (e.g., humpbacks) where changes in distribution are more readily discernible.

(5) Consider briefing Range Control officers concerning the mission of the marine mammal monitoring team. The Range Control interventions during this event were more disruptive of the marine mammal monitoring effort than occurred in the past (Table 6). It is likely that the level of disruption could be reduced by briefing those involved in directing range activities as to the mission and protocols involved in the monitoring effort.

SECTION 6 ACKNOWLEDGEMENTS

We are grateful to Navy personnel from U.S. Pacific Fleet Environmental (No1CEI) and Naval Facilities Engineering Command Pacific EV24 (NAVFA! PAC) for their support, coordination, and facilitation in the implementation of these surveys. Many thanks to my fellow observer, Lenisa Blair and to our pilot team consisting of Matt Dornan, Jeff Kinyon, Nakana Rivera, and John Sharkey. All observations were made in accordance with NOAA permit no. 14451 issued to Joseph R. Mobley, Jr.

SECTION 7 LITERATURE CITED


### APPENDIX A

#### Summary of Sightings with Positions (GPS)

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Species*</th>
<th>Composition (# Indivs)</th>
<th>Latitude (N) (degrees)</th>
<th>Latitude (N) (minutes)</th>
<th>Longitude (W) (degrees)</th>
<th>Longitude (W) (minutes)</th>
</tr>
</thead>
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<td>21</td>
<td>52.08</td>
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<td>53.1</td>
<td>159</td>
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<td>22</td>
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*Species Code    Species (Latin name)
CM                green sea turtle (*Chelonia mydas*)
GM                short-finned pilot whale (*Globicephala macrorhynchus*)
MN                humpback whale (*Megaptera novaeangliae*)
PM                sperm whale (*Physeter macrocephalus*)
SL                spinner dolphin (*Stenella longirostris*)
TT                bottlenose dolphin (*Tursiops truncatus*)
UD                unidentified dolphin spp.
UW                unidentified whale spp.
UT                unidentified sea turtle spp.
APPENDIX B  
Summaries of Behavior

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### Aerial Survey Monitoring for Marine Mammals and Sea Turtles in the Hawaii Range Complex in Conjunction with Two Navy Training Events.

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<td>1</td>
<td>MN</td>
<td>splash</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>3/5/11</td>
<td>13:35:43</td>
<td>61</td>
<td>No</td>
<td>1</td>
<td>MN</td>
<td>sl sw</td>
<td>90</td>
<td></td>
</tr>
<tr>
<td>3/5/11</td>
<td>13:36:23</td>
<td>62</td>
<td>No</td>
<td>1</td>
<td>MN</td>
<td>sl sw</td>
<td>180</td>
<td></td>
</tr>
<tr>
<td>3/5/11</td>
<td>13:38:19</td>
<td>63</td>
<td>No</td>
<td>3 (1)</td>
<td>MN</td>
<td>sl sw</td>
<td>90</td>
<td></td>
</tr>
</tbody>
</table>
### APPENDIX C

**Detail of Videotaped Focal Follow**

<table>
<thead>
<tr>
<th>Date</th>
<th>Clock Begin</th>
<th>Elapsed Begin</th>
<th>Description</th>
<th>Lat/Lon (degrees)</th>
<th>Pod on Video (Y/N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feb. 18</td>
<td>13:19</td>
<td>0:02</td>
<td>Session starts—two humpbacks sighted within 2–4 km of DDG; pod is underwater at start; good sighting conditions (Bf 3); heading 150</td>
<td></td>
<td>N</td>
</tr>
<tr>
<td>13:21</td>
<td>2:06</td>
<td></td>
<td>Pod at surface; visible blow, large splash, peduncle slap by closer whale, then blow; closer animal fluke-up dive; puka visible</td>
<td></td>
<td>Y</td>
</tr>
<tr>
<td>13:21</td>
<td>2:35</td>
<td></td>
<td>Further animal dove; both animals now underwater</td>
<td></td>
<td>N</td>
</tr>
<tr>
<td>13:23</td>
<td>4:38</td>
<td></td>
<td>Both animals up (per audio); backs visible at elapsed time (ET) 4:41; then submerged; blow at ET 5:04, both whales visible, blow at ET 5:30; both submerged at ET 5:34</td>
<td></td>
<td>Y</td>
</tr>
<tr>
<td>13:24</td>
<td>5:34</td>
<td></td>
<td>Both animals submerged, no longer visible</td>
<td></td>
<td>N</td>
</tr>
<tr>
<td>13:26</td>
<td>6:46</td>
<td></td>
<td>Pukas visible (might have missed surfacing)</td>
<td></td>
<td>N</td>
</tr>
<tr>
<td>13:30</td>
<td>11:03</td>
<td></td>
<td>Pilot confirms surfacing (forward of plane); not visible in frame; going in and out of clouds</td>
<td></td>
<td>N</td>
</tr>
<tr>
<td>13:36</td>
<td>17:34</td>
<td></td>
<td>Observer sights pod at surface; blows visible in frame briefly; (aircraft now at 1,400 feet to avoid clouds)</td>
<td></td>
<td>Y</td>
</tr>
<tr>
<td>13:37</td>
<td>17:50</td>
<td></td>
<td>Both animals submerged; no longer visible</td>
<td></td>
<td>N</td>
</tr>
<tr>
<td>13:42</td>
<td>23:18</td>
<td></td>
<td>Conditions changed to Bf 4; still good visibility</td>
<td></td>
<td>N</td>
</tr>
<tr>
<td>13:43</td>
<td>23:46</td>
<td></td>
<td>Pilot sights blow behind left engine; pilot reports both visible (ET 24:13); still swimming line abreast approx. 2 whale lengths apart, heading 150; pilot reports whales no longer visible (ET 25:03)</td>
<td></td>
<td>N</td>
</tr>
<tr>
<td>13:47</td>
<td>28:02</td>
<td></td>
<td>Chafee visible in frame still within 2–4 km</td>
<td></td>
<td>N</td>
</tr>
<tr>
<td>13:50</td>
<td>30:48</td>
<td></td>
<td>Pilot sees blow; not yet visible in frame; still up at ET 31:30;</td>
<td></td>
<td>N</td>
</tr>
<tr>
<td>13:51</td>
<td>32:08</td>
<td></td>
<td>Breaking off episode; animals not visible</td>
<td></td>
<td>N</td>
</tr>
</tbody>
</table>