Protected Species Mitigation and Monitoring Report

Galicia Basin 3D Seismic Survey
in the northeast Atlantic Ocean

1 June 2013 - 2 August 2013

R/V Marcus G. Langseth

Prepared for

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1. EXECUTIVE SUMMARY

The National Science Foundation (NSF) owned research vessel (R/V), *Marcus G. Langseth*, operated by Lamont-Doherty Earth Observatory (L-DEO), a part of Columbia University, conducted a seismic survey in the Deep Galicia Basin of the northeast Atlantic Ocean west of Spain. The purpose of the survey was to characterize the last stage of continental breakup and the initiation of seafloor spreading, relate post-rifting subsidence to syn-rifting lithosphere deformation, and inform the nature of detachment faults. The *Langseth* departed Vigo, Spain on 1 June 2013 and began the survey on 5 June 2013. The *Langseth* returned to port from 25 June 2013 through 15 July 2013 due to engine issues that required repairs. The survey was completed on 31 July 2013 and the *Langseth* arrived back in Vigo on 2 August 2013.

L-DEO submitted an application to the National Marine Fisheries Service (NMFS) for a permit to harass marine mammals, incidental to the marine geophysical survey. An Incidental Harassment Authorization (IHA) was granted on 31 May 2013 (Appendix A) with several mitigation measures that stipulated harassment to marine mammals. Mitigation measures were implemented to minimize potential impacts to marine mammals throughout the duration of the survey. Mitigation measures included, but were not limited to, the use of NMFS approved Protected Species Observers (PSOs) for both visual and acoustic monitoring, establishment of safety radii, and implementation of ramp-up, power-down and shut-down procedures.

RPS was contracted by L-DEO to provide continuous protected species observation coverage and to fulfill the environmental regulatory requirements and reporting mandated by NMFS in the IHA. Four PSOs and one dedicated PAM Operator were present on board the *Langseth* throughout the survey in this capacity. This included one local expert from Vigo, Spain who was familiar with the area and the species therein.

PSOs undertook a combination of visual and acoustic watches, conducting a total of 642 hours 30 minutes of visual observations and 642 hours 37 minutes of acoustic monitoring over the course of the survey.

This visual monitoring effort produced a project total of 155 protected species detection records; all for cetaceans. Mysticetes constituted the majority of sightings with 113 detection records. There were 25 detections of odontocetes as well as 16 detections of unidentified cetaceans. Acoustic monitoring effort produced a project total of four acoustic detections using the passive acoustic monitoring (PAM) system; two of unidentified delphinids and two of sperm whales. One of the acoustic sperm whale detections correlated with a visual sighting.

Detections of protected species resulted in 11 mitigation actions being implemented; all power-downs of the acoustic source. This resulted in a total of 5 hours 19 minutes of mitigation downtime. A known 271 cetaceans and were exposed to received sound levels equal to or greater than 160 dB of sound from the acoustic source, constituting a level B harassment take as defined by NMFS. Cetacean level B harassment takes included 89 fin whales, one fin whale, two sperm whales, 47 unidentified whales, 50 striped dolphins, seven bottlenose dolphins, six unidentified pilot whales, and 69 unidentified dolphins.

A project summary sheet of observation, detection, and operational totals for the *Langseth* can be found in Appendix B.

2. INTRODUCTION

The following report details protected species monitoring and mitigation as well as seismic survey operations undertaken as part of the Galicia 3D (Sawyer) marine geophysical survey on board the *R/V Langseth* from 1 June to 2 August 2013 in the northeast Atlantic Ocean.

This document serves to meet the reporting requirements dictated in the IHA issued to L-DEO by NMFS on 31 May 2013. The IHA authorized non-lethal 'takes' of Level B harassment of specific marine mammals incidental to a marine seismic survey program. NMFS has stated that seismic source received sound levels greater than 160 dB could potentially disturb marine mammals, temporarily disrupting behavior, such that they could be considered as 'takes' of these exposed animals. Potential consequences of Level B harassment taking could include effects such as temporary or permanent hearing threshold shifts, behavior modification and other reactions. It is unknown to what extent cetaceans exposed to seismic noise of this level would express these effects, and in order to take a precautionary approach, NMFS requires that provisions such as safety radii, power-downs and shut-downs be implemented to mitigate for these potential adverse effects.

2.1. PROJECT OVERVIEW AND LOCATION

The survey was conducted in the Deep Galicia Basin of the northeast Atlantic Ocean, off the west coast of Spain. The survey took place in the approximate area of 41.5 to 42.5° North and 11.5 to 17.5° West, where water depths ranged from approximately 3,500 to >5,000 meters (Figure 1). The seismic survey took place in International Waters as well as within the Exclusive Economic Zone (EEZ) of Spain and consisted of 82 track lines (Figure 2). The *Langseth* deployed an array of 18 airguns as an energy source. The receiving system consisted of four six kilometer hydrophone streamers deployed at 200 meter spacing and run in a 64 km by 22.4 km box with a 2D line extending to the West, and an array of 78 Ocean Bottom Seismometers (OBSs). The OBSs were deployed and retrieved by a second vessel, the *R/V Poseidon*, provided by the German Science Foundation. As the airgun array was towed along the survey lines, the hydrophone streamer received the returning acoustic signals and transferred the data to the onboard processing system. The OBSs record the returning acoustic signals internally for later analysis.

The goal of the proposed research was to collect data necessary to study the rifted continental to oceanic crust transition in the Deep Galicia Basin west of Spain. This margin and its conjugate are among the best studied magma-poor, rifted margins in the world, and the focus of studies has been the faulting mechanics and modification of the upper mantle associated with such margins. A total of 4,988.23 km of transect lines were surveyed. The *Langseth*'s cruising speed was about 10-12 knots during transits and varied between 4 and 5 knots during the seismic survey. Seismic acquisition began on 5 June and continued until 23 June when the Langseth experienced engine problems and returned to port to for repairs. Seismic acquisition was resumed on 15 July and continued until the end of the project on 31 July.

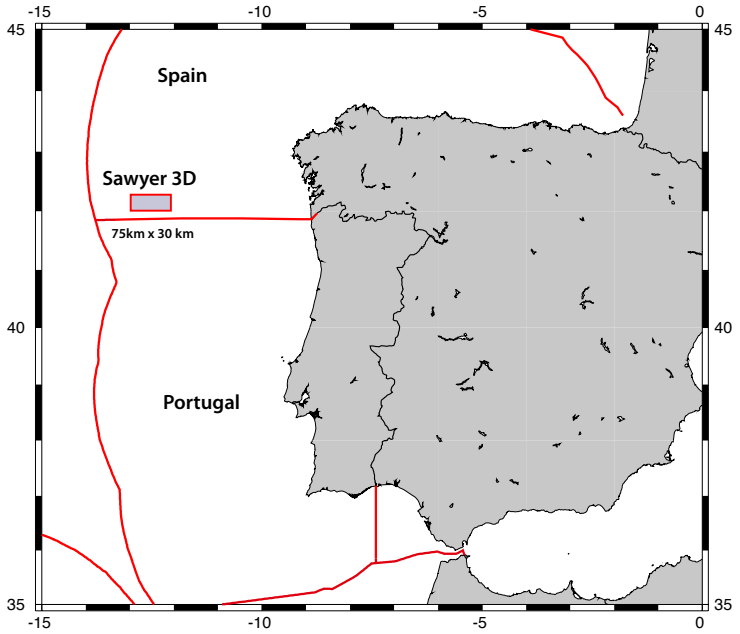

Figure 1. Location of the Galicia 3D (Sawyer) marine geophysical survey in the Northeast Atlantic Ocean, also showing EEZ delineations.

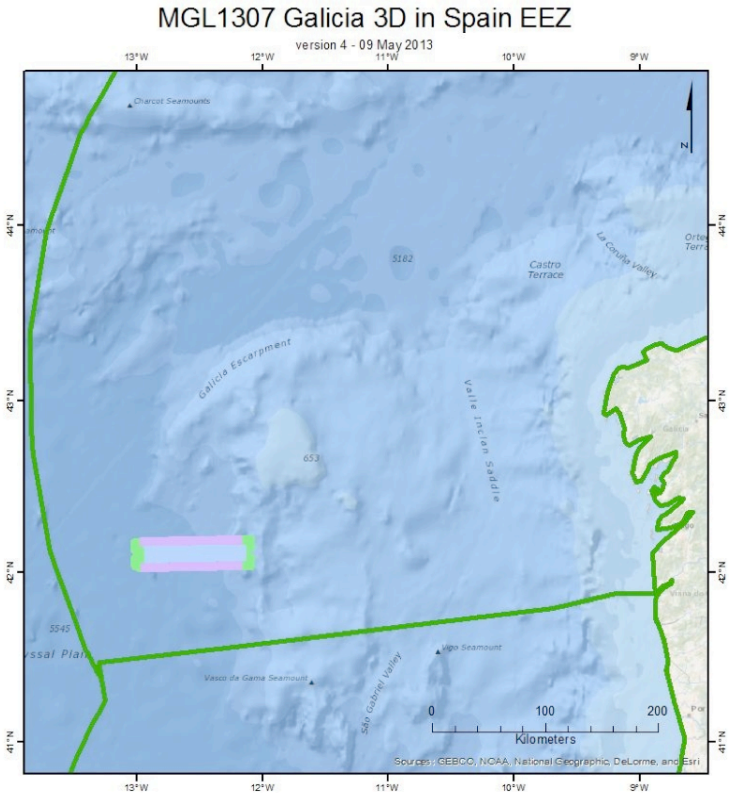

Figure 2. Map of proposed survey lines for the Galicia 3D seismic survey.

2.1.1. Energy Source

The acoustic source consisted of four towed airgun sub-arrays and four hydrophone streamer cables. The sub-arrays were deployed in two pairs located 100 meters apart, within each pair the arrays were separated by eight meters. Only one pair of airgun arrays was fired at a time, switching back and forth. The airguns were towed at a depth of nine meters and were situated 272 meters from the Navigational Reference Point (NRP), which was located on the PSO observation tower.

Each source array utilized a mixture of Bolt 1500LL and Bolt 1900LLX elements ranging in volume from the smallest airgun of 40 in³ to 360 in³. Each sub-array contained ten elements, with the first and last spaced 16 meters apart. Only nine airguns on each sub-array were firing during survey acquisition, with the tenth gun utilized as a spare. The total volume of each sub-array was 1,650 in³. The full power source of a pair of two sub-arrays (18 airguns) had a total discharge volume of 3,300 in³ and a pressure of 2,000 psi. Each discharge of the source consisted of a single brief pulse of sound (duration of approximately 0.1 second) with the greatest energy output occurring in the two to 188 hertz frequency range.

The shot point interval for the MCS survey was 37.5 meters, equating to approximately 15 seconds at typical survey speed. The sound signal receiving system during the acquisition of the MCS transect lines consisted of a four six-kilometre long hydrophone streamers, which received the returning acoustic signals and transferred the data to the processing system located on board the vessel. Due to the length and placement of the cables, the maneuverability of the vessel was limited to turns of five degrees per minute while the gear was being towed. Additionally, OBSs were deployed and retrieved by the R/V Poseidon along a single long survey line extending west of the survey box.

In addition to the operations of the airgun array, a Kongsberg EM 122 multibeam echosounder (MBES), a Knudsen Chirp 3260 sub-bottom profiler (SBP), and a hull-mounted acoustic Doppler current profiler (ADCP) was operated from the *Langseth* continuously throughout the cruise. These sound sources are operated from the *Langseth* simultaneous with the airgun array.

3. MITIGATION AND MONITORING METHODS

The PSO monitoring program on the *Langseth* was established to meet the IHA requirements that were issued to the L-DEO by NMFS, which included both monitoring and mitigation objectives. The survey mitigation program is designed to minimize potential impacts of the *Langseth*'s seismic program on marine turtles, marine mammals, and other protected species of interest. The following monitoring protocols were followed to meet these objectives.

- 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 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 the mitigation objectives outlined in the IHA, PSOs collected and analyzed necessary data mandated by the IHA (see Appendix A).

3.1. VISUAL MONITORING SURVEY METHODOLOGY

There were five trained and experienced PSOs on board to conduct the monitoring for marine mammals, record and report on observations, and request mitigation actions in accordance to the IHA. The PSOs on board were NMFS approved and held certifications from a recognized Joint Nature Conservation Committee (JNCC) course and/or approved Bureau of Ocean Energy Management (BOEM) course. Visual monitoring was primarily carried out from an observation tower (Figure 3) located 18.9 meters above the water surface, which afforded the PSOs a 360 degree viewpoint around the acoustic source.

Figure 3. Protected Species Observer observation tower with mounted big-eye binoculars.

The PSO tower was equipped with Fujinon 7x50 binoculars as well as two mounted 25x150 Big-eye binoculars. Inside the tent located in the middle of the platform was a laptop for data

collection as well as a telephone for communication with the PAM station, bridge, or main lab. Also inside the tent was a monitor that displayed current information about the vessel's position, speed, and heading, along with water depth, wind speed and direction, and source activity. Most observations were held from the tower; however, when there was severe weather or poor environmental conditions observations would be performed from the bridge (~12.8m above sea level) or the catwalk (~12.3m above sea level) in front of the bridge. Night Quest NQ2200 Night Vision Devices were also available to conduct night time observations for nighttime ramp-ups of the acoustic source, but were not used during this survey.

Visual monitoring methods were implemented in accordance with the survey requirements outlined in the IHA. At least one PSO, but most often two PSOs, watched for marine mammals and sea turtles at all times while airguns operated during daylight periods and whenever the vessel was underway when the airguns were not firing.

When the acoustic source was activated from silence, PSOs maintained a two-person watch for 30 minutes prior to the activation of the source. Visual watches commenced each day before sunrise, beginning as soon as the safety radii were visible, and continued past sunset until the safety radii became obscured. Start of observation times ranged from 6:42 to 7:20 local time, while end of observation times ranged from 10:28 to 10:58 local time.

A visual monitoring schedule was established by the PSOs where each person completed visual observations watches which varied in length between one to four hours, two to three times a day, for a total of five to eight hours of visual monitoring per day. This schedule was arranged to ensure that two PSOs were on visual observation duty at all times except during meal breaks when PSOs would each maintain a solo watch so that the entire team could eat while maintaining both visual and acoustic monitoring. Solo watches lasted less than 45 minutes and occurred each day at meal times.

Observations were focused forward of the vessel and to the sides but with regular sweeps through the area around the active acoustic source. PSOs searched for blows indicating the presence of a marine mammal, splashes or disturbances to the sea surface, the presence of large flocks of feeding seabirds and other sighting cues indicating the possible presence of a protected species.

Upon the visual detection of a protected species, PSOs would first identify the animals range to the acoustic source while identifying the observed animal (cetacean, pinniped, or sea turtle) to determine which safety radius applied to the animal. The visual PSOs would then notify the PAM operator, who was located in the main science lab, that there was an animal inside or outside of the safety radius. If the animal was observed inside the safety radius and a mitigation action was necessary, the PAM operator would relay the message to the seismic technician who sits nearby. Table 1 describes the various safety radii applied to cetaceans and pinnipeds, as well as what constituted the Level-B harassment zone. The PAM operator was also notified of all marine mammal sightings as soon as possible in order to enable recordings to be made for possible analysis later by one of the more experienced acoustic operators to determine whether vocalizations had been detected on the PAM system during the sighting.

Table 1. Safety radii (SR) for triggering mitigation.

Source and Volume	Array Tow Depth (m)	Water Depth (m)	Power/Shut-down SR for Cetaceans 180 dB (m)	Level-B Harassment Zone 160 dB (m)
Single Bolt Airgun (40 in³)	9	Deep (>1,000)	100	385
2 Strings 18 Airguns (3,300 in³)	9	Deep (>1,000)	568	4,550

When a protected species was observed range estimations were made using reticle binoculars, the naked eye, and by relating the animal to an object at a known distance, such as the acoustic array located 272 meters from the PSO tower. Specific species identifications were made whenever distance, length of sighting and visual observation conditions allowed. PSOs observed anatomical features of animals sighted with the naked eye and through the big-eyes and reticule binoculars and noted behavior of the animal or group. Photographs were taken during most sightings. Sometimes photographs were not taken due to the brevity of a sighting. The camera used was a Canon EOS 60D with a 300-millimeter telephoto lens. Marine mammal identification manuals were consulted and photos were examined during visual watch breaks to confirm identifications.

During or immediately after each sighting event PSOs recorded the event per the requirements of the IHA. Each sighting event was linked to an entry on a datasheet such that environmental conditions were available for each sighting event.

3.2. ACOUSTIC MONITORING SURVEY METHODOLOGY

PAM was used to augment visual monitoring efforts, by helping to 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.

Three PSOs who were trained and experienced with the use of PAM, were present throughout the cruise. One person was designated as the PAM operator to oversee and conduct the PAM operations. All PSOs completed a PAM training provided by the PAM Operator in the initial days of the hydrophone deployment during which basic PAM system operation was covered. To achieve 24-hours of monitoring, the PSOs and the PAM operator rotated through acoustic monitoring shifts with a trained 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. Monitoring shifts lasted one to six hours. During daylight hours, acoustic operators were in communication with visual PSOs in the tower relaying sighting and seismic activity information. The PAM system was located in the main science lab to provide adequate

space for the system, allow a quick exchange of communications with the visual PSOs on watch and seismic technicians, and to provide access to the vessel's instrumentation. The vessel's position, water depth, heading and speed, vessel and airgun activity were recorded every hour.

Acoustic monitoring for marine mammals was conducted aurally with *Sennheiser* headphones and visually with *Pamguard Beta 1.12.05*. Delphinid whistles, clicks, and burst pulses as well as sperm whale and baleen whale vocalizations may be viewed on a spectrogram display within *Pamguard*. Sperm whale, beaked whale, *Kogia* species, and delphinid echolocation clicks may be viewed on low and high frequency click detector displays. The Spectrogram's amplitude range and appearance were adjusted as needed to suit the operator's preference to maximize the vocalizations appearance above the pictured background noise.

3.2.1. Passive Acoustic Monitoring Parameters

Acoustic monitoring was carried out using a PAM system developed by Seiche Measurements Limited. PAM system specifications can be found in Appendix C. The PAM system consists of seven main components: a 20m hydrophone cable, a 230m hydrophone tow cable, a 100m deck cable, a data processing unit, a rack-mounted computer with two monitoring screens, an acoustic analysis software package, and headphones for aural monitoring.

The hydrophone cable contains four hydrophone elements and a depth gauge molded into a 20m section of the cable. The first two hydrophones are designated as the low frequency channels; these are broadband elements (200Hz to 200kHz). The third and fourth hydrophones are considered the standard elements, and sample high frequencies (2kHz to 200kHz). The four-element linear hydrophone array permits a large range for sampling marine mammal vocalizations.

The electronic processing unit contained a buffer processing unit with USB output, and an *RME Fireface 800 ADC* processing unit with firewire output. The electronic processing unit, and a rack-mounted computer with two monitors were set-up in the main lab. One of the computer's monitors displays a high frequency range (hereafter referred to as the HF system), using the signal from two hydrophones, and the low frequency range is displayed on the other computer's monitor (LF system), receiving signal from all four hydrophones. A GPS feed of INGGA strings was supplied from the ship's Seapath navigation system and connected to the computer and routed to the LF system, reading data every 10 seconds.

The high frequency (HF) system was used to detect and localize ultrasonic pulses produced 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 kilohertz, then processed and displayed on a monitor using the program *Pamguard Beta 1.12.05* via USB connection. The amplitude of clicks detected at the front hydrophone was measured at 5th order Butterworth band-pass filters ranging from 35 kilohertz to 120 kilohertz with a high pass digital pre-filter set at 35 kilohertz (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, which would allow 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 four kilohertz and 24 kilohertz. 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 kilohertz per channel. The LF hydrophone signal was further processed within the *Pamguard* monitoring software 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 bearings of whistles and moans were configured. The bearings and distance to detected whistles and moans can be calculated using a Time-of-Arrival-Distance (TOAD) method (the signal time delay between the arrival of a signal on each hydrophone is 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. 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.

3.2.2. Hydrophone Deployment

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.

Figure 4 shows the position of the PAM hydrophone deployed in relation to the vessel and seismic equipment. Photos of the hydrophone deployment methods and equipment discussed above can be found in Appendix D.

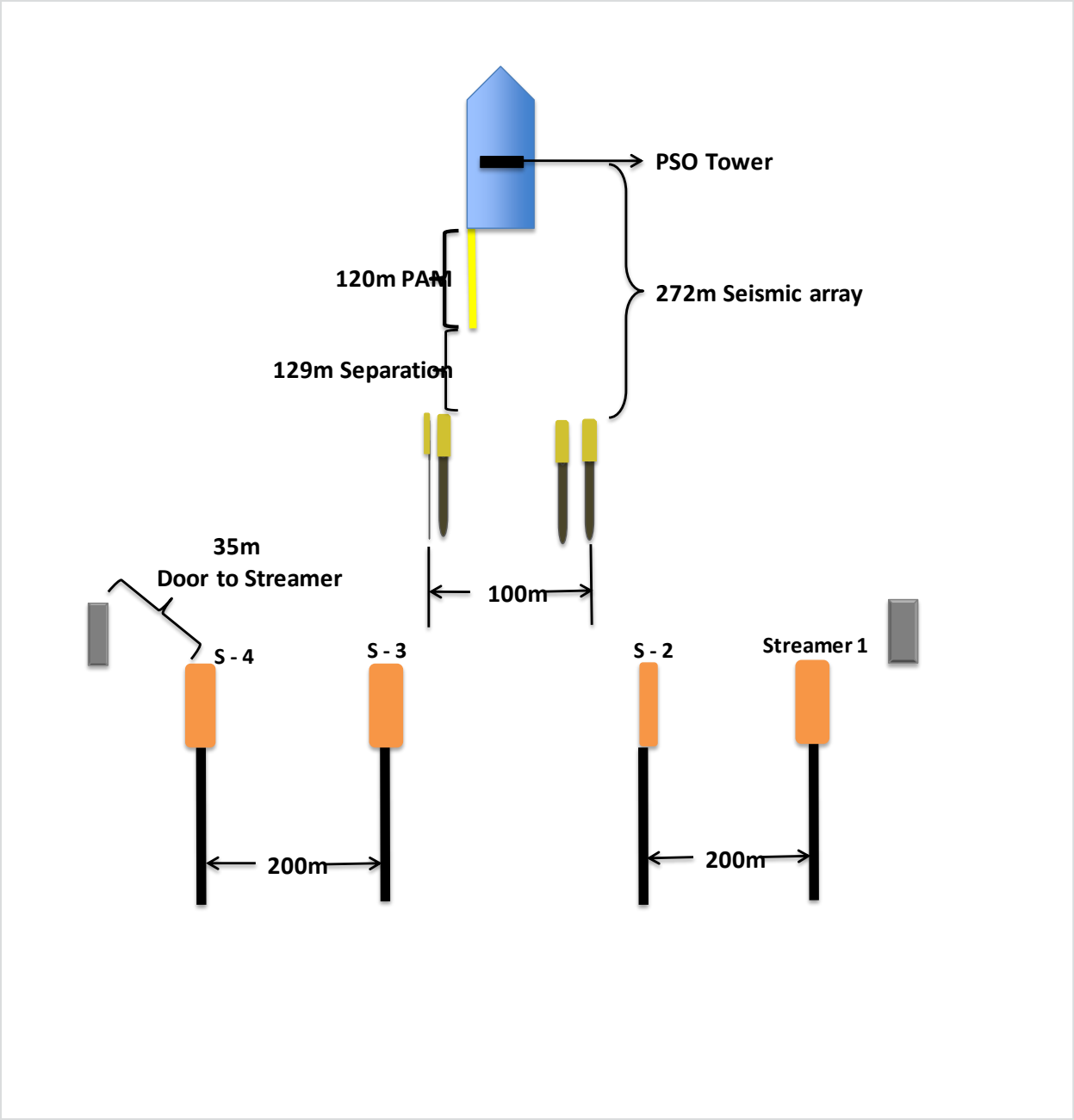

Figure 4. Location of the PAM cable in relation to the seismic gear.

4. MONITORING EFFORT SUMMARY

4.1. SURVEY OPERATIONS SUMMARY

The *R/V Langseth* departed Vigo, Spain for the Galicia 3D seismic survey site at 6:16 UTC on 1 June 2013. The seismic gear was deployed and use of the acoustic source commenced at 14:16 UTC on 5 June. Acquisition began on the first survey line at 23:31 UTC on 5 June. At 0:06 UTC on 23 June the portside engine failed, resulting in all of the seismic gear being retrieved and the *R/V Langseth* returning to port in Vigo to repair the engine. The *Langseth* arrived in port at 9:05 UTC on 25 June. Once the engine was repaired, the *Langseth* departed Vigo for the survey site at 5:15 UTC on 15 July. And use of the acoustic source resumed at 16:00 UTC on 16 July. Acquisition of the survey lines was completed at 17:50 UTC on 31 July. At this time the seismic gear was brought on board and the *Langseth* began the transit to Vigo, Spain arriving at 6:15 UTC on 2 August 2013. The dates and times of acquisition for each survey line can be found in Appendix E.

The acoustic source was active throughout the survey, with few periods of source silence, for a total of 717 hours 06 minutes of source activity. This includes ramp-up of the airguns, full power firing both online and during line changes, and operation of a single 40 in³ mitigation airgun (Figure 5). The mitigation source was used during mitigation power-downs initiated for protected species inside the safety radius as well as for mechanical/technical reasons, and was active for 8 hours 21 minutes during the survey. Full power source operations, while online, accounted for 86% (613 hours 39 minutes) of airgun activity during the project. Line changes were mostly shot at full power, totalling 92 hours 58 minutes of array activity. Additionally, on one occasion lasting several hours the full volume of the acoustic source (18 airguns firing) ranged from 3210 in³ to 3300 in³, caused by various guns of different sizes being changed out on the arrays.

The acoustic source was ramped up five times over the course of the survey in order to commence full power survey operations (Table 3). The ramp-ups occurred over a duration ranging from 15 minutes to 32 minutes. The ramp-ups were conducted using the NMFS approved automated gun controller program, DigiShot which adds guns sequentially to achieve full source over the required period of time. Since a doubling of the number of airguns is typically equal to a 6 dB increase in sound level, the array was not ramped up if more than half of the airguns in the array were already firing.

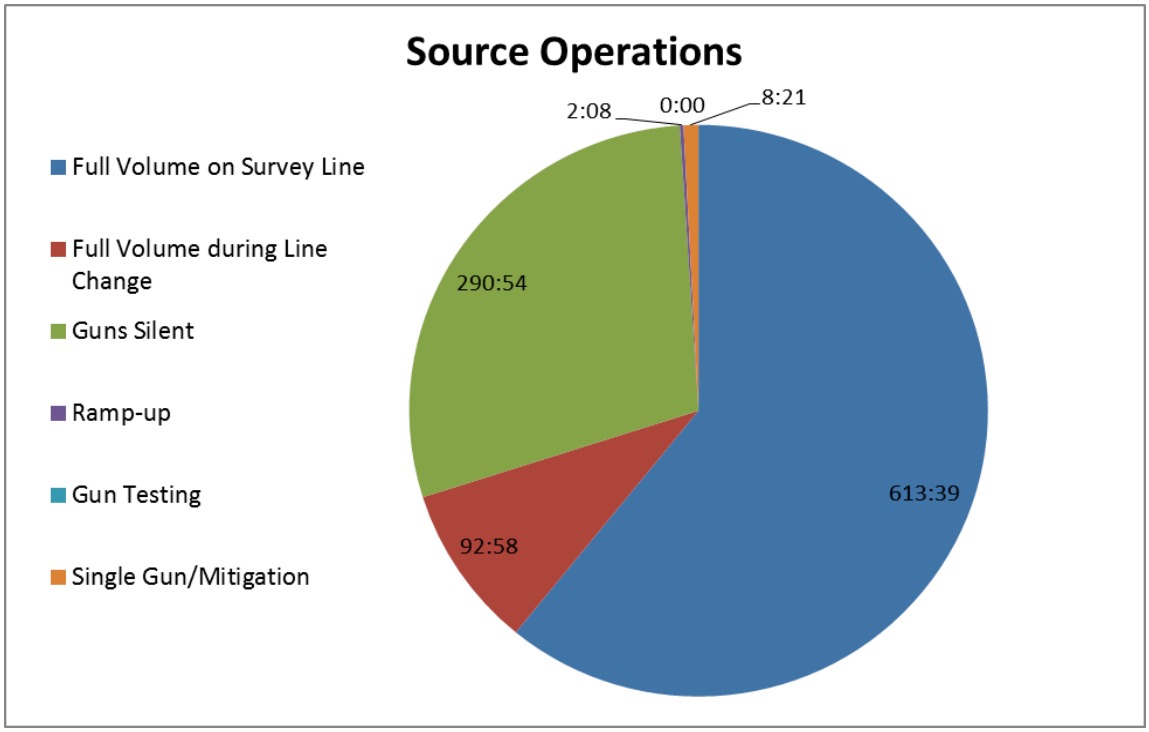

Figure 5. Total acoustic source operations.

Table 2. Total acoustic source operations during the Galicia Basin 3D seismic survey.

Acoustic Source Operations	Number	Duration (hh:mm)
Gun Tests		**00:00**
Ramp-up	**5**	**02:08**
Day time ramp-ups from silence	**5**	
Day time ramp-ups from mitigation	**0**	
Night time ramp-ups from mitigation	**0**	
Full power survey acquisition		**613:39**
Full power line changes		**92:58**
Single airgun (40 in³)		**08:21**
Total time acoustic source was active		**717:06**

4.2. VISUAL MONITORING SURVEY SUMMARY

The PSOs began visual observations immediately upon departure and while in transit to the survey site during both transits to and from Vigo. This was done to collect baseline data about protected species abundance in the area. Visual monitoring began at 6:16 UTC on 1 June 2013 and continued until 9:05 UTC on 25 June when the vessel returned to port for engine repairs. Visual observations resumed at 5:21 UTC on July 15 when the Langseth began transiting back to the survey area to continue the project. Visual monitoring ended at 20:19 UTC on 1 August, the evening before the vessel arrived in Vigo after the completion of the project. Visual monitoring was conducted over a period of about 43 days. Monitoring was conducted by two PSOs each day between just before dawn until just after dusk, when it was too dark for the

entire safety radius to be visible, averaging approximately 15 hours 35 minutes of visual observations per day.

Visual watches were held by two PSOs except during the scheduled meal hours for lunch and dinner when a single PSO continued visual monitoring, in addition to acoustic monitoring conducted by the PAM operator on duty while each PSO rotated for a meal break. Single PSO visual observations during these periods lasted a maximum of 45 minutes. In the event of a sighting event during a single PSO watch a second PSO would be notified and would immediately return to assist observations.

The acoustic source was active during the majority of visual monitoring (72%) as well as the majority of acoustic monitoring (99.77%), as shown in Figure 6.

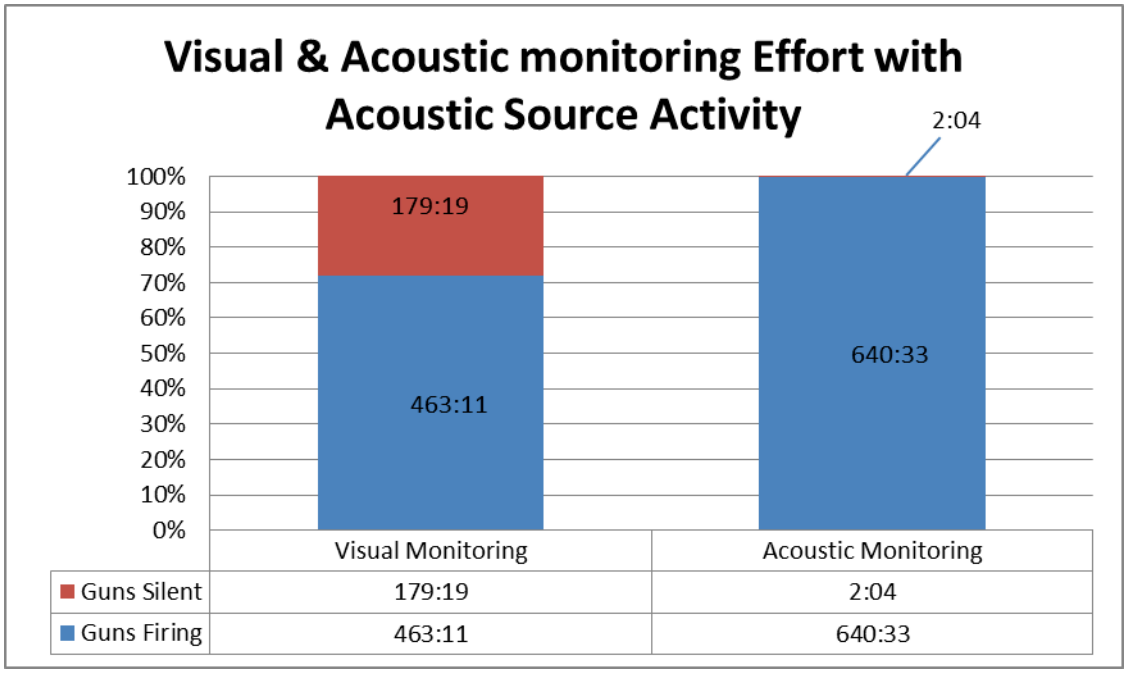

Figure 6. Duration of visual and acoustic monitoring effort while the acoustic source was active vs. silent.

Total visual monitoring effort, divided by monitoring effort while the acoustic source was active and monitoring effort while the source was silent, is listed in Table 4.

Table 3. Total visual monitoring effort.

Visual Monitoring Effort	Duration (hh:mm)
Total monitoring while acoustic source active	463:11
Total monitoring while acoustic source silent	179:19
Total monitoring effort	**642:30**

The PSOs preferred to conduct visual observations from the PSO tower, which provided the PSOs with a 360° view of the water around the vessel and acoustic source. However, visual watches would be conducted from the catwalk or bridge for any health or safety reason or during periods with high winds, large swells, heavy rain, or the ship's exhaust blowing on the tower. As Figure 7 demonstrates approximately 82% of visual monitoring was conducted from the PSO tower during the Galicia Basin 3D seismic survey.

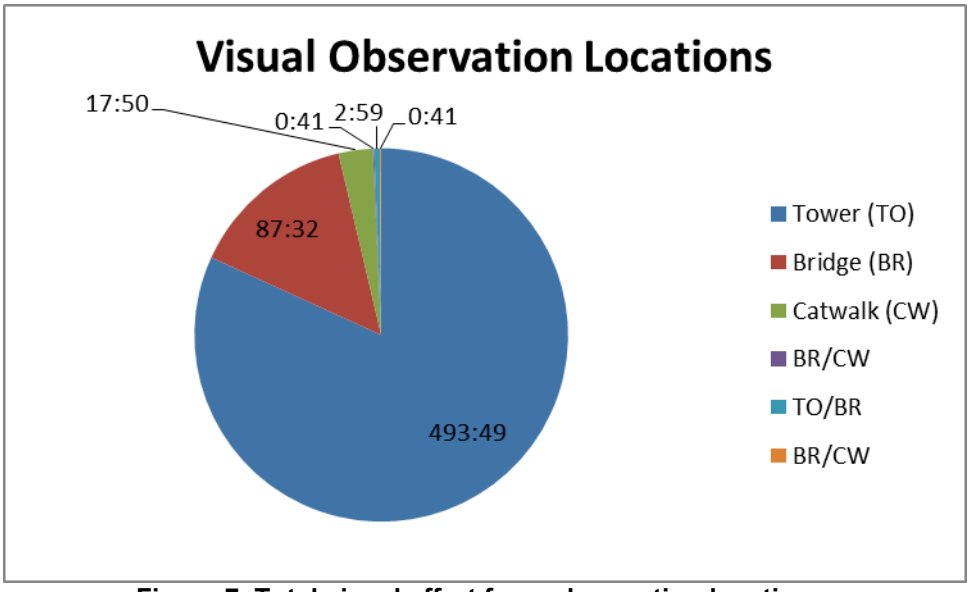

Figure 7. Total visual effort from observation locations.

4.3. ACOUSTIC MONITORING SURVEY SUMMARY

The hydrophone cable was deployed for the first time on 6 June after the vessel had completed deployment of the source arrays and streamers. Acoustic monitoring began at 7:10 UTC on 6 June and continued throughout the project with PSOs monitoring the hydrophones aurally and with the *Pamguard* detection software visually both day and night. Acoustic monitoring for the project ended at 17:50 UTC on 31 July when the hydrophone cable was retrieved, just after completion of the final survey line. Over the course of the project, PSOs conducted 642 hours 37 minutes of acoustic monitoring, all of which occurred while the acoustic source was active (Table 5).

Table 4. Total passive acoustic monitoring (PAM) effort.

Passive Acoustic Monitoring Effort	Duration (hh:mm)
Total night time monitoring	**221:24**
Total day time monitoring	**421:13**
Total monitoring while acoustic source active	**640:33**
Total monitoring while acoustic source silent	**02:04**
Total acoustic monitoring	**642:37**

In Table 6 below the passive acoustic monitoring downtime is shown. The majority of this downtime (58 hours 37 minutes) was attributed to a single incident of poor weather. During the 16 through 19 June the vessel suspended acquisition, and left the survey area to avoid a high-pressure system. The cable remained on board until the sea state had decreased to a sufficient level to ensure the cable was safe to deploy.

Acoustic monitoring was suspended for a total of 57 hours 14 minutes for seismic repairs and maintenance that occurred over eight occasions, (one of which that did extend for weather conditions). A description of each instance of acoustic monitoring downtime is located in Appendix F.

Table 5. Passive acoustic monitoring (PAM) downtime.

Passive Acoustic Monitoring Downtime	Duration (hh:mm)
Weather	**58:37**
Seismic equipment repairs and maintenance	**57:14**
Total Passive Acoustic Monitoring Downtime	**115:51**

4.4. SIMULTANEOUS VISUAL AND ACOUSTIC MONITORING SUMMARY

While visual observations began at 6:16 UTC 1 June, acoustic observations did not begin until 7:10 UTC on 6 June, due to the hydrophone cable needing to be deployed after the airgun arrays to avoid entanglement. Of the total observation effort performed by PSOs during this survey, visual monitoring accounted for 50% (642 hours 30 minutes) while acoustic monitoring accounted for 50% (642 hours 37 minutes). As displayed in Figure 8 there were 421 hours 13 minutes of simultaneous visual and acoustic observations conducted during this survey. Simultaneous visual and acoustic monitoring accounted for 66% of total visual and acoustic monitoring.

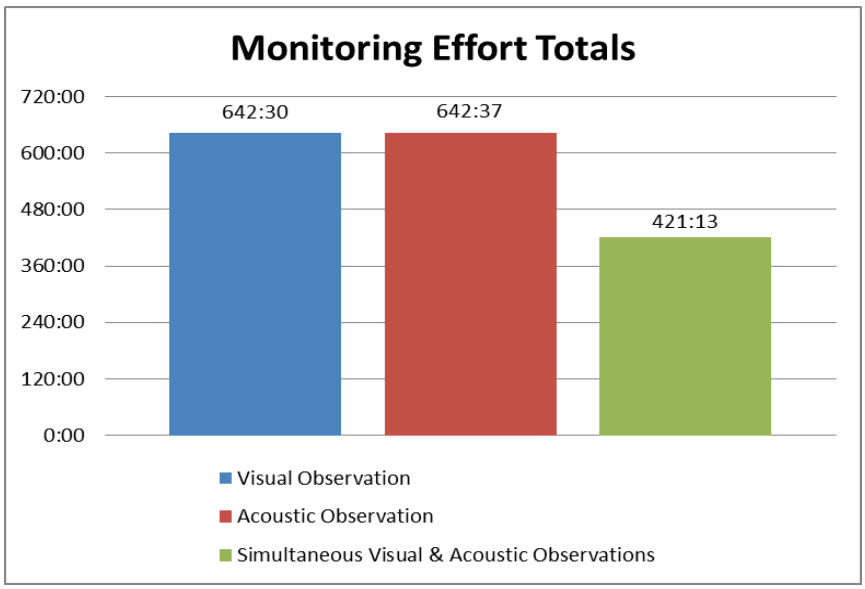

Figure 8. Total acoustic and visual monitoring effort.

4.5. ENVIRONMENTAL CONDITIONS

The environmental conditions varied greatly over the seven weeks during this survey. Periods of fog and light to heavy rain were intermittently present throughout the survey and did at times affect visual observations. A total of 52 hours 24 minutes of precipitation were recorded during the survey, as well as 82 hours 52 minutes of fog. Severe glare was often a factor that could affect sighting abilities. Excellent visibility for sighting conditions was considered to be 10 km or greater, a total of 198 hours 17 minutes was noted having less than 10 km of visibility. Within these hours of reduced sighting conditions there was 10 hours 50 minutes with visibility of less than 2 km. The entirety of the180 dB safety radius was not visible while the airguns were active on three separate occasions during the survey for a total of 1 hour 20 minutes

In week three of the survey there was a notable weather event; the vessel ceased production for an extended period of time (~60 hours), and left the survey area to avoid a high-pressure system.

The Beaufort Sea State ranged from levels 0 through 8 during the survey. The classification of Beaufort 4-5 was noted for a total of 345 hours 18 minutes, and was the most predominant during visual observations throughout the survey. The next most observed sea state was a range of Beaufort 0 – 3, recorded for 315 hours 32 minutes. A Beaufort Sea State reaching greater than 6 was noted for a total of 99 hours 36 minutes. These weekly totals are graphed for comparison in Figure 9 below.

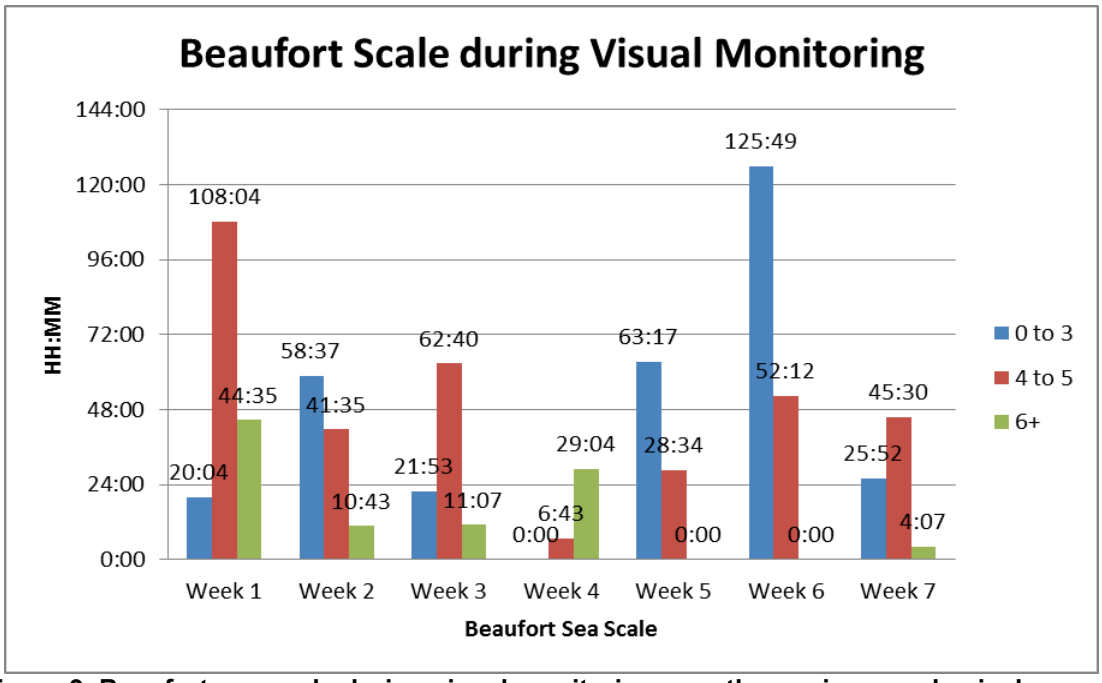

Figure 9. Beaufort sea scale during visual monitoring over the marine geophysical survey.

The predominant wind forces during this report were 11 – 21 knots. Winds less than 10 knots were present for a total of 215 hours 28 minutes, and wind forces from 11-21 knots were present for 399 hours 27 minutes. Winds greater than 22 knots were recorded for 145 hours 31

minutes. These weekly wind force totals are highlighted in Figure 10 below.

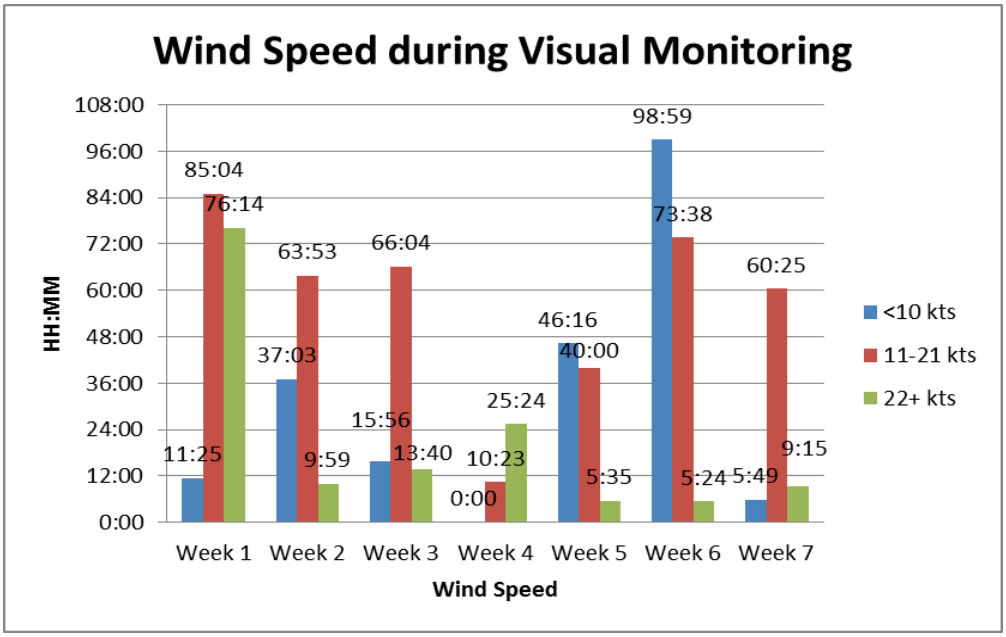

Figure 10. Average wind speed each week during visual monitoring.

Swell heights remained relatively low throughout the survey with a total of 576 hours 15 minutes of swells noted less than two meters. There was 221 hours 30 minutes of swells ranging from 2-4 meters during this survey. Week four of this survey was the only period that swells over 4 meters were recorded; totalling 15 hours 45 minutes. Figure 11 below shows the swell heights broken down into weekly totals.

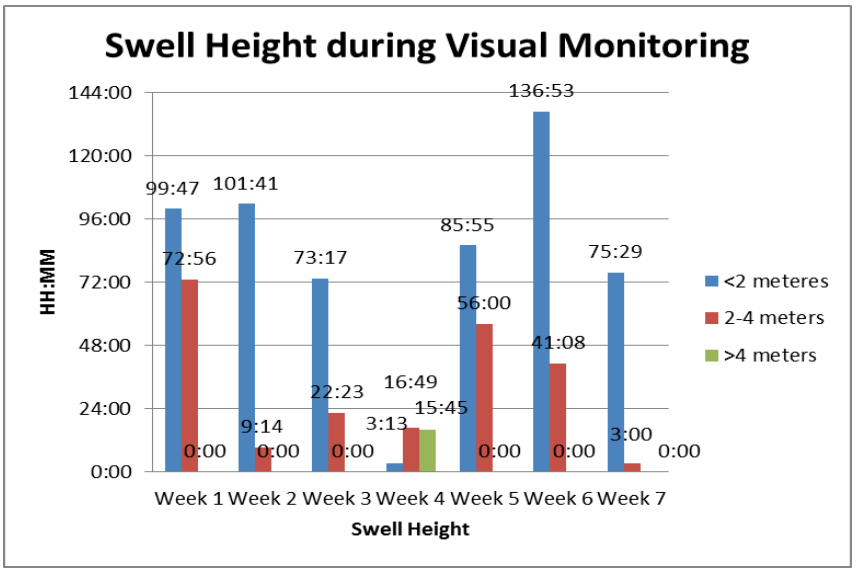

Figure 11. Swell heights while visual monitoring was conducted.

5. MONITORING AND DETECTION RESULTS

5.1. VISUAL DETECTIONS

Visual monitoring conducted during the Galicia Basin 3D seismic survey resulted in the collection of 155 visual records of detection for protected species by observers on the *R/V Langseth* (summarized in Appendix G). Ten species of marine mammals were positively identified, observations were also made of unidentified baleen whales, unidentified whales, and unidentified dolphins. The total number of detection events and total number of animals recorded by species is described in Table 7.

A complete list of birds and other marine animals observed and identified in addition to the approximate number of individuals observed and the number of days on which they were observed can be found in Appendix H.

Table 6. Number of visual detection records collected for each protected species.

	Total Number of Detection Records	Total Number of Animals Recorded
Cetaceans		
Unidentified whale	15	20
Mysticetes		
Fin whale	62	145
Sei whale	2	2
Unidentified baleen whale	49	68
Odontocetes		
Sperm whale	2	2
Pilot whale	1	6
Short-beaked common dolphin	5	13
Risso's dolphin	1	5
Striped dolphin	4	90
Bottlenose dolphin	2	8
Harbor porpoise	1	2
Unidentified dolphin	11	78
TOTAL	**155**	**439**

There were many sightings of protected species during the Galicia basin 3D seismic survey with multiple detections of protected species occurring during most days of the survey (Figures 12 and 13). The most detections occurred on 15 June when there were 14 detections of two different positively identified protected species. The day with the second most detections was 15 July when there were 13 detections of three different positively identified species. This was while the vessel was in transit returning to the survey site.

Of the 155 protected species detection events during the Galicia Basin 3D seismic survey, 99 detections (64%) occurred while the acoustic source was active and 56 detections (36%) occurred while the acoustic source was silent. Figure 14 demonstrates the species detected compared to acoustic source activity.

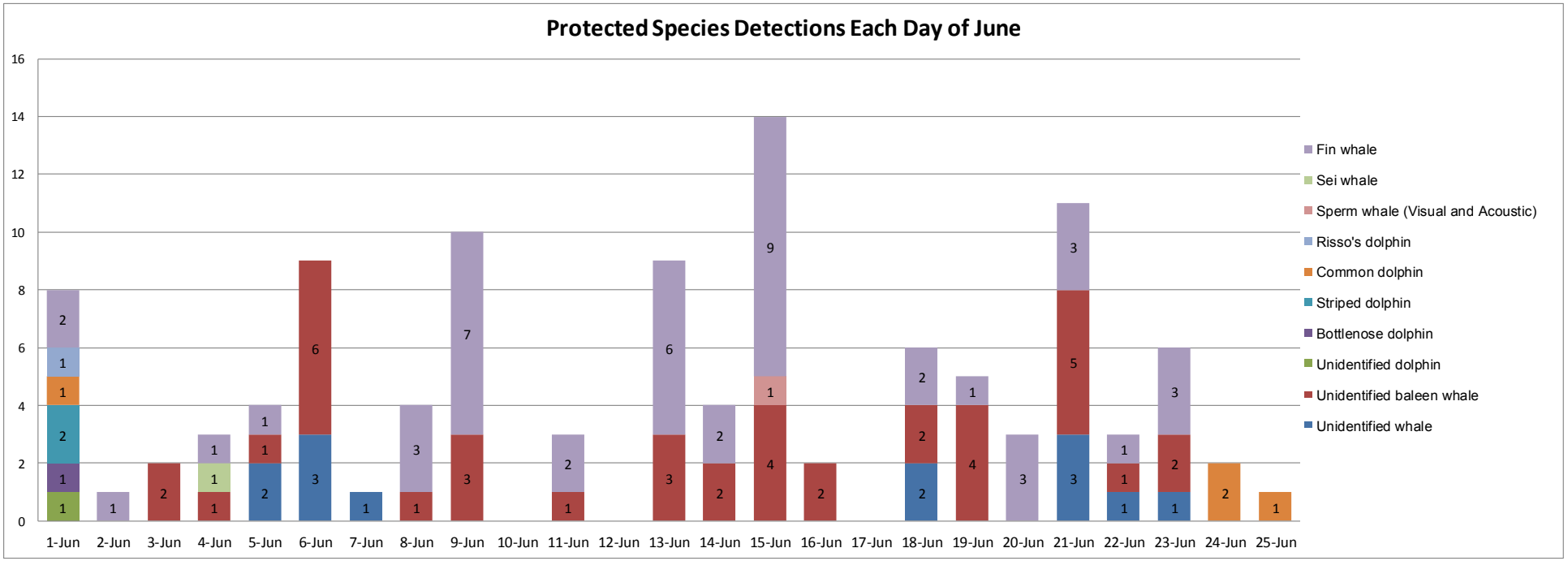

Figure 12. Number of protected species detections each day of June during the Galicia Basin 3D seismic survey.

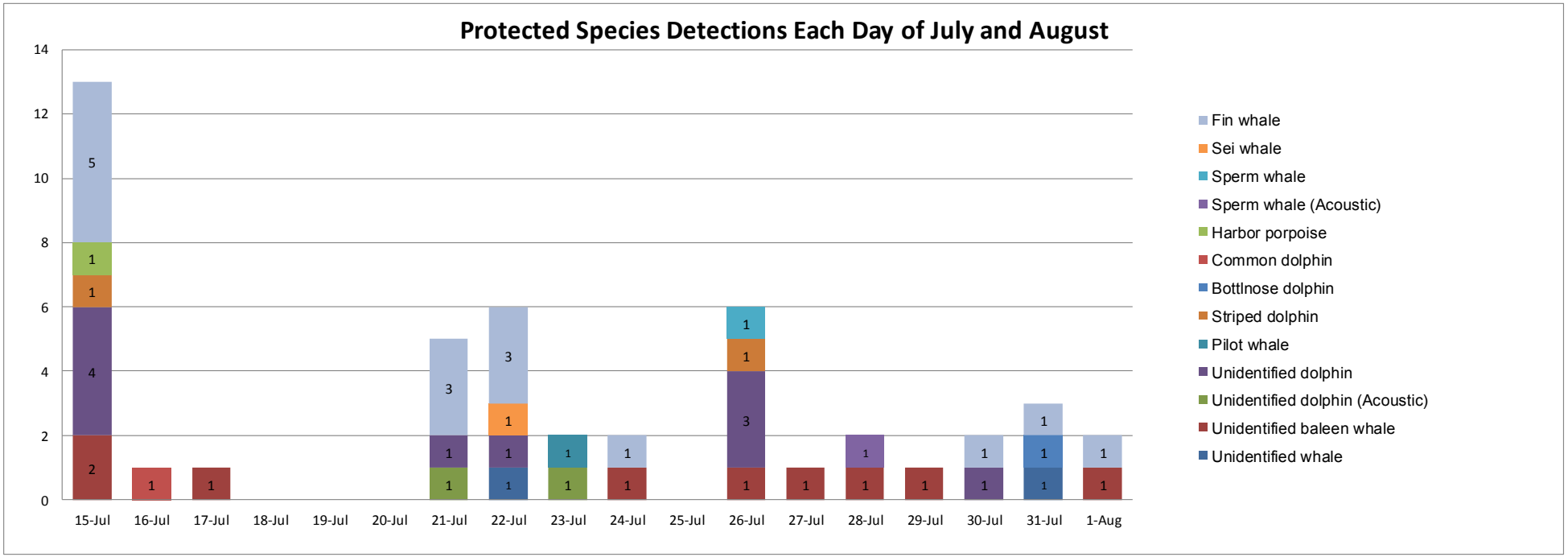

Figure 13. Number of protected species detections each day of July/August during the Galicia Basin 3D seismic survey.

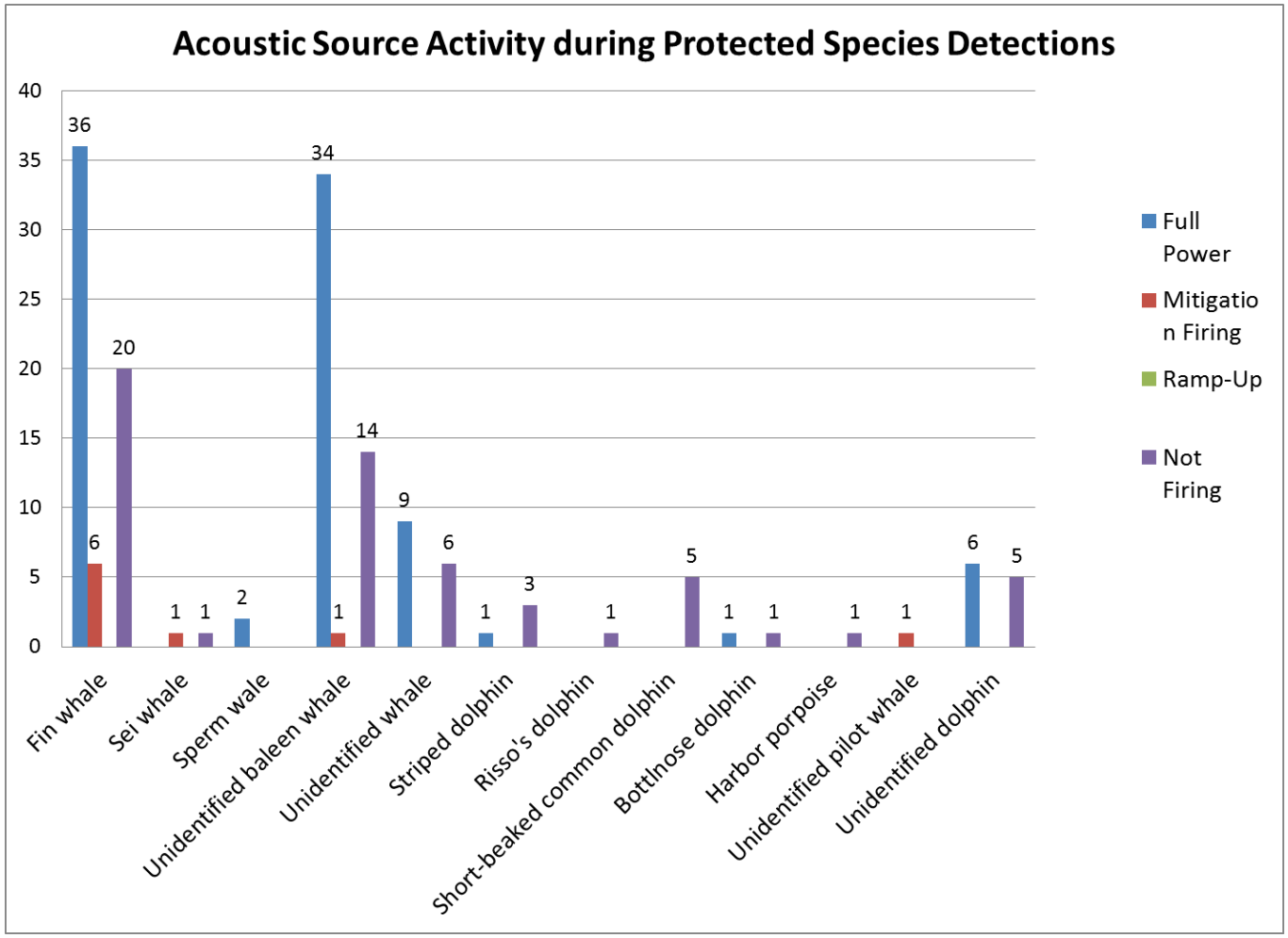

Figure 14: Acoustic source activity compared to protected species detections

Table 8 demonstrates the average closest approach of protected species to the source at various volumes. Only cetaceans were sighted during this survey, with mysticetes being detected most frequently, consisting of 73% (113 detection records) of the total records. Figure 14 demonstrates the total number of animals observed, per species, during the detection events. The most detection records collected for a species was 62 records for fin whales, totaling 145 animals. Additionally, there were 49 detections of unidentified baleen whales, totaling 68 animals, many of which were thought to likely be fin whales.

Table 7. Average closest approach of protected species to the acoustic source at various volumes.

Species Detected	Full Power (3300 in³)		Single Airgun 40 in³		Ramp-up		Not Firing	
	Number of detections	Average closest approach to source (meters)	Number of detections	Average closest approach to source (meters)	Number of detections	Average closest approach to source (meters)	Number of detections	Average closest approach to source (meters)
Fin whale	36	2723	6	1277	0	-	20	1174
Sei whale	0	-	1	500	0	-	1	1200
Sperm whale	2	2825	0	-	0	-	0	-
Unidentified baleen whale	34	3208	1	4096	0	-	14	1769
Unidentified whale	9	4239	0	-	0	-	6	2518
Striped dolphin	1	800	0	-	0	-	3	483
Risso's dolphin	0	-	0	-	0	-	1	450
Short-beaked common dolphin	0	-	0	-	0	-	5	298
Bottlenose dolphin	1	2200	0	-	0	-	1	600
Harbor porpoise	0	-	0	-	0	-	1	700
Unidentified pilot whale	0	-	1	400	0	-	0	-
Unidentified dolphin	6	2027	0	-	0	-	5	568

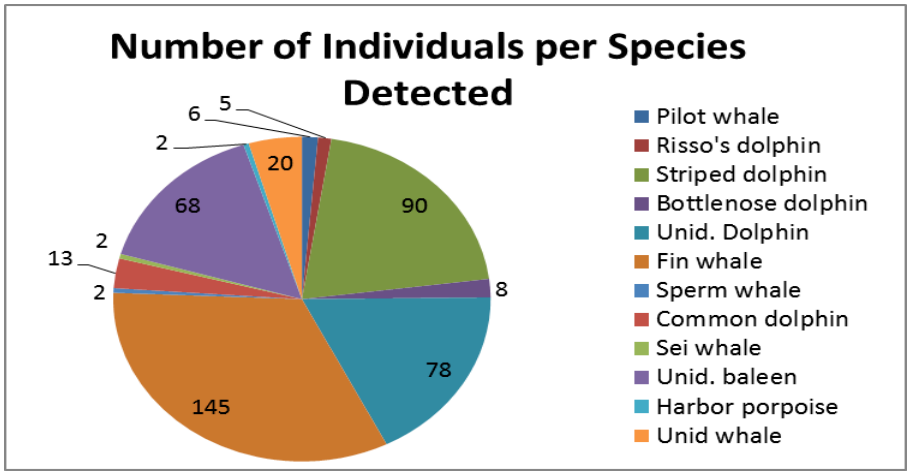

Figure 15. Number of individuals per species detected.

The spatial distribution of marine mammal detections on the *Langseth* during transit between the survey site and port and on the survey site can be seen in Figures 16 and 17.

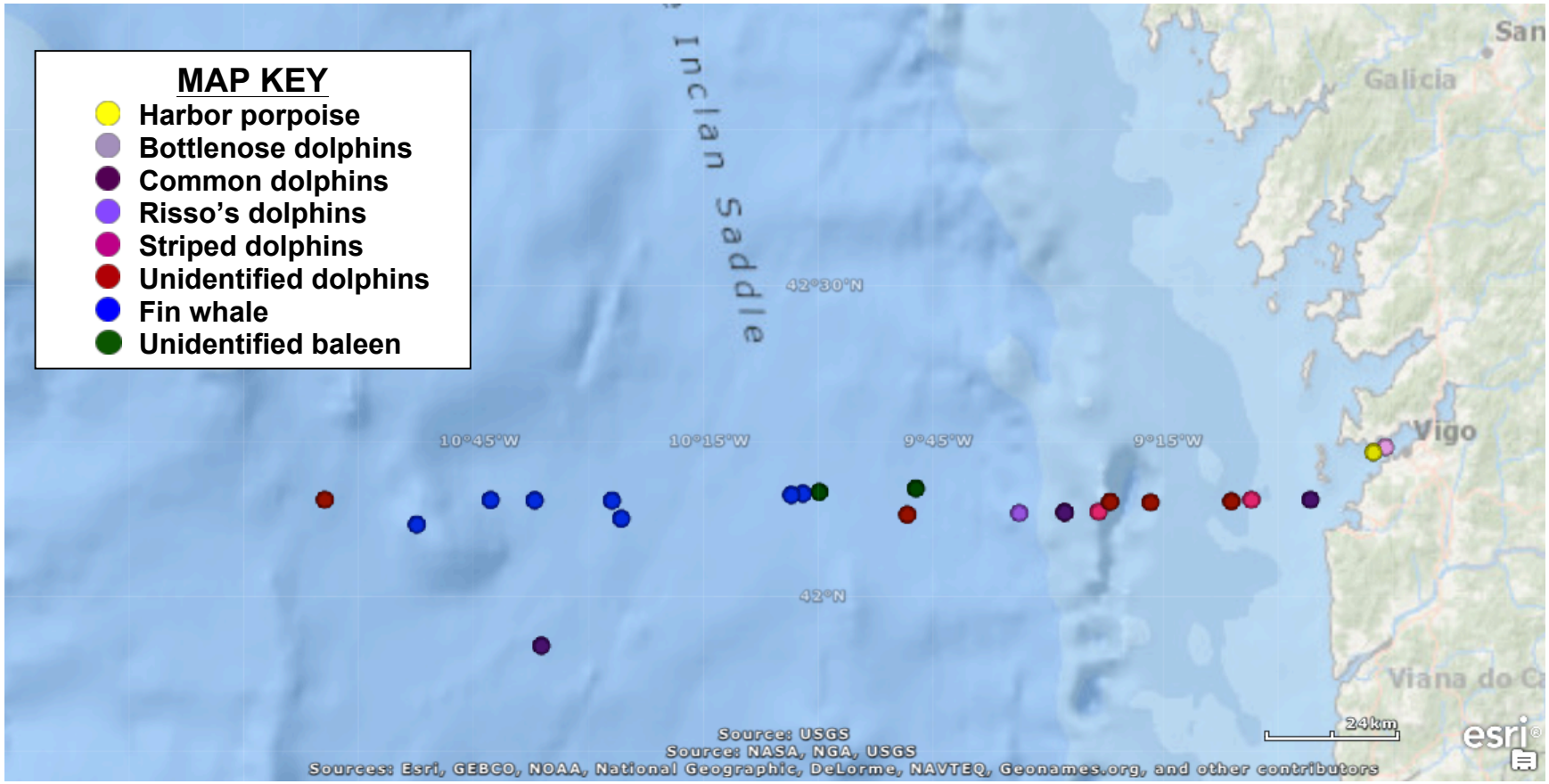

Figure 16: Protected species detections on the Langseth during the transit between port of Vigo and the survey area

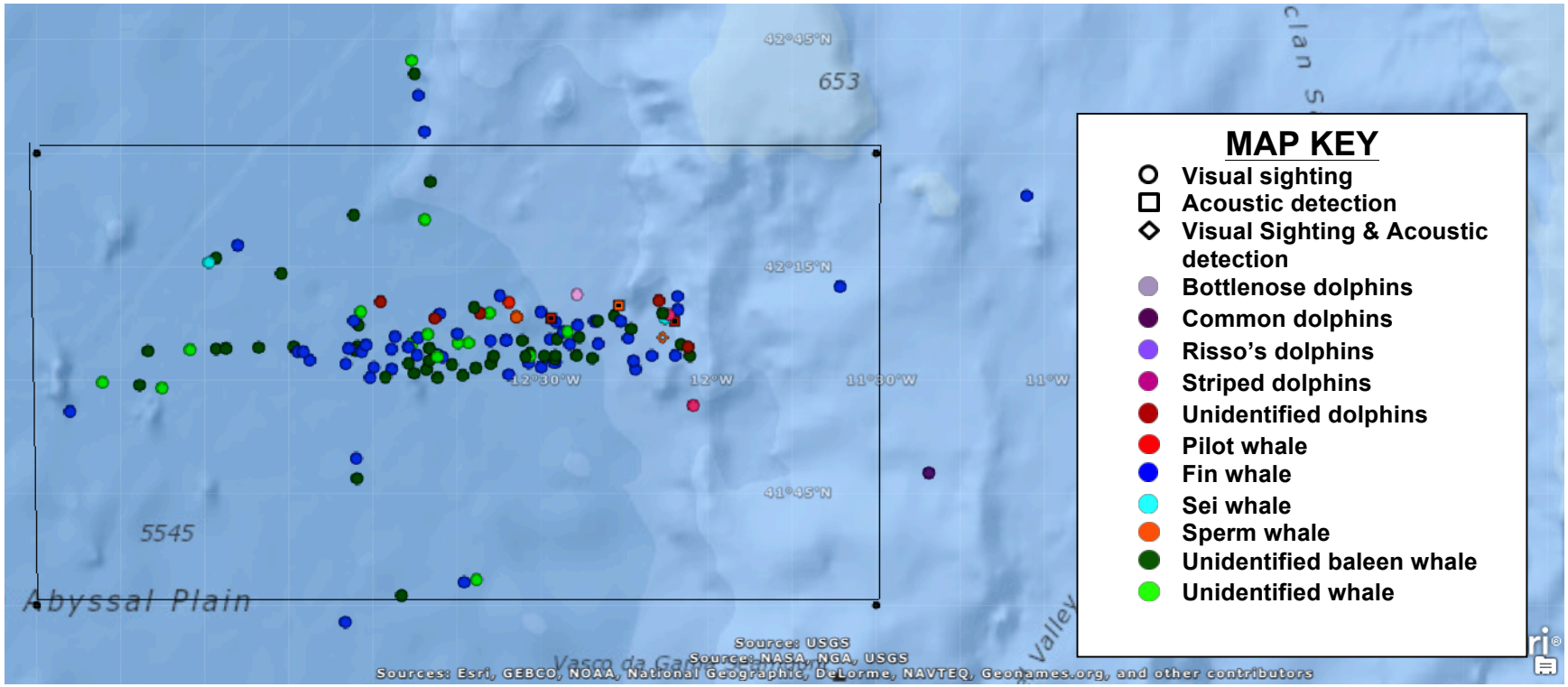

Figure 17:Protected species detections on the Langseth in the survey area

5.1.1. Cetacean Detections

5.1.1.1. Fin whale

There were 62 sightings of fin whales (*Balaenoptera physalus*) during the survey, totaling 147 individuals observed. Seven of these observations resulted in power-downs, totaling 3 hours and 18 minutes of mitigation downtime. The whales were noted to be in depths ranging from 2179 to 5337 meters. The largest group size was eight individuals. Two groups of this size were observed on 9 July. There were 26 sightings consisting of one individual, 14 sightings consisting of two individuals, ten sightings comprised of three individuals, six sightings consisting of four individuals, two sightings with five individuals, one sighting with six, and one sighting with seven individuals. The closest approach to the sound source was 200 meters on 15 July.

Groups of fin whales were frequently observed be very active at the surface, often creating large splashes. They were observed lunge feeding on several occasions and during one sighting a whale was observed breaching repeatedly.

5.1.1.2. Sei whale

There were two sightings of sei whales (*Balaenoptera borealis*) and each sighting consisted of one individual. One sighting, on 22 July, resulted in a mitigation power-down which lasted 24 minutes. Closest approach to the sound source was 500 meters (which prompted the power-down). Water depths ranged from 4093 to 5332 meters.

5.1.1.3. Sperm whale

There were two visual detections of single sperm whales, neither of which led to mitigation actions. Closest approach to airguns was 1750 meters. Water depths ranged from 4368 to 4887 for this species. The first visual sperm whale detection correlated with an acoustic detection of sperm whale clicks that were detected aurally by the PAM operator 18 minutes after the last visual detection of the animal.

5.1.1.4. Risso's dolphin

One group of five Risso's dolphins (*Grampus griseus*) was observed on 1 June while the vessel was in transit to the survey sight and all seismic gear was on board. Water depth was 1590 meters. The dolphins' closest approach to the vessel was 450 meters.

5.1.1.5. Striped dolphin

There were 90 individual striped dolphins (*Stenella coeruleoalba*) observed during four sightings. None of these detections resulted in a mitigation action. Water depths ranged from 112 to 4071 meters. The dolphins' closest approach to the vessel was 450 meters, which occurred when the guns were silent.

5.1.1.6. Bottlenose dolphin

There were two bottlenose dolphins (*Tursiops truncatus*) sightings during the project, totaling eight animals. One sighting consisted of one dolphin just after the vessel left port and was still very close to shore. The second sighting consisted of seven dolphins that were sighted in

offshore waters near the survey area. No mitigation action was taken. Water depths for these two sightings ranged from 142 to 4837 meters. The closest approach to the vessel was 600 meters.

5.1.1.7. Common dolphin

Thirteen individual common dolphins (*Delphinus delphis*) were observed during five sightings, none of which led to mitigation actions. One sighting consisted of one dolphin, two sightings consisted of two dolphins, one sighting consisted of three dolphins and one consisted of five individuals which was the largest group observed. The animals were noted to be in depths ranging from <120 to 5335 meters, and group size ranged from 1-5 individuals. Only one sighting occurred while the vessel was at the survey area; the other four occurred closer to shore while the vessel was in transit to or from port. The closest approach to the vessel was 150 meters on 25 June when the guns were not firing.

5.1.1.8. Harbor porpoise

There was one sighting of two harbor porpoises (*Phocoena phocoena*) observed on 15 July. This sighting occurred just after the vessel left port and was still very close to shore with all seismic gear onboard. The animals were observed at a depth of 39 meters and the closest approach to the vessel was 700 meters.

5.1.1.9. Unidentified pilot whale

There was one sighting of unidentified pilot whales (*Globicephalia sp.*) during the survey, totaling six individuals observed on 23 July. This observation resulted in a power-down which lasted 21 minutes. The whales were noted to be in a depth of 5223 meters. The closest approach to the sound source was 400 meters. As the vessel passed the pilot whales were observed spy-hopping.

5.1.1.10. Unidentified baleen whale

There were 49 sightings of unidentified baleen whales totaling 68 individuals observed during the survey. Two of these detections led to power-downs, which totaled 1 hour 8 minutes of mitigation downtime. The largest group size was four individuals sighted on 3 June and again on 1 August. Thirty-four sightings consisted of one individual and 13 sightings consisted of two whales. Water depths ranged from 2368 to 5329 meters. Closest approach to vessel was 300 meters on 6 June.

5.1.1.11. Unidentified whale

There were 15 sightings of unidentified whales totaling 20 individuals observed during the survey. None of these detections required a mitigation action. The largest group was comprised of four individuals sighted on 22 July. There were 11 sightings consisting of one individual, two sightings consisting of two individuals, and one sighting consisting of four individuals. Water depths ranged from 5039 to 5339 meters. Closest approach to the vessel was 1000 meters on 5 June, when the acoustic source was silent. Often only the blow was visible during these sightings.

5.1.1.12. Unidentified dolphin

There were 11 detections of unidentified dolphins totaling 78 individuals sighted during the survey. No mitigation action was required due to these sightings. Group size ranged from one to 15 individuals. Closest approach to the vessel occurred on 15 July when, during two different detections, dolphins came within 270 meters of the vessel. The airguns were not firing at the time. Water depths ranged from 137 to 5309 meters during these sightings. All dolphin sightings that occurred in June were while the vessel was in transit to or from the survey area. No dolphins were sighted near the survey are until the vessel returned after mid-July.

5.2. ACOUSTIC DETECTIONS

5.2.1. Cetacean Detections

There were four acoustic detections on the PAM system during the Galicia Basin 3D seismic survey; one detection of a sperm whale that was correlated with a visual detection, another detection of a sperm whale with no visual correlation and two acoustic detections of unidentified delphinids. No mitigation actions were required as a result of these acoustic detections.

On 15 June 2013 at 11:15 UTC the PAM operator was notified of a sighting of a sperm whale (visual detection 65) 2.5 kilometers in front of the vessel. At 11:44 UTC faint clicking was heard for one minute, this occurring after the mammal had drove from view. Figure 18 shows a low frequency click tracked estimated the animal was roughly one kilometer off either side of the ship (closest approach seen visually was 1500 meters). The LF click noted on the Low Frequency Click Detector was observed at a bearing of 125 degrees.

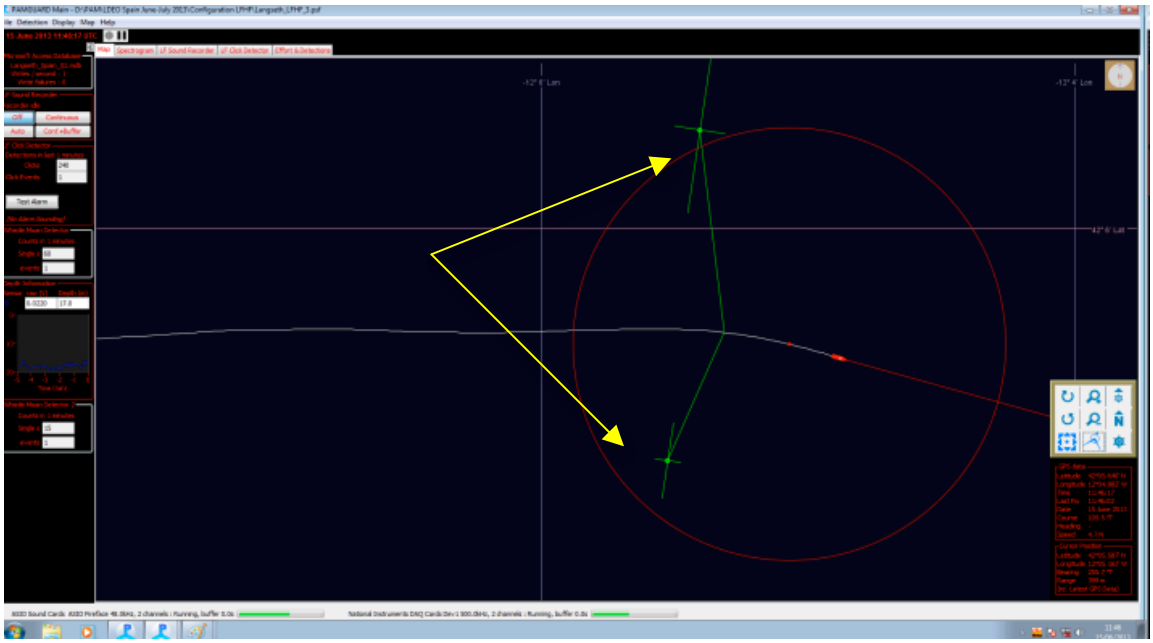

Figure 18. Sperm whale click localized by *Pamguard* to be approximately 1000 meters off either side of the vessel (acoustic detection 1).

On 21 July at 13:51 UTC high frequency delphinid clicks were detected by *Pamguard*. The click trains swept from a bearing of 92 – 130 degrees (Figure 19). Spectrogram 16 review of sound recordings confirmed echolocation clicks ranging from 50 – 200 kHz. The time of final acoustic detection was 14:03 UTC. An hour and 30 minutes later dolphins were visually detected three kilometers off the vessel providing evidence of mammals present in the area.

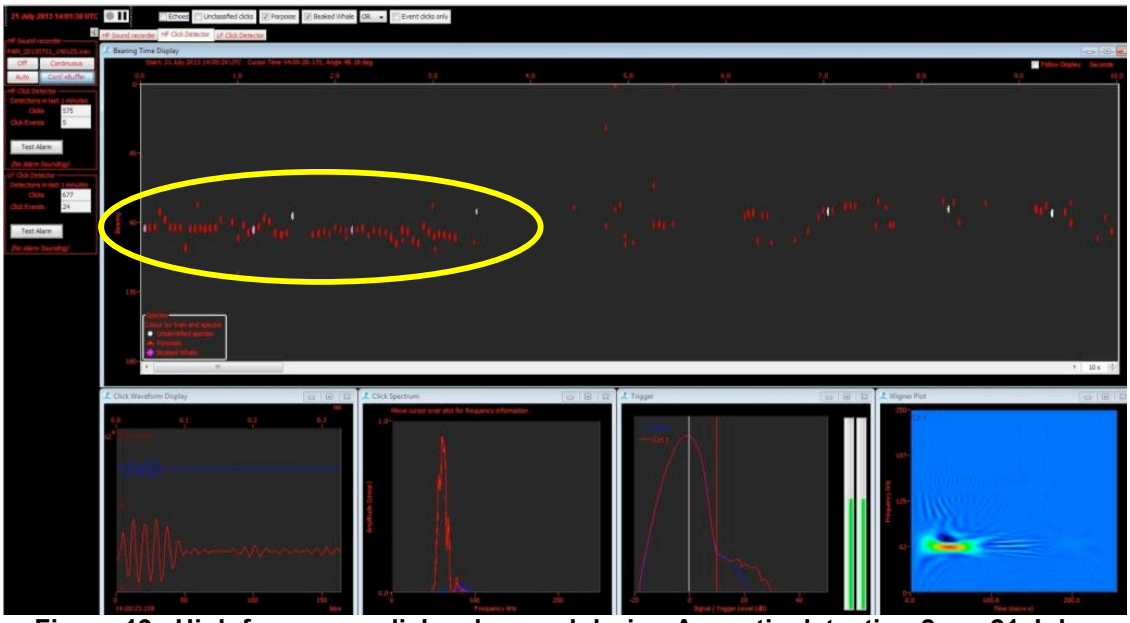

Figure 19. High frequency clicks observed during Acoustic detection 2, on 21 July..

On 23 July a bold HF delphinid click train at a 90 degree bearing was first noted at 22:49 UTC., Numerous whistles were detected aurally, by Spectrogram and the Whistle and Moan Detector (Figure 20) immediately following this click train. For three minutes HF click trains (Figure 21), sinusoidal and upsweeping whistles ranging between 10-23 kHz were continuously detected. Five mammals were estimated to be present during this acoustic detection that ended at 22:56 UTC.

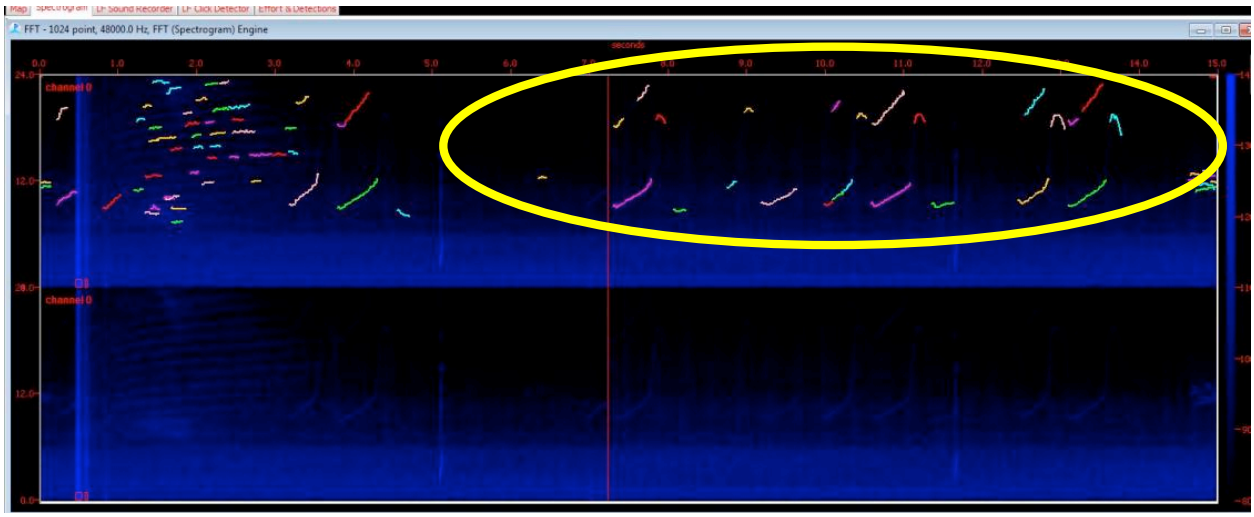

Figure 20. Low frequency delphinid whistles highlighted by the Spectrogram Whistle and Moan Detector (acoustic detection 3).

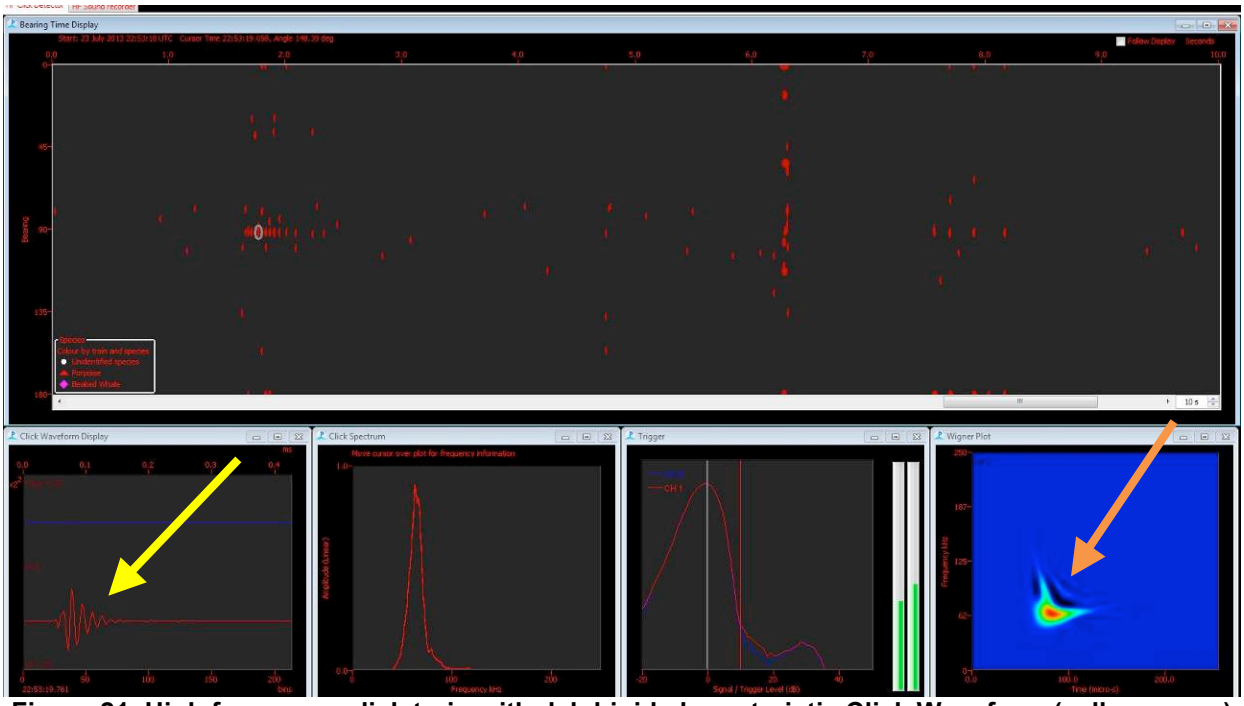

Figure 21. High frequency click train with delphinid characteristic Click Waveform (yellow arrow) and Wigner Plot (orange arrow) (acoustic detection 3).

Acoustic detection 4 occurred on 28 July at 14:50 UTC with low frequency broad band sperm whale clicks aurally detected by the PAM operator and visually on the Spectrogram (Figure 22). The whale was viewed to be at a bearing of 100 degrees via *Pamguard*. The clicks were not heard continuously throughout the detection and therefore the mammal was unable to be tracked on the map. The time of final detection was 14:53.

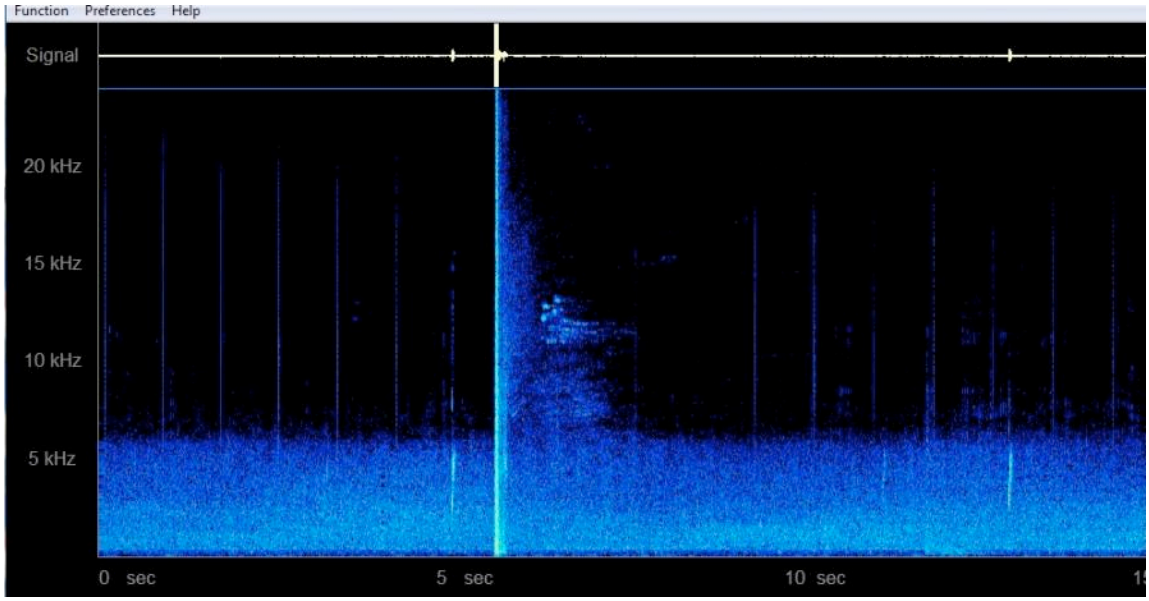

Figure 22. Broad band sperm whale clicks shown on Spectrgram16 and detected aurally on 28 July (acoustic detection 4).

6. MITIGATION ACTION SUMMARY

There were 11 mitigation actions implemented during the Galicia Basin 3D seismic survey due to protected species being observed within the safety radii. All mitigation consisted of power-downs of the acoustic source. The total duration of downtime caused by mitigation actions (including ramp-up, if required) was 5 hours 19 minutes during the survey. The number and duration of mitigation actions is summarized in Table 10. Ten mitigation actions were implemented for mysticetes, while one mitigation action was implemented for odontocetes. There were no issues with implementing mitigation actions during this survey.

Table 8. Number and duration of mitigation actions implemented during the Galicia Basic 3D seismic survey.

Mitigation Action	Cetaceans	
	Number	Duration
Delayed Ramp-up	0	0:00
Power-down	11	5:19
Shut-down	0	0:00
Total	**11**	**5:19**

Mitigation actions were implemented more frequently for fin whales (seven power-downs accounting for 65% of the total mitigation action downtime incurred over the course of the survey) than for any other species. One power-down was implemented for a sei whale detection, one power-down for an unidentified pilot whale detection and two power-downs for unidentified baleen whale detections (21% of the survey's mitigation downtime) (Table 11, Figure 23)

Table 9. Mitigation actions and downtime duration by species.

Species	Number of Power-downs	Duration of Downtime (hh:mm)	Percentage of Mitigation Downtime
Fin whale	7	3:26	**65%**
Sei whale	1	0:24	**7%**
Unidentified pilot whale	1	0:21	**7%**
Unidentified baleen whale	2	1:08	**21%**

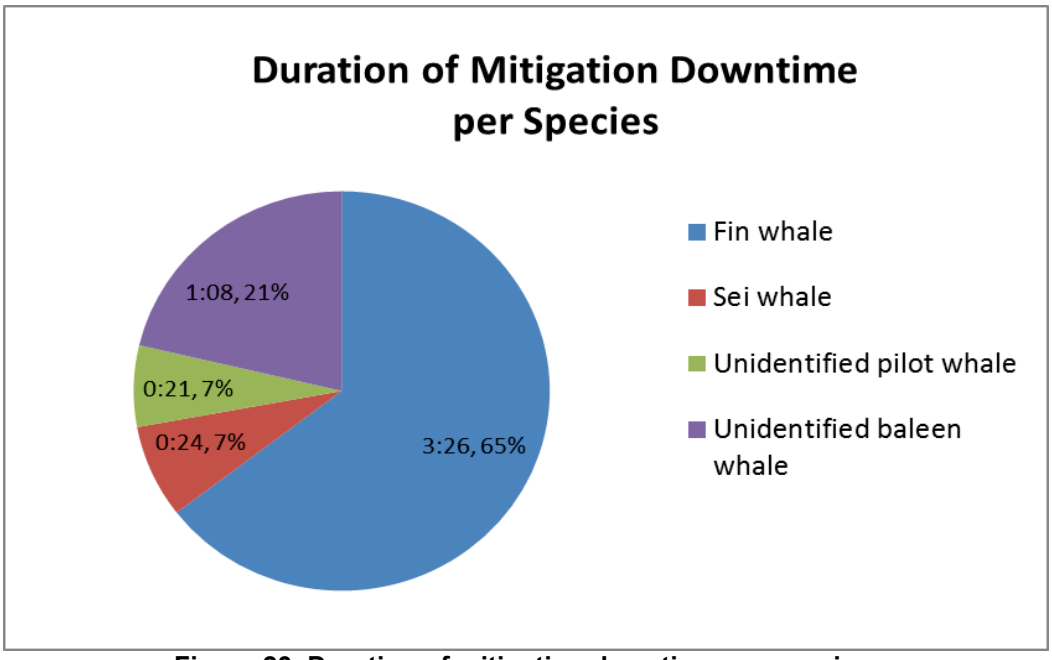

Figure 23. Duration of mitigation downtime per species.

Each mitigation action implemented during the survey is described in detail below:

The first mitigation action was implemented on 6 June for an unidentifiable baleen whale (visual detection 22). The whale was originally observed 800 meters off the port side of the vessel traveling parallel to the vessel, in the opposite direction. The next time the whale was observed it was approximately 300 meters behind the acoustic source traveling the same direction as the vessel. Due to the whale's unforeseen course change the source was not powered-down until after the whale had entered the 180 dB safety radius. The whale was observed at regular intervals remaining approximately 300 meters from the powered-down acoustic source for the next 50 minutes, after which it was observed outside of the 180 dB safety radius and the acoustic source returned to full volume.

On 9 June a concentration of four fin whales was observed lunge feeding within the 160 dB safety radius and the acoustic source was powered-down at 18:39 UTC (visual detection 39). At 19:02 UTC the whales were observed outside of the 160 dB safety radius and the acoustic source returned to full volume. Just four minutes later another group of eight fin whales was observed feeding within the 160 dB safety radius. The acoustic source was once again powered-down, at 19:06 UTC (visual detection 40). These whales were observed leaving the safety radii, however by that time another group of whales had entered and the power-down was extended until 20:02 UTC when they had also left the safety radii (visual detection 41). These three mitigation actions resulted in 1 hour 19 minutes of down time that occurred while the acoustic source was at full volume during a line change.

On 14 June another power-down was implemented due to five fin whales that were observed feeding within the 160 dB safety radius (visual detection 58). The airguns were powered-down

at 19:17 UTC. Fourteen minutes later the whales were observed outside of the 160 dB safety radius and full volume was resumed.

On 15 June two fin whales appeared likely to enter the 180 dB safety radius and a power-down of the acoustic source was implemented at 8:31 UTC (visual detection 62). At 8:33 UTC the two whales were observed approximately 500 meters from the powered-down source. Once the whales were observed outside of the 180 dB safety radius the acoustic source resumed full volume, resulting in 10 minutes of mitigation down time.

On 20 June two fin whales were observed approaching the 180 dB safety radius. The acoustic source was powered-down at 5:34 UTC and the whales were observed within the 180 dB safety radius at 5:35 UTC (visual detection 86). At 5:43 UTC the whales were observed outside of the 180 dB safety radius and the acoustic source resumed full volume. This mitigation action resulted in nine minutes of downtime; however it occurred while the acoustic source was at full volume during a line change. Shortly after losing sight of the fin whales from visual detection 86, two more fin whales were observed traveling across the bow of the vessel, likely to enter the 180 dB safety radius. The acoustic source was powered-down at 6:13 UTC and the whales were observed within the 180 dB safety radius at 6:16 UTC (visual detection 87). At 6:19 UTC the whales had moved outside of the 180 dB safety radius and the acoustic source resumed full volume. This mitigation action resulted in six minutes of down time and occurred while the acoustic source was at full volume on a survey line.

On 22 July a power-down was implemented due to a sei whale (visual detection 131) observed within the 180 dB safety radius. The whale was originally sighted ahead of the vessel crossing the bow perpendicularly. The next time the whale was sighted was within the 180 safety radius traveling parallel, in the same direction as the vessel, resulting in a power-down of the acoustic source at 9:27 UTC. The whale was again observed outside the 180 dB safety radius at 9:51 UTC and the acoustic source resumed full power. The whale's closest approach to the acoustic source was 500 meters at 9:30 UTC when the mitigation source was active.

On 23 July power-down was implemented for a pod of pilot whales (visual detection 137) that were observed to be swimming towards the vessel. As they seemed likely to enter the 180 dB safety radius the acoustic source was powered down at 12:41 UTC. The pilot whales entered the safety radius before turning to travel parallel, in the opposite direction of the vessel. Many of the animals were observed spy-hopping at the vessel passed. The pod was last seen at 12:47 UTC crossing the stern of the vessel still within the 180 dB safety radius. Fifteen minutes was allowed to pass from the last sighting before resuming full volume operations at 13:02 UTC. The pilot whale's closest approach to the acoustic source was 400 meters at 12:44 UTC while the mitigation source was active.

On 31 July a power-down was implemented due to a concentration of three fin whales (visual detection 152) that were observed exhibiting feeding behaviors such as lunging, changing direction frequently and quick bursts of diving, within the 160 dB safety radius. The whales' closest approach to the acoustic source was 600 meters while the mitigation source was firing. Full volume operations were suspended until the whales were outside of the 160 dB safety radius, resulting in 1 hour 46 minutes of mitigation downtime.

Each mitigation action that was implemented during the survey is summarized in Table 12. The total duration of the mitigation event includes the ramp-up to return to full power, if the airguns had been silent for longer than eight minutes.

Table 10. Summary of each mitigation action implemented during the Galicia Basin 3D seismic survey.

Date	Visual Detection Number	Species	Group Size	Source Activity (initial detection)	Closest Approach to Source / Volume	Mitigation Action	Total Duration of Mitigation Event
6-Jun	22	Unidentified baleen whale	1	Full power	300 m / 3300 in³	Power down	0:50
9-Jun	39	Fin whale	4	Full power	800 m / 3300 in³	Power down	0:23
9-Jun	40	Fin whale	8	Full power	2479 m / 40 in³	Power down	0:38
9-Jun	41	Unidentified baleen whale	2	Mitigation firing	4096 m / 40in³	Power down	0:18
14-Jun	58	Fin whale	5	Full power	3011 m / 3300 in³	Power down	0:14
15-Jun	62	Fin whale	2	Full power	500 m / 40in³	Power down	0:10
20-Jun	86	Fin whale	2	Full power	522 m / 40in³	Power down	0:09
20-Jun	87	Fin whale	2	Full power	550 m / 40in³	Power down	0:06
22-Jul	131	Sei whale	1	Full power	500 m / 40in³	Power down	0:24
23-Jul	137	Unidentified pilot whale	6	Full power	400 m / 40in³	Power down	0:21
31-Jul	152	Fin whale	3	Full power	600 m / 40in³	Power down	1:46

6.1. MARINE MAMMALS KNOWN TO HAVE BEEN EXPOSED TO 160 DB OF RECEIVED SOUND LEVELS

NMFS granted an IHA to L-DEO for a marine seismic survey allowing Level B harassment takes (exposure to sound pressure levels greater than or equal to 160 dB re: 1 µPa (rms)) for 17 marine mammal species: five mysticetes and 12 odontocete species. Direct visual observations recorded by PSOs of six species of marine mammals for which Level B harassment takes were granted in the IHA provide a minimum estimate of the actual number of cetaceans exposed to received sound levels of 180 dB and 160 dB.

During the Galicia Basin 3D seismic survey fin whales, sperm whales, a sei whale, bottlenose dolphins, striped dolphins, and pilot whales were observed within both the 160 dB safety radius, where Level B harassment is expected to occur, while the acoustic source was active (Table 13). While only a sei whale and an unidentified baleen whale were observed within the 180 dB safety radius.

Table 11. Level B Harassment Takes authorized by NMFS IHA for the Galicia Basin 3D seismic survey and number of known individuals exposed to 160 dB and 180 dB through visual observations.

Species	IHA Authorized Takes	Number of animals exposed to 180 dB	Number of animals exposed to 160 dB
Mysticetes			
North Atlantic right whale	0	0	0
Humpback whale	2	0	0
Minke whale	3	0	0
Sei whale	106	1	1
Fin whale	1,002	0	89
Blue whale	3	0	0
Unidentified whale / baleen whale	-	1	47
Odontocetes			
Sperm whale	159	0	2
Unidentified *Kogia spp.*	0	0	0
Cuvier's beaked whale	32	0	0
Northern bottlenose whale	4	0	0
Unidentified *Mesoplodon spp.*	7	0	0
Bottlenose dolphin	40	0	7
Atlantic spotted dolphin	0	0	0
Striped dolphin	378	0	50
Short-beaked common dolphin	620	0	0
Risso's dolphin	4	0	0
Pygmy killer whale	0	0	0
False killer whale	10	0	0
Killer whale	5	0	0
Short-finned pilot whale	5	0	0
Long-finned pilot whale	8	0	0
Unidentified pilot whale	-	0	6
Unidentified dolphin	-	0	69

These numbers are very likely to be an underestimate and provide the absolute minimum number of animals actually exposed. It is possible that estimated numbers of animals recorded during each sighting event were underestimates, some animals not being seen or having moved away before they were observed. Besides night time hours there were several occasions during daytime visual watches that the entire 160 dB safety radius was not visible due to fog. Table 14 describes the behavior of all animals, including unidentified species, which were exposed to 160 dB for the duration they were observed.

Table 12. Behavior of species observed to be exposed to 160 dB.

Species	Detection No.	No. of Animals	Initial behavior	Initial direction in relation to vessel	Subsequent and Final behavior	Subsequent and Final direction in relation to vessel
Fin whale	30	1	Blowing	Towards vessel	Traveling	Away from vessel
	31	1	Blowing	Towards vessel	Traveling	Towards vessel
	32	1	Blowing	Parallel, opposite direction	Diving	Parallel, opposite direction
	39	4	Blowing	Variable	Feeding	Variable
	40	8	Blowing	Variable	Feeding	Variable
	42	8	Blowing	Parallel, opposite direction	Fast travel	Parallel, opposite direction
	43	2	Blowing	Perpendicular, ahead of vessel	Slow travel	Perpendicular, ahead of vessel
	45	1	Blowing	Parallel, opposite direction	Diving	Parallel, opposite direction
	46	4	Blowing	Parallel, opposite direction	Feeding	Parallel, opposite direction
	49	1	Blowing	Variable	Diving	Unknown
	50	1	Blowing	Away from vessel	Fast travel	Variable
	51	1	Blowing	Parallel, same direction	Traveling	Parallel, same direction
	52	1	Blowing	Perpendicular, ahead of vessel	Traveling	Variable
	53	3	Blowing	Away from vessel	Slow travel	Away from vessel
	56	2	Blowing	Variable	Feeding	Variable
	58	5	Blowing	Variable	Feeding	Variable
	60	2	Blowing	Parallel, opposite direction	Traveling, Blowing bubbles	Parallel, opposite direction
	61	7	Blowing	Variable	Feeding	Variable
	62	3	Blowing	Variable	Slow travel	Away from vessel
	64	4	Blowing	Perpendicular, ahead of vessel	Traveling	Parallel, opposite direction

Species	Detection No.	No. of Animals	Initial behavior	Initial direction in relation to vessel	Subsequent and Final behavior	Subsequent and Final direction in relation to vessel
Fin whale	66	1	Traveling	Parallel, same direction	Traveling	Parallel, same direction
	68	4	Blowing	Perpendicular, ahead of vessel	Traveling	Parallel, opposite direction
	85	1	Blowing	Away from vessel	Traveling	Towards vessel, Parallel same direction
	86	2	Blowing	Towards vessel	Slow travel	Parallel, opposite direction
	87	2	Blowing	Perpendicular, ahead of vessel	Unknown	Away from vessel
	88	1	Lunging	Parallel, opposite direction	Blowing	Away from vessel
	95	2	Blowing	Perpendicular, ahead of vessel	Traveling	Parallel, same direction
	97	2	Blowing	Perpendicular, ahead of vessel	Fast travel	Perpendicular, ahead of vessel
	98	1	Blowing	Perpendicular, ahead of vessel	Fast travel	Parallel, same direction
	101	1	Blowing	Parallel, opposite direction	Unknown	Unknown
	127	1	Blowing	Parallel, opposite direction	Traveling	Parallel, opposite direction
	128	5	Blowing	Away from vessel	Slow travel	Away from vessel
	133	3	Breaching	Perpendicular, ahead of vessel	Traveling	Perpendicular, ahead of vessel
	136	1	Blowing	Parallel, same direction	Splashing	Parallel, same direction
	139	1	Blowing	Parallel, opposite direction	Fast travel	Parallel, opposite direction
	149	2	Blowing	Variable	Slow travel	Variable
	154	3	Blowing	Parallel, same direction	Diving	Away from vessel
Sperm whale	65	1	Logging	Stationary	Fast travel	Away from vessel
	143	1	Blowing	Parallel, opposite direction	Slow travel	Parallel, opposite direction
Sei whale	131	1	Traveling	Perpendicular, ahead of vessel	Blowing	Parallel, opposite direction

Species	Detection No.	No. of Animals	Initial behavior	Initial direction in relation to vessel	Subsequent and Final behavior	Subsequent and Final direction in relation to vessel
Unidentified pilot whales	137	6	Slow travel	Towards vessel	Spy-hopping	Parallel, opposite direction
Striped dolphins	144	50	Porpoising	Parallel, opposite direction	Leaping	Parallel, opposite direction
Bottlenose dolphins	151	7	Leaping	Perpendicular, ahead of vessel	Traveling	Perpendicular, ahead of vessel
Unidentified baleen whale	19	1	Blowing	Unknown	Unknown	Unknown
	21	2	Blowing	Perpendicular, ahead of vessel	Slow travel	Unknown
	22	1	Blowing	Parallel, opposite direction	Traveling	Parallel, same direction
	23	2	Blowing	Unknown	Milling	Unknown
	24	1	Blowing	Parallel, opposite direction	Diving	Away from vessel
	25	1	Blowing	Towards vessel	Traveling	Unknown
	29	1	Blowing	Parallel, opposite direction	Slow travel	Parallel, opposite direction
	44	2	Blowing	Parallel, same direction	Traveling	Parallel, same direction
	47	1	Blowing	Away from vessel	Unknown	Away from vessel
	48	1	Blowing	Away from vessel	Blowing	Away from vessel
	54	1	Blowing	Perpendicular, ahead of vessel	Milling	Parallel, opposite direction
	55	1	Blowing	Parallel, same direction	Blowing	Parallel, same direction
	57	1	Blowing	Parallel, opposite direction	Blowing	Away from vessel
	63	1	Blowing	Unknown	Unknown	Unknown
	72	2	Blowing	Away from vessel	Blowing	Away from vessel
	73	2	Blowing	Away from vessel	Blowing	Away from vessel
	81	1	Blowing	Perpendicular, behind vessel	Blowing	Parallel, opposite direction
	82	2	Blowing	Parallel, opposite direction	Traveling	Parallel, opposite direction

Species	Detection No.	No. of Animals	Initial behavior	Initial direction in relation to vessel	Subsequent and Final behavior	Subsequent and Final direction in relation to vessel
Unidentified baleen whale	84	1	Blowing	Away from vessel	Traveling	Away from vessel
	89	2	Blowing	Away from vessel	Traveling	Away from vessel
	90	1	Blowing	Parallel, opposite direction	Fast travel	Parallel, opposite direction
	91	1	Blowing	Away from vessel	Traveling	Parallel, opposite direction
	93	2	Blowing	Away from vessel	Traveling	Away from vessel
	94	2	Blowing	Parallel, opposite direction	Traveling	Parallel, opposite direction
	102	2	Blowing	Away from vessel	Slow travel	Away from vessel
	126	1	Blowing	Parallel, opposite direction	Fast travel	Away from vessel
	138	1	Blowing	Parallel, opposite direction	Unknown	Unknown
	140	1	Blowing	Away from vessel	Fast travel	Away from vessel
	146	1	Blowing	Parallel, opposite direction	Traveling	Parallel, opposite direction
	147	1	Blowing	Perpendicular, ahead of vessel	Traveling	Perpendicular, ahead of vessel
	148	1	Blowing	Parallel, opposite direction	Traveling	Parallel, opposite direction
Unidentified whale	27	1	Blowing	Unknown	Unknown	Unknown
	28	1	Blowing	Unknown	Unknown	Unknown
	92	2	Blowing	Unknown	Unknown	Unknown
	96	1	Blowing	Unknown	Unknown	Unknown
	100	1	Blowing	Parallel, opposite direction	Unknown	Unknown
Unidentified dolphin	130	4	Porpoising	Parallel, same direction	Slow travel	Parallel, same direction
	135	15	Feeding	Variable	Fast travel	Away from vessel
	141	10	Porpoising	Parallel, opposite direction	Fast travel	Parallel, opposite direction

	142	12	Traveling	Perpendicular, ahead of vessel	Traveling	Away from vessel
	145	6	Porpoising	Unknown	Unknown	Unknown
	150	12	Porpoising	Perpendicular, ahead of vessel	Fast travel	Perpendicular, ahead of vessel

6.2. IMPLEMENTATION AND EFFECTIVENESS OF THE BIOLOGICAL OPINIONS'S ITS AND IHA

In order to minimize the Level-B incidental taking of marine mammals and sea turtles during the Galicia Basin 3D seismic survey, mitigation measures were implemented whenever these protected species were seen near or within the safety radii designated in the IHA. Multiple mitigation actions were implemented during this survey for mysticetes and odontocetes. Only power-downs of the acoustic source were implemented, no shut-downs or soft-start delays were required during this survey.

Additional mitigation measures specific to the Galicia Basin 3D seismic survey required that if a North Atlantic right whale (*Eubalaena glacialis*) was sighted, the airgun array would be shut-down regardless of the distance of the animal(s) to the sound source and that the array would remain inactive until 30 minutes after the last documented sighting of the whale. No North Atlantic right whales were positively identified during the Galicia Basin 3D seismic survey.

Additionally, concentrations of humpback (*Megaptera novaengliea*), sei (*Balaenoptera borealis*), fin (*Balaenoptera physalus*), blue (*Balaenoptera musculus*), and/or sperm whales (*Physeter macrocephalus*) were avoided when possible (i.e., exposing concentrations of animals to 160 dB), and the array was powered down if necessary. For the purpose of the survey, a concentration of whales consisted of three or more individuals visually sighted that did not appear to be traveling (e.g., feeding, socializing, etc.). Fin whales were the only positively identified species observed in concentrations during the survey.

7. ACKNOWLEDGEMENTS

The Protected Species Observers on board Langseth during the Galicia Basin 3D seismic survey in the northeast Atlantic Ocean would like to thank the National Science Foundation and Lamont-Doherty Earth Observatory for the opportunity to work on this project. It was a pleasure to work with Dr. Dale Sawyer and Donna Shillington, as well as Meagan Cummings, the Marine Environmental Safety Coordinator for L-DEO. 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 program a success.

- Meagan Cummings, Jeff Rupert and Sean Higgins from L-DEO and Holly Smith from NSF for their assistance, planning and preparation for the cruise.
- Jessica Mucci from RPS for her support and installation of the PAM system.
- Matthew Dellinger from RPS for providing logistical support for the project.
- We also thank Stephanie Milne 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.

8. LITERATURE CITED

NOAA, 2013. “Biological Opinion on a Seismic Survey in the Northeastern Atlantic and Issuance of an MMPA IHA”.

APPENDIX A: **Incidental Harassment Authorization for the Galicia Basin 3D marine geophysical survey.**

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

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

MAY 3 1 2013

Dear Ms. Cummings:

Enclosed is an Incidental Harassment Authorization (IHA) issued to the Lamont-Doherty Earth Observatory, under the authority of section 101(a)(5)(D) of the Marine Mammal Protection Act (16 U.S.C. 1361 *et seq.*), to harass small numbers of marine mammals, by Level B harassment, incidental to the R/V *Marcus G. Langseth*'s marine geophysical survey in the northeast Atlantic Ocean during June to July 2013.

You are required to comply with the conditions contained in the IHA which have also been included as Terms and Conditions for incidental take of endangered species in the Biological Opinion. In addition, you must 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 Howard Goldstein, Jeannine Cody, or Jolie Harrison, Office of Protected Resources, NMFS, at 301-427-8401.

Sincerely,

Donna S. Wieting
Director
Office of Protected Resources

Enclosures

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

Incidental Harassment Authorization

The National Marine Fisheries Service (NMFS) hereby authorize Lamont-Doherty Earth Observatory of Columbia University (L-DEO), P.O. Box 1000, 61 Route 9W, Palisades, New York 10964-8000, under section 101(a)(5)(D) of the Marine Mammal Protection Act (MMPA) (16 U.S.C. 1371(a)(5)(D)), to harass small numbers of marine mammals incidental to a marine geophysical (seismic) survey conducted by the R/V *Marcus G. Langseth* (*Langseth*) in the northeast Atlantic Ocean, June to July 2013:

1. This Authorization is valid from June 1 through August 25, 2013.

2. This Authorization is valid only for the *Langseth*'s specified activities associated with seismic survey operations as specified in the L-DEO's Incidental Harassment Authorization application and the National Science Foundation's (NSF) associated *Environmental Analysis of a Marine Geophysical Survey by the R/V Marcus G. Langseth in the Northeast Atlantic Ocean, June-July 2013* in the following specified geographic area:

(a) An area between approximately 41.5° to 42.5° North by approximately 11.5° to 17.5° West in the northeast Atlantic Ocean to the west of Spain.

3. Species Authorized and Level of Takes

(a) This authorization limits the incidental taking of marine mammals, by Level B harassment only, to the following species in the waters of the northeast Atlantic Ocean:

(i) Mysticetes – see Table 1 (attached) for authorized species and take numbers.

(ii) Odontocetes – see Table 1 (attached) for authorized species and take numbers.

(iii) During the seismic activities, if the Holder of this Authorization encounters any marine mammal species under NMFS jurisdiction during seismic activities that are not listed in Table 1 (attached) for authorized taking and are likely to be exposed to sound pressure levels (SPLs) greater than or equal to 160 decibels (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) This Authorization prohibits the taking by injury (Level A harassment), serious injury, or death of any of the species listed in Condition 3(a) above or the taking of any

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kind of any other species of marine mammal thus, it may result in the modification, suspension or revocation of this Authorization.

4. This Authorization limits the methods authorized for taking by Level B harassment to the following acoustic sources without an amendment to this Authorization:

(a) An 18 Bolt airgun array with a total capacity of 3,30O in3 (or smaller);

(b) A multibeam echosounder;

(c) A sub-bottom profiler; and

(d) An acoustic release transponder used to communicate with ocean bottom seismometers (OBS).

5. The taking of any marine mammal in a manner prohibited under this Authorization must be reported immediately to the Office of Protected Resources, NMFS, at 301-427-8401.

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 impact on affected marine mammal species or stocks:

Protected Species Observers and Visual Monitoring

(a) Utilize two, National Marine Fisheries Service (NMFS)-qualified, vessel-based Protected Species Visual Observers (PSVOs) (except during meal times and restroom breaks, when at least one PSVO shall be on watch) to visually watch for and monitor marine mammals near the seismic source vessel during daytime airgun operations (from nautical twilight-dawn to nautical twilight-dusk) and before and during start-ups of airguns day or night.

(i) The *Langseth*'s vessel crew shall also assist in detecting marine mammals, when practicable.

(ii) PSVOs shall have access to reticle binoculars (7 x 50 Fujinon), big-eye binoculars (25 x 150), laser range-finding binoculars, and thermal imaging cameras.

(iii) PSVO shifts shall last no longer than 4 hours at a time.

(iv) When feasible, PSVOs shall also make observations during daytime periods when the seismic system is not operating for comparison of animal abundance and behavior during, between, and after airgun operations.

(v) PSVOs shall conduct monitoring while the airgun array and streamer(s) are being deployed or recovered from the water.

(b) PSVO(s) shall 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), Beaufort sea state and wind force, visibility, and sun glare; and

(iii) The data listed under Condition 6(b)(ii) shall 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.

Passive Acoustic Monitoring

(c) 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 NMFS-qualified Protected Species Observer (PSO) and/or expert bioacoustician (i.e., Protected Species Acoustic Observer [PSAO]) shall monitor the PAM at all times in shifts no longer than 6 hours. An expert 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.

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

(i) Notify the on-duty PSVO(s) immediately of the presence 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. The acoustic detection can also be recorded for further analysis.

Buffer and Exclusion Zones

(e) Establish a 160 dB re 1 μPa (rms) buffer zone as well as 180 dB re 1 μPa (rms) exclusion zone for marine mammals before the 2-string airgun array (3,300 in^3) is in operation; and a 180 dB re 1 μPa (rms) exclusion zone before a single airgun (40 in^3) is in operation, respectively. See Table 2 (attached) for distances and exclusion zones.

Visual Monitoring at the Start of Airgun Operations

(f) Visually observe the entire extent of the exclusion zone (180 dB re 1 μPa [rms] for cetaceans; see Table 2 [attached] for distances) using NMFS-qualified PSVOs, for at least 30 minutes prior to starting the airgun array (day or night).

(i) 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 PSVO shall wait 30 minutes. If the PSVO sees no marine mammals during that time, he/she should assume that the animal has moved beyond the exclusion zone.

(ii) If for any reason the entire radius cannot be seen for the entire 30 minutes (i.e., rough seas, fog, darkness), or if marine mammals are near, approaching, or within the exclusion zone, the airguns may not be resume airgun operations.

(iii) If one airgun is already running at a source level of at least 180 dB re 1 μPa (rms), L-DEO may start the second airgun, and subsequent airguns, without observing the entire exclusion zone for 30 minutes prior, provided no marine mammals are known to be near the relevant exclusion zone (in accordance with Condition 6[g] below).

Ramp-up Procedures

(g) Ramp-up procedures at the start of seismic operations or after a shut-down - Implement a "ramp-up" procedure when starting up at the beginning of seismic operations or anytime after the entire array has been shut-down for more than 8 minutes, which means start the smallest gun first and add airguns in a sequence such that the source level of the array shall increase in steps not exceeding approximately 6 dB per 5-minute period. During ramp-up, the PSVOs shall monitor the 180 dB exclusion zone for cetaceans, and if marine mammals are sighted within or about to enter the relevant exclusion zone, a power-down, or shut-down shall be implemented as though the full

array were operational. Therefore, initiation of ramp-up procedures from a shut-down or at the beginning of seismic operations requires that the PSVOs be able to view the full exclusion zone as described in Condition 6(e) (above).

Power-down Procedures

(h) Power-down the airgun(s) if a marine mammal is detected within, approaches, or enters the relevant exclusion zone (as defined in Table 2, attached). 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 no longer in or about to enter it for the full airgun array. When appropriate or possible, power-down of the airgun array shall also occur when the vessel is moving from the end of one trackline to the start of the next trackline.

(i) Following a power-down, if the marine mammal approaches the smaller designated exclusion zone, the airguns must then be completely shut-down. Airgun activity shall 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 minutes for species with shorter dive durations (small odontocetes) or 30 minutes for species with longer dive durations (mysticetes and large odontocetes, including sperm, pygmy sperm, dwarf sperm, killer, and beaked whales).

(j) Following a power-down and subsequent animal departure, the airgun operations may resume at full power. Initiation requires that the PSVOs can effectively monitor the full exclusion zones described in Condition 6(e). If the PSVO(s) sees a marine mammal within or about to enter the relevant zones, then a course/speed alteration, power-down or shut-down will be implemented.

Shut-down Procedures

(k) Shut-down the airgun(s) if a marine mammal is detected within, approaches, or enters the relevant exclusion zone (as defined in Table 2, attached). A shut-down means all operating airguns are shut-down (i.e., turned off).

(l) Following a shut-down, if the PSVO has visually confirmed that the animal has departed the relevant exclusion zone (and is not likely to return) within a period less than or equal to 8 minutes after the shut-down, then the airgun operations may resume at full power. If the PSVO has not observed the marine mammal(s) exiting the exclusion zone, the airgun operations shall not resume for 15 minutes for species with shorter dive durations (small odontocetes) or 30 minutes for species with longer dive durations (mysticetes and large odontocetes, including sperm, pygmy sperm, dwarf sperm, killer, and beaked whales). Following a shut-down, the *Langseth* may resume airgun operations following ramp-up procedures described in Condition 6(g).

Speed or Course Alteration

(m) 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 a power-down or shut-down, shall be taken.

Survey Operations at Night

(n) Marine seismic 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.

(o) 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 PSVO(s) on duty.

(p) To the maximum extent practicable, schedule seismic operations (i.e., shooting airguns) during daylight hours and OBS operations (i.e., deploy/retrieve) to nighttime hours.

Mitigation Airgun

(q) Use of small-volume airgun (i.e., mitigation airgun) during turns and maintenance shall be operated at approximately one shot per minute and would not be operated for longer than three hours in duration. During turns or brief transits between seismic tracklines, one airgun will continue operating.

Special Procedures for Situations or Species of Concern

(r) If a North Atlantic right whale (*Eubalaena glacialis*) is visually sighted, the airgun array shall be shut-down regardless of the distance of the animal(s) to the sound source. The array shall not resume firing until 30 minutes after the last documented whale visual sighting.

(s) Concentrations of humpback (*Megaptera novaeangliae*), sei (*Balaenoptera borealis*), fin (*Balaenoptera physalus*), blue (*Balaenoptera musculus*), and/or sperm whales (*Physeter macrocephalus*) will be avoided if possible (i.e., exposing concentrations of animals to 160 dB), and the array will be powered-down if necessary. For purposes of the survey, a concentration or group of whales will consist of three or more individuals visually sighted that do not appear to be traveling (e.g., feeding, socializing, etc.).

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 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) for cetaceans with a discussion of any specific behaviors those individuals exhibited; and (B) may have been exposed (based on reported and corrected empirical values for the 36 airgun array and modeling measurements for the single airgun) 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) for cetaceans 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 (attached); and (B) mitigation measures of the Incidental Harassment Authorization. For the Biological Opinion, the report shall 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 Endangered Species Act-listed marine mammals.

(b) Submit a final report to the Chief, Permits and Conservation 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 shall be considered to be the final report.

Reporting Prohibited Take

(c) In the unanticipated event that the specified activity clearly causes the take of a marine mammal in a manner prohibited by this Authorization, such as an injury (Level A harassment), serious injury or mortality (e.g., ship-strike, gear interaction, and/or

entanglement), L-DEO shall immediately cease the specified activities and immediately report the incident to the Chief of the Permits and Conservation Division, Office of Protected Resources, NMFS, at 301-427-8401 and/or by email to Jolie.Harrison@noaa.gov, and Howard.Goldstein@noaa.gov. The report must include the following information:

(i) Time, date, and location (latitude/longitude) of the incident; the name and type of vessel involved; the vessel's speed during and leading up to the incident; description of the incident; status of all sound source use in the 24 hours preceding the incident; water depth; environmental conditions (e.g., wind speed and direction, Beaufort sea state, cloud cover, and visibility); description of marine mammal observations in the 24 hours preceding the incident; species identification or description of the animal(s) involved; the fate of the animal(s); and photographs or video footage of the animal (if equipment is available).

Activities shall not resume until NMFS is able to review the circumstances of the prohibited take. NMFS shall work with L-DEO to determine what is necessary to minimize the likelihood of further prohibited take and ensure MMPA compliance. L-DEO may not resume their activities until notified by NMFS via letter, email, or telephone.

Reporting an Injured or Dead Marine Mammal with an Unknown Cause of Death

In the event that L-DEO discovers an injured or dead marine mammal, and the lead PSO determines that the cause of the injury or death is unknown and the death is relatively recent (i.e., in less than a moderate state of decomposition as described in the next paragraph), L-DEO will immediately report the incident to the Chief of the Permits and Conservation Division, Office of Protected Resources, NMFS, at 301-427-8401, and/or by email to Jolie.Harrison@noaa.gov, and Howard.Goldstein@noaa.gov. The report must include the same information identified in Condition 7(c)(i) above. Activities may continue while NMFS reviews the circumstances of the incident. NMFS will work with L-DEO to determine whether modifications in the activities are appropriate.

Reporting an Injured or Dead Marine Mammal Not Related to the Activities

In the event that L-DEO discovers an injured or dead marine mammal, and the lead PSO determines that the injury or death is not associated with or related to the activities authorized in Condition 2 of this Authorization (e.g., previously wounded animal, carcass with moderate to advanced decomposition, or scavenger damage), L-DEO shall report the incident to the Chief of the Permits and Conservation Division, Office of Protected Resources, NMFS, at 301-427-8401, and/or by email to Jolie.Harrison@noaa.gov, and Howard.Goldstein@noaa.gov, within 24 hours of the discovery. L-DEO shall provide photographs or video footage (if available) or other documentation of the stranded animal

sighting to NMFS and the Marine Mammal Stranding Network. Activities may continue while NMFS reviews the circumstances of the incident.

9. Endangered Species Act Biological Opinion and Incidental Take Statement

(a) L-DEO is required to comply with the Terms and Conditions of the Incidental Take Statement corresponding to NMFS's Biological Opinion issued to both NSF and NMFS's Office of Protected Resources, Permits and Conservation Division (attached).

(b) A copy of this Authorization and the Incidental Take Statement must be in the possession of all contractors and PSOs operating under the authority of this Incidental Harassment Authorization.

MAY 3 1 2013

Donna S. Wieting

Donna S. Wieting
Director
Office of Protected Resources
National Marine Fisheries Service

Date

Attachment

Table 1. Authorized take numbers, by Level B harassment, for each marine mammal species during L-DEO's marine seismic survey in the northeast Atlantic Ocean, June to July 2013.

Species	Authorized Take in the Northeast Atlantic Ocean Study Area
Mysticetes	
North Atlantic right whale (*Eubalaena glacialis*)	0
Humpback whale (*Megaptera novaeangliae*)	2
Minke whale (*Balaenoptera acutorostrata*)	3
Sei whale (*Balaenoptera physalus*)	106
Fin whale (*Balaenoptera borealis*)	1,002
Blue whale (*Balaenoptera musculus*)	3
Odontocetes	
Sperm whale (*Physeter macrocephalus*)	159
Unidentified *Kogia* spp. Pygmy sperm whale (*Kogia breviceps*) and/or Dwarf sperm whale (*Kogia sima*)	0
Cuvier's beaked whale (*Ziphius cavirostris*)	32
Northern bottlenose whale (*Hyperoodon ampullatus*)	4
Unidentified *Mesoplodon* beaked whale (*Mesoplodon* spp. includes True's [*M. mirus*], Gervais' [*M. europaeus*], Sowerby's [*M. bidens*], and Blainville's beaked whale [*M. densirostris*])	7
Bottlenose dolphin (*Tursiops truncatus*)	40
Atlantic spotted dolphin	0

(*Stenella frontalis*)	
Striped dolphin (*Stenella coeruleoalba*)	378
Short-beaked common dolphin (*Delphinus delphis*)	620
Risso's dolphin (*Grampus griseus*)	4
Pygmy killer whale (*Feresa attenuata*)	0
False killer whale (*Pseudorca crassidens*)	10
Killer whale (*Orcinus orca*)	5
Short-finned pilot whale (*Globicephala macrorhynchus*)	5
Long-finned pilot whale (*Globicephala melas*)	8

Table 2. Modeled distances to which sound levels greater than or equal to 160 and 180 dB could be received during the marine seismic survey in the northeast Atlantic Ocean during June to July 2013. The buffer and exclusion zone radii are used for triggering mitigation.

Source and Volume	Tow Depth (m)	Water Depth (m)	Predicted RMS Distances (m)	
			Shut-down Exclusion Zone for Cetaceans 180 dB	Level B Harassment Zone 160 dB
Single Bolt Airgun 40 in^3	9	Deep (>1,000)	100	385
2 Strings 18 Airguns 3,300 in^3	9	Deep (>1,000)	568	4,550

APPENDIX B: Basic Data Summary Form

BASIC DATA FORM				
LDEO Project Number		MGL1307		
Seismic Contractor		Lamont-Doherty Earth Observatory of Columbia University		
Area Surveyed During Reporting Period		Galicia Basin 3D Seismic Survey off the west coast of Spain		
		Approximately between 41.5 to 42.5°N and 11.5 to 17.5°W		
Survey Type		3D surface seismic		
Vessel and/or Rig Name		*R/V Marcus G. Langseth*		
Permit Number		IHA granted by NMFS on 31 May 2013		
Location / Distance of Airgun Deployment		272 meters aft of PSO tower		
Water Depth	**Min**	~3500 meters		
	Max	>5000 meters		
Dates of project		1 June 2013	THROUGH	2 August 2013
Total time airguns operating – all power levels:		717 hours 06 minutes		
Time airguns operating at full power on survey lines:		613 hours 39 minutes		
Time airguns operating at full power on line changes:		92 hours 58 minutes		
Amount of time mitigation gun (40 in³) operations:		8 hours 21 minutes		
Amount of time in ramp-up:		2 hours 08 minutes		
Number daytime ramp-ups:		5		
Number of night time ramp-ups:		0		
Number of ramp-ups from mitigation source:		0		
Amount of time conducted in airgun testing:		None		
Duration of visual observations:		642 hours 30 minutes		
Duration of observations while airguns firing:		463 hours 11 minutes		
Duration of observation during airgun silence:		179 hours 19 minutes		
Duration of acoustic monitoring:		642 hours 37 minutes		
Duration of acoustic monitoring while airguns firing:		640 hours 33 minutes		
Duration of acoustic monitoring during airgun silence:		2 hours 04 minutes		
Duration of simultaneous acoustic and visual monitoring:		421 hours 13 minutes		
Lead Protected Species Observer:		Heidi Ingram		
Protected Species Observers:		Meghan Piercy		
		Rebeca Lago Garza		
		Emily Ellis (1 June – 25 June)		
		Vanesa Brunet Costa (15 July – 2 August)		
Acoustic Observer:		Dara Cameron		
Number of Marine Mammals Visually Detected:		155		
Number of Marine Mammals Acoustically Detected:		4		
Number of acoustic detections confirmed by visual sighting:		0		
Number of visual sighting confirmed by acoustic detection:		1		
Number of Sea Turtles detected:		0		
List Mitigation Actions (eg. Power-downs, shut-downs, ramp-up delays)		10 power-downs		
Duration of operational downtime due to mitigation:		5 hours 19 minutes		

APPENDIX C: Passive Acoustic Monitoring System Specifications

Main cable and spare cable:

1.1 Outline Array
Array serial number SM.2997
Mechanical Information
Length 20m
Diameter 14mm over cable 32mm over mouldings 45mm over connectors
Weight 10kg
Connector Seiche 36 pin

Hydrophone elements
Hydrophone 1 Sphere 1 Broad band 200Hz to 200kHz (3dB points)
Hydrophone 2 Sphere 2 Broad band 200Hz to 200 kHz (3dB points)
Hydrophone 3 Sphere 3 Standard 2 kHz to 200 kHz (3dB points)
Hydrophone 4 Sphere 4 Standard 2 kHz to 200 kHz

Depth Capability 100m
Spacing between elements 1 & 2 (for HF / LF detection) 2.0m 1.28mSecs
Spacing between elements 2 & 3 (for HF / LFdetection) 13.0m 8.32mSecs
Spacing between elements 3 & 4 (for HF detection) 0.25m 0.16mSecs

Interface unit Array 1 outputs

Broad band channel sensitivity -166dB re 1V/uPa
Standard channel sensitivity -166dB re 1V/uPa

1.2 Heavy tow cable
Tow serial number SM.2998
Mechanical Information
Length 230m
Diameter 17mm over cable 32mm over mouldings
Connector Tail end Seiche 36 pin 45mm over connectors
Head end ITT 19 pin 65mm over connectors
Weight 100kg

1.3 Deck cable
Deck serial number SM.2933
Mechanical Information
Length 100m
Diameter 14mm
Connectors ITT 19 pin 65mm over connectors
Weight 25kg

APPENDIX D: PAM Hydrophone Deployment on the *R/V Marcus Langseth*

The hydrophone deployment procedure is a draft document and may be altered at any time to reflect changes in the deployment over time. The deployment requires the PAM operator and one additional person to complete.

Overview

A 20-meter hydrophone array cable and a 230-meter hydrophone tow cable have been supplied for the survey. The linear hydrophone array contains two broadband (200Hz to 200kHz), two low frequency hydrophone elements (2kHz to 200kHz) and a depth gauge (100m capacity) potted directly into the cable. The four hydrophones and their positions on the array cable are shown in Figure 1. A 100-meter deck cable connects the hydrophone tow cable from a winch on the port gun deck to the data processing unit located in the science lab.

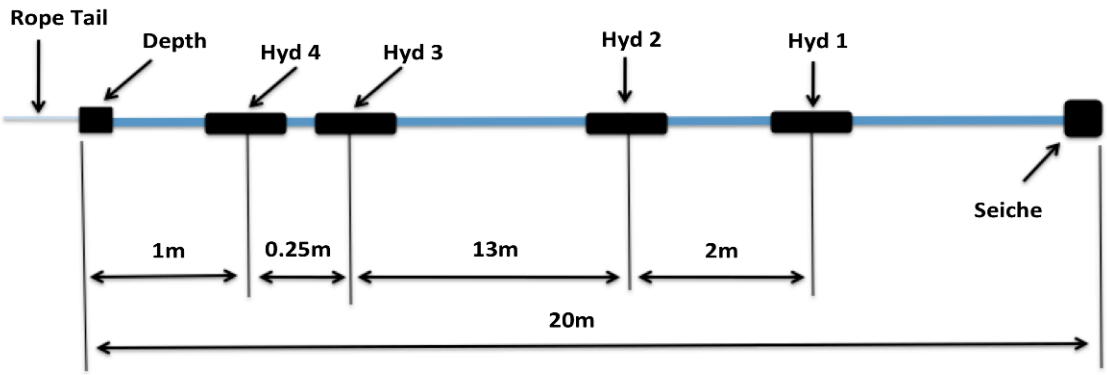

Figure 1: Diagram of the hydrophone array cable indicating the position and separation of the individual hydrophone elements.

The hydrophone array cable, connected to the tow cable, is spooled onto a port hydrolytic winch (Figure 2). The adjoined cables are deployed directed off the stern of the vessel, just aft of the winch. The hydrophone tow cable, with a looped rope attached via Chinese-fingers bound by tape, connects to a towrope with shackle and this is the towing point of the PAM cable system (Figure 3; Left). The towrope is secured to a bitt aft of the winch and run through a chalk (Figure 3; Right) where it connects to the PAM cable.

To ensure a lower placement of the PAM cable in the water column then the adjacent gun cables, weights were dispersed on the system. In total, 22.3kg was added; three sections of chain were bound by tape to the hydrophone tow cable, 3 chain links and a large shackle was tied off to the extending drogue rope. At 3 and 10 meters ahead of the hydrophone cable are 3kg of chain, at 80 meters ahead of the hydrophone cable 6.3kg was added, and 10kg lies on the drogue rope.

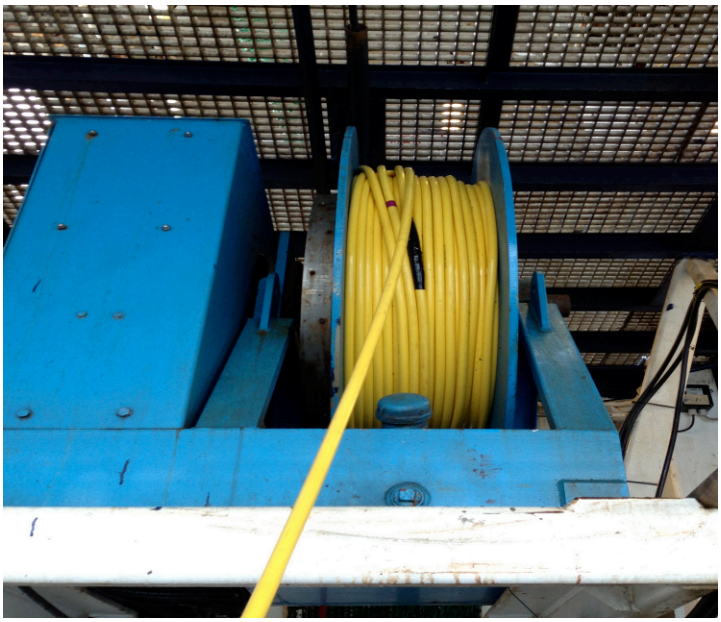

Figure 2: PAM tow cable spooled onto the winch and running aft.

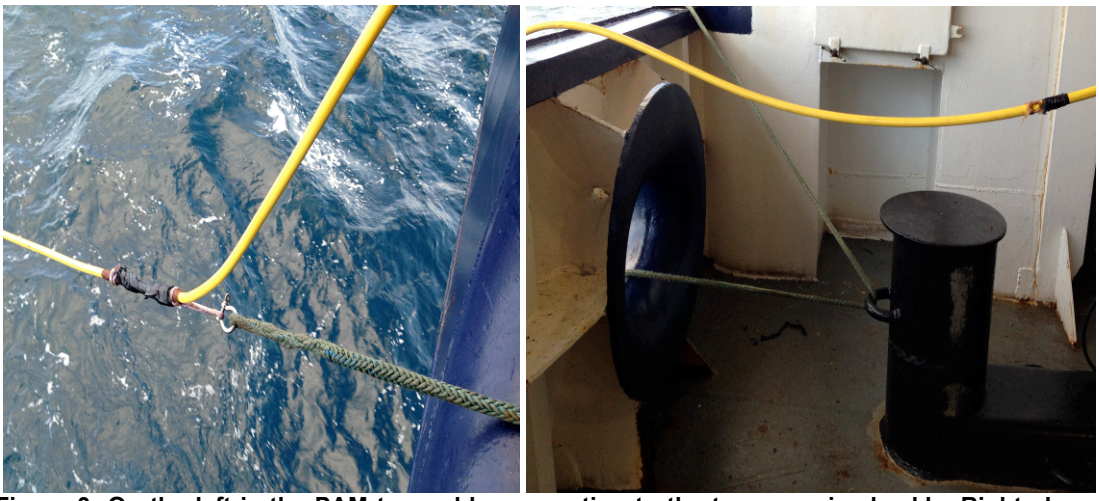

Figure 3: On the left is the PAM tow cable connecting to the towrope via shackle. Right shows PAM going over the stern bulkhead, the towrope tied off to the bitt and threaded through the chalk.

When deployed 120 meters of the PAM cable system is dispensed, (100 meters of tow cable and the 20 meter hydrophone cable). The gun array is placed 249 meters astern of the vessel, this places the separation between the end of the PAM hydrophone cable and the seismic array at 129 meters. The PAM cable is off set to port due to the deployment location.

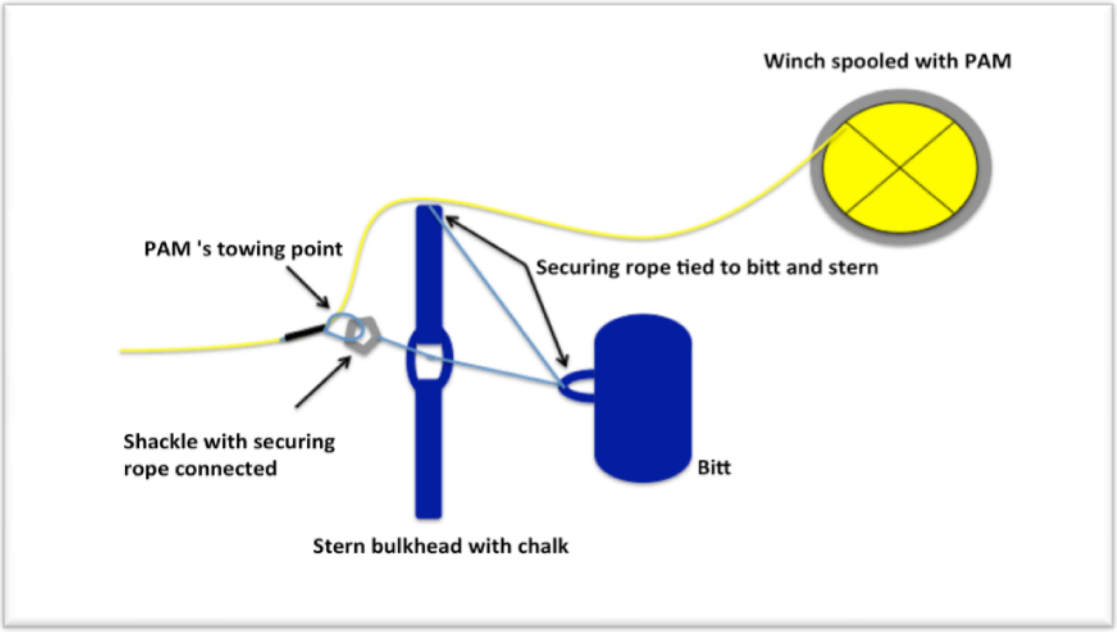

Figure 4: Diagram of PAM deployed off of stern

Pre-Deployment Tasks

The PAM data processing unit, and monitors were setup and secured for rough weather in the main science lab (Figure 5). A GPS feed (GPGGA string) was supplied by the ships navigation system Seapath 200.

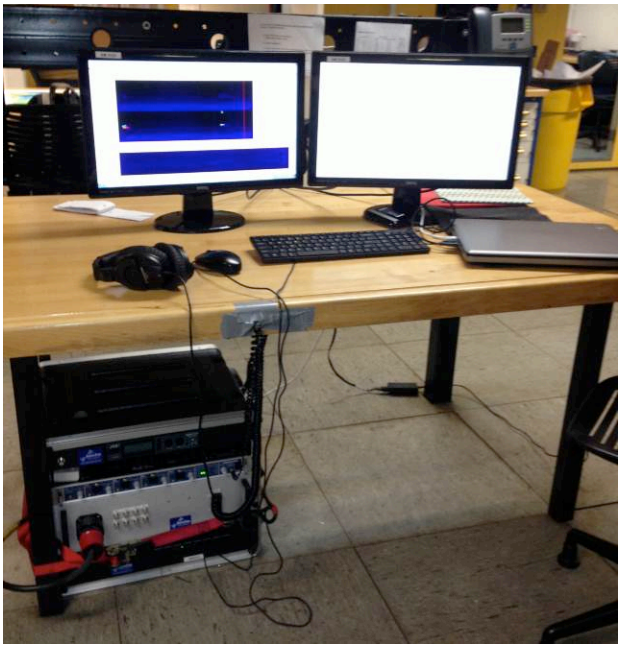

Figure 5: Passive acoustic monitoring station located in the instrument room.

Two 100-meter deck cables are routed from the instrument room to the port gun deck winch, one of which acts as a spare for ease of replacement at sea.

The hydrophone tow cable was measured and marked in 10-meter increments for the first 120 meters from the hydrophone array-tow cables' connection point.

Prior to deployment a tap test was performed to the hydrophones and the depth gauge calibrated.

Deployment

- Ensure that the PAM electronics unit is powered down.
- Alert the bridge of pending hydrophone deployment.
- Ensure the deck cable is disconnected from the hydrophone tow cable.
- Power on winch.
- Pay out 120m of the hydrophone cable from the winch, dispensing the cable into the water on port side of gun umbilicus.
- Tie off towrope to bitt and stern, thread through chalk and attach to the PAM cable via shackle.
- Add a Zip-tie to secure the shackle from coming undone.
- Power off winch.
- Connect the deck cable to the hydrophone cable.
- Power up electronics in the instrument room.

Retrieval

- Power down electronics in the instrument room.
- Alert the bridge of pending hydrophone retrieval.

- Ensure the deck cable is disconnected from the hydrophone cable (tape both connectors to prevent corrosion).
- Disconnect cable from towing point shackle.
- Retrieve the hydrophone cable and wind evenly on winch, paying special attention to weighted sections.

Always ensure the deck cable is disconnected from the tow cable before operating the winch.

HSE

Normal working deck PPE is required (hard hat, boots, gloves, eye protection, and coveralls). A life vest is required for any work involving items going over the side.

The operation carries a relatively low risk. Hazards include working close to the side of the vessel, trip hazards, and pinch points at the winch, shackles, and collar.

A Job Safety Analysis (JSA) has been completed for this task. The JSA will also require further review upon any additional modifications.

APPENDIX E: Survey Lines Acquired

Survey Line	Date Acquisition Commenced	Time Acquisition Commenced	Date Acquisition Completed	Time Acquisition Completed
MGL1307OBS1 Seq001	5-Jun-2013	23:31	6-Jun-2013	03:52
MGL1307OBS2 Seq002	6-Jun-2013	04:09	6-Jun-2013	12:44
MGL13071172 Seq003	6-Jun-2013	13:13	6-Jun-2013	21:45
MGL13071060 Seq004	7-Jun-2013	02:28	7-Jun-2013	12:21
MGL13071164 Seq005	7-Jun-2013	13:45	7-Jun-2013	16:58
MGL13071164A Seq006	7-Jun-2013	17:02	7-Jun-2013	22:47
MGL13071052 Seq007	8-Jun-2013	00:46	8-Jun-2013	01:47
MGL13071052A Seq008	8-Jun-2013	02:13	8-Jun-2013	10:37
MGL13071156 Seq009	8-Jun-2013	12:40	8-Jun-2013	22:20
MGL13071044 Seq010	8-Jun-2013	23:44	9-Jun-2013	03:07
MGL13071148 Seq011	10-Jun-2013	01:41	10-Jun-2013	06:20
MGL13071036 Seq012	10-Jun-2013	07:48	10-Jun-2013	17:22
MGL13071140 Seq013	10-Jun-2013	18:29	11-Jun-2013	03:54
MGL13071028 Seq014	11-Jun-2013	05:21	11-Jun-2013	15:05
MGL13071132 Seq015	11-Jun-2013	16:24	12-Jun-2013	01:59
MGL13071020 Seq016	12-Jun-2013	03:42	12-Jun-2013	07:24
MGL13071020A Seq017	12-Jun-2013	07:30	12-Jun-2013	12:43
MGL13071124 Seq018	12-Jun-2013	14:08	12-Jun-2013	23:51
MGL13071012 Seq019	13-Jun-2013	01:05	13-Jun-2013	10:44
MGL13071116 Seq020	13-Jun-2013	11:51	13-Jun-2013	21:31
MGL13071004 Seq021	13-Jun-2013	22:33	14-Jun-2013	08:13
MGL13071148A Seq022	14-Jun-2013	09:32	14-Jun-2013	16:40
MGL13071044R Seq023	14-Jun-2013	17:28	15-Jun-2013	0:42
MGL13071080 Seq024	15-Jun-2013	02:12	15-Jun-2013	11:38
MGL1307ARC1 Seq025	15-Jun-2013	11:41	15-Jun-2013	12:43
MGL13071068 Seq026	15-Jun-2013	12:53	15-Jun-2013	22:26
MGL13071188 Seq027	15-Jun-2013	23:42	16-Jun-2013	09:14
MGL13071076 Seq028	16-Jun-2013	10:16	16-Jun-2013	20:26
MGL13071196 Seq029	16-Jun-2013	21:30	17-Jun-2013	07:18
MGL13071084 Seq030	19-Jun-2013	07:25	19-Jun-2013	17:16
MGL1307ARC2 Seq031	19-Jun-2013	17:23	19-Jun-2013	18:11
MGL13071204 Seq032	19-Jun-2013	18:15	20-Jun-2013	03:41
MGL13071092 Seq033	20-Jun-2013	05:52	20-Jun-2013	15:03
MGL13071204I Seq034	20-Jun-2013	16:19	6421-Jun-2013	01:48
MGL13071100 Seq035	21-Jun-2013	03:05	21-Jun-2013	12:35
MGL1307ARC5 Seq036	21-Jun-2013	12:43	21-Jun-2013	13:41
MGL13071212 Seq037	21-Jun-2013	13:51	21-Jun-2013	23:25
MGL1307ARC6 Seq038	21-Jun-2013	23:34	22-Jun-2013	00:26
MGL13071108 Seq039	22-Jun-2013	00:44	22-Jun-2013	10:00
MGL13071172R Seq040	22-Jun-2013	11:44	22-Jun-2013	18:54
MGL13071076R Seq041	22-Jun-2013	19:54	23-Jun-2013	00:35

Survey Line	Date Acquisition Commenced	Time Acquisition Commenced	Date Acquisition Completed	Time Acquisition Completed
MGL13071220 Seq042	16-Jul-2013	20:27	16-Jul-2013	20:36
MGL1307T1 Seq043	16-Jul-2013	20:36	17-Jul-2013	01:12
MGL13071220A Seq044	17-Jul-2013	01:20	17-Jul-2013	11:03
MGL1307ARC8 Seq045	17-Jul-2013	11:09	17-Jul-2013	12:00
MGL13071324 Seq046	17-Jul-2013	12:12	17-Jul-2013	20:39
MGL1307ARC9 Seq047	17-Jul-2013	20:44	17-Jul-2013	21:40
MGL13071228 Seq048	17-Jul-2013	21:56	18-Jul-2013	07:14
MGL1307ARC10 Seq049	18-Jul-2013	07:20	18-Jul-2013	08:19
MGL13071332 Seq050	18-Jul-2013	08:27	18-Jul-2013	16:41
MGL1307ARC11 Seq051	18-Jul-2013	16:52	18-Jul-2013	17:42
MGL13071236 Seq052	18-Jul-2013	17:48	19-Jul-2013	03:16
MGL1307ARC12 Seq053	19-Jul-2013	03:23	19-Jul-2013	04:17
MGL13071340 Seq054	19-Jul-2013	04:36	19-Jul-2013	13:48
MGL1307ARC13 Seq055	19-Jul-2013	13:56	19-Jul-2013	14:45
MGL13071244 Seq056	19-Jul-2013	14:52	19-Jul-2013	23:32
MGL1307ARC14 Seq057	19-Jul-2013	23:39	20-Jul-2013	00:31
MGL13071348 Seq058	20-Jul-2013	00:37	20-Jul-2013	09:09
MGL1307ARC15 Seq059	20-Jul-2013	09:15	20-Jul-2013	10:07
MGL13071252 Seq060	20-Jul-2013	10:14	20-Jul-2013	18:39
MGL1307ARC16 Seq061	20-Jul-2013	18:45	20-Jul-2013	19:45
MGL13071356 Seq062	20-Jul-2013	19:59	21-Jul-2013	04:18
MGL1307ARC17 Seq063	21-Jul-2013	04:23	21-Jul-2013	05:08
MGL13071260 Seq064	21-Jul-2013	05:16	21-Jul-2013	13:33
MGL1307ARC18 Seq065	21-Jul-2013	13:39	21-Jul-2013	15:38
MGL13071364 Seq066	21-Jul-2013	15:46	22-Jul-2013	00:15
MGL1307ARC19 Seq067	22-Jul-2013	00:21	22-Jul-2013	01:15
MGL13071268 Seq068	22-Jul-2013	01:19	22-Jul-2013	09:24
MGL13071316 Seq069	22-Jul-2013	11:31	22-Jul-2013	20:12
MGL13071276 Seq070	22-Jul-2013	22:21	23-Jul-2013	06:43
MGL1307ARC20 Seq071	23-Jul-2013	06:48	23-Jul-2013	08:02
MGL13071364i Seq072	23-Jul-2013	08:27	23-Jul-2013	16:55
MGL1307ARC21 Seq073	23-Jul-2013	17:04	23-Jul-2013	17:54
MGL13071284 Seq074	23-Jul-2013	18:05	24-Jul-2013	02:13
MGL1307ARC22 Seq075	24-Jul-2013	02:19	24-Jul-2013	02:58
MGL13071356i Seq076	24-Jul-2013	03:15	24-Jul-2013	11:36
MGL1307ARC23 Seq077	24-Jul-2013	11:42	24-Jul-2013	12:42
MGL13071244i Seq078	24-Jul-2013	12:53	24-Jul-2013	21:27
MGL13071308 Seq079	24-Jul-2013	23:14	25-Jul-2013	08:01
MGL13071236i Seq080	25-Jul-2013	09:33	25-Jul-2013	18:16
MGL1307ARC1A Seq081	25-Jul-2013	18:24	25-Jul-2013	19:17
MGL13071340i Seq082	25-Jul-2013	19:32	26-Jul-2013	04:05
MGL13071292 Seq083	26-Jul-2013	06:13	26-Jul-2013	15:34
MGL1307ARC25 Seq084	26-Jul-2013	15:41	26-Jul-2013	17:35
MGL13071052R Seq085	26-Jul-2013	17:42	27-Jul-2013	02:37
MGL1307ARC26 Seq086	27-Jul-2013	02:42	27-Jul-2013	04:27

Survey Line	Date Acquisition Commenced	Time Acquisition Commenced	Date Acquisition Completed	Time Acquisition Completed
MGL13071300 Seq087	27-Jul-2013	04:54	27-Jul-2013	13:00
MGL13071348i Seq088	27-Jul-2013	15:00	27-Jul-2013	15:57
MGL13071348j Seq089	28-Jul-2013	00:28	28-Jul-2013	02:20
MGL1307ARC27 Seq090	28-Jul-2013	02:28	28-Jul-2013	03:06
MGL13071252i Seq091	28-Jul-2013	03:17	28-Jul-2013	11:34
MGL1307ARC28 Seq092	28-Jul-2013	11:39	28-Jul-2013	13:04
MGL13071348k Seq093	28-Jul-2013	13:17	28-Jul-2013	22:16
MGL13071206i Seq094	28-Jul-2013	23:49	29-Jul-2013	08:46
MGL1307ARC29 Seq095	29-Jul-2013	08:52	29-Jul-2013	09:47
MGL13071372 Seq096	29-Jul-2013	09:56	29-Jul-2013	18:33
MGL13071332i Seq097	29-Jul-2013	20:20	30-Jul-2013	04:53
MGL13071380 Seq098	30-Jul-2013	07:17	30-Jul-2013	16:11
MGL1307ARC30 Seq099	30-Jul-2013	18:45	30-Jul-2013	19:44
MGL13071388 Seq100	30-Jul-2013	19:53	31-Jul-2013	06:05
MGL13071396 Seq101	31-Jul-2013	08:17	31-Jul-2013	17:50

APPENDIX F: Passive Acoustic Monitoring Downtime

Date	Monitoring Suspended	Date	Monitoring Resumed	Duration acoustic monitoring suspended	Comments
6-06-2013	21:49	6-07-2013	17:40	19:51	The hydrophone cable was retrieved prior to the retrieval of arrays 3 and 4 for repair. Remained down for weather.
6-9-2013	4:44	6-9-2013	18:51	14:07	Issue with streamer 4, retrieving PAM and all arrays
6-12-2013	12:35	6-12-2013	13:55	1:20	Port gun strings brought in for maintenance.
6-16-2013	21:17	6-19-2013	7:54	58:37	Cable retrieved d/t increasing ss, anticipated storm with arrays coming in also.
6-20-2013	03:51	6-20-2013	6:30	2:39	Port gun strings brought in for maintenance.
7-26-2013	3:37	7-26-2013	7:42	4:05	Airgun maintenance during line change
7-27-2013	2:05	7-27-2013	5:11	3:06	Airgun maintenance during line change
7:27-2013	15:57	7-28-2013	0:53	8:56	Streamer separation failure
7-29-2013	18:20	7-29-2013	21:30	3:10	Airgun maintenance during line change
			Total PAM Downtime	**115:15**	

APPENDIX G: Summary of visual detections of protected species during the Galicia Basin 3D seismic survey.

Movement Codes: **TV**: towards vessel; **AV**: away from vessel; **PV/SD**: parallel vessel, same direction; **PV/OD**: parallel vessel, opposite direction; **PE (AH/BH):** perpendicular (crossing ahead or behind); **MI**: milling ; **SA**: stationary; **V:** variable, **UN**: unknown**; OM**: other movement

Behavioural Codes: **NS**: normal swimming; **FT**: fast travel; **ST**: slow travel; **PO**: porpoising; **SS**: swimming below surface; **MI**: milling: **BR**: bow/wake riding; **BA**: resting/basking at surface; **FL:** floating; **SA** :surface active (lob tailing/pectoral slapping, full/partial breaching)**; R:** rolling; **DI**: dive; **DF**: dive with fluke; **FF**: feeding/foraging; **SB**: social behaviour; **MT**: mating behaviour; **BV**: blow visible (whale); **SV**: only splashes visible (dolphins); **DV**: dorsal fin visible; **OB**: other behaviour

Record No.	Date	Time (UTC)	Species	Group Size	Vessel Position	Source Activity Initial Detection	Movement/ Behaviour		CPA Source / Source Activity	Mitigation Action	Comments
1	1-Jun	06:27	Bottlenose dolphin	1	42.24097°N 008.76503°W	Not firing	PV/OD	ST	600 m / Not firing	None	Vessel in transit
2	1-Jun	10:02	Striped dolphin	2	42.13735°N 009.38952°W	Not firing	TV	FT, PO	450 m / Not firing	None	Vessel in transit
3	1-Jun	10:22	Striped dolphin	31	42.13640°N 009.46347°W	Not firing	PE/AH	PO, SA	500 m / Not firing	None	Vessel in transit
4	1-Jun	10:22	Common dolphin	1	42.13640°N 009.46347°W	Not firing	PE/AH	FT, PO	500 m / Not firing	None	Vessel in transit. Observed with striped dolphins in Det. 3.
5	1-Jun	10:43	Risso's dolphin	5	42.13500°N 009.56197°W	Not firing	PV/OD	ST	450 m / Not firing	None	Vessel in transit
6	1-Jun	11:50	Unidentifiable dolphin	2	42.13223°N 009.80568°W	Not firing	PV/SD	ST, DV	1150 m / Not firing	None	Vessel in transit
7	1-Jun	14:47	Fin whale	1	42.12608°N 010.42750°W	Not firing	PV/SD	ST, BV	700 m / Not firing	None	Vessel in transit
8	1-Jun	17:20	Fin whale	3	42.11660°N 010.87238°W	Not firing	V	MI, FT	1900 m / Not firing	None	Deploying gear

Record No.	Date	Time (UTC)	Species	Group Size	Vessel Position	Source Activity Initial Detection	Movement/ Behaviour		CPA Source / Source Activity	Mitigation Action	Comments
9	2-Jun	07:15	Fin whale	1	42.20745°N 011.60610°W	Not firing	PE/AH	BV, FF	500 m / Not firing	None	Recovering gear
10	3-Jun	14:24	Unidentifiable baleen whale	4	42.23672°N 013.27102°W	Not firing	PV/SD	BV NS	2000 m / Not firing	None	Deploying gear
11	3-Jun	17:18	Unidentifiable baleen whale	1	42.36537°N 013.05495°W	Not firing	UN	BV	2000 m / Not firing	None	Deploying gear
12	4-Jun	06:04	Fin whale	1	42.29885°N 013.40078°W	Not firing	PV/OD	DV BV ST	2700 m / Not firing	None	Deploying gear
13	4-Jun	06:49	Unidentifiable baleen whale	1	42.27058°N 013.46560°W	Not firing	UN	BV	300 m / Not firing	None	Deploying gear
14	4-Jun	07:01	Sei whale	1	42.26068°N 013.48748°W	Not firing	PV/OD	DV BV NS	1200 m / Not firing	None	Deploying gear
15	5-Jun	08:38	Unidentifiable whale	1	41.99608°N 013.80397°W	Not firing	UN	BV	4500 / Not firing	None	Deploying gear
16	5-Jun	10:00	Unidentifiable baleen whale	1	41.98973°N 013.69285°W	Not firing	UN	BV	2600 m / Not firing	None	Deploying gear
17	5-Jun	10:45	Unidentifiable whale	1	41.98367°N 013.62662°W	Not firing	AV	BV FT	1000 m / Not firing	None	Deploying gear
18	5-Jun	17:09	Fin whale	1	41.93135°N 013.90007°W	Not firing	PV/OD	DV BV NS	1500 m / Not firing	None	Deploying gear
19	6-Jun	05:43	Unidentifiable baleen whale	1	42.06543°N 013.66812°W	Full power	UN	BV	4000 m / Full power	None	Animal exposed to received sound levels of 160 dB.
20	6-Jun	06:56	Unidentifiable whale	1	42.06833°N 013.54250°W	Full power	UN	BV	5000 m / Full power	None	

Record No.	Date	Time (UTC)	Species	Group Size	Vessel Position	Source Activity Initial Detection	Movement/ Behaviour		CPA Source / Source Activity	Mitigation Action	Comments
21	6-Jun	07:42	Unidentifiable baleen whale	2	42.07017°N 013.46513°W	Full power	PE/AH	BV ST	1500 m / Full power	None	Animals exposed to received sound levels of 160 dB.
22	6-Jun	08:00	Unidentifiable baleen whale	1	42.07078°N 013.43568°W	Full power	PV/OD	BV NS	300 m / Full power	Power down	Observed leaving 180 dB safety radius, returned to full power at 9:03 UTC.
23	6-Jun	09:08	Unidentifiable baleen whale	2	42.07290°N 013.33810°W	Full power	MI	BV NS	2614 m / Full power	None	Animals exposed to received sound levels of 160 dB.
24	6-Jun	10:08	Unidentifiable baleen whale	1	42.07460°N 013.23412°W	Full power	PV/OD	BV	3200 m / Full power	None	Animal exposed to received sound levels of 160 dB.
25	6-Jun	13:24	Unidentifiable baleen whale	1	42.08005°N 012.08007°W	Full power	TV	BV	2800 m / Full power	None	Animal exposed to received sound levels of 160 dB.
26	6-Jun	13:39	Unidentifiable whale	2	42.08115°N 012.88277°W	Full power	UN	BV	5859 m / Full power	None	
27	6-Jun	15:27	Unidentifiable whale	1	42.08353°N 012.71310°W	Full power	UN	BV	4270 m / Full power	None	Animal exposed to received sound levels of 160 dB.
28	7-Jun	16:08	Unidentifiable whale	1	42.08272°N 012.74457°W	Full power	UN	BV	1270 m / Full power	None	Animal exposed to received sound levels of 160 dB.
29	8-Jun	12:05	Unidentifiable baleen whale	1	42.07565°N 013.04352°W	Full power	PV/OD	BV ST	2850 m / Full power	None	Animal exposed to received sound levels of 160 dB.
30	8-Jun	15:42	Fin whale	1	42.07407°N 012.89267°W	Full power	TV	BV DV NS	1045 m / Full power	None	Animal exposed to received sound levels of 160 dB.
31	8-Jun	18:58	Fin whale	1	42.08032°N 012.41185°W	Full power	TV	BV NS	2000 m / Full power	None	Animal exposed to received sound levels of 160 dB.
32	8-Jun	19:52	Fin whale	1	42.08147°N 012.32675°W	Full power	PV/OD	BV DV DI	2100 m / Full power	None	Animal exposed to received sound levels of 160 dB.

Record No.	Date	Time (UTC)	Species	Group Size	Vessel Position	Source Activity Initial Detection	Movement/ Behaviour		CPA Source / Source Activity	Mitigation Action	Comments
33	9-Jun	06:24	Unidentified baleen whale	1	42.02770°N 012.69153°W	Not firing	AV	BV	1100 m / Not firing	None	
34	9-Jun	08:26	Unidentified baleen whale	1	42.02453°N 012.83833°W	Not firing	PV/OD	BV NS	1000 m / Not firing	None	
35	9-Jun	09:51	Fin whale	1	42.02565°N 012.94215°W	Not firing	PV/OD	BV NS	1535 m / Not firing	None	
36	9-Jun	10:34	Fin whale	2	42.02922°N 012.99543°W	Not firing	V	DI SB	1600 m / Not firing	None	
37	9-Jun	11:40	Fin whale	3	42.03680°N 013.07878°W	Not firing	V	DI SB	2300 m / Not firing	None	
38	9-Jun	12:56	Fin whale	1	42.04540°N 013.18568°W	Not firing	PV/OD	DV BV NS	1200 m / Not firing	None	
39	9-Jun	18:12	Fin whale	4	42.06360°N 013.22208°W	Full volume	V	FF	800 m / Full volume	Power down	Concentration of feeding whales observed within 160 dB safety radius.
40	9-Jun	19:06	Fin whale	8	42.06385°N 013.20540°W	Full volume	V	FF	2479 m / Mitigation firing	Power down	Concentration of feeding whales observed within 160 dB safety radius.
41	9-Jun	19:35	Unidentified baleen whale	2	42.06692°N 013.04942°W	Mitigation firing	AV	BV	4096 m / Mitigation firing	Power down	Mitigation power down extended
42	9-Jun	20:00	Fin whale	8	42.07083°N 013.07083°W	Mitigation firing	PV/OD	FT DV BV	2000 m / Full volume	None	No mitigation; whales observed traveling.
43	11-Jun	06:32	Fin whale	2	42.02518°N 012.21562°W	Full volume	PE/AH	BV ST	2100 m / Full volume	None	Animals exposed to received sound levels of 160 dB.

Record No.	Date	Time (UTC)	Species	Group Size	Vessel Position	Source Activity Initial Detection	Movement/ Behaviour		CPA Source / Source Activity	Mitigation Action	Comments
44	11-Jun	13:33	Unidentified baleen whale	2	42.01643°N 012.87613°W	Full volume	PV/SD	BV	2800 m / Full volume	None	Animals exposed to received sound levels of 160 dB.
45	11-Jun	16:05	Fin whale	1	42.06380°N 013.03155°W	Full volume	PV/OD	BV DV	1800 m / Full volume	None	Animal exposed to received sound levels of 160 dB.
46	13-Jun	06:10	Fin whale	4	42.01320°N 012.59332°W	Full volume	PV/OD	BV FF	2500 m / Full volume	None	Animals observed traveling while within the 160 dB safety radius, no mitigation.
47	13-Jun	07:39	Unidentified baleen whale	1	42.01163°N 012.73040°W	Full volume	AV	BV NS	4200 m / Full volume	None	Animal exposed to received sound levels of 160 dB.
49	13-Jun	10:08	Unidentified baleen whale	1	42.00743°N 012.96058°W	Full volume	AV	BV NS	4000 m / Full volume	None	Animal exposed to received sound levels of 160 dB.
49	13-Jun	10:31	Fin whale	1	42.00670°N 013.00648°W	Full volume	V	BV DI	3000 m / Full volume	None	Animal exposed to received sound levels of 160 dB.
50	13-Jun	13:13	Fin whale	1	42.05585°N 012.86708°W	Full volume	AV	FT BV	1525 m / Full volume	None	Animal exposed to received sound levels of 160 dB.
51	13-Jun	13:48	Fin whale	1	42.05687°N 012.81338°W	Full volume	PV/SD	BV NS	2614 m / Full volume	None	Animal exposed to received sound levels of 160 dB.
52	13-Jun	13:50	Fin whale	1	42.05692°N 012.81000°W	Full volume	PE/AH	BV NS	2814 m / Full volume	None	Animal exposed to received sound levels of 160 dB.
53	13-Jun	13:54	Fin whale	3	42.05702°N 012.80463°W	Full volume	AV	BV ST	4096 m / Full volume	None	Animals observed traveling while within the 160 dB safety radius, no mitigation.
54	13-Jun	16:51	Unidentified baleen whale	1	42.06083°N 012.52978°W	Full volume	PE/AH	BV MI DI	3200 m / Full volume	None	Animal exposed to received sound levels of 160 dB.

Record No.	Date	Time (UTC)	Species	Group Size	Vessel Position	Source Activity Initial Detection	Movement/ Behaviour		CPA Source / Source Activity	Mitigation Action	Comments
55	14-Jun	05:57	Unidentified baleen whale	1	42.00627°N 012.80578°W	Full volume	PV/SD	BV ST	4100 m / Full volume	None	Animal exposed to received sound levels of 160 dB.
56	14-Jun	10:06	Fin whale	2	42.06968°N 012.94268°W	Full volume	V	FF BV	2600 m / Full volume	None	Animals exposed to received sound levels of 160 dB.
57	14-Jun	11:16	Unidentified baleen whale	1	42.07132°N 012.83012°W	Full volume	PV/OD	BV ST	3200 m / Full volume	None	Animal exposed to received sound levels of 160 dB.
58	14-Jun	19:11	Fin whale	5	42.02967°N 012.49692°W	Full volume	V	FF DV	3011 m / Mitigation firing	Power down	Concentration of feeding whales observed within 160 dB safety radius.
59	15- Jun	05:49	Fin whale	3	42.08802°N 012.64757°W	Full volume	V	FF BV	5800 m / Full volume	None	
60	15- Jun	06:18	Fin whale	2	42.08887°N 012.60108°W	Full volume	PV/OD	BV NS	2100 m / Full volume	None	Animals exposed to received sound levels of 160 dB.
61	15- Jun	06:20	Fin whale	7	42.08887°N 012.60108°W	Full volume	V	FF DV	4100 m / Full volume	None	Three of these animals were exposed to received sound levels of 160 dB.
62	15- Jun	07:39	Fin whale	3	42.09113°N 012.47063°W	Full volume	V	DV ST	500 m / Mitigation firing	Power down	Animals exposed to received sound levels of 160 dB.
63	15- Jun	07:53	Unidentified baleen whale	1	42.09143°N 012.44953°W	Full volume	UN	BV	4300 m / Full volume	None	Animal exposed to received sound levels of 160 dB.
64	15- Jun	10:05	Fin whale	4	42.09365°N 012.23802°W	Full volume	PE/AH	DV NS	3231 m / Full volume	None	Animals exposed to received sound levels of 160 dB.
65	15- Jun	11:11	Sperm whale	1	42.09478°N 012.13608°W	Full volume	ST AV	BA FT	1750 m / Full volume	None	Correlates with acoustic detection 1. Animal exposed to received sound levels of 160 dB.

Record No.	Date	Time (UTC)	Species	Group Size	Vessel Position	Source Activity Initial Detection	Movement/ Behaviour		CPA Source / Source Activity	Mitigation Action	Comments
66	15- Jun	13:54	Fin whale	1	42.04387°N 012.22168°W	Full volume	PV/SD	NS	2596 m / Full volume	None	Animal exposed to received sound levels of 160 dB.
67	15- Jun	14:33	Unidentified baleen whale	1	42.14330°N 012.27907°W	Full volume	UN	BV	10000 m / Full volume	None	
68	15- Jun	16:27	Fin whale	4	42.04035°N 012.45308°W	Full volume	PE/AH	BV NS	2600 m / Full volume	None	Animals exposed to received sound levels of 160 dB.
69	15- Jun	16:44	Fin whale	6	42.04030°N 012.46027°W	Full volume	PV/OD	BV DI	5000 m / Full volume	None	
70	15- Jun	17:17	Fin whale	3	42.03923°N 012.53398°W	Full volume	PE/AH	BV DI NS	6000 m / Full volume	None	
71	15- Jun	18:35	Unidentified baleen whale	1	42.03753°N 012.64707°W	Full volume	UN	BV	5000 m / Full volume	None	
72	15- Jun	19:44	Unidentified baleen whale	2	42.03560°N 012.76245°W	Full volume	UN	BV	4100 m / Full volume	None	Animal exposed to received sound levels of 160 dB.
73	16-Jun	06:07	Unid. baleen whale	2	42.09588°N 012.38438°W	Full volume	AV	BV ST	2700 m / Full volume	None	Animals exposed to received sound levels of 160 dB.
74	16-Jun	19:06	Unid. baleen whale	1	42.03788°N 012.89167°W	Full volume	TV	BV NS	5440 m / Full volume	None	
75	18-Jun	10:09	Unid. whale	1	42.70422°N 012.88290°W	Not firing	AV	BV	4100 m / Not firing	None	
76	18-Jun	10:42	Unid. baleen whale	2	42.67543°N 012.87473°W	Not firing	PV/OD	BV NS	1089 m / Not firing	None	

Record No.	Date	Time (UTC)	Species	Group Size	Vessel Position	Source Activity Initial Detection	Movement/ Behaviour		CPA Source / Source Activity	Mitigation Action	Comments
77	18-Jun	11:20	Fin whale	1	42.62818°N 012.86282°W	Not firing	PV/OD	BV DV	1600 m / Not firing	None	
78	18-Jun	12:40	Fin whale	2	42.54835°N 012.84422°W	Not firing	PE/AH	BV DV FT	850 m / Not firing	None	
79	18-Jun	14:26	Unid. baleen whale	1	42.43850°N 012.82712°W	Not firing	UN	BV	4096 m / Not firing	None	
80	18-Jun	15:41	Unid. whale	1	42.35525°N 012.84397°W	Not firing	PE/BH	BV	1200 m / Not firing	None	
81	19-Jun	06:52	Unid. baleen whale	1	42.05463°N 012.05402°W	Full volume	PE/BH	BV	2400 m / Full volume	None	Animal exposed to received sound levels of 160 dB.
82	19-Jun	10:10	Unid. baleen whale	2	42.04955°N 012.34440°W	Full volume	PV/OD	BV FT	2479 m / Full volume	None	Animals exposed to received sound levels of 160 dB.
83	19-Jun	11:18	Unid. baleen whale	2	42.04807°N 012.45743°W	Full volume	PV/SD	BV ST	5700 m / Full volume	None	
84	19-Jun	15:17	Unid. baleen whale	1	42.04403°N 012.82967°W	Full volume	AV	BV FT	4096 m / Full volume	None	Animal exposed to received sound levels of 160 dB.
85	19-Jun	19:59	Fin whale	1	42.09480°N 012.86387°W	Full volume	AV TV PV/SD	DV BV	1152 m / Full volume	None	Animal exposed to received sound levels of 160 dB.
86	20-Jun	05:17	Fin whale	2	42.05550°N 012.09738°W	Full volume	TV	DV ST	522 m / Mitigation firing	Power down	Powered down before whales entered 180 dB safety radius. Observed leaving 180 dB safety radius, resumed full volume.
87	20-Jun	06:03	Fin whale	2	42.05492°N 012.16690°W	Full volume	PE/AH	DV NS	550 m / Mitigation firing	Power down	Powered down before whales entered 180 dB safety radius. Observed leaving 180 dB safety radius, resumed full volume.

Record No.	Date	Time (UTC)	Species	Group Size	Vessel Position	Source Activity Initial Detection	Movement/ Behaviour		CPA Source / Source Activity	Mitigation Action	Comments
88	20-Jun	16:56	Fin whale	1	42.09732°N 012.93182°W	Full volume	PV/OD	DV FT	1600 m / Full volume	None	Animal exposed to received sound levels of 160 dB.
89	21-Jun	05:58	Unid. baleen whale	2	42.05560°N 012.39158°W	Full volume	AV	BV NS	4096 m / Full volume	None	Animals exposed to received sound levels of 160 dB.
90	21-Jun	06:30	Unid. baleen whale	1	42.05495°N 012.45477°W	Full volume	PV/OD	BV FT	3000 m / Full volume	None	Animal exposed to received sound levels of 160 dB.
91	21-Jun	06:58	Unid. baleen whale	1	42.05453°N 012.48742°W	Full volume	AV	BV NS	2000 m / Full volume	None	Animal exposed to received sound levels of 160 dB.
92	21-Jun	07:16	Unid. whale	2	42.05387°N 012.52967°W	Full volume	UN	BV	4300 m / Full volume	None	Animals exposed to received sound levels of 160 dB.
93	21-Jun	07:30	Unid. baleen whale	2	42.05348°N 012.54310°W	Full volume	AV	BV NS	1535 m / Full volume	None	Animals exposed to received sound levels of 160 dB.
94	21-Jun	08:34	Unid. baleen whale	2	42.05390°N 012.63880°W	Full volume	PV/OD	BV NS	2800 m / Full volume	None	Animals exposed to received sound levels of 160 dB.
95	21-Jun	10:09	Fin whale	2	42.05212°N 012.79103°W	Full volume	PE/AH	DV NS	1800 m / Full volume	None	Animals exposed to received sound levels of 160 dB.
96	21-Jun	15:35	Unid. whale	1	42.10225°N 012.83490°W	Full volume	UN	BV	4300 m / Full volume	None	Animal exposed to received sound levels of 160 dB.
97	21-Jun	16:33	Fin whale	2	42.10377°N 012.74627°W	Full volume	PE/AH	DV FT	1800 m / Full volume	None	Animals exposed to received sound levels of 160 dB.
98	21-Jun	19:51	Fin whale	1	42.10820°N 012.43063°W	Full volume	PE/AH	DV FT	1800 m / Full volume	None	Animal exposed to received sound levels of 160 dB.

Record No.	Date	Time (UTC)	Species	Group Size	Vessel Position	Source Activity Initial Detection	Movement/ Behaviour		CPA Source / Source Activity	Mitigation Action	Comments
99	21-Jun	20:02	Unid. whale	1	42.10832°N 012.41790°W	Full volume	UN	BV	6120 m / Full volume	None	
100	22-Jun	08:00	Unid. whale	1	42.05295°N 012.80658°W	Full volume	PV/OD	BV NS	1535 m / Full volume	None	Animal exposed to received sound levels of 160 dB.
101	22-Jun	12:01	Fin whale	1	42.07877°N 013.01857°W	Full volume	PV/OD	DV NS	1600 m / Full volume	None	Animal exposed to received sound levels of 160 dB.
102	22-Jun	16:58	Unid. baleen whale	2	42.08832°N 012.55307°W	Full volume	AV	BV ST	2500 m / Full volume	None	Animals exposed to received sound levels of 160 dB.
103	23-Jun	06:04	Fin whale	2	41.82715°N 013.04750°W	Not firing	PV/OD	DV FT	450 m / Not firing	None	Retrieving streamers
104	23-Jun	06:49	Unid. baleen whale	1	41.78272°N 013.04562°W	Not firing	AV	BV ST	2800 m / Not firing	None	Retrieving streamers
105	23-Jun	16:04	Fin whale	1	41.46325°N 013.08053°W	Not firing	V	DV DI	500 m / Not firing	None	Vessel in transit
106	23-Jun	17:46	Unid. baleen whale	1	41.52223°N 012.91285°W	Not firing	PV/OD	BV FT	2000 m / Not firing	None	Vessel in transit
107	23-Jun	19:26	Fin whale	1	41.55208°N 012.72605°W	Not firing	UN	DV BV	850 m / Not firing	None	Vessel in transit
108	23-Jun	19:45	Unid. whale	1	41.55785°N 012.68913°W	Not firing	UN	BV	3270 m / Not firing	None	Vessel in transit
109	24-Jun	10:48	Common dolphin	2	41.79507°N 011.18783°W	Not firing	PV/SD	FT	270 m / Not firing	None	Vessel in transit
110	24-Jun	15:55	Common dolphin	2	41.92085°N 010.60113°W	Not firing	TV	PO FT	270 m / Not firing	None	Vessel in transit

Record No.	Date	Time (UTC)	Species	Group Size	Vessel Position	Source Activity Initial Detection	Movement/ Behaviour		CPA Source / Source Activity	Mitigation Action	Comments
111	25-Jun	06:27	Common dolphin	5	42.15648°N 008.92805°W	Not firing	PE/BH	PO FT	150 m / Not firing	None	Vessel in transit
112	15-Jul	05:45	Harbor porpoise	2	42.23313°N 008.79120°W	Not firing	PV/SD	SS	700 m / Not firing	None	Vessel in transit
113	15-Jul	07:04	Striped dolphin	7	42.15647°N 009.05682°W	Not firing	V	PO ST	500 m / Not firing	None	Vessel in transit
114	15-Jul	07:15	Unidentified dolphin	2	42.15390°N 009.09988°W	Not firing	AV	FT	650 m / Not firing	None	Vessel in transit
115	15-Jul	08:02	Unidentified dolphin	2	42.15252°N 009.27658°W	Not firing	PV/SD	FT	500 m / Not firing	None	Vessel in transit
116	15-Jul	08:20	Unidentified dolphin	2	42.15267°N 009.36375°W	Not firing	PV/SD	FT	270 m / Not firing	None	Vessel in transit
117	15-Jul	10:02	Unid. baleen whale	1	42.17455°N 009.78680°W	Not firing	AV	BV	800 m / Not firing	None	Vessel in transit
118	15-Jul	10:38	Unid. baleen whale	1	42.16912°N 009.99702°W	Not firing	PV/OD	BV DV	900 m / Not firing	None	Vessel in transit
119	15-Jul	10:59	Fin whale	3	42.16617°N 010.03225°W	Not firing	PV/OD	DV FT	200 m / Not firing	None	Vessel in transit
120	15-Jul	11:12	Fin whale	1	42.16428°N 010.05772°W	Not firing	TV	DV NS	1000 m / Not firing	None	Vessel in transit
121	15-Jul	12:44	Fin whale	2	42.15530°N 010.44782°W	Not firing	PE/AH	DV NS	1000 m / Not firing	None	Vessel in transit
122	15-Jul	13:23	Fin whale	2	42.15565°N 010.61607°W	Not firing	PV/SD	SA	1100 m / Not firing	None	Vessel in transit

Record No.	Date	Time (UTC)	Species	Group Size	Vessel Position	Source Activity Initial Detection	Movement/ Behaviour		CPA Source / Source Activity	Mitigation Action	Comments
123	15-Jul	13:46	Fin whale	2	42.15598°N 010.71167°W	Not firing	TV	DV FT	600 m / Not firing	None	Vessel in transit
124	15-Jul	15:14	Unidentified dolphin	1	42.15692°N 011.07225°W	Not firing	PV/SD	UN	270 m / Not firing	None	Vessel in transit
125	16-Jul	15:28	Common dolphin	3	42.14582°N 013.29982°W	Not firing	TV	PO SA	300 m / Not firing	None	Deploying gear
126	17-Jul	09:45	Unidentified baleen whale	1	42.11423°N 012.22865°W	Full volume	PV/OD	DV FT	1074 m / Full volume	None	Animal exposed to received sound levels greater than 160 dB.
127	21-Jul	10:25	Fin whale	1	42.12958°N 012.45357°W	Full volume	PV/OD	DV NS	1900 m / Full volume	None	Animal exposed to received sound levels of 160 dB.
128	21-Jul	11:24	Fin whale	5	42.13132°N 012.33912°W	Full volume	AV	DV ST	2300 m / Full volume	None	Animals exposed to received sound levels of 160 dB.
129	21-Jul	12:14	Fin whale	4	42.13157°N 012.26015°W	Full volume	AV	FF SA DV	5800 m / Full volume	None	
130	21-Jul	15:51	Unidentified dolphin	14	42.17672°N 012.14628°W	Full volume	PV/SD	PO	2800 m / Full volume	None	Animals exposed to received sound levels of 160 dB.
131	22-Jul	09:20	Sei whale	1	42.13722°N 012.12790°W	Full volume	PE/AH	DV ST	500 m / Mitigation firing	Power down	Animals exposed to received sound levels of 180 dB. Observed leaving 180 dB safety radius, resumed full volume.
132	22-Jul	11:32	Fin whale	4	42.15675°N 012.08963°W	Full volume	PV/SD	DV ST	4350 m / Full volume	None	Animals exposed to received sound levels of 160 dB.
133	22-Jul	15:18	Fin whale	3	42.15143°N 012.49728°W	Full volume	PE/AH	DV NS SA	4100 m / Full volume	None	Animals exposed to received sound levels of 160 dB.

Record No.	Date	Time (UTC)	Species	Group Size	Vessel Position	Source Activity Initial Detection	Movement/ Behaviour		CPA Source / Source Activity	Mitigation Action	Comments
134	22-Jul	16:57	Unidentified whale	4	42.14922°N 012.65070°W	Full volume	UN	BV	5500 m / Full volume	None	
135	22-Jul	17:07	Unidentified dolphin	15	42.14898°N 012.67893°W	Full volume	AV	FF FT	700 m / Full volume	None	Animals exposed to received sound levels of 160 dB.
136	22-Jul	18:22	Fin whale	1	42.14717°N 012.79905°W	Full volume	PV/SD	DV SA	4096 m / Full Volume	None	Animal exposed to received sound levels of 160 dB.
137	23-Jul	12:41	Unidentified pilot whale	6	42.17288°N 012.59268°W	Full volume	TV	ST SA	400 m / Mitigation firing	Power down	Powered down before animals entered 180 dB safety radius. Not observed leaving 180 dB safety radius, waited 15 min. before resuming full volume.
138	24-Jul	12:25	Unid. baleen whale	1	42.12255°N 013.04078°W	Full volume	PV/OD	BV	3000 m / Full volume	None	Animal exposed to received sound levels of 160 dB.
139	24-Jul	18:42	Fin whale	1	42.12283°N 012.38835°W	Full volume	PV/OD	DV FT	1535 m / Full volume	None	Animal exposed to received sound levels of 160 dB.
140	26-Jul	06:15	Unid. baleen whale	1	42.13198°N 013.05512°W	Full volume	AV	BV FT	950 m / Full volume	None	Animal exposed to received sound levels of 160 dB.
141	26-Jul	08:44	Unidentified dolphin	10	42.13743°N 012.81400°W	Full volume	PV/OD	PO FT	2614 m / Full volume	None	Animals exposed to received sound levels of 160 dB.
142	26-Jul	10:55	Unidentified dolphin	12	42.14070°N 012.57062°W	Full volume	PE/AH	NS DV	750 m / Full volume	None	Animals exposed to received sound levels of 160 dB.
143	26-Jul	11:09	Sperm whale	1	42.14070°N 012.57062°W	Full volume	PV/OD	DV ST	3900 m / Full volume	None	Animal exposed to received sound levels of 160 dB.
144	26-Jul	15:30	Striped dolphin	50	42.14532°N 012.11572°W	Full volume	PV/OD	PO FT	800 m / Full volume	None	Animals exposed to received sound levels of 160 dB.

Record No.	Date	Time (UTC)	Species	Group Size	Vessel Position	Source Activity Initial Detection	Movement/ Behaviour		CPA Source / Source Activity	Mitigation Action	Comments
145	26-Jul	16:36	Unidentified dolphin	6	42.07473°N 012.05890°W	Full volume	UN	PO FT	2600 m / Full volume	None	Animals exposed to received sound levels of 160 dB. Possibly a duplicate of Det. 144.
146	27-Jul	12:44	Unid. baleen whale	1	42.14915°N 012.13533°W	Full volume	PV/OD	DV NS	700 m / Full volume	None	Animal exposed to received sound levels of 160 dB.
147	28-Jul	19:13	Unid. baleen whale	1	42.16162°N 012.69657°W	Full volume	PE/AH	BV	2000 m / Full volume	None	Animal exposed to received sound levels of 160 dB.
148	29-Jul	06:39	Unid. baleen whale	1	42.13198°N 012.32840°W	Full volume	PV/OD	DV NS	1500 m / Full volume	None	Animal exposed to received sound levels of 160 dB.
149	30-Jul	07:06	Fin whale	2	42.18618°N 012.09035°W	Full volume	V	DV MI	1100 m / Full volume	None	Animals exposed to received sound levels of 160 dB.
150	30-Jul	16:00	Unidentified dolphin	12	42.17413°N 012.97545°W	Full volume	PE/AH	PO FT	2700 m / Full volume	None	Animals exposed to received sound levels of 160 dB.
151	31-Jul	11:39	Bottlenose dolphin	7	42.19030°N 012.39065°W	Full volume	PE/AH	SA NS	2200 m / Full volume	None	Animals exposed to received sound levels of 160 dB.
152	31-Jul	14:03	Fin whale	3	42.18735°N 012.62007°W	Full volume	PE/AH	FF DV	600 m / Mitigation firing	Power down	Concentration of feeding whales observed within 160 dB safety radius.
153	31-Jul	18:24	Unidentified whale	1	42.15202°N 013.03445°W	Not firing	UN	BV	1035 m / Not firing	None	Retrieving gear.
154	1-Aug	14:28	Fin whale	3	42.40803°N 011.05077°W	Not firing	PV/SD	DV DI	400 m / Not firing	None	Vessel in transit.
155	1-Aug	18:06	Unidentified baleen whale	4	42.33188°N 010.48463°W	Not firing	UN	BV	3000 m / Not firing	None	Vessel in transit.

Summary of acoustic detections of protected species during the Galicia Basin 3D seismic survey.

Record No.	Date	Time (UTC)	Species	Group Size	Vessel Position	Source Activity Initial Detection	Acoustic Detection Details	CPA Source / Source Activity	Mitigation Action	Comments
1	15-Jun	11:44	Sperm whale	1	42.09355°N 012.07982°W	Full power	Low frequency clicks were detected for 1 minute aurally and via the LF click detector.	1000 m / Full volume	None	Correlates with visual detection 65.
2	21-Jul	13:51	Unidentified dolphin	2	42.13266°N 012.09848°W	Full volume	High frequency click trains swept from a bearing of 92-130 degrees.	Unknown	None	Detection during daytime. No simultaneous visual correlation.
3	23-Jul	22:49	Unidentified dolphin	5	42.13911°N 012.46638°W	Full volume	A bold HF click train at a 90 degree bearing was first noted at 22:49 UTC. Immediately after numerous whistles were detected aurally, by Spectrogram and the Whistle and Moan Detector. For 3 minutes sinusoidal and upsweeping whistles were continuously detected, ranging between 10-23kHz. The final time of detection was 22:56.	Unknown	None	Detection during night time, no visual correlation.
4	28-Jul	14:50	Sperm whale	1	42.16712°N 012.26477°W	Full volume	Broad band low frequency clicks detected aurally by operator as well as on spectrogram.	Unknown / Full volume	None	No visual correlation.

APPENDIX H: **Species of birds and other wildlife observed during the Galicia Basin 3D seismic survey.**

Common Name	Family	Genus	Species	Approximate Number of Individuals Observed	Approximate Number of Days Species Was Observed
Arctic Tern	Sternidae	*Sterna*	*paradisaea*	1	1
Barn Swallow	Passeriformes	*Hiruno*	*rustica*	2	1
Black-headed gull	Laridae	*Chroicocephalus*	*ridibundus*	1	1
Bonaparte's Gull	Laridae	*Chroicocephalus*	*philadelphia*	1	1
Cattle Egret	Ardeidae	*Bulbulcus*	*ibis*	1	1
Cory's Shearwater	Procellariidae	*Puffinus*	*gravis*	163	28
Eleonora's Falcon	Falconidae	*Falco*	*eleonorae*	1	1
Gray-headed Gull	Laridae	*Chroicocephalus*	*cirrocephalus*	3	2
Great Skua	Stercorariidae	*Stercorarius*	*skua*	2	2
Iceland Gull	Laridae	*Larus*	*glaucoides*	1	1
Lesser Black-backed Gull	Laridae	*Larus*	*fuscus*	9	4
Northern Fulmar	Procellariidae	*Fulmarus*	*glacialis*	1	1
Northern Gannet	Pelecaniformes	*Morus*	*bassanus*	52	15
Red phalarope	Scolopacidae	*Phalaropus*	*fulicarius*	1	1
Wilson's Storm Petrel	Hydrobatidae	*Oceanites*	*oceanicus*	100	1
Yellow-legged gull	Laridae	*Larus*	*michahellis*	460	8
UID Cormorant	Pelecaniformes	-	-	5	1
UID Jaeger	Stercorariidae	*Stercorarius*	*Sp.*	5	2
UID Shorebirds	-	-	-	19	2
UID Swallow	Passeriformes	-	-	1	1
Unidentified seabird	-	-	-	3	1

Common Name	Family	Genus	Species	Approximate Number of Individuals Observed	Approximate Number of Days Species Was Observed
Blue shark	Carcharhinidae	*Prionace*	*glauca*	1	1
Bluefin Tuna	Scombridae	*Thunnus*	*thynnus*	3	1
Flying Fish	Exoceoetidae			3	3
Portuguese Man-O-War	Physaliidae	*Physalia*	*physalis*	3	3
Bee	-	-	-	1	1
Butterfly	-	-	-	2	2
Barnacles	-	-	-	150	2
UID Flies	-	-	-	40	2
UID Butterfly	-	-	-	6	4
UID Moth	-	-	-	4	3