Marine Mammal Monitoring During a Low-Energy Seismic Survey by the Scripps Institution of Oceanography Vessel R/V Roger Revelle in the Eastern Tropical Pacific Ocean,

March - April 2006

Prepared by

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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 March 7, 2006. The IHA (Appendix A) authorized non-lethal takes of certain marine mammals incidental to a marine seismic survey in the Eastern Tropical 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.

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I. INTRODUCTION

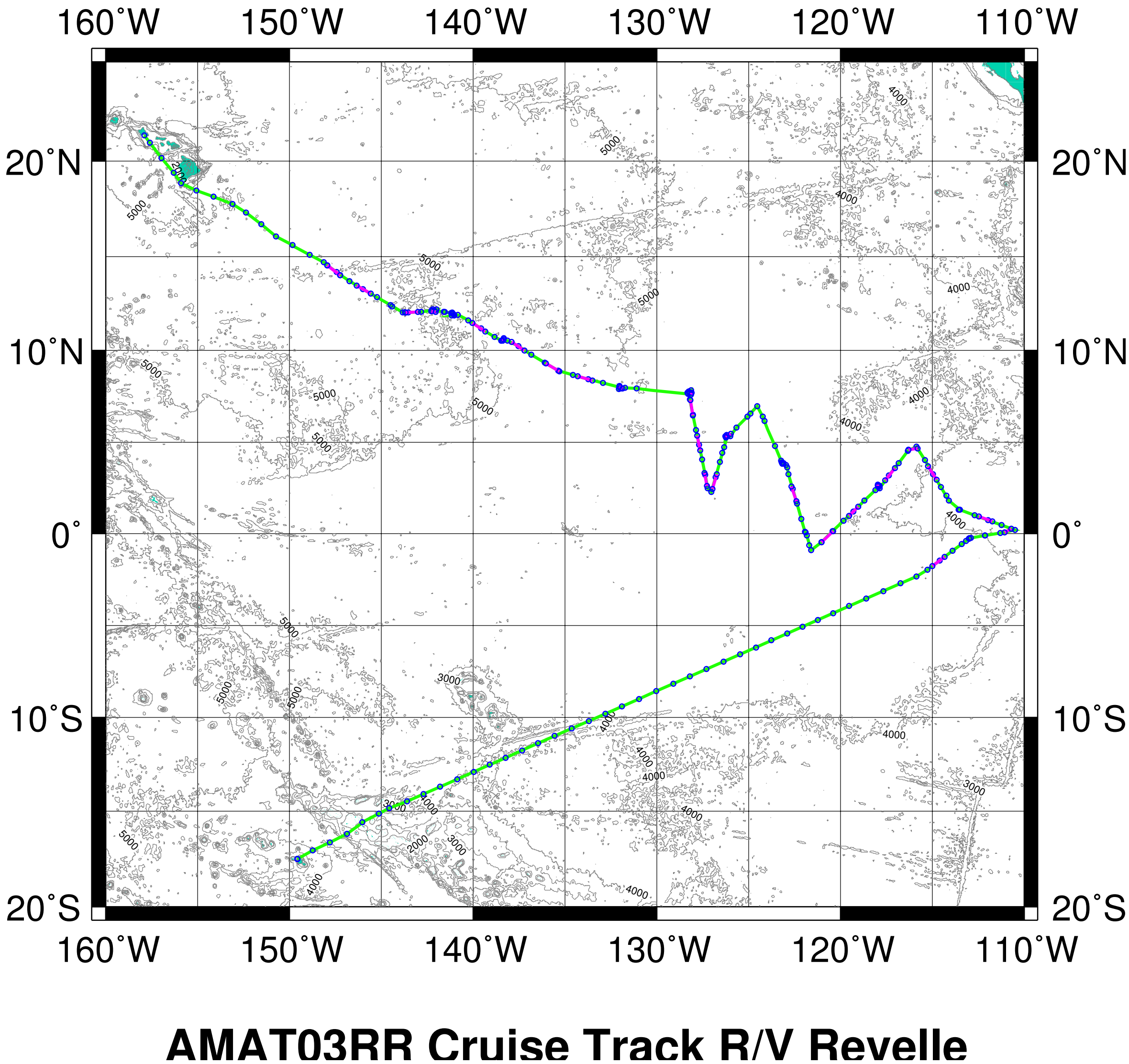
A site survey cruise for the International Ocean Drilling Program (IODP) was conducted by Scripps Institution of Oceanography (SIO) aboard the *Research Vessel Roger Revelle* in the Eastern Tropical Pacific Ocean (Figure 1). The low-energy seismic reflection system was just one tool in the integrated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

The purpose of the seismic survey was to collect the site survey data for a future IODP drilling transect (not currently scheduled). The proposed drilling program will study the structure of the Cenozoic equatorial Pacific by drilling an age-transect flowline along the position of the paleo-equator in the Pacific, targeting selected time-slices of interest where calcareous sediments have been preserved best. The seismic survey and respective drilling transect will span the early Eocene to Miocene equatorial Pacific. Recovered sediments will contribute towards (1) resolving questions of how and why paleo-productivity of the equatorial Pacific changed over time, (2) provide rare material to validate and extend the astronomical calibration of the geological time scale for the Cenozoic, (3) determine sea-surface and benthic temperature and nutrient profiles and gradients, (4) provide important information about the detailed nature of calcium carbonate dissolution and changes of the CCD, (5) enhance our understanding of bio- and magnetostratigraphic datums at the equator, as well as (6) provide information about rapid biological evolution and turn-over during times of climatic stress.

As this cruise also followed a paleo-depth transect, it was planned to improve our knowledge about the reorganization of water masses as a function of depth and time. It is intended to make use of the high level of correlation between tropical sediment sections and seismic stratigraphy collected on this survey cruise to develop a more complete model of equatorial circulation and sedimentation.

The cruise departed Papeete, Tahiti on March 7, 2006 and ended in Honolulu, Hawaii on April 13, 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
LYLE, M.	CHIEF SCIENTIST	BOISE STATE U.
BACKMAN, J.	SCIENTIST	STOCKHOLM U.
BADGER, M	GRADUATE STUDENT	CARDIFF U.
BONDRA, T.	STUDENT	INDIANA U. OF PENN.
CHUN, C.	GRADUATE STUDENT	UC SANTA CRUZ
DRAKE, B	MARINE TECHNICIAN	SIO
EDGAR, K.	GRADUATE STUDENT	SOUTHAMPTON
ELLET, L.	GEOPHYSICAL ENGINEER	SIO
FETTER, B.	STUDENT	INDIANA U. OF PENN.
GOLDSTEIN, H.	MARINE MAMMAL OBSERVER	SIO
HAGUE, A.	STUDENT	INDIANA U. OF PENN.
HERNANDEZ-SANCHEZ,M.	GRADUATE STUDENT	BRISTOL U.
HOVAN, S.	SCIENTIST	INDIANA U. OF PENN.
HUBBARD, D.	CORING TECHNICIAN	OREGON STATE U.
KONDOR, J.	MARINE MAMMAL OBSERVER	SIO
McCARREN, H.	GRADUATE STUDENT	UC SANTA CRUZ
MEYER,J	COMPUTER TECHNICIAN	SIO
MITCHELL, N.	SCIENTIST	CARDIFF U.
MOORE, T.	SCIENTIST	U. OF MICHIGAN
MOORES, L.	MARINE MAMMAL OBSERVER	SIO
MOSER, C.	CORING TECHNICIAN	OREGON STATE U.
MURPHY, B.	GRADUATE STUDENT	BOISE STATE U.
PALIKE, H.	SCIENTIST	SOUTHAMPTON
PARRY, T.	GRADUATE STUDENT	CARDIFF U.
PAUL, C.	GRADUATE STUDENT	BOISE STATE U.
PILLARD, G.	MARINE TECHNICIAN	SIO
PULIDO TABORDA, M.	GRADUATE STUDENT	UNIVERSIDAD EAFIT
REESE, R.	STUDENT	INDIANA U. OF PENN.
SPOFFORTH, D.	GRADUATE STUDENT	SOUTHAMPTON U.
SUTHERLAND, W.	COMPUTER TECHNICIAN	SIO
SUTOR, S.	GRADUATE STUDENT	INDIANA U. OF PENN.
WALCZAK, P.	CORING TECHNICIAN	OREGON STATE U.

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.

<u>GI Air gun Specifications</u>

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 rms[1] (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 air gun arrays. The measurement units used to describe air gun 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 air gun-type source.

Received sound levels have been modeled by L-DEO for a number of air gun configurations, including two 45-in3 Nucleus G-guns, in relation to distance and direction from the air guns (Figure 2). The model does not allow for bottom interactions, and is most directly

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

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 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 air guns 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 survey occurred in depths of 3500 - 5500 m, so no correction factor was 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, we requested the use of the values predicted by L-DEO's model (Table 1). Therefore, the assumed 180- and 190-dB radii were taken as 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

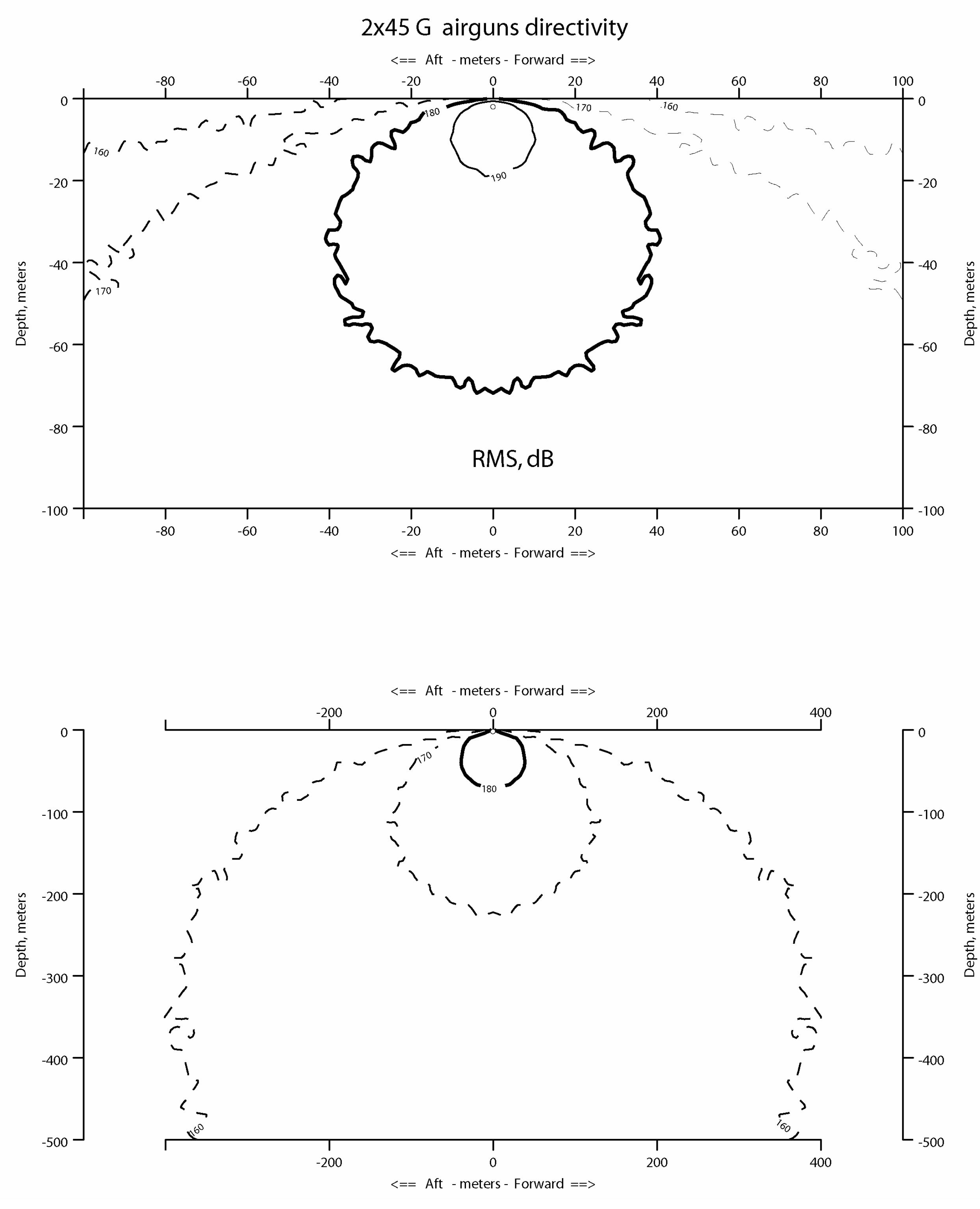


FIGURE 2. Modeled received sound levels from two 45-in^3 G-guns, similar to the two 45-in^3 GI guns used during the SIO survey. Model results provided by the Lamont-Doherty Earth Observatory of Columbia University.

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.

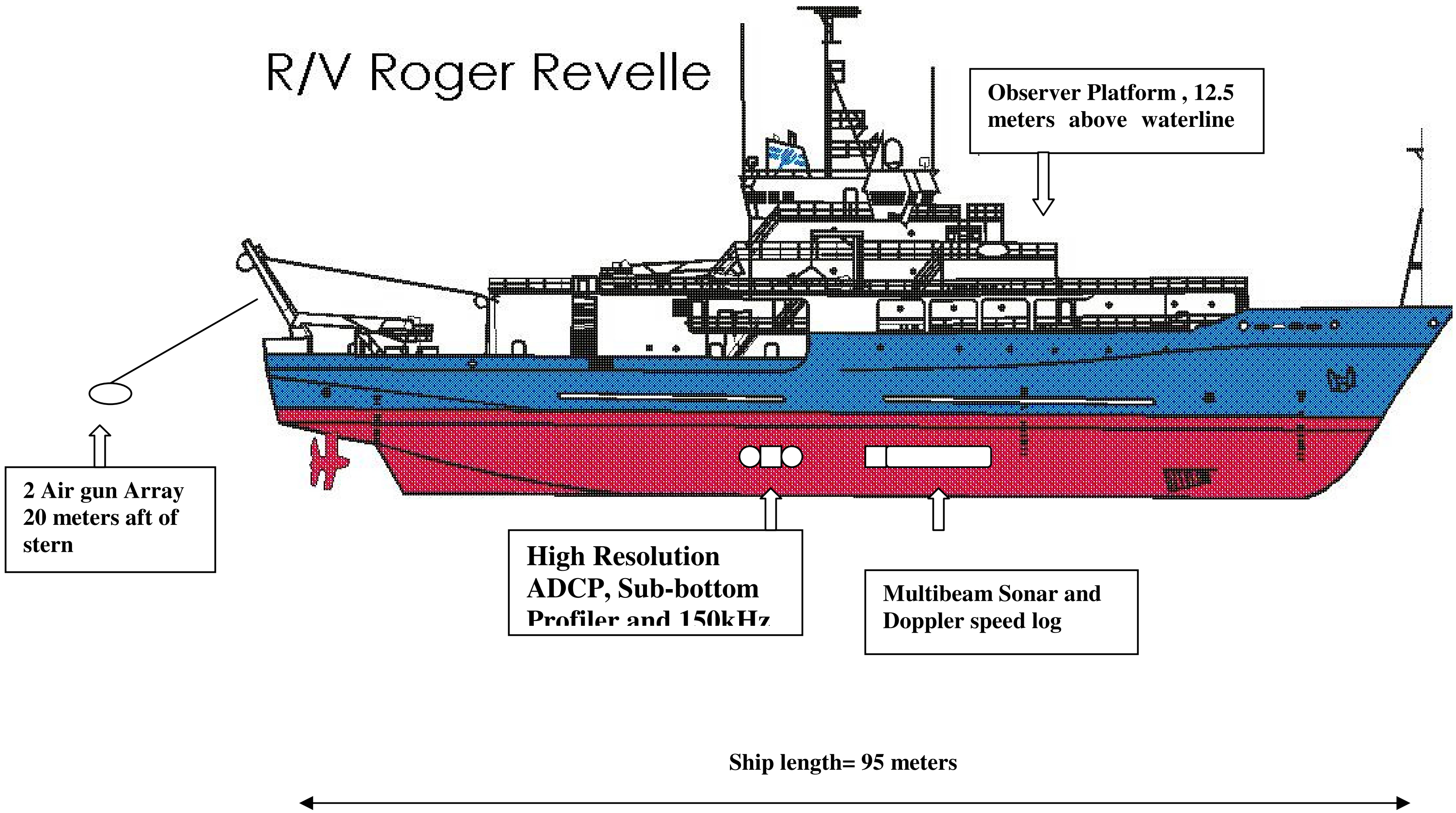
Mitigation watches by at least one observer (or a trained member of the science party during night time operations) were conducted 100% of the time during seismic operations, regardless of weather or sea conditions. The daytime observer platform was located one deck below and forward of the bridge (12.46 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 (Figure 3). Nighttime observations, were conducted from the second level below the bridge looking aft for an unobstructed view of the air guns. Night vision binoculars were utilized for these periods.

During daylight startups before commencing seismic operations, two observers would maintain a 360-degree watch for all marine mammals and sea turtles for at least 30 minutes. During night start ups, watch was restricted to the 40 meter safety radius due to the limitations of night viewing. If no marine mammals or turtles were observed within the safety radius during this time, the observers would notify the seismic personnel of an “all clear” status. A ramp-up procedure was employed when beginning seismic operations. With the marine mammal observers on watch, one seismic source would be energized for 5 minutes. The second source would be brought on-line only after confirmation that no animals were sighted within the 180 dB safety radius.

After ramp-up, one observer would stand watch during nighttime operations. Watch periods were scheduled as a 2-hour rotation, with one observer maintaining a 4- hour watch during the night. 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 within the 40-meter zone, the seismic personnel were contacted via handheld radios and the seismic source was secured 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 20 x 150 and 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 the location of the 40-meter zone (Heinemann 1981). These simple devices proved more reliable for open water sighting than the laser range finders, which were also provided.

Figure 3. Ship Specifics for Marine Mammal Observations



The marine mammal observers provided brief training to the bridge crew at the beginning of each cruise. More importantly, the bridge officers were instructed to alert the observer on watch of any suspected marine mammal sighting. A hand held Motorola radio on the bridge was tuned to the same frequency used by the observers and seismic personnel. Thus, bridge crew 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.

On most occasions, seismic operations continued through the night. Marine mammal observers would stand watch for a total of 20 hours a day. The remaining 4 nighttime hours allowed for trained members of the science party and bridge personnel to monitor for possible signs of marine mammals. The observers would resume watch at civil twilight-sunrise. When seismic operations were halted at night, they were not resumed until the 2-observer, 30 minute watch and ramp-up procedure could be conducted.

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 ships 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 distances are recorded and a unique number is generated for the sighting (Kinsey et al 2000). WinCruz automatically calculates distances when either 7 x 50, or 20 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 observers 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, 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, 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. Watch was also suspended during coring operations during which time the vessel was on station.

V. OBSERVATIONS

Seismic operations were conducted on 21 distinct periods during the 38 days of this cruise. (Table 3). The seismic source was active for 466 of the total 880 hours the ship was underway.

There were 21 sightings of marine mammals (Table 4) during this cruise. None of the observed mammals approached or entered the safety radius of the seismic source when it was active. None of the marine mammals were observed to be evasive of the research ship; 11 sightings were non-evasive and the reaction of the other 10 could not be determined.

There were 10 sightings of sea turtles or other protected marine animals (Table 5). On 2 occasions, a change in the behavior of the sea turtle was observed as the distance between it and the ship lessened. However, both instances occurred outside of the 40-meter safety zone established for the seismic sources used during this cruise.

TABLE 3. Seismic Operations Log

START								END							
Date	Time	Lat Deg	Lat Min		Lon Deg	Lon Min		Date	Time	Lat Deg	Lat Min		Lon Deg	Lon Min	
16-Mar	0113	2	15.79	S	115	43.14	W	16-Mar	2125	0	16.19	S	113	1.58	W
18-Mar	0457	0	15.42	S	113	0.57	W	19-Mar	2002	1	24.31	N	113	46.38	W
19-Mar	2004	1	24.42	N	113	46.65	W	22-Mar	0050	2	39.18	N	117	53.5	W
22-Mar	1045	2	27.03	N	118	1.74	W	23-Mar	0326	0	35.2	N	119	57.26	W
23-Mar	0428	0	27.89	N	120	4.81	W	23-Mar	2327	0	4.23	N	121	55.17	W
24-Mar	0917	0	11.89	N	121	57.05	W	25-Mar	0521	3	25.26	N	122	53.38	W
25-Mar	1014	3	42.67	N	122	55.46	W	25-Mar	2358	3	53.82	N	123	12.16	W
26-Mar	0930	3	56.02	N	123	12.76	W	27-Mar	0300	6	37.49	N	124	20.54	W
27-Mar	0501	6	47.88	N	124	24.91	W	28-Mar	0947	5	28.04	N	126	17	W
28-Mar	1917	5	15.26	N	126	11.84	W	30-Mar	0047	3	27.07	N	127	25.16	W
30-Mar	0049	3	27.48	N	127	25.24	W	31-Mar	1530	7	45.87	N	128	16.07	W
1-Apr	0117	7	39.32	N	128	16.87	W	1-Apr	2009	7	56.84	N	131	17.71	W
1-Apr	2011	7	56.86	N	131	17.95	W	1-Apr	2341	7	57.51	N	131	43.5	W
2-Apr	0012	7	58.34	N	131	46.35	W	2-Apr	1341	7	58.04	N	132	1.35	W
2-Apr	2255	8	0.15	N	132	3.22	W	4-Apr	1335	10	28.67	N	137	57.97	W
4-Apr	1502	10	28.79	N	138	4.53	W	5-Apr	0409	10	28.95	N	138	22.65	W
5-Apr	1410	10	29.98	N	138	29.2	W	6-Apr	0627	11	54.99	N	140	45.18	W
6-Apr	0832	11	54.99	N	140	55.82	W	6-Apr	2210	11	52.82	N	141	11.75	W
7-Apr	0747	11	56.59	N	141	1.29	W	8-Apr	0609	12	2.86	N	142	9.49	W
8-Apr	1551	12	5.21	N	142	19.89	W	8-Apr	0235	12	2.01	N	143	45.19	W
9-Apr	1952	12	0.91	N	143	45.07	W	11-Apr	0325	14	45.83	N	148	15.38	W

TABLE 4. Marine Mammal Sightings

Date	Time (GMT)	GMT offset	Sighting	LAT deg	LAT min	N/S	LON deg	LON min	E/W	Species Code	# of Animals	Air Gunning	Air Guns Stopped	Closest Dist. (meters)
14-Mar-06	1729	-9	1	4	45.79	S	121	21.47	W	77	20	NO	NO	4000
15-Mar-06	0115	-9	2	4	12.04	S	120	5.26	W	34	28	NO	NO	100
15-Mar-06	1824	-9	3	2	47.39	S	116	54.35	W	77	35	NO	NO	4000
15-Mar-06	2214	-9	4	2	29.04	S	116	13.00	W	77	140	NO	NO	7500
16-Mar-06	0039	-9	5	2	17.70	S	115	47.44	W	77	40	NO	NO	1241
17-Mar-06	1607	-9	6	0	15.09	S	113	0.17	W	99	1	NO	NO	815
17-Mar-06	1830	-9	7	0	15.00	S	113	0.05	W	77	7	NO	NO	2000
17-Mar-06	1918	-9	8	0	14.99	S	112	59.96	W	99	1	NO	NO	2790
17-Mar-06	2233	-9	9	0	15.00	S	113	0.00	W	99	1	NO	NO	2797
18-Mar-06	1552	-9	10	0	0.24	N	111	32.67	W	36	20	YES	NO	700
18-Mar-06	1704	-9	11	0	2.39	N	111	20.39	W	96	5	YES	NO	2790
18-Mar-06	2029	-9	12	0	8.23	N	110	46.88	W	77/99	50/1	YES	NO	2790
18-Mar-06	2241	-9	13	0	13.95	N	110	32.79	W	46	1	YES	NO	815
20-Mar-06	1946	-9	14	4	49.60	N	115	53.74	W	77	40	YES	NO	2790
20-Mar-06	2336	-9	15	4	38.27	N	116	16.32	W	77	45	YES	NO	3000
22-Mar-06	1426	-9	16	2	1.56	N	118	28.07	W	36	8	YES	NO	1722
23-Mar-06	2149	-9	17	0	10.70	S	121	49.32	W	34	17	YES	NO	200
29-Mar-06	0146	-9	18	4	12.23	N	126	29.35	W	77	20	YES	NO	1722
4-Apr-06	103	-9	19	9	22.33	N	136	9.32	W	77	2	YES	NO	160
13-Apr-06	106	-10	20	19	4.50	N	156	4.89	W	79	12	NO	NO	1300
13-Apr-06	251	-10	21	19	4.80	N	156	8.93	W	77	15	NO	NO	1300

Species Key:

34 Globicephala sp. (Unidentified pilot whale)
36 Globicephala macrorhynchus (Short-finned pilot whale, blackfish, pothead)
46 Physeter macrocephalus (Sperm whale)
77 (Unidentified dolphin or porpoise)
79 (Unidentified large whale)
96 (Unidentified cetacean)
99 Balaenoptera borealis/edeni (Rorqual identified as a Sei or Bryde's whale)

TABLE 5. Sea Turtle Sightings

DATE	TIME	LAT	LON	SPECIES	# ANIMALS	AIR GUNS	AIR GUNS	EVASIVE
(GMT)	(GMT)	Deg Min	Deg Min			ON	SHUT DOWN	BEHAVIOR
3/18/06	1714	0 2.66 N	111 18.86 W	UH	1	Y	N	N
3/18/06	2159	0 10.80 N	110 32.22 W	LV	1	Y	N	Y
3/18/06	2346	0 17.35 N	110 42.11 W	UH	1	Y	N	N
3/19/06	2000	1 24.10 N	113 45.78 W	LV	1	Y	Y	N
3/20/06	1852	4 41.81 N	115 49.04 W	LV	1	Y	N	N
3/20/06	1934	4 47.97 N	115 52.75 W	UH	1	Y	N	N
3/28/06	2131	4 54.54 N	126 17.60 W	LV	1	Y	N	N
3/29/06	0047	3 27.15 N	127 25.17 W	UH	1	Y	Y	Y
3/30/06	1727	6 10.05 N	127 57.34 W	LV	1	Y	**N**	N
4/1/06	2009	7 56.84 N	131 17.71 W	LV	1	Y	Y	N

Species Key
UH Other than D. coriacea (Unidentified hardshell sea turtle)
LV Lepidochelys olivacea (Olive Ridley sea turtle)

VI. Mitigation Effectiveness

March 19, 2006 @ 20:00 GMT

At 20:00 GMT an adult Olive Ridley sea turtle was observed 30 meters off the starboard bow passing down the starboard side as it rested at the surface. As the sea turtle appeared to be entering the seismic safety zone, a shut down of the air guns was called for via radio by the MMOs on watch. There was a delay in response by the seismic personnel on duty in the lab, and the sea turtle entered the safety zone as the air guns were shut off. The guns remained off for 2 minutes as the turtle passed thru the safety zone. One gun resumed firing after the sea turtle passed out of the zone, followed by the 2nd gun 5 minutes later. There was no reaction observed of the sea turtle. Although the observers and seismic operation personnel reacted as quickly as possible, this event was not in compliance with the rules and procedures described in the Incidental Harassment Authorization (IHA).

March 23, 2006 @ 03:26 GMT

At 03:26 GMT, the guns were shut down due to the MMO's inability to observe the entire 40-meter safety radius from the night viewing position due to lights on deck. Once operations on deck were completed, a 30-minute watch and ramp up procedure was conducted by 2 MMOs and 1 gun started at 04:28 GMT, followed by the 2nd gun 5 minutes later at 04:33 GMT.

March 25, 2006 @ 05:21 GMT and 11:44 GMT

At 05:21 GMT, the air guns were shut down due to the MMO's inability to observe the entire 40-meter safety radius due to rain showers, which limited visibility. Once the inclement weather sufficiently cleared so that the entire safety radius could be viewed, the requisite 30-minute 2-person observation period and ramp up procedure was conducted and 1 gun began firing at 10:14 GMT, followed by the 2nd gun 5 minutes later at 10:19 GMT.

At 11:44 GMT it was necessary for the aft deck lights to be turned on for deck work on the fantail. The air guns were shut down as the visibility around the 40-meter safety zone was obscured. Once operations on the stern were completed and deck lights turned off, a 2-person 30-minute observation period and ramp up procedure began with 1 gun firing at 13:09 GMT followed by the 2nd gun 5 minutes later at 13:14 GMT.

March 27, 2006 @0300GMT

At 03:00 GMT, the one air gun firing was shut down while the second gun was being deployed. Deck lights were needed due to night time working conditions, thus the entire 40-meter safety radius could not be viewed. At 04:31 GMT, a 30-minute observation period and ramp up procedure began, and one gun began firing at 05:01 GMT. Due to technical problems, operations continued with only 1 air gun.

March 29, 2006 @ 00:47 GMT

On March 29, 2006, an unidentified adult sea turtle was sighted by the MMO on watch from the observer station. The turtle was first sighted swimming under the surface from port to starboard approximately 110 meters ahead of the ship. It surfaced about 25-30 meters off the starboard side as the ship continued shooting, where it was seen resting and logging at the surface. As the vessel passed the sea turtle, it appeared as though the animal was going to enter the 40-meter seismic safety zone around the air guns and a shut down was called for by the MMO on watch. The seismic source was shut down in response. This was a conservative measure since only the port side air gun was deployed at the time of the sighting and the animal may have passed just outside or on the border of the safety zone. The single air gun was cleared to reenergize and resumed shooting after the sea turtle safely passed through the radius and was several hundred meters behind the vessel.

A change in behavior was observed as the sea turtle was first seen swimming at a moderate pace under the surface, then was later seen basking and resting on the surface. The animal was well outside of the safety zone of the seismic source when this change in behavior was noted.

March 30, 2006 @ 17:27 GMT

On March 30, 2006, an adult Olive Ridley sea turtle was sighted by marine mammal observers (MMO's) from the observer station. The sea turtle was first sighted approximately 75 meters off the port bow resting and logging at the surface. As the vessel passed the sea turtle 35-40 meters off of the ships beam, it appeared as though the animal was going to enter the 40-meter seismic safety zone around the air guns and a shut down was called for by the MMO on watch. There was a communication failure over the 2-way radios between the MMO's and seismic personnel in the lab due to malfunctioning of the radio equipment, and a shut down was not implemented in time. The sea turtle passed through the seismic safety zone as the air guns continued to fire. The animal did not display a change in behavior, but this event was not in compliance with the rules and procedures described in the Incidental Harassment Authorization (IHA). After the occurrence of this event, procedures were put in place to more carefully monitor the operational condition of the radios and communication checks were made between the lab personnel and observers on an hourly basis.

April 1, 2006 @ 20:12 GMT

On April 1, 2006, an adult Olive Ridley sea turtle was sighted by marine mammal observers (MMO's) from the observer station. The sea turtle was first sighted approximately 150 meters off the port bow resting and logging at the surface. The third mate on watch on the bridge alerted the science personnel in the lab of the presence of the turtle and its proximity to the ship. As the vessel passed the sea turtle, it appeared as though the animal was going to enter the 40-meter safety zone. A shut down was called for by the MMO's and the air guns were shut down before the sea turtle entered the safety zone. Seismic profiling resumed after the sea turtle was observed to have passed safely through the radius and the zone was determined clear by the MMO. The Olive Ridley sea turtle remained resting at the surface during the entire event and did not exhibit any change in behavior.

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APPENDICES

A. Incidental Harassment Authorization

B. NOAA Sighting Form

DEPARTMENT OF COMMERCE

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

NATIONAL MARINE FISHERIES SERVICE

Incidental Harassment Authorization

Scripps Institution of Oceanography, 9500 Gilman Drive, La Jolla, CA 92093-0210, 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 a seismic survey conducted by the *R/V Roger Revelle* in the Eastern Tropical Pacific Ocean (ETP), March-April, 2006:

1. This Authorization is valid from March 10, 2006, through March 9, 2007.

2. This Authorization is valid only for the *R/V Roger Revelles*'s seismic survey in the ETP, from March-April, 2006.

3. (a) The incidental taking of marine mammals, by Level B harassment only, is limited to no more than the following numbers of each species:

Sperm whale (*Physeter macrocephalus*) – 17
Dwarf sperm whale (*Kogia sima*) – 145
Blainville's beaked whale (*Mesoplodon densirostris*) – 182
Bottlenose dolphin (*Tursiops truncatus*) – 285
Pantropical spotted dolphin (*Stenella attenuate*) – 3424
Spinner dolphin (*Stenella longirostris*) – 627
Striped dolphin (*Stenella coeruleoalba*) – 694
Short-beaked common dolphin (*Delphinus delphis*) – 5275
Fraser's dolphin (*Lagenodelphis hosei*) – 808
Risso's dolphin (*Grampus griseus*) - 573
Killer whale (*Orcinus orca*) - 8
Short-finned pilot whale (*Globicephala macrorhynchus*) - 105
Bryde's whale (*Balaenoptera edeni*) – 4
Blue whale (*Balaenoptera musculus*) - 2

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

(b) The taking of any marine mammal in a manner prohibited under this Authorization must be reported immediately to the Southwest Regional Office, National Marine Fisheries Service (NMFS), at (562) 980-3232, and the Office of Protected Resources (NMFS), at (301) 713-2289.

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

5. Mitigation and Monitoring

The holder of this Authorization is required to:

(a) Utilize two NMFS-approved marine mammal observers (MMOs) to monitor marine mammals and sea turtles near the seismic source vessel during any start ups of the airgun(s) (day or night) and at least one MMO to monitor the safety radius during all daytime seismic operations, as described in (b), below. During night-time seismic operations, trained bridge personnel will look forward for marine mammals and sea turtles while an MMO or trained member of the science crew looks aft to the safety radius around the GI guns. Shifts will last no longer than 4 hours at a time, and usually no more than 2 hours.

(b) Visually observe the entire extent of the safety radius (190 dB for pinnipeds, 180 dB for cetaceans and sea turtles) using two marine mammal observers, at least 30 minutes prior to starting the airguns during the day or at night. If for any reason the entire radius cannot be seen for the entire 30 minutes (i.e. rough seas, fog, darkness), or if marine mammals or sea turtles are near, approaching, or in the safety radius, the airguns may not be started up. If one airgun is already running, SIO may start the second gun without observing the entire safety radius for 30 minutes prior, provided no marine mammals or sea turtles are known to be near the safety radius.

(c) Implement a "ramp-up" procedure when starting up the two-gun array, which means start up one gun, and wait five minutes before starting up the other.

(d) Alter speed or course during seismic operations if a marine mammal or sea turtle, based on its position and relative motion, appears likely to enter the safety zone. If speed or course alteration is not safe or practical, or if after alteration the marine mammal or sea turtle still appears likely to enter the safety zone, the airguns will be shut down immediately.

(e) Shut-down of the airguns if a marine mammal or sea turtle appears likely to enter the safety radius, or is already within the safety radius when first seen. A shut-down means all operating airguns are shut down. Airgun activity will not resume until the marine mammal or sea turtle has cleared the safety radius, which means it was visually observed to have left the safety radius, or has not been seen within the radius for 15 min (small odontocetes, pinniped, and sea turtles) or 30 min (mysticetes and large odontocetes, including sperm and beaked whales).

6. Reporting

The holder of this authorization is required to:

(a) Submit a report on all activities and monitoring results to the Office of Protected Resources, NMFS, and the Southwest Regional Administrator, NMFS, within 90 days of the completion of the *R/V Roger Revelles*'s cruise. This report must contain and summarize the following information:

(1) Dates of, times of, locations of, and weather during (including Beaufort Sea State) all seismic operations;

(2) Species, number, location, and behavior of any marine mammals, as well as associated seismic activity, observed throughout all monitoring activities.

(3) An estimate of the number (by species) of marine mammals that (i) are known to have been exposed to the seismic activity at received levels greater than or equal to 180 dB re 1 microPa (rms) with a discussion of any specific behaviors those individuals exhibited and (ii) may have been exposed to the seismic activity at received levels greater than or equal to 180 dB re 1 microPa (rms) with a discussion of the nature of the probable consequences of that exposure on the individuals that have been exposed.

(4) A description of the implementation and effectiveness of the mitigation and monitoring measures required by this document for minimizing the adverse effects of the action on marine mammals and sea turtles.

(b) In the unanticipated event that any cases of marine mammal injury or mortality are judged to result from these activities, SIO will immediately shut down airguns and report the incident to NMFS and the local stranding network. Airgun operation will then be postponed until NMFS is able to review the circumstances and work with EAFB to determine whether modifications in the activities are appropriate and necessary.

7. A copy of this Authorization must be in the possession of all contractors and marine mammal monitors operating under the authority of this Incidental Harassment Authorization.

MAR - 7 2006

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

Date

Attachment

Appendix B. NOAA Sighting Form (88-208)

SWFSC Marine Mammal Sighting Form

NOTES: w/ ANGLE

Date __/__/__ (YYMMDD)   Cruise # ________   Sighting# ________

Time ________   Effort ON OFF   Observer # ________

SPECIES DETERMINATION

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 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

Guide to Behavioral Data Collection (for Observers) – CSCAPE 2005
Protocol and some hints for recording behavioral data on Marine Mammal Sighting Forms
24 May 2005

GENERAL INSTRUCTIONS

Purpose: The purpose of recording behavioral observations on the sighting forms is to enable us to standardize the behavioral data that comes back from the field. We will use these data to document the reaction of dolphins to the research vessel and to better understand how dolphin behavior affects our ability to detect and count animals. We greatly appreciate your time and effort in this pursuit. You are our eyes; tell us what you see!

Use: The behavior fields on the front and the back of the Marine Mammal Sighting Form should be filled out for each sighting. We would like your observations on every species but we also know that you are under tight time constraints on the flying bridge. Therefore, sampling priorities are:

Priority Group 1.	small delphinids (common, white-sided, striped, bottlenose) and porpoises
Priority Group 2.	pilot whales, Risso's; all other medium-sized delphinids;
Priority Group 3.	any other odontocete species.

We have collected behavioral data on these species during the previous ORCAWLE cruise and similar data are also collected during the CalCOFI cruises, enabling us to better understand the vessel response behavior of California current animals. In addition, these data provide interesting comparisons to data collected on the same species in the eastern Tropical Pacific.

Questions: During CSCAPE 2005 we have two main questions, which build upon what we have learned by observing dolphin behavior in previous cruises:

(1) *Ship avoidance/attraction*. To look at the behavior of cetaceans relative to our presence, we are collecting data on the movement of dolphin schools relative to the research vessel.

(2) *Sex and age composition of schools*. Little is known about the social structure of pelagic dolphins. We will use these sighting forms to gain insights into how the sex and age composition of schools influences observable school behavior.

Forms*:* The following forms are designed to be used together. The *SWFSC Marine Mammal Sighting Form* (NOAA Form 88-208) has a front and a back side on which to record your behavioral observations. The *"Observer Guide to Dolphin Behavior"* defines terms and standardizes terminology. Please refer to it when describing dolphin behavior. It is pasted into the front of your green book. The *"Guide to Behavioral Data Collection for Observers"* (this document) describes the protocol for recording behavioral observations on the flying bridge and instructions for filling out the sighting form.

Data entry: Eric Archer created an Access data entry program for transcribing the behavioral data on the sighting forms into the Behavior Data Archive. Ideally, one observer would be designated to do this throughout the cruise and would enter the behavioral data each evening.

Protocol: You've just sighted a dolphin school at 30 degrees right, reticle 1.3. What do you do?

The first priority for you and the rest of the observers is to make your species identification and abundance estimates. Then, make your behavioral observations. We are especially interested in whether the dolphins react to the research vessel and at what distance they react. If you, or any other observer, see such a change in dolphin behavior, call out the reticle to the recorder who will record a resighting in WINCRUZ. It is very important that the recorder also records a comment so that we know that this resighting referred to a change in dolphin behavior. In the comment field, write something concise like: "dolphins run from research vessel". If the dolphins changed behavior while you were in the middle of making your abundance estimate, don't interrupt what you're doing, but note the reticle if possible (or just estimate the distance by eye) and keep it in mind until you have a moment to tell the recorder or to write it on the sighting sheet.

After making your species ID and abundance estimate, it is best to fill out the front and the back of the sighting form while you are still on watch. We've designed the back of the form to go as fast as possible; just circle the appropriate answer. If you do not have time, make a few notes and fill out the behavioral fields after the watch.

In general, observers fill out the narrative portion after their watch is over. You might also want to write more later on when you have a chance to chat with the other observers. This is fine; in fact we encourage you, to talk with the other observers about dolphin behavior. Add their observations to the narrative (or ask them to add a sheet of their own).

Some general notes on recording behavioral data*:* Behavioral data is inherently variable and difficult to quantify reliably. However, if the terminology and the data collection are standardized, we can gain considerable information from the field that would otherwise be lost. Here are a few other hints when recording behavioral data:

Categorical data. We've tried to strike a balance between making the form quick and easy to fill out (by creating behavioral categories for you to circle) and by leaving room for you to describe your observations (in the narrative). On the backside of the sighting form, do your best to pick one of the categories. Undoubtedly, situations will arise in which our categories do not describe what you see. There are options to cover these situations:

> U = unknown/cannot be determined; use this when you did not systematically look for a particular behavior. For example, if the question is, "Calves present?" but the school was at reticle 0.1 and you feel that you would not have been able to see calves at that distance, even if they had been present, then you should circle the "U."

O = other/please explain; use this category when you do not think that what you observed is explained by the categories given. If this is the case, circle the "O" and use the narrative to describe what you did observe.

Leaving fields blank. Please don't. Let's say the question on the sighting form is: "bow-riding?" and you leave the field blank. Back on dry land, we do not know if you looked for bow-riding and didn't see it (a negative answer) or if you didn't or couldn't look (an unknown/cannot be determined answer).

Describe what you see. The most important trick to good behavioral observations is to describe only what you see. Please keep what you see (your description of dolphin behavior) separate from what you think is going on (your interpretation of dolphin behavior). It is important to communicate both to us, however. You are the best one to interpret what is going on out there because you can take the entire scene into account. For example, please don't just write dolphins are "feeding." How do you know they are feeding? Write instead … "I observed three dolphins with tightly rounded backs, diving slowing and surfacing with fish in their mouths," or, "I *think* they were feeding." Similarly, if you think that the dolphin school was *"evasive*" (your interpretation), please describe the specific dolphin behaviors that gave you that impression (e.g., the dolphins "ran," "scattered," and "frequently changed direction," etc.).

Change in behavior. Because we are interested in dolphin behavior in response to the research vessel, we are talking about *changes* in dolphin behavior. There are two tricks to recording changes in behavior. First, have a firm idea of what *no change*, or in this case what *no response* to the research vessel, would look like. (*No response* = dolphins just keep on doing exactly the same thing, before, during and after the research vessel moved on through.) The second trick to describing changes in behavior is to record what was happening *initially* (e.g., before the dolphins detected the research vessel) and what happened *subsequently* (after they detected the research vessel). You should be able to say something like this … "When *initially* sighted, the dolphins were milling around in a loosely spaced school. *Then*, the dolphins closed ranks, and they began to run directly away from the ship." We need your description of events before and after the dolphins detect the ship to determine if a change in behavior occurred.

THE FRONT OF THE SIGHTING FORM

Narrative

Please use the narrative section on the front of the sighting form to describe dolphin behavior in detail. Use additional paper if needed and feel free to draw us a map of the dolphin track during the sighting. We are especially interested in you elaborating on the following:

Describe dolphin behavior. What were the dolphins doing? We use the terms milling, traveling and associated-swimming but elaborate, tell us about their aerial activity, diving behavior, etc.

What are dolphins doing when they associate with birds and tuna? We don't know what the dolphins are doing when they aggregate with birds and tuna. Describe what the dolphins are doing. How is it different than what dolphins do when they are not in these multi-species aggregations? Please systematically look for evidence of dolphin feeding.

How did the school respond to the research vessel? For example, if you circled on the back side of the sighting form that the school was *"evasive,"* in the narrative please describe the specific dolphin behaviors that gave you that impression (*evasive* = the dolphins "ran," "scattered," and "frequently changed direction," etc.). If your impression was that the school was *not evasive*, please tell us the behaviors that you observed that gave you that impression (*not evasive* = the dolphins showed "no response" to the research vessel or they were "attracted" to the research vessel; e.g., bow-riding or wake-riding). See note above on recording changes in behavior.

If dolphin behavior changed in response to the research vessel, when did it change? Describe behavior before and after and record the reticle/distance at which the change was detected. Remember to record the angle and reticle at which dolphin behavior changed and to record a resight in WINCRUZ.

Describe the composition and spatial distribution of the school. Please describe the species composition of the school. Describe age (calves, juveniles, adults present?) and gender (can you see any adult males?) of the dolphins. Describe the spatial distribution of individuals within the school; is it uniform or are different types of dolphins seen together?

Does the school change shape in response to the research vessel? If the school splits, please describe the sequence of events and what happens to the different species in mixed-species schools.

THE BACK OF THE SIGHTING FORM

****Note: Mixed species sightings**

If the sighting contains multiple species, please take care when filling out the back of the sighting form to indicate which species performed which behavior. If only one response is circled for each question, we can only assume that each species performed the exact same behaviors throughout the sighting, which is rarely the case! One method would be to put a circle around the behavior for one species, and a square around the behavior for the second species, and draw a key indicating which symbol represents which species.

In your estimation, were the animals already reacting to the research vessel?

Sometimes, when you *first* make a sighting, the school is already moving away from the research vessel, or toward it. We need to know if, in your estimation, you observed the dolphins before they responded to the research vessel (a negative answer) or if you think that the dolphins were already responding to the research vessel when first sighted (a positive answer).

School Behavior

Behavior when first observed: Choices are traveling, milling, associated-swimming, approaching the ship, and bow-riding. We've tried to make the categories as mutually exclusive as possible, but sometimes they will not work out that way. Circle all that apply and use the narrative to explain. For example, you might observe dolphins "associated swimming" that are also "slow traveling" … circle both.

Did dolphin behavior change during the observation? Y or N**.** What we are asking here is whether or not you think that dolphin behavior changed during the course of the sighting. If the answer is a positive one, remember to record a resight, so that we can determine the distance at which the change occurred. When you first observed the school, if they were traveling rapidly away from the ship and they continued to do this until you lost them in the distance, record a negative answer (no, dolphin behavior did not *change* during the sighting). Note: dolphin behavior might have changed before the sighting, but you did not see that. If you record a negative answer, do not answer the next question.

If behavior changed, what did the behavior change to? Answer this only if you answered "yes" to the previous question. Choices are the same as above; circle all that apply.

School Shape

As above, we are interested in the initial shape of the school and whether or not it changed during the sighting. If it did change, what did it change to? Please see terms regarding aggregation (tight or loose) and clumping (uniform or clumped).

School Composition

Were calves present? Y or N. We don't really know how to tell what a "calf" is either! What we mean by a calf is one that is dependent on its mother and thus still nursing. We cannot, however, tell whether an individual is nursing just by looking. Do your best; look for small animals with different coloration patterns than adults and – most importantly – look to see whether the animal is in the "calf position," that is, swimming in close proximity to an adult (presumably the mother, but we don't have anyway of knowing this either). Do your best to estimate the percentage or to quantify the number of calves present. What if you see "juveniles?" Juveniles are not calves. We define juveniles as individuals that are no longer nursing, not swimming in "calf position," but that have yet to reach adult size (and along with it sexual or social maturity). Answer "no" to the question about calves but please do tell us about the presence of juveniles in the narrative.

If you answered "yes" to the previous question, please estimate the percent of calves in the school. Were neonates present? Neonates we define as calves that are visibly pink and/or with fetal folds and/or with folded dorsal. Again, do your best to quantify the percentage or number of neonates that you observe.

Reaction to the Vessel

Please see the definition of terms. The questions we ask here are only some of the many possible reactions dolphins might have to the research vessel. Please use the narrative to describe other types of reactions not mentioned here. We are interested in both the presence/absence of these behaviors and the distance at which they occur from the ship. Estimate distance either by recording the reticle or by eye.

Does the school split? Y or N. After detecting the ship, the school may split into smaller groups. These subgroups can vary in size from one individual to many. Not applicable to schools that when initially sighted are already in subgroups (a "clumped" distribution). "Shattering" or "exploding" or "starburst" describes a special case when dolphins move away in all different directions, singly or in groups.

If the school splits, do the subgroups move off in different directions? Y or N. What we are trying to get at here is whether the subgroups continue to move in the same direction (e.g., the school breaks up into subgroups but all subgroups continue moving north) or if they move away from one another (e.g., the school splits up and the subgroups scatter in different directions).

If the school splits, and it's a mixed species school, is the subgroup composition: mixed or single species? Answer this question only if the school was a mixed school. Answer this question when you last see the school; consider the species composition at the end of the splitting. We are curious about how the two species segregate themselves when a school splits up. Do the subgroups have the same composition as the initial school? Our impression (from observer observations) is that generally, when a mixed school splits up, the two species segregate into single species subgroups. This question may be slightly confusing to answer as we understand that in mixed schools (before they are disturbed), the species are often segregated spatially (e.g., a small group of spinners in the back of a big school of spotters). For the sake of

answering this question, however, consider this a mixed species school and don't worry about where the species are located in the school. Now, let's imagine that the ship approaches this school and then it splits up. Wait till the end of the sighting and take a look at the subgroups …. are they single or mixed species?
Please use the narrative to fill in the details.

In your estimation, relative to the research vessel, was this school …

Here, we are interested in your opinion of the schools reaction to the research vessel. Choices are *evasive* (e.g., running, low swimming, frequent changes of direction, school splitting, etc.); *non-evasive* (e.g., schools that show no response to the research vessel or that show a positive response to the research vessel such as attracted to the boat, bow-riding, or wake-riding, etc.); or *both* (e.g., most individuals within the school run but some individuals come over and bow-ride).

If you answered "evasive" to the previous question, please estimate the distance (reticle or by eye) from the ship at which you felt the animals showed a strong evasive response (i.e., when the dolphins got up and ran).

We thank you for your time in filling out these forms.

Questions/comments: Sarah Mesnick (sarah.mesnick@noaa.gov) or Anne Allen (anne.allen@noaa.gov).

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Observer guide to dolphin behavior

I. School Behavior

A. *Traveling* – the movement in a given direction of an individual or school, at approximately 3 knots or greater. Movement of school is polarized (all individuals are moving in the same direction) and coordinated (moving at the same pace). Aerial activity may be observed. Can be:

1. *Fast traveling* – characterized by rapid, directed swimming with many porpoising individuals; school is highly polarized.
2. *Moderate traveling* – some of the individuals are porpoising; school is traveling at medium speeds.
3. *Slow traveling* – few or no individuals porpoising; school is traveling at slower speeds; movement of the school is less directed and school may be less polarized.

B. *Milling* – animals remain in the same general area; school is not polarized. Movement of individuals is characterized by frequent changes in direction over a small spatial scale; speed approximately less than 2 knots. Aerial activity may be observed.

Associations

A. *Associated-swimming* – swimming/diving in association with birds and tuna. Generally, individuals are moving slowly, diving and spending less time at the surface. The school is not polarized. It is not known if the dolphins are feeding at this time, even if there is evidence that the birds and tuna are feeding, so this term should be used only with direct evidence of feeding dolphins. *Note: animals can be associated-swimming while traveling or milling.

III. Individual Behavior

A. *Lob tailing* – one or more individuals slapping the surface of the water with the tail flukes. This behavior makes splashes on the water.

B. *Aerial activity* – one or more individuals are seen leaping, spinning, breaching, tail walking, roto-tailing, head slapping, etc. These activities usually associated with splash entries into the water.

C. *Porpoising* – smooth arching leaps clear out of the water while traveling; entry into the water is splashless and rostrum first.

D. *Other* – describe behavior.

IV. Behavior Relative to the Research Vessel

* Please note the distance from the ship at which the behavior first occurs (reticle or estimate by eye)

A. *Approach the boat* – individual/s alter course to swim directly towards the vessel, approaching but not bow riding.

B. *Bow riding* – diving and surfacing in the bow wave of the boat.

C. *Wake riding* – diving and surfacing in the wake of the boat.

D. *Running from the boat* – swimming at high speed directly away from the boat. This means that the school has changed direction and/or increased speed.

E. *School splitting* – a larger school breaks up into smaller groups, which are spatially segregated clusters of animals. Subgroups may vary in size but they are always smaller than the initial school. Please describe how the school splits up and the species composition of the school before and after splitting. "Shattering" describes a special case when dolphins move away in all directions, singly or in small groups.

1. When the school first splits, do the individuals/subgroups:
   a. *move off in different directions.*
   b. *continue to move in the same direction.*

2. During your final observation of the school, is the composition:
   a. *mixed* – different species in the same subgroup.
   b. *single species* – subgroups are species-specific.

F. *School coalescing* – after initial sighting, a more scattered school closes ranks and becomes more tightly aggregated, cohesive, and polarized.

G. *Low swimming* – only the dorsals or small patches of back are visible at the surface, making the animals very difficult to see.

H. *Other "evasive," "attractive," or "neutral" behaviors* – describe any other behaviors that you think may indicate that the dolphins are attracted to, are avoiding, or are not responding to the research vessel.

V. Spatial Distribution of Individuals

A. *Aggregation* – the distance between individuals within the school.

1. *tight* - most animals are within one body length of each other. School has easily discernible shape; the beginning and end are well defined.
2. *loose* - most animals are distributed greater than one body length apart. School shape is difficult to discern; the beginning and end are not well defined.

B. Clumping – the degree of clustering within the school.

1. *uniform* – ca. equal amounts of space between all individuals in the school.
2. *clumped* – the school is divided into subgroups, with more space between subgroups than among individuals in each subgroup.

VI. Composition of Schools

A. Note the presence or absence of neonates, calves and/or juveniles in the school.

B. Note the species composition of the school at the beginning and end of the sighting.