Marine Mammal Monitoring During a Low-Energy Seismic and OBS Survey in the NE Pacific Ocean by Scripps Institution of Oceanography, on board the OSU Research Vessel *WECOMA*

September 5-11 2007

Prepared by

Scripps Institution of Oceanography
Shipboard Technical Support
9500 Gilman Drive
La Jolla, California 92093-0214

FORWARD

This document serves to meet reporting requirements specified by the National Marine Fisheries Service, Office of Protected Resources (NMFS/OPR) in the Incidental Harassment Authorization (IHA) issued to Scripps Institution of Oceanography (SIO) on September 4, 2007. The IHA (Appendix A) authorized non-lethal takes of certain marine mammals and sea turtles incidental to a low-energy marine seismic survey in the northeastern 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 marine mammals are unknown. Nonetheless, to minimize the possibility of any negative impact, and to document the extent and nature of any disturbance effects, NMFS requires that seismic research conducted under an IHA include provisions to monitor for marine mammals and sea turtles and to power down the sound sources when these marine protected species are detected within designated safety radii. Safety radii were defined based on the distance at which the received level of seismic sounds (RMS) were calculated at 180 db and 190 db re 1uPa-m, 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

SIO staff, with on-board assistance by the scientists who had proposed the study, deployed 16 ocean-bottom seismometers (OBSs) and conducted high resolution seismic surveys at each of the OBS sites (Figure 1). The Chief Scientist for the cruise was Dr. Anne Trehu of Oregon State University.

The purpose of the research program is to record microearthquakes in the forearc to determine whether seismicity on the plate boundary is characteristic of a locked or a freely slipping fault plane. Several earthquakes large enough to be recorded on land-based seismic nets have occurred along this segment in the past several years. The occurrence of "repeating earthquakes" (earthquakes with identical waveforms indicating repeated rupture of almost the same fault patch) suggests that this region is at a boundary between a freely slipping and a locked portion of the fault. Some models suggest that the forearc basin north of the seismically active zone may be locked; others suggest that the basement high to the south of this region is locked. Numerous very small earthquakes are expected in the portion of the fault that is slipping freely. Ocean bottom seismographs (OBSs) were deployed and will be left in place for a year. A seismic survey was conducted at each site to locate the instruments accurately and precisely on the seafloor and to characterize the shallow sediment structure around the instrument. In addition to seismic surveys, a 3.5-kHz sub-bottom profiler was operated nearly continuously throughout the cruise, and a towed magnetometer was operated on the transit between OBS locations.

The cruise departed Newport, Oregon on September 5, 2007 and ended in Newport Oregon on September 11, 2007. The research vessel, R/V *WECOMA*, is owned by the National Science Foundation (NSF) and operated by the College of Oceanic and Atmospheric Sciences, Oregon State University.

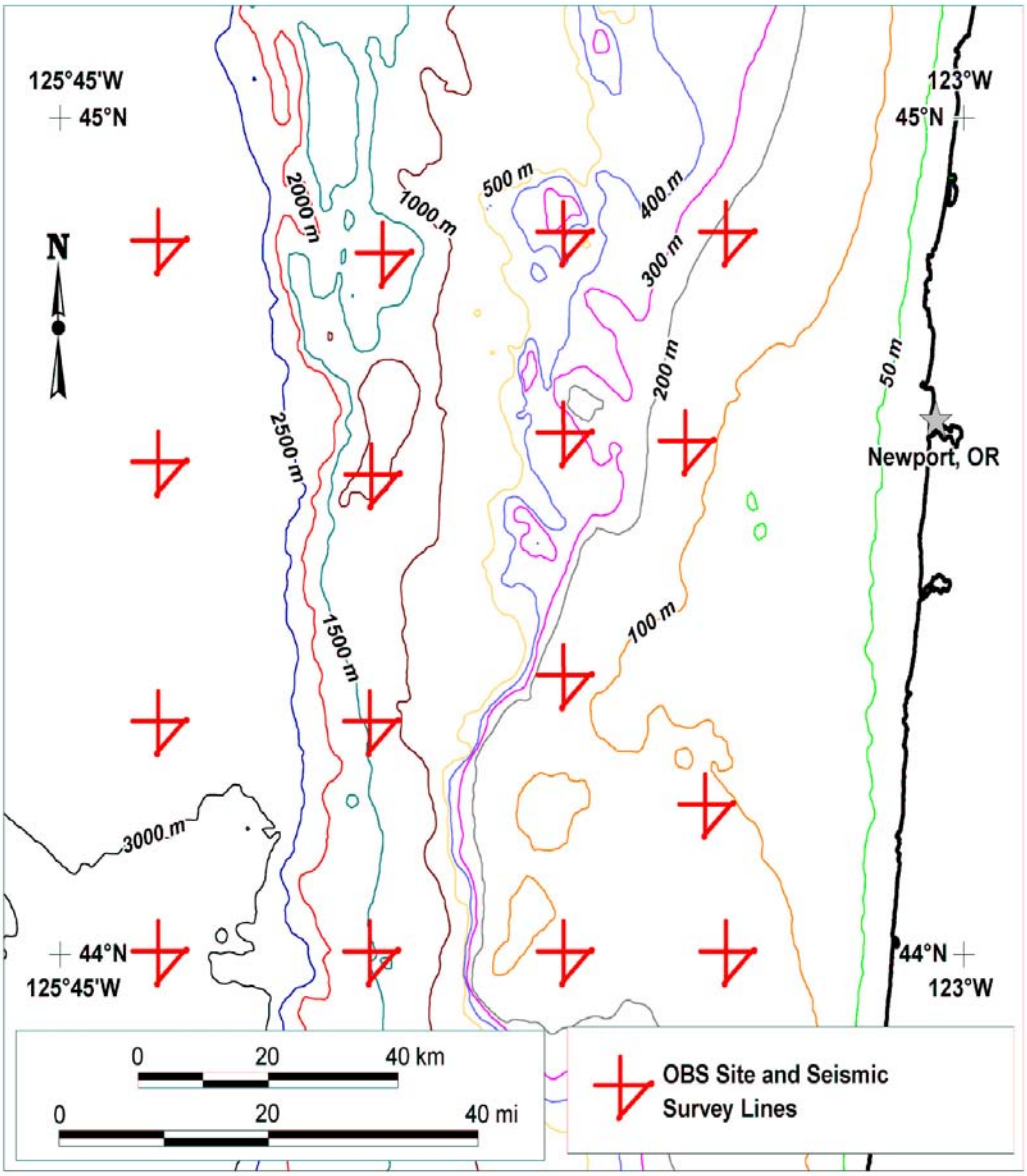


Figure 1. Map of study area showing the OBS deployment sites and track lines for high resolution seismic surveys.

II. SCIENTIFIC PERSONNEL

Two observers were on board 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 Pacific Ocean. In addition, all observers had experience in field identification of sea turtles.

Two geophysical engineers from the Shipboard Technical Support division of Scripps Institution of Oceanography were on board for the full cruise. Both had prior experience with conducting seismic surveys under the regulations of a Incidental Harassment Authorization.

III. SEISMIC SYSTEMS

The seismic sound source was a single Generator-Injector (G.I.) "gun" manufactured by Seismic Systems, Inc. (SSI) of Houston, Texas. The generator chamber of the GI gun, the one responsible for introducing the sound pulse into the ocean, was 45 in^3. The larger (105-in^3) injector chamber injects air into the previously-generated bubble to maintain its shape, and does not introduce more sound into the water. The single 45-in^3 GI gun was towed off the starboard side of the ship, 24 m back and at a depth of 4 m. Seismic pulses were emitted at intervals of 10 seconds. At a speed of 6 knots (11.1 km/h), the 10-s spacing corresponded to a shot interval of ~31 m horizontal distance.

GI-gun Specifications

Energy Source	GI gun of 45 in^3
Source output (downward)	0–pk is 1.8 bar-m (225.3 dB re 1 $\mu Pa \cdot m_p$); pk–pk is 3.4 bar-m (230.7 dB re 1 $\mu Pa \cdot m_{p-p}$)
Towing depth of energy source	4 m
Air discharge volume	45 in^3
Dominant frequency components	0–188 Hz

The rms[1] (root mean square) received levels used as impact criteria for marine mammals are not directly comparable to the peak (pk or 0–pk) or peak to peak (pk–pk) 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 dB re 1 μPa_{rms} in the far field would typically correspond to a peak measurement of ~170–172 dB, and to a peak-to-peak measurement of ~176–178 dB, 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 Lamont-Doherty Earth Observatory of Columbia University (LDEO) for a number of air gun configurations, including one 45-in^3 GI gun (Fig. 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 gun 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 a 2.5-m tow depth, the distances in Table 1 slightly underestimate the distances for the 45-in^3 GI gun towed at 4-m depth.

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

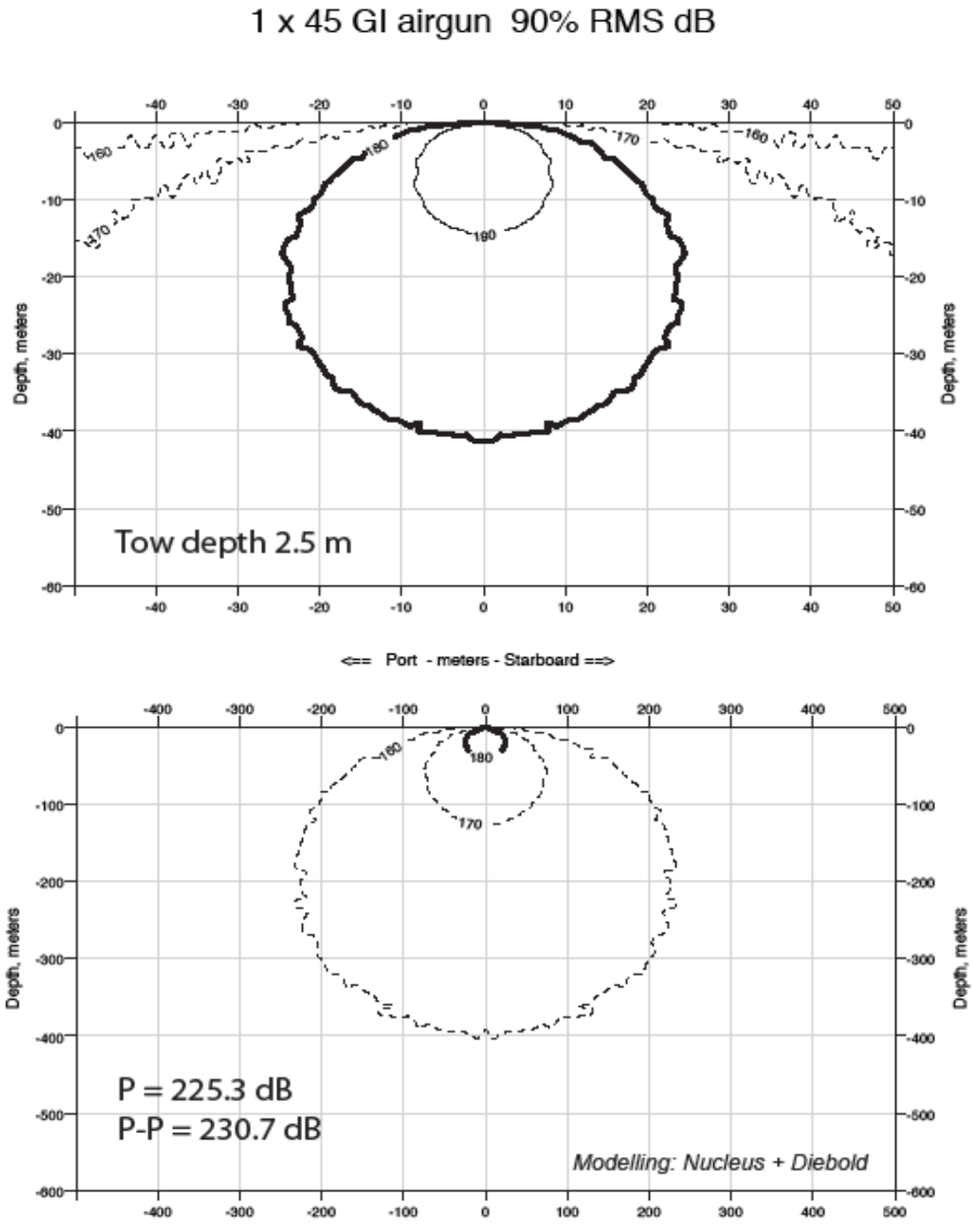


FIGURE 2. Modeled received sound levels from the 45-in^3 GI gun that will be used during the SIO survey in the northeastern Pacific Ocean during September 2007. Model results provided by the Lamont-Doherty Earth Observatory of Columbia University.

Empirical data concerning the 180-, 170-, and 160-dB distances have been acquired based on measurements during the acoustic verification study conducted by LDEO 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 proposed survey will occur in depths ~110–3050 m, so the correction factors for the latter are not relevant here.

The empirical data indicate that, for ***deep water*** (>1000 m), the LDEO 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, the safety radii for GI-gun operations in deep water was that as predicted by LDEO's model (Table 1).

Empirical measurements were not conducted for ***intermediate depths*** (100–1000 m). On the expectation that results will be intermediate between those from shallow and deep water, a 1.5x correction factor was applied to the estimates provided by the model for deep water situations. This is the same factor that was applied to the model estimates during LDEO cruises in 2003. The predicted 180 and 190 dB radii in intermediate-depth water were 35 m and 12 m, respectively (Table 1).

TABLE 1. Calculated distances of received sound levels at ≥190, 180, 170, and 160 dB re 1 μPa_{rms} for a single 45-in^3 GI gun. Distances are based on model results provided by LDEO.

Water depth	Estimated Distances (m) at Received Levels			
	190 dB	180 dB	170 dB	160 dB
100–1000 m	12	35	105	330
>1000 m	8	23	70	220

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 and alert the seismic personnel on watch to shut down the source should a protected animal move within the designated 180 dB re 1 µPa·m safety radius for cetaceans and sea turtles and 190 dB re 1 µPa·m radius for pinnipeds.

Mitigation watches by at least one observer were conducted 100% of the time during daylight hours of seismic operations, regardless of weather or sea conditions. During seismic operations, MMO's were on watch from civil twilight in the morning until civil twilight in the evening. On days in which no seismic operations were conducted, observers were on watch from sunrise to sunset. The daytime observer platform was located forward of the bridge 7.46 meters above the waterline, affording a relatively unobstructed 180-degree forward view. Aft views of the vessel could be obtained along the port and starboard decks (Figure 3).

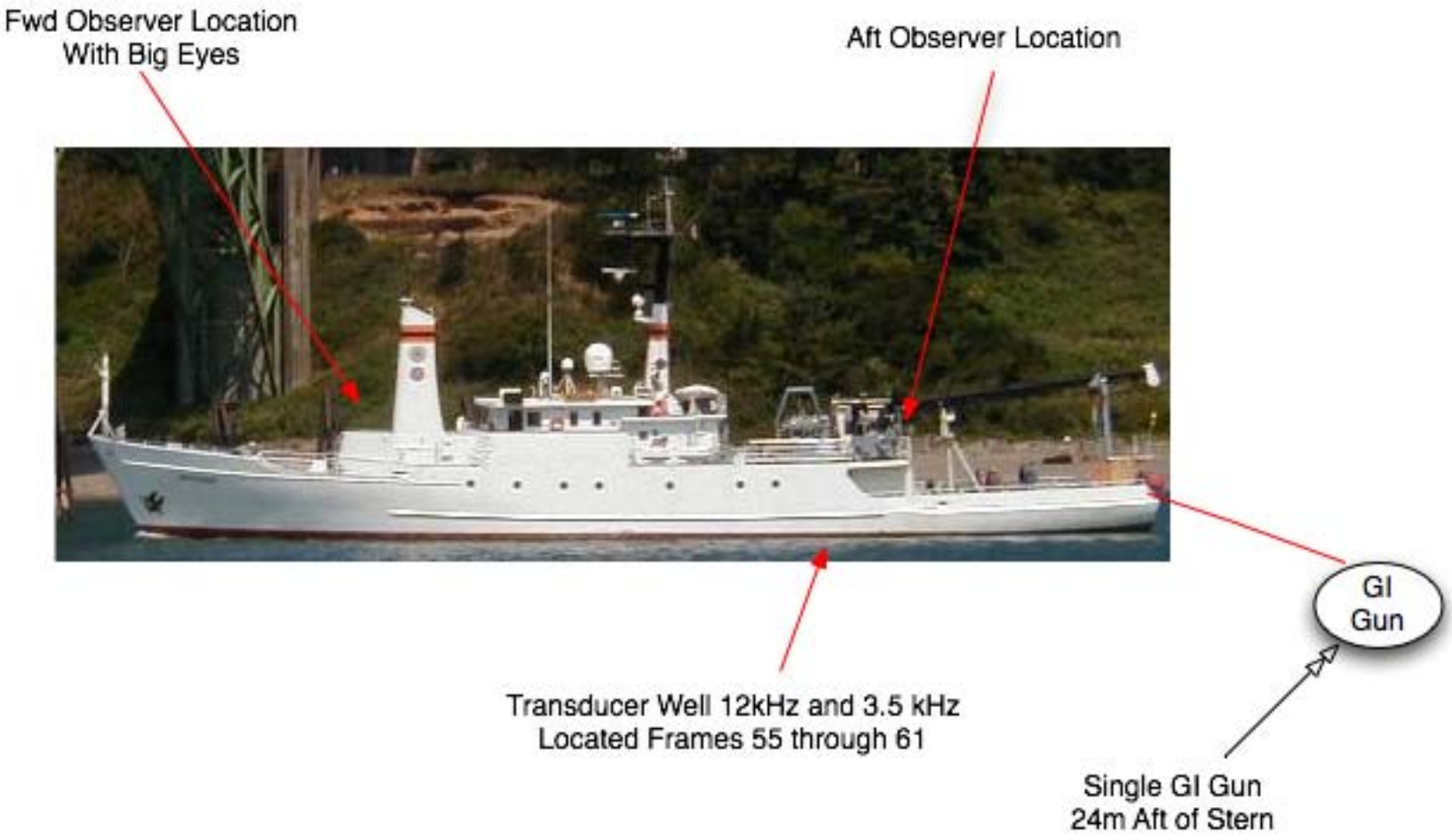
During daylight and night time start-ups, two observers would maintain a 360-degree watch for all marine mammals and sea turtles for at least 30 minutes prior to activation of the seismic source. During night time operations, watch was restricted to the designated safety radii around the seismic source due to the limitations of night viewing. Thus, night time observations were conducted from the second level below the bridge and above the hangar, looking aft for an unobstructed view of the air gun. Night vision binoculars were utilized for these periods.

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 port and starboard beams. In the event of any marine mammal or sea turtle approaching or within the 23/35 -meter safety zone, the seismic personnel were contacted via hand held radios and/or telephone and the seismic source was secured for the duration of the animal's presence with the zone, as determined by the observer on duty. Seismic operations would resume 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 25x150 big eye binoculars and 7x50 hand held binoculars to determine bearing and distance of sightings. A clinometer was used to determine distances of animals in close proximity to the vessel. This simple device proved more reliable for open water sighting than the laser range finders, which were also provided.

The marine mammal observers provided training to the scientists and bridge crew at the beginning of the cruise. More importantly, the bridge officers and other crew were instructed to alert the observer on watch of any suspected marine mammal sighting. A hand held VHF radio was used by the observers for communication with the bridge. A phone and hand held radio were used to communicate with the seismic personnel in the lab spaces. If needed, the bridge could be contacted in order to maneuver the ship to avoid interception with approaching marine mammals or sea turtles.

Figure 3. Ship Specifics of R/V *Wecoma* for Observers



When seismic operations continued through the night, marine mammal observers would continue observations until civil twilight or 30 minutes after sunset. Marine mammal observers would resume observations again at civil twilight or 30 minutes prior to sunrise the following morning. If seismic operations were halted or suspended at night for more than 5 minutes, a 30 minute watch and ramp-up procedure were required before resuming operations. In addition, almost all nighttime seismic gear deployment and recovery were observed.

Data collection procedures were adapted from the 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 this cruise. 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). 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 indicates that the vessel does not purposely approach the sighting and so was used exclusively for this cruise. Effort is further identified as being "on" or "off". For the purpose of this cruise, "on effort" was entered when one or both observers were on watch.

When a marine mammal or sea turtle was first sighted, a sighting event was entered in WinCruz, the bearing and distances were recorded and a unique number was generated for the specific sighting (Kinsey et. al. 2000). WinCruz automatically calculates distances when either 7x50, or 25x150 reticle values are entered based on the observers' height above the water (Table 2). Aided by the GPS input, WinCruz plotted sightings on a real time map. This function allowed observers to track animals and helped minimize duplicate sightings. The map was particularly useful in assisting with relocation of animals that were lost from view or to avoid duplicate sighting data of the same school or pod when the vessel changed 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 R/V *Wecoma* (one level slightly above the bridge-7.46 meters) and an observer height of 6' 0", 1.83 m

	7x Binocs		25x BigEyes	
Reticle	N miles	Meters	N miles	Meters
0	6.81	12,598	6.81	12,598
0.1	3.39	6278	4.71	8723
0.2	2.59	4791	4.06	7519
0.4	1.82	3367	3.3	6112
0.6	1.41	2609	2.83	5151
0.8	1.16	2146	2.49	4611
1	0.99	1832	2.24	4148
1.5	0.72	1332	1.8	3334
2	0.57	1054	1.51	2797
2.5	0.47	870	1.3	2408
3	0.4	741	1.15	2130
4	0.31	574	0.93	1722
5	0.25	462	0.78	1444
6	0.21	388	0.67	1241
7	0.18	333	0.59	1093
8	0.16	296	0.53	981
9	0.14	259	0.48	889
10	0.13	240	0.44	815
11	0.12	222	0.4	741
12	0.11	203	0.37	685
13	0.1	185	0.34	630
14	0.09	166	0.32	593
15	0.09	166	0.3	556
16	0.08	148	0.29	537

The observers entered values in WinCruz for weather conditions, such as Beaufort sea state, swell, and visibility (quantified in nautical miles) as conditions changed during their watch. The SWFSC software also provided an event key to record vessel traffic, i.e. distance and bearing relative to the research ship. Finally, a comment key was used to add additional information as necessary.

At the end of each day the observers checked the sighting data for errors and edited as appropriate. Behavioral data were 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 forms (adapted from format used by LDEO/LGL Environmental Consulting, Inc.) were used to record sighting data. 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, closes point of approach, sighting cue, identification reliability, pace, and any other comments). The paper data sheets were checked for accuracy and the data later entered into the computer database program.

When the seismic sound source was not active, MMO watch was suspended during poor sighting conditions, such as in high Beaufort sea state, strong winds and spray, and rain.

V. OBSERVATIONS/RESULTS

The cruise departed Newport, Oregon on September 5, 2007 and returned to Newport on September 11, 2007. The leased air compressor for the seismic source was delayed in shipping and did not arrive before the ship was scheduled to depart. The Chief Scientist decided to depart on time and use the first two days of the cruise for OBS deployment. The ship returned to port on September 7 to load the compressor. Seismic operations began on September 8, but were terminated after only one hour due to problems with the compressor. The compressor was repaired at sea, and seismic operations began again on September 9. The seismic surveys continued for 53.5 hours, except for a shut-down period of 5 minutes when a group of porpoise approached the ship. (Table 3). Observers were on watch for 100% of the time when the seismic source was active. Observers were on watch for most of the daylight hours during non-seismic periods when the ship was underway.

There were 14 sightings of marine mammals during this cruise (Table 4). Only one of these sightings was made while the seismic source was active. A few Dall's porpoise came to ride the bow wake of the ship and the seismic source was secured. They were seen to leave the area and the seismic source was energized five minutes later. The animals did not enter the safety radius while the source was active. No apparent reaction to the seismic sound source was observed.

Table 3. Seismic Operations Log

Date GMT	Start GMT	End GMT	Tot time (Hr:min)	Tot Time (Hr)	Start Lat	Start Long	End Lat	End Long	#guns	comments
Survey 1										
08-Sept-07	09:04:10				44° 15.306N	124° 34.946W			1	Start Air Gun
08-Sept-07		10:11:34	1:07	1.12			44° 18.819N	124° 42.549W	1	Stop Air Gun
										Equipment Problems
08-Sept-07	10:56:14				44° 20.306N	124° 48.383W			1	Start Air Gun
08-Sept-07		10:58:34	:02	0.03			44° 20.072N	124° 48.640W	1	Stop Air Gun
Survey 2:										
09-Sept-07	06:24:35				44° 16.112N	125° 34.733W			1	Start survey
09-Sept-07		21:31:37	15:07	15.12			44° 44.799N	124° 29.854W	1	Shut Down for Mammal Sighting
09-Sept-07	21:36:46				44° 44.804N	124° 29.177W			1	Start Air Gun
11-Sept-07		11:50:01	38:14	38.23			44° 46.740N	124° 34.190W	1	Stop Air Gun

Table 4. Marine Mammal Sightings during cruise on R/V *WECOMA*

Date	Time (GMT)	GMT offset	Sighting	Species Code	# of Animals	Air Gunning	Air Guns Stopped	Closest Dist. (meters)
9/5/2007	19:37:40	-7	1	76	1	NO		50
9/5/2007	20:10	-7	2		1	NO		150
9/5/2007	23:18:10	-7	3	22	4 TO 7	NO		10
9/6/2007	16:49:00	-7	4	76		NO		
9/6/2007	16:54:00	-7	5	76		NO		
9/6/2007	17:37:00	-7	6	76		NO		800
9/7/2007		-7	7	44		NO		1
9/9/2007	21:31:37	-7	8	44	2	YES	YES	1
9/10/2007		-7	9		1	NO		95
9/11/2007	16:45	-7	10	22		NO		30
9/11/2007	18:04:00	-7	11	37	2	NO		300
9/11/2007	20:38:00	-7	12	22		NO		1
9/11/2007	20:47:00	-7	13	76		NO		3200
9/11/2007	20:52:00	-7	14	76		NO		5000

Species Key:
022 Lagenorhynchus obliquidens, Pacific white-sided dolphin, lag, hookfin porpoise
037 Orcinus orca, Killer whale
044 Phocoenoides dalli, Dall's porpoise
076 Megaptera novaeangliae, Humpback whale

VI. MITIGATION EFFECTIVENESS

September 9, 2007 @ 21:31:37 GMT

At 21:31:37 GMT a small group of Dall's porpoises (*Phocoenoides dalli*) were sighted approximately 400-350 meters off the starboard bow traveling and milling near a flock of birds at the surface in an area high in fishing boat traffic. Their "rooster tail" splashes were cued by the marine mammal observer on watch. The animals were first sighted traveling at a heading of 100 degrees relative to the ship and as the vessel continued on its course with seismic gear deployed, the animals turned and began charging and approaching the vessel until close enough to bowride. As the animals approached the ship a shut down was called for twice and the bridge crew also relayed the shut down call to the lab because of communication difficulties, where the lab and seismic personnel immediately shut off the air guns. A pair of porpoises continued to bowride moving from port to starboard to port again before sounding and disappearing from view. After 5 minutes passed after the shut down, the air guns were re-energized when the animals were not seen again and appeared to have left the area deeming the safety zone clear. The porpoises were never observed to have entered the safety radius of the air guns.

VI. LITERATURE CITED

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APPENDICES

A. Incidental Harassment Authorization

B. NOAA Sighting Form (88-208)

C. General Instructions for Completion of NOAA Sighting Form

D. Observer Guide to Dolphin Behavior

Appendix A. Incidental Harassment Authorization

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 low-energy seismic survey conducted by the *R/V Wecoma* in the northeastern Pacific Ocean, September, 2007:

1. This Authorization is valid from September 5, 2007, through September 30, 2007.

2. This Authorization is valid only for the *R/V Wecoma*'s seismic survey in the northeastern Pacific Ocean, during September, 2007.

3. (a) The incidental taking of marine mammals, by Level B harassment only, is limited to the following species:

(i) Odontocetes – pygmy sperm whale (*Kogia breviceps*), short-beaked common dolphin (*Delphinus delphis*), Pacific white-sided dolphin (*Lagenorhynchus obliquidens*), northern right whale dolphin (*Lissodelphis borealis*), Risso's dolphin (*Grampus griseus*), and Dall's porpoise (*Phocoenoides dalli*).

(ii) Pinnipeds – northern fur seal (*Callorhinus ursinus*) and harbor seal (*Phoca vitulina richardsi*).

(b) 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.

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

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

6. Mitigation and Monitoring

The Holder of this Authorization is required to:

(a) Utilize NMFS-approved, vessel-based marine mammal visual observers (MMVOs) to monitor marine mammals near the seismic source vessel during any start ups of the

airgun (day or night) and at least one MMVO to monitor the safety radius during all daytime seismic operations, as described in (b) below. Vessel crew will also assist in detecting marine mammals. Shifts will last no longer than 4 hours at a time. MMVOs will also make observations during daytime periods when the seismic system is not operating for comparison of animal abundance and behavior, when feasible.

(b) Visually observe the entire extent of the safety radius (190 dB for pinnipeds, 180 dB for cetaceans) using NMFS-approved MMVOs, for at least 30 minutes prior to starting the airgun (day or 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 airgun may not be started up.

(c) Minimize approaches to slopes and submarine canyons, if possible, because of sensitivity of beaked whales.

(d) Alter speed or course during seismic operations if a marine mammal, 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 still appears likely to enter the safety zone, the airgun will be shut down immediately.

(e) Shut-down of the airgun if a marine mammal appears likely to enter the safety radius or is already within the safety radius when first seen (see attached). Airgun activity will not resume until the marine mammal 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 and pinnipeds) or 30 min (mysticetes and large odontocetes, including sperm, pygmy sperm, dwarf sperm, and beaked whales).

7. Reporting

The Holder of this Authorization is required to submit a report on all activities and monitoring results to the Office of Protected Resources, NMFS, within 90 days of the completion of the *R/V Wecoma*'s cruise. This report must contain and summarize the following information:

(1) Dates, times, locations, heading, speed, weather during (including Beaufort Sea State), and associated activities during 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 (visual observation) at received levels greater than or equal to 160 dB re 1 microPa (rms) and/or 180 dB re 1 microPa (rms) with a discussion of any specific behaviors those individuals exhibited and (ii) may have been exposed (modeling results) to the seismic activity at received levels greater than or equal to 160 dB re 1 microPa

(rms) and/or 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.

8. 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 the airgun 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 SIO to determine whether modifications in the activities are appropriate and necessary.

9. 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.

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

9/4/07
Date

Attachment

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 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

Appendix C. General Instructions for Completion of NOAA Sighting Form

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

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.

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

A. *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.

B. *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. 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: A Microsoft Access data entry program has been written 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 are 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).

Questions/comments:
Sarah Mesnick (sarah.mesnick@noaa.gov) or Anne Allen (anne.allen@noaa.gov).
Updated 13 August 2004.

Appendix D. 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:

i. *Fast traveling* – characterized by rapid, directed swimming with many porpoising individuals; school is highly polarized.
ii. M*oderate traveling* – some of the individuals are porpoising; school is traveling at medium speeds.
iii. *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.

II. Associations

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.

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

ii. 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.

i. *tight* - most animals are within one body length of each other. School has easily discernible shape; the beginning and end are well defined.
ii. *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.

i. *uniform* – ca. equal amounts of space between all individuals in the school.
ii. *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.