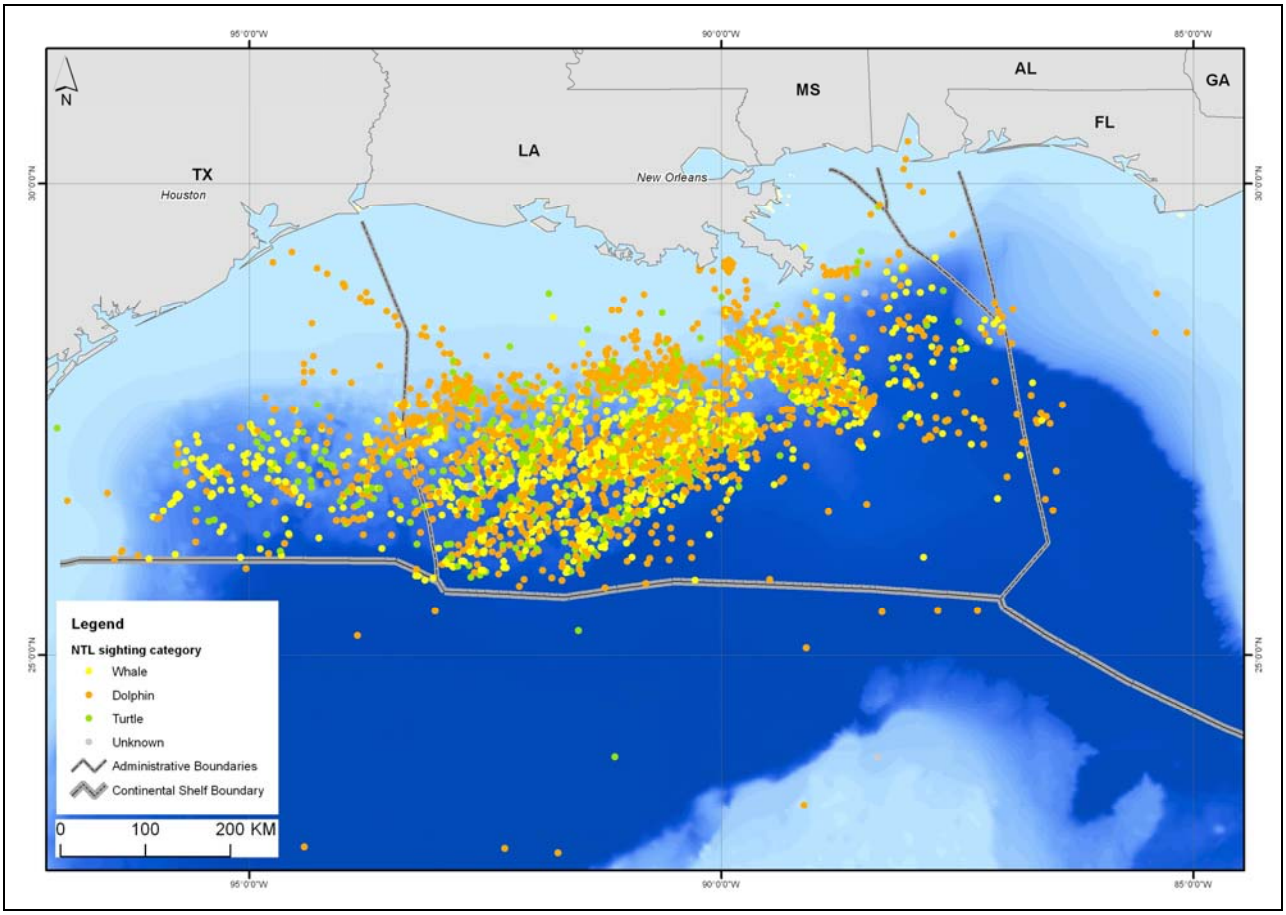
OCS Study
BOEM 2012-015

Seismic Survey Mitigation Measures and Marine Mammal Observer Reports



U.S. Department of the Interior
Bureau of Ocean Energy Management
Gulf of Mexico OCS Region

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Seismic Survey Mitigation Measures and Marine Mammal Observer Reports

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1.0. EXECUTIVE SUMMARY

- Mitigation observation data were collected during seismic survey operations in the Gulf of Mexico (GOM), United States of America (USA) between December 2002 and December 2008 under Notice to Lessees (NTL) 2007-G02 and earlier versions. The required submissions included observer effort, record of operations and sighting report data forms within each biweekly report.
- A total of 1,440 bi-weekly reports were received by the Bureau of Ocean Energy Management (BOEM), formerly the Minerals Management Service (MMS), for seismic surveys; a total of 194,273 visual survey hours were recorded.
- Visual observations yielded 3,963 complete sighting records; approximately 28,000 individual animals were represented in the records.
- Cetaceans comprised 3,335 (85%) of these records with 20 species identified. Sea turtles comprised the remaining 579 (15%) records with five species identified. The most common cetacean encountered was the sperm whale, *Physeter macrocephalus* (N=1,136 records); the most common small cetacean identified was the pantropical spotted dolphin (*Stenella attenuata*), (N=740 records).
- There were 32,939 ramp-ups recorded within all bimonthly reports. Of these records 65% were fully complete or nearly complete so that ramp-up activity and compliance were clearly discernible. Of the ramp-ups recorded, 90% were between 20 and 40 minutes in duration, as required by the NTL.
- Of the daytime ramp-up records 86% had data complete enough to discern compliance with the pre-firing survey requirement. Only 3% of the pre-firing surveys were less than the required 30 minute duration.
- There were 32 delays in ramp-ups due to the presence of protected species in the exclusion zone during the 30 minutes immediately prior to ramp-up. Of these delays, 24 (75%) were due to dolphins, four (12.5%) due to sea turtles, and four (12.5%) due to sperm whales.
- There was a total of 18.5 hours of down time attributed to ramp-up delays.
- There were 144 occurrences of whales visually detected in the exclusion zone that resulted in a shutdown of airguns. Of the required 144 shutdown events, 139 (97%) were due to sperm whales.
- The average downtime resulting from shutdowns was 58 minutes and there was a total of 125.74 hours of down time attributed to shutdowns.
- Shut down frequency for sperm whales was 0.71 shutdowns per 1,000 hours of observation, resulting in an estimated 1 shutdown for every 1,500 hours (or roughly 125 days) of daylight survey operations, assuming observations are conducted during all daylight hours regardless of gun operations.
- The mean dolphin sighting frequency decreased 9% during airgun ramp-up procedures when compared to airgun silence. However, dolphin sighting frequency during minimum source firing sightings was equal to that during gun

silence. Dolphin sighting frequency when airguns were at full power increased 14% when compared to silent mode.

- The minimum distance of dolphins to airguns increases from silent, to ramp-up, to mitigation, and full power. At full power, the mean closest approach of dolphins to airgun arrays was 90% further away than during silent status.

2.0. INTRODUCTION

The Outer Continental Shelf (OCS) region of the United States Gulf of Mexico (GOM) is one of the world's most active hydrocarbon exploration and production areas. A major element of the continuing work in this region is the use of deep-water seismic surveys in order to identify potential hydrocarbon resources. Marine seismic surveys involve the use of a seismic sound source (typically an "airgun array") which generates sounds which propagate through the water column and the seafloor; sound reflected and refracted by geological boundaries is recorded for interpretation (Kearey et al. 2002). Seismic airgun arrays produce a predominantly low-frequency sound, though the production of high frequency sound has also been demonstrated (Goold and Fish 1998). The sound impulse is repeated at intervals of about 10 seconds (dependent on the water depth and geological target depth); a survey is generally several weeks to several months in duration.

There is growing concern that sound from anthropogenic sources such as seismic surveys has the potential to impact marine wildlife, and in particular cetaceans, which use sound to communicate, navigate, and hunt (Richardson et al. 1995; Hatch and Wright 2007). The dominant sound frequencies produced by airgun arrays (<200 Hz) overlap with those used by mysticetes, while the high frequency content of the sound impulse overlaps with frequencies used by odontocetes (Richardon et al. 1995). A growing body of research has documented a wide range of behavioral responses of cetaceans and other marine fauna to sound sources, with any potential for long term consequences unknown (Richardson et al. 1995, Gordon et al. 2003). The potential for causing temporary physical damage to auditory systems has been experimentally demonstrated, and hypotheses have been put forward regarding the behaviorally mediated stranding of animals (Finneran et al. 2005; Jepson et al. 2003). Sound perception varies widely between marine species and therefore, there is no single model or agreement for source impacts to all marine mammal and sea turtle species for all circumstances. Behavioral responses to sound have been suggested for marine mammals at sound pressures ranging from 90 dB re 1µPa to 200 dB re 1µPa (Baily et al. 2010). Southall et al. (2007) suggests using a sound level of 230 dB re 1µPa as the onset of permanent threshold shifts to cetaceans.

In light of concerns regarding the potential impacts of underwater sound from seismic surveys, a number of countries have implemented mitigation measures designed to minimize the potential for disturbance and injury to marine species (Compton et al. 2007). The Bureau of Ocean Energy Management (BOEM) conveys regulations to offshore operators via the Notice to Lessees (NTL), which mandates standard operating procedures necessary to comply with the Endangered Species Act (ESA) and the Marine Mammal Protection Act (MMPA). Mitigation is required for all geophysical survey operators working in waters greater than 200 meters throughout the GOM and in all water depths in the Eastern Planning Area (**Figure 1**). The

regulations follow NTL 2007-G02 (and previous versions): *Implementation of Seismic Survey Mitigation Measures and Protected Species Observer Program*.[1]

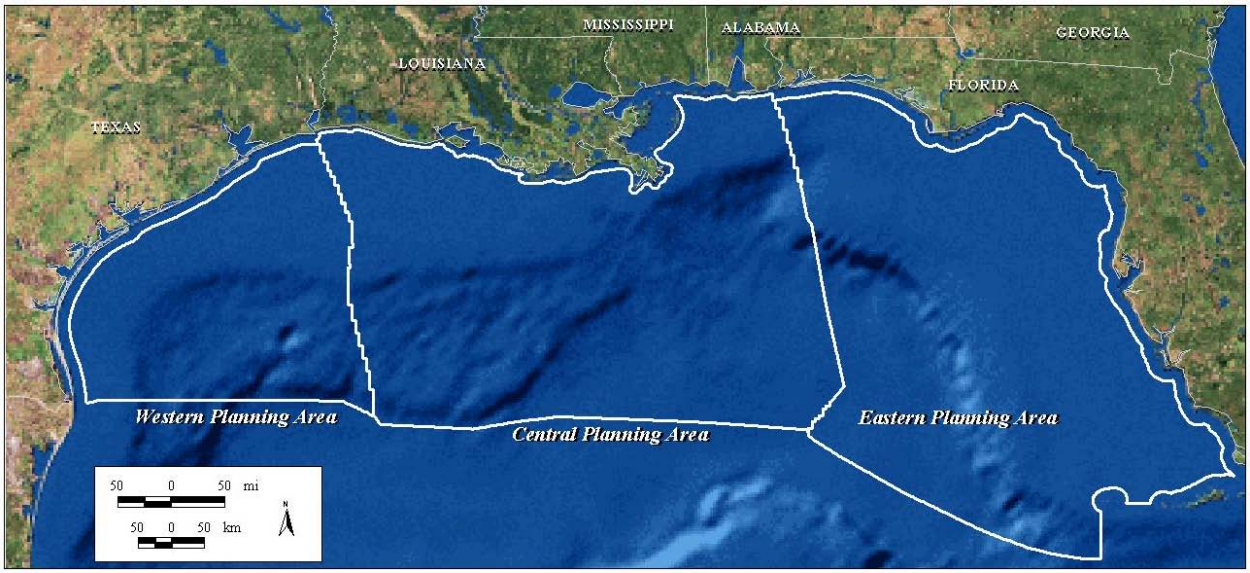

Figure 1. Gulf of Mexico regional map depicting BOEM planning areas.

The mitigation measures are designed to minimize potential noise impacts to protected marine species through visual monitoring, ramp-up procedures, maintenance of an exclusion zone around surveying vessels, operational shut-down protocols, and regulatory reporting. The mitigation measures require the following:

- Use of three trained observers on board all source vessels, with maximum observer hours established at a continuous four hours with a 2-hour break and no single observer working greater than 12 hours over a 24-hour period.
- Observers must monitor an exclusion zone of 500 meters around the center of the airgun array and the area within the immediate vicinity of the vessel.
- Operators must ramp-up the survey array from silence to full power over a time period between 20 and 40 minutes.
- Observers must maintain continuous watches during all airgun operations during daylight hours.
- Operators may reduce the source level of the airgun array, using the same shot interval as the seismic survey, to maintain a minimum source level of 160 dB during turns and unscheduled maintenance.

[1] This NTL was superceded by Joint NTL 2012-G02 on January 1, 2012. Available from http://boem.gov/Regulations/Notices-To-Lessees/Notices-to-Lessees-and-Operators.aspx.

- Cetaceans are grouped into the regulatory categories of Whales, which includes all Mysticete whales, sperm whales (*Physeter macrocephalus*), dwarf and pygmy sperm whales (*Kogia spp*.), and all species of beaked whales (*Ziphius, Mesoplodon*); and Dolphins which includes all other Odontocetes.
- The start of airguns must be delayed until the exclusion zone is free of marine mammals and sea turtles for 30 minutes.
- Airguns must be shut off if a whale enters the zone within 500 meters of the airgun source.
- Reports must be submitted to BOEM on the first and 15th of each month.

Data collected in biweekly reports were compiled in three data forms. These data forms emulate the Joint Nature Conservancy Committee (JNCC) forms for seismic surveys and were modified for Gulf of Mexico operations; these included: Observer Effort (*Location and Effort*), Survey Report (*Record of Operations*), and Sighting Report (*Record of Sighting*). Standardized data forms, however, were not required but the required information itself provided to BOEM in the forms was standardized; thus, observer providers submitted varying forms with the same data requirements.

Previous analyses have been conducted on datasets collected by marine mammal observers (MMOs) working under guidelines issued by the JNCC in the United Kingdom (Stone and Tasker, 2006; Stone, 1997; 1998; 2000; 2001; 2003a; 2003b). This report represents the compilation of visual observer data collected within the GOM OCS region over six years, between December 2002 and December 2008, by way of compliance reports submitted to BOEM. The observer data were used to examine compliance levels with NTL guidelines, and investigate the potential effects of seismic operations on marine species.

3.0. METHODOLOGY

3.1. DATA COLLECTION AND RECORDING

Observers recorded all field data during observations and submitted biweekly reports to BOEM in electronic format. Reports were submitted on the first and 15th of each month; therefore, multiple reports were submitted for the same seismic project depending on the duration of that project. Some GOM seismic projects last months to years and thus will have multiple reports from multiple observers over the course of the project.

A total of 1,440 bi-weekly reports were received by BOEM for seismic surveys conducted in the GOM between December 2002 and December 2008. Bi-weekly reports were reviewed and data from each of the three forms within the reports were entered into databases.

The *Location and Effort* (Observer Effort) form summarized the location and duration of visual surveys as well as the physical observation conditions encountered by the observer (**Appendix A**). Survey location was recorded using latitude and longitude coordinates as well as the BOEM protraction blocks and numbers (**Figure 2**). Protraction areas and the observation hours were used for statistical analysis rather than a linear distance of surveys due to the fact that track line data were not required on the effort forms. Distribution of effort was calculated using

the difference between start and end of time of watch, and assigned that time in units of minutes to the start block ID. Where multiple effort records were available for the same start block across the six years, the minutes from all records were summed in order to get the total minutes in that block.

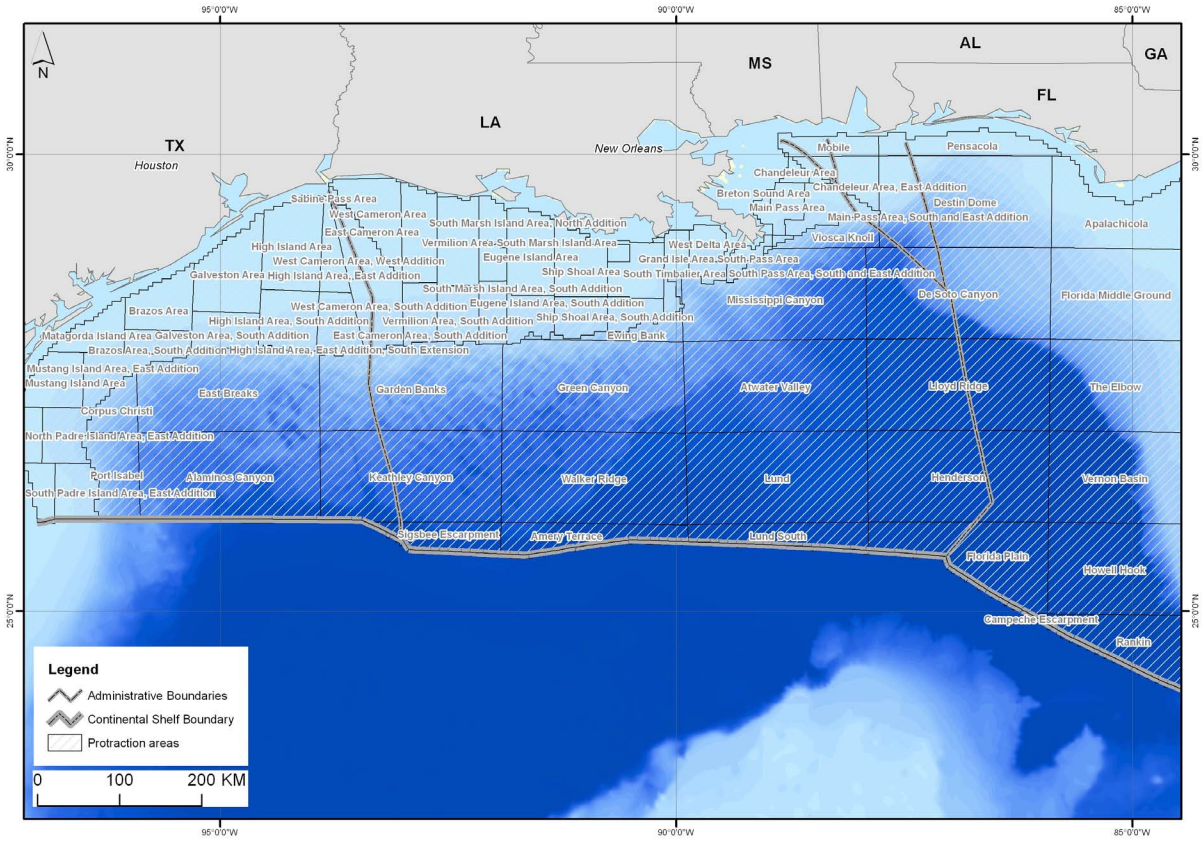

Figure 2. BOEM protraction areas within the Gulf of Mexico OCS.

The *Record of Operations* (Survey) form was used to record all ramp-up times and durations; pre-ramp-up visual survey times; documentation of protected species during the pre-ramp-up visual surveys; and any mitigation actions (delays or shut downs) that were required for NTL compliance (**Appendix B**). Data from the *Record of Operations* were used to summarize frequency and duration of ramp-ups and compliance regularity of ramp-ups and mitigation actions. Airgun activity was recorded as full power, ramp-up, mitigation firing, or silent.

Ramp-up of airguns is a mitigation used to minimize noise impacts to marine mammal and sea turtle species. The reasoning behind using ramp-ups, also called soft-starts, is to "warn" individuals who may be in the highest risk zone for noise impacts by starting at a lower power source and incrementally increasing source power to survey strength, thereby allowing individuals time to move away from the sound source before being subjected to the maximum sound levels. All ramp-up start and end times were recorded on the *Record of Operations* forms. Under the NTL: ramp-up should be initiated and ended within the time constraints of 20-40 minutes; no ramp-ups can take place from silence during darkness or during incompatible visual observation conditions; and ramp-ups cannot be initiated only to establish mitigation

shooting or to avoid a later ramp-up (Epperson 2007). In the case of non-visual conditions (darkness or fog), a ramp-up may occur only if a constant source has maintained at least 160 dB re 1 µPa-m (rms) and has been operated continuously since the cessation of full power shooting. In that case, ramp-up is conducted from the minimum source level up to full power in the 20-40 minute time constraint.

The *Record of Sighting* (Sighting) form was used to record each protected species (individual or group) that was detected during all visual surveys (**Appendix C**). Species were recorded regardless of their location in relation to the exclusion zone and during all operations whether guns were firing or not. There were occasions when no protected species were observed; therefore, not every submitted report contained sighting records. The *Sighting* form documented species identification and behavior information, the spatial relation of the animal to the vessel and sound source, gun operations during the sighting period, location information, observation conditions, and any required mitigation actions.

3.2. DATA ENTRY

The transfer of data from the bi-weekly Protected Species Observer reports to a Microsoft Excel® spreadsheet was done separately by a group of data entry personnel according to the three standard forms found within the observer reports. The personnel compiling the database signed non-disclosure agreements with BOEM. The majority of reports contained all three forms; however, the biweekly reports were not uniform in structure. The biweekly reports had varied inputs and information in the earlier years of the program and began to become more consistent in the latter years.

The standard forms were used as a template to collect data from previous reports because they corresponded with the majority of the consistent data. The majority of the Protected Species Observer reports were in a pdf format; only a few reports were in Microsoft Word or Excel®. Data entry personnel copied and pasted or hand typed the exact data found within the reports over to the Excel® spreadsheet with the exception of the latitude and longitude fields. The format of the latitudes and longitudes were adjusted if needed so that they provided a decimal conversion in the subsequent columns. This was done so that all positional information was in a consistent format for analysis. Other fields contained various inputs such as symbols, words, numbers or a combination thereof. To prevent potential bias, unintentional changing of data or interpretation of data during data entry phase the other fields were copied over to the *Excel* database exactly as they were entered in the reports.

For example, some start times for monitoring had an input of “continuous monitoring” instead of a specific time, thus the words “continuous monitoring” were entered into the database instead of interpreting the potential times that monitoring may have begun. Data entry was examined for errors after each report was entered and then again once all the data was compiled into one spreadsheet. The data was primarily inspected for potential errors in typing because many of the entries in the database were entered by hand.

3.3. DATA ANALYSIS

Data from three airgun firing modes comprising ramp-up, mitigation, and full power were analyzed separately and each compared against sightings during which airguns were silent.

Sightings of different species groups were analyzed separately for Baleen whales, Delphinids, sperm whales, and sea turtles. An analysis was undertaken for all cetaceans combined (excluding sea turtles).

Data analyses were comprised of two core methodologies. The first was the analysis of sightings collated by block identification for use in determining sightings frequency per 1,000 hrs effort per block, average sightings duration per block, and the average closest distance of approach of animals to airguns per block. The data were not normally distributed and Kruskal-Wallis analysis of variance was used to determine the significance of different firing modes on sightings frequency, duration, and closest distance of approach for each species group. In order to remove geographical bias the block data was aggregated at the level of Protraction Area and, where areas contained either only firing or only silent for any firing mode/species group, the blocks from these areas were removed from the dataset before running the Kruskal-Wallis analysis.

The second methodology comprised analyzing individual sightings events for analysis of animal behavior in response to airgun firing modes. Data were not normally distributed and Chi-Squared analysis was used to determine differences in the frequencies of recorded behavior between each airgun firing mode in turn against silent. Geographical bias was removed by aggregating sightings at the level of Protraction Area and, where areas contained sightings occurring either only during firing or only during silent for any firing mode/species group, the sightings from these areas were removed before running the Chi-Squared analysis.

The behavior categories analyzed included Blow, Bow Riding, Feeding, Logging, Porpoising, Surfacing, Swimming below the Surface, and Other. A minimum of five sightings per behavior category were required for inclusion of that behavior in the analysis. An initial analysis was run per species category comparing behavior frequency distributions across all behavior categories. A second more detailed analysis was then undertaken for Delphinids and sperm whales comparing each specific behavior against all other behaviors so that the significance of changes in the frequency of individual behaviors could be determined between firing modes.

4.0. RESULTS

4.1. SEISMIC OPERATION RECORDS

Survey Report forms were used to record pre ramp-up survey times, start and end of ramp-ups, delays or shutdowns for protected species, and general survey activity. There were 32,939 ramp-up records documented in the *Survey Report* forms. Different compliance categories showed different levels of completeness in the data records (**Table 1**). Information that was specifically listed in the NTL as required on the record of operations data forms and were included on the sample data forms referenced in NTL 2007-G02 showed completion rates higher than data that would inherently assist in compliance consideration but was not specifically required in the NTL. A high percentage of data records that were complete enough to determine compliance in the duration of the ramp-up (96%) and the duration of the pre-ramp-up survey (86%). Sixty-five percent of these records were completed in a way that day or night start of the ramp-up was clearly discernible. However, duration of minimum source firing had to be derived from data input and this showed a completion rate of only 18% in the record.

Table 1.

Data Completeness Summary from All Survey Report Forms

Analysis Topic	Number of Records Complete for Analysis Topic	Percentage of Records Complete for Analysis Topic
Ramp-up duration	31,512	96%
Mitigation gun firing duration	6,063	18%
Day or night ramp-up start	21,546	65%
Thirty-minute pre-shooting survey compliance	10,702	86%

Individual vessels ramped-up between zero to 20 times within a 24-hour period, with an average of 2.53 ramp-ups within a 24-hour operating period per vessel. Fifty-seven percent of all ramp-ups recorded took place during daylight hours with the remaining 43% conducted during non-visual conditions (night-time or poor weather) and were conducted from the mitigation source. There are occasions on the vessels where night-time ramp-ups were not recorded; therefore, this may be an underestimation of the actual percentage of ramp-ups taking place during darkness. From the data form structure it was not possible to determine how many ramp-ups were initiated from silence compared with how many were initiated from a minimum source. Ramp-ups from silence during darkness are not permitted.

Ramp-ups are required to be 20-40 minutes in duration. The *Survey* forms clearly require entry of the ramp-up duration, which is reflected in the high number of accurate data records for this activity. Ninety-six percent of the *Survey* Report records contained data that clearly discerned ramp-up time compliance. Of these complete records, 90% were between the required 20 and 40 minute duration. Short ramp-ups were noted for other operational activities such as gun testing, noise files, aborted ramp-ups, and shut downs for protected species. There were 195 (0.5% total ramp-ups) events that were less than 20 minutes and had no other operational explanation within the data form and, therefore, would not be in compliance with ramp-up requirements. There were 143 (<0.5%) ramp-up events that were greater than 40 minutes and contained no operational explanation. There were 262 concise records (<1%) of vessels ramping up only to the mitigation source, which would not be in compliance with the NTL. This number may be slightly underrepresented because data forms did not specify gun power at final ramp-up and a ramp-up to the mitigation source is often not possible; instead, the mitigation source is turned on and represents minimum power levels. This action is not in compliance; the mitigation source is to be used between full power survey lines, not as a means to allow a later ramp-up. Eighty-six percent of the daytime ramp-up records had data complete enough to discern compliance with the pre-firing 30-minute survey requirement. Three percent of the surveys were less than the required 30 minute duration.

4.2. SIGHTING RECORDS

There were 3,963 complete sighting reports for protected species submitted in biweekly reports. Sighting reports with records of "unidentified cetacean" (N = 17) were not used in the analyses. Unidentified dolphins, whales, and turtles with an identification level of "best guess" or below were removed from analysis (N=32). Identification changes were made on some sighting reports after review of descriptive data and/or photographs (N=18). Some of these involved a change

from Sei (*Balaenoptera borealis*) and Fin (*Balaenoptera physalus*) whales to Bryde's whales (*Balaenoptera edeni*). All other changes placed the identified species into a more general taxonomic category that did not change the overall group in which the species would be identified for analysis.

A preliminary analysis of individual observer effort and sightings frequency was undertaken to help identify any anomalous records. There were no anomalous MMO records in relation to sightings frequency per observer. Observer identification on the data forms do not specifically indicate whether or not the observer is a third party contractor or a trained crew member; however, a very low number of crew members performed MMO duties in the GOM during this period (Barkaszi, personal communication 2011).

Observers were required to identify species to the lowest taxonomic group possible and to state their certainty of identification (sure, most likely, best guess). Observers scored the certainty of identification using criteria listed on the individual data forms. These scores were tallied into the following categories: 1 = Best Guess, 2 = Most Likely, 3 = Sure. Overall, 67% of the identifications were classified as "Sure", while 13% were classified as "Most Likely" and 20% classified as "Best Guess". Most sightings were identified to species level (87%); family was the next most common taxonomic group identified (10%).

A total of 3,914 sighting records (98%) were used in the final sighting analyses (**Figure 3**). Approximately 28,000 individual animals were identified in these sighting records. Cetaceans comprised 3,335 (85%) of these records with 20 species identified. Sea turtles comprised the remaining 579 (15%) records with five species identified.

The most common cetacean encountered was the sperm whale, *Physeter macrocephalus*, (N=1,136 records); the most common small cetacean identified was the pantropical spotted dolphin (*Stenella attenuata*), (N=740 records) (**Table 2**).

Not all sighting reports recorded the number of individuals or adults and juveniles. Only those records that contained complete information on the number of individuals were used in the analysis of juvenile presence. Sea turtles showed the greatest percentage of juveniles recorded (47.2%). These were all single individuals and no carapace measurements were recorded. Approximately 27% of dolphin groups reported included juveniles, with an average of four juveniles per group (when recorded). Sperm whales were the only whales that had juveniles reported, with 20.9% having juveniles as part of their group. The average number of juveniles seen with any sperm whale group was 1.37.

Group sizes for all species also varied. Sea turtles had the smallest average group size (1.04), while dolphins were reported in groups of one to over 200, with an average group size of 15.9 individuals. Sperm whale groups ranged in size from one to 16 with an average group size of 2.63.

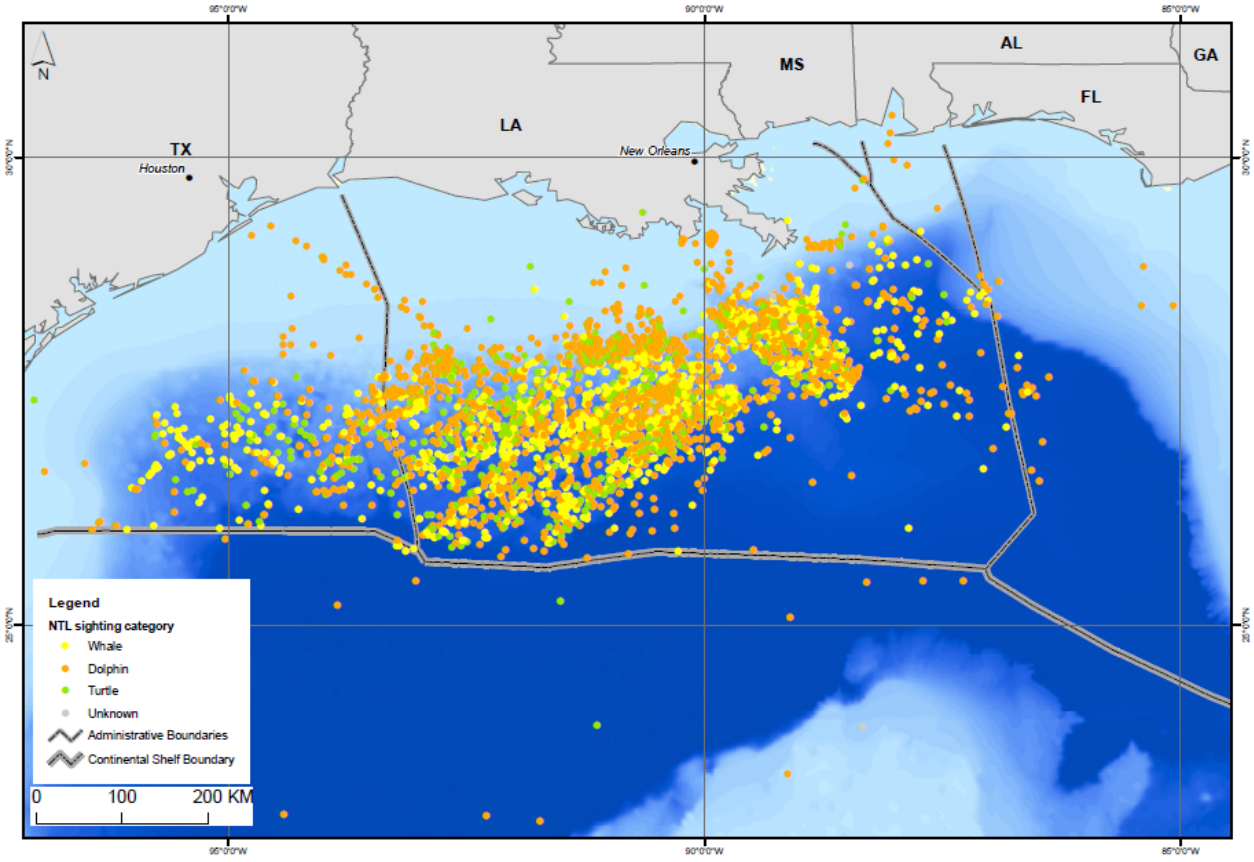

Figure 3. Distribution of cetacean and sea turtle sightings.

Table 2.

Species Sighting Summaries by Lowest Identified Taxonomic Group

NTL Category	Family	Genus	Species	Common Name	Number of Sighting Records Represented	Number of Individuals Recorded	Mean Group Size	Mean Closest Distance from Airguns (meters)	Sighting Frequency per 1,000 Hours
WHALE					30	36	1.8	2597.0	0.15
	Balaenopteridae	*Balaenoptera*			6	6	1.0	1290.0	0.03
		Balaenoptera	*brydei*	Bryde's Whale	6	9	1.8	1436.6	0.03
	Kogiidae	*Kogia*	*breviceps* or *sima*	Pygmy or Dwarf Sperm Whale	20	59	3.2	773.6	0.10
	Physeteridae	*Physeter*	*macrocephalus*	Sperm Whale	1136	2554	2.5	1777.1	5.84
	Ziphiidae	*Ziphius* or *Mesoplodon*	spp	Beaked Whale	11	14	2.0	1575.0	0.05
DOLPHIN									
	Delphinidae				328	1693	11.5	1140.0	1.68
		Feresa	*attenuata*	Pygmy Killer Whale	44	442	13.8	577.6	0.22
		Globicephala	*macrorhynchus*	Shortfinned Pilot Whale	174	1566	12.5	734.9	0.89
		Grampus	*griseus*	Risso's Dolphin	31	189	7.0	754.2	0.15
		Lagenodelphis	*hosei*	Fraser's Dolphin	16	187	16.0	751.2	0.08
		Orcinus	*orca*	Killer Whale	5	20	5.0	1110.0	0.02
		Peponocephala	*electra*	Melonheaded Whale	42	719	22.4	724.6	0.21
		Pseudorca	*crassidens*	False Killer Whale	46	285	8.3	1044.1	0.23
		Stenella	spp	Stenellid Dolphin	34	553	23.0	1196.7	0.17

Table 2.

Species Sighting Summaries by Lowest Identified Taxonomic Group (continued)

NTL Category	Family	Genus	Species	Common Name	Number of Sighting Records Represented	Number of Individuals Recorded	Mean Group Size	Mean Closest Distance From Airguns (meters)	Sighting Frequency per 1,000 Hours
DOLPHIN									
		Stenella	*attenuata*	Pantropical Spotted Dolphin	740	10429	18.6	497.4	3.79
		Stenella	*clymene*	Clymene Dolphin	69	1015	18.8	659.6	0.35
		Stenella	*coeruleeoalba*	Striped Dolphin	12	169	24.1	1431.9	0.06
		Stenella	*frontalis*	Atlantic Spotted Dolphin	53	566	13.4	234.4	0.27
		Stenella	*longirostris*	Spinner Dolphin	77	1162	19.0	933.5	0.39
		Steno	*bredanensis*	Rough-toothed Dolphin	103	1055	12.1	428.9	0.53
		Tursiops	*truncatus*	Bottlenose Dolphin	352	2644	8.4	353.9	1.81
TURTLE									
	Chelonidae				53	53	1.0	166.4	0.27
		Caretta	*caretta*	Loggerhead Turtle	233	239	1.0	149.7	1.19
		Chelonia	*mydas*	Green Turtle	127	130	1.0	178.6	0.65
		Eretmochelys	*imbricata*	Hawksbill Turtle	18	19	1.0	153.0	0.09
		Lepidochelys	*kempii*	Kemps Ridley Turtle	55	55	1.0	169.9	0.28
	Dermochelyidae	*Dermochelys*	*coriacea*	Leatherback Turtle	93	93	1.0	243.7	0.47

4.2.1. Distance from the Seismic Source

The median closest distance of approach to the seismic source was compared between active seismic source conditions and silence. **Table 3** summarizes the Kruskal-Wallis analysis of variance results. All species groups were found to occur at statistically significant greater distances from the seismic source during times of full power source operation when compared to silence (Kruskal-Wallis, $p<0.05$), as can be seen from **Figure 4**. A similar pattern can be seen during mitigation source operation, though the differences are reduced (**Figure 5**). This difference remains statistically significant for the "all cetaceans" group, Delphinids, and sea turtles only (Kruskal-Wallis, $p<0.05$). When comparing the distance to source between ramp-up and silence, the sample sizes are very low. A significant difference was found for "baleen whales" (Kruskal-Wallis, $p<0.05$), though, with a sample size of 15, this result is questionable.

Table 3.

Kruskal-Wallis Analysis of Variance Results for the Closest Approach to the Seismic Source
(n.s.: not significant)

	Species Group	N	z	Median	p
Full Power vs. Silent	All Cetaceans	1591	9.92	900	*0.000*
	Baleen Whales	39	2.49	1000	*0.013*
	Delphinids	1049	9.54	500	*0.000*
	Sperm Whales	495	3.25	180	*0.001*
	Turtles	342	3.23	100	*0.001*
Mitigation vs. Silent	All Cetaceans	577	3.35	540	*0.001*
	Baleen Whales	6	1.01	1000	n.s.
	Delphinids	386	3.77	400	*0.000*
	Sperm Whales	172	1.00	1091	n.s.
	Turtles	82	3.12	150	*0.002*
Ramp-up vs. Silent	All Cetaceans	417	-0.10	363	n.s.
	Baleen Whales	15	2.09	1750	*0.036*
	Delphinids	281	-0.34	250	n.s.
	Sperm Whales	120	-0.46	1063	n.s.
	Turtles	52	0.95	90	n.s.

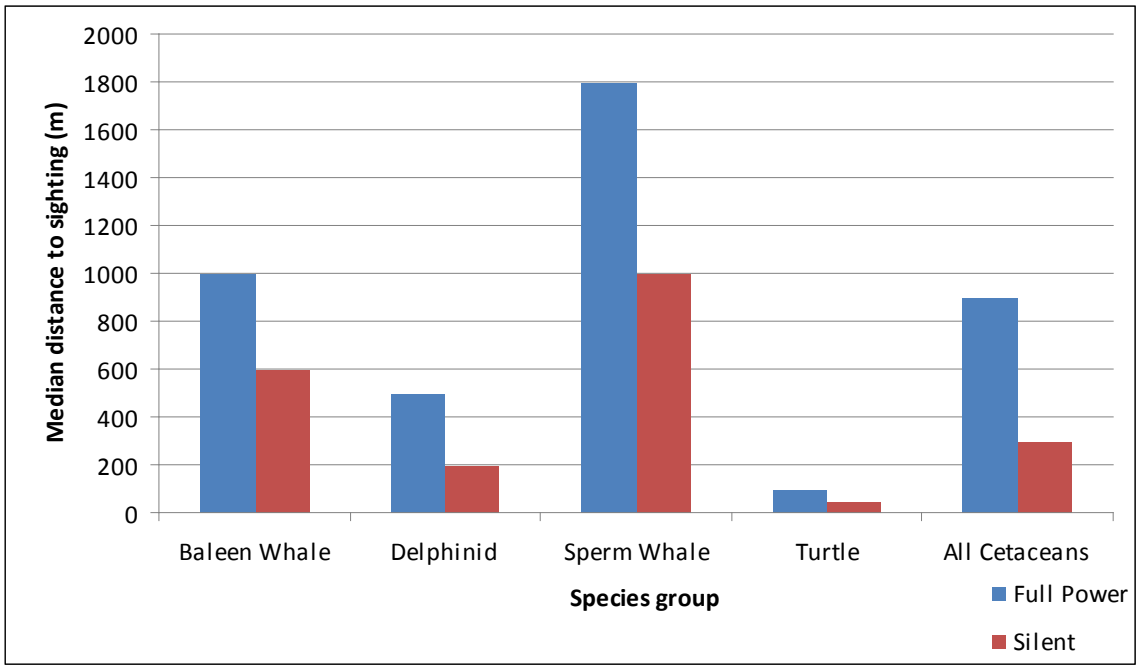

Figure 4. Comparison of the distance to the seismic source during full power and silence.

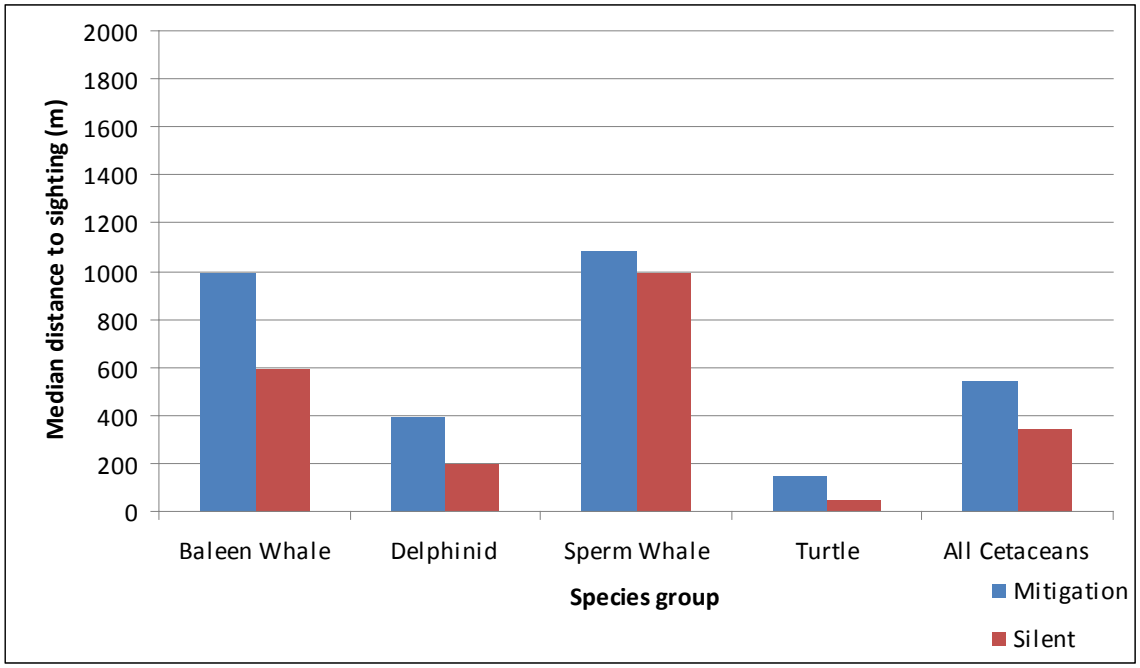

Figure 5. Comparison of the distance to the seismic source during mitigation and silence.

4.2.2. Sighting Duration

Comparing the median sighting duration for each active seismic source conditions against silence showed sighting duration for both "Delphinids" and the "all cetaceans" species groups to be significantly longer during full power than during silence (Kruskal-Wallis, $p<0.05$), as summarized in **Table 4**, and illustrated in **Figure 6**. No further differences were statistically significant either for other species groups or lower volume active source conditions.

Table 4.

Krustal-Wallis Analysis of Variance Results for Sighting Duration
(n.s.: not significant)

	Species	N	z	Median	p
Full Power vs. Silent	All Cetaceans	1324	2.33	11	*0.020*
	Baleen Whales	20	0.83	5	n.s.
	Delphinids	879	2.62	11	*0.009*
	Sperm Whales	419	0.13	10	n.s.
	Turtles	250	-0.15	1	n.s.
Mitigation vs. Silent	All Cetaceans	468	0.92	10	n.s.
	Baleen Whales	6	1.46	20	n.s.
	Delphinids	322	0.31	10	n.s.
	Sperm Whales	137	1.00	12.5	n.s.
	Turtles	70	-0.44	1	n.s.
Ramp-up vs. Silent	All Cetaceans	325	0.97	12.5	n.s.
	Baleen Whales	6	1.46	20	n.s.
	Delphinids	225	0.99	13	n.s.
	Sperm Whales	92	-0.50	13	n.s.
	Turtles	40	0.43	1	n.s.

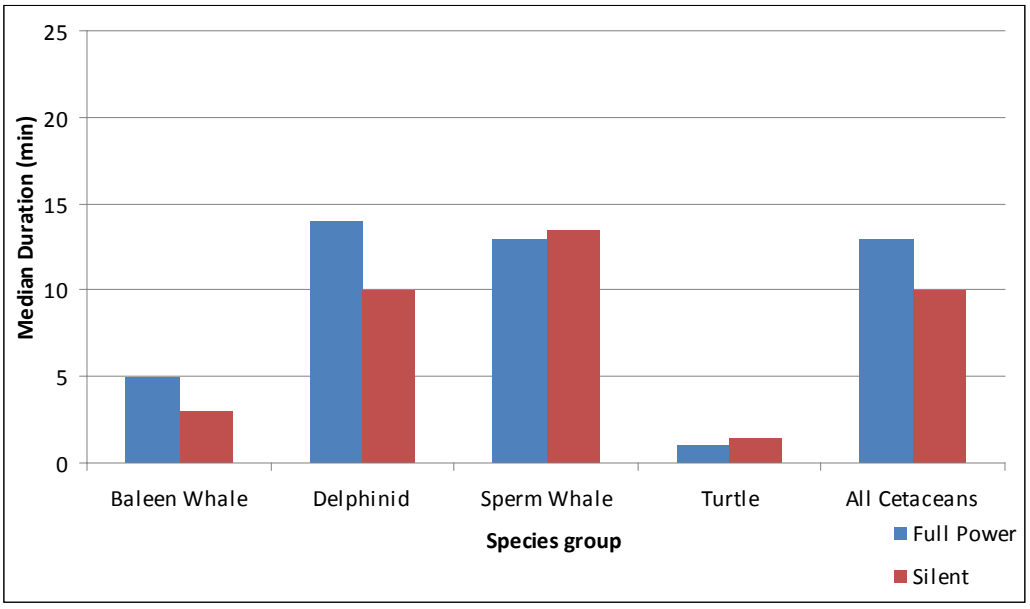

Figure 6. Comparison of median sighting duration during full power and silence.

4.2.3. Behavioral Observations

A lack of consistent recording of behaviors limited the sample size for species groups and for behavior types. By combining the behaviors and assessing whether there was a difference in response, rather than a specific type of response, it was possible to establish that there were statistically significant differences in behavior between times when the seismic source was active compared with when it was silent. Baleen whales were excluded from all behavioral analyses due to low sample size (N=15).

For all other species groups, when comparing full power source operations with silence, there are statistically significant differences between the responses of those groups. This can be seen in behaviors such as blowing and bow-riding, which are more prevalent during periods of silence. When the seismic source was at full power, surface behaviors including logging, porpoising, and surfacing are more prevalent (**Figure 7**).

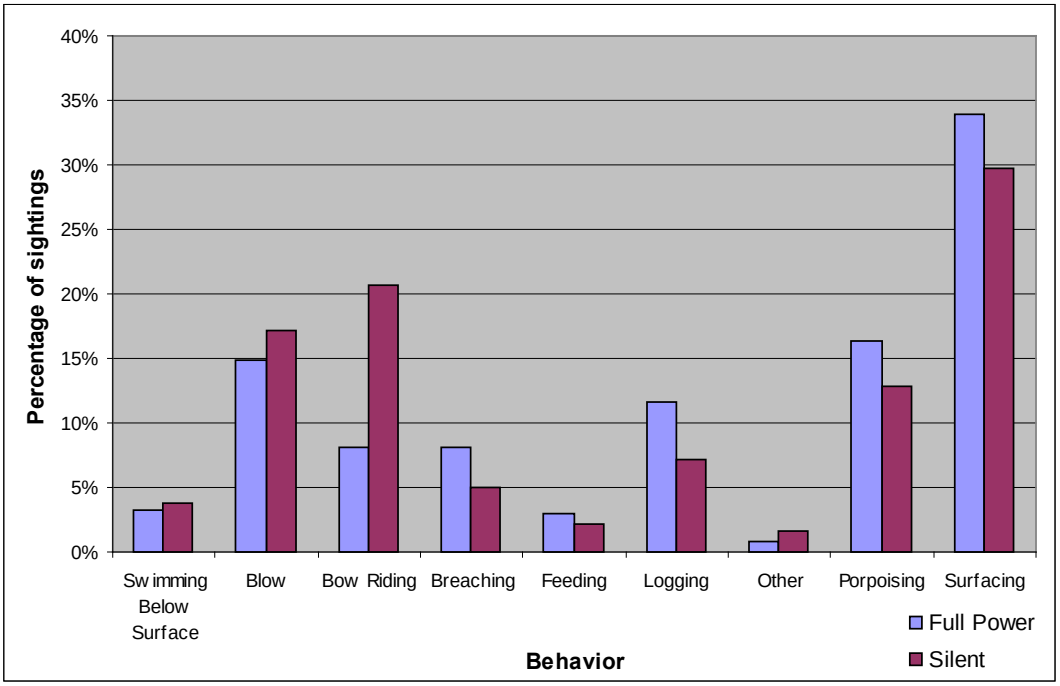

Figure 7. Comparative behavioral responses of the "all cetaceans" group during full power and silence.

This pattern is repeated for comparisons of both mitigation and ramp-up with silence, illustrated in **Figure 8** and **Figure 9**. The differences are statistically significant for both mitigation and ramp-up when compared with silence, though small sample size limited the inclusion of sperm whales and sea turtles in the analysis.

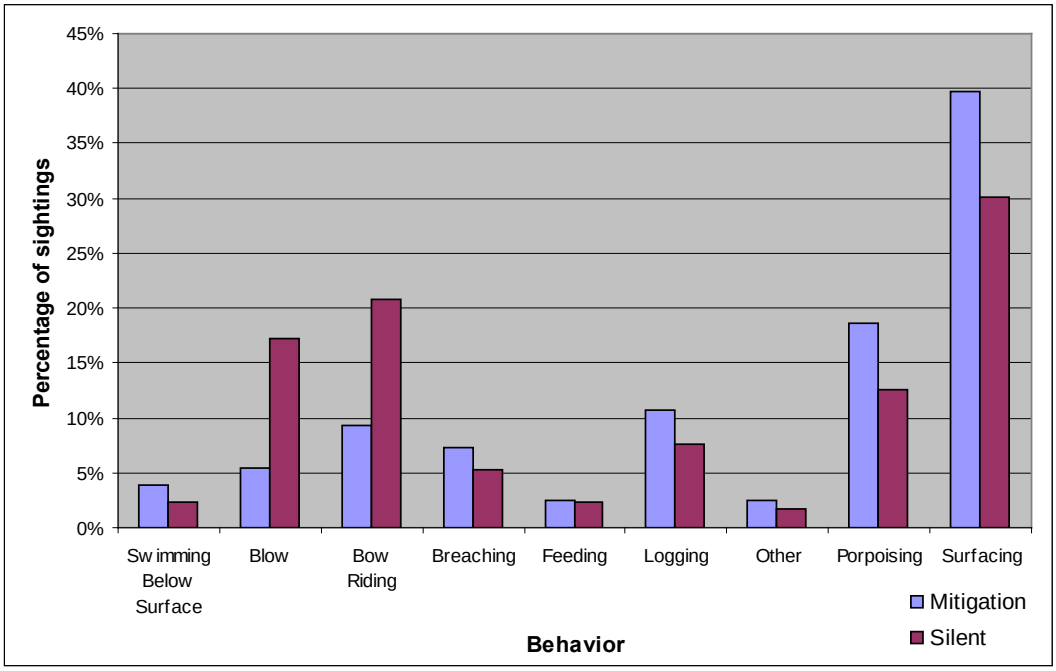

Figure 8. Comparative behavioral responses of the "all cetaceans" group during mitigation and silence.

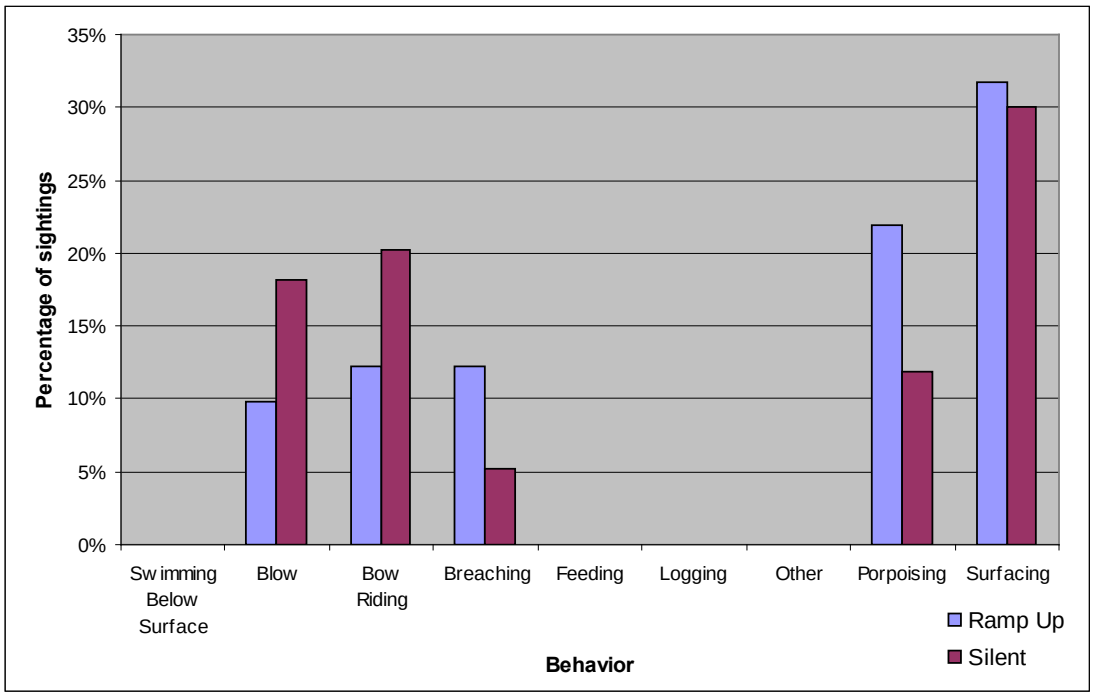

Figure 9. Comparative behavioral reponses of the "all cetaceans" group during ramp-up and silence.

Sample size was sufficiently large enough to allow further analysis of individual behaviors for delphinids during all seismic source conditions, and for sperm whales during full power and mitigation, as summarized in **Table 5**. Complete dolphin records showed that 58% were within the exclusion zone. Out of these 1,248 records, 1,044 records had some behavior noted. In these records, 33% included bow-riding behavior. Of the 23 dolphin records that resulted in ramp-up delays, 61% were recorded bow-riding.

Table 5.

Chi-squared Results for Grouped Behaviors by Seismic Status
(Greyed areas not included within analysis due to low sample size.)

	Species Group	Airgun Activity	Swimming below Surface (%)	Blow (%)	Bow Riding (%)	Breeching (%)	Feeding (%)	Logging (%)	Other (%)	Porpoising (%)	Surfacing (%)	2	n	d.f.	p
Full power	All Cetaceans	Full	3	15	8	8	3	12	1	16	34	202.79	1375	8	*0.000*
		Silent	4	17	21	5	2	7	2	13	30				
	Delphinids	Full	5	2	13	12	4	4	1	26	33	180.26	836	7	*0.000*
		Silent	5	3	30	6	3	0	2	18	31				
	Sperm Whales	Full	1	37	0	1	0	25	0	0	35	24.44	483	2	*0.000*
		Silent	0	48	0	2		23	0	0	27				
	Turtles	Full	42	0	0	0	0	18	1	0	38	135.69	308	2	*0.000*
		Silent	18	0	0	0	0	16		0	66				
Mitigation	All Cetaceans	Mitigation	4	5	9	7	2	11	2	19	40	49.11	204	8	*0*
		Silent	2	17	21	5	2	8	2	13	30				
	Delphinids	Mitigation	5	1	13	8	3	2	3	25	40	25.19	143	5	*0.000*
		Silent	3	3	30	7	3	0	2	18	31				
	Sperm Whales	Mitigation		19	0	6	0	37	0	0	38	14.36	49	2	*0.001*
		Silent	0	46	0	2	0	24	0	0	28				
	Turtles	Mitigation	35	0	0	0	0	17	0	0	48	7.93	46	2	*0.019*
		Silent	19	0	0	0	0	17	0	0	64				
Ramp-up	All Cetaceans	Ramp-Up	0	10	12	12		7	0	22	32	9.96	36	4	*0.041*
		Silent	2	18	20	5	2	8	2	12	30				
	Delphinids	Ramp-Up	0	0	17	17	7	3	0	30	27	8.46	27	3	*0.037*
		Silent	4	0	31	7	4	1	3	18	32				
	Sperm Whales	Ramp-Up	0	33	0	0	0	22	0	0	44		9		
		Silent	0	47	0	2	0	23	0	0	28				
	Turtles	Ramp-Up	38	0	0	0	0	13	0	0	50		8		
		Silent	18	0	0	0	0	18	0	0	64				

There are significant differences in delphinid behaviors for all listed in **Table 6** when the seismic source is active compared with silence, including greater incidences of porpoising, breaching, and surfacing, and a much lower incidence of bow-riding. When the source is at full power, sperm whales are surfacing more often, although there are fewer records of blowing behavior at full power.

Table 6.

Chi-squared Results for Individual Behaviors

	Species Group	Behavior Category	Airgun Activity	Behavior Frequency	^{2}	n	d.f.	p
Full power	Delphinids	Blow	Full Power Silent	2% 3%	6.07	836	1	*0.014*
		Bow Riding	Full Power Silent	13% 30%	109.81	836	1	*0.000*
		Breaching	Full Power Silent	12% 6%	58.87	836	1	*0.000*
		Feeding	Full Power Silent	4% 3%	6.11	836	1	*0.013*
		Porpoising	Full Power Silent	26% 18%	36.50	836	1	*0.000*
		Surfacing	Full Power Silent	33% 31%	4.36	836	1	*0.037*
	Sperm Whales	Blow	Full Power Silent	37% 48%	21.86	483	1	*0.000*
		Logging	Full Power Silent	25% 23%	1.39	483	1	0.239
		Surfacing	Full Power Silent	35% 27%	16.89	483	1	*0.000*
Mitigation	Delphinids	Bow Riding	Mitigation Silent	13% 30%	24.01	143	1	*0.000*
		Breaching	Mitigation Silent	8% 7%	0.29	143	1	0.587
		Feeding	Mitigation Silent	3% 3%	0.01	143	1	0.943
		Porpoising	Mitigation Silent	25% 18%	4.43	143	1	*0.035*
		Surfacing	Mitigation Silent	40% 31%	5.38	143	1	*0.020*
	Sperm Whales	Blow	Mitigation Silent	19% 46%	14.17	49	1	*0.000*
		Logging	Mitigation Silent	37% 24%	5.70	49	1	*0.017*
		Surfacing	Mitigation Silent	38% 28%	3.60	49	1	0.058
Ramp-up	Delphinids	Bow Riding	Ramp-up Silent	17% 31%	3.28	27	1	0.070
		Breaching	Ramp-up Silent	17% 7%	4.21	27	1	*0.040*
		Porpoising	Ramp-up Silent	30% 18%	2.67	27	1	0.102
		Surfacing	Ramp-up Silent	27% 32%	0.53	27	1	0.467

Delphinids follow a similar pattern during mitigation as they do during full power source operation. During ramp-up, delphinids breach more often. Sperm whales have a similar observed reduction in blowing during mitigation, but spend more time logging at the surface. Low sample size excluded sperm whales from analysis of behaviors during ramp-up operations.

4.3. OBSERVER SURVEY EFFORT

There were 194,273 total hours of visual surveying recorded over the five-year period. To estimate the amount of observer effort under each gun operation mode, we used only the location and effort information for data entries in which sightings occurred (26,482 hours) because detailed gun operation information was not recorded on the *Location and Effort* forms. Sixty-three percent of the survey effort was conducted during full power airgun firing, 2% took place during ramp-up, 10% took place during minimal source firing, and 23% took place during gun silence. The remaining 2% is made up of gun testing and unspecified gun operations.

The BOEM uses Official Protraction Diagrams (OPD) for geographic mapping of the Outer Continental Shelf (OCS) regions. A standard OPD is one degree in latitude by two degrees in longitude (USDOI BOEMRE 2010). Protraction diagram sheet names relate to land features, or to hydrographic features contained within the limits of the diagram (USDOI BOEMRE 2010). Actual seismic survey track lines and visual survey track lines in a Geographical Position System (GPS) format were not available; therefore, survey effort was calculated using the OPD and OCS block numbers of the visual survey start entry on the *Location and Effort* form and the total survey time for that entry attributed to that single block. Survey effort was recorded for 52 OPD areas within the GOM region; however, 90% of all survey effort took place in just 11 OPD areas: Mississippi Canyon, Green Canyon, Walker Ridge, Keathley Canyon, Garden Banks, Atwater Valley, The Elbow, Alaminos Canyon, East Breaks, Ewing Bank, and Lloyd Ridge.

The greatest amount of survey effort took place in the Mississippi Canyon (29%) and Green Canyon (20%) OPD areas, and made up nearly 50% of all survey effort over the five year data collection period. Species sighting frequency followed some trends in survey effort; however, Green Canyon and Atwater Valley showed a pronounced greater percentage of all protected species sightings than the percent survey effort. Conversely, Mississippi Canyon showed a lower percentage of all protected species sightings than average from the total survey effort.

Three of the OPD areas, Atwater Valley, Sigbee Escarpment, and Desoto Canyon, showed a sighting frequency greater than the average across the surveyed GOM. Mississippi Canyon, an area noted for frequent and regular sperm whale observations, showed a lower than average sighting frequency for sperm whales even though this area represented the second highest number of sperm whale sightings (N=180). Green Canyon had the highest number of sperm whale sighting records (N=234), dolphin sighting records (N=485) and sea turtle sighting records (N=130); however, sighting rates for these species were closer to the overall average than some of the other areas. Sighting rates within each area do not take into account seasons, surveys over multiple years compared with shorter time periods, or other geospatial variables.

4.3.1. Sighting Rate

Using the total survey effort of 194,273 hours, the overall sighting frequency for protected species was 20.15 sighting records per 1,000 hours of observation. The overall sighting frequency for sperm whales was 5.84 sperm whale sighting records per 1,000 observation hours.

Sighting rates for gun operations were calculated per unit effort (1,000 hours of observation) using only the location and effort information for data entries in which sightings occurred, and compared between among seismic source conditions: full power, mitigation, ramp-up and silence. **Table 7** summarizes Kruskal-Wallis analysis of variance results. The combined results for "all cetaceans" show a statistically significant variation in sighting rate, with a higher sighting rate during full power than silence (Kruskal-Wallis, $p<0.05$), as shown in **Table 7** and **Figure 10**.

Table 7.

Krustal-Wallis Analysis of Variance Results for Sighting Rate/1,000 Hours
(n.s.: not significant)

	Species Group	N	z	Median	p
Full Power vs. Silent	All Cetaceans	1650	2.33	92	*0.020*
	Baleen Whales	40	0.37	83	n.s.
	Delphinids	1096	1.68	94	n.s.
	Sperm Whales	506	1.66	92	n.s.
	Turtles	359	-0.17	84	n.s.
Mitigation vs. Silent	All Cetaceans	606	0.93	91	n.s
	Baleen Whales	17	-1.26	60	n.s
	Delphinids	411	0.22	88	n.s
	Sperm Whales	175	1.26	94	n.s
	Turtles	90	-0.12	82	n.s
Ramp-up vs. Silent	All Cetaceans	448	0.07	84	n.s.
	Baleen Whales	16	0.34	71	n.s.
	Delphinids	306	-0.06	82	n.s.
	Sperm Whales	124	-0.02	84	n.s.
	Turtles	60	-1.63	70	n.s.

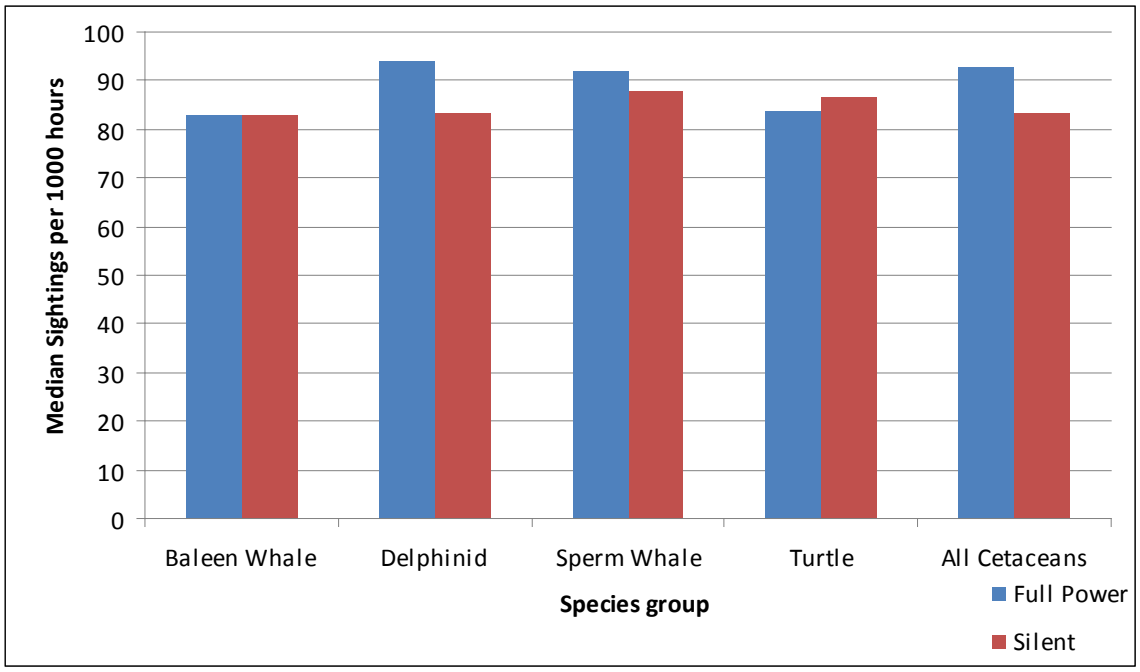

Figure 10. Comparison of sightings frequency during full power and silence.

5.0. MITIGATION

There were 32 delays in ramp-ups due to the presence of protected species in the exclusion zone during the 30 minutes immediately before ramp-up. Of these delays, 24 (75%) were due to dolphins, four (13%) due to sea turtles, and four (13%) due to sperm whales. There is a required 30-minute waiting period after a protected species had been sighted within the exclusion zone, which allows for a full 30 minutes of visual clearance before any airguns are started. Downtime in operations due to ramp-up delays ranged from four minutes to 87 minutes, with an average delay time of 33 minutes. A total of 18.5 hours down time was attributed to ramp-up delays.

There were 194 occurrences of whales spotted in the exclusion zone; 144 (72.4%) resulted in a shutdown of airguns. The remaining 50 sightings within the exclusion zone occurred during silence in gun operations. Of the required shutdown events, 139 (97%) were due to sperm whales. The remaining five shutdowns were due to *Kogia* spp. (N=2) and Bryde's whales, *Balaenoptera brydei* (N=2), and one unidentified whale (N=1). The average downtime resulting from shutdowns was 58 minutes and there was a total of 125.74 hours of down time attributed to shutdowns.

At the time of shutdown, airgun operations were at full power 112 times (76.3%), minimum (mitigation) sourcing 24 times (15.9%), and six ramp-up/gun testing (4.1%). The remaining 2 shutdowns recorded were one that was voluntary to go to other operations and one that coincided with the end of a survey line by which there was no loss in production.

Shut down frequency for sperm whales was 0.71 shutdowns per 1,000 hours of observation, an estimated one shutdown for every 1,500 hours (or roughly 125 days) of daylight survey

operations, assuming observations are conducted during daylight hours regardless of gun operations.

Two voluntary shutdowns were implemented when dolphins entered the exclusion zone of a vessel. One shutdown was during minimum source firing whereby operations could be ramped up again later and the other was during a ramp-up whereby the survey line was still a number of hours away and ramp-up could be conducted later. One voluntary shutdown of guns was implemented when a sea turtle was spotted in the exclusion zone during gun testing. Gun testing was resumed at a later time. In addition to these voluntary cessations of airgun firing, a number of operators implemented voluntary "turtle pauses" whereby guns would be stopped for a series of shots to allow the gun array to be silent as it passed the last visual location of the turtle but did not result in lost seismic survey data. Voluntary shot pauses were recorded 95 times for sea turtles in the exclusion zone.

A 30-minute wait period is required after any shutdown due to whales in the exclusion zone. Therefore, the minimum delay time for any mitigation-required shutdown is 30 minutes. However, two operational delays were under the 30 minute minimum (13 minutes and 29 minutes). No explanations were provided to account for the two shortened waiting periods. All other shutdown delays ranged from 30 minutes to slightly over 13 hours (when a shut down occurred immediately before darkness and guns could not be re-started until daylight conditions allowed visual observations).

6.0. PASSIVE ACOUSTIC MONITORING

Passive acoustic monitoring (PAM) is an optional technology; it is allowable under the NTL and can be used by seismic operators to reduce the chances of operational downtime during darkness or inclement weather. Use of PAM is voluntary but it does afford the operator additional opportunities for ramp-up from silence and eliminates the need for visual conditions to clear the vessel for starting operations. There were 54 acoustic detection records over the five-year period. None of the data from acoustic detections were used in the analyses unless there was a corresponding visual sighting record.

7.0. DISCUSSION

Completeness in recording and reporting is evident from the data submitted indicating that the submission periods and methodologies lend themselves to high compliance reporting standards. In terms of actual compliance data, there appears to be high levels of compliance by operators and observation personnel in regard to ramp-up times, pre-watch conditions, and mitigation actions. However, portions of the data used in this report were derived from recorded data that were not required by regulations or on standardized data forms. For example, the high amount of observation time that took place during gun silence was due mainly to the scope of work laid out by observer contractors and not by NTL regulations (Barkaszi, personal communication 2011). Additionally, mitigation measures such as the use of minimum source firing is not expressly monitored on the standardized data forms; therefore, the times and use of this procedure cannot be adequately determined for compliance.

Source array volume is not consistent across all geophysical surveys in the Gulf of Mexico. Source volume is not a required data collection item and therefore cannot be analyzed within the

statistical parameters of this document. Typical volumes of individual air-guns used by the geophysical industry can range from 20 in^3 to 800 in^3. Strings of airguns are used within an array so that a typical survey involves between 12 and 48 guns, with a sum volume in the range of 3,000-8,000 in^3 during full power firing. The source volume is normally reduced to a single airgun for mitigation firing to maintain a minimal source output as defined in the NTL. Other variability in received source levels is derived from newer techniques in survey design. Rather than using a single source vessel to transect a survey area, multi-vessel surveys became more common in 2006-2007 and have become a standard practice in recent years. The multiple vessel configurations as used in wide azimuth or rich azimuth surveys can use two to six source vessels in varying patterns to survey the area simultaneously. All data collection is vessel-specific; therefore, no distinction has been made between single vessel and multi-vessel surveys within the data analysis. These vessels typically work within a one to two kilometer range from one another; therefore, sightings tend to be duplicated across the vessel fleet. Regulations, however, require that each vessel maintain independence in all operational and sighting records and, therefore, all sighting information is treated independently.

There was a high level of compliance with regard to shut-down requirements and ramp-up delays. Between 2002 and 2003 over 730,000 track line miles of 3D seismic surveys were permitted in GOM waters greater than 200 meters (Continental Shelf Associates, Inc. 2004). On average, the BOEM administers 100 seismic permits per year. Given these levels of permitted activities, and the nearly 200,000 hours of observer effort, operational down time due to mitigation measures represented a small proportion of overall survey time.

Sea turtles demonstrate the closest mean distance to air gun arrays reported by observers. This is likely due the fact that only turtles close to the vessel are most visible to observers. There is little known about the impact of seismic operations, and noise in general, on sea turtles. However, the close exposure distances and the fact that all sea turtles are listed under the Endangered Species Act (ESA), make this group a potential concern in the regulatory environment. The current NTL requires a 30 minute waiting period before starting any airguns if a sea turtle is spotted within the exclusion zone. There is also extensive use of voluntary shutdowns for sea turtles when they are detected in the exclusion zone during airgun firing; however, there is no requirement to do so under the NTL.

Sighting duration was found to be longer during times of full power seismic source operation when compared with silence, for both the “delphinid” species group and “all cetaceans” group. Looking at each of these measures; sighting rate, distance from seismic source and sighting duration, there is no consistency of significance for any one species group, other than the combined “all cetaceans” group. This may indicate a lack of clear response from any one species group, or a limitation in terms of sample size. Taking the “all cetaceans” group, an indication from the results is that there is spatial avoidance both laterally (greater sighting distances from the active seismic source), and vertically (increased sighting frequency and duration). A comparison of each behavior and sighting factor with seismic source status indicates that the differences are most pronounced for full power source operation. While a similar pattern in sighting rate or closest distance of approach might be apparent at lower seismic source volumes (mitigation and ramp-up), there are less statistically significant results. The sighting rates for all individual cetacean groups was higher while the seismic source was active, compared to silence, with the combined “all cetaceans” group being significant. This contrasts

with previous findings, where the sighting rate of small odontocetes (*T. truncatus, Lagenorhyncus spp., D. delphis, S. coeruleoalba, P. phocoena*) was found to decrease significantly when the seismic source was active, whereas no differences for other groups were observed (Stone and Tasker 2006).

Each species group was found to be sighted at significantly greater distances from the seismic source during full power compared with silence, illustrating a level of spatial avoidance to the seismic source. This finding concurs with previous findings, in which a number of small odontocete species and a combined "all mysticetes" group were found to occur at significantly greater distances from large volume seismic sources (Stone and Tasker 2006). These results, however, diverge somewhat from the controlled exposure experiments (CEE) conducted by the Sperm Whale Seismic Study (SWSS) (Jochens et al. 2008). In the SWSS CEE studies, the direction of movement in eight tagged sperm whales was determined over a series of 30-minute intervals during pre-exposure, ramp-up, and full-array firing. Results showed no horizontal avoidance to airgun exposure of <150 dB re 1 μPa (rms). These sound exposure levels were reached by whales that were 1.4 – 12.6 kilometers from the source array. Similar analysis showed that the direction of movement of the eight sperm whales did not change at the onset of gradual ramp-up at ranges of 7.3 – 12.5 kilometers or during full power firing at ranges between 1.5 and 12.6 kilometers. The CEE studies also looked at diving and foraging rates in the eight tagged whales. These experiments showed that seven of the eight whales continued deep foraging diving during controlled acoustic exposure; however, one whale, which had the closest approach by the source array, rested at the surface for an interval of over four hours. This rest period was twice as long as the 10 other resting bouts of≤ two hours during pre -exposure that were observed for this animal during the study. It dove immediately following the final airgun transmission. The SWSS report suggests that the animals' behavior may be a response to the airgun sounds and that the sperm whale had chosen to rest at the surface until airgun exposure ceased. The average closest distance for sperm whales reported in our data was 1.7 kilometers which is at the lower end of the range for the eight sperm whales studied. Given the fact that the closest sperm whale in the SWSS CEE studies did appear to exhibit more surface behavior than the other seven whales, it is a comparable result to the findings of increased surface behavior of sperm whales during active gun operations in the observer data. Increased surface behaviors may therefore be more of an indication of sperm whale avoidance of airgun noise exposure than changes in direction.

For lower volumes (ramp up and mitigation firing) the differences in sighting distance are less pronounced and are also limited by sample size. During mitigation operation, "all cetaceans" occurred at greater distances during source operation, though no individual species groups did. The significant result for baleen whales during ramp-up operation is based on a sample size of only six sightings, so is clearly not representative of any wider trend in relation to that species group and ramp-up operations. Due to the overlap of the peak frequencies of the seismic source array and those used by baleen whales, this group has been considered most vulnerable (Richardson et al. 1995). The dataset presented here, which is representative of the cetacean diversity of the GOM, makes thorough analysis of any potential effects on this group of species largely impossible. Baleen whale numbers for the Gulf of Mexico are low, due to the fact that there is only one regularly occurring mysticete, Bryde's whale, in the Gulf. Population estimates for *B. brydei* in the northern GOM range from 15 to 40; the lower estimate is typically used as

the most current information; therefore, the low sighting rates for baleen whales in this GOM data set is not unexpected.

The sperm whale is regarded as the umbrella species for regulations in the Gulf of Mexico. They are the most abundant large cetacean in the GOM and have a larger population estimate than the most common GOM baleen whale. Unlike other odontocetes in the GOM which are protected only under the Marine Mammal Protection Act (MMPA), the sperm whale is also listed as endangered under the ESA. Evidence may indicate that sperm whale hearing is not impacted by the predominant low frequency impulse of airguns, but there is some evidence that anthropogenic sound, including seismic surveys, can alter behavior in sperm whales (International Whaling Commission 2007). As such, the most recent NOAA-NMFS Biological Opinion (2007) requires that protection measures for sperm whales are implemented during seismic surveys in the GOM.

Of note, however, are the statistically significant observations relating to delphinid species. Considered as being less likely to be impacted by operations using primarily low frequency sources, this data has demonstrated that delphinids show spatial avoidance, display more surface behaviors such as breaching and porpoising, and are less likely to display bow-riding behavior.

Assessing observer data has demonstrated a high level of compliance with regard to implementing specific mitigation measures in order to minimize the potential impacts of sound on protected species. While the data has demonstrated a number of short-term behavioral effects, the consequences in the long-term remain unknown, highlighting the need for precaution. It is also clear that the data have limitations regarding the collection, interpretation and analysis of behavioral observations in relation to their use in impact assessment. Nevertheless, the data presented here provides a unique insight into the responses of protected species in the GOM in relation to commercial seismic activity.

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Appendix A

Location and Effort (Observer Effort) Form

RPS GeoCet

PROTECTED SPECIES RECORDING FORM

EFFORT

Regulatory reference number _____ **Vessel name** _____

Project number _____ **Effort page number** _____

Date	Visual or PAM	Observers' initials	Start of watch				End of watch				Wind speed (knots)	Wind direction	Beaufort sea state	Swell (m)	Visibility (km)	Glare severity
			Time	Latitude	Longitude	Depth (m)	Time	Latitude	Longitude	Depth (m)						

Appendix B

Record of Operations (Survey) Form

R PS GeoCet

PROTECTED SPECIES RECORDING FORM

OPERATIONS

Regulatory reference number _____ **Vessel name** _____

Project number _____ **Page number** _____

Date	Time pre-shooting monitoring began	Time monitoring ended	Time PAM began	Time PAM ended	Was it day or night In period prior to firing?	Reason for firing s = survey t = test x = test followed immediatel y by survey	Time soft start/ ramp-up began	Time soft start/ ramp-up ended	Time of start of line/ test	Time Of End of line/ test	Time mitigation gun enabled/ source output reduced	Time all airguns/ source stopped	Was any mitigation action required?

Appendix C

Record of Sighting (Sighting) Form

RPS GeoCet

PROTECTED SPECIES RECORDING FORM
DETECTION

Date	**Project number**	**Time at first detection** (UTC)	**Time at last detection** (UTC)	**Visual detection number**	**Acoustic detection number**

Regulatory reference number	**Vessel name**	**Survey type**	**Observer(s)**
Detection was made	**Detection was first made**		
Latitude of vessel	**Longitude of vessel**	**Bearing of vessel** (degrees)	**Water depth** (metres)

Swell height (metres)	**Beaufort sea state**	**Precipitation**	**Visibility** (km)	**Cloud cover** (%)	**Glare severity and direction**

Common name	**Scientific name**	**Certainty of identification**

Total number	**Number of adults**	**Number of juveniles**	**Bearing to animal(s) when first detected** (degrees)	**Range to animal(s) when first detected** (metres)

Description (include features such as overall size; shape of head; colour and pattern; size, shape, and position of dorsal fin; height, direction, and shape of blow; etc.)	**Visual sighting and/or Acoustic detection details** (note behavior, especially changes in relation to gun activity and distance from gun array)

Direction of travel / first approach (relative to vessel)		**Initial compass heading** (degrees)	**Final compass heading** (degrees)
Closest distance of animals to airguns/source (metres)	**Closest distance of animals to vessel** (metres)	**Source activity at initial detection**	**Source activity at final detection**
Time at closest approach (UTC)	**Distance during soft start** (m) **First** **Closest** **Last**	**Source mitigation action(s) required**	**Strike avoidance maneuvers required**
		Total duration of mitigation action(s) (HH:MM)	**Total duration of production loss due to mitigation** (HH:MM)
		Other notes or comments	

Appendix D

Notice to Lessees 2007-G02

OMB Control Number: 1010-0151
OMB Expiration Date: December 31, 2011

UNITED STATES DEPARTMENT OF THE INTERIOR
MINERALS MANAGEMENT SERVICE (MMS)
GULF OF MEXICO (GOM) OCS REGION

NTL No. 2007-G02 Effective Date: February 7, 2007

NOTICE TO LESSEES AND OPERATORS (NTL) OF FEDERAL OIL, GAS, AND SULPHUR LEASES IN THE OUTER CONTINENTAL SHELF, GULF OF MEXICO OCS REGION

Implementation of Seismic Survey Mitigation Measures and Protected Species Observer Program

This NTL supersedes and replaces NTL No. 2004-G01. It does not introduce any new types of mitigation measures; however, it clarifies how you should implement seismic survey mitigation measures, including ramp-up procedures, the use of a minimum sound source, airgun testing and protected species observation and reporting. The measures contained herein apply to all on-lease surveys you conduct under 30 CFR 250 and all off-lease surveys you conduct under 30 CFR 251.

Background

The use of an airgun or airgun arrays while conducting seismic operations may have an impact on marine wildlife, including marine mammals and sea turtles. Some marine mammals, such as the sperm whale (*Physeter macrocephalus*), and all sea turtles that inhabit the GOM are protected under the Endangered Species Act (ESA). All marine mammals are protected under the Marine Mammal Protection Act (MMPA).

In order to protect marine mammals and sea turtles during seismic operations, the National Marine Fisheries Service (NMFS) requires seismic operators to use ramp-up and visual observation procedures when conducting seismic surveys. Procedures for ramp-up, protected species observer training, visual monitoring and reporting are described in detail in this NTL. These mitigation measures apply to geophysical activities conducted under lease terms, for all seismic survey operations conducted in waters deeper than 200 meters (656 feet) throughout the GOM and, in the GOM waters east of 88.0° W. longitude, for all seismic survey operations conducted regardless of water depth. Performance of these mitigation measures is also a condition of the approval of applications for geophysical permits. You must demonstrate your compliance with these mitigation measures by submitting to MMS certain reports detailed in this NTL.

Definitions

Terms used in this NTL have the following meanings:

1. Airgun means a device that releases compressed air into the water column, creating an acoustical energy pulse with the purpose of penetrating the seafloor.
2. Ramp-up means the gradual increase in emitted sound levels from an airgun array by systematically turning on the full complement of an array's airguns over a period of time.
3. Visual monitoring means the use of trained observers to scan the ocean surface visually for the presence of marine mammals and sea turtles. These observers must have successfully completed a visual observer training program as described below. The area to be scanned visually includes, but is not limited to, the exclusion zone. Visual monitoring of an exclusion zone and adjacent waters is intended to establish and, when visual conditions allow, maintain a zone around the sound source and seismic vessel that is clear of marine mammals and sea turtles, thereby reducing or eliminating the potential for injury.
4. Exclusion zone means the area at and below the sea surface within a radius of 500 meters surrounding the center of an airgun array and the area within the immediate vicinity of the survey vessel. Each survey vessel must maintain its own unique exclusion zone.
5. Whales mean all marine mammals in the GOM except dolphins (see definition below) and manatees. This includes all species of baleen whales (Suborder *Mysticeti*), all species of beaked whales (*Ziphius cavirostris* and *Mesoplodon sp*.), sperm whales (*Physeter macrocepahalus*), and pygmy and dwarf sperm whales (*Kogia sp*.). Of the baleen whales, only the Bryde's whale (*Balaenoptera edeni*) is expected to be present in the northern GOM and is considered uncommon. This species has primarily been sighted in water depths less than 200 m in the eastern GOM. Sightings of other baleen whale species are highly unlikely.
6. Dolphins mean all marine mammal species in the Family *Delphinidae*. In the GOM, this includes, among others, killer whales, pilot whales, and all of the "dolphin" species.

Ramp-up Procedures

The intent of ramp-up is to warn marine mammals and sea turtles of pending seismic operations and to allow sufficient time for those animals to leave the immediate vicinity. Under normal conditions, animals sensitive to these activities are expected to move out of the area. For all seismic surveys, including airgun testing, use the ramp-up procedures described below to allow whales, other marine mammals, and sea turtles to depart the exclusion zone before seismic surveying begins.

Measures to conduct ramp-up procedures during all seismic survey, including airgun testing, operations are as follows:

1. Visually monitor the exclusion zone and adjacent waters for the absence of marine mammals and sea turtles for at least 30 minutes before initiating ramp-up procedures. If none are detected, you may initiate ramp-up procedures. Do not initiate ramp-up procedures at night or when you cannot visually monitor the exclusion zone for marine mammals and sea turtles if your minimum source level drops below 160 dB re 1 μPa-m (rms) (see measure 5). Altering the vessel's course to shallower water depths (< 200m in the Central and Western Planning Areas) to circumvent ramp-up requirements of the 200 meter isobath will be considered noncompliant.

2. Initiate ramp-up procedures by firing a single airgun. The preferred airgun to begin with should be the smallest airgun, in terms of energy output (dB) and volume (in^3).
3. Continue ramp-up by gradually activating additional airguns over a period of at least 20 minutes, but no longer than 40 minutes, until the desired operating level of the airgun array is obtained.
4. Immediately shut down all airguns ceasing seismic operations at any time a whale is detected entering or within the exclusion zone. You may recommence seismic operations and ramp-up of airguns only when the exclusion zone has been visually inspected for at least 30 minutes to ensure the absence of marine mammals and sea turtles.
5. You may reduce the source level of the airgun array, using the same shot interval as the seismic survey, to maintain a minimum source level of 160 dB re 1 μPa-m (rms) for the duration of certain activities. By maintaining the minimum source level, you will not be required to conduct the 30-minute visual clearance of the exclusion zone before ramping back up to full output. Activities that are appropriate for maintaining the minimum source level are: (1) all turns between transect lines, when a survey using the full array is being conducted immediately prior to the turn and will be resumed immediately after the turn; and (2) unscheduled, unavoidable maintenance of the airgun array that requires the interruption of a survey to shut down the array. The survey should be resumed immediately after the repairs are completed. There may be other occasions when this practice is appropriate, but use of the minimum source level to avoid the 30-minute visual clearance of the exclusion zone is only for events that occur during a survey using the full power array. The minimum sound source level is not to be used to allow a later ramp-up after dark or in conditions when ramp-up would not otherwise be allowed.

Protected Species Observer Program

Visual Observers

Visual observers who have completed a protected species observer training program as described below are required on all seismic vessels conducting operations in water depths greater than 200 meters (656 ft) throughout the GOM. Visual observers are required on all seismic vessels conducting operations in OCS water depths less than 200 meters (656 ft.) in the GOM waters east of 88.0° W. longitude. At least two protected species visual observers will be required on watch aboard seismic vessels at all times during daylight hours (dawn to dusk) when seismic operations are being conducted, unless conditions (fog, rain, darkness) make sea surface observations impossible. If conditions deteriorate during daylight hours such that the sea surface observations are halted, visual observations must resume as soon as conditions permit. Operators may engage trained third party observers, may utilize crew members after training as observers, or may use a combination of both third party and crew observers. During these observations, the following guidelines shall be followed: (1) other than brief alerts to bridge personnel of maritime hazards, no additional duties may be assigned to the observer during his/her visual observation watch (if conditions warrant more vigilant look-outs when navigating around or near maritime hazards, additional personnel must be used to ensure that watching for protected species remains the primary focus of the on-watch observers), (2) no observer will be allowed more than 4 consecutive hours on watch as a visual observer, (3) a “break” time of no less than 2 hours must be allowed before an observer begins another visual monitoring watch rotation (break time means no assigned observational duties), and (4) no person (crew or third party) on watch as a visual observer will be assigned a combined watch schedule of more than 12 hours in a 24-hour period. Due to the concentration and diligence required

during visual observation watches, operators who choose to use trained crew members in these positions may select only those crew members who demonstrate willingness as well as ability to perform these duties.

Training

All visual observers must have completed a protected species observer training course. MMS will not sanction particular trainers or training programs. However, basic training criteria have been established and must be adhered to by any entity that offers observer training. Operators may utilize observers trained by third parties, may send crew for training conducted by third parties, or may develop their own training program. All training programs offering to fulfill the observer training requirement must: (1) furnish to MMS, at the address listed in this NTL, a course information packet that includes the name and qualifications (i.e., experience, training completed, or educational background) of the instructor(s), the course outline or syllabus, and course reference material; (2) furnish each trainee with a document stating successful completion of the course; and (3) provide MMS with names, affiliations, and dates of course completion of trainees.
The training course must include the following elements:

I. Brief overview of the MMPA and the ESA as they relate to seismic acquisition and protection of marine mammals and sea turtles in the GOM,

II. Brief overview of seismic acquisition operations in the GOM,

III. Overview of seismic mitigation measures (NTLs) and the protected species observer program in the GOM,

IV. Discussion of the role and responsibilities of the protected species observer in the GOM, including:
- a) Legal requirements (why you are here and what you do),
- b) Professional behavior (code of conduct),
- c) Integrity,
- d) Authority of protected species observer to call for shut-down of seismic acquisition operations,
- e) Assigned duties,
- 1) What can be asked of the observer,
- 2) What cannot be asked of the observer,
- f) Reporting of violations and coercion,

V. Identification of GOM marine mammals and sea turtles, with emphasis on whales,

VI. Cues and search methods for locating marine mammals, especially whales, and sea turtles,

VII. Data collection and reporting requirements:

a) Forms and reports to MMS via email at protectedspecies@mms.gov on the 1st and 15th of each month,

b) Whale in exclusion zone/shut-down report within 24 hours.

Visual Monitoring Methods

The observers on duty will look for whales, other marine mammals, and sea turtles using the naked eye and hand-held binoculars provided by the seismic vessel operator. The observers will stand watch in a suitable location that will not interfere with navigation or operation of the vessel and that affords the observers an optimal view of the sea surface. The observers will provide 360^{o} coverage surrounding the seismic vessel and will adjust their positions appropriately to ensure adequate

coverage of the entire area. These observations must be consistent, diligent, and free of distractions for the duration of the watch.

Visual monitoring will begin no less than 30 minutes prior to the beginning of ramp-up and continue until seismic operations cease or sighting conditions do not allow observation of the sea surface (e.g., fog, rain, darkness). If a marine mammal or sea turtle is observed, the observer should note and monitor the position (including lat./long. of vessel and relative bearing and estimated distance to the animal) until the animal dives or moves out of visual range of the observer. Make sure you continue to observe for additional animals that may surface in the area, as often there are numerous animals that may surface at varying time intervals. At any time a whale is observed within an estimated 500 meters (1,640 feet) of the sound source array ("exclusion zone"), whether due to the whale's movement, the vessel's movement, or because the whale surfaced inside the exclusion zone, the observer will call for the immediate shut-down of the seismic operation, including airgun firing (the vessel may continue on its course but all airgun discharges must cease). The vessel operator must comply immediately with such a call by an on-watch visual observer. Any disagreement or discussion should occur only after shut-down. When no marine mammals or sea turtles are sighted for at least a 30-minute period, ramp-up of the source array may begin. Ramp-up cannot begin unless conditions allow the sea surface to be visually inspected for marine mammals and sea turtles for 30 minutes prior to commencement of ramp-up (unless the method described in the section entitled "Experimental Passive Acoustic Monitoring" is used). Thus, ramp-up cannot begin after dark or in conditions that prohibit visual inspection (fog, rain, etc.) of the exclusion zone. Any shut-down due to a whale(s) sighting within the exclusion zone must be followed by a 30-minute all-clear period and then a standard, full ramp-up. Any shut-down for other reasons, including, but not limited to, mechanical or electronic failure, resulting in the cessation of the sound source for a period greater than 20 minutes, must also be followed by full ramp-up procedures. In recognition of occasional, short periods of the cessation of airgun firing for a variety of reasons, periods of airgun silence **not exceeding 20 minutes** in duration will not require ramp-up for the resumption of seismic operations if: (1) visual surveys are continued diligently throughout the silent period (requiring daylight and reasonable sighting conditions), and (2) no whales, other marine mammals, or sea turtles are observed in the exclusion zone. If whales, other marine mammals, or sea turtles are observed in the exclusion zone during the short silent period, resumption of seismic survey operations must be preceded by ramp-up.

Reporting

The importance of accurate and complete reporting of the results of the mitigation measures cannot be overstated. Only through diligent and careful reporting can MMS, and subsequently NOAA Fisheries, determine the need for and effectiveness of mitigation measures. Information on observer effort and seismic operations are as important as animal sighting and behavior data. In order to accommodate various vessels' bridge practices and preferences, vessel operators and observers may design data reporting forms in whatever format they deem convenient and appropriate. Alternatively, observers or vessel operators may adopt the United Kingdom's Joint Nature Conservation Committee forms (available at their website www.jncc.gov.uk). At a minimum, the following items should be recorded and included in reports to the MMS:

Observer Effort Report: Prepared for each day during which seismic acquisition operations are conducted. Furnish an observer effort report to MMS on the 1st and the 15th of each month that includes:

- Vessel name,
- Observers' names and affiliations,
- Survey type (e.g., site, 3D, 4D),
- MMS Permit Number (for "off-lease seismic surveys") or OCS Lease Number (for "on-lease seismic surveys"),
- Date,
- Time and lat./long. when daily visual survey began,
- Time and lat./long. when daily visual survey ended,
- Average environmental conditions while on visual survey, including

Wind speed and direction,
Sea state (glassy, slight, choppy, rough or Beaufort scale),
Swell (low, medium, high or swell height in meters),
Overall visibility (poor, moderate, good).

Survey Report: Prepared for each day during which seismic acquisition operations are conducted and the airguns are being discharged. Furnish a survey report to MMS on the 1st and the 15th of each month during which operations are being conducted that includes:

- Vessel name,
- Survey type (e.g., site, 3D, 4D),
- MMS Permit Number (for "off-lease seismic surveys") or OCS Lease Number (for "on-lease seismic surveys"),
- Date,
- Time pre-ramp-up survey begins,
- What marine mammals and sea turtles were seen during pre-ramp-up survey?
- Time ramp-up begins,
- Were whales seen during ramp-up?
- Time airgun array is operating at the desired intensity,
- What marine mammals and sea turtles were seen during survey?
- If whales were seen, was any action taken (i.e., survey delayed, guns shut down)?
- Reason that whales might not have been seen (e.g., swell, glare, fog),
- Time airgun array stops firing.

Sighting Report: Prepared for each sighting of a marine mammal (whale or dolphin) or sea turtle made during seismic acquisition operations. Furnish a sighting report to MMS on the 1st and the 15th of each month during which operations are being conducted that includes:

- Vessel name,
- Survey type (e.g., site, 3D, 4D),
- MMS Permit Number (for "off-lease seismic surveys") or OCS Lease Number (for "on-lease seismic surveys"),
- Date,
- Time,
- Watch status (Were you on watch or was this sighting made opportunistically by you or someone else?),

- Observer or person who made the sighting,
- Lat./long. of vessel,
- Bearing of vessel,
- Bearing and estimated range to animal(s) at first sighting,
- Water depth (meters),
- Species (or identification to lowest possible taxonomic level),
- Certainty of identification (sure, most likely, best guess),
- Total number of animals,
- Number of juveniles,
- Description (as many distinguishing features as possible of each individual seen, including length, shape, color and pattern, scars or marks, shape and size of dorsal fin, shape of head, and blow characteristics),
- Direction of animal's travel – compass direction,
- Direction of animal's travel – related to the vessel (drawing preferably),
- Behavior (as explicit and detailed as possible; note any observed changes in behavior,)
- Activity of vessel,
- Airguns firing? (yes or no),
- Closest distance (meters) to animals from center of airgun or airgun array (whether firing or not).

Note: If this sighting was of a whale(s) within the exclusion zone that resulted in a shut-down of the airguns, include in the sighting report the observed behavior of the whale(s) before shut-down, the observed behavior following shut-down (specifically noting any change in behavior), and the length of time between shut-down and subsequent ramp-up to resume the seismic survey (note if seismic survey was not resumed as soon as possible following shut-down). Send this report to MMS **within 24 hours of the shut-down**. These sightings should also be included in the first regular semi-monthly report following the incident.

Additional information, important points, and comments are encouraged. All reports will be submitted to MMS on the 1st and the 15th of each month (with one exception noted above). Forms should be scanned (or data typed) and sent via email to protectedspecies@mms.gov**.**

Please note that these marine mammal and sea turtle reports are in addition to any reports you submit under NTL No. 98-20, dated September 15, 1998, and NTL No. 2005-G07, effective July 1, 2005, and all progress and final reports required as a condition of your geophysical permit.

Borehole Seismic Surveys

Borehole seismic surveys differ from surface seismic surveys in a number of ways, including the use of much smaller airgun arrays, having an average survey time of 12-24 hours, utilizing a sound source that is not usually moving at 4-5 knots, and requiring the capability of moving the receiver in the borehole between shots. Due to these differences, the following altered mitigations apply only to borehole seismic surveys:

- During daylight hours, when visual observations of the exclusion zone are being performed as required in this NTL, borehole seismic operations will not be required to ramp-up for shutdowns of 30 minutes or less in duration, as long as no whales, other marine mammals, or sea turtles are observed in the exclusion zone during the shutdown. If a whale, other marine mammal, or sea turtle is sighted in the exclusion

zone, ramp-up is required and may begin only after visual surveys confirm that the exclusion zone has been clear for 30 minutes.

- During nighttime or when conditions prohibit visual observation of the exclusion zone, ramp-up will not be required for shutdowns of 20 minutes or less in duration. For borehole seismic surveys that utilize passive acoustics during nighttime and periods of poor visibility, ramp-up is not required for shutdowns of 30 minutes or less.
- Nighttime or poor visibility ramp-up is allowed only when passive acoustics are used to ensure that no whales are present in the exclusion zone (as for all other seismic surveys). Operators are strongly encouraged to acquire the survey in daylight hours when possible.
- Protected species observers must be used during daylight hours, as required in this NTL, and may be stationed either on the source boat or on the associated drilling rig or platform if a clear view of the sea surface in the exclusion zone and adjacent waters is available.
- All other mitigations and provisions for seismic surveys as set forth in this NTL will apply to borehole seismic surveys.
- Reports should reference OCS Lease Number, Area/Block and Borehole Number.

Experimental Passive Acoustic Monitoring

Whales, especially sperm whales, are very vocal marine mammals, and periods of silence are usually short and most often occur when these animals are at the surface and may be detected using visual observers. However, sperm whales are at the greatest risk of potential injury from seismic airguns when they are submerged and under the airgun array. Passive acoustic monitoring appears to be very effective at detecting submerged and diving sperm whales, and some other marine mammal species, when they are not detectable by visual observation. MMS strongly encourages operators to participate in an experimental program by including passive acoustic monitoring as part of the protected species observer program. Inclusion of passive acoustic monitoring does **not** relieve an operator of any of the mitigations (including visual observations) in this NTL **with the following exception**: Monitoring for whales with a passive acoustic array by an observer proficient in its use will allow ramp-up and the subsequent start of a seismic survey during times of reduced visibility (darkness, fog, rain, etc.) when such ramp-up otherwise would not be permitted using only visual observers. If you use passive acoustic monitoring, include an assessment of the usefulness, effectiveness, and problems encountered with the use of that method of marine mammal detection in the reports described in this NTL. A description of the passive acoustic system, the software used, and the monitoring plan should also be reported to MMS at the beginning of its use.

Paperwork Reduction Act

The PRA (44 U.S.C. Chapter 35) requires us to inform you that we collect the information described in this NTL to ensure that you conduct operations in a manner that will not jeopardize threatened or endangered species or destroy or adversely modify critical habitat that has been designated for those species. We protect all proprietary information submitted according to the Freedom of Information Act and 30 CFR 250.196. An agency may not conduct or sponsor a collection of information unless it displays a currently valid Office of Management and Budget (OMB) control number. You are not obligated to respond until the OMB has approved this

collection of information. We estimate the total hour burden to be 751 hours and the total "non-hour cost" burden to be $1,854,080. Direct comments regarding the burden, or any other aspect of this information collection, to the Information Collection Clearance Officer, Mail Stop 5438, Minerals Management Service, 1849 C Street, NW, Washington, DC 20240.

In addition, this NTL refers to information collection requirements under 30 CFR 250, subpart B. The OMB has approved all of the information collection requirements in these regulations and assigned OMB Control Number 1010-0151.

Contact

Any questions regarding this NTL should be submitted in writing to: protectedspecies@mms.gov. Submittals by mail may be directed to:

Minerals Management Service Gulf of Mexico OCS Region Attention: Environmental Sciences Unit (MS 5430) 1201 Elmwood Park Blvd. New Orleans, LA 70123-2394

[original signed by]

Chris C. Oynes Regional Director

The Department of the Interior Mission

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the sound use of our land and water resources, protecting our fish, wildlife and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island communities.

The Bureau of Ocean Energy Management

The Bureau of Ocean Energy Management (BOEM) works to manage the exploration and development of the nation's offshore resources in a way that appropriately balances economic development, energy independence, and environmental protection through oil and gas leases, renewable energy development and environmental reviews and studies.