Marine Mammal and Sea Turtle Monitoring Report
for the

Costa Rica 3D Seismic Survey
(Bangs Crisp Project)

in the Pacific Ocean offshore Costa Rica
7 April 2011- 12 May 2011
R/V Marcus G. Langseth

Prepared for

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACRONYMNS AND ABBREVIATIONS

3D	three-dimensional
CPA	Closest Point of Approach
EEZ	Exclusive Economic Zone
ESA	(U.S.) Endangered Species Act
ETP	Eastern Tropical Pacific
hp	horsepower
IHA	Incidental Harassment Authorization (under U.S. MMPA)
ITS	Incidental Take Statement
in	inch
IUCN	International Union for the Conservation of Nature
kHz	kilohertz
kt	knot
km	kilometer
L-DEO	Lamont-Doherty Earth Observatory of Columbia University
Langseth	R/V *Marcus G. Langseth*
LME	Large Marine Ecosystem
m	meter
MBES	Multibeam echosounder
MMPA	(U.S.) Marine Mammal Protection Act
ms	millisecond
NEPA	(U.S.) National Environmental Policy Act
NMFS	(U.S.) National Marine Fisheries Service
NOAA	(U.S.) National Oceanic and Atmospheric Administration
NRC	(U.S.) National Research Council
NRP	Navigational Reference Point
NSF	(U.S.) National Science Foundation
NVD	Night Vision Device
PAM	Passive Acoustic Monitoring
PEEZ	Pacific Exclusive Economic Zone
PSO	Protected Species Observer
PTS	Permanent Threshold Shift
RL	Received Level
R/V	Research Vessel
SBP	Sub-Bottom Profiler
SE	southeast
SEL	Sound Exposure Level (a measure of acoustic energy)
SL	Source Level
SPL	sound pressure level
TDR	Time-domain reflectometer
TOAD	Time-of-Arrival-Distance
TTS	Temporary Threshold Shift
U.S.	United States of America
USCG	United States Coast Guard

1. EXECUTIVE SUMMARY

This report reviews the mitigation and monitoring activities for seismic operations onboard the *R/V Marcus G. Langseth* in Costa Rican Pacific waters from 7 April 2011 through 12 May 2011. The *Langseth* is owned by the National Science Foundation (NSF) and operated by Lamont-Doherty Earth Observatory (L-DEO). L-DEO was contracted to acquire a marine multichannel seismic (MCS) reflection survey in the Eastern Tropical Pacific (ETP) Ocean offshore Costa Rica to image the structures along a major plate boundary subduction fault zone. RPS was contracted by L-DEO to provide continuous protected species observation coverage and to fulfil the environmental regulatory requirements and reporting mandated by the National Marine Fisheries Service (NMFS). NMFS enforces the Marine Mammal Protection Act (MMPA) and Endangered Species Act (ESA). The MMPA and the ESA mandate that an Incidental Harassment Authorization (IHA) be issued for activities with potential to harm marine life by noise. Marine geophysical surveys use acoustic energy pulses to reflect geological features from the seabed to generate an image of the subsurface. Although the effects to marine life from seismic procedures are not well understood, it has a potential to disturb marine life and thus requires an IHA permit to conduct operations. On 6 April 2011, an IHA was issued to L-DEO by NMFS which required them to implement mitigation measures for marine mammals and sea turtles (Appendix A). Five Protected Species Observers (PSOs) were onboard to conduct visual observations and call for mitigation actions according to the IHA. One of the PSOs also was a trained and experienced Passive Acoustic Monitoring (PAM) operator who conducted and managed PAM operations. Each PSO underwent a basic PAM training conducted by the Dedicated PAM operator and rotated through acoustic watches to achieve 24 hours of monitoring. PAM was used to augment visual observations and was not used for mitigation actions unless confirmed by a visual detection. Each PSO undertook a combination of visual and acoustic watches, accumulating a total of 433 hours and 46 minutes of visual observations and an additional 542 hours and 25 minutes of acoustic monitoring over the course of the survey project.

This visual and acoustic monitoring effort produced a project total of 361 protected species detection records. Cetacean detections accounted for 108 records, 2 of which were collected for whale species and the remaining 106 for animals in the dolphin family, Delphinidae. While the majority of the marine mammal detections of the project were made visually, there were nine acoustic detections through the PAM system, five of which were correlated with a visual sighting of the animals. An additional 253 sea turtle sighting records were collected over the duration of the survey.

These detections of protected species, both cetaceans and marine turtles, resulted in a total of 176 mitigation actions being implemented: 118 power-downs, 39 shut-downs and 19 delays to ramp-ups of the airguns (Appendix B).

The Bangs Crisp 3D marine seismic survey program was conducted as mandated by the IHA, through excellent communication and co-operation between the PSOs and *Langseth*'s science technicians.

2. INTRODUCTION

Lamont-Doherty Earth Observatory (L-DEO) conducted a marine multichannel seismic (MCS) reflection survey in the Eastern Tropical Pacific Ocean offshore Costa Rica onboard the *R/V Marcus G. Langseth* from 7 April 2011 to 9 May 2011. The seismic research was funded by National Science Foundation (NSF) and conducted on the *R/V Marcus G. Langseth* which is owned by NSF and operated by L-DEO on behalf of NSF via a Cooperative agreement. The Principal Investigators aimed to examine and acquire the three-dimensional (3D) structure of the Costa Rica convergent margin near the Osa peninsula. The scientific objectives of the survey were evaluated through a standard NSF merit review process and required the use of 3D seismic equipment to obtain data for research and analysis. Marine seismic surveys involve employing an acoustic sound source into the environment which may have impacts on marine life, particularly marine mammals and sea turtles. The Marine Mammal Protection Act (MMPA) and Endangered Species Act (ESA) mandate that an Incidental Harassment Authorization (IHA) be issued for activities with potential to "take" or harass marine life through noise. The National Marine Fisheries Service (NMFS) considers that marine mammals exposed to sound pressure levels greater than or equal to 160 dB re 1 µPa rms may be disturbed by the noise and considered a form of harassment which requires a permit to be issued to the vessel that may alter an animal's normal behaviour. NMFS issued an IHA to L-DEO on 6 April 2011 which authorized non-lethal takes of Level B harassment of specific marine mammals that are incidental to the marine seismic survey program (See Appendix A). Moreover, an Incidental Take Statement (ITS) was included with the IHA where NMFS anticipates that the Bangs Crisp 3D Seismic Survey will also take sea turtles in the form of harassment as a result of exposure to acoustic energy. To minimize incidental sea turtle takes by harassment, the NMFS mandated that additional mitigation measures such as powerdowns or shutdowns be applied to sea turtles observed within the 180 dB isopleths.

While it is unclear to what extent that cetaceans exposed to seismic noise of different levels would express changes of behaviour, NMFS requires provisions such as using a calculated safety zone to implement power-downs or shut-downs in order to provide mitigation from the potential impacts of noise to the animals in the area. Therefore, L-DEO adheres to a strict set of procedures within the IHA that are designed to minimize interactions between the acoustic sources and marine mammals. Five Protected Species Observers (PSOs), one of which consisted of a local PSO from Costa Rica, were onboard the *Langseth* to monitor the areas around the vessel and sound source and to call for mitigation actions in accordance with the IHA. Passive Acoustic Monitoring (PAM) was also utilized to augment visual monitoring by listening for marine mammal vocalizations. The following report serves to meet the reporting requirements specified by the IHA and details the protected species monitoring, mitigation, and seismic survey operations undertaken as part of the Bangs Crisp 3D Marine Seismic Survey from 7 April 2011 to 12 May of 2011 inside the economic exclusive zone (EEZ) of Costa Rica along the Pacific coast.

2.1. SCIENTIFIC SURVEY PROGRAM OVERVIEW

The Bangs Crisp 3D Seismic Survey investigated the changes in structural and physical properties along the earthquake prone subduction zone off southern Costa Rica using 3D seismic imaging made possible through the use of the seismic equipment onboard the R/V *Langseth*. The Pacific margin of Central America is a subduction zone area that regularly generates earthquakes and tsunamis as part of subduction systems that rim the Pacific. The

Costa Rica margin is an ideal location to look at subduction zone megathrusts because of the circumstances that have caused subduction thrust earthquakes to be unusually shallow. Understanding how subduction zone earthquakes are generated could provide valuable insight into the nature of these natural disruptions and refine global models of earthquake rupture for subduction megathrust zones.

A team of 18 scientists and 25 crew members supported the research under the direction of the Principal Investigators, Dr. Nathan Bangs (University of Texas at Austin, Institute of Geophysics), Dr. Kirk McIntosh (University of Texas at Austin, Institute of Geophysics), Dr. Eli Silver (University of California, Santa Cruz). Other participating scientists included Dr. Shannon Cavanaugh (University of Texas at Austin, Institute of Geophysics), Dr. Roland von Huene (United States Geological Survey), and Dr. Cesar Ranero (ICREA at the Spanish National Research Council in Barcelona, Spain).

2.2. SURVEY OVERVIEW

On 10 November 2010, Lamont-Doherty Earth Observatory of Columbia University, with research funding from the NSF, applied for an Incidental Harassment Authorization for this marine seismic survey, specifically requesting permission by the NMFS to incidentally take 19 species of marine mammals within the waters of the Exclusive Economic Zone of Costa Rica by Level B harassment. NMFS issued L-DEO an Incidental Harassment Authorization (IHA) on 6 April 2011 for Level B harassment only (Appendix A). The NSF submitted a Section 7 consultation request to NMFS on November 19, 2011. A Biological Opinion was issued on April 6, 2011 (See Appendix A) which contained specific reasonable and prudent measures, and terms and conditions, which both NSF and LDEO agreed to adhere.

The Incidental Take Statement did not specify a number of allowable takes for sea turtles during this seismic survey, but the NMFS did expect harassment of sea turtles to occur at received levels above 166 dB re1µPa. Non-discretionary, reasonable and prudent mitigation measures for sea turtles included implementation of the 180 dB re1µPa rms isopleth for shut-down procedures. Reasonable and prudent measures also included the monitoring and reporting conditions stated in the IHA and ITS, as well as the reporting of any injured or dead endangered or protected species and their locations to the NMFS Permits Division and the NSF.

The *Marcus G. Langseth* was the source/acquisition research vessel used to acquire the Bangs Crisp 3D Survey. In addition to the source vessel there were two local chase boats used during the survey, the *Reel Deal and Oberon*. The energy source and two additional acoustical data acquisition systems were configured and used as stated in the IHA Application. The IHA Application can be found online at http://www.nmfs.noaa.gov/pr/permits/incidental.htm#applications.

The vessel departed the port of Puntarenas in Costa Rica on 9 April 2011 and returned to Puntarenas on 12 May 2011. Acquisition took place over a total of 31 days beginning on 11 April 2011 and ending on 11 May 2011.

2.2.1. Visual Observer Personnel and Equipment

There were five trained and experienced Protected Species Observers (PSOs) on board the *R/V Marcus G. Langseth* during the Bangs Crisp Seismic Survey to conduct monitoring for marine mammals and sea turtles, record and report on observations, and request mitigation

actions in accordance to the IHA. The PSOs onboard were NMFS-approved and contracted through RPS. L-DEO coordinated the survey activities with a Costa Rican environmental organization, Fundación Keto. One of the marine biologists from the organization also served as a Protected Species Observer during the survey and provided local knowledge for the area surveyed. The *Langseth's* crew also assisted in visual observations when practical.

The PSOs conducted both visual and acoustic monitoring and implemented mitigation actions. At least two PSOs watched for marine mammals and sea turtles during airguns operations in daylight periods. At least one PSO, and when possible two PSOs, watched for marine mammals and sea turtles during night-time ramp-ups and during daytime transit, deployment and recovery periods, when no guns were operating.

The PSOs scanned the surface of the water around the vessel in search of marine mammals and sea turtles during the survey. They used 7 x 50 reticle binoculars, 25 x 150 Big-eye reticle binoculars and the naked eye during daylight observations and night vision devices during night-time ramp-ups. Most of the observations were made from the PSO Tower, the observation platform on the *Langseth*. The PSO Tower is 18.9 meters above the sea level and provides a 360° visibility. Night-time observations during ramp-ups were made mostly from the Bridge, where the eye level is about 12.8 meters above sea level. Distances were estimated using the reticles in the binoculars and Big-eyes or by comparing known distances.

2.2.2. Passive Acoustic Monitoring Personnel and Equipment

PAM was used to augment visual monitoring efforts, by helping detect, identify, and locate marine mammals within the area. PAM was also used during periods of darkness or low visibility when visual monitoring might not be applicable or effective. The PAM system was monitored to the maximum extent possible, 24-hours a day during seismic operations, and the times when monitoring was possible while the airguns were not in operation. PAM was not used exclusively to execute any mitigation actions without a concurrent visual sighting of the marine mammal.

A trained and experienced PAM operator, was present throughout the cruise to oversee and conduct the PAM operations. To achieve 24-hours of monitoring, the PSOs and the PAM operator rotated through acoustic monitoring shifts with the PAM operator monitoring many of the night time hours when PSOs were not making visual observations and the PAM was the only system in use for detecting cetaceans. All PSOs completed a PAM training provided by the PAM Operator onboard in the initial days of the hydrophone deployment during which basic PAM system operation was covered.

The PAM system was tested and installed by the RPS Acoustic Program Manager and *Langseth* crew members in the San Diego Nimitz Marine Facility on 2 March 2011. Acoustic monitoring was carried out using a system developed by Seiche Measurements Ltd (PAM system specifications can be found in Appendix C). The system was comprised of 250 meters of hydrophone cable deployed from a deckhead winch at the port stern of the gun deck connected via 100 meters of deck cable to electronic processing modules located in the main science lab.

The hydrophone cable consists of a five meter linear array of four hydrophones (three broadband and one low frequency) pre-amplifiers and a depth gauge. Three hydrophones (hydrophone number one, two and three) were broadband elements, sampling mid-range frequencies of 2kHz to 200kHz. Hydrophone number four was a lower frequency hydrophone with a range of 75 Hz to 30 kHz. One spare tow array, also 250 meters with the same

hydrophone configuration, and a spare 100 meters deck cable were also supplied and available onboard during the cruise.

The electronic processing unit contained a buffer processing unit with USB output, an RME *Fireface 800* ADC processing unit with firewire output, a *Behringer Ultralink Pro mixer,* a *Behringer Ultralink Pro graphic equalizer* and a Sennheiser radio headphone transmitter. A mixer unit enabled the operator to adjust stereo signal levels from each of the four hydrophones. The PAM Operator monitored the hydrophone signals aurally using headphones and visually via the screen displays. Two laptops were set-up in the main lab next to the electronic processing unit to display a high frequency range on one laptop (hereafter referred to as the HF laptop) using the signal from two hydrophones, and the low frequency on the other laptop (LF laptop) receiving signal from all four hydrophones. A GPS feed of INGGA strings was supplied from the ship's navigation system and connected to the LF laptop, reading data every 20 seconds.

The high frequency (HF) system was used to detect and localize ultrasonic pulses used by some dolphins, beaked whales and *Kogia* species. The signal from two hydrophones was digitized using an analogue-digital National Instruments data acquisition (DAQ) soundcard at a sampling rate of 500 kHz, then processed and displayed on a laptop computer using the program, *Pamguard version 1.9.01,* via a USB connection. *Pamguard* is an open-source software developed with industry funding to acoustically detect, localize, and identify vocalizing species in support of mitigation (www.pamguard.org). The amplitude of clicks detected at the front hydrophone was measured at 5th order Butterworth band-pass filters ranging from 35 kHz to 120 kHz with a high pass digital pre-filter set at 35kHz (Butterworth 2nd order). *Pamguard* can use the difference between the time that a sound signal arrived at each of the two hydrophones to calculate and display the bearing to the source of the sound. A scrolling bearing time display in *Pamguard* also can display the detected clicks within the HF envelope band pass filter in real time, allowing the identification and directional mapping of detected animal click trains.

The low frequency (LF) system was used to detect sounds produced by marine mammals in the human audible band between approximately 4 kHz and 24 kHz. The low frequency system used four hydrophones, the signal was interfaced via a firewire cable to a laptop computer, where it was digitized at 48 kHz per channel. The LF hydrophone signal was further processed within *Pamguard* by applying Engine Noise Fast Fourier Transform (FFT) filters including click suppression and spectral noise removal filters (median filter, average subtraction, Gaussian kernel smoothing and thresholding). In addition to the Spectrogram available for each of the four hydrophones, modules for Click Detector, Mapping, Sound Recording and Radar displays for bearing to whistles and moans were configured. The bearings and distance to detected whistles and moans were calculated using the Time-of-Arrival-Distance (TOAD) method (the signal time delay between the arrival of a signal on each hydrophone was compared), and presented on a radar display along with amplitude information for the detected signal as a proxy for range. The vessel's GPS connected to the LF laptop via serial USB and allowed delphinid whistles and other cetacean vocalizations to be plotted onto a map module where bearing and range to the vocalizing animal's actual position could be obtained. Typical screenshots from the HF and LF laptop *Pamguard* program during the Bangs Crisp 3D Seismic Survey can be found in Appendix D.

2.2.2.1. Hydrophone Deployment

Several methods of hydrophone deployment were tested throughout the cruise. The vessel crew

and PAM Operator worked to safely deploy the hydrophone cable among the seismic equipment (gun umbilicals and streamer lead-ins) in a manner that minimized the risk of entanglement with vessel gear while achieving the best acoustic range possible to enable effective acoustic monitoring. This can be achieved by deploying the hydrophone cable deep enough to minimize surface swell noise and far enough astern of the vessel propellers such that their low frequency vibrations would not mask cetacean vocalizations. Figure 1 shows the position of the hydrophone deployments in relation to the vessel and seismic equipment. Photos of the hydrophone deployment methods and equipment discussed below can be found in Appendix E.

The vessel had a winch installed on the port stern deckhead of the gun deck for deployment of the PAM hydrophone cable. Two deck cables, the main cable and a spare were installed along the gun deck deckhead running from the winch to the science lab. Both the primary and spare deck cables were installed prior to leaving port to seal watertight areas and to meet Coast Guard Standards.

The cable was initially deployed off of a sliding collar affixed to a port streamer lead-in so that the cable would tow off to the side of the gun umbilicals enabling the vessel to retrieve airguns independently of the hydrophone cable. The collar and a depressor were both affixed to the hydrophone cable by Chinese finger at a point 20 m ahead of the first potted hydrophone and 150 m of the cable was deployed, the collar sliding along the lead-in below the surface of the water. Five days after the cable was first deployed a rapid decrease in acoustic signal strength was observed before the signal dropped out entirely. The cable was retrieved and inspected for superficial damage with none observed, but a time-domain reflectometer (TDR) test revealed an internal break in the cable. Due to the possibility that tension on the hydrophone cable from towing the collar and a depressor under the surface had contributed to the break in the cable, a new deployment method was used with the spare cable.

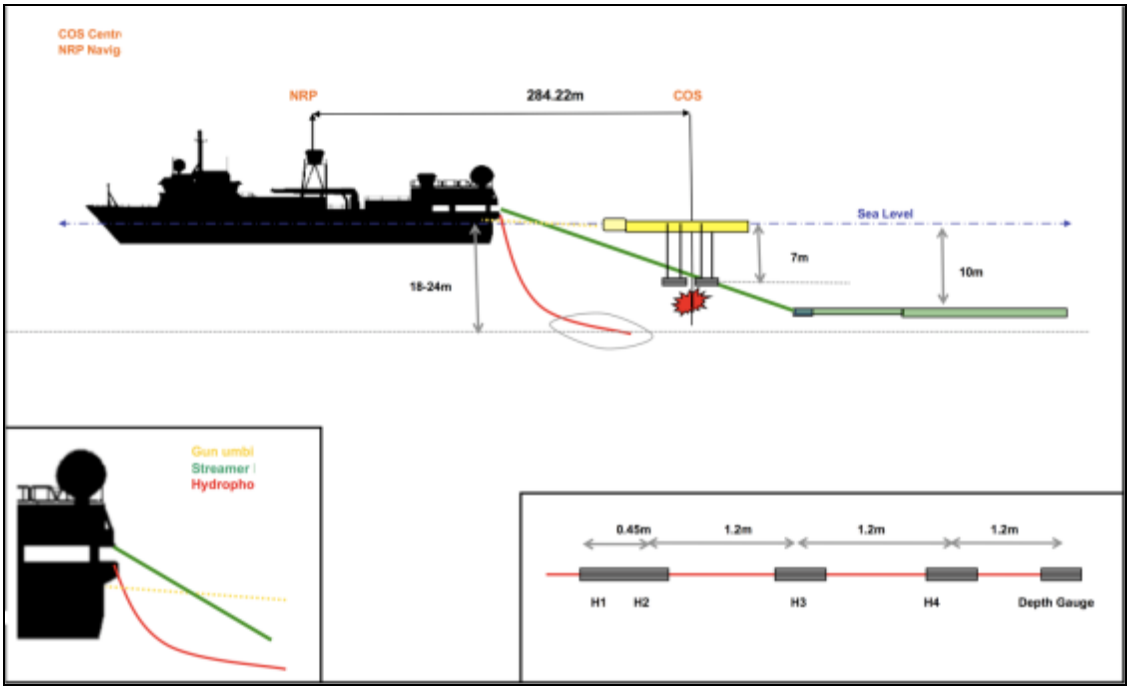


Figure 1. Location of the hydrophone deployment

Subsequent deployments no longer utilized the collar on the lead-in to act as a diverter for the

hydrophone cable from the seismic towed gear, thus minimizing tension on the hydrophone cable. Several methods of cable deployment were then tested that continued to use the depressor to provide depth and distance from the seismic equipment where a line was utilized to absorb the towing tension of the depressor and taped connections were used to affix the cable to the rope (Figure 2). These configurations continued to achieve a good towing depth of over 20 m but were time consuming to deploy or retrieve the cable and required several crew to carry out the operations.

On 16 April 2011, the spare hydrophone cable in use at the time was damaged when the hydrophone cable winch was operated without first disconnecting the hydrophone cable from the deck cable. Thus, the hydrophone cable connector head was sheared completely off. With both hydrophone cables damaged, the vessel received permission from the manufacturing company of the hydrophone equipment, Seiche Measurements Ltd., to splice sections of the two damaged cables together to create one cable for use during the remainder of the survey. The repairs were completed on 20 April 2011 and the cable was deployed using the same method, enabling acoustic monitoring to resume.

Figure 2. Hydrophone deployment method using a taut line to absorb the tension of a weighted depressor affixed to the hydrophone cable to give it sufficient towing depth to drop below the gun umbilicals and streamer lead-ins.

This deployment method could not completely prevent hydrophone cable entanglements with gun umbilicals, especially during the retrieval of port gun strings, and after a couple of near miss incidents the decision was made to take a cautious approach with the only remaining non-damaged hydrophone cable on board and the cable was retrieved prior to all streamer or gun retrievals.

Between 24 April 2011 and 28 April 2011 there were numerous seismic equipment retrievals and during this time the hydrophone cable was deployed and retrieved more than a dozen times. At this time the vessel crew and the PAM Operator began to evaluate other deployment options that would be less time consuming and labour intensive. On 2 May 2011, when a drop-out in the hydrophone signal indicated a potential problem and the cable was retrieved for inspection, it was discovered that the cable and line with depressor had become wrapped

around a lead-in. The decision was made at this time to revise the deployment method, eliminating the use of the line and the depressor and using weight affixed directly to the cable to achieve sufficient towing depth. The cable was then deployed directly off the winch enabling retrieval and deployment to proceed quickly and easily with only two personnel required to perform the operations.

On 10 May 2011 the hydrophone cable was severed mid-way along the cable during a line change. The cable had remained deployed during previous line changes without incident, but on this occasion the inner streamer lead-ins were also being partially retrieved and re-deployed and it is likely that the hydrophone cable became entangled and then snapped under tension. As this was the only undamaged cable remaining on the vessel, acoustic monitoring for the project ceased at 07:20 UTC, on the last day of the project.

3. MITIGATION AND MONITORING METHODS

The vessel-based PSO monitoring program was established to meet the requirements of the IHA issued to L-DEO by NMFS including both monitoring and mitigation objectives. The mitigation program was established to minimize potential impacts of the *Langseth*'s seismic program on marine turtles and cetaceans, and is outlined in detail in Section 3.3 of this report and in the IHA found in Appendix A. To achieve these objectives, the following monitoring protocols were established:

- Visual observations were established to provide real-time sighting data, allowing for the implementation of mitigation procedures as necessary
- Operation of a Passive Acoustic Monitoring (PAM) system to compliment visual observations and provide additional marine mammal detection data
- Ascertain the effects of marine mammals and marine turtles exposed to sound levels constituting a "take"

In addition to achieving the mitigation objectives outlined in the IHA, PSOs collected and analyzed necessary data for this report, as mandated by the IHA including but not limited to:

- Dates, times locations, heading, speed, weather, sea conditions (including Beaufort sea state and wind force), and associated activities during all seismic operations and marine mammal sightings
- Species, number, location, distance from the vessel, and behaviour of any marine mammals, as well as associated seismic activity (number of power downs and shut downs), observed throughout all monitoring activities
- An estimate by the number (by species) of marine mammals that: (a) are known to have been exposed to the seismic activity (based on visual observation) at received levels greater than or equal to 160 dB re 1 μPa (rms) and/or 180 re 1 μPa (rms) with a discussion of any specific behaviours those individuals exhibited; and (B) may have been exposed (based on modelling results) to the seismic activity at received levels greater than or equal to 160 dB re 1 μPa (rms) and/or 180 dB re 1 μPa (rms) with a discussion of the probable consequences of that exposure on the individuals that have been exposed
- A description of the implementation and effectiveness of the: (A) terms and conditions of the Biological Incidental Take Statement (ITS) and (B) mitigation measures of the IHA.

3.1. VISUAL MONITORING SURVEY METHODOLOGY

The visual monitoring methods implemented on this project were conducted to meet the requirements of the IHA. Visual monitoring consisted on having at least two trained and experienced PSOs during daylight airgun operations, especially during the 30 minutes periods before and during ramp-ups, and at least one PSO when the vessel was underway and the airguns were not operating. Observations were primarily made from the *R/V Marcus G. Langseth* observation tower (also known as the PSO tower). Observations were also made from the bridge and the catwalk when required by weather and visibility conditions.

Visual observations were conducted from dawn to dusk in 1-2 hours shifts, with a maximum of 3 hours. PSOs alternated with PAM watches and had 1-2 hours breaks, for a total of about 7 hours of visual watches per day by each PSO. The visual watches consisted of conducting

observations during daylight using the naked eye and alternating with 7 x 50 reticle binoculars and 25 x 150 Big-eye binoculars to scan the surface and detect and identify species or group sizes. At night-time, night vision devices were used to search for marine mammals at a range of 200m from the vessel. Previous surveys by L-DEO that implemented the night-vision devices established that the detection range of the night-vision device is only about 200 meters.

The PSOs searched for marine mammals and sea turtles around the vessel, focusing mainly forward of the vessel but also searched aft the vessel. Night-time visual watches were conducted during night-time ramp-ups and for visual confirmation of marine mammal acoustic detections at night. If a marine mammal or sea turtle was detected within the safety radii, mitigation procedures were implemented.

The PSOs recorded systematically the vessel's position and activity, as well as environmental conditions and airgun operations at least every hour during watches, or every time conditions changed or a sighting was made. Additional data related to the characteristics of the sighting were recorded during marine mammal and sea turtle observations. All information was recorded in UTC time and positions and headings were relative to the vessel. The list of data recorded for effort and sightings can be found on Appendix F. The distances to marine mammals and sea turtles were estimated from the observer's position (mainly the PSO tower) using reticle charts or comparing known distances. However, mitigation was implemented considering distances from the animal to the airguns. All data were recorded into a *Microsoft Excel*® worksheet previously constructed and validated to prevent any entry values that were in consistent or out of range.

3.2. ACOUSTIC MONITORING SURVEY METHODOLOGY

Acoustic monitoring operators monitored the LF and HF laptops visually while listening to the hydrophone output through headphones either through the Fireface unit with a seismic veto enabled to remove the noise of the airguns through the Sennheiser transmitter unit. Acoustic monitoring took place in the main lab. Daytime monitoring shifts lasted one or two hours at a time, during which PAM Operators (including PSOs functioning as a PAM Operator) were in communication with visual PSOs in the observation tower who relayed sighting information. At the time of any visual sighting of a marine mammal, the acoustic operator was notified and sound recordings were made for later analysis by the fully trained PAM Operator. Night time acoustic monitoring shifts were broken into four or five hours to ensure that the PAM operator could maintain concentration and diligently monitor the screens.

Acoustic operators recorded vessel position, water depth, heading and speed, vessel and airgun activity every hour using the vessel's instrumentation available in the main lab and rated the background noise level on the Gannier scale (Gannier, 2002). The LF Spectrogram was monitored for delphinid whistles and sperm whale clicks while the Click Detectors on the HF and LF system were monitored for indications of echolocation clicks. The amplitude range and appearance of the Spectrogram were adjusted as necessary to maximize the appearance of vocalizations above the background noise pictured.

3.3. MITIGATION METHODS

The following mitigation measures were implemented during the Bangs Crisp Seismic Survey as mandated by the IHA granted by NMFS on 6 April 2011 and found in Appendix A.

3.3.1. Safety Radii

Safety radii for the Bangs Crisp 3D survey program were established using conservative distances and are outlined in Table 1 below and are the same as those identified in Table 1 of the IHA (See Appendix A) and as described in the IHA Application.

Table 1: Predicted distances that 160 and 180 dB re 1μPa sound levels could be received and which will be used as safety radii for an 18 gun source and a single airgun during the Bangs Crisp 3D survey program.

Source and Volume	Water Depth	Predicted RMS Distances (m)	
		180 dB	160 dB
Single Bolt airgun (40 in^3)	Shallow < 100 m	296	1050
	Intermediate 100–1,000 m	60	578
	Deep > 1,000 m	40	385
18-Airgun source (3,300 in^3)	Shallow < 100 m	1030	*19,000
	Intermediate 100–1,000 m	675	5,700
	Deep > 1,000 m	450	3,800

***** This is likely an overestimate, as the measured distance for the 36-airgun array operating in shallow waters of the northern Gulf of Mexico was 17,500 m (17.5 km).

3.3.2. Ramp-ups and Visual Pre-searches

Ramp-ups or soft starts of the acoustic source were conducted prior to the commencement of any seismic activity from silence or reduced power that lasted for a period greater than eight minutes. For ramp-up procedures, the smallest airgun in the array (40 in^3) was activated followed by airguns added in a sequence such that the source level of the array increased in steps not exceeding 6 dB per 5-minute period over a total duration of approximately 30 minutes. The safety radii were monitored by PSOs throughout ramp-ups, day or night, and if marine mammals or turtles were sighted inside the safety radii, a power down or shut down was implemented as though the full array were operational. Night time ramp-ups were conducted only when a single airgun had been active during the period prior to the night time ramp-up and PSOs conducted visual observations throughout the ramp-up using night vision devices. Daytime ramp-ups could be conducted from airgun silence if PSOs had maintained continuous visual observation during the silent period prior to ramp-up commencement. If observations were not continuous, then a 30 minute pre-ramp-up survey of the safety radii was conducted. If no protected species were observed inside the exclusion zones then ramp-up could proceed. Ramp-up was delayed if a protected species was detected inside the larger safety radius and could proceed only when:

1. The animal was visually observed to have left the safety zone.
2. The animal has not been seen within the zone for 15 minutes in the case of small Odontocetes or 30 min in the case of Mysticetes and large Odontocetes.
3. The vessel has moved outside the zone for marine turtles, which were treated as stationary objects

3.3.3. Power-down Procedures

A power-down was implemented by decreasing the number of active airguns to a single airgun (40 in^3) such that the size of the 180-dB safety radius was decreased, placing marine mammals or turtles in the vicinity safely outside this exclusion zone. A single airgun was operated throughout a power-down rather than shutting down the source entirely to act a warning beacon for cetaceans of pending seismic activity.

Power-down procedures were conducted for marine mammals and turtles detected inside the 180 dB safety radius as well as for animals outside the exclusion zone but that were likely to enter it imminently. Following a power-down, seismic operations were resumed only when the marine mammal or turtle had cleared the safety zone, as determined by:

1. The animal was visually observed leaving the safety zone.
2. The animal had not been sighted inside the safety zone for 15 minutes in the case of small Odontocetes, or 30 minutes in the case of large Mysticetes or large Odontocetes.
3. Sufficient time had passed to allow the vessel to move past a stationary animal, such that it could be considered to be outside the safety radius (sea turtles).

Following power-downs lasting longer than eight minutes, a ramp-up procedure was required to resume seismic operations.

3.3.4. Shut-down Procedures

The active airgun(s) were shut down if a marine mammal or sea turtle was observed inside or approaching the safety radius for the single 40 in^3 airgun, either after a power-down had already been initiated or if the animal was initially detected within the safety radius of the single airgun. Seismic operations resumed using the same criteria outlined for resumption of operations following a power down.

An additional requirement was outlined in the IHA, specifying that if a dead animal was observed in the survey area, the airgun array must be shut down if there was reason to believe that the death was/could have been related to seismic operations.

3.4. TAKE ESTIMATE ANALYSIS PROCEDURES

3.4.1. Estimates from Direct Observations

The number of marine mammals observed from the *Langseth* during a seismic survey can be used to estimate a minimum of the number of animals potentially affected by seismic sounds. However, this is most likely an underestimate of the actual number potentially affected as it is unlikely that PSOs detect all of the marine mammals near the vessel trackline due to environmental conditions (visibility, light, rain, glare, waves, sea state, etc.) or behavior of the animals (diving, swimming away before coming within visual range, etc.). During daylight animals cannot be seen if they are below the surface. Marine mammals are known to spend much of their time underwater which may reduce the possibility of a visual detection. The use of a PAM system assisted in making detections; however, PAM is only capable of detecting marine mammals that vocalize granted those vocalizations are perceived and distinguished by the hydrophones and PAM Operator. Also, some small, less conspicuous marine mammals may

have been missed. As seismic activity may continue during day and night, it is important to consider that during night-time, PSOs were not on duty and visual observations were conducted just during ramp-ups and to confirm acoustic detections. Even for these short night time observation periods, marine mammals cannot be seen effectively in darkness.

It is assumed that the distribution and behavior of marine mammals may have been altered within a > 160 dB radius (i.e., up to 19.5 km at depth <100m with the 18 guns array) around the active sound source, and perhaps farther away in the case of more sensitive species. These changes in distribution and behavior could occur as a result of reactions to the airguns or to the vessel itself.

For analyses, visual effort and visual detections data were categorized as “active” and “inactive” periods. For the purposes of this study, the “active” category included all data collected while the airguns were operating, including ramp-ups and power-down periods, while the “inactive” category included all data obtained while airguns were not operating.

4. MONITORING EFFORT SUMMARY

4.1. SURVEY OPERATIONS SUMMARY

The *Marcus G. Langseth* departed the port of Puntarenas for the survey site at 2:33 UTC on 9 April 2011, and arrived in the study area later that day at which time the crew began the deployment of the seismic equipment. Deployment of the airguns was completed on 10 April 2011 at 22:07 UTC at which time a single 40 in^3 airgun was enabled with the first shot fired at 23:56 UTC. Maintenance and testing of the seismic equipment continued until 12 April 2011 at 13:06 UTC when production began with the acquisition of survey line MGL11061006. Acquisition was completed at 6:09 UTC on 11 May 2011 with the acquisition of survey line MGL11061140I.

There were several delays and suspensions of survey operations over the course of the project due to seismic equipment failure and issues with the vessel's main engines and propulsion systems. Between 14th and 20th of April the vessel experienced engine failure causing seismic operations to be suspended on several occasions. The longest period of down-time occurred on 18 April 2011 at 21:03 UTC when seismic equipment had to be recovered after a main engine failure, and operations did not resume until 12:21 UTC on 19 April 2011. On 24 April, a streamer failure caused operations to be delayed for a day, and compressor failure between 23 April and 4 May also resulted in several suspensions of seismic acquisition, with the longest suspension during this time being from 21:47 UTC on 3 May to 21:31 UTC on 4 May.

Overall, the acoustic source was active for a total of 663 hours and 07 minutes over the course of the Bangs Crisp survey, which included ramping-up of the airguns, full power acquisition (both online and during line changes), and the operation of a single 40 in^3 mitigation airgun (Figure 3).

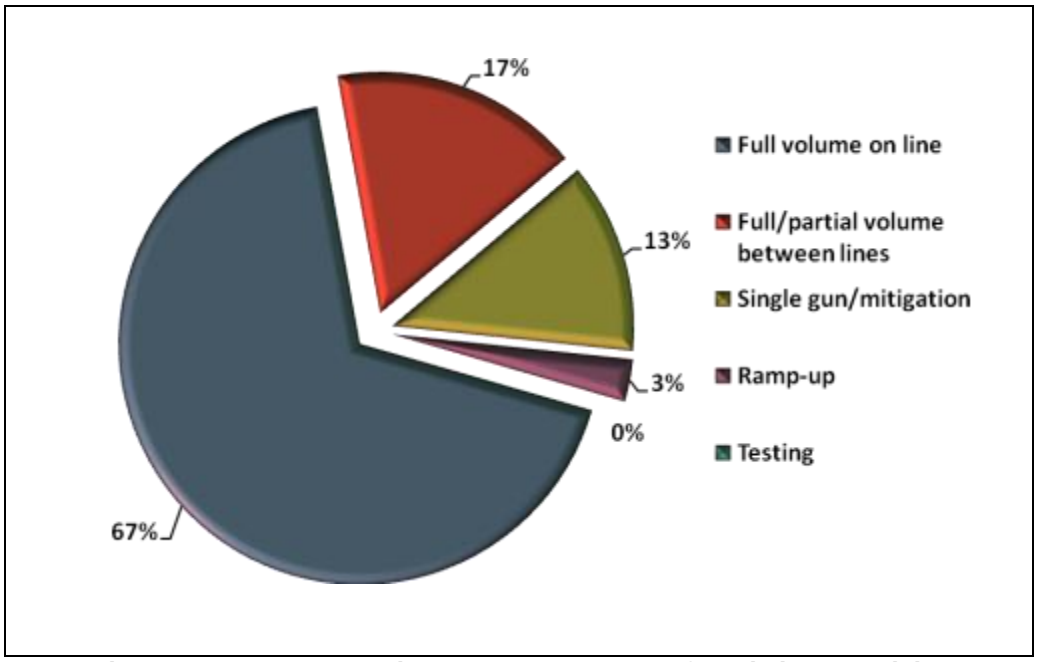


Figure 3. Source operations as a percentage of total airgun activity

Full power source operations accounted for 84% of airgun activity during the project. Survey

acquisition accounted for most full power seismic activity, totalling at 449 hours and 02 minutes (67% of full source airgun activity). As the vessel continued to activate the source at full power on most line changes, there was an additional 111 hours and 03 minutes of full power source operations throughout the survey (17% of full source airgun activity) (Table 2).

Table 2: Source operations during Bangs Crisp marine seismic survey

Acoustic Source Operations	Number	Duration (hh:mm)
Gun Tests	0	00:00
Ramp-ups	61	18:36
Daytime ramp-ups from silence	19	-
Daytime ramp-ups from mitigation source	36	-
Night time ramp-ups (from mitigation source)	6	-
Survey Acquisition	-	449:02
Full power line changes	-	111:03
Single 40 in^3 airgun	-	84:26
Total time airguns were active	-	663:07

The airguns were ramped up 61 times over the course of the survey in order to commence full power survey operations in compliance with the IHA, accounting for 3% (18 hours and 36 minutes) of the total airgun activity (Figure 4). Each ramp-up was conducted over approximately 25 to 30 minutes, where the seismic operator controlled the source volume, adding guns sequentially to achieve full source volume over the required period of time. Most ramp-ups were conducted during daylight hours, with only six ramp-ups conducted at night (Figure 8). Night time ramp-ups were only permitted to begin if a mitigation gun was already active. Daytime ramp-ups could begin from airgun silence if a 30 minute pre-survey was conducted by PSOs on watch. A total of 19 daytime ramp-ups were conducted throughout the acquisition of the survey from airgun silence. The remaining 36 daytime ramp-ups were initiated with a mitigation source already active.

The single mitigation source (1 airgun 40 in^3) was active during mitigation power-downs that were initiated for protected species inside the respective safety radius as well as for mechanical/technical reasons. There were also two occasions where the acoustic source was powered down at the request of the PSO on watch for a protected species sighted within the safety radius when after the power-down, upon closer observation, it was discovered that debris had been mistakenly identified. The source was immediately powered back up to full volume and operations continued.

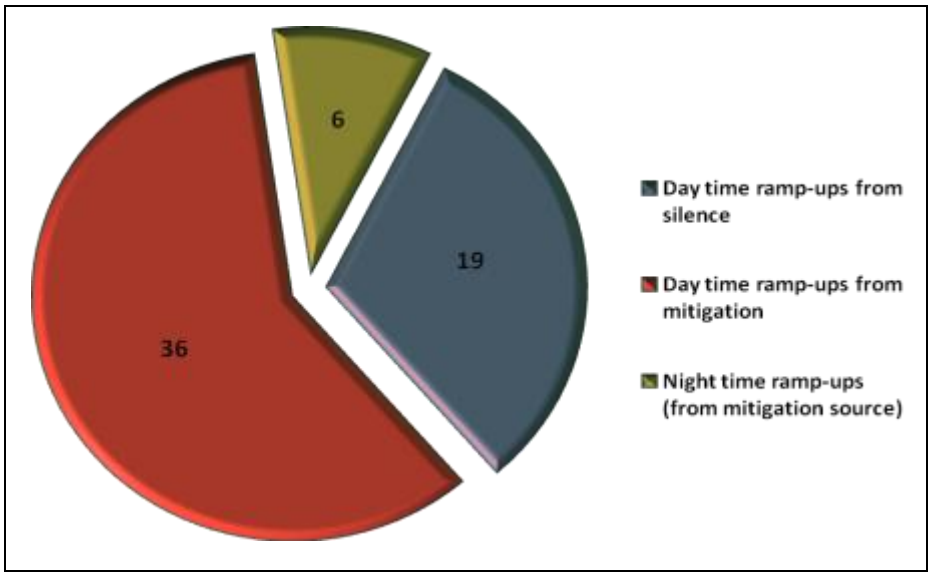


Figure 4. Number of night and day ramp-ups conducted during the Bangs Crisp survey

4.2. ENVIRONMENTAL CONDITIONS

Visual monitoring conditions were generally excellent throughout the project. Visibility ranged from <1 km to 8 km, and averaged 7 kilometers. There were a few scattered rainsqualls and occasional haze that came with high humidity, resulting is slightly decreased visibility for short durations of monitoring effort. The survey took place at the beginning of Costa Rica's rainy season and there were periods of rain on 14 of the 33 survey project days. There was a total of 21 hours and 11 minutes of rain occurring during daylight visual observations.

The sea state was generally low throughout the project, ranging from 0 to 5 and averaging 2 on the Beaufort scale (Figure 5; Appendix G). There were very few hours of monitoring effort impeded by choppy seas and whitecaps. Swell remained low throughout the project, only increasing above 2 meters on one day for a couple of hours.

Wind force varied from 0 knots to 15 knots, but generally remained between 5 and 10 knots. Wind direction was highly variable throughout the survey.

Water clarity was moderate. There were a few days where a considerable amount of marine debris floating on the surface of the project area was noted.

Ship traffic in the area was minimal.

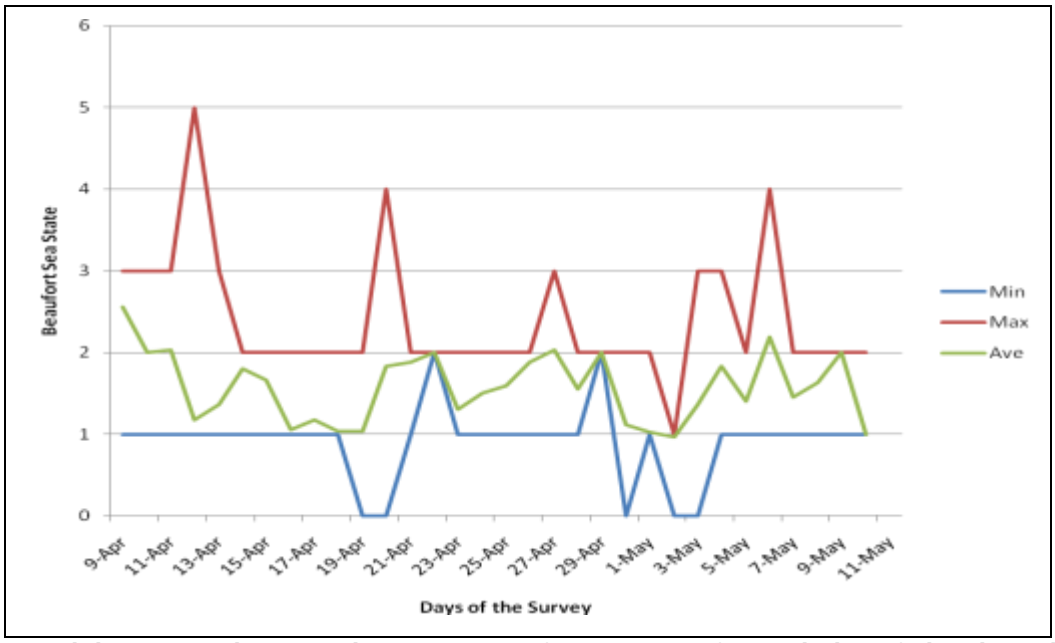


Figure 5. Minimum, maximum and average Beaufort sea state for each day of visual monitoring effort during the survey.

4.3. MONITORING SUMMARY

Monitoring was conducted over a period of 33 days within and adjacent to the Bangs Crisp 3D Survey area. Monitoring was conducted whilst the vessel engaged in seismic operations, and in addition, throughout the deployment and retrieval of seismic equipment, during periods of technical downtime and while maintenance was performed on airguns or streamers. Of the total observation effort achieved by Protected Species Observers, 34 % (433 hours and 23 minutes) was visual monitoring effort and 43% (542 hours and 25 minutes) was acoustic monitoring effort. There was also 23% (289 hours and 40 minutes) of simultaneous visual and acoustic observation completed during this survey (Figure 6).

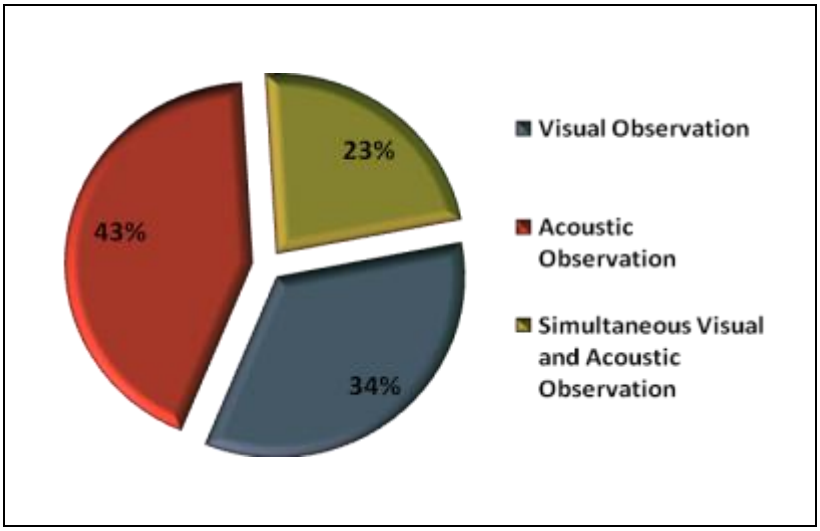


Figure 6. Type of monitoring shown as a percentage of total monitoring effort

Airguns were active throughout the majority of the visual and acoustic monitoring effort. Once the survey acquisition began, the source was only disabled for protected species mitigation shut-down procedures and when mechanical complications arose requiring the survey to be suspended. Of the acoustic monitoring effort, 95% (517 hours and 04 minutes) occurred while the guns were firing and 5% (25 hours and 21 minutes) occurred while they were silent (Figure 7).

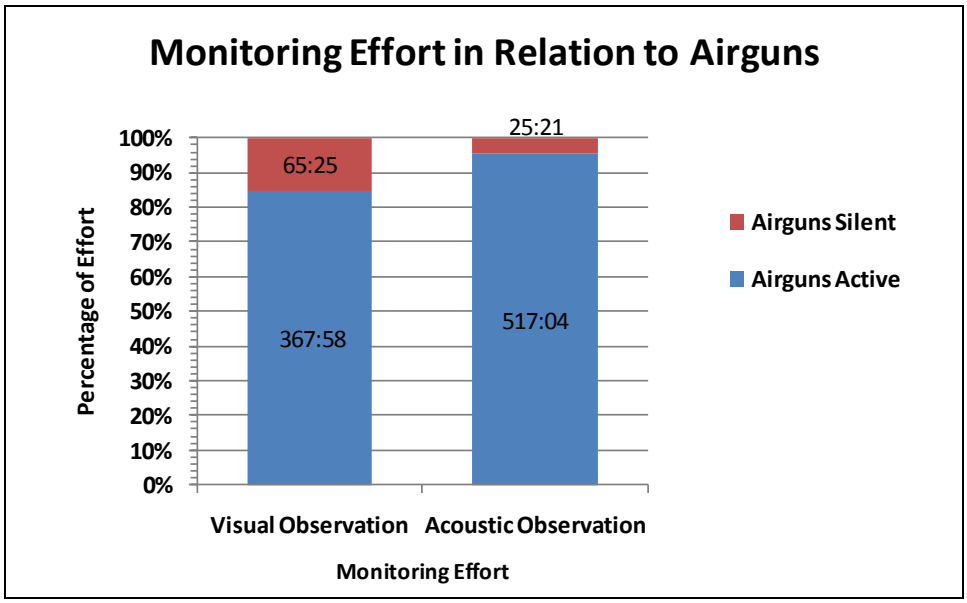


Figure 7. Breakdown of visual and acoustic monitoring while guns were firing and silent.

4.3.1. Visual Monitoring Survey Summary

Visual monitoring began on 9 April 2011 and continued until 11 May 2011 when the vessel returned to port. Monitoring was conducted by two observers every day prior to dawn until just after dusk when it became too dark for the entire safety radius to be visible (approximately 10:50 UTC to 00:10 UTC). Visual monitoring averaged approximately 13 hours and 15 minutes of observations per day. Of the total 433 hours and 23 minutes of visual monitoring conducted, 85% (367 hours and 58 minutes) occurred while the guns were firing and 15% (65 hours and 25 minutes) occurred while they were silent (Figure 7 above, Table 3).

Table 3: Visual monitoring effort during the Bangs Crisp survey

Visual Monitoring	Duration (hh:mm)
Total monitoring while airguns active	367:58
Total monitoring during airgun silence	65:25
Total visual monitoring	433:23

On 4 May 2011 single-observer ancillary watches were conducted, as the vessel was not

conducting any source operations for most of the day due to a compressor failure. Full two-observer watches resumed before the end of the day and continued until survey acquisition stopped at the end of the project on 10 May 2011. Single observer watches were conducted again on 11 May 2011 until 20:30 UTC when visual observations were completed for the project.

4.3.2. Acoustic Monitoring Survey Summary

The hydrophone cable was deployed for the first time on 11 April 2011 after the vessel had completed deployment of the seismic equipment. Acoustic monitoring began immediately at 01:45 UTC and continued throughout the project with PSOs monitoring the hydrophones aurally and visually via the *Pamguard* detection software both day and night. Acoustic monitoring for the project ended at 07:20 UTC on 10 May 2011 when the hydrophone cable was severed with the hydrophone sections lost. This damage to the cable was likely a result of entanglement with a lead-in on a line change while the lead-in was being partially recovered and retrieved.

Over the course of the project, PSOs conducted 542 hours and 25 minutes of acoustic monitoring, 95% (517 hours and 04 minutes) occurred while the guns were firing and 5% (25 hours and 21 minutes) occurred while they were silent (Figure 7 above, Table 4).

Table 4: Acoustic monitoring effort during Bangs Crisp 3D seismic survey

Acoustic Monitoring	Duration (hh:mm)
Total Night time monitoring	252:45
Total Day time monitoring	289:40
Total monitoring while airguns active	517:04
Total monitoring during airgun silence	25:21
Total acoustic monitoring	542:25

There was 101 hours and 14 minutes of acoustic monitoring downtime accumulated throughout the project. Downtime was during occasions when the PAM system could not be utilized, primarily because the hydrophones were not deployed. The hydrophone cable was retrieved for inspection whenever the PAM Operator detected a potential problem with the system, which was usually a potential hydrophone cable entanglement with seismic equipment. Acoustic monitoring was also suspended and the cable retrieved during numerous instances for seismic repairs/maintenance and vessel malfunctions/repairs. Downtime was attributed to seismic equipment when it related to repairs, maintenance or malfunctioning of streamers, airguns or compressors (Table 5) whereas vessel downtime consisted of occasions when the main engines or propulsion failed, requiring seismic gear and the hydrophone cable to be retrieved. Other instances of acoustic monitoring downtime included the incident on 16 April 2011 when the hydrophone cable was damaged from operating the PAM winch while the cable was connected to the deck cable or occasions when acoustic monitoring was suspended for PSO meetings. These were included in the 'Other' category (Table 5, Figure 8). Appendix H also details acoustic monitoring downtime.

Table 5. Acoustic monitoring downtime during Bangs Crisp 3D seismic survey

Acoustic Monitoring Downtime	Duration (hh:mm)
Seismic Equipment Repairs	50:11
Vessel Equipment Failure / Repairs	2:33
PAM Cable Malfunction	4:01
PAM Cable Entanglement	28:43
Other	15:46
Total Acoustic Monitoring Downtime	101:14

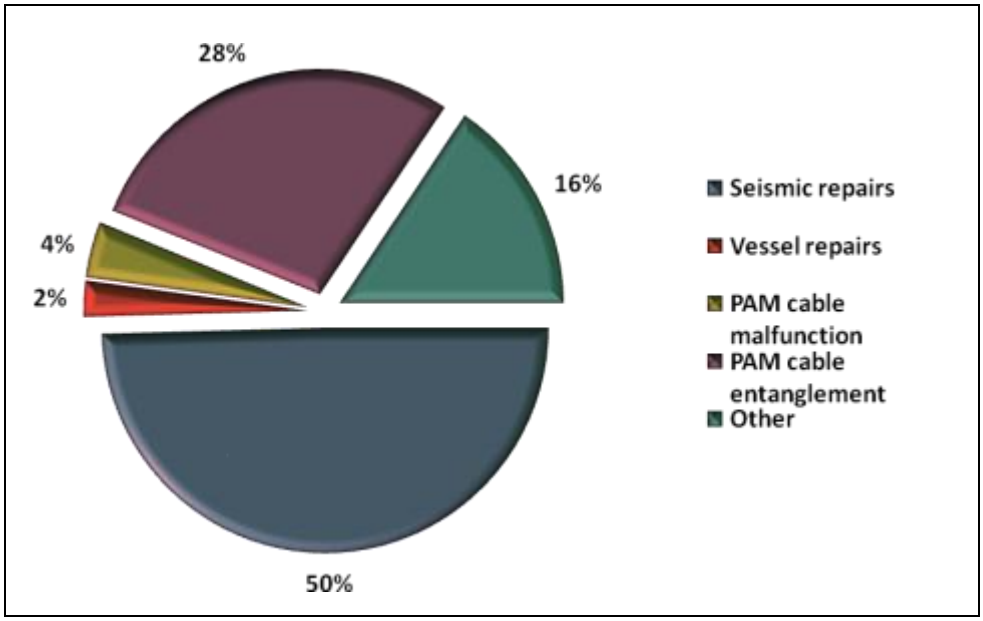


Figure 8. Acoustic monitoring project downtime

4.3.3. Simultaneous Visual and Acoustic Monitoring Summary

As acoustic monitoring continued day and night whenever the hydrophone cable could remain deployed, numerous hours of acoustic observations were conducted overlapping with visual observations, a total of 263 hours and 10 minutes over the course of the survey. Simultaneous acoustic and visual monitoring accounted for 53% of the acoustic monitoring conducted this survey.

5. DETECTION RESULTS

Monitoring effort undertaken during the Bangs Crisp 3D marine seismic survey resulted in the collection of 361 records of detection for protected species (summarized in Appendix I). Fourteen species of marine mammals and an additional three species of sea turtles were identified (Table 6 below)

Table 6: Number of protected species records collected for each marine mammal and sea turtle species detected during the survey

Cetacean Species	Total Number of Detection Records	Total Number of Individual Animals Recorded
Humpback whale	1	1
Sperm whale	1	Unknown due to acoustic detection
Common bottlenose dolphin	11	285
Fraser's dolphin	2	18
False killer whale	1	16
Killer whale	1	10
Melon-headed whale	1	50
Pantropical spotted dolphin	39	548
Pygmy killer whale	1	8
Risso's dolphin	2	7
Rough-toothed dolphin	9	189
Short-finned pilot whale	3	25
Short-beaked common dolphin	11	1472
Spinner dolphin	10	1174
Unidentified dolphin sp	24	567
Marine turtle species		
Green sea turtle	5	5
Olive Ridley sea turtle	230	328
Hawksbill sea turtle	1	1
Unidentified shelled turtle	17	17

Sea turtles were detected far more frequently than cetaceans, making up 70% (253 records) of the total 361 detection records collected. Marine mammal detections were predominantly collected for dolphin species with whale detections accounting for only two of the 108 cetacean detection records of the project.

An average of 10.94 detection records for protected species were collected for each of the 33 days where monitoring was conducted by PSOs. However, the actual number of detections per day varied widely from a day where there were no detections at all (11 April 2011) to days where there were an exceptionally large number of detections, 35 detections on 10 April 2011 and 41 detections on 18 April 2011 (Figure 9).

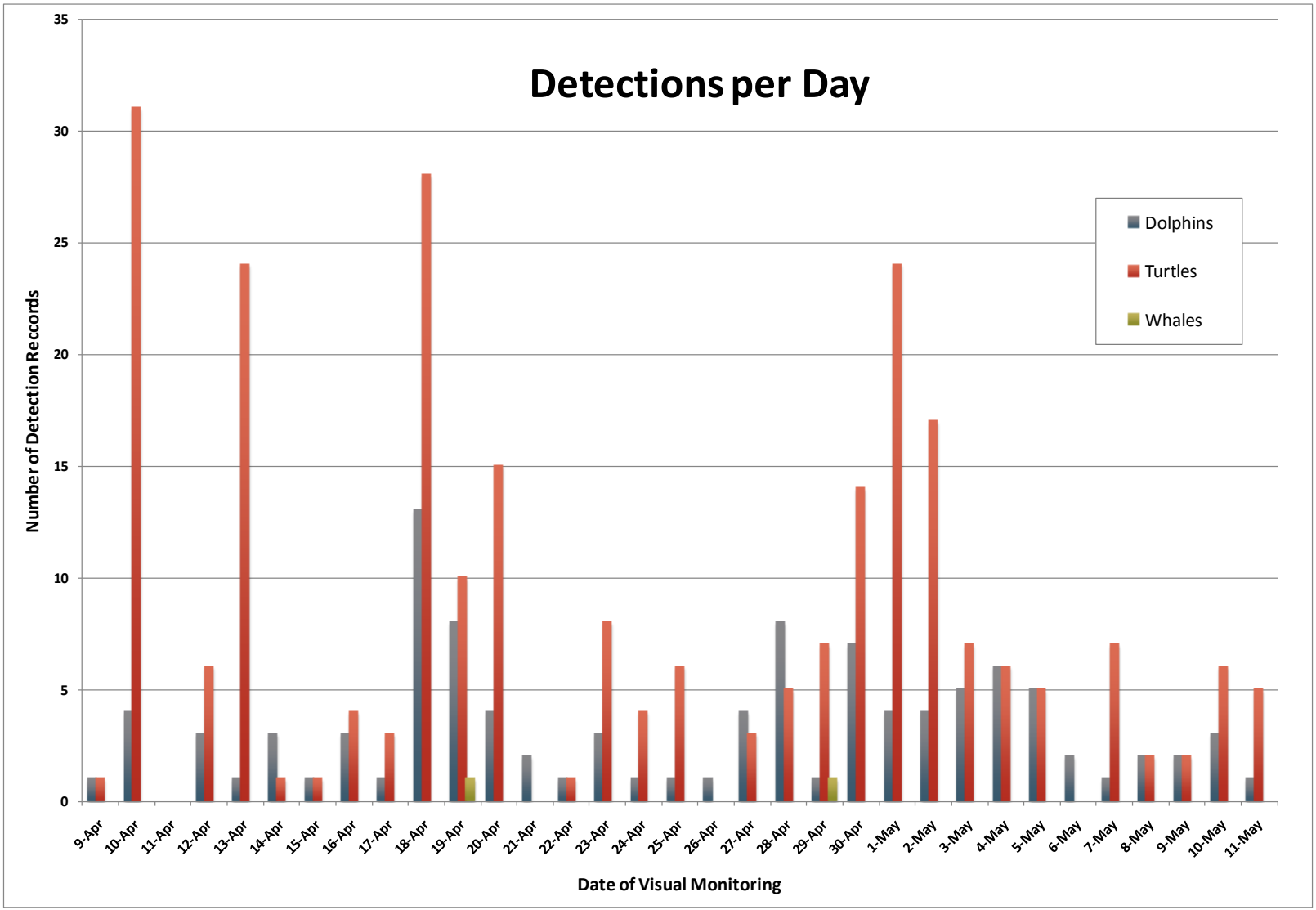


Figure 9. Number of detection records of protected species each day of the project

The number and type of protected species varied with water depth, with both whale detections occurring in deeper water (one in water depth between 100 and 1000m and the other in water greater than 1000m deep). The highest percentage of dolphin detections were made in water depths less than 100m whereas the greatest number of sea turtles were sighted in water depths of greater than 1000 meters (Figure 10).

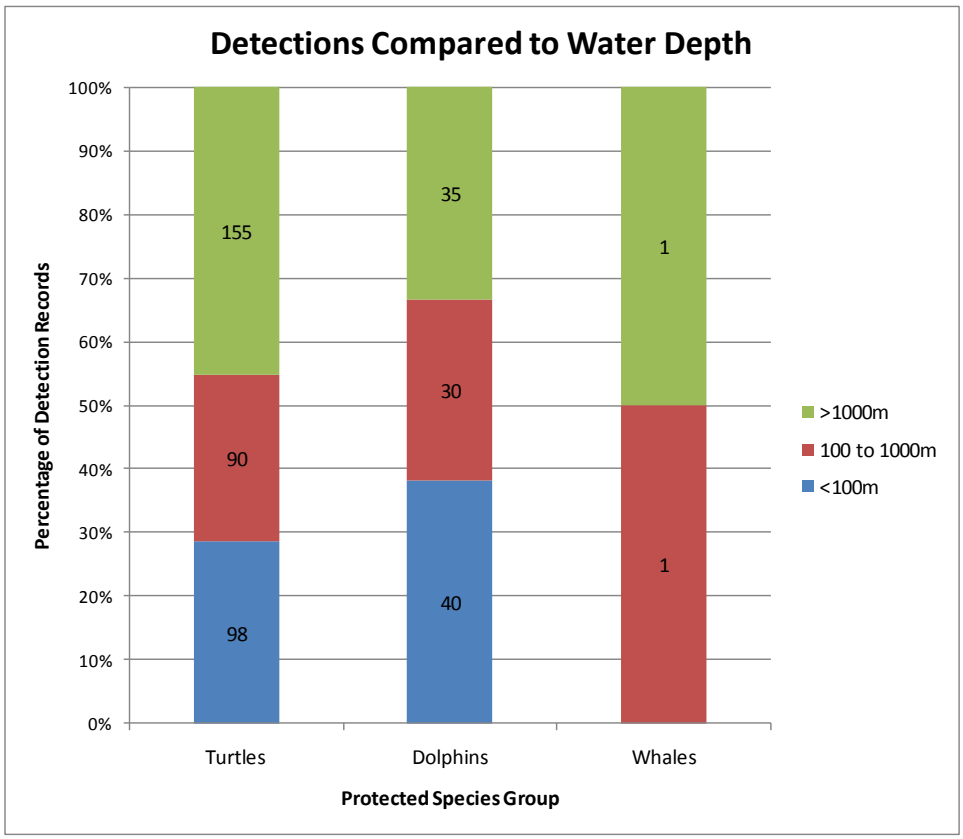


Figure 10. Number of protected species detections made at varying water depths

5.1. MARINE MAMMAL DETECTIONS

Marine mammals belonging to the Order Cetacea were the only marine mammals detected during the survey. No sirenians or pinnipeds were detected nor were they expected to be detected due to the location of the survey. Delphinids were detected much more frequently than whales, making up 98% (106 records) of all cetacean records collected. The majority of the cetacean detections were made visually by the PSOs with only nine acoustic detections made on the PAM system. Of the nine acoustic detections five were correlated to visual detections. These five detections that were correlated were all of pantropical dolphins. There were four acoustic detections that were not correlated to a visual detection. These four acoustic detections consisted of three pantropical dolphins and one sperm whale. The distributions of the visual and acoustic detections can be seen in Figure 11.

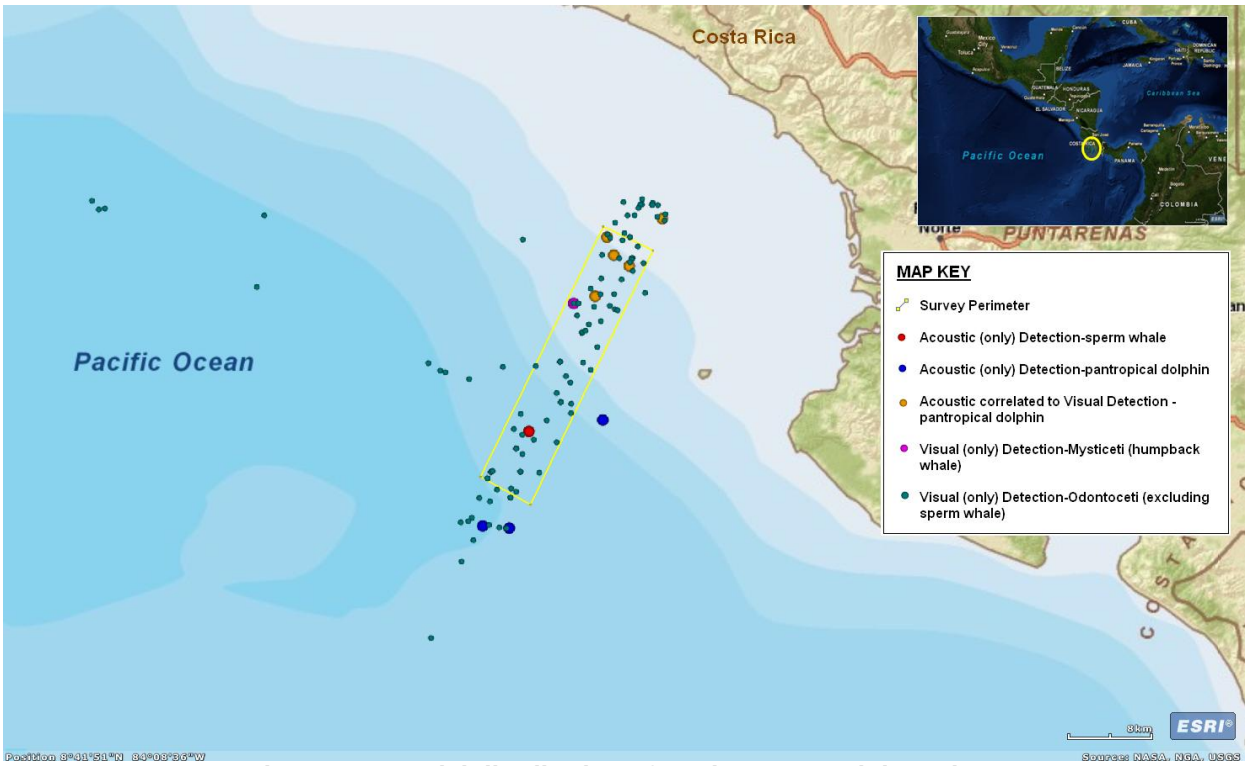


Figure 11. Spatial distribution of marine mammal detections

Detection rates (number of detections per monitoring effort) for the marine mammals observed throughout the project are recorded in Table 7 and depicted in Figure 12 below. The airguns were considered to be firing regardless of the source volume so detections of protected species made while the single 40 in^3 airgun was operating are included in this category.

Table 7: Detection rate of cetaceans while the acoustic source was active and silent

Type of Monitoring	Airguns Firing			Airguns Not Firing		
	Hrs of Monitoring	# Cetacean Detections	Dets/Hr Monitoring	Hrs of Monitoring	# Cetacean Detections	Dets/Hr Monitoring
Visual	367:58:00	91	0.2473	65:25:00	13	0.19873
Acoustic	516:14:00	8	0.0156	28:58:00	1	0.03452

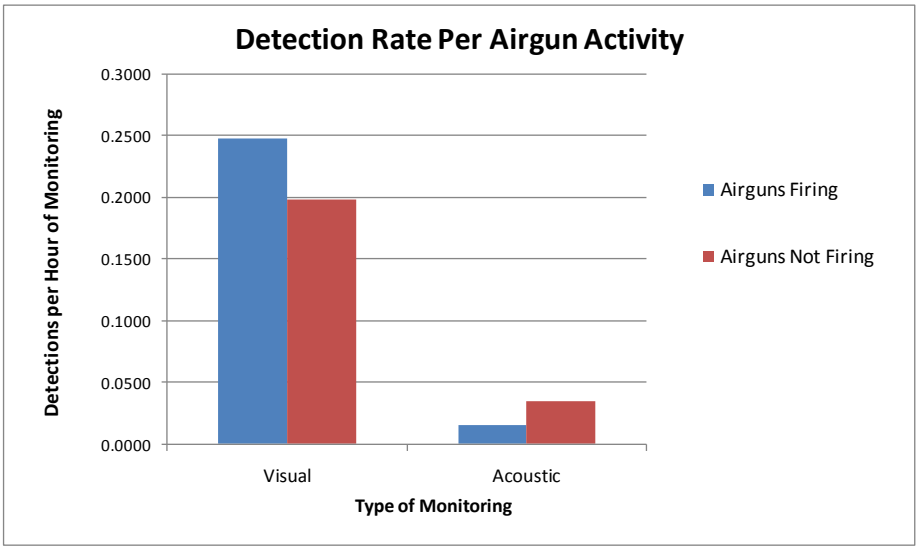


Figure 12. Acoustic and visual monitoring detection rates of cetaceans while airguns active and silent

5.1.1. Visual Detections

One of the two detections of a whale during the Bangs Crisp Seismic Survey was made visually. A Humpback whale was tentatively identified based on the blow and body shape seen briefly from a distance of almost 4 kilometers (Detection #141 on 19 Apr). All of the remaining visual sightings of cetaceans were delphinids, with 12 different dolphin species identified. Pantropical spotted dolphins (*Stenella attenuata*) were sighted more frequently than any other species, a total of 39 times during the project (Table 7). Many species were observed infrequently, including a few sighted on only on occasion: killer whales, false killer whales and melon-headed whales (Figure 14). Several of the dolphin records were collected for pods of dolphins that could not be identified to the species level. Many species of dolphins have a similar appearance, with different species distinguished by difficult to observe features such as size and shape of the beak or distinct colouration. These features can be invisible at a distance or during a brief sighting. These animal(s) were included in the classification group 'Unidentified Dolphin sp'.

Dolphin pod sizes varied with small (less than 10 animals) and average sized pods (between 10 and 50 animals) sighted more often than large pods containing more than 50 animals (Figure 13). Pod sized varied with species and some species, short-beaked common dolphins and spinner dolphins were sighted more often in large groups, and so while they were not observed as frequently, these two species were observed in the highest numbers throughout the survey (Figure 15).

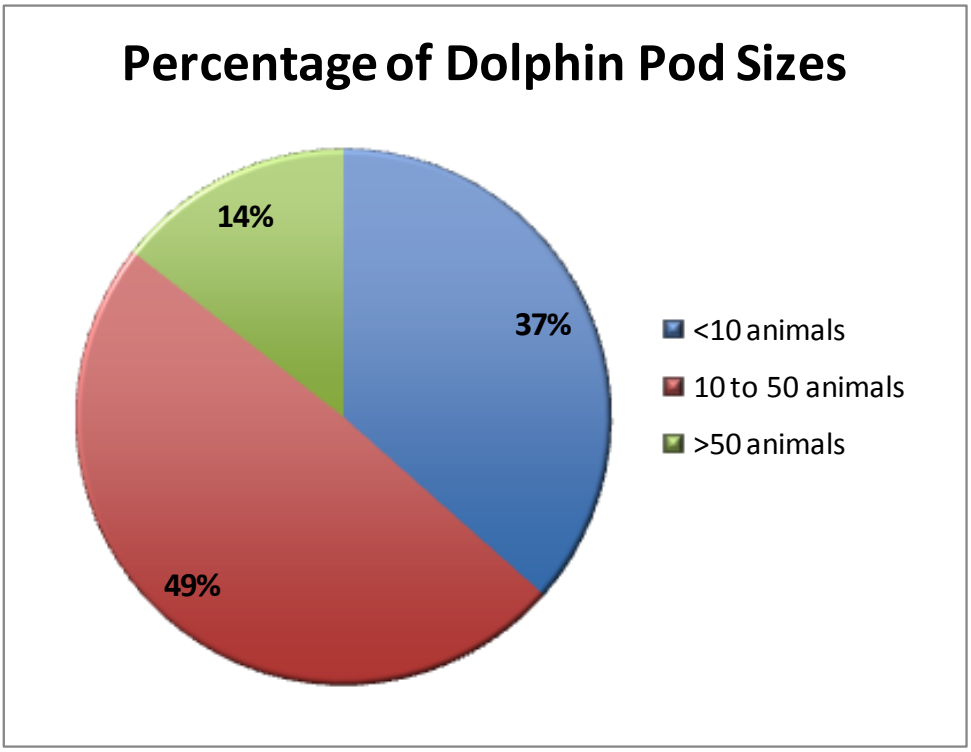


Figure 13. Percentage of sizes of dolphin pods sighted during the Bangs survey

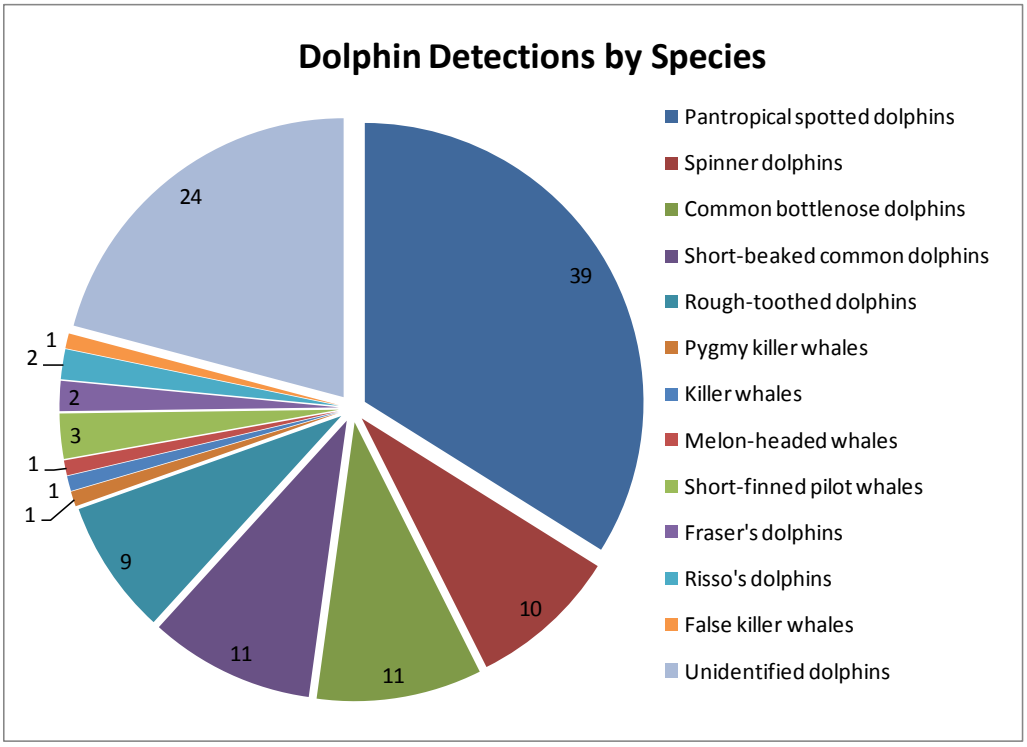


Figure 14. Number of sighting records of dolphin species during the Bangs Crisp survey

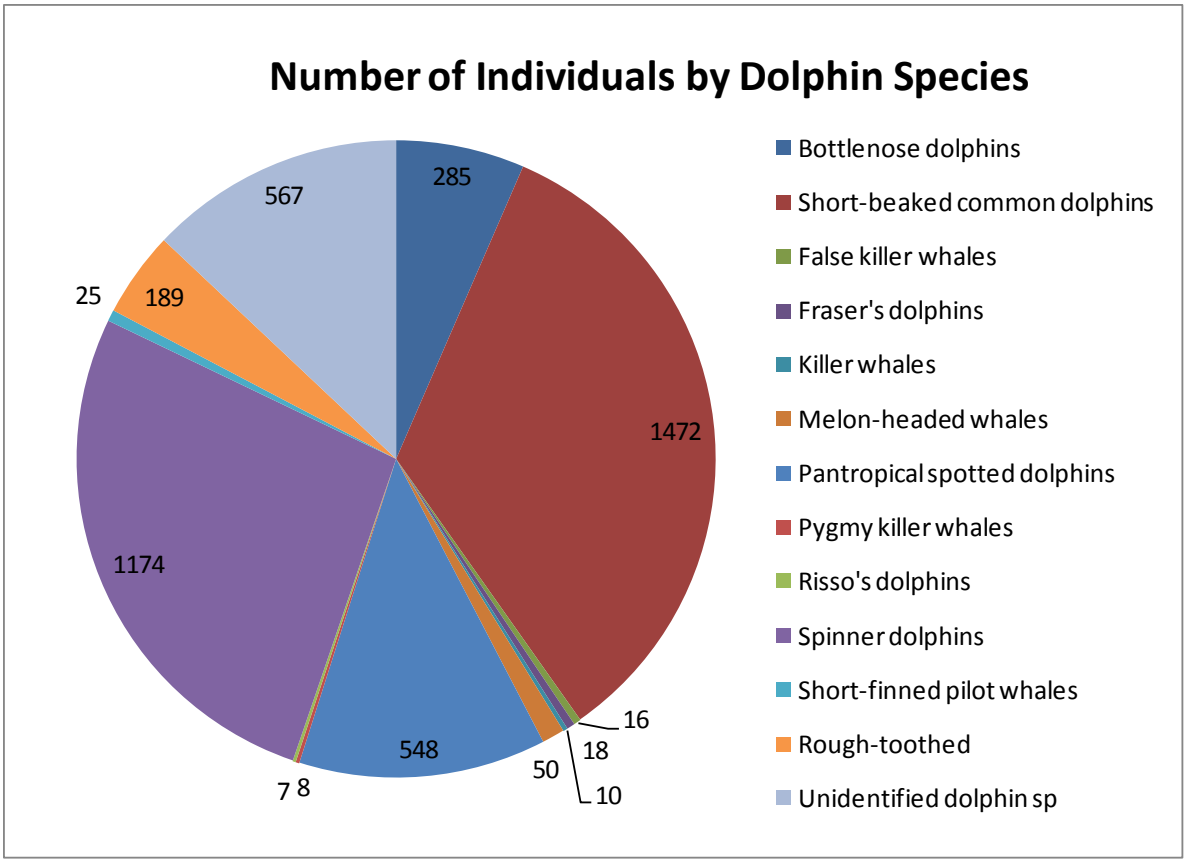


Figure 15. Number of animals sighted of each dolphin species during the Bangs Crisp survey

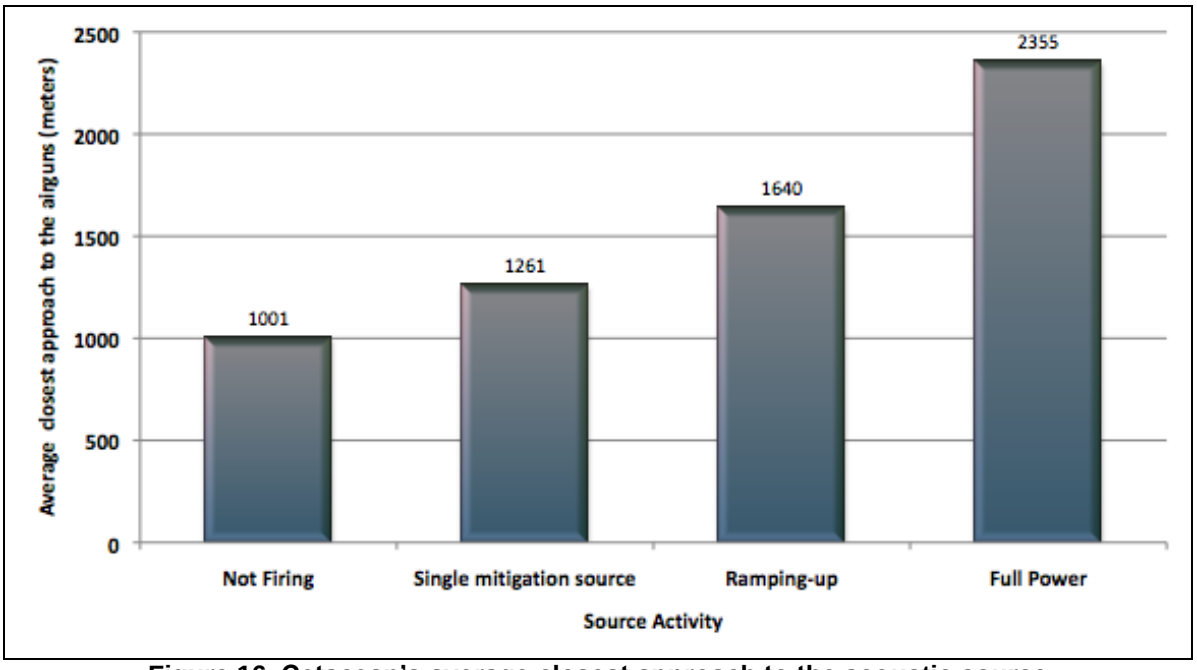


Figure 16. Cetacean's average closest approach to the acoustic source

The closest approach to the vessel's acoustic source was recorded each time a cetacean species was sighted, regardless of the source activity (firing on full power, ramping-up, single 40

in^3 gun firing or source silent). Cetaceans sighted while the acoustic sources were silent had an average closest approach to the airguns of 1001m (Figure 16) whereas cetaceans sighted while the airguns were firing on full power had an average closest approach to the source of 2355m.

5.1.2. Acoustic Detections

Nine acoustic detections were made on the installed PAM system during the Bangs Crisp survey. All the acoustic detections were of delphinid species with the exception of one sperm whale (*Physeter macrocephalus*) detected on 28 April (Acoustic Detection Record #4). Acoustic detections are summarized in Table 8 below.

Table 8: Acoustic detections during the Bangs Crisp seismic survey

Date	Detection Record	Corresponding Visual Sighting?	Species	Detection Cues	Airgun activity
16-Apr	1	Y (#84)	Pantropical spotted dolphins	Whistles	Full power
21-Apr	2	Y (#168)	Pantropical spotted dolphins	Whistles	Full power
27-Apr	3	Y (#197)	Pantropical spotted dolphin	Whistles	Full power
28-Apr	4	N	Sperm whale	Echolocation clicks	Full power
28-Apr	5	Y (#204)	Pantropical spotted dolphins	Whistles	Full power
3-May	6	N	Unidentified dolphin sp	Whistles	Single gun 40 in^3
4-May	7	Y (#308)	Pantropical spotted dolphin	Echolocation clicks	Not firing
5-May	8	N	Unidentified dolphin sp	Echolocation clicks	Full power
5-May	9	N	Unidentified dolphin sp	Whistles	Full power

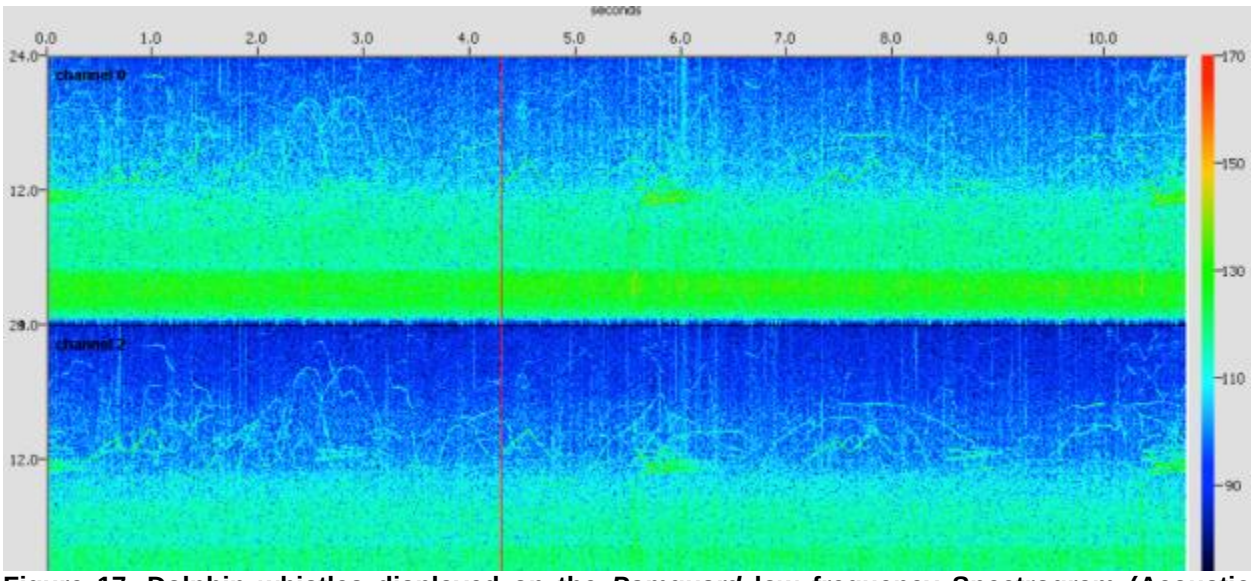


Figure 17. Dolphin whistles displayed on the *Pamguard* low frequency Spectrogram (Acoustic Detection #9, 3 May)

Most acoustic detections were short, lasting a couple of minutes and consisting of delphinid whistles detected aurally and visually on the low frequency Spectrogram. The longest acoustic detection occurred on 5-May (Acoustic Detection #9) when the operator detected dolphin whistles for nearly ten minutes (Figure 17). Acoustic vocalizations had a detection signal

strength of 2.5 to 4 rated on the Gannier scale (Gannier, 2002) where the signal is rated against the background noise level.

There were four acoustic detections that occurred at night when no PSOs were conducting visual observations. A PSO was notified and a visual search of the safety radius was performed using the night vision devices, however no animals were sighted in any of these acoustic detection events. These vocalizations were often short in duration and may not have allowed sufficient time for a PSO to get into position on deck or bridge to begin the search. Moreover, the range capabilities of the night vision devices may have limited the possibility of a visual detection.

The only acoustic detection of a sperm whale(s) occurred over a period over three minutes when loud echolocation clicks were detected aurally and by *Pamguard* on the low frequency Spectrogram and Click Detector. The PAM Operator began to track the clicks (Figure 18) in order to determine and display a range to the animal on the Map module when the clicks stopped abruptly. Insufficient time had passed to allow *Pamguard* to get an accurate fix on the range of the animal.

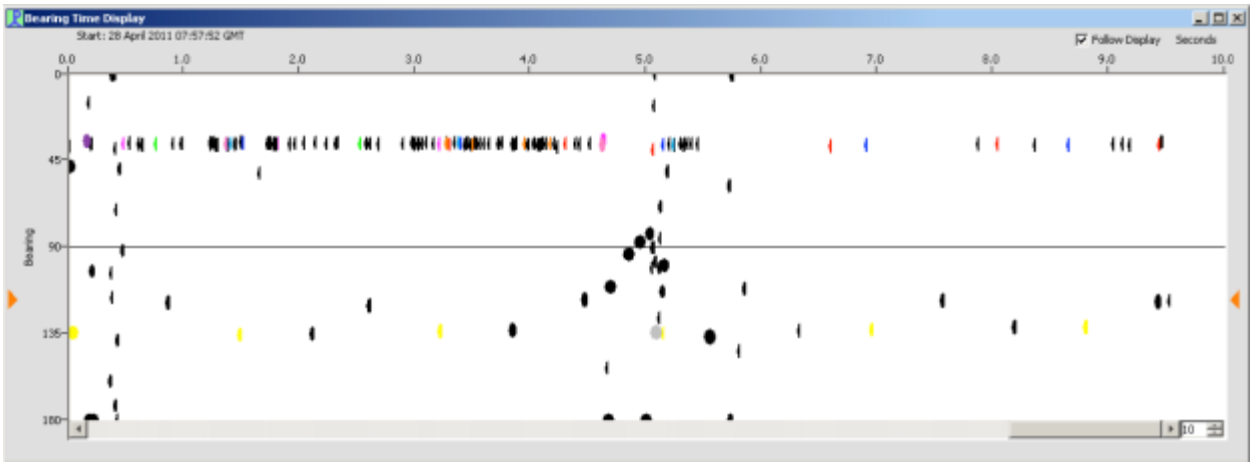


Figure 18. Sperm whale clicks displayed on the bearing screen of the Pamguard low frequency click detector, tracked to determine range to the animal

5.1.3. Correlated Visual and Acoustic Detections

Five of the project's acoustic marine mammal detections occurred in conjunction with a visual sighting of the animal. These acoustic detections correlated with a visual detection were all pods of pantropical spotted dolphins. In each instance, the first visual sighting of the dolphins occurred before the first acoustic detection of the animals. All of the acoustic detections accompanied by correlated visual sightings occurred with pods of dolphins that approached the vessel within less than one kilometre of the source. Not all close visual sightings of cetaceans resulted in a corresponding acoustic detection. No acoustic detection of marine mammals occurred during any of the 69 sightings of dolphin pods for which the hydrophone cable was deployed with closest approaches to the source greater than one kilometer (Table 9).

Table 9. Acoustic detections with correlated visual sightings by closest approach of the cetacean group to the source

Cetacean Sightings	Number Visual Sightings	Number Sightings Occurring with Simultaneous Acoustic Monitoring	Number of Correlated Acoustic Detections
Cetaceans sighted <1000m from source	35	20	4
Cetaceans sighted >1000m from source	69	38	0

5.2. SEA TURTLE SIGHTINGS

Sea turtles were the most abundant of protected species sighted during this seismic survey, with a total of 351 individual sea turtles observed within 253 detections of sea turtles. The sea turtle detections included 230 sightings of olive ridley turtles, 17 unidentified hard-shelled turtles, five green sea turtles, and one hawksbill sea turtle (Figure 19). Most sightings were comprised of a single individual, with the exception of some of the olive ridley sightings which were recorded together as one sighting as if they were detected at the same time while the ship was passing through groups of them. The distribution of sea turtle detections can be seen in Figure 20.

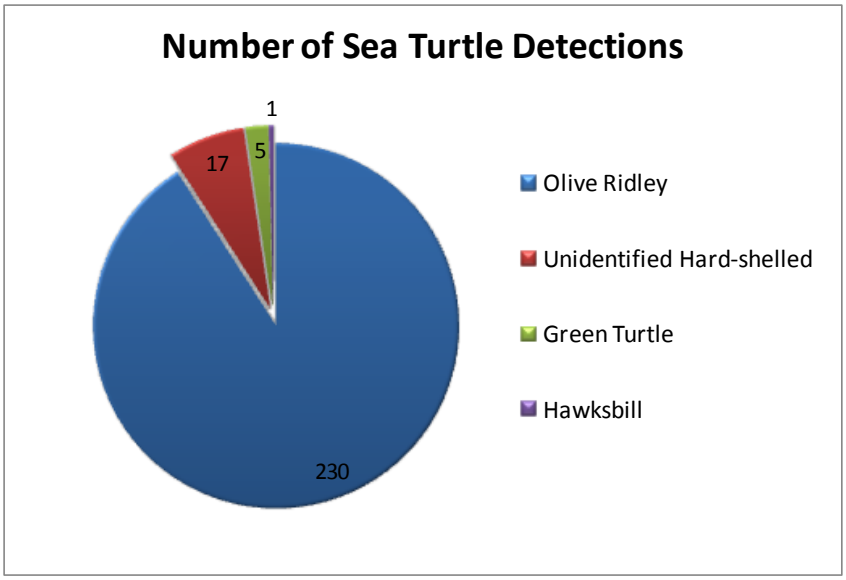


Figure 19. Number of sea turtle sightings by species detected by PSOs.

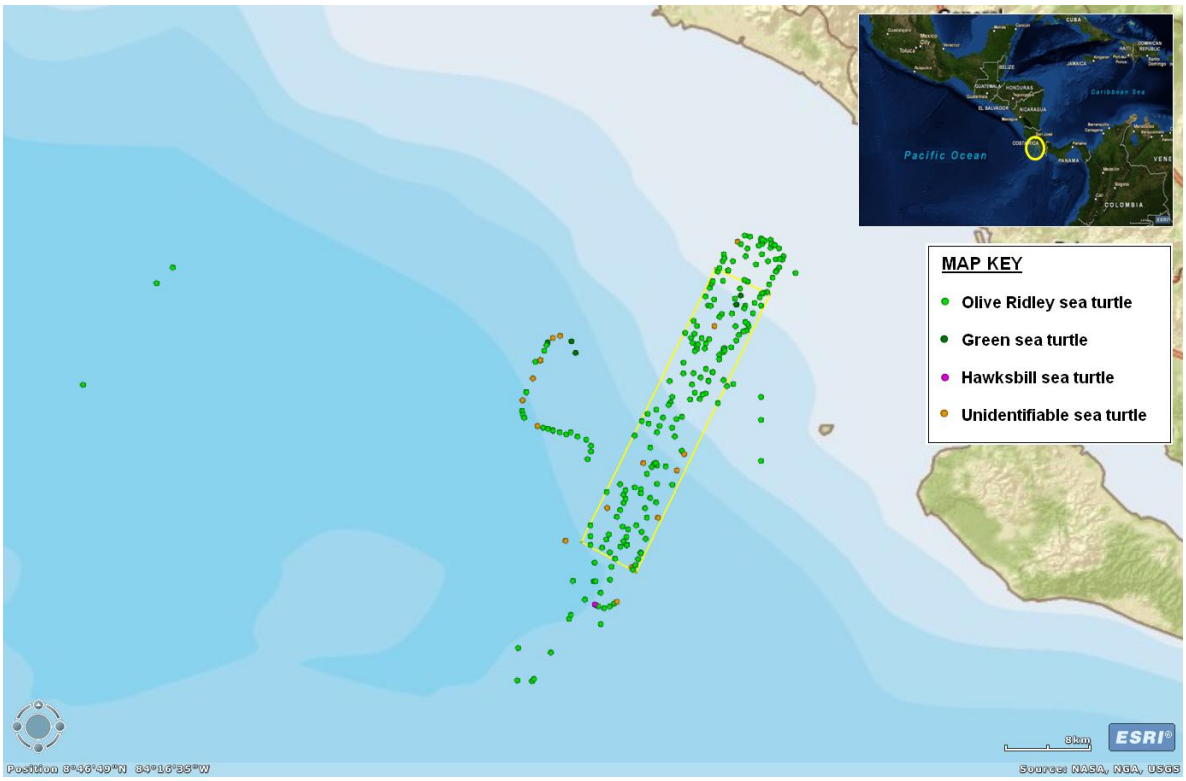


Figure 20. Spatial distribution of sea turtle detections

Keeping in mind the conservation recommendations of the IHA, which advises that the "NSF should promote and fund research examining the potential effects of seismic surveys on listed sea turtles," the sea turtle data were analysed to determine if there might be any changes in behaviour in relation to gun activity and the turtle's location inside or outside the 180 dB radii. These data were not designed as a scientific study and these results are not conclusive, but given the high number of sea turtle sightings during this seismic survey, an effort was made to summarize the most important observations.

The appropriate safety radius was applied according to requirements of the IHA (Table 1 in Appendix A). Sightings consisting of multiple turtles were not included as it was not possible to determine how many turtles had exhibited potential avoidance behaviour. Detections where key data were incomplete, i.e. water depth where airguns were not active were also eliminated, since the safety radius of 180 dB is dependent on water depth. Excluded data consisted of thirty-five records which had more than one turtle sighted, nine records with no water depth recorded, and one record that did not include the turtle's proximity to the safety radius.

Significantly fewer turtles were observed while the airguns were silent compared with the number detected while the airguns were firing throughout most of the survey and the majority of the visual observation effort (36 turtles were detected while the airguns were silent compared with 181 turtles detected while the airguns were firing.) In order to compare the behaviour of turtles not exposed to airgun activity vs. those exposed to airgun activity, a hypothetical 180dB safety radius was determined where a full power source was assumed and the water depth at the time of the sighting was accounted for. For example, a turtle sighted in shallow water of depth less than 100 meters while the airguns were not firing was considered to be within the 180dB safety radius if it was within 1030 meters of the center of the non-firing source (the same

180dB safety radius for the source were it firing on full power).

Of the 36 sea turtles detected while the airguns were not firing, 26 were inside the hypothetical 180dB safety radius and 10 were outside the radius. Of the turtles observed within the safety radius, 73% changed behaviour while 90% of turtles located outside the radius showed changed behaviour.

When comparing the percentages of changes in behaviour between the safety radii and gun activity there appears to be little difference in rates of change in behaviour of sea turtles whether the guns were active or silent (Figure 21). It is possible that the vessel approach is the major source change in sea turtle behaviour and the airgun activity has a negligible effect. It is also possible that the safety radius of the 180dB may not be sufficient to ensure that sea turtles located outside the radius are in fact not still experiencing and reacting to effects from the acoustic source, in which case the effect of the vessel on turtle behaviour has not been adequately separated from the effects of the active acoustic source.

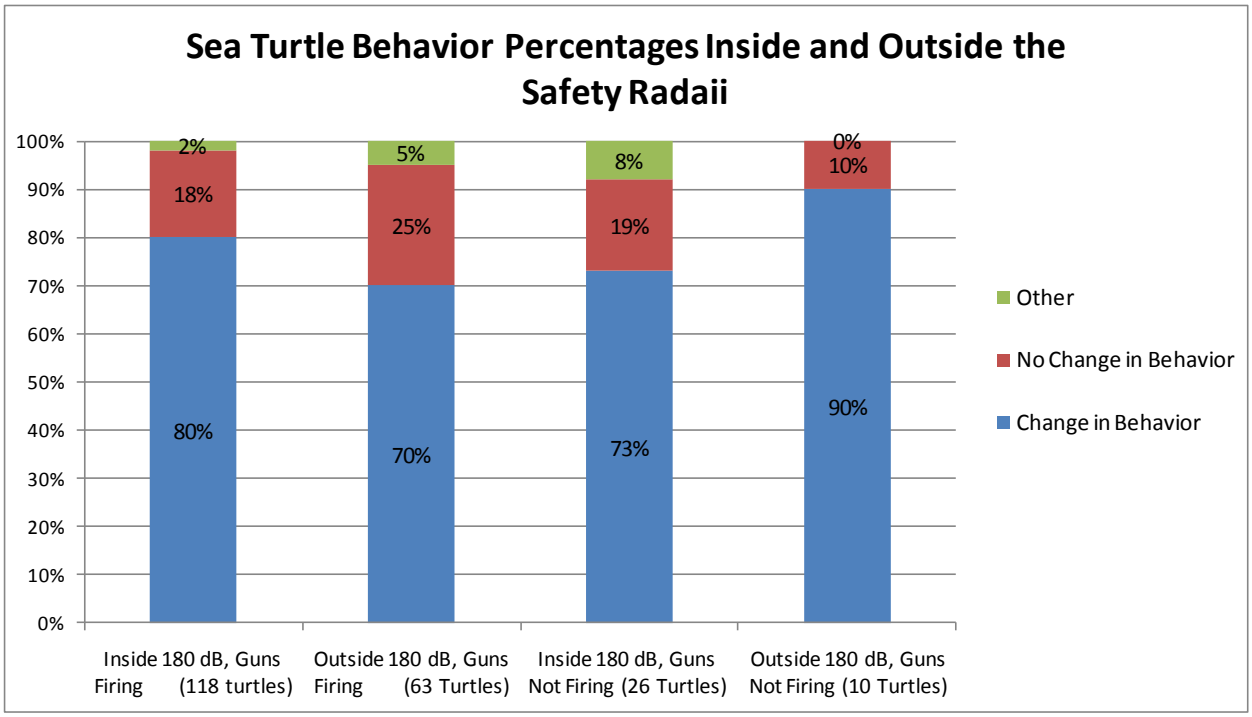


Figure 21. Comparison sea turtle behaviour percentages inside and outside safety radii.

Diving behaviour was the most commonly observed change in behaviour, followed by turtles observed changing heading and diving (Figure 22). While these behaviours have been classified as "potential avoidance behaviours," there is also the potential that these activities were not undertaken by the turtle in order to avoid the vessel and/or acoustic source. Sea turtles may dive or change directions for a multitude of natural reasons unrelated to vessel or seismic activity and experts in sea turtle biology and behaviour would be essential in determining actual avoidance behaviours from estimations of avoidance behaviours.

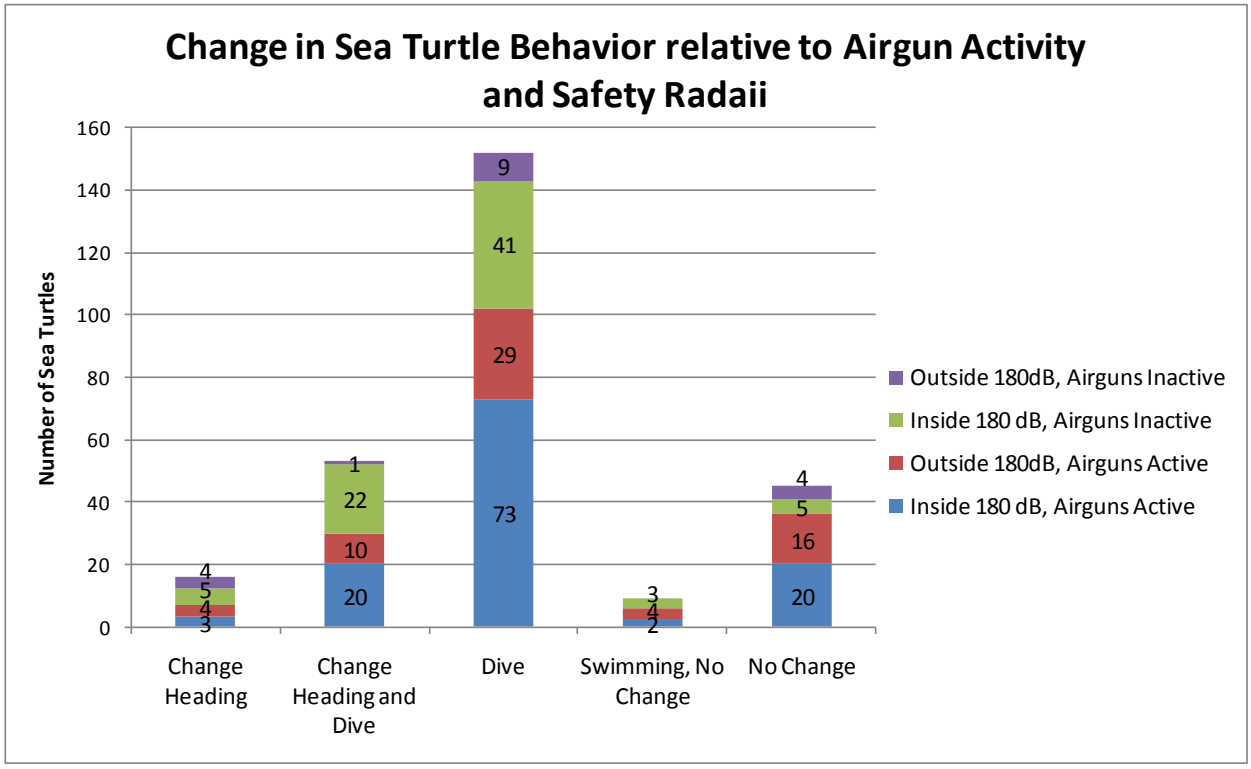


Figure 22. Number of occurrences of each type of potential avoidance behaviour by gun activity and the animal's location in relation to the 180dB safety radius.

6. MITIGATION ACTION SUMMARY

There were a total of 176 mitigation actions implemented during this survey, the complete list of which can be found in Appendix J. This included 19 delays of ramp-ups (2 hours and 14 minutes), 118 power-down procedures (11 hours and 43 minutes), and 39 shut-down procedures (4 hours and 17 minutes (Table 10).

Table 10: Number and duration of mitigation procedures implemented during the Bangs Crisp survey

Mitigation Action	Cetaceans		Sea Turtles		Total	
	Number	Duration	Number	Duration	Number	Duration
Delayed Ramp-ups	4	0:35	15	1:39	**19**	**2:14**
Power-downs	12	2:07	106	9:36	**118**	**11:43**
Shut-downs	4	0:48	35	3:29	**39**	**4:17**
Total	**20**	**3:30**	**156**	**14:44**	**176**	**18:14**

The majority of the mitigation procedures implemented during this survey were due to the sighting of a sea turtle inside the safety radius. Of the 19 delays to ramp-up performed during the survey, four were initiated due to cetaceans present in the safety radius prior to the commencement of seismic operations and the remaining 15 were implemented for sea turtles. Only 12 of the survey's 108 power-down procedures were implemented for cetaceans (a total duration of 2 hours and 7 minutes). Sea turtle power-down procedures were initiated 106 times with a duration of 9 hours and 36 minutes. Four shut-down procedures were performed for cetacean species (a total of 48 minutes) while 35 sea turtle shut-downs were accumulated over the course of the survey, with a total duration of 3 hours and 29 minutes (Table 10).

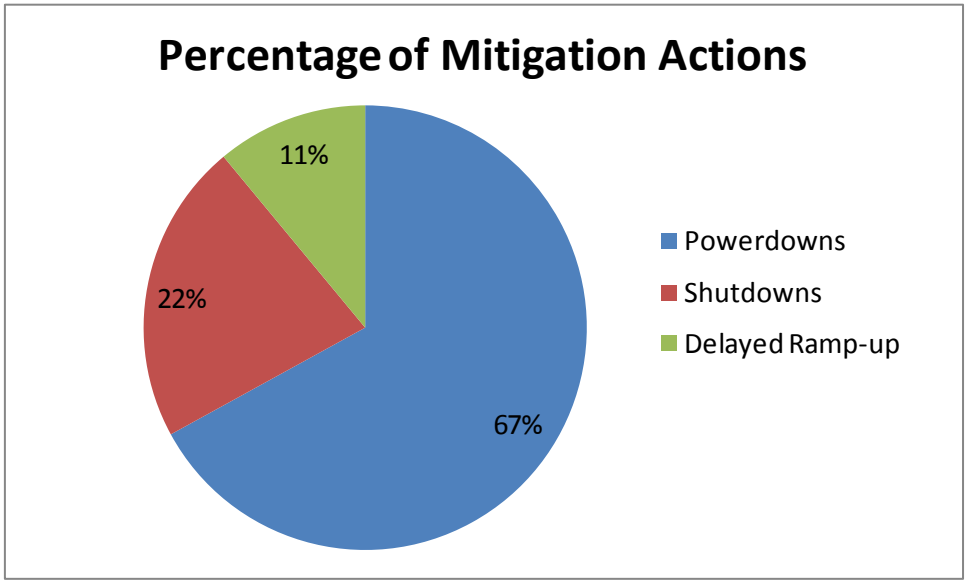


Figure 23. Number of each type of mitigation action implemented over the survey as a percentage of the total number of mitigation actions implemented

More power-down procedures were initiated than any other mitigation actions, accounting for 67% of all mitigation procedures implemented during this survey (Figure 23). Delays to ramp-ups were the most infrequently performed mitigation action, accounting for only 11% of the total number of mitigation actions taken. Power-downs procedures also resulted in the greatest duration of mitigation down-time of all the mitigation actions. Power-down procedure downtime accounted for 64% of the total mitigation downtime of the project. (Figure 24). Mitigation downtime consists of the time period for which acquisition is suspended in order to perform the mitigation procedure required by the IHA. For vessel purposes, the actual downtime resulting for a mitigation action is much longer, when the time required to return to acquire the missing data is factored in.

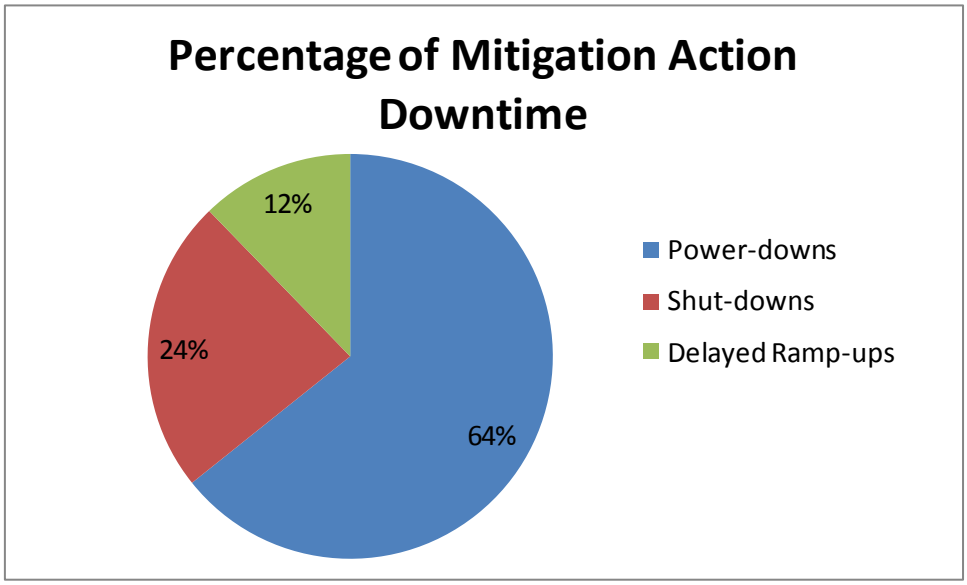


Figure 24. Duration of mitigation procedures as a percentage of total mitigation action downtime.

6.1. ESTIMATED NUMBER OF MARINE MAMMAL POTENTIALLY EXPOSED TO THE ENERGY SOURCE

Estimates from Direct Observations:
Marine mammals potentially exposed to sounds ≥ 160 dB re 1 µParms.
From the total of 99 groups of cetaceans sighted during airguns activity, 65 groups of them (2387 individuals) occurred within the ≥ 160 dB radius. The species included in those groups were eight of short-beaked common dolphins, one group of pigmy killer whale, one group of short-finned pilot whales, one group of Risso's dolphins, two groups of Fraser's dolphins, 22 groups of pantropical spotted dolphins, six of spinner dolphins, eight of rough toothed dolphins, seven groups of bottlenose dolphins and nine groups of unidentified dolphins. A humpback whale was also detected within this radius (See Table 11).

The ≥ 160 dB radius of the 18 airguns array was estimated to be of 19.5 km in shallow (<100m) waters, 5.7 km for medium (100-1000 m) and 3.8km for deep (>1000 m) waters. It is possible that small cetaceans exposed to that sound level probably surfaced without being seen by the PSOs. Other cetaceans would be also exposed during airgun activity in nighttime and poor visibility periods. However, exposure of delphinids to levels ~160 dB re 1 μPa_{rms} may not result in significant disturbance.

Table 11. Number of groups and individuals exposed to sounds > 160 dB re 1 μPa_{rms}

Species	Number of groups				Number of individuals			
	<100m	100-1000m	>1000m	Total	<100m	100-1000m	>1000m	Total
Humpback whale						1		1
Pigmy killer whale		1		1		8		8
Short-finned pilot whale		1		1		12		12
Risso's dolphin			1	1			5	5
Fraser's dolphin	2			2	18			18
Pantropical spotted dolphin	14	7	1	22	133	132	11	276
Spinner dolphin	1	2	3	6	20	270	266	556
Rough-toothed dolphin		5	3	8		138	49	187
Short-beaked common dolphin	2	2	4	8	15	525	517	1057
Bottlenose dolphin	3	3	1	7	9	65	45	119
Unidentified dolphins	2	5	2	9	16	83	49	148
Totals	24	26	15	65	211	1234	942	2387

Marine mammals potentially exposed to sounds ≥ 180 dB re 1 µParms.

From the total of 99 groups of cetaceans sighted during airguns activity, 14 groups (totaling 181 individuals) were detected within the ≥ 180 dB radius, comprising one group of short-finned pilot whale, 12 groups of pantropical spotted dolphins, one individual of bottlenose dolphin and one group of unidentified dolphins (See Table 12). Mitigation measures were implemented for sightings occurred within this safety radius. However, at least five groups of pantropical spotted dolphins (totaling 66 individuals), one group of 25 unidentified dolphins and one individual of bottlenose dolphin were exposed to sound levels ≥ 180 dB prior to the power-down, as animals were below the surface while inside the safety radius before surfacing and being detected by the PSOs.

Table 12. Number of groups and individuals exposed to sounds > 180 dB re 1 μPa_{rms}

Species	Number of groups				Number of individuals			
	<100m	100-1000m	>1000m	Total	<100m	100-1000m	>1000m	Total
Humpback whale								
Pigmy killer whale								
Short-finned pilot whale			1	1			8	8
Risso's dolphin								
Fraser's dolphin								
Pantropical spotted dolphin	9	3		12	102	45		147
Spinner dolphin								
Rough-toothed dolphin								
Short-beaked common dolphin								
Bottlenose dolphin					1			1
Unidentified dolphins	1			1	25			25
Totals	10	3	1	14	128	45	8	181

It is important to consider that the estimated 180 dB radii includes the maximum distances from the airgun array where sound levels are expected to be ≥ 180 dB re 1 μPa_{rms} and these distances differ depending of the water depth and the direction from the airgun array. Received sound levels near the surface are reduced because of pressure release effects, being stronger

directly below the airguns. Some animals may have been within the 180 dB radius while underwater and not visible to the PSOs and seen later outside this radius. It is unknown if the animals detected at the surface during airguns operation were earlier or later exposed to greater sound levels when diving.

Also, airgun operation during nighttime periods when PSOs were generally not on duty or had reduced visibility to detect marine mammals may be considered. Assuming that marine mammals could be detected in same numbers during nighttime as during day time, then the total numbers of exposed individuals to various sound levels should be considerably greater than numbers estimated by direct observations during daylight. These considerations mentioned above make difficult to accurately assess the maximum level to which the marine mammals have been exposed during this survey.

7. CONCLUSIONS AND RECOMMENDATIONS

7.1. IMPLEMENTATION AND EFFECTIVENESS OF THE BIOLOGICAL OPINION'S ITS AND IHA

The NMFS recommended in the ITS that "NSF should promote and fund research examining the potential effects of seismic surveys on listed sea turtles." This was a recommendation for future NSF consideration and potential action and was not considered to be practically achievable within the timeframe of the cruise. Thus no additional conservation recommendations were implemented during the action. Should the NSF fund future research on this topic through the standard NSF Merit Review process, the results would be made eventually publicly available.

8. ACKNOWLEDGEMENTS

The Protected Species Observers on board *Langseth* during the 2011 BANGS CRISP survey from RPS would like to thank the National Science Foundation (NSF), and Lamont-Doherty Earth Observatory (L-DEO) for the opportunity to work on this project. It was a pleasure to work with Dr. Nathan Bangs, Dr. Kirk McIntosh, Dr. Eli Silver and the other scientists. We would also like to thank the marine crew and science team on board the R/V *Langseth* for their assistance and hospitality.

We would like to thank the following individuals for their considerable help in making the programme a success.

- Meagan Cummings and Jeff Rupert from L-DEO and Holly Smith and Olivia Lee from NSF, and for their assistance, planning and preparation for the cruise.
- Rebecca Snyder from RPS for her support and installation of the PAM system.
- Matthew Dellinger from RPS and Vasile Tudoran from Tudoran Transport for providing logistical support to and from the project.
- We also thank Meagan Cummings and Anne Unietis for reviewing this report.

We would like to extend our sincere thanks and gratitude to everyone who helped support this project as it would not have been possible without the efforts and assistance of the many individuals and organizations involved.

9. LITERATURE CITED

Gannier, A., Drouot, V., andGoold, J.C., 2002, Distribution and relative abundance of sperm whales in the Merditeranian Sea*, Marine Ecology Progress series*, Volume 243 2002

APPENDIX A: INCIDENTAL HARASSMENT AUTHORIZATION

UNITED STATES DEPARTMENT DF CDMMERCE
National Dceanic and Atmospherlc Administration
NATIONAL MARINE FISHERIES SERVICE
Silver Spring, MD 20910

AR 0 6211

Meagan J. Cummings *1* Jeff Rupert
Marine Enviromnental & Safety Coordinator
Department of Marine Operations
Lamont-Doherty Earth Observatory
P.O. Box 1000
Palisades, New York 10964-8000

Dear Ms. Cummings:

Enclosed is an Incidental Harassment Authorization (IHA) issued to the Lamont-Doherty Earth Observatory, under the authority ofSection 101(a)(5)(D) ofthe Marine Mammal Protection Act (16 U.S.C. 1361 *et seq.),* to harass small numbers ofmarine mammals, by Level B harassment, incidental to the RIV *Marcus G. Langseth's* marine seismic survey offshore Costa Rica in the eastern tropical Pacific Ocean during April through June, 2011.

You are required to comply with the conditions contained in the IHA. In addition, you must cooperate with any Federal, state, or local agency monitoring the impacts ofyour activity and submit a report to the National Marine Fisheries Service's (NMFS) Office of Protected Resources within 90 days of the completion of the cruise. The IHA requires monitoring of marine mammals by qualified individuals before, during, and after seismic activities and reporting of marine mammal observations, including species, numbers, and behavioral modifications potentially resulting from this activity.

If you have any questions concerning the IHA or its requirements, please contact Jeannine Cody, Office ofProtected Resources, NMFS, at 301-713-2289.

Sincerely,

James H. Lecky
Director
Office of Protected Resources

Enclosures

*

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Silver Spring, MD 20910

DEPARTMENT OF COMMERCE

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

NATIONAL MARINE FISHERIES SERVICE

Incidental Harassment Authorization

Lamont-Doherty Earth Observatory, Columbia University, P.O. Box 1000, 61 Route 9W, Palisades, New York 10964-8000, is hereby authorized under section 101(a)(5)(D) of the Marine Mammal Protection Act (MMPA) (16 U.S.C. 1371(a)(5)(D)) and 50 CFR 216.107, to harass small numbers of marine mammals incidental to a marine geophysical survey conducted by the R/V *Marcus G. Langseth* (*Langseth*) offshore from Costa Rica in the Pacific Ocean April through June 2011.

1. This Authorization is valid from April 7, 2011 through June 6, 2011.

2. This Authorization is valid only for specified activities associated with the R/V *Marcus G. Langseth*'s (*Langseth*) seismic operations in the following specified geographic area:

   (a) Offshore Costa Rica, bounded by 8.5–9° N, 83.75–84.25° W offshore in the Pacific Ocean, as specified in L-DEO's Incidental Harassment Authorization application and Environmental Analysis.

3. Species Authorized and Level of Takes

   (a) The incidental taking of marine mammals, by Level B harassment only, is limited to the following species in the waters offshore from Costa Rica in the Pacific Ocean:

   (i) Mysticetes – see Table 2 (attached) for authorized species and take numbers.

   (ii) Odontocetes – see Table 2 (attached) for authorized species and take numbers.

   (iii) If any marine mammal species are encountered during seismic activities that are not listed in Table 2 (attached) for authorizing taking and are likely to be exposed to sound pressure levels (SPLs) greater than or equal to 160 dB re 1 µPa (rms), then the Holder of this Authorization must alter speed or course, power-down or shut-down the airguns to avoid take.

(b) The taking by injury (Level A harassment), serious injury, or death of any of the species listed in 3(a) or the taking of any kind of any other species of marine mammal is prohibited and may result in the modification, suspension or revocation of this Authorization.

(c) The methods authorized for taking by Level B harassment is limited to the following acoustic sources without an amendment to this Authorization:

(i) an 18-airgun subarray that may range in size from 40 to 360 cubic inches (in^3) with a total volume of approximately 3,300 cubic inches (in^3) as an energy source;

(ii) a multi-beam echosounder; and

(iii) a sub-bottom profiler.

4. The taking of any marine mammal in a manner prohibited under this Authorization must be reported immediately to the Office of Protected Resources, National Marine Fisheries Service (NMFS), at 301-713-2289.

5. The Holder of this Authorization is required to cooperate with NMFS and any other Federal, state or local agency monitoring the impacts of the activity on marine mammals.

6. Mitigation and Monitoring Requirements

The Holder of this Authorization is required to implement the following mitigation and monitoring requirements when conducting the specified activities to achieve the least practicable adverse impact on affected marine mammal species or stocks:

(a) Utilize two, NMFS-qualified, vessel-based Protected Species Visual Observers (PSVOs) (except during meal times and restroom breaks, when at least one PSVO will be on watch) to visually watch for and monitor marine mammals near the seismic source vessel during daytime airgun operations (from civil twilight-dawn to civil twilight-dusk) and before and during start-ups of airguns day or night. The *Langseth*'s vessel crew will also assist in detecting marine mammals, when practicable. PSVOs will have access to reticle binoculars (7x50 Fujinon), big-eye binoculars (25x150), and night vision devices. PSVO shifts will last no longer than 4 hours at a time. PSVOs will also make observations during daytime periods when the seismic system is not operating for comparison of animal abundance and behavior, when feasible.

(b) PSVOs will conduct monitoring while the airgun array and streamers are being deployed or recovered from the water.

(c) Record the following information when a marine mammal is sighted:

(i) species, group size, age/size/sex categories (if determinable), behavior when first sighted and after initial sighting, heading (if consistent), bearing and distance from seismic vessel, sighting cue, apparent reaction to the airguns or vessel (e.g., none, avoidance, approach, paralleling, etc., and including responses to ramp-up), and behavioral pace; and

(ii) time, location, heading, speed, activity of the vessel (including number of airguns operating and whether in state of ramp-up or power-down), sea state, visibility, and sun glare; and

(iii) the data listed under 6(c)(ii) will also be recorded at the start and end of each observation watch and during a watch whenever there is a change in one or more of the variables.

(d) Utilize the passive acoustic monitoring (PAM) system, to the maximum extent practicable, to detect and allow some localization of marine mammals around the *Langseth* during all airgun operations and during most periods when airguns are not operating. One PSVO and/or bioacoustician will monitor the PAM at all times in shifts no longer than 6 hours. A bioacoustician shall design and set up the PAM system and be present to operate or oversee PAM, and available when technical issues occur during the survey.

(e) Do and record the following when an animal is detected by the PAM:

(i) notify the PSVO immediately of a vocalizing marine mammal so a power-down or shut-down can be initiated, if required;

(ii) enter the information regarding the vocalization into a database. The data to be entered include an acoustic encounter identification number, whether it was linked with a visual sighting, date, time when first and last heard and whenever any additional information was recorded, position, and water depth when first detected, bearing if determinable, species or species group (e.g., unidentified dolphin, sperm whale), types and nature of sounds heard (e.g., clicks, continuous, sporadic, whistles, creaks, burst pulses, strength of signal, etc.), and any other notable information.

(f) Visually observe the entire extent of the exclusion zone (180 dB for cetaceans; see Table 1 [attached] for distances) using NMFS-qualified PSVOs, for at least 30 minutes prior to starting the airgun (day or night). If the PSVO finds a marine mammal within the exclusion zone, L-DEO must delay the seismic survey until the marine mammal(s) has left the area. If the PSVO sees a marine mammal that surfaces, then dives below the surface, the observer shall wait 30 minutes. If the PSVO sees no marine mammals during that time, they should assume that the animal has moved beyond the exclusion zone. If for any reason the entire radius cannot be seen for the entire 30 minutes (min) (i.e., rough seas, fog, darkness), or if marine mammals are near, approaching, or in the exclusion zone, the airguns may not be

started up. If one airgun is already running at a source level of at least 180 dB, L-DEO may start the second gun without observing the entire exclusion zone for 30 min prior, provided no marine mammals are known to be near the exclusion zone (in accordance with condition 6(h) below).

(g) Establish a 180-dB exclusion zone for marine mammals before the 18-airgun subarray (3,330 in^3) is in operation; and a 180-dB exclusion zone before a single airgun (40 in^3) is in operation, respectively. See Table 1 (attached) for distances and safety radii.

(h) Implement a "ramp-up" procedure when starting up at the beginning of seismic operations or anytime after the entire array has been shutdown for more than 8 min, which means start the smallest gun first and add airguns in a sequence such that the source level of the array will increase in steps not exceeding approximately 6 dB per 5-minute period. During ramp-up, the PSVOs will monitor the exclusion zone, and if marine mammals are sighted, a course/speed alteration, power-down, or shut-down will be implemented as though the full array were operational. Therefore, initiation of ramp-up procedures from shut-down requires that the PSVOs be able to view the full exclusion zone as described in 6(f) (above).

(i) Alter speed or course during seismic operations if a marine mammal, based on its position and relative motion, appears likely to enter the relevant exclusion zone. If speed or course alteration is not safe or practicable, or if after alteration the marine mammal still appears likely to enter the exclusion zone, further mitigation measures, such as power-down or shut-down, will be taken.

(j) P ower-down or shut-down the airgun(s) if a marine mammal is detected within, approaches, or enters the relevant exclusion zone (as defined in Table 1, attached). A shut-down means all operating airguns are shut-down. A power-down means reducing the number of operating airguns to a single operating 40 in^3 airgun, which reduces the exclusion zone to the degree that the animal(s) is outside of it.

(k) Following a power-down, if the marine mammal approaches the smaller designated exclusion zone, the airguns must then be completely shut-down. Airgun activity will not resume until the PSVO has visually observed the marine mammal(s) exiting the exclusion zone and is not likely to return, or has not been seen within the exclusion zone for 15 min for species with shorter dive durations (small odontocetes) or 30 min for species with longer dive durations (mysticetes and large odontocetes, including sperm, pygmy sperm, dwarf sperm, killer, and beaked whales).

(l) Following a power-down or shut-down and subsequent animal departure, airgun operations may resume following ramp-up procedures described in 6(h).

(m) Marine geophysical surveys may continue into night and low-light hours if such segment(s) of the survey is initiated when the entire relevant exclusion zones are visible and can be effectively monitored.

(n) No initiation of airgun array operations is permitted from a shut-down position at night or during low-light hours (such as in dense fog or heavy rain) when the entire relevant exclusion zone cannot be effectively monitored by the PSVOs on duty.

(o) To the maximum extent practicable, schedule seismic operations (i.e., shooting airguns) during daylight hours.

7. Reporting Requirements

The Holder of this Authorization is required to:

(a) Submit a draft report on all activities and monitoring results to the Office of Protected Resources, NMFS, within 90 days of the completion of the *Langseth*'s Costa Rica cruise. This report must contain and summarize the following information:

(i) Dates, times, locations, heading, speed, weather, sea conditions (including Beaufort sea state and wind force), and associated activities during all seismic operations and marine mammal sightings;

(ii) Species, number, location, distance from the vessel, and behavior of any marine mammals, as well as associated seismic activity (number of power-downs and shut-downs), observed throughout all monitoring activities.

(iii) An estimate of the number (by species) of marine mammals that: (A) are known to have been exposed to the seismic activity (based on visual observation) at received levels greater than or equal to 160 dB re 1 µPa (rms) and/or 180 dB re 1 µPa (rms) with a discussion of any specific behaviors those individuals exhibited; and (B) may have been exposed (based on modeling results) to the seismic activity at received levels greater than or equal to 160 dB re 1 µPa (rms) and/or 180 dB re 1 µPa (rms) with a discussion of the nature of the probable consequences of that exposure on the individuals that have been exposed.

(iv) A description of the implementation and effectiveness of the: (A) terms and conditions of the Biological Opinion's Incidental Take Statement (ITS) (attached); and (B) mitigation measures of the Incidental Harassment Authorization. For the Biological Opinion, the report will confirm the implementation of each Term and Condition, as well as any conservation recommendations, and describe their effectiveness, for minimizing the adverse effects of the action on listed marine mammals.

(b) Submit a final report to the Chief, Permits, Conservation, and Education Division, Office of Protected Resources, NMFS, within 30 days after receiving comments from NMFS on the draft report. If NMFS decides that the draft report needs no comments, the draft report will be considered to be the final report.

8. In the unanticipated event that any taking of a marine mammal in a manner prohibited by this Authorization occurs, such as an injury, serious injury or mortality, and are judged to result

from these activities, L-DEO will immediately report the incident to the Chief of the Permits, Conservation, and Education Division, Office of Protected Resources, NMFS, at 301-713-2289. L-DEO will postpone the research activities until NMFS is able to review the circumstances of the take. NMFS will work with L-DEO to determine whether modifications in the activities are appropriate and necessary, and notified the permit holder that they may resume sound source operations.

9. In the event that L-DEO discovers an injured or dead marine mammal that is judged to not have resulted from these activities, L-DEO will contact and report the incident to the Chief of the Permits, Conservation, and Education Division, Office of Protected Resources, NMFS, at 301-713-2289 within 24 hours of the discovery.

10. L-DEO is required to comply with the Terms and Conditions of the Incidental Take Statement (ITS) corresponding to NMFS' Biological Opinion issued to both NSF and NMFS' Office of Protected Resources (attached).

11. A copy of this Authorization and the ITS must be in the possession of all contractors and protected species observers operating under the authority of this Incidental Harassment Authorization.

APR 06 2011

James H. Lecky

Date

Director
Office of Protected Resources
National Marine Fisheries Service

Attachments

Attachment

Table 1. Exclusion Zone Radii for Triggering Mitigation.

Source and Volume	Water Depth	Predicted RMS Distances (m)	
		180 dB	160 dB
Single Bolt airgun (40 in^3)	Shallow < 100 m	296	1,050
	Intermediate 100 – 1,000 m	60	578
	Deep > 1,000 m	40	385
18-Airgun subarray (3,300 in^3)	Shallow < 100 m	1,030	19,500
	Intermediate 100 – 1,000 m	675	5,700
	Deep > 1,000 m	450	3,800

Table 2. Authorized Take Numbers for Each Marine Mammal Species in the ETP Survey Area.

Species	Authorized Take
Humpback whale (*Megaptera novaeangliae*)	18
Bryde's whale (*Balaenoptera brydei*)	10
Sei whale (*Balaenoptera borealis*)	0*
Fin whale (*Balaenoptera physalus*)	0*
Blue whale (*Balaenoptera musculus*)	8
Sperm whale (*Physeter macrocephalus*)	40
Pygmy/Dwarf sperm whale (*Kogia breviceps*)	0
Cuvier's beaked whale (*Ziphius cavirostris*)	15
Mesoplodon spp.	4
Rough-toothed dolphin (*Steno bredanensis*)	45
Bottlenose dolphin (*Tursiops truncatus*)	366
Pantropical spotted dolphin (*Stenella attenuata*)	954
Spinner dolphin (*Stenella longirostris*)	1,468
Striped dolphin (*Stenella coeruleoalba*)	622
Short-beaked common dolphin (*Delphinus delphis*)	3,077
Risso's dolphin (*Grampus griseus*)	91
Melon-headed whale (*Peponocephala electra*)	258[2]
Pygmy killer whale (*Feresa attenuata*)	30[2]
False killer whale (*Pseudorca crassidens*)	0
Killer whale (*Orcinus orca*)	52
Short-finned pilot whale (*Globicephala macrorhynchus*)	114

* The Incidental Take Statement does not authorize take for sei or fin whales.

Incidental take statement

Section 9 of the ESA and federal regulation pursuant to section 4(d) of the ESA prohibit the "take" of endangered and threatened species, respectively, without special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by the NMFS as an act which actually kills or injures wildlife, which may include significant habitat modification or degradation which actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of sections 7(b)(4) and 7(o)(2), taking that is incidental and not intended as part of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are nondiscretionary, and must be undertaken by the NSF and the Permits Division so that they become binding conditions for L-DEO for the exemption in section 7(o)(2) to apply. Section 7(b)(4) of the ESA requires that when a proposed agency action is found to be consistent with section 7(a)(2) of the ESA and the proposed action may incidentally take individuals of listed species, the NMFS will issue a statement that specifies the impact of any incidental taking of endangered or threatened species. To minimize such impacts, reasonable and prudent measures and term and conditions to implement the measures, must be provided. Only incidental take resulting from the agencies actions and any specified reasonable and prudent measures and terms and conditions identified in the incidental take statement are exempt from the taking prohibition of section 9(a), pursuant to section 7(o) of the ESA.

Section 7(b)(4)(C) of the ESA specifies that in order to provide an incidental take statement for an endangered or threatened species of marine mammal, the taking must be authorized under Section 101(a)(5) of the MMPA. One of the federal actions considered in this Opinion is the Permits Division's proposed authorization of the incidental taking of blue, humpback, and sperm whales pursuant to Section 101(a)(5)(D) of the MMPA. With this authorization, the incidental take of listed whales is exempt from the taking prohibition of Section 9(a), pursuant to Section 7(o) of the ESA.

Amount or extent of take

The NMFS anticipates the proposed seismic survey in the eastern tropical Pacific Ocean might result in the incidental take of listed species. The proposed action is expected to take 8 blue (8 exposures), 18 humpback (18 exposures), and 40 sperm whales (40 exposures) by exposing individuals to received seismic sound levels greater than 160 dB re 1 µPa by harassment. These estimates are based on the best available information of whale densities in the area to be ensonified above 160 dB re 1 µPa during the proposed activities. This incidental take would result primarily from exposure to acoustic energy during seismic operations and would be in the form of harassment. Death or injury of any individuals that are exposed is not expected.

We expect the proposed action will also take individual sea turtles as a result of exposure to acoustic energy during seismic studies, and we expect this take would also be in the form of harassment, with no death or injury expected for individuals exposed. Harassment of sea turtles is expected to occur at received levels above 166 dB re 1 µPa. As we cannot determine the number of individuals to which harassment will occur, we expect the extent of exposure will

occur within the 166 dB isopleth of the *Langseth's* airgun array.

Harassment of blue, humpback, and sperm whales exposed to seismic studies at levels less than 160 dB re 1 µPa, or of green, hawksbill, leatherback, loggerhead, and olive ridley sea turtles at levels less than 166 dB re 1 µPa, is not expected. If overt adverse reactions (for example, startle responses, dive reactions, or rapid departures from the area) by listed whales or sea turtles are observed outside of the 160 dB or 166 dB re 1 µPa isopleths, respectively, while airguns are operating, incidental take may be exceeded. If such reactions by listed species are observed while airguns, multibeam echosounder, or sub-bottom profiler are in operation, this may constitute take that is not covered in this Incidental Take Statement. The NSF and the Permits Division must contact the Endangered Species Division to determine whether reinitiation of consultation is required because of such operations.

Any incidental take of blue whales, humpback whales, sperm whales, or green sea turtles, hawksbill sea turtles, leatherback sea turtles, loggerhead sea turtles, and olive ridley sea turtles is restricted to the permitted action as proposed. If the actual incidental take meets or exceeds the predicted level, the NSF and Permits Division must reinitiate consultation. All anticipated takes would be "takes by harassment", as described previously, involving temporary changes in behavior.

Reasonable and prudent measures

The NMFS believes the reasonable and prudent measures described below are necessary and appropriate to minimize the impact of incidental take of listed whales and sea turtles resulting from the proposed action. These measures are non-discretionary and must be binding conditions of the NSF funding of the proposed seismic studies and the NMFS' authorization for the exemption in section 7(o)(2) to apply. If the NSF or the NMFS fail to ensure compliance with these terms and conditions, the protective coverage of section 7(o)(2) may lapse.

1. For listed sea turtle and marine mammal species these measures include the following: vessel-based visual monitoring by marine mammal and sea turtle observers as specified in the environmental assessment; speed or course alteration as practicable; implementation of a marine mammal and sea turtle exclusion zone within the 180 dB re 1 μPa_{rms} isopleth for shut-down procedures; and emergency shutdown procedures in the event of an injury or mortality of a listed marine mammal or sea turtle. The measures for marine mammals are required to be implemented through the terms of the IHA issued under section 101(a)(5)(D) and 50 CFR 216.107.
2. The implementation and effectiveness of mitigation measures incorporated as part of the Reasonable and Prudent Measure mentioned above and the associated Terms and Conditions must be monitored.

Terms and conditions

In order to be exempt from the prohibitions of section 9 of the ESA, the NSF, Permits Division, and L-DEO must comply with the following terms and conditions, which implement the Reasonable and Prudent Measures described above. These terms and conditions are non-discretionary.

To implement the Reasonable and Prudent Measures, the NSF and the NMFS shall ensure that

1. L-DEO implements the mitigation, monitoring, and reporting conditions contained in

the IHA and this Opinion.

2. The Chief of the Endangered Species Division is immediately informed of any changes or deletions to any portions of the monitoring plan or IHA.
3. L-DEO immediately reports all sightings and locations of injured or dead endangered and threatened species to the Permits Division and the NSF.
4. The NSF and the Permits Division provide a summary of the implementation and effectiveness of the terms of the IHA to the Chief of the Endangered Species Division. This report shall confirm the implementation of each term and summarize the effectiveness of the terms for minimizing the adverse effects of the project on listed whales and sea turtles.

Conservation recommendations

Section 7(a)(1) of the ESA directs federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

We recommend the following conservation recommendations, which would provide information for future consultations involving seismic surveys and the issuance of incidental harassment authorizations that may affect endangered large whales and endangered or threatened sea turtles

1. *Effects of seismic noise on sea turtles.* The NSF should promote and fund research examining the potential effects of seismic surveys on listed sea turtle species.

In order for the Endangered Species Division to be kept informed of actions minimizing or avoiding adverse effects on, or benefiting ESA-listed species or their habitats, the Permits Division should notify the Endangered Species Division of any conservation recommendations they implement in their final action.

Reinitiation notice

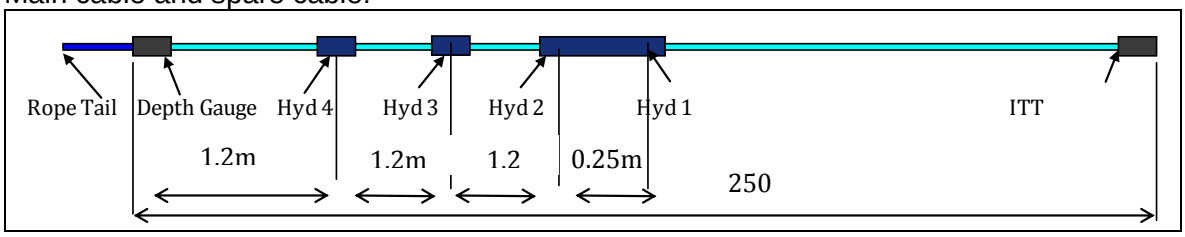
This concludes formal consultation on the proposed seismic source survey to be funded by the NSF and conducted by the L-DEO on board the *R/V Langseth* in the eastern tropical Pacific, and the issuance of an incidental harassment authorization for the proposed studies pursuant to section 101(a)(5)(D) of the Marine Mammal Protection Act (MMPA). As provided in 50 CFR §402.16, control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of authorized take is exceeded, section 7 consultation must be reinitiated immediately.

APPENDIX B: SUMMARY OF BASIC DATA

BASIC DATA FORM			
Project Number		UME4064	
Seismic Contractor		Lamont-Doherty Earth Observatory of Columbia University	
Client		National Science Foundation	
Area Surveyed During Reporting Period		**Latitude**	**Longitude**
	NW Corner	08.98˚N	84.075˚W
	NE Corner	08.9375˚N	83.98563˚W
	SW Corner	08.534˚N	84.296˚W
	SE Corner	08.4843˚N	84.206˚W
Survey Type		3D marine seismic	
Vessel and/or Rig Name		*R/V Marcus G. Langseth*	
Permit Number		IHA granted by NMFS on 6 April 2011	
Location / Distance of Airgun Deployment		Dual sources deployed 252.84m astern of vessel	
Water Depth	**Min**	58 meters	
	Max	2900 meters	
Dates of project		7 April 2011 through 12 May 2011	
Total time airguns operating – all power levels:		663:07	
Amount of time airguns operating at full power:		560:05	
Time airguns operating at full power on a survey line:		449:02	
Time airguns operating at full power on line changes:		111:03	
Amount of time mitigation gun operations (1 gun 40cu^3):		84:26	
Amount of time in ramp up:		18:36	
Number daytime ramp ups:		55	
Number of night time ramp ups:		6	
Number of ramp ups from mitigation source:		42	
Amount of time conducted in airgun testing:		00:00	
Duration of visual observations:		433:23	
Duration of observations while airguns firing:		367:58	
Duration of observation during airgun silence:		65:25	
Duration of acoustic monitoring:		542:25	
Duration of acoustic monitoring while airguns firing:		517:04	
Duration of acoustic monitoring during airgun silence:		25:21	
Visual Observers:		Diana Antochiw	
		Amanda Dubuque	
		Jose David Palacios	
		Meghan Piercy	
Primary PAM Operator:		Stephanie Milne	
Number of Marine Mammals Visually Detected:		108	
Number of Marine Mammals Acoustically Detected:		9	
Number of acoustic detections confirmed by visual sighting:		5	
Number of Sea Turtles detected:		253	
List Mitigation Actions (Shut-downs, Delayed ramp-ups; Power-downs)		Power-downs: 118; Shut-downs: 39; Delayed ramp-ups: 19	
Duration of operational downtime due to mitigation:		18:14	

APPENDIX C: PASSIVE ACOUSTIC MONITORING SYSTEM SPECIFICATIONS

Main cable and spare cable:



Mechanical Information

Length	250m		
Diameter	14mm over cable	32mm over mouldings	64mm over connectors
Weight	60kg		
Connector	CEEP 39 pin		

Hydrophone elements

Hydrophone 1	Sphere 1	Broad band	2 kHz to 200kHz	(3dB points)
Hydrophone 2	Sphere 2	Broad band	2 kHz to 200 kHz	(3dB points)
Hydrophone 3	Sphere 3	Broad band	2 kHz to 200 kHz	(3dB points)
Hydrophone 4	Sphere 4	Low frequency	75Hz to 30 kHz	(3dB points)

Depth Capability	100m	
Spacing between elements 1 & 2 (for HF detection)	0.25m	0.16mSecs
Spacing between elements 2 & 3 (for HF detection)	1.2m	0.8mSecs
Spacing between elements 3 & 4 (for LF detection)	1.2m	0.8mSecs

Interface unit Array 1 outputs

Broad band channel sensitivity	-166dB re 1V/uPa
Low frequency channel sensitivity	-157dB re 1V/uPa

Deck cable specification

Length	100m
Diameter	14mm
Connectors	39 pin ITT female
Flying lead for onboard connection	
Connector Diameter	64mm

Inboard Deck Cable specification

Length	1m
Diameter	14mm
Connectors	39 pin ITT male
Flying lead for onboard connection	
Connector Diameter	64mm

APPENDIX D: TYPICAL PAMGUARD SCREENSHOTS DURING THE BANGS CRISP 3D SEISMIC SURVEY

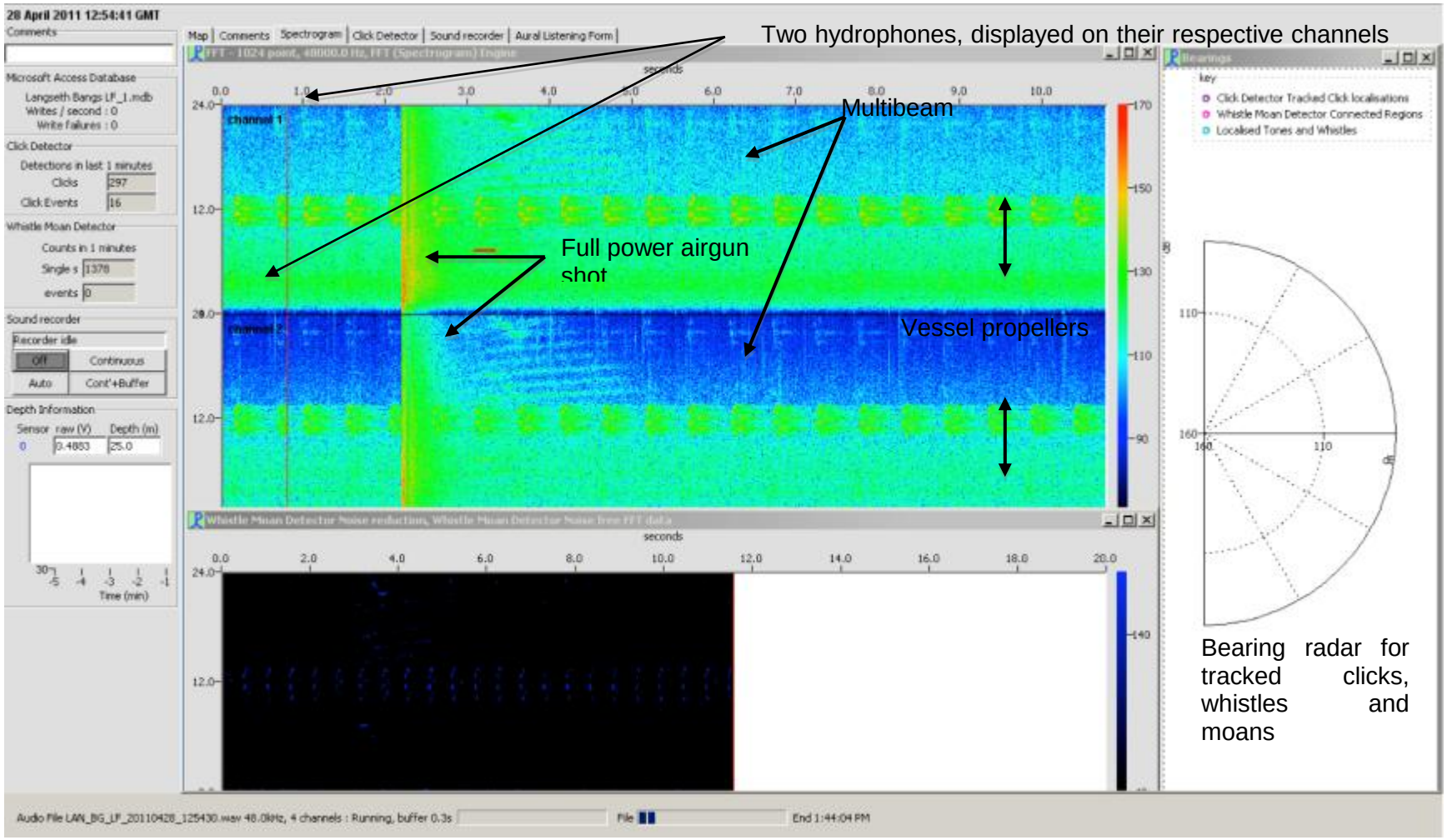


Figure 25. Main Pamguard low frequency operation screen displaying scrolling Spectrograms from two hydrophone channels and the Whistle and Moan Bearing Radar which plots the bearing of detected whistles and moans in relation to the hydrophones

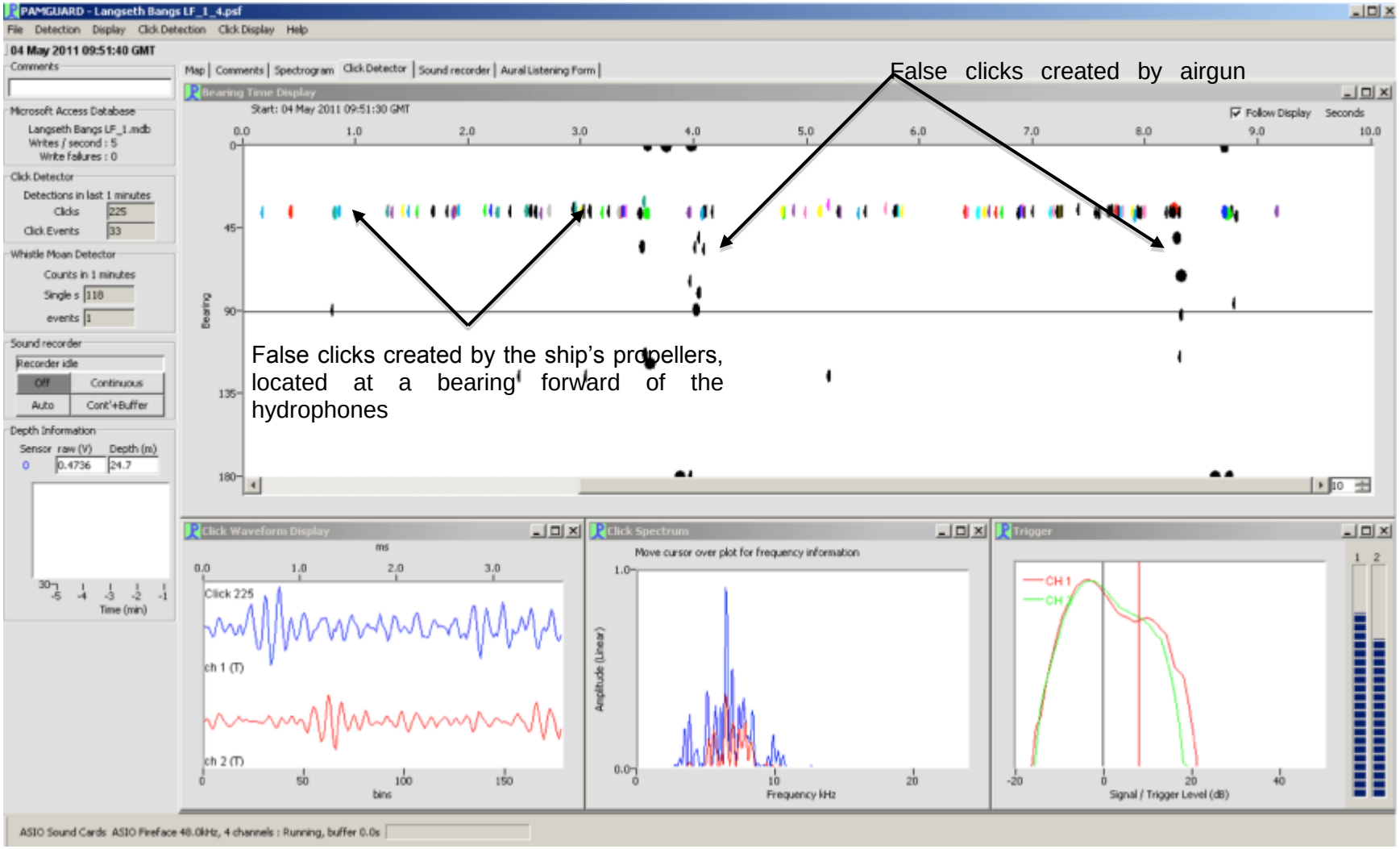


Figure 26. Click Detector module used on both high frequency and low frequency Pamguard laptops to track echolocation clicks

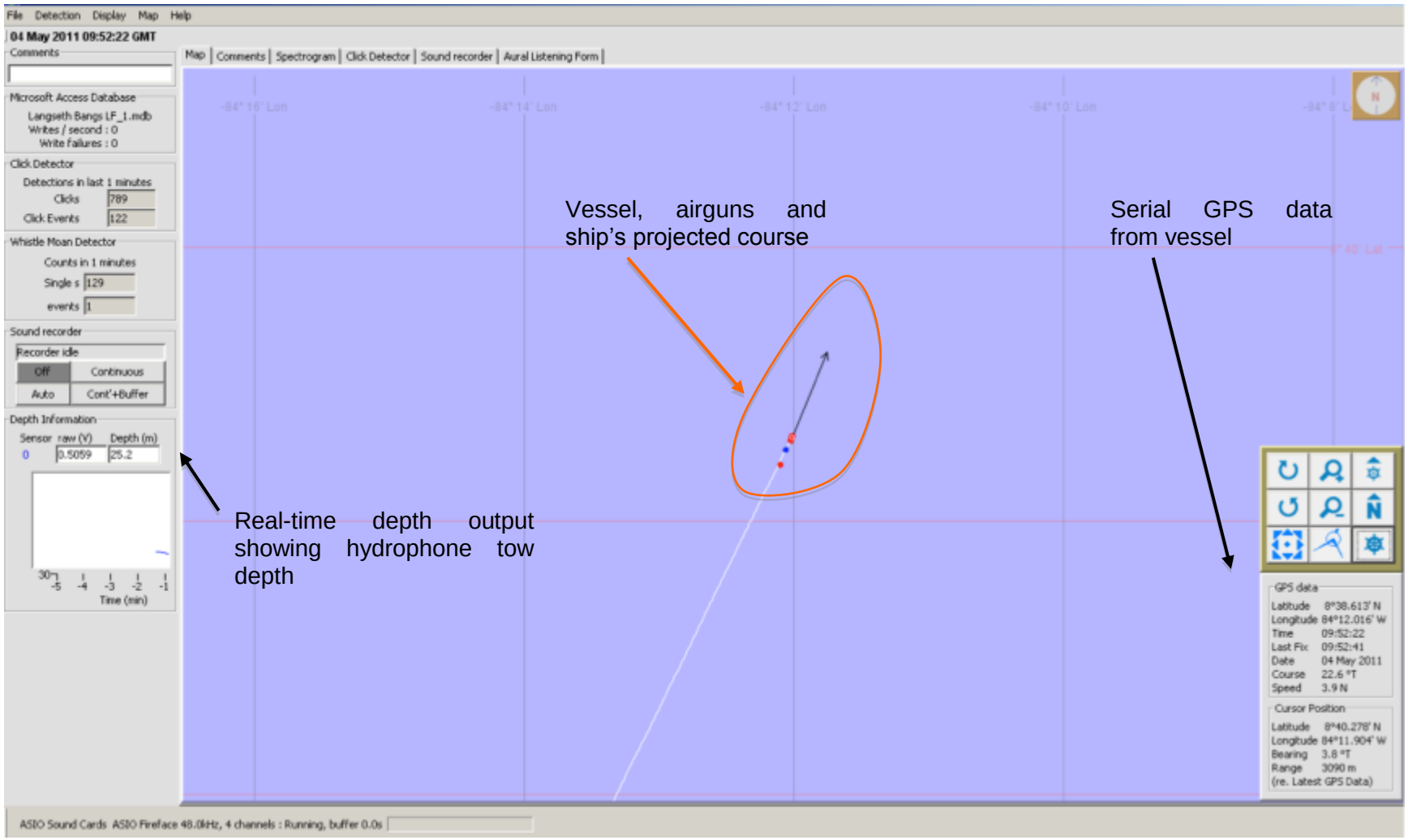


Figure 27. Map module on the low frequency Pamguard laptop where tracked marine mammal vocalisations can be plotted and range can be calculated

APPENDIX E: PAM HYDROPHONE DEPLOYMENT ON R/V MARCUS *LANGSETH*

OVERVIEW

The PAM hydrophone cable is deployed from a deckhead winch on the port stern gun deck directly off the stern over the side. The cable is pulled off the port side by a line attached to the barovane platform. The cable is weighted in two locations with lengths of chain, the first chain weighing 12kg taped in place parallel along the cable 20m ahead of the first hydrophone, and the second chain, weighing approximately the same, taped 75m from the end of the cable.

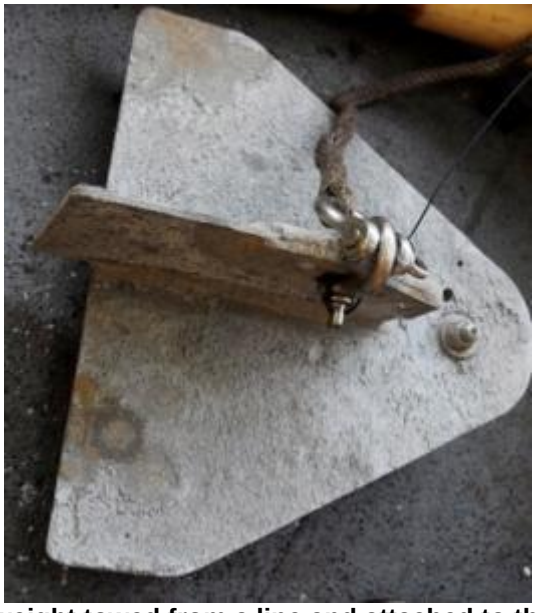


Figure 28. Depressor weight towed from a line and attached to the hydrophone cable to achieve sufficient towing depth to get below the gun umbilicals and streamer lead-ins

Once deployed this cable is connected to deck cable which transmits a 12 V power supply to the PAM hydrophones and the hydrophone signals to the onboard system in the science lab.

PAM HYDROPHONE CABLE

The PAM cable is 250 m in length total, although only approximately 150 m will be deployed. The final in-sea section includes 3 potted sections with hydrophone elements and a fourth potted section with a depth sensor. Towing depth is between 20 m and 25 m.

Once deployed the remaining hydrophone cable is kept on the deckhead winch on the port stern of the gun deck. It is connected to the deck cable at this location. The deck cable is routed to the PAM desk located in the science lab. The winch is disabled such that it cannot be operated while the deck cable and tow cable are connected.

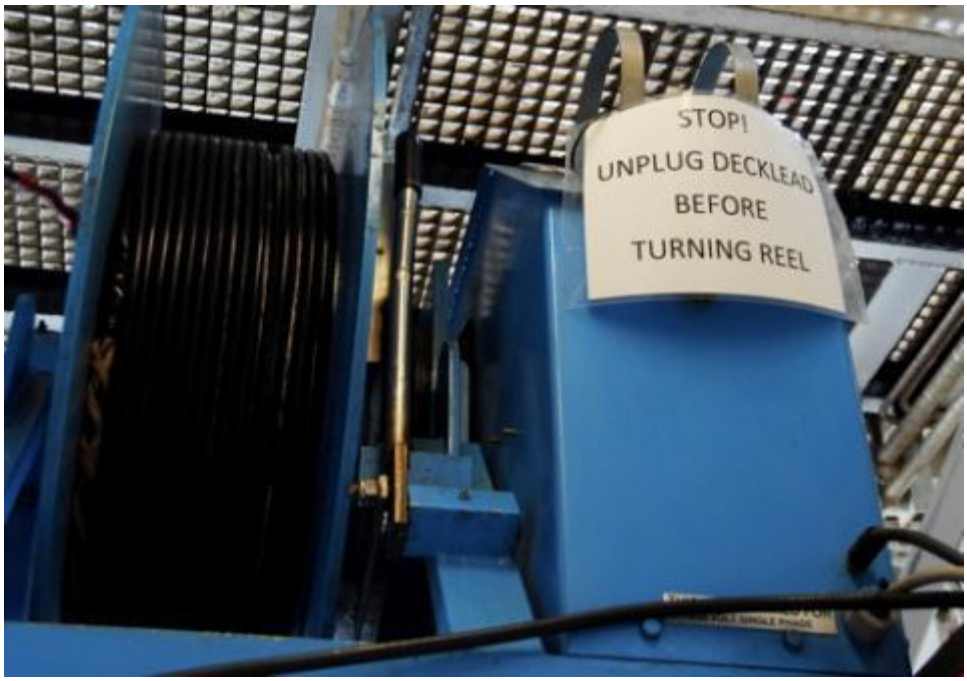


Figure 29. Deckhead winch on port stern gun deck with PAM hydrophone cable. Sign is placed over the switch that must be turned on to activate the winch. Winch cannot be operated while hydrophone cable and deck cable are connected

HSE

Personal protective equipment in required while deploying any equipment over the side (hard hat, steel toes, work vest). The operation carries a relatively low risk. Hazards include cable parting under tension, working close to the side of the vessel, entrapment in loose bights of cable, strain from heavy lifting and possible jellyfish stings during hand retrieval of the cable.

DEPLOYMENT

Deployment should proceed at a steady controlled pace. One person is required to operate the winch that deploys the hydrophone cable, a second person is required to assist in paying out the hydrophone cable sections where chain weights are attached.

1. Prior to the first deployment, 20 m of hydrophone cable should be measured from the first hydrophone element and three chain lengths taped end to end lying directly along the length of hydrophone cable. The chain should be taped tightly such that it does not rattle and as securely as possible in a streamlined manner to avoid creating points that could collect debris.
2. The hydrophone cable is paid out over the stern then deployed slowly using the winch.
3. After 75 m of cable have been deployed the second length of chain should be taped in place lying parallel along the cable in the same manner as the first chain.
4. Once approximately 150 m of hydrophone cable have been deployed, attach a chinese finger to the cable and connect to the line fixed to the outer barovane platform with a shackle. Deploy a few more meters of cable until the line goes taut, pulling the hydrophone cable off to the port side and away from the lead-in and umbilicals.

Figure 30. New PAM cable deployment set-up used after 2 May where depressor and it's tow line are eliminated. Cable is deployed by itself off PAM winch with diverter rope from port side barovane platform attached by chinese finger to pull the cable off to the port side

Figure 31. Two chinese fingers on the hydrophone cable 20m ahead of the first hydrophones. Shackle and line attach to the depressor weight

5. Power off the deckhead winch. Connect the deck cable to the hydrophone cable. Place lock-out tag over remote controls for winch to remind operator to check that deck and tow cables are disconnected before running the winch.

RETRIEVAL

Retreival should proceed at a steady controlled pace. One person is required to operate the winch that brings in the hydrophone cable, a second person is required to bring the cable sections on board where chain is attached.

1. The deck cable is disconnected from the hydrophone cable, ensuring that the spliced section of connector is tucked safely inside the reel or is disconnected.
2. The shackle connecting the Chinese finger on the hydrophone cable to the line from the barovane platform is disconnected.
3. The hydrophone cable is retrieved slowly using the winch, the assistant hauling the chain-weighted sections in by hand and guiding them onto the reel.
4. The hydrophone section of the cable is brought on board by hand and then spooled up onto the winch and off the deck.

Other Photos

Figure 32. Depressor tow line deployed from capsan alongside PAM hydrophone cable which is deployed from the deckhead winch

Figure 33. Hydrophone cable and depressor tow line wrapped around inner port side lead-in on 2 May.

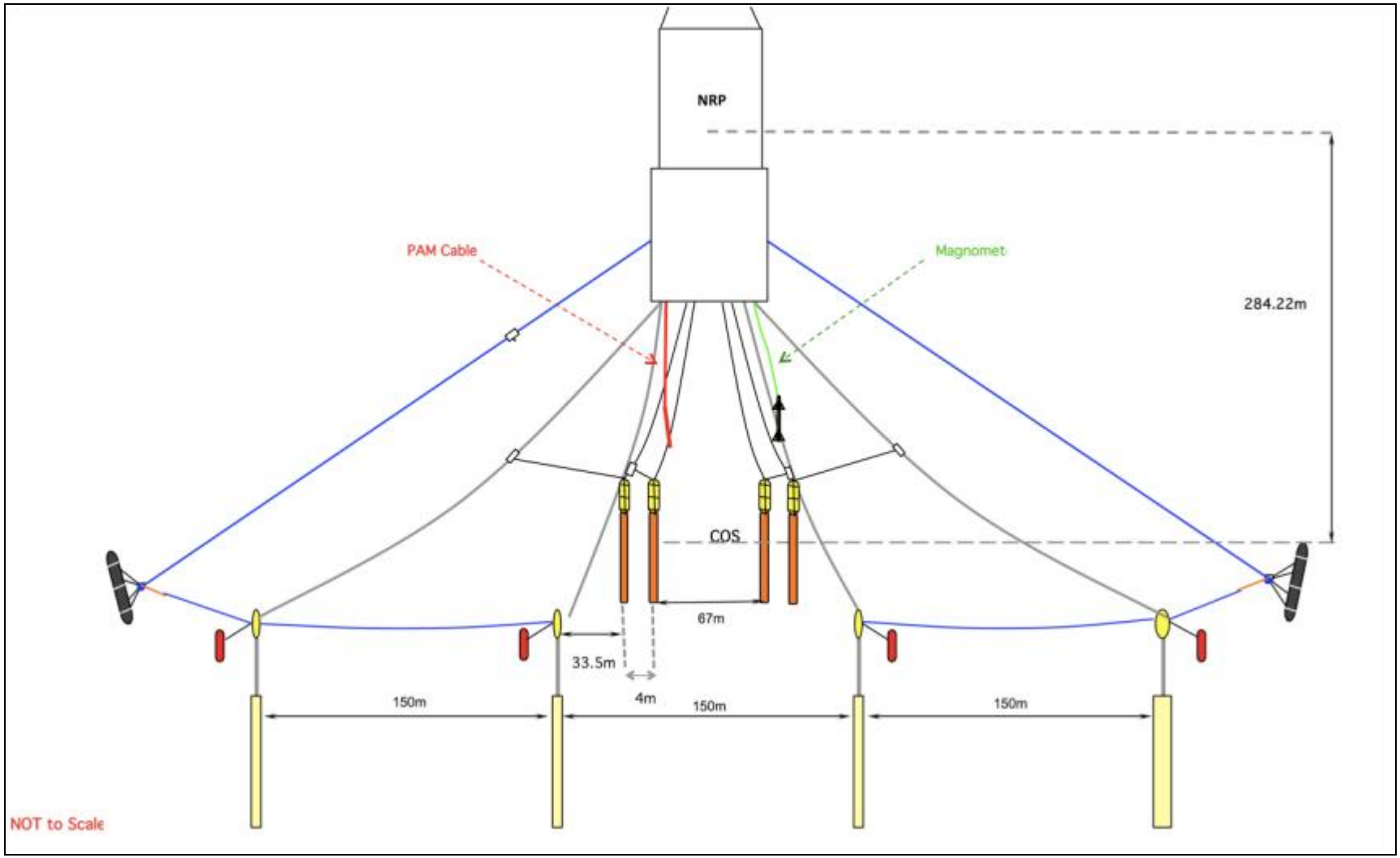


Figure 34. Location of the hydrophone cable while deployed with vessel seismic equipment (top view)

APPENDIX F: DATA RECORDED ON THE EFFORT AND DETECTION FORMS

Effort forms

Date: in YYYY-MM-DD format
Observers location: TW (MMO Tower), BR (Bridge), CW (Catwalk)
Observers' initials: DA (Diana Antochiw), AD (Amanda Dubuque), SM (Stephanie Milne), DP (José David Palacios Alfaro), MP (Meghan Piercy)

Start and end of observations
Time: in UTC with 24 hour format
Latitude: in decimals
Longitude: in decimals
Water depth: in meters

Vessel / Seismic Activity
Compass heading of vessel: in degrees
Speed of vessel: in knots
Line number: Survey line number, usually composed by MGL1106XXXXY, where XXXX was the number of the line and Y was a letter indicating repetitions in the same line
Vessel Activity: Ship milling/stopped, In Transit, Ramp-up, Line Shooting, Seismic Testing, Full power between/Off lines, Shooting Reduced power Between/Off.Lines, Mitigation Shut-Down, Mitigation Power Down, Mechanical/Technical Shut Down, Mechanical/Technical Power-Down, Deploying Equipment, Recovering Equipment, Other (comment and describe)
Number of guns: Number of guns firing
Array Volume: Volume of compressed air being released by the firing guns
Array Depth: Depth at which array was towed

Weather and visibility conditions
Precipitation: none, fog, light rain, heavy rain, squall, storm
Light or Dark
Visibility; in kilometers
Glare severity: none, little, moderate, severe
Glare direction: clock face
Sea state: different from Beaufort wind force (see Appendix H)
Swell: high of swell in meters; <2, 2-4, >2
Wind speed: in knots, not corrected
Wind direction: in degrees, not corrected
Comments or notes: related to effort

Detection forms

Detection forms included all effort data listed above, as well as data listed below:
Visual detection number: Correlated
Detection was first made: visually dectected by observer keeping a continuous watch, visually spotted incidentally by observer or someone else, acoustically detected by PAM, both visually and acoustically before operaotrs/observers infomred each other
Detection cue: Body, Head, Splash, Breach, Blow, Tail, Birds feeding
Common name
Scientific name
Family
Certainity of identification: Definite (when no doubt about the species exists), probable (when the species could not be definite identified but there is no other possible species to be identified), possible (when the species could not be identified but their characteristics lead to the PSO to make a "best guess")
Number of adults
Number of juveniles

Total number of animals: Adults and juveniles present in the group
Bearing to animal(s) when first detected: in degrees, in relation to the ship, considering the bow to be at 0 degrees
Number of Reticles or Eyeball: Reticles in 7x50 binoculars were differentiated from reticles in the Big-Eyes by adding (BE) to the last ones.
Initial behaviour #1: Behaviour observed at the moment the animals were detected
Behaviour #2: Change in behaviour after first behaviour was recorded
Animal(s) Pace: Sedate, moderate, vigorous
Direction of travel / first approach (relative to vessel): towards vessel, away from vessel, in same direction as vessel,parallel in opposite direction as vessel,crossing ahead of vessel,crossing astern of vessel,variable,milling, stationary,other, unknown
Initial heading of animal(s): in degrees, relative to vessel.
Final heading of animal(s): in degrees, relative to vessel.
Description: description of the animals, including features such as overall size; shape of head; colour and pattern; size, shape, and position of dorsal fin; height, direction, shape of blow, sex/age if determinable, etc.
Source activity at final detection: full power while on survey line, full power while not on survey line, soft start / ramp-up, mitigation firing, other reduced power firing, not firing
Time animals entered the mitigation/exclusion zone: in UTC in 24 hours format, when animals were detected before they entered the mitigation/exclusion zone.
Time animals left the mitigation/exclusion zone: in UTC in 24 hours format.
Closest distance of animals to airguns: in meters
Closest distance of animals to vessel: in meters
Time at closest approach to airguns: in UTC in 24 hours format

If observed/detected during soft start
First distance: in meters
Closest distance: in meters
Last distance: in meters

Source mitigation action required: none, delayed start of firing, shutdown of active source, power reduction of active source, power reduction then shutdown of active source
Avoidance manoeuvres conducted: yes or no
Time at last visual sighting: in UTC in 24 hours format
Other vessels in the nearby vicinity: yes or no
Comments: Related to the detection

APPENDIX G: ENVIRONMENTAL CONDITIONS

Table 13. Beaufort sea scale

Beaufort Number	Wind Speed (knots)	Wind Description	Specification for Use
0	Less than 1	Calm	Sea like a mirror
1	1 to 3	Light air	Ripple with the appearance of scales are formed, but without foam crests.
2	4 to 6	Light breeze	Small wavelets, still short, but more pronounced. Crests have a glassy appearance and do not break.
3	7 to 10	Gentle breeze	Large wavelets. Crests begin to break. Foam of glassy appearance. Perhaps scattered white horses.
4	11 to 16	Moderate breeze	Small waves, becoming larger; fairly frequent white horses.
5	17 to 21	Fresh breeze	Moderate waves, taking a more pronounced long form; many white horses are formed. Chance of some spray.
6	22 to 27	Strong breeze	Large waves begin to form; the white foam crests are more extensive everywhere. Probably some spray.
7	28 to 33	Near gale	Sea heaps up and white foam from breaking waves begins to be blown in streaks along the direction of the wind.
8	34 to 40	Gale	Moderately high waves of greater length; edges of crests begin to break into spindrift. The foam is blown in well-marked streaks along the direction of the wind.
9	41 to 47	Strong gale	High waves. Dense streaks of foam along the direction of the wind. Crests of waves begin to topple, tumble and roll over. Spray may affect visibility.
10	48 to 55	Storm	Very high waves with long overhanging crests. The resulting foam, in great patches, is blown in dense white streaks along the direction of the wind. On the whole the surface of the sea takes on a white appearance. The 'tumbling' of the sea becomes heavy and shock-like. Visibility affected.
11	56 to 63	Violent storm	Exceptionally high waves (small and medium-size ships might be for a time lost to view behind the waves). The sea is completely covered with long white patches of foam lying along the direction of the wind. Everywhere the edges of the wave crests are blown into froth. Visibility affected.
12	More than 64	Hurricane	The air is filled with foam and spray. Sea completely white with driving spray; visibility very seriously affected.

Table 14. Visual monitoring environmental conditions during the Bangs Crisp survey

DATE	BEAUFORT SEA STATE			VISIBILITY (km)			WIND (knots)			Hrs visual monitoring with rain	Number sightings per day
	Min	Max	Ave	Min	Max	Ave	Min	Max	Ave		
9-Apr	1	3	3	<1	7	7	0	5	3	3:54	2
10-Apr	1	3	2	<1	8	7	1	5	3	1:42	35
11-Apr	1	3	2	<1	8	7	2	4	3	2:40	0
12-Apr	1	5	1	<1	8	8	1	4	2	2:53	9
13-Apr	1	3	1	7	8	8	1	4	3	0	25
14-Apr	1	2	2	<3.5	8	7	1	4	3	2:47	4
15-Apr	1	2	2	<3.5	8	7	1	3	2	0	2
16-Apr	1	2	1	<1	8	7	0	3	2	0	7
17-Apr	1	2	1	<3.5	7	7	1	5	2	1:07	4
18-Apr	1	2	1	<3.5	7	7	1	3	2	0	41
19-Apr	0	2	1	<3.5	8	6	0	3	2	0	19
20-Apr	0	4	2	6	8	8	1	6	3	0	19
21-Apr	1	2	2	7	8	8	1	4	3	0	2
22-Apr	2	2	2	<1	8	7	1	4	3	0:20	2
23-Apr	1	2	1	<3.5	7	6	1	4	2	0	11
24-Apr	1	2	2	<3.5	8	7	0	4	2	0	5
25-Apr	1	2	2	<3.5	8	6	0	3	2	0	7
26-Apr	1	2	2	<3.5	7	6	1	4	2	1:23	1
27-Apr	1	3	2	<3.5	8	6	0	6	3	1:12	7
28-Apr	1	2	2	<1	7	5	1	4	3	0	13
29-Apr	2	2	2	<3.5	8	8	1	4	3	0:23	9
30-Apr	0	2	1	<3.5	8	7	0	4	2	0:16	21
1-May	1	2	1	<3.5	7	7	0	3	2	0	28
2-May	0	1	1	<3.5	8	7	1	3	2	0	21
3-May	0	3	1	>3.5	8	7	1	4	3	0	12
4-May	1	3	2	>3.5	8	7	1	6	3	0:38	12

5-May	1	2	1	3.5	7	6	1	4	3	0:06	10
6-May	1	4	2	>3.5	8	6	2	5	3	1:50	2
7-May	1	2	1	<1	8	7	0	4	2	0	8
8-May	1	2	2	<3.5	7	6	1	4	3	0	4
9-May	1	2	2	<3.5	7	5	1	4	3	1:07	4
10-May	1	2	1	<3.5	8	8	0	3	1	0	9
11-May											
Number of Days										**14**	
Min/Max	**0**	**5**		**<1**	**8**		**0**	**6**			
Average			**2**			**7**			**2**		

APPENDIX H: ACOUSTIC MONITORING DOWNTIME

Table 15. Passive acoustic monitoring downtime during the Bangs Crisp seismic survey.

Date	Time Watch Suspended	Date	Time Watch Resumed	Duration acoustic monitoring suspended	Comments
2011-04-11	08:45	2011-04-11	09:37	00:52	Recovering hydrophone to recover port streamers
2011-04-11	11:36	2011-04-12	04:05	16:29	Recovering hydrophone to recover port streamers
2011-04-12	04:05	2011-04-12	04:30	0:25	Trying new hydrophone deployment methods
2011-04-15	01:00	2011-04-15	02:00	1:00	MMO Meeting (data forms)
2011-04-15	18:24	2011-04-15	22:00	3:36	Deterioration in hydrophone signal. Retrieving cable. Rigged and deployed spare cable
2011-04-16	01:00	2011-04-16	01:48	00:48	MMO Meeting (watch schedule)
2011-04-16	12:49	2011-04-16	15:22	2:33	Retrieve cable when vessel lost main engine and propulsion.
2011-04-17	01:37	2011-04-20	20:30	100:53	Crew member operated PAM winch while deck cable was connected to tow cable and severed ITT connector head
2011-04-24	00:36	2011-04-24	02:02	1:26	While retrieving gun string, PAM cable became tangled in an umbilical and was retrieved
2011-04-24	13:20	2011-04-24	15:25	2:05	Hydrophone cable retrieved to bring in streamers to free birds from lead-in
2011-04-24	22:42	2011-04-26	00:37	25:54	Hydrophone cable retrieved to bring in streamers for repair
2011-04-27	00:58	2011-04-27	02:05	1:07	Hydrophone cable retrieved to bring in gun string on port side
2011-04-27	23:30	2011-04-27	23:45	00:15	Hydrophone cable retrieved when compressors failed to retrieve gun string but redeployed when compressor was repaired
2011-04-28	03:42	2011-04-28	05:45	2:03	Hydrophone cable retrieved to bring in gun string on port side
2011-05-02	14:31	2011-05-	21:23	6:32	Signal on H3 dropped out. Cable retrieved for inspection and tangle with

Date	Time Watch Suspended	Date	Time Watch Resumed	Duration acoustic monitoring suspended	Comments
		02			lead-in discovered. Streamer partially retrieved, cable freed. New deployment configured and cable redeployed
2011-05-03	22:12	2011-05-03	23:32	1:20	Hydrophone cable retrieved to bring in a port side gun string. Gun string retrieval began with cable deployed but halted when cable tow depth increased 10m abruptly, suggesting that cable was above gun umbilical and could tangle
2011-05-07	20:50	2011-05-07	21:35	0:45	Hydrophone cable retrieved to bring in a port side gun string.
2011-05-10	07:20	2011-05-11	06:09	22:11	Hydrophone cable severed after probably entanglement with a lead-in during a line change. Lead-in was partially retrieved and re-deployed at the time incident occurred. No spare cable on board to allow acoustic monitoring to continue.

APPENDIX I: VISUAL AND ACOUSTIC DETECTIONS OF PROTECTED SPECIES DURING L-DEO BANGS SEISMIC SURVEY

Table 16. Detection table for protected species records collected during the Bangs Crisp seismic survey.

Visual detection number	Date	Time at first visual sighting (HH:MM)	How was detection made?	Common name	Number of adults	Number of juveniles	Latitude	Longitude	Bearing to animal(s) when first detected (degrees)	Range to animal(s) when first detected (metres)	Initial Behavior # 1	Behavior # 2	Closest distance of animals to airguns (metres)	Closest distance of animals to vessel (metres)	Source mitigation action required
1	2011-04-09	16:56	V	Spinner dolphin	3	0	Unknown	Unknown	90	845	Breaching	Porpoising	N/A	845	none
2	2011-04-09	23:15	V	Unidentifiable shelled sea turtle	1	0	08.53600°N	084.32200°W	210	10	Swimming parallel to vessel on the surface in the opposite direction	Swimming on the surface astern of the vessel	N/A	10	none
3	2011-04-10	11:49	V	Green sea turtle	1	0	08.84228°N	084.30517°W	5	302	Swimming on surface	Diving	N/A	302	none
4	2011-04-10	12:06	V	Green sea turtle	1	0	08.86150°N	084.31200°W	255	690	Swimming on surface	Diving	N/A	632	none
5	2011-04-10	12:24	V	Unidentifiable shelled sea turtle	0	1	08.87000°N	084.33117°W	60	1196	Swimming on surface	Diving	N/A	1196	none
6	2011-04-10	12:33	V	Unidentifiable shelled sea turtle	1	0	08.86683°N	084.34267°W	262	302	Resting at surface	Diving	N/A	280	none
7	2011-04-10	12:43	V	Green sea turtle	1	0	08.85967°N	084.35117°W	324	120	Resting at surface	Diving	N/A	100	none
8	2011-04-10	12:47	V	Olive Ridley sea turtle	0	1	08.85517°N	084.35317°W	290	80	Swimming on surface	Diving	N/A	80	none
9	2011-04-10	12:55	V	Olive Ridley sea turtle	1	0	08.84617°N	084.35683°W	230	50	Swimming on surface	Diving	N/A	3.5	none
10	2011-04-10	13:10	V	Olive Ridley sea turtle	1	0	08.83050°N	084.36333°W	230	50	Resting at surface	Resting at surface	N/A	10	none
11	2011-04-10	13:10	V	Unidentifiable shelled sea turtle	1	0	08.83050°N	084.36333°W	180	2727	Resting at surface	Resting at surface	N/A	2727	none
12	2011-04-10	13:26	V	Olive Ridley sea turtle	1	0	08d49.68m N	084.37150°W	230	505	Turtle was swimming toward ship, altered its course, swam away from ship, and then dove	Diving	N/A	505	none
13	2011-04-10	13:36	V	Unidentifiable shelled sea turtle	1	0	08.80083°N	084.37583°W	259	3922	Resting on the Surface	Resting on the surface	N/A	3922	none
14	2011-04-10	13:56	V	Olive Ridley sea turtle	2	0	08.77833°N	084.38617°W	171	500	Resting on the Surface	Resting on the Surface	N/A	500	none
15	2011-04-10	13:56	V	Olive Ridley sea turtle	1	0	08.77833°N	084.38617°W	289	1000	Resting on the Surface	Resting on the Surface	N/A	1000	none
16	2011-04-10	14:08	V	Unidentifiable shelled sea turtle	1	0	08.76488°N	084.39283°W	283	2479	Resting on the Surface	Resting on the Surface	N/A	2479	none
17	2011-04-10	14:22	V	Olive Ridley sea turtle	1	0	08.74767°N	084.39350°W	132	150	Resting at surface	Resting at surface	N/A	150	none

18	2011-04-10	14:28	V	Olive Ridley sea turtle	0	1	08.74180°N	084.39183°W	130	100	Swimming at surface	Swimming at surface	N/A	50	none
19	2011-04-10	14:32	V	Olive Ridley sea turtle	8	0	08.73637°N	084.38967°W	86	845	Resting at surface	Resting at surface	N/A	505	none
20	2011-04-10	14:32	V	Risso's dolphin	2	0	08.73637°N	084.38967°W	146	845	Porpoising	Porpoising	N/A	505	none
21	2011-04-10	14:55	V	Unidentifiable shelled sea turtle	1	0	08.72332°N	084.36800°W	50	583	Swimming at surface	Diving	N/A	580	none
22	2011-04-10	14:56	V	Unidentifiable dolphin	2	0	08.72332°N	084.36800°W	20	583	Porpoising towards an unidentified turtle	Porpoising	N/A	580	none
23	2011-04-10	15:04	V	Olive Ridley sea turtle	11	1	08d43.233 mN	084.35883°W	50	845	Swimming at surface	Swimming at surface	N/A	845	none
24	2011-04-10	15:04	V	Rough-toothed dolphin	2	0	08.72055°N	084.35883°W	50	2100	Porpoising	Diving	N/A	2000	none
25	2011-04-10	15:11	V	Olive Ridley sea turtle	1	0	08.71832°N	084.35083°W	80	150	Swimming at surface	Swimming at surface	N/A	150	none
26	2011-04-10	15:18	V	Olive Ridley sea turtle	6	0	08.71597°N	084.34267°W	80	445	Resting at surface	Resting at surface	N/A	200	none
27	2011-04-10	15:18	V	Olive Ridley sea turtle	9	2	08.71597°N	084.34267°W	170	300	Resting at surface	Resting at surface	N/A	100	none
28	2011-04-10	15:28	V	Olive Ridley sea turtle	1	0	08.71278°N	084.33133°W	170	398	Resting at surface	Resting at surface	N/A	120	none
29	2011-04-10	15:38	V	Olive Ridley sea turtle	1	0	08.70975°N	084.32067°W	20	400	Resting at surface	Resting at surface	N/A	400	none
30	2011-04-10	15:41	V	Short-finned pilot whale	5	0	08.70858°N	084.31617°W	50	583	Porpoising	Diving	N/A	580	none
31	2011-04-10	15:52	V	Olive Ridley sea turtle	5	0	08.70572°N	084.30217°W	80	951	Resting at surface	Resting at surface	N/A	150	none
32	2011-04-10	16:08	V	Olive Ridley sea turtle	2	0	08.70083°N	084.28767°W	70	845	Resting at surface	Resting at surface	N/A	690	none
33	2011-04-10	16:22	V	Olive Ridley sea turtle	3	0	08.69067°N	084.27983°W	106	329	Resting at surface	Resting at surface	N/A	200	none
34	2011-04-10	16:30	V	Olive Ridley sea turtle	1	0	08.68183°N	084.28000°W	223	505	Swimming at surface	Diving	N/A	3	none
35	2011-04-10	16:42	V	Olive Ridley sea turtle	1	0	08.66933°N	084.28567°W	230	280	Resting at surface	Diving	N/A	3	none
36	2011-04-10	22:00	V	Olive Ridley sea turtle	1	0	08.36100°N	084.40000°W	170	20	Swimming at surface	Swimming at surface	N/A	10	none
37	2011-04-10	22:49	V	Olive Ridley sea turtle	1	0	08.30817°N	084.40150°W	170	15	Swimming at surface	Diving	N/A	15	none
38	2011-04-12	14:11	V	Olive Ridley sea turtle	0	1	08.56100°N	084.28067°W	Unknown	50	Swimming close a small debris	Diving	250	30	power reduction of active source
39	2011-04-12	14:57	V	Olive Ridley sea turtle	1	0	08.61533°N	084.25380°W	135	250	Swimming at surface	Diving	250	250	power reduction of active source
40	2011-04-12	16:20	V	Olive Ridley sea turtle	1	0	08.70742°N	084.20820°W	185	60	Resting at surface	Resting at surface	35	30	shutdown of active source
41	2011-04-12	16:42	V	Unidentifiable dolphin	15	0	08.73133°N	084.19617°W	30	1600	Surfacing	Milling and slowly swimming	1000	900	none
42	2011-04-12	17:05	V	Olive Ridley sea turtle	1	0	08.73133°N	084.19617°W	40	1274	Resting at surface	Diving	1000	800	none
43	2011-04-12	18:34	V	Unidentifiable dolphin	1	0	08.86178°N	084.00000°W	80	4000	Breaching	Breaching	4000	4000	none

44	2011-04-12	18:53	V	Olive Ridley sea turtle	1	0	08.87483°N	084.12467°W	165	50	Diving	Swimming Away	310	50	power reduction of active source
45	2011-04-12	20:50	V	Olive Ridley sea turtle	1	0	09.00313°N	084.06090°W	60	300	Diving	Swimming Away	350	300	power reduction of active source
46	2011-04-12	21:53	V	Unidentifiable dolphin	10	0	09.02917°N	084.00467°W	95	1030	Breaching	Porpoising as they traveled away from vessel	1300	1030	none
47	2011-04-13	11:32	V	Olive Ridley sea turtle	1	0	08d44.573 mN	84d11.198m w	45	200	swimming	dive	200	250	power reduction of active source
48	2011-04-13	13:48	V	Olive Ridley sea turtle	2	0	08d53.69m N	84d06.67mW	278	891	resting	diving	200	200	power reduction of active source
49	2011-04-13	14:12	V	Olive Ridley sea turtle	1	0	08d55.17m n	84d05.94nw	285	1089	resting	Diving	300	3000	power reduction of active source
50	2011-04-13	14:27	V	Olive Ridley sea turtle	1	0	08d56.05m n	084d05.50m W	210	100	resting	resting	100	100	power reduction then shutdow n of active source
51	2011-04-13	14:41	V	Olive Ridley sea turtle	3	0	08d56.87m n	84d05.08mw	40	500	resting	Diving	500	500	power reduction of active source
52	2011-04-13	14:48	V	Olive Ridley sea turtle	2	0	08d57.31m n	84d04.86mw	70	400	resting	Diving	400	400	delayed start of firing
53	2011-04-13	14:52	V	Olive Ridley sea turtle	1	0	08d57.54m n	84d04.75mw	240	250	resting	Diving	10	40	shutdow n of active source
54	2011-04-13	15:02	V	Olive Ridley sea turtle	2	0	8d58.48mn	84d04.27mw	200	150	resting	Diving	150	150	delayed start of firing and shut down
55	2011-04-13	15:12	V	Olive Ridley sea turtle	2	0	8d58.87mn	84d04.087m w	135	60	Resting	Diving	60	60	delayed start of firing
56	2011-04-13	15:22	V	Olive Ridley sea turtle	1	0	8d59.50mn	84d03.77mw	90	450	Resting	Diving	450	450	none
57	2011-04-13	15:27	V	Olive Ridley sea turtle	4	0	8d59.80mn	84d03.62mw	20	845	Resting	Diving	845	845	none
58	2011-04-13	15:30	V	Olive Ridley sea turtle	1	0	08d57.52m N	084d01.34m W	30	50	Resting	Diving	20	50	power reduction then shutdow n of active source
59	2011-04-13	15:34	V	Olive Ridley sea turtle	1	0	08d57.52m N	084d01.34m W	90	600	Resting	Diving	600	600	none

60	2011-04-13	16:35	V	Olive Ridley sea turtle	0	1	09d01.46mN	84d00.01mW	60	100	Swimming	Diving	265	100	shutdown of active source
61	2011-04	16:41	V	Olive Ridley sea turtle	0	1	09d01.202'N	083d59.900'W	270	75	Basking	Diving	20	30	delayed start of firing
62	2011-04	16:50	V	Olive Ridley sea turtle	1	0	09d00.190'N	083d59.911'W	270	60	Basking	Diving	10	10	shutdown of active source
63	2011-04-13	17:08	V	Olive Ridley sea turtle	1	0	8d59.200mn	84d00.508mw	90	50	Swimming	Diving	275	50	shutdown of active source
64	2011-04-13	17:55	V	Green sea turtle	1	0	8d56.120mn	84d02.014mw	90	70	Swimming	Diving	275	60	shutdown of active source
65	2011-04-13	18:00	V	Olive Ridley sea turtle	1	0	08d55.28mN	84d02.44mW	200	50	Swimming	Diving	275	50	delayed start of firing
66	2011-04-13	18:01	V	Green sea turtle	1	0	08d55.28mN	84d02.44mW	220	500	Resting at surface	Diving	300	500	delayed start of firing
67	2011-04-13	18:22	V	Olive Ridley sea turtle	1	0	08d54.38'N	084d02.87'W	150	100	Breathing at surface	Diving	50	10	shutdown of active source
68	2011-04-13	19:53	V	Olive Ridley sea turtle	1	0	08d48.13mn	84d05.96mw	100	60	Swimming	Diving	50	50	power reduction then shutdown of active source
69	2011-04-13	20:27	V	Olive Ridley sea turtle	1	0	8d46.01mn	084d07.02mw	275	30	Swimming	Diving	250	20	power reduction of active source
70	2011-04-13	22:04	V	Olive Ridley sea turtle	0	1	08d39.55mN	084d10.24mw	100	20	Swimming	Diving	20	260	power reduction of active source
71	2011-04-13	22:56	V	False killer whale	15	1	8d36.015mn	084d12.00mw	90	3031	Travelling	travelling	4000	4000	none
72	2011-04-14	15:35	V	Olive Ridley sea turtle	1	0	8d44.289mn	84d07.787mW	45	60	logging	dive	200	60	shutdown of active source
73	2011-04-14	16:02	V	Rough-toothed dolphin	35	1	8d42.79mN	84d08.52mW	210	1196	Surfacing	Breaching	1500	1196	none
74	2011-04-14	19:14	V	spinner dolphin	200	10	8d30.782mN	84d14.44mW	300	5664	Breaching	Breaching	5664	5664	none
75	2011-04-14	21:25	V	Unidentifiable dolphin	10	0	08d27.17mN	084d19.87mW	190	4000	Porpoising	Porpoising	4000	4200	none
76	2011-04-15	17:16	V	Olive Ridley sea turtle	1	0	8d32.62mn	84d16.840mw	280	20	Swimming	Diving	280	20	shutdown of active source

77	2011-04-15	20:41	V	Spinner dolphin	50	10	8d31.88mN	84d17.01mW	30	3031	Fishing with large group of Short-beaked common dolphins and brown boobies and masked boobies	Porpoising, jumping, breaching, spinning	1500	1500	none
77	2011-04-15	20:41	V	Long-beaked common dolphin	175	50	8d31.88mN	84d17.01mW	30	3031	Fishing with large group of spinner dolphins and brown boobies and masked boobies	Porpoising, jumping breaching, somersaulting	1500	1500	none
78	2011-04-16	18:40	V	Olive Ridley sea turtle	1	0	8d34.013mn	84d165.776mw	280	20	Swimming at surface	Dive	40	10	power reduction of active source
79	2011-04-06	19:21	V	spinner dolphin	1	0	08d37.16'N	084d14.148'W	340	9229	Jumping	Jumping	1000	900	none
80	2011-04-16	19:43	V	Long-beaked common dolphin	250	20	8d38.742mN	84d13.393mW	340	4619	Jumping	Jumping	3417	3417	none
81	2011-04-16	22:35	V	Olive Ridley sea turtle	1	0	08d52.01mN	84d06.90mW	20	50	Swimming at surface	Diving	200	20	shutdown of active source
82	2011-04-16	22:53	V	Olive Ridley sea turtle	1	0	8d53.19mn	84d06.34mw	120	40	Swimming	Diving	270	10	shutdown of active source
83	2011-04-16	23:27	V	Olive Ridley sea turtle	1	0	08d55.7mN	84d0510mW	90	20	Swimming	Diving	200	20	shutdown of active source
84/A1	2011-04-16	23:53	VA	pantropical spotted dolphin	2	0	8d57.677mn	84d04.079mw	280	40	swimming	bow riding	280	1	shutdown of active source
85	2011-04-17	15:45	V	Olive Ridley sea turtle	1	0	08d52.408mn	84d06.577mw	60	60	resting	dive	285	30	shutdown of active source
86	2011-04-17	16:22	V	Olive Ridley sea turtle	1	0	8d55.19mN	84d05.21mW	250	1102	swimming	swimming	1102	1102	none
87	2011-04-17	17:17	V	pantropical spotted dolphin	30	2	8d59.22mn	84d03.206mw	80	4619	porpoising	swimming	4619	4619	none
88	2011-04-17	18:19	V	Olive Ridley sea turtle	1	0	9d01.488mn	83d59.621mw	270	120	resting	dive	280	120	shutdown of active source
89	2011-04-18	11:19	V	Unidentifiable dolphin	25	0	9d01.174mn	83d59.263mw	350	200	porpoising	dive	280	280	power reduction of active source
90	2011-04-18	11:24	V	Olive Ridley sea turtle	1	0	9d00.805mn	83d59.077mw	280	280	swimming	swimming	285	5	shutdown of active source
91	2011-04-18	11:29	V	Olive Ridley sea turtle	1	0	09d00.386'N	083d59.368;W	350	445	swimming	swimming	720	445	none
92	2011-04-18	12:40	V	pantropical spotted dolphin	12	0	8d55.296mn	84d01.446mw	300	3031	swimming	dive	3031	3031	none

93	2011-04-18	12:42	V	Olive Ridley sea turtle	1	0	8d55.149mn	84d01.545mw	290	1196	resting	dive	1196	1196	none
94	2011-04-18	12:44	V	pantropical spotted dolphin	10	0	8d54.984mn	84d01.611mw	280	1823	swimming	dive	1823	1823	none
95	2011-04-18	12:45	V	Olive Ridley sea turtle	1	0	8d54.893mn	84d01.648mw	280	952	resting	resting	600	850	power reduction of active source
96	2011-04-18	13:10	V	Olive Ridley sea turtle	1	0	8d53.14mN	84d02.52mW	330	951	resting	dive	951	400	power reduction of active source
97	2011-04-18	13:10	V	pantropical spotted dolphin	3	0	8d53.14mN	84d02.52mW	330	1089	breaching	dive	1023	760	delayed start of firing
98	2011-04-18	13:32	V	pantropical spotted dolphin	35	5	8d51.589mn	84d03.306mw	100	1611	swimming	swimming	1611	1611	none
99	2011-04-18	13:41	V	Olive Ridley sea turtle	0	1	8d51.02mN	84d03.59mW	150	1611	resting	resting	30	40	shutdown of active source
100	2011-04-18	13:50	V	Olive Ridley sea turtle	3	0	8d50.59mn	84d03.80mW	15	30	resting	dive	30	30	delayed start of firing
101	2011-04-18	13:57	V	Olive Ridley sea turtle	2	0	08d50.32mN	84d04.15mW	300	1200	resting	resting	1000	1000	none
102	2011-04-18	14:07	V	Olive Ridley sea turtle	1	0	08d48.68'N	084d04.756'w	280	800	resting	diving	800	800	none
103	2011-04-18	14:07	V	pantropical spotted dolphin	50	2	08d48.68'N	084d04.756'w	310	800	porposing	porpoising	700	700	none
104	2011-04-18	14:12	V	Olive Ridley sea turtle	1	0	8d49.91mN	84d04.15mW	310	1250	resting	resting	1000	1000	none
105	2011-04-18	14:18	V	Olive Ridley sea turtle	1	0	08d48.65'n	084d04.775'w	300	1823	resting	resting	1600	1600	none
106	2011-04-18	14:22	V	Olive Ridley sea turtle	1	0	08d47.79'n	084d05.17'w	350	3031	resting	resting	2800	2800	none
107	2011-04-18	14:34	V	Olive Ridley sea turtle	2	0	08d47.79'n	084d05.17'w	350	2100	resting	resting	50	50	power reduction of active source
108	2011-04-18	14:49	V	Olive Ridley sea turtle	1	0	8d46.24mN	84d05.94nw	340	200	resting	resting	30	30	power reduction then shutdown of active source
109	2011-04-18	14:52	V	Olive Ridley sea turtle	1	0	8d46.02mN	084d06.04mW	270	2100	resting	dive	2000	2000	none
110	2011-04-18	14:57	V	Olive Ridley sea turtle	16	0	08d45.62mN	84d04.24mW	360	1535	resting	diving	20	20	power reduction of active source
111	2011-04-18	15:21	V	Olive Ridley sea turtle	1	0	8d44.00mN	84d07.05MW	90	400	resting	resting	100	100	power reduction of active source
112	2011-04-18	15:48	V	Rough-toothed dolphin	4	1	08d42.121'n	084d08.040'w	60	845	porpoising	diving	845	845	none
113	2011-04-18	16:20	V	Common dolphin	500	0	8d40.03mN	84d09.09mW	340	5664	jumping	swimming	1000	1000	none

113	2011-04-18	16:20	V	Rough-toothed dolphin	80	2	8d40.03mN	84d09.09mW	340	5664	swimming	swimming	1000	1000	none
114	2011-04-18	16:28	V	Olive Ridley sea turtle	2	0	8d39.42mN	84d09.40mW	4	30,311,309	resting	diving	1250	1300	none
115	2011-04-18	16:53	V	Olive Ridley sea turtle	0	2	8d37.73mN	84d10.26mW	360	250	resting	resting	40	40	power reduction then shutdown of active source
116	2011-04-18	17:12	V	Olive Ridley sea turtle	1	0	8d36.35mN	84d10.94mW	360	250	resting	resting	100	100	power reduction of active source
117	2011-04-18	17:27	V	Olive Ridley sea turtle	0	1	8d35.35mN	84d11.46mW	300	800	resting	resting	300	300	power reduction of active source
118	2011-04-18	17:53	V	Olive Ridley sea turtle	1	0	8d33.648mn	84d12.338mw	225	80	resting	dive	250	60	power reduction of active source
119	2011-04-18	18:14	V	Olive Ridley sea turtle	0	1	08d31.74mN	84d13.28mW	340	50	resting	diving	60	20	power reduction of active source
120	2011-04-18	18:17	V	Olive Ridley sea turtle	1	0	08d31.74mN	84d13.28mW	270	500	resting	diving	500	500	none
121	2011-04-18	18:19	V	Olive Ridley sea turtle	1	0	08d31.74mN	84d13.28mW	90	261	resting	diving	280	260	power reduction of active source
122	2011-04-18	18:36	V	Unidentifiable dolphin	40	0	8d30.44mN	84d13.89mW	100	4619	swimming	swimming	4619	4619	none
123	2011-04-18	18:51	V	Common dolphin	25	0	8d29.823mn	84d14.496mw	265	3031	swimming	swimming	3031	3031	none
123	2011-04-18	18:51	V	Short-finned pilot whale	10	2	8d29.823mn	84d14.496mw	265	3031	swimming	swimming	2000	2000	none
124	2011-04-18	19:17	V	Olive Ridley sea turtle	1	0	08d28.354'n	084d14.926'W	45	1611	resting	resting	1611	1611	none
125	2011-04-18	20:08	V	Olive Ridley sea turtle	1	0	08d26.41'N	84d17.42'W	60	10	resting	resting	300	400	power reduction of active source
126	2011-04-18	20:24	V	Short-finned pilot whale	8	0	08d27.66'n	084d18.67'w	40	845	porpoising	porpoising	250	250	power reduction of active source
126	2011-04-18	20:24	V	Rough-toothed dolphin	20	0	08d27.66'n	084d18.67'w	40	845	porpoising	porpoising	2400	2180	none
127	2011-04-18	20:50	V	Rough-toothed dolphin	20	0	8d29.77mN	84d17.87mW	300	3031	swimming	jumping	3031	3031	none
128	2011-04-18	21:40	V	Spinner dolphin	5	0	8d32.56mN	84d16.63mW	330	3922	breaching/jumping	porpoising	N/A	500	none
128	2011-04-18	21:40	V	Common Dolphin	8	2	8d32.56mN	84d16.63mW	330	3922	breaching/jumping	porpoising	N/A	500	none
129	2011-04-18	22:51	V	Olive Ridley sea turtle	1	0	08d37.69'N	084d13.93'w	70	50	swimming	diving	N/A	15	none
130	2011-04-19	12:05	V	Common dolphin	90	10	8d14.776mn	84d23.086mw	270	2274	porpoising	porpoising	N/A	2274	none

131	2011-04-19	14:33	V	Common dolphin	70	5	08d27.29'N	084d19.05'w	290	3417	swimming	jumping	3417	3417	none
132	2011-04-19	14:42	V	Olive Ridley sea turtle	1		08d28.22'N	084d18.59'W	360	2479	resting	diving	1823	1823	none
133	2011-04-19	15:32	V	Olive Ridley sea turtle	1	0	8d31.76mN	84d16.84mW	0	150	resting	diving	275	10	power reduction of active source
134	2011-04-19	15:43	V	Common dolphin	15	2	8d32.66mN	84d16.45mW	270	1535	swimming	porpoising	1535	1535	none
135	2011-04-19	16:19	V	Unidentifiable shelled sea turtle	0	1	08d35.37mN	084d15.19mW	300	400	resting	resting	75	30	power reduction of active source
136	2011-04-19	17:22	V	Olive Ridley sea turtle	1	0	8d39.99mN	84d12.95MW	130	645	resting	resting	645	645	none
137	2011-04-19	18:10	V	Olive Ridley sea turtle	1	0	8d43.591mn	84d11.096mw	300	690	resting	dive	950	690	none
138	2011-04-19	18:29	V	Olive Ridley sea turtle	1	0	8d44.998mn	84d10.342mw	90	100	resting	diving	70	100	power reduction of active source
139	2011-04-19	19:04	V	Olive Ridley sea turtle	2	0	8d47.77mN	84d09.03mW	290	40	resting	diving	40	200	power reduction of active source
140	2011-04-19	19:16	V	Olive Ridley sea turtle	1	0	8d48.54mN	84d06.67mW	320	10	swimming	diving	280	10	power reduction of active source
141	2011-04-19	19:27	V	Humpback whale	1	0	08d50.60mN	084d07.67mW	40	3922	blowing	dive	3922	3922	none
142	2011-04-19	20:39	V	Spinner dolphin	19	1	08d52.6mN	84d7.7mW	330	4619	porpoising	jumping	1711	1711	none
143	2011-04-19	21:20	V	Common dolphin	10	0	08d57.96mN	084d04.05mW	120	3000	porpoising	porpoising	3000	3000	none
144	2011-04-19	22:05	V	pantropical spotted dolphin	3	0	09d01.40mN	084d02.31mW	20	200	swimming	swimming	270	5	power reduction of active source
145	2011-04-19	22:07	V	Unidentifiable shelled sea turtle	1	0	09d01.40mN	084d02.31mW	270	60	swimming	diving	270	20	none
146	2011-04-19	22:18	V	Olive Ridley sea turtle	1	0	09d02.04mN	084d01.61mW	290	50	swimming	diving	270	50	none
147	2011-04-19	22:44	V	pantropical spotted dolphin	14	2	9d01.57mN	084d59.69mW	280	445	swimming	milling	450	450	none
148	2011-04-19	22:58	V	pantropical spotted dolphin	4	2	9d00.63mN	084d58.93mW	330	505	swimming	swimming	300	300	none
149	2011-04-20	14:17	V	Olive Ridley sea turtle	1	0	8d49.59mN	84d07.65mW	90	583	resting	diving	583	700	power reduction of active source
150	2011-04-20	14:32	V	Rough-toothed dolphin	3	0	08d50.608'n	084d07.180'W	270	2479	swimming	swimming	1196	1196	none
151	2011-04-20	14:45	V	Olive Ridley sea turtle	1	0	8d51.52mN	84d06.74mW	30	632	resting	diving	632	632	power reduction of active source
152	2011-04-20	15:38	V	Olive Ridley sea turtle	1	0	8d55.119mn	84d04.958mW	280	80	swimming	diving	150	50	power reduction of active source

153	2011-04-20	15:50	V	Olive Ridley sea turtle	1	0	8d55.77mN	84d04.64mW	80	2100	resting	diving	845	845	none
154	2011-04-20	16:10	V	Fraser's dolphin	10	2	08d57.59mN	084d03.74mW	270	700	milling at surface, possibly fishing	porpoising	600	200	none
154	2011-04-20	16:10	V	pantropical spotted dolphin	15	2	08d57.59mN	084d03.74mW	270	700	milling at surface, possibly fishing	porpoising	600	200	none
155	2011-04-20	16:17	V	Olive Ridley sea turtle	1	0	08d57.59mN	084d03.74mW	270	20	swimming	diving	50	20	none
156	2011-04-20	16:37	V	Olive Ridley sea turtle	1	0	08d58.60mN	084d03.23mW	270	711	resting	resting	711	711	none
157	2011-04-20	16:39	V	Olive Ridley sea turtle	1	0	08d58.60mN	084d03.23mW	260	1196	resting	resting	1196	1196	none
158	2011-04-20	16:39	V	Olive Ridley sea turtle	1	0	08d58.60mN	084d03.23mW	260	3000	resting	resting	3000	3000	none
159	2011-04-20	16:39	V	Olive Ridley sea turtle	1	0	08d58.60mN	084d03.23mW	260	1900	resting	resting	1900	1900	none
160	2011-04-20	16:51	V	Olive Ridley sea turtle	1	0	08d59.51mN	084d02.79mW	90	1900	resting	resting	1900	1900	none
161	2011-04-20	17:24	V	Olive Ridley sea turtle	1	0	09d01.18mN	084d01.96mW	290	2000	resting	resting	2000	2000	none
162	2011-04-20	17:40	V	Olive Ridley sea turtle	1	0	9d01.88mN	84d01.08mW	90	80	swimming	swimming	200	80	none
163	2011-04-20	17:55	V	Olive Ridley sea turtle	2	0	09d01.71mN	083d59.97mW	90	445, 360	resting	resting	440,360	440,360	none
164	2011-04-20	18:04	V	Unidentifiable dolphin	15	0	09d01.12mN	083d59.20mW	340	600	milling at surface, possibly fishing	milling at surface, possibly fishing	300	300	none
165	2011-04-20	18:27	V	Olive Ridley sea turtle	1	0	8d59.505mn	83d59.302mw	300	150	resting	diving	200	100	none
166	2011-04-20	19:28	V	pantropical spotted dolphin	20	5	8d55.45mN	84d01.40mW	340	60	swimming	swimming	60	350	none
167	2011-04-20	20:30	V	Olive Ridley sea turtle	1	0	08d50.980'n	084d03.68'w	240	30	swimming	swimming	150	60	delayed start of firing
168/A2	2011-04-21	13:21	VA	pantropical spotted dolphin	15	5	8d54.60mN	84d01.68mW	10	1611	feeding	swimming	100	760	power reduction then shutdown of active source
169	2011-04-21	14:17	V	pantropical spotted dolphin	2	1	8d50.34mN	84d03.80mW	320	951	swimming	jumping	1130	850	none
170	2011-04-22	19:55	V	Olive Ridley sea turtle	1	0	8d51.26mN	84d06.37mW	80	300	resting	diving	200	200	power reduction of active source
171	2011-04-22	23:21	V	pantropical spotted dolphin	15	0	8d59.87mN	83d58.65mW	240	800	swimming	swimming	800	800	power reduction of active source
172	2011-04-23	12:02	V	Olive Ridley sea turtle	1	0	8d44.195mn	84d09.675mW	275	583	resting	dive	583	583	power reduction of active source
173	2011-04-23	12:26	V	Olive Ridley sea turtle	1	0	8d45.715mn	84d08.928mw	80	8	swimming	dive	280	8	shutdown of active source

174	2011-04-23	13:06	V	Olive Ridley sea turtle	1	0	8d48.521mN	84d07.68mW	290	200	resting	dive	400	200	power reduction of active source
175	2011-04-23	13:50	V	Olive Ridley sea turtle	1	0	8d50.90mN	84d06.35mW	300	250	swimming	dive	100	150	power reduction of active source
176	2011-04-23	14:06	V	Olive Ridley sea turtle	1	0	08d51.98'N	084d05.86'W	30	350	resting	diving	150	35	power reduction of active source
177	2011-04-23	15:38	V	Fraser's dolphin	6	0	8d57.409mn	84d13.177mw	20	3417	porpoising	porpoising	3417	3417	none
178	2011-04-23	16:21	V	pantropical spotted dolphin	10	4	9d00.000mn	84d01.882mw	20	1823	breaching/jumping	breaching/jumping	1523	1523	none
179	2011-04-23	17:27	V	Olive Ridley sea turtle	0	1	8d59.69mN	83d58.53mW	340	20	swimming	dive	250	20	shutdown of active source
180	2011-04-23	17:58	V	Olive Ridley sea turtle	1	0	8d57.365mn	84d59.737mw	270	320	swimming	dive	200	180	power reduction then shutdown of active source
181	2011-04-23	19:22	V	Olive Ridley sea turtle	1	0	08d51.10'N	084d02.95'W	15	10	swimming	dive	320	15	power reduction of active source
182	2011-04-23	19:27	V	Rough-toothed dolphin	12	0	08d49.98'N	084d03.2522'W	345	1314	swimming	porpoising	845	815	none
183	2011-04-24	13:13	V	Olive Ridley sea turtle	1	0	8d55.441mn	84d00.603mw	45	80	surfacing	dive	100	80	shutdown of active source
184	2011-04-24	16:28	V	Olive Ridley sea turtle	1	0	8d40.97mN	084d07.82mW	280	2479	resting	resting	2479	2479	none
185	2011-04-24	17:36	V	Olive Ridley sea turtle	2	0	8d35.921mn	84d10.360mw	320	120	resting	dive	260	10	power reduction of active source
186	2011-04-24	18:15	V	Olive Ridley sea turtle	1	0	8d33.0333mn	84d11.801mw	90	690	swimming	dive	690	690	none
187	2011-04-24	22:45	V	Common bottlenose dolphin	135	15	08d35.06mN	084d13.89mW	70	1823	jumping	porpoising	1200	1500	none
187	2011-04-24	22:45	V	Pantropical spotted dolphin	30	2	08d35.06mN	084d13.89mW	70	1823	jumping	porpoising	1200	1500	none
188	2011-04-25	16:20	V	Olive Ridley sea turtle	1	0	8d18.41mn	84d22.64mw	60	280	resting	dive	280	280	none
189	2011-04-25	16:26	V	Olive Ridley sea turtle	1	0	8d18.63mN	84d22.44mW	300	200	resting	dive	125	125	none
190	2011-04-25	17:20	V	Olive Ridley sea turtle	1	0	8d21.22mn	84d20.78mw	80	838	resting		360	360	none
191	2011-04-25	17:52	V	Killer whale	8	2	8d22.978mn	84d19.788mw	280	845	feeding	dive	845	845	none
192	2011-04-25	18:29	V	Olive Ridley sea turtle	1	0	8d24.519mn	84d18.953mw	90	150	slow swimming		150	150	none

193	2011-04-25	18:36	V	Olive Ridley sea turtle	1	0	8d24.902mn	84d18.779mw	330	80	slow swimming	dive	35	35	shutdown of active source
194	2011-04-25	22:26	V	Olive Ridley sea turtle	2	0	8d36.67mn	84d13.59mw	45	329	sexual behavior	sexual behavior	250	300	none
195	2011-04-26	16:06	V	Spinner dolphin	175	30	8d30.654mn	84d15.969mw	320	2479	fast swimming	fast swimming	600	600	none
196	2011-04-27	17:36	V	Olive Ridley sea turtle	1	0	8d51.48mN	84d05.44mW	80	150	resting	resting	80	100	power reduction of active source
197/A3	2011-04-27	18:48	VA	Pantropical spotted dolphin	4	0	8d55.752mn	84d03.338mw	355	5	surfacing	fast swimming	300	5	power reduction of active source
198	2011-04-27	19:31	V	Pantropical spotted dolphin	4	0	8d58.09mN	84d02.19mW	355	4619	breaching	porpoising	3600	3417	none
199	2011-04-27	20:24	V	Pantropical spotted dolphin	1	0	09d01.15'N	084d00.49'W	310	3922	breaching	breaching	4100	3922	none
200	2011-04-27	20:52	V	Pantropical spotted dolphin	4	0	9d00.74mN	8d358.28mW	120	300	surfacing	surfacing	300	300	delayed start of firing
201	2011-04-27	22:41	V	Olive Ridley sea turtle	0	1	08d53.13mN	084d01.20mW	290	40	slow swimming	dive	300	40	power reduction of active source
202	2011-04-27	22:47	V	Olive Ridley sea turtle	1	0	08d52.71mN	84d01.43mW	300	80	logging	dive	320	60	delayed start of firing
A4	2011-04-28		A	Sperm whale	>2		08d36.91mN	084d12.50mW	135						none
203	2011-04-28	11:48	V	Olive Ridley sea turtle	4	0	8d50.977mn	84d05.547mw	250	350	resting	resting	300	300	power reduction of active source
204/A5	2011-04-28	12:31	VA	Pantropical spotted dolphin	20	5	8d51.361mn	84d05.362mw	340	1373	porpoising	porpoising	59	200	power reduction then shutdown of active source
205	2011-04-28	12:34	V	Olive Ridley sea turtle	2	0	8d51.877mn	84d05.121mw	340	1309	resting	dive	1609	1309	none
206	2011-04-28	12:43	V	Olive Ridley sea turtle	1	0	8d54.35mn	84d03.88mW	70	2100	resting	dive	986	986	none
207	2011-04-28	13:58	V	Pantropical spotted dolphin	1	0	8d57.34mn	84d02.43mw	270	1000	jumping	jumping	1200	1000	none
208	2011-04-28	14:46	V	Pantropical spotted dolphin	2	1	9d00.016mn	84d01.102mw	70	2479	jumping	jumping	2479	2479	none
209	2011-04-28	15:16	V	common dolphin	4	1	9d00.792mn	84d00.693mw	25	3031	surfacing	jumping	1952	1952	none
210	2011-04-28	15:28	V	Pantropical spotted dolphin	12	2	09d01.156mN	84d00.311mw	345	2727	jumping	fast swimming	1444	1444	none
211	2011-04-28	15:35	V	Common bottlenose dolphin	2	0	8d59.46mN	83d57.88mW	290	2479	jumping	jumping	2479	2479	none
212	2011-04-28	16:21	V	Olive Ridley sea turtle	1	0	8d58.89mN	84d58.15mw	40	30	resting	resting	20	30	shutdown of active source

213	2011-04-28	16:44	V	Olive Ridley sea turtle	1	0	8d56.480mn	83d59.390mw	40	40	resting	resting	200	7	shutdown of active source
214	2011-04-28	17:06	V	Pantropical spotted dolphin	6	2	8d54.90mn	84d00.15mw	315	1196	porpoising	dive	1196	1196	none
215	2011-04-28	21:22	V	Unidentifiable dolphin	45	0	8d32.48mN	84d11.39mW	35	1535	porpoising	porpoising	1534	1534	none
216	2011-04-29	13:52	V	Olive Ridley sea turtle	1	0	8d47.87mn	84d03.69mw	290	100	swimming	dive	250	100	power reduction of active source
217	2011-04-29	14:35	V	Common bottlenose dolphin	25	10	8d43.50mN	84d05.84mW	350	1309	swimming	swimming	1300	1100	none
218	2011-04-29	17:45	V	Olive Ridley sea turtle	1	0	8d32.336mn	84d11.384mw	240	1102	resting	resting	1102	1102	none
219	2011-04-29	18:21	V	Unidentifiable shelled sea turtle	1	0	8d29.558mn	84d12.740mw	340	450	swimming	dive	730	430	power reduction of active source
220	2011-04-29	19:10	V	Olive Ridley sea turtle	0	1	8d26.01mN	84d14.54mW	300	15	swimming	dive	200	15	power reduction of active source
221	2011-04-29	19:23	V	Olive Ridley sea turtle	0	1	8d25.72mN	84d14.96mW	280	60	swimming	dive	230	50	power reduction of active source
222	2011-04-29	20:18	V	Olive Ridley sea turtle	1	0	8d28.21mN	84d16.53mW	70	50	swimming	resting	40	50	shutdown of active source
223	2011-04-29	22:44	V	Olive Ridley sea turtle	1	0	8d38.72mN	84d11.27mW	70	50	swimming	dive	200	40	power reduction of active source
224	2011-04-30	12:15	V	Spinner dolphin	110	10	8d38.841mn	84d07.967mw	160	3922	swimming	swimming	3100	3417	none
225	2011-04-30	12:58	V	Melon-headed whale	50	0	8d35.748mn	84d09.528mw	260	5664	swimming	swimming	5664	5664	none
226	2011-04-30	13:15	V	Unidentifiable shelled sea turtle	1	0	8d34.410mn	84d10.192mw	270	1021	logging	dive	1021	1021	none
227	2011-04-30	13:58	V	Olive Ridley sea turtle	6	0	8d31.01mN	84d11.89mw	290	378	resting	dive	378	378	power reduction of active source
228	2011-04-30	14:04	V	Olive Ridley sea turtle	1	0	08d30.946mn	084d11.866mw			resting	slow swimming	450	450	power reduction of active source
229	2011-04-30	14:12	V	Olive Ridley sea turtle	7	0	8d30.35mn	84d12.14mW	300	1089	resting	slow swimming	1000	800	none
230	2011-04-30	14:20	V	Olive Ridley sea turtle	1	0	8d29.78mn	84d12.43mW	280	360	resting	dive	302	302	power reduction of active source
231	2011-04-30	14:26	V	Olive Ridley sea turtle	1	0	8d29.33mN	84d12.65mW	310	1089	resting	dive	1089	1089	none
232	2011-04-30	15:09	V	Unidentifiable shelled sea turtle	1	0	8d26.186mn	84d14.226mw	280	951	slow swimming	dive	951	951	none
233	2011-04-30	15:56	V	Unidentifiable dolphin	20	0	8d26.880mn	84d16.828mw	190	5664	jumping	dive	5300	5664	none

234	2011-04-30	16:18	V	Olive Ridley sea turtle	1	0	8d28.204mn	84d16.358mw	60	505	resting	dive	398	398	power reduction of active source
235	2011-04-30	17:08	V	Olive Ridley sea turtle	1	0	8d31.03mN	84d14.94mW	0	306	resting	dive	300	100	power reduction of active source
236	2011-04-30	17:46	V	Olive Ridley sea turtle	1	0	08d33.55'N	084d13.680mw	340	505	resting	resting	275	275	power reduction of active source
237	2011-04-30	18:06	V	Unidentifiable dolphin	3	1	8d34.481mn	84d13.203mw	250	2614	fast swimming	dive	2614	2614	none
238	2011-04-30	18:52	V	Olive Ridley sea turtle	1	0	8d37.202mn	84d11.857mw	290	845	resting	dive	845	845	none
239	2011-04-30	19:14	V	Olive Ridley sea turtle	1	0	8d34.41mn	84d11.27mw	70	250	resting	dive	100	100	power reduction of active source
240	2011-04-30	19:32	V	Olive Ridley sea turtle	1	0	08d39.38'N	84d10.79mW	80	100	swimming	dive	300	60	power reduction of active source
241	2011-04-30	22:07	V	Pygmy killer whale	8	0	8d47.44mN	84d06.81mW	340	3922	jumping	feeding	900	1100	none
241	2011-04-30	22:09	V	Common bottlenose dolphin	8	0	8d47.52mN	84d06.76mW	340	3922	jumping	feeding	900	1100	none
242	2011-04-30	22:09	V	Olive Ridley sea turtle	1	0	8d47.44mN	84d06.81mW	220	50	resting	diving	70	10	power reduction of active source
243	2011-04-30	23:00	V	Pantropical spotted dolphin	2	0	08d50.24mn	084d05.47mw	80	3922	jumping	jumping	3900	3900	none
244	2011-04-30	23:25	V	Pantropical spotted dolphin	15	2	08d51.56mn	084d04.81mw	10	200	slow swimming	jumping	370	50	power reduction of active source
245	2011-05-01	11:44	V	Unidentifiable shelled sea turtle	1	0	8d25.847mn	84d16.261mw	315	50	surface	dive	330	20	power reduction of active source
246	2011-05-01	12:27	V	Olive Ridley sea turtle	1	0	8d278.155mn	84d17.355mw	270	125	resting	dive	125	125	power reduction of active source
247	2011-05-01	12:49	V	Rough-toothed dolphin	8	1	8d29.388mn	84d16.736mw	310	2100	swimming	milling	2100	1611	none
248	2011-05-01	13:00	V	Olive Ridley sea turtle	1	0	8d30.010mn	84d16.432mw	280	743	resting	dive	749	749	none
249	2011-05-01	13:27	V	Olive Ridley sea turtle	1	0	8d31.48mn	84d15.69mw	100	690	resting	resting	690	690	none
250	2011-05-01	13:41	V	Olive Ridley sea turtle	1	0	8d32.29mN	84d15.29mW	80	100	resting	resting	250	100	power reduction of active source
251	2011-05-01	13:50	V	Olive Ridley sea turtle	2	0	8d32.77mN	84d15.05mW	340	1196	resting	dive	1091	891	none
252	2011-05-01	14:18	V	Olive Ridley sea turtle	1	0	08d34.49'N	084d14.25'W	30	845	resting	dive	220	220	power reduction of active source

253	2011-05-01	14:31	V	Olive Ridley sea turtle	1	0	8d35.17mN	84d13.91mW	20	150	resting	resting	100	150	power reduction of active source
254	2011-05-01	14:43	V	Olive Ridley sea turtle	1	0	8d35.86mN	84d13.56mW	290	360	resting	dive	300	350	power reduction of active source
255	2011-05-01	14:49	V	Olive Ridley sea turtle	1	0	08d36.25mN	084d13.37'W	320	1102	resting	resting	200	200	delayed start of firing
256	2011-05-01	14:50	V	Common bottlenose dolphin	5	2	08d36.55'N	084d13.22'W	310	1102	swimming	milling	838	838	none
257	2011-05-01	15:00	V	Olive Ridley sea turtle	1	0	08d37.093mN	084d13.37'W	210	50	resting	dive	180	50	power reduction of active source
258	2011-05-01	15:49	V	Unidentifiable shelled sea turtle	1	0	8d39.750mn	84d11.630mw	90	3	swimming		270	3	power reduction of active source
259	2011-05-01	16:17	V	Olive Ridley sea turtle	1	0	8d41.27mN	84d10.93mW	320	445	slow swimming	slow swimming	75	150	power reduction of active source
260	2011-05-01	16:40	V	Olive Ridley sea turtle	1	0	8d42.76mN	84d10.28mW	40	1611	slow swimming	dive	791	791	none
261	2011-05-01	16:54	V	Olive Ridley sea turtle	1	0	8d43.41mN	84d10.01mW	90	505	resting	dive	445	445	power reduction of active source
262	2011-05-01	17:30	V	Olive Ridley sea turtle	1	0	8d45.45mn	84d09.13mW	40	1611	resting	dive	1800	1611	none
263	2011-05-01	17:44	V	Olive Ridley sea turtle	1	0	8d46.228mn	84d08.771mw	280	505	resting	resting	505	505	power reduction of active source
264	2011-05-01	19:05	V	Olive Ridley sea turtle	1	0	08d50.71'N	0884d06.53'W	110	80	swimming	dive	80	80	power reduction of active source
265	2011-05-01	19:20	V	Olive Ridley sea turtle	1	0	08d51.38'N	084d06.208'W	45	250	swimming	dive	200	300	power reduction of active source
266	2011-05-01	19:34	V	Pantropical spotted dolphin	2	0	8d52.16mN	84d05.84mW	90	3417	jumping	fast swimming	3414	3417	none
267	2011-05-01	22:01	V	Olive Ridley sea turtle	1	0	9d00.74mN	84d01.36mW	280	1444	resting	dive	1444	1444	none
268	2011-05-01	22:27	V	Olive Ridley sea turtle	1	0	9d01.60mN	83d59.85mW	100	50	swimming	dive	200	50	power reduction of active source
269	2011-05-01	22:39	V	Olive Ridley sea turtle	3	0	9d01.60mN	083d59.05mw	90	40	swimming	dive	70	40	power reduction of active source
270	2011-05-01	22:45	V	Olive Ridley sea turtle	1	0	9d01.10mN	83d58.74mW	90	10	swimming	dive	10	200	delayed start of firing

271	2011-05-01	23:04	V	Common bottlenose dolphin	1	0	9d00.13mN	83d57.81mw	70	100	swimming	swimming	300	100	power reduction of active source
272	2011-05-01	23:08	V	Olive Ridley sea turtle	1	0	8d59.99mN	83d57.78mW	290	100	resting	dive	350	80	none
273	2011-05-02	11:42	V	Olive Ridley sea turtle	1	0	8d39.733mn	84d10.540mw	100	250	slow swimming	dive	200	200	power reduction of active source
274	2011-05-02	12:47	V	Olive Ridley sea turtle	1	0	8d43.229mn	84d08.797mw	355	1196	slow swimming	dive	125	125	power reduction of active source
275	2011-05-02	13:04	V	Olive Ridley sea turtle	1	0	8d44.08mN	84d08.36mW	280	40	slow swimming	dive	300	40	power reduction of active source
276	2011-05-02	13:43	V	unidentifiable dolphin	10	0	8d49.29mN	84d07.31mW	320	2100	jumping	swimming	2100	2100	none
277	2011-05-02	14:02	V	Olive Ridley sea turtle	1	0	08d47.42'N	084d067'W	10	3031	swimming	dive	1025	845	none
278	2011-05-02	16:26	V	Common bottlenose dolphin	3	0	8d55.41mn	84d02.77mW	10	3031	breaching	porpoising	3200	3000	none
279	2011-05-02	16:32	V	Olive Ridley sea turtle	1	0	08d55.85'N	084d02.55'W	10	1309	resting	dive	1200	1060	none
280	2011-05-02	16:50	V	Olive Ridley sea turtle	2	0	8d56.808mn	84d02.062mw	50	505	resting	resting	200	150	power reduction of active source
281	2011-05-02	17:05	V	Olive Ridley sea turtle	2	0	8d57.681mn	84d01.636mw	20	1309	resting	resting	60	60	power reduction of active source
282	2011-05-02	17:05	V	Common bottlenose dolphin	4	0	8d57.681mn	84d01.636mw	30	1952	swimming	swimming	915	645	delayed start of firing followed by shut down of active source
283	2011-05-02	17:05	V	Unidentifiable dolphin	2	0	8d57.681mn	84d01.636mw	0	5664	jumping	jumping	5664	5664	none
284	2011-05-02	18:00	V	Olive Ridley sea turtle	2	0	9d01.038mn	84d00.205mw	270	845	resting	dive	845	845	power reduction of active source
285	2011-05-02	18:21	V	Olive Ridley sea turtle	1	0	9d01.217mn	83d58.971mw	80	250	resting	dive	250	250	power reduction of active source
286	2011-05-02	18:26	V	Olive Ridley sea turtle	1	0	9d01.068mn	83d58.646mw	290	10	swimming	dive	275	10	delayed start of firing
287	2011-05-02	18:33	V	Olive Ridley sea turtle	1	0	9d00.75mN	83d58.22mW	270	20	swimming	dive	275	20	delayed start of firing
288	2011-05-02	18:50	V	Olive Ridley sea turtle	1	0	8d59.644mn	83d57.882mw	310	845	resting	dive	845	845	power reduction of active source

289	2011-05-02	19:03	V	Olive Ridley sea turtle	1	0	08d58.88'N	083d58.20'W	100	329	resting	dive	329	329	power reduction of active source
290	2011-05-02	19:09	V	Olive Ridley sea turtle	1	0	08d58.56mN	083d58.43mW	300	505	resting	dive	200	200	delayed start of firing
291	2011-05-02	19:13	V	Olive Ridley sea turtle	1	0	8d58.36mN	083d56.57mW	300	30	swimming	dive	150	30	delayed start of firing followed by shut down of active source
292	2011-05-02	19:21	V	Olive Ridley sea turtle	1	0	08d57.88'N	083d58.84mW	90	749	resting	resting	445	445	none
293	2011-05-02	19:32	V	Olive Ridley sea turtle	1	0	08d57.22mN	083d59.18mW	270	5	swimming	dive	200	5	shutdown of active source
A6	201105-03		A	Unidentifiable dolphin			08d38.13mn	084d04.52mw							none
294	2011-05-03	13:06	V	Pantropical spotted dolphin	8	2	9d01.10mn	83d58.604mw	45	951	porpoising	porpoising	583	583	power reduction of active source
295	2011-05-03	13:28	V	Olive Ridley sea turtle	1	0	8d59.71mn	83d58.12mw	280	711	resting	dive	711	711	power reduction of active source
296	2011-05-03	14:28	V	Olive Ridley sea turtle	1	0	8d56.39mn	83d59.73mw	320	500	slow swimming	dive	500	500	power reduction of active source
297	2011-05-03	15:03	V	Olive Ridley sea turtle	1	0	8d54.41mn	84d00.79mw	250	1823	slow swimming	dive	1823	1823	none
298	2011-05-03	15:21	V	Olive Ridley sea turtle	1	0	8d53.374mn	84d01.332mw	80	250	slow swimming	dive	550	250	power reduction of active source
299	2011-05-03	15:33	V	Olive Ridley sea turtle	1	0	8d52.638mn	84d01.724mw	25	60	slow swimming	dive	335	60	power reduction of active source
300	2011-05-03	15:38	V	Unidentifiable dolphin	20	0	8d52.341mn	84d041.869mw	280	3031	surfacing	slow swimming	2100	2100	none
301	2011-05-03	16:15	V	Pantropical spotted dolphin	10	2	08d49.85'N	084d02.95'W	250	2479	porpoising	porpoising	1823	1823	none
302	2011-05-03	19:15	V	Olive Ridley sea turtle	1	0	8d37.64mn	84d08.76mw	270	40	swimming	swimming	100	20	power reduction of active source
303	2011-05-03	22:45	V	Olive Ridley sea turtle	1	0	8d24.00mn	84d15.82mw	250	244	slow swimming	slow swimming	200	200	none
304	2011-05-03	23:32	V	Common bottlenose dolphin	6	2	8d25.25mn	84d18.52mw	10	360	jumping	slow swimming	600	200	none
305	2011-05-04	11:38	V	Spinner dolphin	350	50	8d44.347mn	84d09.152mw	90	1535	feeding	milling	1535	1535	none
305	2011-05-04	11:38	V	Common dolphin	280	25	8d44.347mn	84d09.152mw	90	1535	feeding	milling	1535	1535	none

306	2011-05-04	14:20	V	Unidentifiable dolphin	2	0	8d53.25mn	84d04.73mw	350	445	swimming	swimming	445	445	none
307	2011-05-04	16:12	V	Pantropical spotted dolphin	30	10	8d59.99mn	84d41.07mw	30	1444	swimming	swimming	1021	1021	none
308/A7	2011-05-04	17:29	VA	Pantropical spotted dolphin	10	2	8d59.65mn	83d58.11mw	30	845	slow swimming	slow swimming	225	150	none
309	2011-05-04	17:45	V	Olive Ridley sea turtle	1	0	8d58.477mn	83d58.532mw	270	120	resting	swimming	200	120	none
310	2011-05-04	18:34	V	Olive Ridley sea turtle	2	0	8d56.358mn	83d59.900mw	45	130	sexual behavior	sexual behavior	320	120	none
311	2011-05-04	18:44	V	Olive Ridley sea turtle	1	0	8d55.977mn	84d00.102mw	30	398	slow swimming	dive	678	378	none
312	2011-05-04	19:40	V	Olive Ridley sea turtle	1	0	08d52.279'N	084d02.182'W	320	35	resting	dive	30	300	none
313	2011-05-04	21:45	V	Unidentifiable dolphin	30	0	8d45.92mN	84d05.14mW	30	1952	porpoising	jumping	1952	1952	none
314	2011-05-04	23:14	V	Unidentifiable shelled sea turtle	0	1	8d40.64mn	84d07.58mw	270	50	resting	diving	300	50	power reduction of active source
315	2011-05-04	23:27	V	Spinner dolphin	125	25	8d39.85mn	84d07.96mW	30	3922	porpoising	jumping	3922	3922	none
316	2011-05-04	23:37	V	Unidentifiable shelled sea turtle	1	0	08d39.04mn	084d08.30mw	45	1500	resting	diving	500	200	power reduction of active source
A8	2011-05-05		A	Unidentifiable dolphin			8d26.56mN	84d14.61mW							none
A9	2011-05-05		A	Unidentifiable dolphin			8d26.79mN	84d17.48mW							none
317	2011-05-05	11:33	V	Unidentifiable shelled sea turtle	0	1	8d53.165mn	84d04.596mw	270	120	resting	dive	395	120	power reduction of active source
318	2011-05-05	11:48	V	Olive Ridley sea turtle	1	0	8d54.051mn	84d04.104mw	280	229	swimming	dive	500	229	power reduction of active source
319	2011-05-05	13:27	V	Olive Ridley sea turtle	1	0	8d59.98mn	84d01.53mW	250	70	swimming	dive	100	70	shutdown of active source
320	2011-05-05	14:23	V	Pantropical spotted dolphin	5	0	09d01.32'N	083d59.17'W	80	3922	swimming	dive	3922	3922	none
321	2011-05-05	16:45	V	Pantropical spotted dolphin	10	2	08d54.06'N	084d01.30'W	320	1952	jumping	dive	750	450	power reduction of active source
322	2011-05-05	16:53	V	Olive Ridley sea turtle	1	0	8d53.560mn	84d01.551mw	310	1444	resting	dive	1444	1444	none
323	2011-05-05	17:27	V	Olive Ridley sea turtle	1	0	8d51.75mN	84d02.46mw	280	15	resting	dive	200	15	power reduction of active source
324	2011-05-05	19:41	V	Unidentifiable dolphin	3	0	08d44.24'N	084d06.66'W	20	5664	porpoising	milling	5864	56664	none
325	2011-05-06	13:54	V	Pantropical spotted dolphin	8	3	8d56.66mn	84d00.77mw	300	1089	jumping	swimming	632	632	power reduction of active source
326	2011-05-06	14:15	V	Pantropical spotted dolphin	3	0	8d55.44mn	84d01.34mw	250	2100	jumping	diving	1800	2100	none

327	2011-05-07	12:55	V	Olive Ridley sea turtle	1	0	8d50.75mn	84d03.59mw	90	5	resting	dive	280	5	power reduction of active source
328	2011-05-07	16:27	V	Pantropical spotted dolphin	11	0	8d38.07mn	84d10.60mw	315	4619	jumping	fast swimming	2727	2727	none
329	2011-05-07	19:01	V	Olive Ridley sea turtle	1	0	8d32.53mN	84d13.29mw	280	329	slow swimming	dive	400	300	power reduction of active source
330	2011-05-07	19:09	V	Olive Ridley sea turtle	1	0	8d32.10mn	84d13.58mW	300	40	slow swimming	slow swimming	60	40	power reduction of active source
331	2011-05-07	19:18	V	Olive Ridley sea turtle	1	0	08d31.57'N	084d13.88'W	20	50	resting	dive	30	40	power reduction then shutdown of active source
332	2011-05-07	19:31	V	Olive Ridley sea turtle	1	0	8d30.40mn	84d14.407mw	340	500	resting	resting	20	30	power reduction then shutdown of active source
333	2011-05-07	19:46	V	Olive Ridley sea turtle	1	0	8d29.62mn	84d14.79mw	100	1523	resting	resting	1523	1523	none
334	2011-05-07	20:02	V	Olive Ridley sea turtle	1	0	8d27.07mN	84d15.84mW	80	1611	resting	dive	1611	1611	none
335	2011-05-08	13:02	V	Common bottlenose dolphin	20	2	8d48.356mn	84d06.036mw	350	1309	jumping	fast swimming	1102	1102	none
336	2011-05-08	13:16	V	Pantropical spotted dolphin	40	5	8d47.664mn	84d06.396mw	270	3031	fast swimming	feeding	3031	3031	none
337	2011-05-08	15:51	V	Olive Ridley sea turtle	1	0	8d39.774mn	84d10.399mw	60	30	slow swimming	dive	240	20	power reduction of active source
338	2011-05-08	16:45	V	Olive Ridley sea turtle	1	0	08d36.81'N	084d11.87'W	270	5	slow swimming	dive	250	5	power reduction of active source
339	2011-05-09	11:29	V	Olive Ridley sea turtle	2	0	8d48.960mn	84d05.430mw	330	200	sexual behavior	sexual behavior	240	240	power reduction of active source
340	2011-05-09	12:15	V	Olive Ridley sea turtle	1	0	8d46.638mn	84d06.533mw	290	229	slow swimming	dive	150	150	power reduction of active source
341	2011-05-09	14:18	V	unidentifiable dolphin	15	3	08d41.00'N	084d09.52'W	220	5664	swimming	swimming	5664	5664	none
342	2011-05-09	19:07	V	unidentifiable dolphin	50	10	8d26.54mN	84d14.93mW	340	4619	feeding	jumping	4619	4619	none
343	2011-05-10	13:37	V	Olive Ridley sea turtle	1	0	8d42.37mn	84d08.51mw	270	50	slow swimming	dive	100	50	power reduction of active source

344	2011-05-10	16:45	V	Olive Ridley sea turtle	1	0	08d33.29'N	084d13.13'W	20	473	resting	dive	300	20	power reduction of active source
345	2011-05-10	17:00	V	Unidentifiable dolphin	200		8d32.577mn	84d13.431mw	10	9229	porpoising	feeding	8000	8000	none
346	2011-05-10	17:00	V	Common bottlenose dolphin	40	5	8d32.577mn	84d13.431mw	5	3030	porpoising	slow swimming	1102	1102	none
347	2011-05-10	19:36	V	Olive Ridley sea turtle	1	0	08d25.55'N	084d15.51'W	20	1250	resting	dive	1250	1250	none
348	2011-05-10	19:41	V	Risso's dolphin	4	1	08d26.60'N	084d15.72'W	310	300	slow swimming	slow swimming	300	300	delayed start of firing
349	2011-05-10	19:46	V	Olive Ridley sea turtle	1	0	08d25.75'N	084d16.07'W	290	329	resting	dive	350	350	none
350	2011-05-10	19:52	V	Hawksbill sea turtle	0	1	08d25.92'N	084d16.42'W	280	5	swimming	swimming	200	5	none
351	2011-05-10	23:21	V	Olive Ridley sea turtle	1	0	8d37.40mn	84d12.47mw	20	1823	resting	slow swimming	1	20	power reduction then shutdown of active source
352	2011-05-11	13:33	V	Olive Ridley sea turtle	1	0	08d47.51'N	084d02.73mw	350	398	swimming	diving	N/A	398	none
353	2011-05-11	13:50	V	Olive Ridley sea turtle	1	0	8d47.30mn	84d03.35mw	20	229	resting	diving	N/A	229	none
354	2011-05-11	14:43	V	Olive Ridley sea turtle	1	0	8d46.58mn	84d05.48mw	260	200	slow swimming	diving	N/A	200	none
355	2011-05-11	14:49	V	Olive Ridley sea turtle	1	0	8d46.46mn	84d05.77mw	350	541	resting	diving	N/A	541	none
356	2011-05-11	18:35	V	unidentifiable dolphin	30	5	08d43.79mn	084d15.32mw	250	1500	breaching	porpoising	N/A	1500	none
357	2011-05-11	20:04	V	Olive Ridley sea turtle	1	0	8d42.77mn	84d18.78mw	290	200	restng	diving	N/A	200	none

APPENDIX J: MITIGATION ACTIONS EXECUTED DURING BANGS CRISP SEISMIC SURVEY

Table 17. Delayed Ramp-up Mitigation Actions

Date	Detection #	Acoustic Detection #	Species or common name	Group Size	Closest Range to energy source	Source Activity (initial detection)	Mitigation Action	Duration
4/13/2011	52		Olive Ridley sea turtle	2	<300	Powered down	Delayed Ramp-up	0:10
4/13/2011	54		Olive Ridley sea turtle	2	<300	Powered down	Delayed Ramp-up	0:06
4/13/2011	55		Olive Ridley sea turtle	2	<300	Powered down	Delayed Ramp-up	0:08
4/13/2011	61		Olive Ridley sea turtle	1	30	Shut down	Delayed Ramp-up	0:08
4/13/2011	65		Olive Ridley sea turtle	1	50	Shut down	Delayed Ramp	0:01
4/13/2011	66		Green sea turtle	1	500	Shut down	Delayed Ramp	0:07
4/18/2011	97		Pantropical spotted dolphins	3	1023	Power Down	Delayed ramp-up.	0:21
4/18/2011	100		Olive Ridley sea turtle	3	30	Mitigation firing	Delayed ramp-up.	0:10
4/20/2011	167		Olive Ridley sea turtle	1	150	Mechanical power down (40 cu in)	Delay to ramp-up.	0:02
4/27/2011	200		Pantropical spotted dolphin	4	300	Reduced power (1 gun 40 cu in)	Delayed Ramp-up.	0:04
4/27/2011	202		Olive Ridley sea turtle	1	320	Mitigation firing	Delay to return to firing	0:08
5/1/2011	255		Olive ridley sea turtle	1	200	Mitigation firing	Delayed ramp-up.	0:05
5/1/2011	270		Olive ridley sea turtle	1	10	Mitigation power down	Delayed ramp-up	0:07
5/2/2011	282		Bottlenose dolphin	4	60	Mitigation power down	Delayed ramp-up	0:05
5/2/2011	286		Olive ridley sea turtle	1	275	Mitigation power down	Delayed ramp-up	0:07
5/2/2011	287		Olive ridley sea turtle	1	275	Mitigation power down	Delayed ramp-up	0:08
5/2/2011	290		Olive ridley sea turtle	1	200	Mitigation power down	Delayed ramp-up	0:04
5/2/2011	291		Olive ridley sea turtle	1	150	Mitigation power down	Delayed ramp-up	0:08
5/10/2011	348		Risso's Dolphins	5	300	Technical power down	Delay of ramp up	0:05

Table 18. Power Down Mitigation Actions

Date	Detection #	Acoustic Detection #	Species or common name	Group Size	Closest Range to energy source	Source Activity (initial detection)	Mitigation Action	Duration
4/12/2011	38		Olive Ridley sea turtle	1	250	Full power on line	Power Down	0:05
4/12/2011	39		Olive Ridley sea turtle	1	250	Full power on line	Power Down	0:05
4/12/2011	44		Olive Ridley sea turtle	1	310	Full power on line	Power Down	0:07
4/12/2011	45		Olive Ridley sea turtle	1	350	Full power on line	Power Down	0:06
4/13/2011	47		Olive Ridley sea turtle	1	250	Full power on line	Power Down	0:06
4/13/2011	48		Olive Ridley sea turtle	2	200	Full power on line	Power Down	0:10
4/13/2011	49		Olive Ridley sea turtle	1	3000	Ramping up	Power Down	0:07
4/13/2011	50		Olive Ridley sea turtle	1	<300	Ramping up	Power Down	0:04
4/13/2011	51		Olive Ridley sea turtle	3	<300	Ramping up	Power Down	0:08
4/13/2011	58		Olive Ridley sea turtle	1	50	Ramping up	Power Down	0:01
4/13/2011	68		Olive Ridley sea turtle	1	50	Full power on line	Power Down	0:02
4/13/2011	69		Olive Ridley sea turtle	1	20	Full power on line	Power Down	0:06
4/13/2011	70		Olive Ridley sea turtle	1	260	Full power 0	Power Down	0:04
4/16/2011	78		Olive Ridley sea turtle	1	40	Full power on line	Power down.	0:04
4/18/2011	89		Unidentified dolphin sp	25	280	Full power between lines	Power Down	0:07
4/18/2011	95		Olive Ridley sea turtle	1	850	Full power online	Power Down	0:08
4/18/2011	96		Olive Ridley sea turtle	1	951	Full power online	Power Down	0:07
4/18/2011	107		Olive Ridley sea turtle	2	50	Ramp-up	Power Down.	0:10
4/18/2011	108		Olive Ridley sea turtle	1	30	Ramp-up	Power Down	0:01
4/18/2011	110		Olive Ridley sea turtle	16	20	Ramp-up	Power Down	0:19
4/18/2011	111		Olive Ridley sea turtle	1	100	Ramp-up	Power Down	0:05
4/18/2011	115		Olive Ridley sea turtle	2	40	Full power online	Power Down	0:01
4/18/2011	116		Olive Ridley sea turtle	1	100	Ramp-up	Power Down	0:03
4/18/2011	117		Olive Ridley sea turtle	1	300	Ramp-up	Power Down	0:03

Date	Detection #	Acoustic Detection #	Species or common name	Group Size	Closest Range to energy source	Source Activity (initial detection)	Mitigation Action	Duration
4/18/2011	118		Olive Ridley sea turtle	1	250	Full power online	Power Down.	0:03
4/18/2011	119		Olive Ridley sea turtle	1	60	Full power online	Power Down.	0:03
4/18/2011	121		Olive Ridley sea turtle	1	280	Full power online	Power Down.	0:03
4/18/2011	125		Olive Ridley sea turtle	11	1611	Full power line change	Power Down	0:03
4/18/2011	126		Short-finned pilot whales Rough-toothed dolphins	8 20	250 2400	Full power line change	Power Down for the pilot whales	0:07
4/19/2011	133		Olive Ridley sea turtle	1	275	Full power online	Power Down.	0:04
4/19/2011	135		Unidentified shelled turtle	1	75	Full power online	Power Down.	0:04
4/19/2011	138		Olive Ridley sea turtle	1	70	Full power online	Power Down.	0:05
4/19/2011	139		Olive Ridley sea turtle	2	40	Full power online	Power Down.	0:05
4/19/2011	140		Olive Ridley sea turtle	1	280	Full power online	Power Down.	0:05
4/20/2011	144		Pantropical spotted dolphin	3	270	Reduced power firing (1650 cu in)	Power Down.	0:02
4/20/2011	149		Olive Ridley sea turtle	1	583	Full power online	Power Down.	0:07
4/20/2011	151		Olive Ridley sea turtle	1	632	Full power online	Power Down.	0:03
4/20/2011	152		Olive Ridley sea turtle	1	150	Ramp-up	Power Down.	0:07
4/21/2011	168	2	Pantropical spotted dolphin	20	100	Full power online	Power Down	0:13
4/22/2011	170		Olive Ridley sea turtle	1	200	Full power online	Power Down	0:05
4/22/2011	171		Pantropical spotted dolphin	15	200	Full power line change	Power Down.	0:06
4/23/2011	172		Olive Ridley sea turtle	1	583	Full power online	Power Down.	0:05
4/23/2011	174		Olive Ridley sea turtle	1	400	Full power online	Power Down.	0:05
4/23/2011	175		Olive Ridley sea turtle	1	100	Full power online	Power Down	0:06
4/23/2011	176		Olive Ridley sea turtle	1	150	Full power online	Power Down.	0:06
4/23/2011	180		Olive Ridley sea turtle	1	200	Full power online	Power Down	0:02
4/23/2011	181		Olive Ridley sea turtle	1	320	Full power online	Power Down.	0:05
4/24/2011	185		Olive Ridley sea turtle	2	260	Full power online	Power Down.	0:04

Date	Detection #	Acoustic Detection #	Species or common name	Group Size	Closest Range to energy source	Source Activity (initial detection)	Mitigation Action	Duration
4/27/2011	196		Olive Ridley sea turtle	1	80	Full power online	Power Down.	0:05
4/27/2011	197	3	Pantropical spotted dolphin	4	300	Full power online	Power Down.	0:21
4/27/2011	201		Olive Ridley sea turtle	1	300	Full power online	Power Down.	0:06
4/28/2011	203		Olive Ridley sea turtle	4	300	Full power online	Power Down.	0:05
4/28/2011	204	5	Pantropical spotted dolphin	25	59	Full power online	Power Down	0:02
4/29/2011	216		Olive Ridley sea turtle	1	250	Full power online	Power Down	0:05
4/29/2011	219		Unidentified shelled turtle	1	730	Full power online	Power Down.	0:03
4/29/2011	220		Olive Ridley sea turtle	1	200	Full power line change	Power Down	0:04
4/29/2011	221		Olive Ridley sea turtle	1	230	Full power line change	Power Down	0:04
4/29/2011	223		Olive Ridley sea turtle	1	200	Full power online	Power Down.	0:04
4/30/2011	227		Olive Ridley sea turtle	6	378	Full power online	Power Down.	0:05
4/30/2011	228		Olive Ridley sea turtle	1	450	Full power online	Power Down	0:04
4/30/2011	230		Olive Ridley sea turtle	1	302	Full power online	Power Down	0:04
4/30/2011	234		Olive Ridley sea turtle	1	398	Full power online	Power Down.	0:04
4/30/2011	235		Olive Ridley sea turtle	1	300	Full power online	Power Down.	0:04
4/30/2011	236		Olive Ridley sea turtle	1	275	Full power online	Power Down.	0:07
4/30/2011	239		Olive Ridley sea turtle	1	100	Full power online	Power Down.	0:04
4/30/2011	240		Olive Ridley sea turtle	1	300	Full power online	Power Down.	0:03
4/30/2011	242		Olive Ridley sea turtle	1	70	Full power online	Power Down	0:06
4/30/2011	244		Pantropical spotted dolphin	17	370	Full power online	Power Down.	0:19
5/1/2011	245		Unidentified shelled turtle	1	330	Full power line change	Power Down.	0:04
5/1/2011	246		Olive ridley sea turtle	1	125	Full power line change	Power Down.	0:06
5/1/2011	250		Olive ridley sea turtle	1	250	Full power online	Power Down.	0:04
5/1/2011	252		Olive ridley sea turtle	1	220	Full power online	Power Down.	0:08

Date	Detection #	Acoustic Detection #	Species or common name	Group Size	Closest Range to energy source	Source Activity (initial detection)	Mitigation Action	Duration
5/1/2011	253		Olive ridley sea turtle	1	100	Full power online	Power Down.	0:06
5/1/2011	254		Olive ridley sea turtle	1	300	Full power online	Power Down.	0:06
5/1/2011	257		Olive ridley sea turtle	1	180	Ramp-up	Power Down.	0:05
5/1/2011	258		Unidentified shelled turtle	1	270	Full power online	Power Down.	0:05
5/1/2011	259		Olive ridley sea turtle	1	75	Full power online	Power Down.	0:06
5/1/2011	261		Olive ridley sea turtle	1	445	Full power online	Power Down.	0:05
5/1/2011	263		Olive ridley sea turtle	1	505	Full power online	Power Down.	0:05
5/1/2011	264		Olive ridley sea turtle	1	80	Full power online	Power Down.	0:05
5/1/2011	265		Olive ridley sea turtle	1	200	Full power online	Power Down.	0:05
5/1/2011	268		Olive ridley sea turtle	1	200	Full power line change	Power Down.	0:08
5/1/2011	269		Olive ridley sea turtle	3	70	Full power line change	Power Down.	0:05
5/1/2011	271		Bottlenose dolphin	1	300	Ramp-up	Power Down.	0:16
5/2/2011	273		Olive ridley sea turtle	1	200	Full power online	Power Down.	0:03
5/2/2011	274		Olive ridley sea turtle	1	125	Full power online	Power Down.	0:10
5/2/2011	275		Olive ridley sea turtle	1	300	Ramp-up	Power Down.	0:06
5/2/2011	280		Olive ridley sea turtle	2	200	Full power online	Power Down.	0:10
5/2/2011	281		Olive ridley sea turtle	2	60	Ramp-up	Power Down.	0:05
5/2/2011	284		Olive ridley sea turtle	2	845	Ramp-up	Power Down.	0:07
5/2/2011	285		Olive ridley sea turtle	1	250	Full power line change	Power Down.	0:05
5/2/2011	288		Olive ridley sea turtle	1	845	Ramp-up	Power Down.	0:07
5/2/2011	289		Olive ridley sea turtle	1	329	Ramp-up	Power Down.	0:07
5/3/2011	294		Pantropical spotted dolphin	10	583	Full power line change	Power Down	0:07
5/3/2011	295		Olive ridley sea turtle	1	711	Full power line change	Power Down.	0:08
5/3/2011	296		Olive ridley sea turtle	1	500	Full power online	Power Down.	0:08
5/3/2011	298		Olive ridley sea turtle	1	550	Full power online	Power Down.	0:07

Date	Detection #	Acoustic Detection #	Species or common name	Group Size	Closest Range to energy source	Source Activity (initial detection)	Mitigation Action	Duration
5/3/2011	299		Olive ridley sea turtle	1	335	Full power online	Power Down.	0:08
5/3/2011	302		Olive ridley sea turtle	1	100	Full power online	Power Down.	0:03
5/4/2011	314		Unidentified shelled sea turtle	1	300	Full power online	Power Down.	0:05
5/4/2011	316		Unidentified shelled sea turtle	1	500	Full power online	Power Down.	0:06
5/5/2011	317		Unidentified shelled sea turtle	1	395	Full power online	Power Down.	0:07
5/5/2011	318		Olive ridley sea turtle	1	500	Full power online	Power Down.	0:08
5/5/2011	321		Pantropical spotted dolphin	12	750	Full power online	Power Down.	0:17
5/5/2011	323		Olive ridley sea turtle	1	200	Ramping up	Power Down.	0:05
5/6/2011	325		Pantropical spotted dolphin	11	632	Full power online	Power Down.	0:10
5/7/2011	327		Olive ridley sea turtle	1	280	Full power online	Power Down.	0:07
5/7/2011	329		Olive ridley sea turtle	1	400	Full power online	Power Down.	0:04
5/7/2011	330		Olive ridley sea turtle	1	60	Full power online	Power Down.	0:06
5/7/2011	331		Olive ridley sea turtle	1	30	Full power online	Power Down	0:05
5/7/2011	332		Olive ridley sea turtle	1	20	Full power online	Power Down	0:03
5/8/2011	337		Olive ridley sea turtle	1	240	Full power online	Power down	0:04
5/8/2011	338		Olive ridley sea turtle	1	250	Full power online	Power down	0:04
5/9/2011	339		Olive ridley sea turtle	2	240	Full power online	Power down	0:12
5/9/2011	340		Olive ridley sea turtle	1	150	Full power online	Power down	0:07
5/10/2011	343		Olive ridley sea turtle	1	100	Full power online	Power down	0:07
5/10/2011	344		Olive ridley sea turtle	1	300	Full power online	Power down	0:05
5/10/2011	351		Olive ridley sea turtle	1	1	Full power online	Power down	0:05
4/12/2011	40		Olive Ridley sea turtle	1	35	Full power on line	Shut Down	0:05
4/13/2011	50		Olive Ridley sea turtle	1	<300	Powered down	Shut Down	0:02
4/13/2011	53		Olive Ridley sea turtle	1	40	Powered down	Shut Down	0:03
4/13/2011	54		Olive Ridley sea turtle	2	<300	Powered down	Shut Down	0:04
4/13/2011	58		Olive Ridley sea turtle	1	50	Powered down	Shut Down	0:04
4/13/2011	60		Olive Ridley sea turtle	1	100	Full power between lines	Shut Down	0:05

Date	Detection #	Acoustic Detection #	Species or common name	Group Size	Closest Range to energy source	Source Activity (initial detection)	Mitigation Action	Duration
4/13/2011	62		Olive Ridley sea turtle	1	10	Ramping up	Shut Down	0:10
4/13/2011	63		Olive Ridley sea turtle	1	50	Ramping up	Shut Down	0:05
4/13/2011	64		Green sea turtle	1	60	Full power between lines	Shut Down	0:05
4/13/2011	67		Olive Ridley sea turtle	1	10	Ramping up	Shut Down	0:08
4/13/2011	68		Olive Ridley sea turtle	1	50	Powered down	Shut Down	0:05
4/14/2011	72		Olive Ridley sea turtle	1	200	Full power on line	Shut Down	0:06
4/15/2011	76		Olive Ridley sea turtle	1	280	Full power between lines	Shut Down	0:04
4/16/2011	81		Olive Ridley sea turtle	1	200	Full power on line	Shut down	0:08
4/16/2011	82		Olive Ridley sea turtle	1	270	Full power on line	Shut down	0:08
4/16/2011	83		Olive Ridley sea turtle	1	200	Full power on line	Shut down	0:07
4/16/2011	84	1	Pantropical spotted dolphins	2	280	Full power on line	Shut down	0:05
4/17/2011	85		Olive Ridley sea turtle	1	285	Full power on line	Shut Down	0:07
4/17/2011	88		Olive Ridley sea turtle	1	280	Reduced power firing (1650 cu in)	Shut Down	0:08
4/18/2011	90		Olive Ridley sea turtle	1	285	Mitigation firing	Shut Down	0:17
4/18/2011	99		Olive Ridley sea turtle	1	30	Ramp-up	Shut Down	0:04
4/18/2011	108		Olive Ridley sea turtle	1	30	Power Down	Shut Down	0:05
4/18/2011	115		Olive Ridley sea turtle	2	40	Power Down	Shut Down	0:09
4/21/2011	168	2	Pantropical spotted dolphin	20	100	Power Down	Shut Down.	0:05
4/23/2011	173		Olive Ridley sea turtle	1	280	Full power online	Shut Down.	0:05
4/23/2011	179		Olive Ridley sea turtle	1	250	Full power line change	Shut Down.	0:07
4/23/2011	180		Olive Ridley sea turtle	1	200	Power Down	Shut Down.	0:06
4/24/2011	183		Olive Ridley sea turtle	1	100	Full power online	Shut Down.	0:07
4/25/2011	193		Olive Ridley sea turtle	1	35	Reduced power (1 gun 40 cu in)	Shut Down	0:01
4/28/2011	204	5	Pantropical spotted dolphin	25	59	Power Down	Shut Down.	0:26

Date	Detection #	Acoustic Detection #	Species or common name	Group Size	Closest Range to energy source	Source Activity (initial detection)	Mitigation Action	Duration
4/28/2011	212		Olive Ridley sea turtle	1	20	Full power line change	Shut Down.	0:07
4/28/2011	213		Olive Ridley sea turtle	1	200	Full power online	Shut Down.	0:07
4/29/2011	222		Olive Ridley sea turtle	1	40	Full power line change	Shut Down.	0:04
5/2/2011	282		Bottlenose dolphin	4	60	Mitigation power down	Shut Down	0:12
5/2/2011	293		Olive ridley sea turtle	1	200	Ramp-up	Shut Down	0:07
5/5/2011	319		Olive ridley sea turtle	1	100	Full power online	Shut Down.	0:08
5/7/2011	331		Olive ridley sea turtle	1	30	Mitigation power down	Shut Down.	0:01
5/7/2011	332		Olive ridley sea turtle	1	20	Mitigation power down	Shut Down.	0:03
5/10/2011	351		Olive ridley sea turtle	1	1	Mitigation power down	Shut down	0:07

APPENDIX K: OTHER WILDLIFE OBSERVED DURING BANGS CRISP SEISMIC SURVEY

During the Bangs Crisp Seismic survey other wildlife were opportunistically recorded when marine mammals or sea turtles were not detected. Watches were conducted with searches for marine mammals and sea turtles as a priority, however to keep alertness and to add more baseline wildlife data, other wildlife species were recorded when possible.

Table 19. Bird species and numbers observed during the Bangs Crisp survey.

Common Name	Order	Family	Genus	Species	Approximate Number of Individuals Observed					Total # of Individuals (approx.)	Total # of Days Observed
					Week 1	Week 2	Week 3	Week 4	Week 5		
Brown Booby	Pelecaniformes	Sulidae	*Sula*	*leucogaster*	187	694	218	405		1504	28
Masked booby	Pelecaniformes	Sulidae	*Sula*	*dactylatra*	50	50	55	27		182	19
Magnificent frigatebird	Pelecaniformes	Fregatidae	*Fregata*	*magnificens*	23	19	16	26		84	26
Brown pelican	Pelecaniformes	Pelicanidae	*Pelecanus*	*occidentalis*	50	1	5	6		62	11
Audubon's shearwater	Procellariiformes	Procellariidae	*Puffinus*	*lherminieri*	101	937	200	93		1331	26
Pink-footed shearwater	Procellariiformes	Procellariidae	*Puffinus*	*creatopus*	-	40	80	48			7
Buller's shearwater	Procellariiformes	Procellariidae	*Puffinus*	*bulleri*	1	15	-	-		16	2
Townsend's Shearwater	Procellariiformes	Procellariidae	*Puffinus*	*auricularis*		205	-	-		205	2
Laughing Gull	Charadriiformes	Laridae	*Leucophaeus*	*atricilla*	1	4	2			7	4
Swallow-tailed gull	Charadriiformes	Laridae	*Creagrus*	*furcatus*	23	11	-	2		36	11
Bridled Terns	Charadriiformes	Sternidae	*Sterna*	*anaethetus*	6	308	121	66		501	13
Black Tern	Charadriiformes	Sternidae	*Childonias*	*niger*	-	-		107			
Sooty Tern	Charadriiformes	Sternidae	*Onychoprion*	*fuscatus*	-	-	124	6			6
Common Tern	Charadriiformes	Sternidae	*Sterna*	*hirundo*	-	-	3	-			1
Sandwich Tern	Charadriiformes	Sternidae	*Thalasseus*	*sandvicensis*	5					5	3
Unidentified Jaeger	Charadriiformes	Stercorariidae	*Stercoriarus*	-	3	-	-	-		3	3
Barn swallow	Passeriformes	Hirundinidae	*Hirundo*	*rustica*	6	9	4	5		24	17
Cliff swallow	Passeriformes	Hirundinidae	*Petrochelidon*	*pyrrhonota*	-	-	2	1			3

Common Name	Order	Family	Genus	Species	Approximate Number of Individuals Observed					Total # of Individuals (approx.)	Total # of Days Observed
					Week 1	Week 2	Week 3	Week 4	Week 5		
Rough-winged swallow	Passeriformes	Hirundinidae	*Stelgidopteryx*	*serripennis*	-	-	-	2			
Summer tanager	Passeriformes	Cardinalidae	*Piranga*	*rubra*	1	-	-	-		1	1
Philadelphia vireo	Passeriformes	Vireonidae	*Vireo*	*philadelphicus*	2	-	-	-		2	2
Social flycatcher	Passeriformes	Tyrannidae	*Myiozetetes*	*similis*	2	-	-	1		3	2
Streaked flycatcher	Passeriformes	Tyrannidae	*Myiodynastes*	*maculatus*	5	2	-	-		7	2
Tropical kingbird	Passeriformes	Tyrannidae	*Tyrannus*	*melancholicus*	-	12	-	-		12	2
Eastern kingbird	Passeriformes	Tyrannidae	*Tyrannus*	*tyrannus*	-	-	-	101			
Unid. Empidonax flycatcher	Passeriformes	Tyrannidae	*Empidonax*	-	1	-	-	1		2	2
Blackburnian Warbler	Passeriformes	Parulidae	*Dendroica*	*fusca*	-	-	3	-			3
Brown-headed Cowbird	Passeriformes	Icteridae	*Molothrus*	*ater*	-	-	1	-			1
Blue-gray Tanager	Passeriformes	Thraupidae	*Thraupis*	*episcopus*	-	-	1	-			1
Cattle Egret	Passeriformes	Ardeidae	*Bulbulcus*	*ibis*	4	5	2	1		12	10
Unidentified egret	Passeriformes	Ardeidae	-	-	3	-	-	-		3	1
Merlin	Falconiformes	Falconidae	*Falco*	*columbarius*	1	-	-	-		1	1
Peregrine falcon	Falconiformes	Falconidae	*Falco*	*peregrinus*	1	1	-	-		2	2
Unidentified shearwater	Procellariiformes	Procellariidae	-	-	86	25	-	3		114	7
Unidentified Petrel	Charadriiformes	Procellariidae	-	-	1	-	-	-		1	1
Unidentified Shorebird		Scolopacidae	-	-	27	-	-	69		96	3
Unidentified Warbler	Passeriformes	-	-	-	-	-	-	3			

Table 20. Fish species and numbers observed during the Bangs Crisp seismic survey.

Common Name	Class	Order	Family	Genus	Species	Approximate Number of Individuals Observed					Number of Individuals Observed (approx.)	Number of Days Species Was Observed
						W1	W2	W3	W4	W5		
Black Skipjack Tuna	Actinoptergii	Perciformes	Scombridae	*Euthynnus*	*lineatus*	-	-	100	80		180	2
Sailfish	Actinopterygii	Perciformes	Istiophoridae	*Istiophorus*	*platypterus*	42	1	-	-		43	2
Pacific bonito	Actinoptergii	Perciformes	Scombridae	*Sarda*	*chiliensis*	-	150	200	100		450	3
Mahi Mahi	Actinopterygii	Perciformes	Coryphaenidae	*Coryphaena*	*hipparus*	1	-	1	-		2	2
Tripletail	Actinopterygii	Perciformes	Lobotidae	*Lobotes*	*surinamensis*	3	-	-	4		7	2
Marlin sp	Actinopterygii	Perciformes	Istiophoridae	-	-	26	-	8	7		41	3
Remora sp	Actinopterygii	Perciformes	Echeneidae	-	-	1	-	2	-		3	2
Scribbled leatherjacket filefish	Actinopterygii	Tetraodontiformes	Monacanthidae	*Aluterus*	*scriptus*	-	-	-	1		1	1
Flying fish sp	Actinopterygii	Beloniformes	Exocoetidae	-	-	29	48	6	14			
Neelefish sp	Actinopterygii	Beloniformes	Belonidae	-	-	-	-	-	1		1	1
Cownose Ray	Chondrichthyes	Myliobatiformes	Myliobatidae	*Rhinoptera*	*bonasus*	3	7	-	-		10	2
Manta ray	Chondrichthyes	Myliobatiformes	Mobulidae	*Manta*	*enana*	6	11	6	38		61	4
Unidentified Shark	Chondrichthyes	Lamniformes	Cetorhinidae	*Cetorhinus*	*maximus*	1	-	-	-		1	1
Hammerrhead Shark	Chondrichthyes	Carachartiniformes	Sphymidae	*Sphyrna*	-	1	-	-	-		1	1
Unidentified fish	-	-	-	-	-	-	10000	-	3		10003	2

Table 21. Invertebrate, Insect, Reptile and Crustacean species and numbers observed during the Bangs Crisp seismic survey.

Common Name	Class	Order	Family	Genus	Species	Approximate Number of Individuals Observed					Approximate Number of Individuals Observed	Approximate Number of Days Species Was Observed
						Week 1	Week 2	Week 3	Week 4	Week 5		
Unidentified butterfly	Insecta	Lepidoptera	-	-	-	5	1	3	2		11	4
Dragonfly	Insecta	Odonata	-	-	-	2	1	3	2		8	4
Unidentified moth	Insecta	Lepidoptera	-	-	-	1	-	-	1		2	2
Lacewing	Insecta	Neuroptera	-	-	-	-	1	-	-		1	1
Wasp	Insecta	-	-	-	-	-	-	-	1		1	1
Unidentified Insect	Insecta	-	-	-	-	-	-	-	650		650	1
Sea snake	Reptilia	Squamata	Elapidae	*Pelamis*	*platurus*	1	-	-	-			
Salp	Thaliacea	Salpida	Salpidae	-	-	2	-	-	-		2	1
Unidentified Jellyfish	Scyphozoa	-	-	-	-	1	-	-	-		1	1
Unidentified Crab	Malacostraca	Decopoda	-	-	-	1	-	1	-		2	2