Marine Mammal Monitoring During a Low-Energy Seismic Survey by the Scripps Institution of Oceanography Vessel *R/V Roger Revelle*

in the Louisville Ridge area of the Southwestern Pacific Ocean,

January – March, 2006

Prepared by

Scripps Institution of Oceanography
Ship Operations & Marine Technical Support
9500 Gilman Drive
La Jolla, California 92093-0210

FORWARD

This document serves to meet reporting requirements specified by the National Marine Fisheries Service, Office of Protected Resources (NMFS/OPR) in an Incidental Harassment Authorization (IHA) issued to Scripps Institution of Oceanography (SIO) on January 20, 2006. The IHA (Appendix A) authorized non-lethal takes of certain marine mammals incidental to a marine seismic survey in the southwest Pacific Ocean. Behavioral disturbance of marine mammals is considered to be "take by harassment" under the provisions of the U.S. Marine Mammal Protection Act (MMPA).

The temporary or permanent impact of seismic exploration sounds to any marine mammals is unknown. Nonetheless, to minimize the possibility of any injurious effects (auditory or otherwise), and to document the extent and nature of any disturbance effects, NMFS requires that seismic research conducted under IHAs include provisions to monitor for marine mammals and to power down the seismic sources when mammals are detected within designated safety radii. Safety radii were defined based on the estimated radius at which the received level of seismic sounds (on an rms basis) was expected to diminish to 180 dB re 1 μPa, as specified by NMFS. The IHA also required monitoring and mitigation procedures to minimize potential harassment of sea turtles using the same safety zone.

TABLE OF CONTENTS

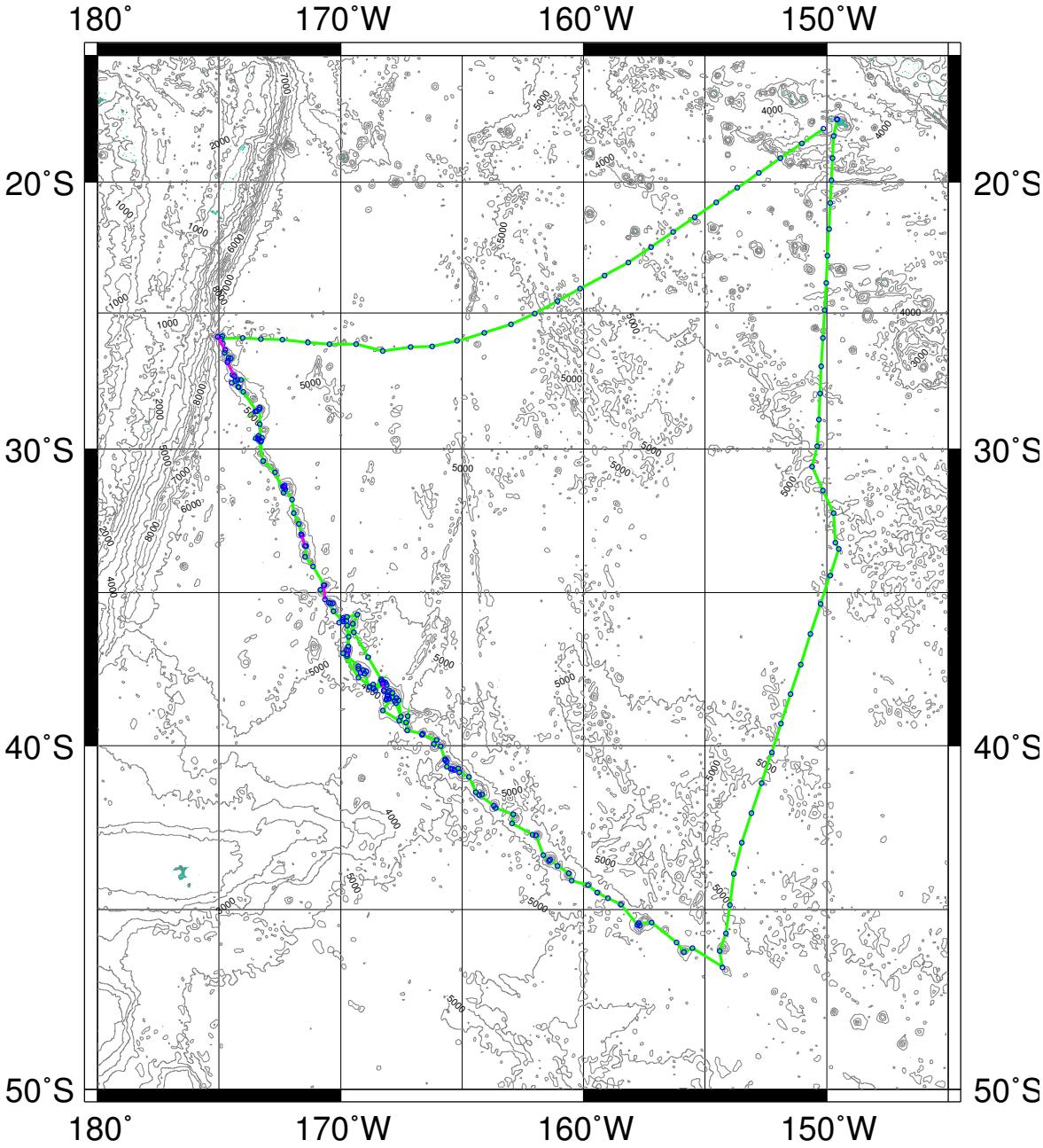
I. INTRODUCTION

A site survey cruise for the International Ocean Drilling Program (IODP) was conducted by Scripps Institution of Oceanography (SIO) aboard the *Research Vessel Roger Revelle* in the southwestern Pacific Ocean (Figure 1). The low-energy seismic reflection system was just one tool in the integrated marine geology and geophysical studies that also employed a bathymetric echosounder, passive geophysical sensors (gravimeter, magnetometer), and geologic sampling tools (rock dredges).

The Louisville seamount chain is a 4300km long but only 75km wide belt of submarine volcanoes that are inferred to have been built in the past 80 Myr as the Pacific plate moved over a persistent melt anomaly or hotspot. In many ways the chain is the South Pacific counterpart of the much better known and much more accessible Hawaiian-Emperor chain, where some of the extinct and active volcanoes are exposed as islands. The field research was designed (i) to test hypotheses about the eruptive history of the chain and the subsequent formation (by subaerial erosion and submergence) of its many guyots, and about motion of the hotspot plume, and (ii) for collection and interpretation of data needed to design an effective IODP drilling campaign on carefully selected Louisville seamounts.

The cruise departed Papeete, Tahiti on January 20, 2006 and ended back in Papeete on March 3, 2006. The research was completely in International Waters. There were a few days of transiting with the ship to and from port, when no scientific work was performed.

Figure 1. Cruise track of *R/V Roger Revelle*.
Green = Seismic System Secured, Magenta = Seismic System Active



II. SCIENTIFIC PERSONNEL

Three observers were onboard for the entire cruise specifically to conduct the marine mammal mitigation and monitoring procedures. All observers were accredited by NMFS, having previous training and experience with NMFS marine mammal surveys in the eastern tropical Pacific Ocean. In addition, all observers had experience in field identification of sea turtles.

The full scientific party list was:

NAME	POSITION	INSTITUTION
Lonsdale,Dr.P.	Chief Scientist	SIO
Mahoney, Dr.J.	Scientist	Univ. of Hawaii
Gee, Dr.J.	Scientist	SIO
Eakins, Dr.B.	Scientist	SIO
Koppers, Dr.A.	Scientist	SIO
Comer,R.L.	Resident Technician	SIO
Dorrance, J.	Resident Technician	SIO
Laughlin, J.	Computer Technician	SIO
Ellett, L.	Geophysical Engineer	SIO
Perez, J.	Lab Assistant	SIO
Vanderkluysen, L.	Graduate Student	Univ. Of Hawaii
Konder, J.	Marine Mammal Observer	NOAA
Morse, L.	Marine Mammal Observer	NOAA
Goldstein, H.	Marine Mammal Observer	NOAA

III. SEISMIC SYSTEMS

The seismic sound source was a pair of Generator-Injector (G.I.) “GUNs” manufactured by Seismic Systems, Inc. (SSI) of Houston, Texas. The generator chamber of each G.I. GUN, the one responsible for introducing the sound pulse into the ocean, is 45 in3. The larger (105 in3) injector chamber injects air into the previously-generated bubble to maintain its shape, and does not introduce more sound into the water. The two 45/105 in3 G.I. GUNs were towed 8 m apart side by side, 20 m behind the *Roger Revelle,* at a depth of 2 m.

GI Airgun Specifications

Energy Source	Two GI guns of 45 in^3
Source output (downward)	0-pk is 3.4 bar-m (230.7 dB re 1 μPa·m); pk-pk is 6.2 bar-m (235.9 dB)
Towing depth of energy source	2 m
Air discharge volume	Approx. 90 in^3
Dominant frequency components	0–188 Hz
Gun positions used	Two side by side guns 8 m apart
Gun volumes at each position (in^3)	45, 45

The nominal downward-directed source levels indicated above do not represent actual sound levels that can be measured at any location in the water. Rather, they represent the level that would be found 1 m from a hypothetical point source emitting the same total amount of sound as is emitted by the combined GI guns. The actual received level at any location in the water near the GI guns will not exceed the source level of the strongest individual source. In this case, that will be about 224.6 dB re 1μPa-m peak, or 229.8 dB re 1μPa-m peak-to-peak. Actual levels experienced by any organism more than 1 m from either GI gun will be significantly lower.

A further consideration is that the rms1 (root mean square) received levels that are used as impact criteria for marine mammals are not directly comparable to the peak or peak to peak values normally used to characterize source levels of airgun arrays. The measurement units used to describe airgun sources, peak or peak-to-peak decibels, are always higher than the "root mean square" (rms) decibels referred to in biological literature. A measured received level of 160 decibels rms in the far field would typically correspond to a peak measurement of about 170 to 172 dB, and to a peak-to-peak measurement of about 176 to 178 decibels, as measured for the same pulse received at the same location (Greene 1997; McCauley et al. 1998, 2000). The precise difference between rms and peak or peak-to-peak values depends on the frequency content and duration of the pulse, among other factors. However, the rms level is always lower than the peak or peak-to-peak level for an airgun-type source.

Received sound levels have been modeled by L-DEO for a number of airgun configurations, including two 45-in3 Nucleus G-guns, in relation to distance and direction from the airguns (Figure 2). The model does not allow for bottom interactions, and is most directly applicable to deep water. Based on the modeling, estimates of the maximum distances from the GI guns where sound levels of 190, 180, 170, and 160 dB re 1 μPa (rms) are predicted to be received in deep (>1000-m) water are shown in Table 1. Because the model results are for G guns, which have more energy than GI guns of the same size, those distances are overestimates of the distances for the 45-in3 GI guns.

Empirical data concerning the 180-, 170-, and 160- dB distances have been acquired based on measurements during the acoustic verification study conducted by L-DEO in the

[1] The rms (root mean square) pressure is an average over the pulse duration.

northern Gulf of Mexico from 27 May to 3 June 2003 (Tolstoy et al. 2004). Although the results are limited, the data showed that radii around the airguns where the received level would be 180 dB re 1 µPa (rms), the safety criterion applicable to cetaceans (NMFS 2000), vary with water depth. Similar depth-related variation is likely in the 190-dB distances applicable to pinnipeds. Correction factors were developed for water depths 100–1000 m and <100 m. The proposed survey will occur in depths 800–2300 m, so only the correction factor for intermediate water depths is relevant here.

The empirical data indicate that, for deep water (>1000 m), the L-DEO model tends to overestimate the received sound levels at a given distance (Tolstoy et al. 2004). However, to be precautionary pending acquisition of additional empirical data, it is proposed that safety radii during airgun operations in deep water will be the values predicted by L-DEO's model (Table 1). Therefore, the assumed 180- and 190-dB radii are 40 m and 10 m, respectively.

TABLE 1. Distances to which sound levels ≥190, 180, 170, and 160 dB re 1 µPa (rms) might be received from two 45-in^3 G guns, similar to the two 45-in^3 GI guns that will be used during the seismic survey in the SW Pacific Ocean during January–February 2006. Distances are based on model results provided by the Lamont-Doherty Earth Observatory of Columbia University.

Water depth	Estimated Distances at Received Levels (m)			
	190 dB	180 dB	170 dB	160 dB
100–1000 m	15	60	188	525
>1000 m	10	40	125	350

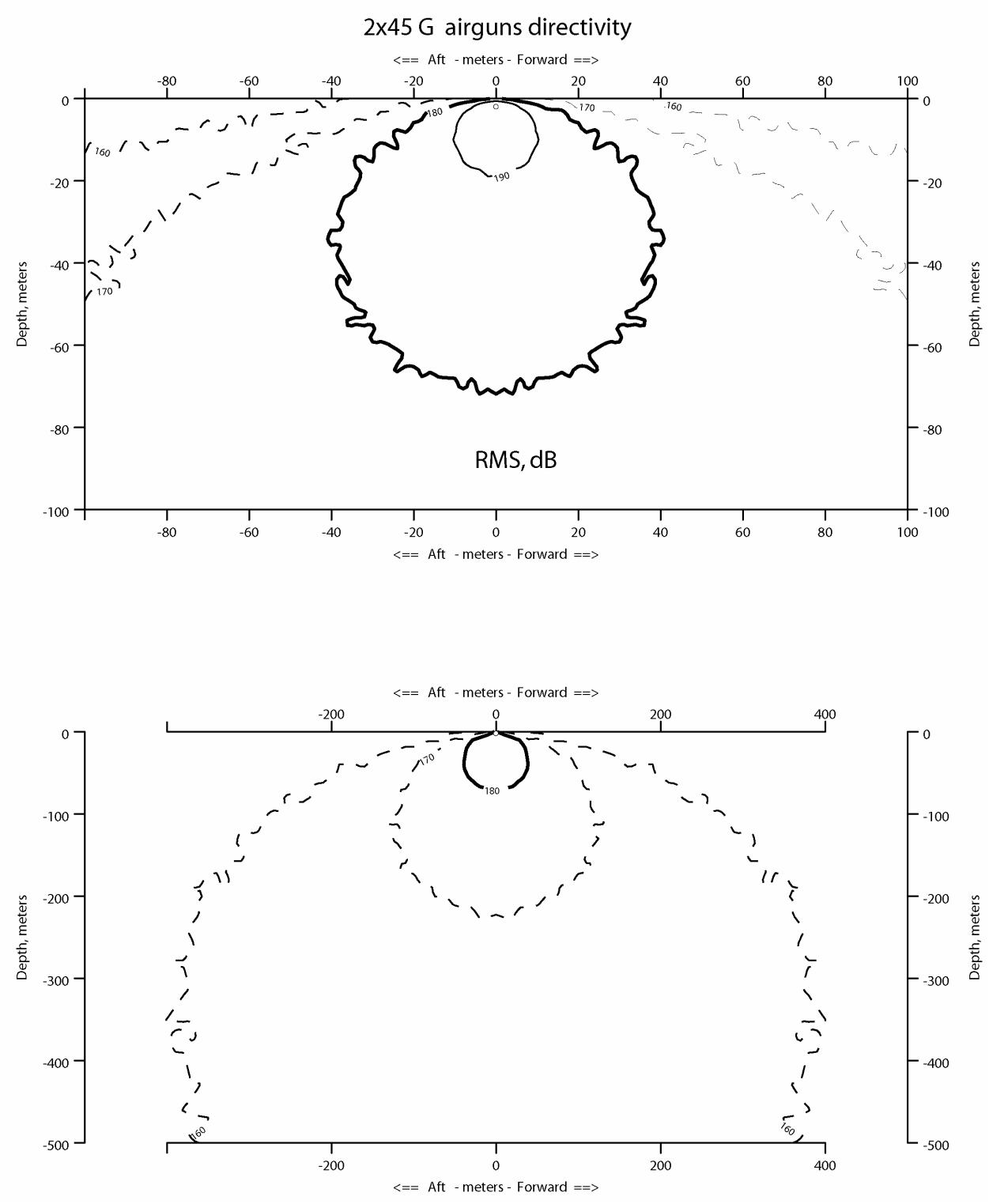


FIGURE 2. Modeled received sound levels from two 45-in^3 G guns, similar to the two 45-in^3 GI guns used during the SIO survey in the SW Pacific Ocean during January–February 2006. Model results provided by the Lamont-Doherty Earth Observatory of Columbia University.

IV. MITIGATION PROCEDURES

The primary responsibility of the marine mammal observers (MMOs) was to maintain a watch for marine mammals, sea turtles, and other protected marine animal species within the designated 40-meter safety radius around the seismic GI gun source, and alert the seismic personnel, who would then shut down the seismic source.

Mitigation watches by at least one observer were conducted 100% of the time from civil sunrise (approximately 30 minutes before sunrise) to civil sunset (approximately 30 minutes after sunset) during seismic operations, regardless of weather or sea conditions. The observer platform was located one deck below and forward of the bridge (12.46 meters above the waterline), affording relatively unobstructed 180-degree forward view. Aft views of the vessel could be obtained along the port and starboard decks, as well as above the Hanger overlooking the stern (Figure 3).

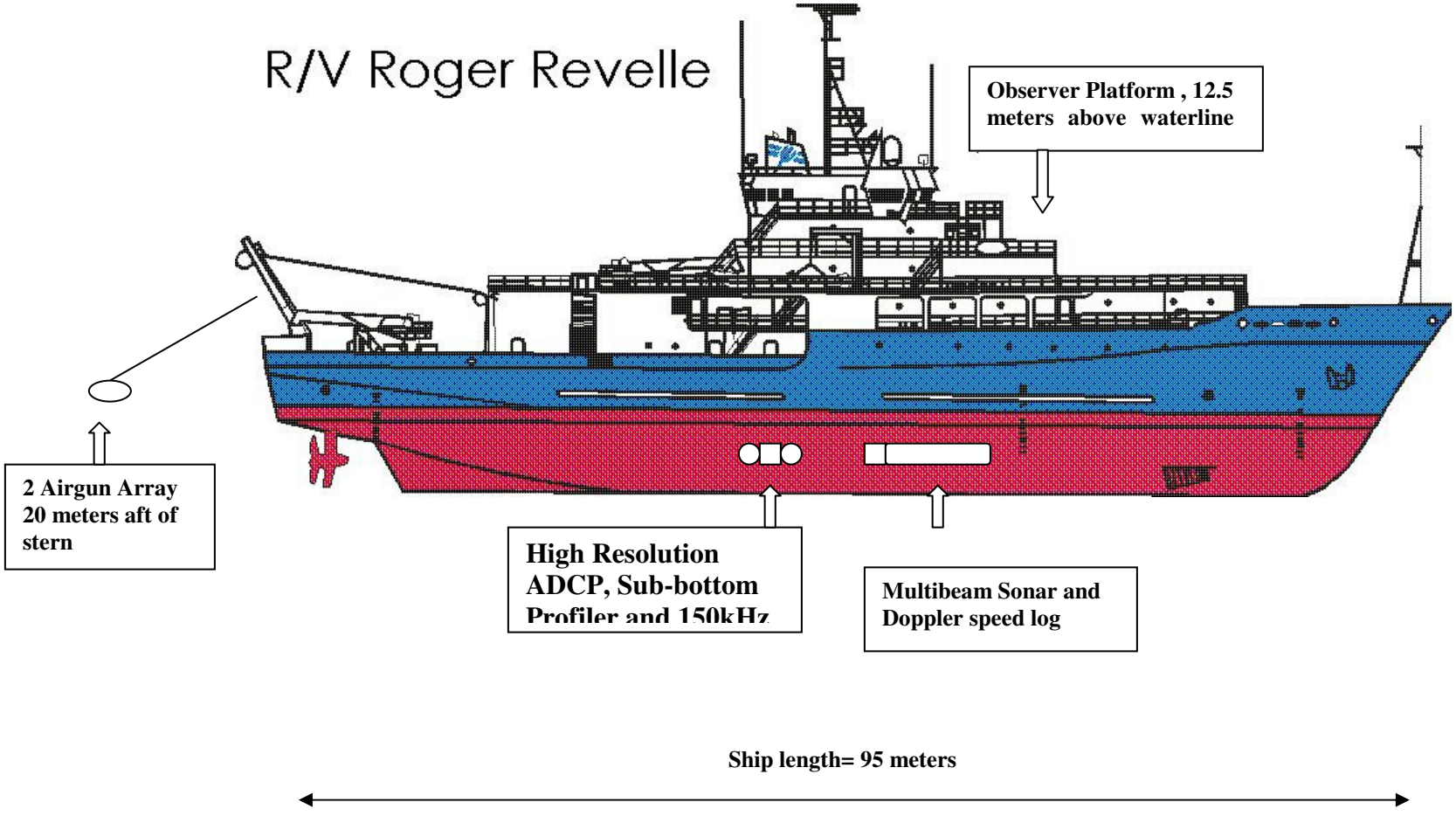
Before commencing seismic operations, two observers would maintain a 360-degree watch around the research vessel for all marine mammals and sea turtles for at least 30 minutes. If no marine mammals were observed within the safety radius during this time, the MMOs would notify the seismic personnel of an "all clear" status. A ramp-up procedure was employed when beginning seismic operations. With the MMOs on watch, the ramp-up procedure consisted of one seismic source being energized, and after 5 minutes the second seismic source would be brought on-line only after confirmation that no animals were sighted within the 180 dB safety radius.

After ramp-up, one or two MMOs would stand watch during daylight hours. Watch periods were scheduled as a 2-hour rotation. The observers continually scanned the water from the horizon to the ship's hull, and forward of 90 degrees from the bow port and starboard. In the event of any marine mammal or sea turtle approaching or entering within the 40 meter seismic safety zone, the seismic personnel were contacted via handheld VHF radios and the seismic source was secured (shut down) for the duration of the animal's presence within the zone, as determined by the observer on duty. Seismic operations were resumed only after the animals were seen to exit the safety radius, or after no further visual detection of the animal for 15 minutes (for small ondontocetes and pinnipeds) or 30 minutes (for mysticetes and large odontocetes).

Observers utilized reticulated 25 x 150 big-eye binoculars as well as reticulated 7 x 50 handheld binoculars with an internal compass to determine bearing and distance of sightings. A handheld fixed range-finder was used to measure and mark the location of the 40 meter seismic safety zone (Heinemann 1981). These simple devices proved more reliable for open water sighting than the laser range finders which were also provided. The 25 x 150 big-eye binoculars, mounted on a stand located on the port side of the observing station, were utilized for identification of animals sighted at a distance.

The MMOs provided brief training to the bridge and science crew at the beginning of the cruise. More importantly, the bridge officers and any other ship personnel were instructed to alert

Ship Specifics for Marine Mammal Observations



the observer on watch of any suspected marine mammal or sea turtle sighting. A VHF radio on the bridge and in the science lab space was tuned to the same frequency used by the MMOs and seismic personnel. Thus, bridge crew and scientists could monitor communication between the observers and seismic personnel and prepare to maneuver the ship to avoid interception with approaching marine mammals or sea turtles.

When seismic operations continued through the night no MMOs were required to stand watch, but the bridge crew were instructed to stay alert for possible signs of marine mammals. The MMOs would resume watch at civil twilight-sunrise. When seismic operations were halted or restarted at night, they were resumed after a 30 minute observation period of the seismic safety zone utilizing night-vision binoculars and a ramp-up procedure, conducted by the 2 MMOs on watch. Also, MMOs were required to observe when deploying or recovering scientific gear. Observation during the start up protocol was conducted from the top of the aft hanger, and all lights were turned off so the 40 meters safety radius could be well viewed by the night-vision binoculars.

Data collection procedures were adapted from line-transect protocols developed by the National Oceanic and Atmospheric Administration (NOAA) Southwest Fisheries Science Center (SWFSC) for their marine mammal abundance research cruises (Kinzey et al 2000; Mesnick, unpublished). The data collection software package WinCruz (http://swfsc.nmfs.noaa.gov/PRD/software/WinCruz.pdf) written by Robert Holland at SWFSC was utilized for these cruises. A laptop computer was located on the observer platform for ease of data entry. The computer was connected to the ship's Global Position System (GPS), which allowed a record of time and position to be made at 3-minute intervals and for each event entered (such as sightings, weather updates and effort changes). The computer was also interfaced with the ship's network, allowing data backup to be made in real time to the ship's server. WinCruz DAS files were created for each day's survey effort, and were edited and saved at the end of each day.

Watch effort is recorded in WinCruz in "passing" or "closing" mode. Passing mode indicated that the vessel does not purposely approach the sighting and so was used exclusively for these cruises. Effort is further identified as being "on" or "off". For the purpose of these cruises, "on effort" is when one or both observers are on watch.

When a marine mammal or sea turtle is first sighted, a sighting event is made in WinCruz, the bearing and distance are recorded and a unique number is generated for the sighting (Kinsey et al 2000). WinCruz automatically calculates distances when 7 x 50 and 25 x 150 reticle values are entered based on the observers' height above the water (12.46 meters) (Table 2). Aided by the GPS input, WinCruz plots sightings on a real time map. This function permits MMOs to track animals and helps minimize duplicate sightings. The map is particularly useful in assisting with relocation of animals that are lost from view or to avoid duplicate sighting data of the same school or pod when the vessel changes course. At the completion of the sighting, estimates of group size were recorded. A two sided sighting form (NOAA form 88-208, Appendix B) was filled out detailing identification characteristics and behavior of the animals observed. Particular attention has been taken for this survey to record as much behavioral information as possible (Mesnick, unpublished).

Table 2. Calculated Distances in Reference to Reticle Values of Binoculars. This scale is for the observer platform level on the *RVRoger Revelle* (one level below bridge-12.47 meters),

Reticle	Nmiles 7x	Meters	NM 25x	Meters	7x on bridge	Meters
0	6.81	12,598	6.81	12,598	7.46	13816
0.1	3.39	6278	4.71	8723	3.83	7093
0.2	2.59	4791	4.06	7519	2.96	5482
0.4	1.82	3367	3.3	6112	2.1	3889
0.6	1.41	2609	2.83	5151	1.64	3037
0.8	1.16	2146	2.49	4611	1.36	2519
1	0.99	1832	2.24	4148	1.16	2148
1.5	0.72	1332	1.8	3334	0.85	1574
2	0.57	1054	1.51	2797	0.67	1241
2.5	0.47	870	1.3	2408	0.56	1037
3	0.4	741	1.15	2130	0.47	870
4	0.31	574	0.93	1722	0.37	685
5	0.25	462	0.78	1444	0.3	556
6	0.21	388	0.67	1241	0.25	463
7	0.18	333	0.59	1093	0.22	407
8	0.16	296	0.53	981	0.19	352
9	0.14	259	0.48	889	0.17	315
10	0.13	240	0.44	815	0.16	296
11	0.12	222	0.4	741	0.14	259
12	0.11	203	0.37	685	0.13	240
13	0.1	185	0.34	630	0.12	222
14	0.09	166	0.32	593	0.11	203
15	0.09	166	0.3	556	0.11	203
16	0.08	148	0.29	537	0.1	185

The observers entered values in WinCruz for weather conditions, such as Beaufort state, swell size and direction, wind speed and direction, and visibility (quantified in nautical miles) as conditions changed during their watch. The SWFSC software also provides an event key to record vessel traffic, distance and bearing relative to the research ship. Finally, a comment key is available to add any additional information as necessary.

At the end of each day, the observers checked the sighting data for errors and edited as appropriate. Behavioral data was coded and entered into separate databases for marine mammals and sea turtles (Mesnick et al, 2002).

In instances, events, and weather conditions where the MMO laptop computer could not be used, paper sheets were used to collect data and adapted from Lamont-Doherty Earth Observatory/LGL Environmental Consulting, Inc. marine mammal and sea turtle monitoring and observation procedures. The information collected by this method included observation location, date, watch start or end, observer on watch, time, vessel position (latitude and longitude), seismic activity, sea state, visibility, glare, and marine mammal sighting data (identification #, number of individuals, movement, behaviors, location, initial distance, closest point of approach, sighting cue, identification reliability, pace, and any other comments). The paper data sheets were checked for accuracy and the data entered into a computer database program.

Whenever possible, the MMOs maintained a daytime watch schedule on days without seismic operations. MMOs were relieved during meal times. When seismic operations were not being performed, watch was suspended during poor sighting conditions, such as high Beaufort sea state and rain. An observer watch was also conducted during dredge operations, even while the vessel was on station.

V. OBSERVATIONS

Seismic operations were conducted on 96 distinct periods during the 43 days of this cruise. (Table 3). This resulted from running short high resolution survey lines over the tops of individual sea mounts in perpendicular directions, with the seismic source secured during the turns. The seismic source was active for 146 of the 1000 hours of this cruise.

There were 5 sightings of marine mammals and no sightings of sea turtles or other protected marine animals during this cruise (Table 4). All observed marine mammals were non-evasive of the research ship and its activities. Only one sighting occurred while the seismic source was active. This animal's closest approach to the ship was greater than 2 kilometers, well outside the 40 m safety radius for the seismic source used on this cruise.

TABLE 3. Seismic Operations Log

START		S		W		END		S		W	
Date	Time	Lat Deg	Lat Min	Lon Deg	Lon Min	Date	Time	Lat Deg	Lat Min	Lon Deg	Lon Min
26-Jan	0955	25	56.308	174	01.857	26-Jan	1404	25	53.56	174	48.92
26-Jan	1410	25	53.821	174	49.636	26-Jan	1644	26	01.78	175	04.67
26-Jan	1735	25	58.932	175	06.254	26-Jan	1934	25	54.14	174	53.02
26-Jan	2209	25	54.262	175	03.14	27-Jan	0032	26	04.78	174	51.43
27-Jan	0036	26	05.899	174	51.03	27-Jan	0139	26	15.69	174	49.29
27-Jan	0159	26	19.039	174	48.69	27-Jan	0218	26	20.91	174	48.35
27-Jan	0283	26	22.157	174	47.381	27-Jan	0313	26	23.227	174	44.27
27-Jan	0331	26	24.92	174	42.41	27-Jan	0427	26	30.91	174	44.13
27-Jan	0546	26	28.462	174	46.724	27-Jan	0637	26	28.73	174	40.88
27-Jan	0702	26	30.647	174	39.527	27-Jan	0724	26	32.86	174	40.35
27-Jan	0733	26	33.797	174	40.241	27-Jan	0946	26	45.85	174	33.59
27-Jan	0155	26	41.814	174	31.144	27-Jan	1155	26	36.66	174	35.11
27-Jan	1306	26	37.52	174	32.229	27-Jan	1422	26	42.76	174	38.65
27-Jan	1531	26	39.821	174	39.582	27-Jan	1745	26	38.886	174	25.004
27-Jan	1857	26	37.362	174	28.999	27-Jan	2030	26	44.80	174	36.026
27-Jan	2241	26	56.20	174	40.00	28-Jan	0107	27	17.03	174	31.509
28-Jan	0120	27	17.715	174	31.60	28-Jan	0216	27	18.395	174	23.83
28-Jan	0240	27	20.04	174	22.883	28-Jan	0321	27	24.30	174	25.838
28-Jan	0343	27	26.413	174	25.531	28-Jan	0745	27	48.388	174	09.718
28-Jan	0827	27	46.85	174	07.315	28-Jan	1126	27	30.391	174	15.505
28-Jan	1210	27	29.463	174	12.56	28-Jan	1407	27	40.666	174	06.96
28-Jan	1453	27	39.441	174	04.203	28-Jan	1621	27	31.148	174	08.233
28-Jan	1310	27	33.98	174	03.93	28-Jan	2051	27	35.14	174	22.86
29-Jan	2189	28	39.68	173	42.81	29-Jan	2150	28	38.12	173	38.83
29-Jan	2150	28	38.12	173	38.83	29-Jan	2320	28	38.728	173	27.729
29-Jan	2328	28	38.62	173	27.48	29-Jan	2357	28	35.957	173	25.27
30-Jan	0009	28	35.392	173	24.009	30-Jan	0141	28	33.247	173	12.919
30-Jan	0240	28	35.612	173	15.799	30-Jan	0348	28	30.031	173	19.216
30-Jan	0420	28	31.66	173	21.36	30-Jan	0530	28	38.63	173	16.61
1-Feb	1200	31	32.332	172	14.35	1-Feb	1305	31	27.26	172	08.079
1-Feb	1348	31	24.922	172	10.491	1-Feb	1448	31	29.433	172	15.889

START		S		W		END		S		W	
Date	Time	Lat Deg	Lat Min	Lon Deg	Lon Min	Date	Time	Lat Deg	Lat Min	Lon Deg	Lon Min
1-Feb	1535	31	26.992	172	18.469	1-Feb	1726	31	19.396	172	09.224
1-Feb	1823	31	18.20	172	13.14	1-Feb	1946	31	24.94	172	20.39
1-Feb	2032	31	21.63	172	23.10	1-Feb	2142	31	16.80	172	17.47
1-Feb	2226	31	14.59	172	20.11	1-Feb	2342	31	19.309	172	27.138
2-Feb	0106	31	15.671	172	26.26	2-Feb	0515	31	33.409	172	03.576
2-Jan	0927	32	10.534	171	53.517	2-Feb	1001	32	13.94	171	52.64
2-Jan	1104	32	12.25	171	51.47	2-Feb	1144	32	14.319	171	55.471
2-Jan	1312	32	25.77	171	48.20	2-Feb	1429	32	34.276	171	48.201
2-Jan	1531	32	31.80	171	50.91	2-Feb	1622	32	32.81	171	44.86
2-Jan	1718	32	42.14	171	40.60	2-Feb	1812	32	43.898	171	35.869
2-Jan	1908	32	41.09	171	36.35	2-Feb	1948	32	44.28	171	39.07
2-Jan	2116	32	57.78	171	37.40	2-Feb	2205	33	02.39	171	35.86
2-Jan	9345	33	17.82	171	31.22	3-Feb	0107	33	25.615	171	27.101
3-Feb	0203	33	24.527	171	30.90	3-Feb	0242	33	24.038	171	26.422
3-Feb	0322	33	20.479	171	25.862	3-Feb	0407	33	21.442	171	31.501
3-Feb	0408	33	21.442	171	31.501	3-Feb	0558	33	35.46	171	31.35
3-Feb	0600	33	38.46	171	31.35	3-Feb	0713	33	43.786	171	24.528
3-Feb	0852	33	43.614	171	30.26	3-Feb	0951	33	40.396	171	24.047
3-Feb	1130	33	53.40	171	14.60	3-Feb	1206	33	59.228	171	13.735
3-Feb	1719	34	41.33	170	40.629	3-Feb	1759	34	45.418	170	40.371
3-Feb	1846	34	45.77	170	37.40	3-Feb	1923	34	42.15	170	37.64
3-Feb	2038	34	43.27	170	35.31	3-Feb	2131	34	44.39	170	41.58
4-Feb	0230	35		170		4-Feb	0300	35	16.31	170	33.085
4-Feb	1301	35	16.31	170	33.085	4-Feb	0543	35	28.421	170	18.763
4-Feb	0710	35	27.12	170	23.28	4-Feb	0815	35	22.586	170	17.436
4-Feb	0855	35	20.825	170	19.716	4-Feb	1019	35	26.36	170	27.36
4-Feb	1115	35	23.91	170	29.29	4-Feb	1214	35	19.81	170	23.48
4-Feb	1329	35	19.02	170	26.69	4-Feb	1514	35	26.819	170	18.331
4-Feb	1636	35	33.40	170	14.57	4-Feb	1725	35	38.296	170	13.104
4-Feb	1850	35	37.09	170	18.17	4-Feb	2006	35	33.91	170	09.48
7-Feb	0133	36	02.818	169	27.696	7-Feb	0220	36	2.226	169	33.615
7-Feb	0355	36	01.44	169	29.125	7-Feb	0500	36	7.07	169	32.773

START		S		W		END		S		W	
Date	Time	Lat Deg	Lat Min	Lon Deg	Lon Min	Date	Time	Lat Deg	Lat Min	Lon Deg	Lon Min
10-Feb	2223	37	44.06	168	53.37	10-Feb	2251	37	45.247	168	56.784
10-Feb	2258	37	44.74	168	57.603	10-Feb	0102	37	33.77	169	04.90
11-Feb	0131	37	33.92	169	07.999	11-Feb	0221	37	38.183	169	10.768
11-Feb	0328	37	42.521	169	07.215	11-Feb	0819	37	34.87	168	58.247
11-Feb	0549	37	26.644	168	56.317	11-Feb	0708	37	42.25	169	03.76
11-Feb	0846	37	41.965	169	01.139	11-Feb	0922	37	38.93	169	08.60
11-Feb	0431	37	38.256	169	09.387	11-Feb	1101	37	31.04	169	15.89
11-Feb	1101	37	31.07	169	15.89	11-Feb	1240	37	24.19	169	24.78
11-Feb	1320	37	25.99	169	27.18	11-Feb	1437	37	30.91	169	19.83
11-Feb	1453	37	31.19	169	18.05	11-Feb	1822	37	29.713	169	14.89
11-Feb	1003	37	26.949	169	16.454	11-Feb	1721	37	29.119	169	28.892
11-Feb	1743	37	28.157	169	28.113	11-Feb	2040	37	08.37	169	43.49
11-Feb	2047	37	07.49	169	43.49	11-Feb	2120	37	03.60	169	43.52
11-Feb	2126	37	02.95	169	43.776	11-Feb	2327	36	51.509	169	49.281
12-Feb	0049	36	53.452	169	33.395	12-Feb	0236	36	55.497	169	39.885
12-Feb	0359	36	57.655	169	37.61	12-Feb	0525	36	56.335	169	48.739
12-Feb	1640	38	08.859	168	37.917	12-Feb	1713	38	12.122	168	38.524
12-Feb	1822	38	10.719	168	40.696	12-Feb	1853	38	11.08	168	26.63
12-Feb	1945	38	06.94	168	29.03	12-Feb	2017	38	04.58	168	25.01
12-Feb	2059	38	02.02	168	14.26	12-Feb	2208	37	56.54	168	14.01
12-Feb	2342	37	57.324	168	20.305	13-Feb	0118	38	03.338	168	12.52
13-Feb	0141	37	05.97	168	12.13	13-Feb	0300	38	16.44	168	12.46
13-Feb	0310	38	17.474	168	11.648	13-Feb	0702	38	32.03	167	43.307
13-Feb	0725	38	31.55	167	44.86	13-Feb	0817	38	27.31	167	40.95
13-Feb	0846	38	25.19	167	42.49	13-Feb	0953	38	25.65	167	50.78
13-Feb	1006	38	25.18	167	52.313	13-Feb	1207	38	16.54	168	03.47
13-Feb	1256	38	14.37	168	00.82	13-Feb	1659	38	32.038	167	39.57
14-Feb	0538	38	31.615	167	85.407	14-Feb	0731	38	25.18	168	07.49
14-Feb	0750	38	23.88	168	07.84	14-Feb	0948	38	13.97	167	59.41
14-Feb	1027	38	14.85	167	56.451	14-Feb	1322	38	29.82	168	08.94
14-Feb	1416	38	30.62	168	05.23	14-Feb	1731	38	13.781	167	51.727
14-Feb	1811	38	15.063	167	45.651	14-Feb	2136	38	32.76	168	02.63
14-Feb	2231	38	39.88	167	57.98	14-Feb	2351	38	28.454	167	51.731

TABLE 4. Full list of sightings during this cruise.

Sighting	Date	Time (GMT)	GMT offset	LAT deg	LAT min	N/S	LON deg	LON min	E/W	Species	# of Animals	Source Active	Forced Shut Down	Closest Dist. (meters)
1	25-Jan-06	1835	-11	26	8.70	S	171	18.98	W	49	3	NO	NO	4000
2	4-Feb-06	0516	-11	35	26.31	S	170	21.05	W	46	1	YES	NO	2408
3	15-Feb-06	2215	-11	39	21.25	S	167	25.32	W	51	4	NO	NO	4000
4	15-Feb-06	2312	-11	39	29.81	S	167	19.24	W	46	9	NO	NO	7500
5	15-Feb-06	2348	-11	39	31.20	S	167	14.82	W	77	60	NO	NO	6200

Species Key:

46	Sperm whale, Physeter macrocephalus
49	Ziphiid whale, Unidentified beaked whale
51	Mesoplodon sp. Unidentified Mesoplodon
77	Unidentified dolphin or porpoise

VI. Mitigation Effectiveness

During the entire seismic cruise study, from January 20th to March 3rd 2006, no mitigation procedures were implemented due to marine mammals, sea turtles, or any other marine protected species entering or appearing as if they were about to enter the seismic safety zone.

Literature Cited

Heinemann, D. (1981) A range finder for pelagic bird censusing. *Journal of Wildlife Management*. 45(2):31-35.

Greene, C.R. 1997. An autonomous acoustic recorder for shallow arctic waters. *J. Acoust. Soc. Am*. 102(5, Pt. 2):3197.

Kinzey, D., Olson, P. and Gerodette,T. 2000. Marine mammal data collection procedures on research ship line-transect surveys by the Southwest Fisheries Science Center. Adminisrative Report LJ-00-08. Southwest Fisheries Science Center, National Marine Fisheries Service. P.O.Box 271, LaJolla, CA 92038. 32pp.

McCauley, R.D., M.-N. Jenner, C. Jenner, K.A. McCabe, and J. Murdoch. 1998. The response of humpback whales (Megaptera novangliae) to offshore seismic survey noise: preliminary results of observations about a working seismic vessel and experimental exposures. *APPEA (Austral. Petrol. Product. Explor. Assoc.) Journal* 38:692-707.

McCauley, R.D., J. Fewtrell, A.J. Duncan, C. Jenner, M.-N. Jenner, J.D. Penrose, R.I.T. Prince, A. Adhitya, J. Murdoch, and K. McCabe. 2000. Marine seismic surveys: Analysis of airgun signals; and effects of air gun exposure on humpback whales, sea turtles, fishes and squid. *Rep. from Centre for Marine Science and Technology, Curtin Univ., Perth, W.A., for Austral. Petrol. Prod. Assoc., Sydney, N.S.W.* 188 p.

Mesnick,S.L. Guide to Behavioral Data Collection (for Observers):Protocol and some hints for recording behavioral data on Marine Mammal Sighting Forms. Unpublished. Southwest Fisheries Science Center. National Marine Fisheries Service

Mesnick, S.L., Archer, F.I., Allen, A.C., and Dizon, A.E. 2002. Evasive behavior of Eastern Tropical Pacific dolphins relative to effort by the tuna purse-seine fishery. Adminisrative Report LJ-02-30. Southwest Fisheries Science Center, National Marine Fisheries Service. P.O.Box 271, LaJolla, CA 92038. 35pp.

Tolstoy, M., J. Diebold, S. Webb, D. Bohnenstiehl, and E. Chapp. 2004. Acoustic calibration measurements. Chapter 3 In: W.J. Richardson (ed.), Marine mammal and acoustic monitoring during Lamont-Doherty Earth Observatory's acoustic calibration study in the northern Gulf of Mexico, 2003. *[Revised ed.] Rep. from LGL Ltd., King City, ON, for Lamont-Doherty Earth Observ., Palisades, NY, and Nat. Mar. Fish. Serv., Silver Spring, MD.* [Advance copy of updated Chapter 3.]

APPENDICES

A. Incidental Harassment Authorization

B. NOAA Sighting Form

Appendix A. Incidental Harassment Authorization Granted to SIO

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

JAN 20 2006

Mr. Woody C. Sutherland
Shipboard Technical Support
University of California, San Diego
Scripps Institution of Oceanography
La Jolla, California 92093-0214

Dear Mr. Sutherland:

Enclosed is an Incidental Harassment Authorization (IHA) issued to Scripps Institution of Oceanography, pursuant to Section 101(a)(5)(D) of the Marine Mammal Protection Act (16 U.S.C. 1361 et seq.), to take by harassment, marine mammals incidental to conducting an oceanographic seismic survey on the Louisville Ridge in the Southwestern Pacific Ocean by the *R/V Roger Revelle*. Scripps is required to comply with the conditions contained in the IHA In addition, Scripps must cooperate with any Federal, state, or local agency monitoring the impacts of your activities, and submit a draft report to the National Marine Fisheries Service's (NOAA Fisheries) Office of Protected Resources, within 90 days after completion of the work authorized herein. Along with other mitigation measures to be incorporated, the IHA requires monitoring for the presence and behavior of marine mammals.

If you have any questions concerning the IHA or its requirements, please contact Ken Hollingshead, NOAA Fisheries Service, Office of Protected Resources, at (301) 713-2289, ext. 128.

Sincerely,

James H. Lecky
Director
Office of Protected Resources

Enclosure

Printed on Recycled Paper

DEPARTMENT OF COMMERCE

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

NATIONAL MARINE FISHERIES SERVICE

Incidental Harassment Authorization

The Scripps Institution of Oceanography, La Jolla, California, is hereby authorized under section 101(a)(5)(D) of the Marine Mammal Protection Act (16 U.S.C. 1371 (a)(5)(D)) and 50 CFR 216.107, to harass small numbers of marine mammals incidental to conducting a marine seismic survey program in the Louisville Ridge area of the Southwestern Pacific Ocean, contingent upon the following conditions:

1. This Authorization is valid from January 27, 2006, through January 26, 2007.

2. This Authorization is valid only for activities associated with the *R/V Roger Revelle* conducting a seismic survey program in the Southwestern Pacific Ocean, as part of the Integrated Ocean Drilling Program.

3. (a) The taking, by incidental harassment only, is limited to the species listed under condition 3(b) below. The taking by serious injury or death of these species or the taking by harassment, injury or death of any other species of marine mammal is prohibited and may result in the modification, suspension or revocation of this Authorization.

(b) The species authorized for incidental harassment takings are:

(*i*) Mysticete whales: humpback whale (*Megaptera novaeangliae*), southern right whale (*Eubalaena australis*), pygmy right whale (*Caperea marginata*), minke whale (*Balaenoptera acutorostrata*), Antarctic minke whale (*B. bonaerensis*), sei whale (*B. borealis*), fin whale (*B. physalus*), Bryde's whale (*B. edeni*), and blue whale (*B. musculus*);

(*ii*) Odontocete whales/dolphins: sperm whale (*Physeter macrocephalus*), dwarf sperm whale (*Kogia sima*), pygmy sperm whale (*K. breviceps*), southern bottlenose whale (*Hyperoodon planifrons*), Arnoux's beaked whale (*Berardius arnuxii*), Cuvier's beaked whale (*Ziphius cavirostris*), Shepherd's beaked whale (*Tasmacetus shepherdi*), Andrew's beaked whale (*Mesoplodon bowdoini*), Blainville's beaked whale (*M. densirostris*), ginkgo-toothed whale (*M. ginkgodens*), Gray's beaked whale *(M.. grayi*), Hector's beaked whale (*M.. hectori*), strap-toothed whale (*M. layardii*), spade-toothed whale (*M. traversii*), rough-toothed dolphin (*Steno bredanensis*), bottlenose dolphin (*Tursiops truncatus*), pantropical spotted dolphin (*Stenella attenuata*), spinner dolphin (*S. longirostris*), striped dolphin (*S. coeruleoalba*), short-beaked common dolphin (*Delphinus delphis*), hourglass dolphin (*Lagenorhynchus cruciger*), Fraser's dolphin (*Lagenodelphis hosei*), Risso's dolphin (*Grampus griseus*), southern right whale dolphin (*Lissodelphis peronii*), spectacled porpoise (*Phocoena dioptrica*), melon-headed whale

(*Peponocephala electra*), pygmy killer whale (*Feresa attenuata*), false killer whale (*Pseudorca crassidens*), killer whale (*Orcinus orca*), long-finned pilot whale (*Globicephala melas*) and short-finned pilot whale (*G. macrorhynchus*);

(*iii*) Pinnipeds: southern elephant seal (*Mirounga leonina*), leopard seal (*Hydrurga leptonyx*), crabeater seal (*Lobodon carcinophagus*), Antarctic fur seal (*Arctocephalus gazella*), and sub-Antarctic fur seal (*A. tropicalis*).

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

(*i*) A seismic airgun array with no more than 2-General Injector (GI) airguns operating;
(*ii*) A multi-beam bathymetric sonar; and
(*iii*) A sub-bottom profiler.

(d) The taking of any marine mammal in a manner prohibited under this Authorization must be reported within 48 hours of the taking to the Chief of the Permits, Conservation and Education Division, Office of Protected Resources, National Marine Fisheries Service, at (301) 713-2289, ext 110, or his designee.

4. The holder of this Authorization is required to cooperate with the National Marine Fisheries Service and any other Federal, state or local agency monitoring the impacts of the activity on marine mammals. The holder must notify the Chief of the Permits, Conservation and Education Division, Office of Protected Resources at least 48 hours prior to starting the seismic survey (unless constrained by the date of issuance of this Authorization in which case notification shall be made as soon as possible).

5. Mitigation. The holder of this Authorization is required to:

(a) (*i*) Establish and monitor the safety zone for cetaceans and sea turtles surrounding the 2-GI airgun array where the received level would be 180 dB re 1 µPa rms. This radius is estimated to be 60 m (197 ft) from the seismic source in water depth from 100-1000 m (328-3280 ft) and 40 m (131 ft) in water depths greater than 1000 m (3280 ft);

(a)(*ii*) Establish and monitor the safety zone for pinnipeds surrounding the 2-GI airgun array where the received level would be 190 dB re 1 µPa rms. This radius is estimated to be 15 m (49 ft) from the seismic source in water depths from 100-1000 m (328-3280 ft) and 10 m (33 ft) in water depths greater than 1000 m (3280 ft);

(b) Immediately shut-down the seismic airgun array and/or other acoustic sources, whenever any marine mammals or sea turtles are sighted approaching close to or within the area delineated by the 180 dB (re 1 μPa_{rms}), or 190 dB (re 1 μPa_{rms}) isopleth as established under

condition 5(a) for the 2-GI airgun array.

(c) A power-down of the airguns is not authorized; both airguns must be shut-down whenever a marine mammal or sea turtle enters its designated safety zone.

(d) Not proceed with ramping up airguns from a shut-down unless the entire safety zones described in condition 5(a) are visible and no marine mammals or sea turtles are detected within the appropriate safety zones; or until 15 minutes (for small odontocetes, pinnipeds or sea turtles) or a minimum of 30 minutes (for mysticetes/large odontocetes) after there has been no further visual detection of the animal(s) within the safety zone and the trained marine mammal observer on duty is confident that no marine mammals or sea turtles remain within the appropriate safety zone. During ramp-up procedures, the safety radius for the 2 GI-guns will be maintained.

(e) Prior to commencing ramp-up described in condition 5 (g), conduct a 30-minute period of observation by at least one trained marine mammal observer (i) at the commencement of seismic operations and (ii) at any time electrical power to the airgun array is discontinued for a period of 4 minutes or more.

(f) If the complete safety radii are not visible for at least 30 minutes prior to ramp-up in either daylight or nighttime, not commence ramp-up.

(g) If no marine mammals or sea turtles have been observed while undertaking mitigation condition 5(c), 5(d) and 5(e), ramp-up airgun arrays no greater than 1 GI-gun per 5-minute interval or approximately 6 dB per 5-minute period: (i) At the commencement of seismic operations, and (ii), anytime after the airgun array has been shut down for more than 4 minutes.

(h). If possible, reduce the volume of the airgun array during vessel turns while running seismic lines.

(i) To the extent practical, whenever a marine mammal is detected outside the safety radius, and based on its position and motion relative to the ship track is likely to enter the safety radius, an alternative ship speed or track will be calculated and implemented.

(j) Emergency shut-down. If observations are made or credible reports are received that one or more marine mammals or sea turtles are within the area of this activity in an injured or mortal state, or are indicating acute distress, the seismic airguns will be immediately shut down and the Chief of the Permits, Conservation and Education Division, Office of Protected Resources or a staff member contacted. The airgun array will not be restarted until review and approval has been given by the Director, Office of Protected Resources or his designee.

6. Monitoring.

(a) The holder of this Authorization must designate at least two biologically-trained, on-site individuals to be onboard the *R/V Roger Revelle*, approved in advance by National Marine Fisheries Service, to conduct the visual monitoring programs required under this Authorization and to record the effects of seismic surveys and the resulting noise on marine mammals and sea turtles.

(b) Monitoring is to be conducted by the biological observers described in condition 6(a) above, onboard the active seismic vessel. At least one observer must be on active watch whenever the seismic airgun array is operating during all daytime airgun operations, during any nighttime start-ups of the airguns and at night, whenever daytime monitoring resulted in one or more shut-down situations due to marine mammal presence. To the maximum extent possible two observers will be on-watch whenever the seismic array is being ramped up to (*i*) ensure that no marine mammals or sea turtles enter the appropriate safety zone whenever the seismic array is on, and (*ii*) to record marine mammal and sea turtle activity as described in condition 6(f) below.

(c) To the extent possible, observers will be on watch for continuous periods of 4 hours or less.

(d) At all times, the crew must be instructed to keep watch for marine mammals and sea turtles. If any are sighted, the bridge watch-stander must immediately notify the biological observer on-watch. If a marine mammal or sea turtle is within, or closely approaching, its designated safety zone, the 2-GI airgun array must be immediately shut-down.

(e) Observations by the biological observers described in condition 6(a) on marine mammal presence and activity will begin a minimum of 30 minutes prior to the estimated time that the seismic source is to be turned on and/or ramped-up.

(f) Monitoring will consist of noting: (*i*) the species, group size, age/size/sex categories (if determinable), the general behavioral activity, heading (if consistent), bearing and distance from seismic vessel, sighting cue, behavioral pace, and apparent reaction of all marine mammals and sea turtles seen near the seismic vessel and/or its airgun array (e.g., none, avoidance, approach, paralleling, etc) and; (*ii*) the time, location, heading, speed, and activity of the vessel (shooting or not), along with sea state, visibility, cloud cover and sun glare at (1) any time a marine mammal or sea turtle is sighted, (2) at the start and end of each watch, and (3) during a watch (whenever there is a change in one or more variable); and, (iii) the identification of all vessels that are visible within 5 km of the seismic vessel whenever a marine mammal is sighted, and the time observed, bearing, distance, heading, speed and activity of the other vessel(s).

(g) Biological observers will also conduct monitoring onboard the *R/V Roger Revelle* while the seismic array is being deployed or being pulled from the water.

(h) All biological observers must be provided with and use appropriate night-vision devices, Big Eyes, and reticulated and/or laser range finding binoculars.

7. Reporting.

(a) A draft report will be submitted to the National Marine Fisheries Service within 90 days after the end of the seismic survey program in Southwestern Pacific Ocean. The report will describe in detail (*i*) the operations that were conducted, (*ii*) the marine mammals and sea turtles that were detected near the operations, (*iii*) to the extent possible the results of the acoustical measurements to verify the safety radii, and (*iv*) the methods, results, and interpretation pertaining to all monitoring tasks, a summary of the dates and locations of seismic operations, sound measurement data, marine mammal and sea turtle sightings (dates, times, locations, activities, associated seismic survey activities), and estimates of the numbers of affected marine mammals and a description of their reactions.

(b) The 90-day draft report will be subject to review and comment by the National Marine Fisheries Service. Any recommendations made by the National Marine Fisheries Service must be addressed in the final report prior to acceptance by the National Marine Fisheries Service. The draft report will be considered the final report for this activity under this Authorization if the National Marine Fisheries Service has not provided comments and recommendations within 90 days of receipt of the draft report.

8. Activities related to the monitoring described in this Authorization do not require a separate scientific research permit issued under section 104 of the Marine Mammal Protection Act.

9. A copy of this Authorization must be in the possession of the operator of the vessel operating under the authority of this Incidental Harassment Authorization.

James H. Lecky
Director, Office of Protected Resources
National Marine Fisheries Service

11/30/06
Date

Appendix B. NOAA Sighting Form (88-208)

SWFSC Marine Mammal Sighting Form

NOTES: w/ ANGLE

Date ___/___/___ (Y Y M M D D) Cruise # _____ Sighting# _____

Time _____ Effort ON OFF Observer # _____

SPECIES DETERMINATION	CODES
1.	
2.	
3.	
4.	

ASSOCIATED ANIMALS: List ID and number of other species near the sighting.

DIAGNOSTIC FEATURES: Describe and sketch the shape, size and markings of the species identified.

BEHAVIOR: Describe the aggregations, movements, blows, etc. of the animals.

School Movement: Initial Speed _____ Direction Relative to Bow _____ Closest Distance _____

Calibration Y N Bow Riding Y N Biopsy Y N Photographs Y N

NOAA Form 88-208 (8-02)

Behavioral Observations

When first observed, do you think the animals were already reacting to the research vessel? Y N U O

I. School Behavior

What was the behavior of the school when first observed (circle all that apply):

fast traveling | moderate traveling | slow traveling | milling | associated swimming | approaching | bow riding | unknown | other

Did the behavior change one or more times during observation? Y N U O

If yes, what did the behavior change to (circle all that apply)?

fast traveling | moderate traveling | slow traveling | milling | associated swimming | approaching | bow riding | unknown | other

II. School Shape

What was the school shape when first observed? tight & uniform | tight & clumped | loose & uniform | loose & clumped | unknown | other

Did the school shape change one or more times during observation? Y N U O

If yes, what did the school shape change to? tight & uniform | tight & clumped | loose & uniform | loose & clumped | unknown | other

III. School Composition

Calves present? Y N U O

If yes, estimate percent_____: were neonates present? Y N U O

IV. Reaction to the Vessel

					Distance reticle	Distance OR estimate
Approach the boat?	Y	N	U	O	_____	_____
Bow ride?	Y	N	U	O		
Run from the boat?	Y	N	U	O	_____	_____
Low swimming?	Y	N	U	O	_____	_____
Did the school split?	Y	N	U	O	_____	_____
If yes, did the subgroups move off in different directions?	Y	N	U	O		

If it's a mixed school, was the last observed subgroup composition: mixed | single species | both mixed & single species | unknown | other

V. In your estimation, relative to the research vessel, was this school:

evasive | non-evasive (including attracted to the boat and/or indifferent) | both | cannot be determined | other

If the school was evasive, at what distance did you first see a strong evasive response (ie., when did the dolphins get up and run)? _____ _____

Key: Y = yes N = no U = unknown/cannot be determined O = other, please explain