STATE OF CALIFORNIA -- THE RESOURCES AGENCY GRAY DAVIS, Governor

CALIFORNIA COASTAL COMMISSION
45 FREMONT STREET, SUITE 2000
N FRANCISCO, CA 94105-2219
E AND TDD (415) 904-5200

RECORD PACKET COPY

Tu 5d

STAFF RECOMMENDATION

ON CONSISTENCY DETERMINATION

Consistency Determination No.	**CD-14-02**
Staff:	MPD-SF
File Date:	2/8/2002
60th Day:	4/9/2002
75th Day:	4/24/2002
Commission Meeting:	4/9/2002

FEDERAL AGENCY: **U.S. Geological Survey (USGS)**

PROJECT LOCATION: Southern California offshore waters, nearshore areas to 30 km (18.6 mi.) offshore, between Point Arguello, Santa Barbara Co. and Point Dume, Los Angeles Co. (Exhibit 1)

PROJECT DESCRIPTION: High-resolution seismic surveys to map earthquake faults and other subsea stratigraphic information

SUBSTANTIVE FILE DOCUMENTS: See page 16.

EXECUTIVE SUMMARY

The U.S. Geological Survey (USGS) has submitted a consistency determination for a seismic survey in southern California offshore waters to collect high-resolution seismic reflection data to investigate landslide and earthquake hazards in waters offshore of Pt. Dume, Los Angeles

County, to Gaviota, Santa Barbara County (with additional side-scan sonar surveying in waters offshore of the Pt. Arguello-Pt. Conception area of Santa Barbara County). The survey would take three weeks to complete and is scheduled for June 2002.

Seismic surveys usually involve loud seismic pulses which can disturb marine resources. For example, most oil exploration seismic surveys use very loud and often multiple airguns, with sounds on the order of 230-259 decibels (dB)[1]. Typical oil company surveys use airgun sizes on the order of thousands of cubic inches. In the past, USGS has used either a much smaller (35 cu. in.) airgun (maximum sound level of 220 dB) or a minisparker system (maximum sound level of 209 dB). USGS proposed the minisparker for its last survey (2000), primarily to enable it to receive State Lands Commission approval for State water surveying without having to prepare an EIS.

The 1999 USGS airgun survey raised concerns over nighttime operation, when visibility is limited. With a 100 meter (m) marine mammal preclusion area for the 220 dB source, and only a 30 m ability to detect marine mammals at night, the Commission only authorized that survey after USGS agreed to avoid nighttime use of the main airgun. The Commission concurred with USGS' 2000 survey, including nighttime use, with the minisparker, because the preclusion area was much smaller. This year's survey includes use of multiple-equipment: a small airgun (35 cu. in.), a minisparker, a boomer or similar "geopulse," and, off Pt. Conception-Pt. Arguello, a side-scan sonar (which has traditionally not raised marine mammal concerns). The loudest source, the airgun, would not be used at night or in state waters.

The survey equipment is loud enough to warrant concerns over effects on marine mammals and trigger the need for monitoring and avoidance measures. Accordingly, USGS has committed to monitoring marine mammals in the survey vicinity and avoiding subjecting marine mammals to sound levels above 180 dB. USGS expects the sound from the airgun to attenuate to 180 dB at 100 meters (m). Responding to Commission requests during past surveys, USGS has agreed to use to the greater of these preclusion radii, thus assuming spherical spreading (20 log R) for both deep and shallow waters. In addition, the project has been timed to avoid the gray whale migration season.

With the monitoring and avoidance commitments, along with USGS' proven ability to monitor and protect marine mammals in its past surveys, the project is consistent with the marine resource, environmentally sensitive habitat, commercial and recreational fishing and diving policies (Sections 30230, 30240, 30234, 30234.5, 30213 and 30220) of the Coastal Act.

---

[1] All decibel references in this report will be based on the water reference standard, at 1 meter from the source (i.e., re: 1 micropascal (μPa) @ 1 m), unless otherwise noted. Where followed by "RMS," the reference means one micropascal measured at one meter from the sound source root mean square, which means "average pressure squared over the pulse duration" (i.e., the average acoustic energy over the duration of the pulse). Where "received levels" (RL) are specified, these refer to the intensity received by the marine mammal (and not the source level).

STAFF SUMMARY AND RECOMMENDATION

I. Project Description. USGS proposes a high-resolution seismic survey in southern California offshore waters in order to evaluate earthquake and landslide hazards and in waters offshore of Los Angeles, Ventura and Santa Barbara Counties, consisting of a two part survey: (1) a multi-equipment survey offshore of Los Angeles Co. (Pt. Dume) to Santa Barbara Co. (Gaviota); and (2) a side scan sonar survey in waters offshore of the Pt. Arguello-Pt. Conception area of Santa Barbara Co. The surveys would extend from nearshore areas to a about 30 km (18.6 mi.) offshore (Exhibit 1).

The surveys are part of a multiyear effort to collect high-resolution seismic-reflection data to investigate the hazards posed by landslides and potential earthquake faults in the nearshore region from Santa Barbara to San Diego. USGS describes the purpose and need for this year's survey as follows:

> *Important geologic information that the USGS will derive from this project's seismic-reflection data concerns how earthquake deformation is distributed offshore - that is, where the active faults are and what the history of movement along them has been. This information is needed to improve our understanding of the shifting pattern of deformation that occurred over both the long term (approximately the last 100,000 years) and short term (the last few thousand years). We seek to identify actively deforming structures that may represent significant earthquake threats. In addition, the work will document existing submarine landslide failures and map areas with the potential for mass failure and resulting destructive tsunamis.*

During the survey the USGS will operate several sound sources, as follows:

> *The USGS plans to collect seismic-reflection data using three basic instrument systems:*
>
> *1) Huntec™ or a Geopulse™ boomer sound-source to collect high-resolution seismic-reflection data of the sub-seafloor and*
>
> *2) a high-resolution multi-channel system for which the primary source will be either a 2-kJoule sparker system for shallow water or a small GI airgun in deeper water. The type of sparker to be used will depend on the results of a sparker feasibility study completed earlier this year in the Seattle, Washington area. A 250-m-long hydrophone streamer is used for both multi-channel sources.*
>
> *3) Klein sidescan sonar for the environmental survey off Pt. Conception.*
> *The high-resolution Huntec™ boomer system uses an electrically powered sound source that is towed behind the ship at depths between 30 m and 160 m below the sea surface. The hydrophone arrays for listening are attached to the tow vehicle that houses the sound source. We plan to use the Huntec™ primarily in water depths*

greater than 300 m. The system is triggered at 0.5 to 1.25 second intervals, depending upon the source tow depth. This system provides detailed information about stratified sediment, so that dates obtained from fossils in sediment samples can be correlated with episodes of fault offset. The sound pressure level (SPL) for this unit is 205 dB re 1 µPa-m RMS. The output-sound bandwidth is 0.5 kHz to 8 kHz, with the main peak at 4.5 kHz.

Additional equipment specifications and details can be found in USGS' Incidental Harassment Authorization (IHA) application to the National Marine Fisheries Service(NMFS) (Exhibit 2). The following table summarizes this information and provides the sources' acoustic characteristics:

Table 1
Acoustic Source Characteristics

	Small airgun	**Minisparker**	**Boomer (Huntec)**	**Boomer (Geopulse)**	**Side-scan (Klein)**
Power	2 chambers 35cu.in. @ 3000 psi	1.8 kiloJoules	340 Joules	350 Joules	
Sound Pressure Level (SPL) *	220dB re 1 µPa-m RMS	209 dB RMS	205 dB RMS	204 dB RMS	100kHz 210dB RMS; 500kHz 200dB RMS
Frequency range	20-500 Hz	150-1700 Hz	0.5 to 8 kHz	0.75 to 3.5 kHz	100kHz and 500kHz
Repetition rate	8 to 12 sec	1 to 4 sec	0.5 to 1.25 sec	0.5 to 1 sec	0.25 sec
Towing depth	1 to 2 meters	Surface	10-150 meters	Surface	1-10 meters
Pulse duration	10 msec typical	0.8 msec typical	.11 msec typical	.05 msec typical	Less than 0.1 msec
Proposed safety zone for pinnipeds and odontocetes	100 meters	30 meters	30 meters	30 meters	30 meters
Proposed safety zone for mysticetes	100 meters	100 meters	100 meters	100 meters	100 meters
Hours of operation	Daylight hours only	24 hours	24 hours	24 hours	24 hours

* Note: Sound Pressure Levels are referenced to 1 microPascal @ 1 meter

The project is currently scheduled to be conducted for 13 days in June 2002, although USGS states it may occur any time between mid-May to mid-August 2002. Also, within the survey area proposed USGS may include a small portion of surveying within the Channel Islands National Marine Sanctuary (see Exhibit 1, where survey area transects the Sanctuary boundary north of Santa Cruz and Anacapa Islands), if USGS receives permission from the Sanctuary program. Surveying is proposed within state waters, but only using the smaller energy sources; the airgun will not be used at night or within state waters.

II. Historic Commission Review of USGS Seismic Surveys. In 1991 the Commission concurred with USGS' consistency determination for a seismic survey in the San Francisco Bay Region (CD-47-91). Only two days of that survey were within areas of Commission jurisdiction; the primary portions of the survey were within the jurisdiction the San Francisco Bay Conservation and Development Commission (BCDC). That survey involved use of a relatively large airgun array (10 guns, 5828 cu. in.). The monitoring report for the survey concluded that the airgun profiling did not alter the feeding behavior of sea lions, seals, or pelicans, all of which were observed feeding in parts of the study area.

More recently the Commission has reviewed two consistency determinations for USGS surveys in southern California. The 1999 survey involved use of a small, 35 cu. inch airgun (CD-32-99). This survey was originally proposed for both state and federal waters; however when the State Lands Commission (SLC) would not authorize use of an airgun within state waters (absent an Environmental Impact Report), USGS withdrew the state water portion of the survey. The 2000 survey involved use of a lower energy minisparker (CD-16-00), which the SLC did not consider a high-energy system, thus enabling USGS to obtain SLC permission for surveying in state waters.

Both the 1999 and 2000 surveys included trained observers monitoring marine mammals and avoidance of the gray whale migration season. Additional measures included:

- 1999 Survey: Avoid subjecting marine mammals to sound levels above 180 dB (within 100 m of the source). (When concerns were raised about a possible lesser standard for odontocetes, USGS agreed to modify the project to expand the marine mammal protection radius for odontocetes to be the same as mysticetes.)

- Because nighttime operation significant reduced visibility and ability to detect marine mammals, which was acknowledged in earlier monitoring reports (i.e., because the clearly observable area at night (20-30m) was smaller than the recommended mammal preclusion radius (100 m)), USGS agreed to avoid nighttime use of the main airgun.

- 2000 Survey: Use a lower energy device (a minisparker instead of an airgun), which has several benefits: the 180 dB area of acoustic footprint is much smaller, enabling USGS, even at night, to maintain visibility within the area for preclusion of marine mammals, and

from a procedural standpoint, use of this device enabled USGS to receive CSLC approval to work in State waters.

- Monitor marine mammals in the survey vicinity and avoiding subjecting marine mammals to sound levels above 180 dB (30 m in deep water and 15 m in shallow waters). When concerns were raised USGS agreed to expand the preclusion area for nearshore waters to be the same 30 m radius as was agreed to for deeper waters.

III. Federal Agency's Consistency Determination. The USGS has determined the project consistent to the maximum extent practicable with the California Coastal Management Program.

IV. Staff Recommendation. The staff recommends that the Commission adopt the following motion:

MOTION: ***I move that the Commission concur with consistency determination CD-14-02 that the project described therein is fully consistent, and thus is consistent to the maximum extent practicable, with the enforceable policies of the California Coastal Management Program (CCMP).***

STAFF RECOMMENDATION:

Staff recommends a **YES** vote on the motion. Passage of this motion will result in an agreement with the determination and adoption of the following resolution and findings. An affirmative vote of a majority of the Commissioners present is required to pass the motion.

RESOLUTION TO CONCUR WITH CONSISTENCY DETERMINATION:

The Commission hereby **concurs** with the consistency determination by USGS, on the grounds that the project described therein is fully consistent, and thus is consistent to the maximum extent practicable, with the enforceable policies of the CCMP.

V. Findings and Declarations:

The Commission finds and declares as follows:

A. Marine Resources/Environmentally Sensitive Habitat.

1. Coastal Act Policies. Section 30230 of the Coastal Act provides:

Marine resources shall be maintained, enhanced, and where feasible, restored. Special protection shall be given to areas and species of special biological or economic significance. Uses of the marine environment shall be carried out in a manner that will sustain the biological productivity of coastal waters and that will maintain healthy populations of all species of marine organisms adequate for long-term commercial, recreational, scientific, and educational purposes.

Section 30240 provides:

(a) Environmentally sensitive habitat areas shall be protected against any significant disruption of habitat values, and only uses dependent on such resources shall be allowed within such areas.

(b) Development in areas adjacent to environmentally sensitive habitat areas and parks and recreation areas shall be sited and designed to prevent impacts which would significantly degrade such areas, and shall be compatible with the continuance of such habitat areas.

2. Marine Species. The Southern California Bight supports a diverse assemblage of 29 species of cetaceans (whales, dolphins and porpoises) and 6 species of pinnipeds (seals and sea lions). The species of marine mammals that are likely to be present in the seismic research area include the bottlenose dolphin (Tursiops truncatus), common dolphin (Delphinus delphis), killer whale (Orcinus orca), Pacific white-sided dolphin (Lagenorhynchus obliquidens), northern right whale dolphin (Lissodelphis borealis), Risso's dolphin (Grampus griseus), pilot whale (Globicephala macrorhynchus), Dall's porpoise (Phocoenoides dalli), sperm whale, humpback whale (Megaptera novaengliae), gray whale (Eschrichtius robustus), blue whale (Balaenoptera musculus), minke whale (Balaenoptera acutorostrata), fin whale (Balaenoptera physalus), harbor seal (Phoca vitulina), elephant seal (Mirounga angustirostris), northern sea lion (Eumetopias jubatus), and California sea lion (Zalophus californianus), northern fur seal (Callorhinus ursinus) and sea otter (Enhydra lutris) (NMFS, Fed. Reg., 3/5/99).

USGS identifies the species and numbers of marine mammals likely to be found within the activity area as follows:

SPECIES OF MARINE MAMMALS	Estimated population	Strategic Status	Number Sighted during previous USGS surveys*			Notes
			1998	1999	2000	
Bottlenose Dolphin Calif coastal stock	206	NO		2	82	b
Dall's Porpoise Calif/Oregon/ Washington stock	117,016	NO		25	2	a
Pacific White-sided Dolphin Calif/Oregon/Washington stock	25,825	NO		118		a
Risso's Dolphin Calif/Oregon/Washington Stock	16,483	NO	8	27	120	a
Bottlenose Dolphin Calif/Oregon/Washington Stock	956	NO				a
Striped Dolphin Calif/Oregon/Washington Stock	20,235	NO				a
Short Beaked Common Dolphin Calif/Oregon/Washington Stock	373,573	NO	3981	11569	3764	a, c
Long Beaked Common Dolphin California Stock	32,239	NO				a, c
Northern Right-Whale Dolphin Calif/Oregon/Washington Stock	13,705	NO				A
Killer Whale Eastern North Pacific Southern; Resident Stock Transient Stock Offshore Stock	 82 346 285	NO				a,b
Short-Finned Pilot Whale Calif/Oregon/Washington Stock	970	NO				A
Baird's Beaked Whale Calif/Oregon/Washington Stock	379	NO				A
Mesoplodont Beaked Whales Calif/Oregon/Washington Stock	3,738	NO				A
Cuvier's Beaked Whale Calif/Oregon/Washington Stock	5,870	NO	1			A
Pygmy Sperm Whale Calif/Oregon/Washington Stock	2,933	NO				A
Sperm Whale Calif/Oregon/Washington Stock	1,407	YES				B
Humpback Whale Calif/Oregon/Washington - Mexico Stock	1,024	YES	1	39	2	B
Blue Whale Eastern North Pacific Stock	1,940	YES	3 (blue	32	5	a
Fin Whale Calif/Oregon/Washington Stock	1,851	YES	or fin)	1	1	b
Minke Whale Calif/Oregon/Washington Stock	631	NO	4		3	a
Unidentified dolphin			2159	1637	627	
Unidentified porpoise			5			
Unidentified whale			1	12	3	
Unidentified pinnipeds			2	2	3	
Harbor Seal Calif Stock	30,293	NO			8	a
Northern Elephant Seal Calif Breeding Stock	84,000	NO			1	b
California Sea Lion U.S. Stock	214,000	NO	146	21	171	a
Guadalupe Fur Seal	7,408	YES				a
Northern Fur Seal	4,336	NO	2	1		b

* as reported by biologist observers and included in Normark et al. (1999a, 1999b), and Gutmacher et al. (2000).

Notes

a) source: Barlow (1997) as reported in Forney et al. (2000)
b) source: Barlow and Taylor (in press) as reported in Barlow et al. (2001)
c) USGS numbers for common dolphins combine short and long beaked

3. Issues. Marine mammals rely on sound for communication, orientation, and detection of predators and prey. In recent years the Commission's and the public's awareness of the effects of underwater noise, particularly low frequency noise, has increased significantly. In reviewing the Scripps' ATOC[2] and the Navy's LFA[3] research and operational LFA[4] efforts, the Commission noted: (1) the growing evidence that anthropogenic sounds can disturb marine mammals (Richardson et al. 1995); (2) that observed mammal responses to such sounds include silencing, disruption of activity and movement away from the source; and (3) that low frequency sound carries so well underwater that animals have been affected many tens of kilometers away from a loud acoustic source. Recent (March 2000) whale deaths in the Bahamas, probably caused by Navy mid-frequency sonar activities (see Exhibit 4), have magnified these concerns.

When conducted using extensive airgun arrays, seismic surveys are among the very loudest of anthropogenic sounds. Richardson et al. (1995) notes that "Peak levels of sound pulses from airgun arrays are much higher than the continuous sound levels from any ship or industrial noise." The maximum noise attributed to an oil exploration array is 259 dB; the general range fur such surveys is 230-259 dB. Typical oil company surveys use airgun sizes on the order of thousands of cubic inches. The 1999 USGS survey used a single, relatively small, 35 cu. in. airgun, which emitted a maximum source level of 220 dB. USGS' 2000 survey used a significantly quieter minisparker, with a maximum source level of 209 dB RMS. The current proposal would use several types of equipment, with the loudest being the same size (35 cu. in.) airgun as the 1999 survey, with the same 220 dB maximum. As noted in the Commission's previous review of the previous two USGS surveys, any received level above 180 dB raises cause for concern and warrants the need for monitoring and avoidance measures. The proposed survey is partly located within the coastal zone, and it triggers the need for National Marine Fisheries Service (NMFS) "take" permit under the Marine Mammal protection Act (MMPA).[5] Therefore the Commission believes the survey would clearly affect the coastal zone and needs to be carefully reviewed for its marine resource impacts.

---

2 Scripps Institution of Oceanography, Acoustic Thermometry of Ocean Climate (ATOC) Project and Marine Mammal Research Program (MMRP), CC-110-94/CDP 3-95-40.

3 Consistency Determinations No. CD-95-97 and CD-153-97 (Navy, Low-Frequency Active (LFA) Sonar Research, Phases I and II).

4 CD-113-00 (Surveillance Towed Array Sensor System (SURTASS) Low-Frequency Active (LFA) Sonar Program) – Commission review still pending.

5 For purposes of NMFS review under the Marine Mammal Protection Act of 1973 (MMPA) and, for endangered marine

4. <u>Project Impacts</u>. USGS' application to NMFS for an Incidental Harassment Authorization describes the project's impacts on marine mammals as follows:

> *Depending upon ambient conditions and the sensitivity of the receptor, underwater sounds produced by acoustic operations may be detectable a substantial distance from the activity. Any sound that is detectable is (at least in theory) capable of eliciting a disturbance reaction by a marine mammal or of masking a signal of comparable frequency. An incidental harassment take is presumed to occur when mammals in the vicinity of the acoustic source (or vessel) react to the generated sounds or visual cues.*
>
> *When the received levels of noise exceed some behavioral reaction threshold, cetaceans will show disturbance reactions (Richardson et al., 1995). The levels, frequencies, and types of noise that will elicit a response vary between and within species, individuals, locations, and seasons. We anticipate little or no behavioral disturbance and no lasting effects on marine mammals from our proposed activities.*
>
> *Hearing damage is not expected to occur as a result of this project. While it is not known whether a marine mammal very close to a sound source of modest power would be at risk, a temporary threshold shift (TTS) is a theoretical possibility (Richardson et al., 1995).*

USGS Calculates the marine mammal preclusion radii for the various acoustic systems as follows:

> *Maximum Sound-Exposure Levels for Marine Mammals*
>
> *The adverse effects of underwater sound on mammals have been documented for exposure times that last for tens of seconds or minutes, but adverse effects have not been documented for the brief pulses typical of the minisparker (0.8 ms) and the Huntec™ system (typically 0.3 ms). The National Marine Fisheries Service (NMFS) proposed that the maximum SPL to which mysticetes and sperm whales can be exposed is 180 dB re 1 µPa-m RMS, but for odontocetes and pinnipeds, the level is 190 dB re 1 µPa-m RMS. In 1999, the California Coastal Commission limited this maximum sound-exposure level to 180 dB re 1 µPa-m RMS for all marine mammals.*
>
> *Below we provide two estimates of how closely marine mammals can approach each sound source before it needs to be shut off. The first estimate follows the procedure required by the California Coastal Commission in 1999, in that underwater sound is*

---

mammals, the Endangered Species Act (ESA) of 1973, and their respective amendments, which prohibit taking (including harassment, harm, and mortality), unless under permit or authorization or exempted from the provisions of these Acts.

assumed to attenuate with distance according to 20 log(R), and the maximum SPL to which marine mammals can be exposed is 180 dB re 1μPa-m RMS. The alternative estimate of safe distance is proposed for operations in shallow water. In shallow water, sound from the sources will decay with distance more sharply than 20 log(R) because some of the sound energy will exit the water and penetrate the sea floor when the source is physically close to the sea floor.

The zone of influence for the sound sources is a circle whose radius is the distance from the source to where the SPL is reduced to 180 dB re 1 μPa-m RMS. In the deeper water (>50 m) areas of the proposed survey, for a 20 log(R) sound attenuation, the zone of influence for a 209 dB RMS minisparker source has a radius of 28 m. The 204 dB Geopulse™ and 205 dB Huntec™ boomers yield radii of 16 and 18 m respectively. The 210dB Klein sidescan fish yields a safety radius of 32 m, and the 220dB GI gun yields a safety radius of 100 m. We propose that safety zones of 30 m around the boomers, minisparker, sidescan fish, and of 100 m around the airgun be used in water deeper than 50 m.

In water <50 m deep, underwater sound commonly attenuates more sharply than 20 log(R). In 1999 the USGS measured a sound attenuation of 27 log(R) off southern California, so we propose that for inshore areas, underwater sound attenuates approximately like 25 log(R). Strictly for inshore areas, then, an attenuation of 25 log(R) yields zones of influence for the boomers of 10 m, for minisparker 15 m, and for sidescan 20 m.

Because of this short radius of the zone of influence in shallow water, we propose that the minisparker and/or boomers or sidescan can be used at night, using spotlights to illuminate the zone of influence around the source in use.

USGS has incorporated the following mitigation measures into the survey:

(1) The survey is planned for June, when Gray whales are not migrating.

(2) The smallest possible acoustic sources have been selected to minimize the chances of incidental harassment.

(3) To avoid potential incidental harassment of, or injury to, marine mammals, safety zones will be established and monitored continuously. Whenever the seismic source(s) approaches a marine mammal closer than the assigned safe distance the USGS will shut them down.

(4) For mysticetes and sperm whales, the marine mammal species near the survey area that are considered to be most sensitive to the frequency and intensity of sound that will be emitted by the seismic sources, operations will cease when members of these species approach within 100 m of the sound source.

(5) For odontocetes, ... operations will [also] cease when these animals approach a safety zone of 30 m from the boomer, minisparker, or sidescan fish, and a zone of 100 m from the airgun. ...

(6) For pinnipeds (seals and sealions): if the research vessel approaches a pinniped, a safety radius of 30 m around the boomer, minisparker, or sidescan fish and 100 m around the airgun will be maintained from the animal(s). However, if a pinniped approaches the seismic source, the USGS will not be required to shut it down. Experience indicates that pinnipeds will come from great distances to scrutinize seismic-reflection operations. Seals have been observed swimming within airgun bubbles, 10 m (33 ft) away from active arrays. More recently, Canadian scientists, who were using a high-frequency seismic system that produced sound closer to pinniped hearing than will the USGS sources, describe how seals frequently approached close to the seismic source, presumably out of curiosity. Therefore, because pinnipeds indicate no adverse reaction to seismic noise, the above-mentioned mitigation plan is proposed. In addition, the USGS will gather information on how often pinnipeds approach the sound source(s) on their own volition, and what effect the source(s) appears to have on them.

(7) During seismic-reflection survey operations, the ship's speed will be 4 to 5 knots so that when the seismic sources are being discharged, nearby marine mammals will have gradual warning of the ship's approach and can move away.

(8) The USGS will have marine biologists onboard the seismic vessel who will have the authority to stop seismic operations whenever a mammal enters the safety zone. These observers will monitor the safety zone to ensure that no marine mammals enter the zone, and record observations on marine mammal abundance and behavior.

(9) Emergency shut-down. If observations are made that one or more marine mammals of any species are attempting to beach themselves when the seismic source is operating in the vicinity of the beaching, the seismic sources will be immediately shut off and NMFS contacted.

(10) Upon notification by a local stranding network that a marine mammal has been found dead where the seismic sources had recently been operated, NMFS will investigate the stranding to determine whether a reasonable chance exists that the seismic survey caused the animal's death. If NMFS determines, based upon a necropsy of the animal(s), that the death was likely due to the seismic source, the survey shall cease until procedures are altered to eliminate the potential for future deaths.

To summarize, as it agreed to for the last two surveys, USGS: (1) has agreed to use a 180 dB exclusion area for both odontocetes and mysticetes; (2) will avoid the gray whale migration season; (3) will monitor marine mammal presence and cease operating whenever a mammal

would be exposed to > 180 dB. USGS has committed that the operations will cease when mysticetes and odontocetes approach within 100 m of the airgun sound source, and within 30 m of the other sound sources. Similar to last year's survey, for pinnipeds (seals and sea lions), USGS is proposing (see mitigation measure #6 above) that when a pinniped approaches the sound source (as opposed to when the vessel approaches the pinniped), USGS will not be required to shutdown the source. (Instead, USGS will gather information on how often pinnipeds approach the minisparker on their own volition, and what effect the minisparker appears to have on them.) The Commission concurred with this exception for the 2000 survey.

5. <u>Monitoring</u>. USGS will maintain marine biologists onboard the seismic vessel who will have the authority to stop operations whenever a mammal enters the marine mammal preclusion zone. These observers will monitor the zone to ensure that no marine mammals enter the zone, invoke shutdown procedures where specified, and record observations on marine mammal abundance and behavior (see mitigation measures 8-10 above). USGS elaborates on the monitoring program as follows:

> *Monitoring of marine mammals while the sparker or airgun sound sources are active will be conducted continuously. Trained marine mammal observers will be onboard the vessel to mitigate the potential environmental impact from either of the two systems and to gather data on the species, number, and reaction of marine mammals to the sources. Each observer will use equipment such as Tasco 7x50 binoculars with internal compasses and reticules to record the horizontal and vertical angle to sighted mammals. Nighttime operations in shallow water will be conducted with a spotlight to illuminate the radius of influence around the minisparker tow sled and observers will have night-vision goggles.*
>
> *Monitoring data to be recorded during seismic-reflection operations include which observer is on duty and what the weather conditions are like, such as Beaufort Sea state, wind speed, cloud cover, swell height, precipitation and visibility. For each mammal sighting the observer will record the time, bearing and reticule readings, species, group size, and the animal's surface behavior and orientation. Observers will instruct geologists to shut all active seismic sources whenever a marine mammal enters a safety zone.*

Monitoring reports from USGS' southern California 1998 survey (which the Commission did not formally review as a consistency matter) indicated no adverse environmental impacts. Monitoring results for the 1999 survey (CD-32-99), which included an airgun, stated: "Marine mammal movements and behaviors observed during the seismic-reflection operations revealed no apparent patterns of avoidance and none could be interpreted as harassment." Monitoring results for the 2000 survey, which are attached as Exhibit 3, concluded:

> *Overall marine mammal monitoring and mitigation appeared successful in meeting the objectives of the study. There were more shut-downs in 2000 compared to either 1998 or 1999 and even though these provided effective mitigation, they*

interrupted the objectives of the seismic survey. Most of the shut-downs were from common dolphins, a species that was sighted more often in 2000 than in 1998 and 1999, but this increased sighting rate was not enough to account for the difference. Additionally, the safety zone for pinnipeds and small cetaceans in 1998 and 1999 was 100 m, greater than the 30 m zone used in 2000. Shut-downs at night were a principal reason for the higher number of total shut-downs in 2000. In 1999 there were no night operations. In 1998 there were night operations but only two shut-downs called at night compared to 18 in 2000. Sighting conditions in 1998 were not as good with only one observer on duty and inferior night vision gear to that used in 2000. That combined with a lower presence of dolphins in the study area likely accounted for the difference between 1998 and 2000.

Also, USGS agrees to submit the monitoring report for the currently proposed survey to the Commission staff.

6. <u>Commission Conclusion</u>. As noted in its review of USGS's 1999 and 2000 surveys, NMFS' proposed "pulsed power" exercise (CD-102-99), and Navy LFA and Scripps ATOC acoustic research activities, the Commission remains concerned over the lack of reliable information regarding the effects of underwater sounds on the marine environment. To date, a 180 dB threshold for impulse noises such as those in seismic surveys has generally been accepted in determining the appropriate preclusion areas for marine mammals for the relatively temporary seismic surveys. USGS' proposed survey would be consistent with this approach. As discussed above, because of the different dispersion between deep water (where spherical spreading is the rule) and shallow water (where waves scatter noise at the surface and the subsea floor absorbs a certain percentage of the sound) USGS expects the sound to attenuate to 180 dB at 100 meters (m) from the source in deep water and at lesser distances in shallow waters; nevertheless based on historic Commission concerns USGS agrees to use the more conservative, "spherical spreading" (i.e., 20 log R) assumption, for both deep and shallow waters.

Another issue of Commission concern has been operations during nighttime and other reduced-visibility conditions (such as fog). In reviewing the 1999 USGS survey, the Commission objected to USGS' consistency determination because during nighttime operations of the airgun USGS marine mammal monitors would be unable to see the 100 m preclusion area needed for the airgun noise to attenuate to 180 dB. USGS acknowledged it could only reliably see up to 30 m at night. USGS subsequently modified the project to avoid nighttime operations. For the 2000 survey, USGS calculated the 180 dB preclusion area to be no more than 30 m, a distance which can be effectively monitored because it can be seen at night with the lights USGS will use. USGS therefore proposed 24-hour operations for that survey, and the Commission concurred. For this year's survey, USGS agrees not to use the airgun at night, and the remaining equipment would all involve a marine mammal preclusion area of 30 m or less. USGS has also agreed to not operate active acoustics during the daytime when visibility is less than the preclusion area.

In conclusion, the Commission notes that: (1) USGS has agreed to marine mammal preclusion radii that are adequate to protect marine mammals, as well as other avoidance, monitoring and mitigation and monitoring measures requested by the Commission in its review of USGS' previous two surveys; (2) USGS has committed to monitoring and avoiding subjecting marine mammals to above 180 dB; (3) USGS has established a successful track record in monitoring and avoiding adverse effects during past Pacific Ocean surveys; and (4) USGS is also avoiding operating during the gray whale migration period. Considering these factors, the Commission concludes that, with the monitoring and mitigation commitments incorporated by USGS, the proposed surveys would not cause significant adverse reactions or physiological effects on marine resources, and, therefore, that the project is consistent with the marine resource and environmentally sensitive habitat policies (Sections 30230 and 30240) of the Coastal Act.

B. Commercial and Recreational Fishing. Section 30230 of the Coastal Act, quoted on page 6-7 above, provides for the protection of economically (as well as biologically) significant marine species. Section 30234 provides that: "Facilities serving the commercial fishing and recreational boating industries shall be protected and, where feasible, upgraded." Section 30234.5 provides that: "The economic, commercial, and recreational importance of fishing activities shall be recognized and protected."

In reviewing the 2000 USGS survey, the Commission noted:

> *One of the concerns the Commission has historically had with oil exploration seismic surveys, aside from noise issues, has been the milti-mile tow lines attaching the survey ships to the airgun arrays, which can disrupt fishing gear. The proposed USGS's survey, with its single airgun and short tow line, does not raise this concern, and, as noted in the previous section of this report, the survey would be significantly less noisy than a typical oil exploration seismic survey. These facts, along with the nature of USGS' survey, which is to continue transiting along a long stretch of coastline over a relatively short period of time, lead to the conclusion that the project will minimize adverse effects on commercial and recreational fishing in the area. The Commission therefore finds that the project is consistent with Sections 30230, 30234 and 30234.5 of the Coastal Act.*

For this year's survey, the Commission reiterates these findings and agrees that the project would not adversely affect commercial and recreational fishing and is consistent with Sections 30230, 30234 and 30234.5 of the Coastal Act.

C. Public Access and Recreation. Sections 30210-30212 of the Coastal Act provide for the maximization of public access and recreational opportunities. Section 30213 provides that "Lower cost visitor and recreational facilities shall be protected, encouraged, and, where feasible, provided." Section 30220 provides that: "Coastal areas suited for water-oriented recreational activities that cannot readily be provided at inland water areas shall be protected for such uses."

In previous Commission reviews of the impacts of Navy acoustic tests on recreational diving activities, the Navy has committed to avoiding active acoustic operations within 0.5 miles of diving activities. In reviewing LFA Phase I research (CD-95-97), the Commission concluded that Navy avoidance of exposing divers to sounds exceeding 130 dB would be adequate, based in part on advice and research from the Navy's Bureau of Medicine and Surgery. USGS has agreed to post Coast Guard Notice to Mariners and to observe a 1 km (0.5 nautical mile) safety zone around any vessels displaying a "diver down" flag. The Commission finds that, with this commitment, the proposed survey will minimize adverse effects on recreational diving in the project vicinity, and that the project is consistent with Sections 30210-30212, 30213 and 30220 of the Coastal Act.

VI. SUBSTANTIVE FILE DOCUMENTS:

1. Consistency Determinations No. CD-16-00 (USGS, 2000 Southern California seismic survey and CD-32-99 (USGS, 1999 Southern California seismic survey), and accompanying monitoring reports.

2. "Low-frequency Sound and Marine Mammals: Current Knowledge and Research Needs, Committee on Low-frequency Sound and Marine Mammals," Ocean Studies Board, Commission on Geosciences, Environment, and Resources, National Research Council, March 21, 1994.

3. "Marine Mammals and Noise," Richardson, W. J., C. R. Greene, et al., New York, Academic Press, 1995.

4. Consistency Determination No. CD-102-99, National Marine Fisheries Service, small test of "pulsed power" acoustic harassment device to protect recreational fishing from sea lions.

5. "Request by the U.S. Geological Survey for an Incidental Harassment Authorization Under the Marine Mammal Protection Act, to Use a Small Airgun Near Marine Mammals in the Southern California Bight," USGS, submitted February 10, 1999.

6. National Marine Fisheries Service, Federal Register Notice of March 5, 1999: "Small Takes of Marine Mammals Incidental to Specified Activities; Seismic Hazards Investigation in Southern California; Notice of receipt of application and proposed authorization for a small take exemption; request for comments."

7. Consistency Determinations No. CD-113-00 (Navy, Operation of Surveillance Towed Array Sensor System Low-Frequency Active (LFA) Sonar Program.

8. Consistency Determinations No. CD-95-97 and CD-153-97 (Navy, Low-Frequency Active (LFA) Sonar, Phases I and II).

9. Draft Environmental Assessment for Low-Frequency Sound Scientific Research Program in the Southern California Bight, September/October 1997, National Marine Fisheries Service, June 1997.

10. Consistency Certification CC-110-94/Coastal Development Permit Application 3-95-40, Scripps Institution of Oceanography, Acoustic Thermometry of Ocean Climate (ATOC) Project and Marine Mammal Research Program (MMRP).

11. "Investigations of the potential effects of underwater noise from petroleum industry activities on migrating gray whale behavior. Phase II: January 1984 migration," Malme CI, PR Miles, CW Clark, P Tyack and JE Bird, 1984, (Bolt Beranek and Newman Report No. 5586 submitted to Minerals Management Service, U. S. Dept. of the Interior).

12. "Investigations of the potential effects of underwater noise from petroleum industry activities on migrating gray whale behavior," Malme CI, PR Miles, CW Clark, P Tyack and JE Bird, 1983 (Bolt Beranek and Newman Report No. 5366 submitted to Minerals Management Service, U. S. Dept. of the Interior).

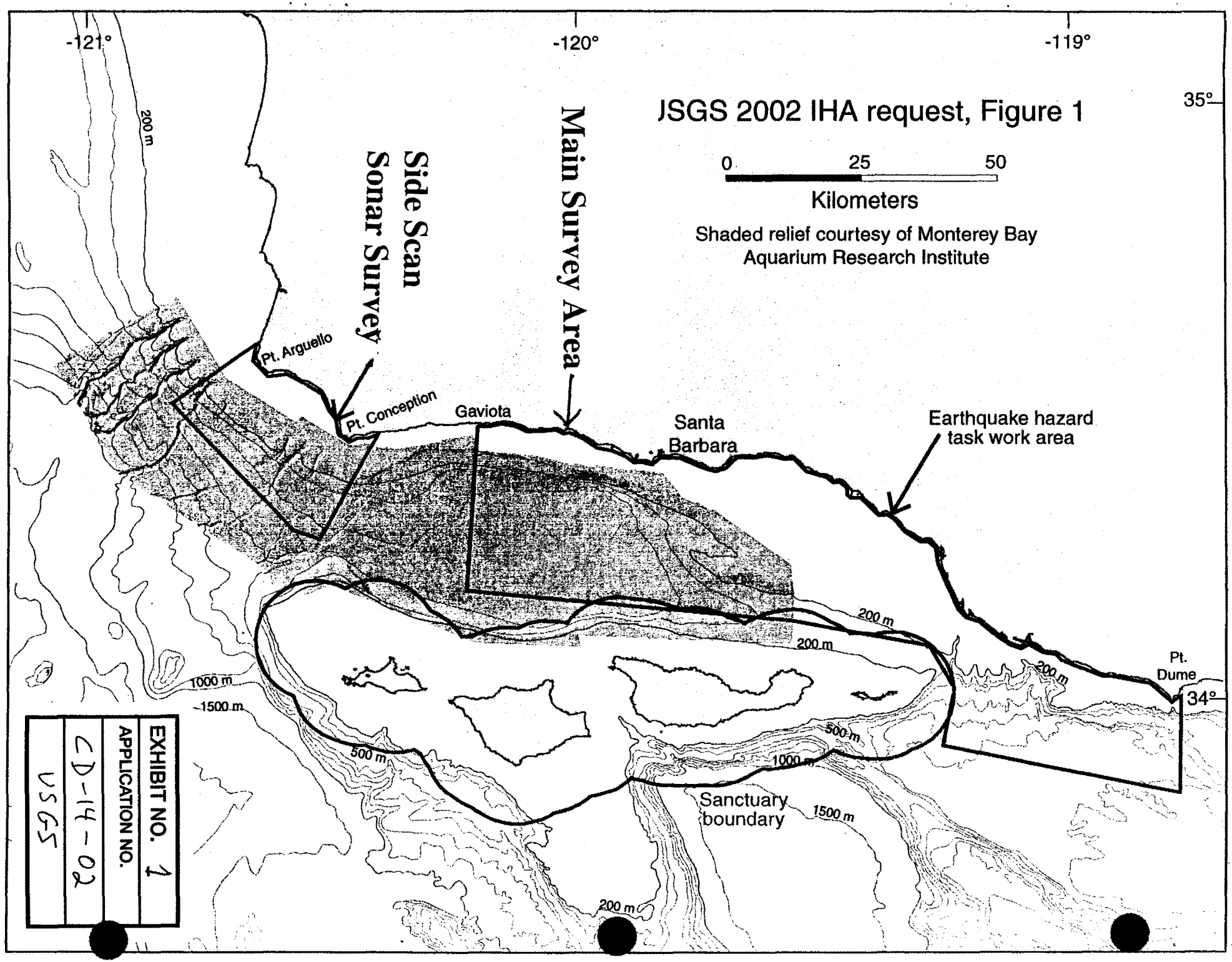
13. Quick Look – Playback of low frequency sound to gray whales migrating past the central California coast – January, 1998, Peter Tyack, Christopher Clark, 23 June 1998.

14. Summary Record and Report SACLANTCEN Bioacoustics Panel, NATO (A. D'Amico, Editor), El Spezia, Italy, 15-17 June 1998.

15. Consistency Determination No. CD-109-98, Advanced Deployable System (ADS) acoustic undersea surveillance system tests.

16. "High Energy Seismic Survey Review Process and Interim Operational Guidelines for Marine Surveys Offshore Southern California," the High Energy Seismic Survey Team (HESS), for the California State Lands Commission and the U.S. Minerals Management Service Pacific OCS Region, September 1996 – February 1999.

17. Joint Interim Report, Bahamas Marine Mammal Stranding, Events of 15-16 March 2000, NOAA Fisheries and U.S. Navy, December, 2001.


-121°
-120°
-119°
35°
34°
200 m
JSGS 2002 IHA request, Figure 1
0
25
50
Kilometers
Shaded relief courtesy of Monterey Bay Aquarium Research Institute
Side Scan Sonar Survey
Main Survey Area
Pt. Arguello
Pt. Conception
Gaviota
Santa Barbara
Earthquake hazard task work area
Pt. Dume
1000 m
1500 m
500 m
Sanctuary boundary
EXHIBIT NO. 1
APPLICATION NO.
CD-14-02
USGS

Request by the U.S. Geological Survey for an Incidental Harassment Authorization to conduct a survey in the Santa Barbara Channel

Summary Request

The U.S. Geological Survey (USGS) hereby requests an Incidental Harassment Authorization from the National Marine Fisheries Service to allow the incidental harassment of marine mammals that may occur while collecting marine seismic-reflection data offshore southern California. Seismic-reflection data to be collected during June 2002 will be used to support ongoing studies of the regional landslide and earthquake hazards effecting people within the coastal cities of southern California. The 2002 survey will be primarily restricted to the offshore area between Pt. Dume and Gaviota, and to a second area offshore Pt. Arguello (see Figure 1).

Contacts:

William R. Normark (task chief)
U.S. Geological Survey
Coastal and Marine Geology Team, MS 999
345 Middlefield Rd
Menlo Park, CA 94025
wnormark@usgs.gov
tel 650-329-5200
fax 650-329-5198

Michael A. Fisher (technical adviser)
U.S. Geological Survey
Coastal and Marine Geology Team, MS 999
345 Middlefield Rd
Menlo Park, CA 94025
mfisher@usgs.gov
tel 650-329-5158
fax 650-329-5299

(1) A detailed description of the specific activity or class of activities that can be expected to result in incidental taking of marine mammals;

The U. S. Geological Survey proposes to conduct a high-resolution seismic-reflection survey offshore from southern California for two weeks during June 2002. The USGS will collect these seismic-reflection data to investigate the hazards posed by landslides, tsunamis, and potential earthquake faults in the nearshore region from Ventura to Santa Barbara. This task is part of a multiyear hazard analysis that requires high-resolution, seismic-reflection data using several acoustic sources. A few days of survey time will be used to conduct a seafloor imaging survey in support of environmental studies in the area offshore Pt. Conception.

The USGS plans to collect seismic-reflection data using three basic instrument systems:

1) Huntec™ or a Geopulse™ boomer sound-source to collect high-resolution seismic-reflection data of the sub-seafloor and

2) a high-resolution multi-channel system for which the primary source will be either a 2-kJoule sparker system for shallow water or a small GI airgun in deeper water. The type of sparker to be used will depend on the results of a sparker feasibility study completed earlier this year in the Seattle, Washington area. A 250-m-long hydrophone streamer is used for both multi-channel sources.

3) Klein sidescan sonar for the environmental survey off Pt. Conception.

The high-resolution Huntec™ boomer system uses an electrically powered sound source that is towed behind the ship at depths between 30 m and 160 m below the sea surface. The hydrophone arrays for listening are attached to the tow vehicle that houses the sound source. We plan to use the Huntec™ primarily in water depths greater than 300 m. The system is triggered at 0.5 to 1.25 second intervals, depending upon the source tow depth. This system provides detailed information about stratified sediment, so that dates obtained from fossils in sediment samples can be correlated with episodes of fault offset. The sound pressure level (SPL) for this unit is 205 dB re 1 μPa-m RMS. The output-sound bandwidth is 0.5 kHz to 8 kHz, with the main peak at 4.5 kHz.

We plan to use the surface-towed Geopulse™ boomer system in the shallow water parts of the survey area, typically in water depths from 20 m to 300 m. The sound source consists of two ORE Geopulse™ 5813A boomer plates mounted on a catamaran sled built in-house. The catamaran is towed just aft of the vessel, while the 5-m-long hydrophone streamer is usually towed from a boom on one side of the vessel. The source level for the Geopulse™ is 204 dB re 1 μPa-m RMS, and its effective bandwidth is about 0.75 to 3.5 kHz. The firing rate is generally 0.5 to 1 second interval.

The primary sound source for the high-resolution multi-channel system will be a 2.0 kJoule (kJ) sparker system such as the SQUID 2000™ minisparker system manufactured by Applied Acoustic Engineering, Inc. This minisparker includes electrodes that are mounted on a small pontoon sled. The electrodes simultaneously discharge electric current through the seawater to an electrical ground. This discharge creates an acoustic signal. The pontoon sled that supports the minisparker is towed on the sea surface, approximately 5 meters behind the ship.

Source characteristics of the SQUID 2000™ provided by the manufacturer show a sound-pressure level (SPL) of 209 dB re 1 μPa-m RMS. The amplitude spectrum of this pulse indicates that most of the sound energy lies between 150 Hz and 1700 Hz, and the peak amplitude is at 900 Hz. The output sound pulse of the minisparker has a duration of about 0.8 ms. When operated at sea for the multichannel seismic-reflection survey proposed herein, the minisparker will be discharged every 1 to 4 seconds.

The second source for the multi-channel system is a small airgun of special type called a generator-injector, or GI gun (trademark of Seismic Systems, Inc., Houston, TX). This type of airgun consists of two small airguns within a single steel body. The two small airguns are fired sequentially, with the precise timing required to nullify the bubble oscillations that typify sound pulses from a single airgun of common type. These oscillations impede detailed analysis of fault structure. For arrays consisting of many airguns, bubble oscillations are cancelled by careful selection of airgun sizes. The GI gun is a mini-array that is carefully adjusted to achieve the desired bubble cancellation. Airguns and GI guns with similar chamber sizes have similar peak output pressures. The GI gun for this survey has two chambers of equal size-35 cubic inches- and the gun will be fired every 12 seconds. Compressed air delivered to the GI gun will have a pressure of about 3000 psi. The gun will be towed 12 meters behind the vessel and suspended from a float to maintain a depth of about 1 m.

The manufacturer's literature indicates that a GI gun of the size we will use has a sound-pressure level (SPL) of about 220 dB re 1 μPa-m RMS. The GI gun's output sound pulse has a duration of about 10 ms. The amplitude spectrum of this pulse, as shown by the manufacturer's data, indicates that most of the sound energy is at frequencies below 500 Hz. Field measurements by USGS personnel indicates that the GI gun output low sound amplitudes at frequencies above 500 Hz. Thus high-amplitude sound from this source is at frequencies that are outside the main hearing band of odontocetes and pinnipeds (Richardson et al. 1995, p. 205-240).

The environmental survey off Pt. Conception will be accomplished with sidescan-sonar surveying. The system that will be used will be the Klein 3000 or the Klein 2000. The Klein 2000 sidescan sonar uses an electrically powered sound source. In operation, the sound source, or "fish", is towed behind the research vessel at depths of 1-10 m below the sea surface. The unit emits a short pulse of sound about every 0.25 second; the interval depends on the swath width (i.e., the area of sea floor to be imaged). The sidescan-sonar system measures the return time and intensity of echoes to create a high-resolution image of the seafloor that is similar to an air photo on land. The sidescan system has a sound pressure level (SPL) of about 210 dB re 1 μPa-m RMS. The output sound pulse is very short, with a time duration of less than 0.1 ms. The frequency bandwidth of the outgoing signal is 100khz or 500 kHz.

The Klein 3000 is a system that has just been developed and its operating frequencies are 128khz and 445khz. It is presumed that the output power levels are similar to the Klein 2000. Information on the output sound level for this instrument is not available at this time. The pulse lengths are selectable from among 50/100/200/400 micro-seconds.

(2) The date(s) and duration of such activity and the specific geographical region where it will occur;

The work is planned for thirteen days during the June 2002. The possible operational window is from mid-May to mid-August 2002 but the preferred time is early June. We are in the process of leasing a vessel, and exact availability is not yet known. The primary work area (70% of the time) is between Pt. Dume and offshore Gaviota, California, in the western Santa Monica Basin and Santa Barbara Channel. The secondary work area is offshore between Pt. Conception and Pt. Arguello (but staying within 30 km of the coast). If given permission we will work inside a small part of the Channel Islands Marine Sanctuary. Some work might be attempted during transit between the two work areas.

(3) The species and numbers of marine mammals likely to be found within the activity area;

SPECIES OF MARINE MAMMALS	Estimated population	Strategic Status	Number Sighted during previous USGS surveys* '98	'99	'00	Notes
Bottlenose Dolphin Calif coastal stock	206	NO		2	82	b
Dall's Porpoise Calif/Oregon/ Washington stock	117,016	NO		25	2	a
Pacific White-sided Dolphin Calif/Oregon/Washington stock	25,825	NO		118		a
Risso's Dolphin Calif/Oregon/Washington Stock	16,483	NO	8	27	120	a
Bottlenose Dolphin Calif/Oregon/Washington Stock	956	NO				a
Striped Dolphin Calif/Oregon/Washington Stock	20,235	NO				a
Short Beaked Common Dolphin Calif/Oregon/Washington Stock	373,573	NO	3981	11569	3764	a, c
Long Beaked Common Dolphin California Stock	32,239	NO				a, c
Northern Right-Whale Dolphin Calif/Oregon/Washington Stock	13,705	NO				a
Killer Whale Eastern North Pacific Southern; Resident Stock Transient Stock Offshore Stock	 82 346 285	NO				a,b
Short-Finned Pilot Whale Calif/Oregon/Washington Stock	970	NO				a
Baird's Beaked Whale Calif/Oregon/Washington Stock	379	NO				a
Mesoplodont Beaked Whales Calif/Oregon/Washington Stock	3,738	NO				a
Cuvier's Beaked Whale Calif/Oregon/Washington Stock	5,870	NO	1			a
Pygmy Sperm Whale Calif/Oregon/Washington Stock	2,933	NO				a
Sperm Whale Calif/Oregon/Washington Stock	1,407	YES				b
Humpback Whale Calif/Oregon/Washington - Mexico Stock	1,024	YES	1	39	2	b
Blue Whale Eastern North Pacific Stock	1,940	YES	3 (blue	32	5	a
Fin Whale Calif/Oregon/Washington Stock	1,851	YES	or fin)	1	1	b
Minke Whale Calif/Oregon/Washington Stock	631	NO	4		3	a
Unidentified dolphin			2159	1637	627	
Unidentified porpoise			5			
Unidentified whale			1	12	3	
Unidentified pinnipeds			2	2	3	
Harbor Seal Calif Stock	30,293	NO			8	a
Northern Elephant Seal Calif Breeding Stock	84,000	NO			1	b
California Sea Lion U.S. Stock	214,000	NO	146	21	171	a
Guadalupe Fur Seal	7,408	YES				a
Northern Fur Seal	4,336	NO	2	1		b

* as reported by biologist observers and included in Normark et al. (1999a, 1999b), and Gutmacher et al. (2000).

Notes

a) source: Barlow (1997) as reported in Forney et al. (2000)
b) source: Barlow and Taylor (in press) as reported in Barlow et al. (2001)
c) USGS numbers for common dolphins combine short and long beaked

(4) A description of the status, distribution, and seasonal distribution (when applicable) of the affected species or stocks of marine mammals likely to be affected by such activities;

NOTE: The following was taken from the National Marine Fisheries U.S. Pacific Marine Mammal Stock Assessment: 2000 (Forney et al. 2000) and Draft U.S. Pacific Marine Mammal Stock Assessment: 2001 (Barlow et al. 2001). The references cited below can be found in those two documents. These were accessed via www.nmfs.noaa.gov/prot_res/PR2/Stock_Assessment_Program/sars.html.

Bottlenose Dolphin, California Coastal Stock

Bottlenose Dolphins are mostly in warm tropical waters. In California, separate coastal and offshore populations are known (Walker 1981; Ross and Cockcroft 1990; Van Waerebeek et al. 1990). California coastal bottlenose dolphins are found within about one kilometer of shore (Hansen 1990; Carretta et al. 1998; Defran and Weller 1999) primarily from Point Conception south into Mexican waters. Since the 1982-83 El Nino they have been seen consistently sighted in central California as far north as San Francisco. The weighted average abundance estimate for the 1999-2000 surveys is 206 using the same method as Carretta et al. (1998). Bottlenose Dolphins are not listed as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act.

Bottlenose Dolphin, California/Oregon/Washington Stock

There is an offshore Bottlenose Dolphin population as well as a separate coastal population in many areas as well as California (Walker 1981; Ross and Cockcroft 1990; Van Waerebeek et al.1990). Surveys conducted off California, offshore bottlenose dolphins have been found at distances greater than a few kilometers from the mainland and throughout the Southern California Bight. Records of sightings off California and Baja California (Lee 1993; Mangels and Gerrodette 1994) suggest the animals have a continuous distribution in these two regions. Aerial surveys conducted during winter/spring 1991-92 (Forney et al. 1995) and shipboard surveys conducted in summer/fall 1991 (Barlow 1995) suggests that no seasonality in distribution is apparent (Forney and Barlow 1998), but they may range into the cooler waters of Oregon and Washington during the warm water periods. The abundance estimate for California, Oregon and Washington is 956 based on the 1991-96 ship surveys (Barlow 1997). They are not listed as "threatened" or "endangered" under the Endangered Species Act or as "depleted" under the MMPA.

Dall's Porpoise, California/Oregon/Washington Stock

Dall's porpoise are commonly found in the temperate waters of the North Pacific Ocean. Off the west coast they are commonly seen in shelf, slope and offshore waters. The southern end of this population's range is not well-documented, but they are commonly seen off Southern California in winter, and during cold-water periods may range into Mexican waters off northern Baja California. The 1991-96 average abundance estimate for California, Oregon, and Washington waters based on three ship surveys is 116,016 (Barlow 1997). Dall's porpoise are not considered as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act.

Pacific White-Sided Dolphins, California/Oregon/Washington Stock

Pacific White-Sided Dolphins are typically found in temperate waters of the North Pacific Ocean. Primarily found in shelf and slope waters with north-south movements as water temperatures change (Green et al. 1992;1993; Barlow 1995; Forney et al. 1995). Sighting patterns from recent shipboard and aerial surveys conducted in California, Oregon, and Washington at different times of the year (Green et al. 1992; 1993; Barlow 1995; Forney et al. 1995) indicate seasonal north-south movements, with animals found primarily off California during the colder water months and shifting northward as water temperatures increase in late spring and summer (Green et al. 1992; Forney 1994). The average abundance estimate for California, Oregon and Washington waters based on the 1991-96 three ship surveys is 25,825 (Barlow 1997). Pacific White-Sided Dolphins are not listed as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act.

Risso's Dolphin, California/Oregon/Washington Stock

Off the West coast Risso's dolphins are commonly seen on the shelf in the Southern California Bight and in the offshore waters of California, Oregon and Washington. Surveys conducted during different seasons indicate that as water temperatures increase during late spring and early summer the animals are thought to shift northward into the cooler waters of Oregon and Washington. The average abundance estimate for California, Oregon and Washington waters based on the 1991-96 three ship surveys is 16,483 (Barlow 1997). Risso's dolphins are not listed as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act.

Striped Dolphin, California/Oregon/Washington Stock

Striped dolphins reside in tropical and warm temperate waters. They have been sighted 100 to 300 nautical miles off the coast of California. No sightings have been reported for Oregon and Washington waters but there have been strandings in

both states (Oregon Department of Fish and Wildlife, unpublished data; Washington Department of Fish and Wildlife, unpublished data). Based on sighting records off California and Mexico there appears to be continuous distribution in offshore waters of the two regions (Perrin et al. 1985; Mangels and Gerrodette 1994). There is no information on seasonal distribution because the only surveys done were done in the summer/fall period. The average abundance estimate for California, Oregon and Washington waters based on the 1991-96 three ship surveys is 20,235 (Barlow 1997). Striped dolphins are not listed as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act.

Short-Beaked Common Dolphin, California/Oregon/Washington Stock

Short-beaked common dolphins are widely spread between the coast and 300 nautical miles from shore. They are primarily reported south of Pt. Conception (Dohl et al. 1986). During three surveys in the summer/fall of (1991/93/96) they were sighted as far north as 42degreesN. Significant seasonal shifts in the distribution of common dolphins has been identified based on winter/spring 1991-92 and summer/fall 1991 surveys (Forney and Barlow 1998). The average abundance estimate for California, Oregon and Washington waters based on the 1991-96 three ship surveys is 373,573 (Barlow 1997). Short-beaked dolphins are not listed as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act.

Long-Beaked Common Dolphin, California Stock

Long-beaked common dolphins are found along the U.S. west coast. Their distribution overlaps with the Short-beaked common dolphin. They are commonly found within about 50nmi of the coast from Baja California north to Central California. The 1991-96 weighted average abundance estimate for California, Oregon and Washington waters based on three ship surveys is 32,239 (CV =0.18) long-beaked common dolphins (Barlow 1997). Long-beaked dolphins are not listed as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act.

Northern Right-Whale Dolphin, California/Oregon/Washington Stock

Northern Right-Whale dolphins are typically found in the temperate waters of the North Pacific Ocean. They have been seen primarily in shelf and slope waters with seasonal movements into Southern California Bight (Leatherwood and Walker 1979; Dohl et al. 1980; 1983; NMFS unpublished data). Aerial and shipboard surveys off California, Oregon and Washington during different seasons (Green et al. 1992; 1993; Forney et al.1995; Barlow 1995) suggest seasonal north-south movements, with animals found off California during the colder water months and moving north as water temperatures increase in late spring and early summer (Green et al. 1992; Forney 1994; Forney and Barlow 1998). The average abundance estimate for California, Oregon and Washington waters based on the 1991-96 three ship surveys is 13,705 (Barlow 1997). Northern Right-Whale dolphins are not listed as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act.

Killer Whale, Eastern North Pacific Southern Resident, Transient, and Offshore Stock

Killer whales have been observed in all oceans and seas of the world (Leatherwood and Dahlheim 1978). Killer whales prefer colder waters with the greater abundances found within 800 km of major continents (Mitchel 1975). The Eastern North Pacific Southern Resident Stock - occurring mainly within the inland waters of Washington State and southern British Columbia, but also in coastal waters from British Columbia through California, the Eastern North Pacific Transient stock - occurring from Alaska through California and the Eastern North Pacific Offshore stock – occurring from Southeast Alaska through California. Offshore killer whales have more recently been identified off the coasts of California, Oregon, and rarely, in Southeast Alaska (Ford et al. 1994, Black et al. 1997, Dahlheim et al. 1997). They apparently do not mix with the transient and resident killer whale stocks found in these regions (Ford et al. 1994, Black et al. 1997). In 1993, the three pods comprising the Resident stock totaled 96 killer whales (Ford et al. 1994). The population increased to 99 whales in 1995, then declined to the current population of 82 whales in 2000 (Ford et al. 2000; Center for Whale Research, unpublished data). The Transient stock combines the counts of cataloged 'transient' whales gives a minimum number of 346 for the Transient Stock abundance. A conservative number of 285 for the offshore killer whale abundance estimate may be appropriate because offshore whales are seen less frequently near the coast (Black et al. 1997), and therefore photographic sampling may be biased towards transient whales. Killer whales are not listed as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act.

Short-Finned Pilot Whale, California/Oregon/Washington Stock

Short-finned pilot whales were once commonly seen off Southern California, residents as well as seasonal migrants. In 1993, six groups of short-finned pilot whales were seen off California (Carretta et al. 1995; Barlow and Gerrodette 1996) after all most no sightings were made between the 1982-83 El Nino and 1993. The full population off the California/Oregon/Washington coast is not known. The average abundance estimate for California, Oregon and

Washington waters based on the 1991-96 three ship surveys is 970 (Barlow 1997). Short-finned pilot whales are not listed as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act.

Baird's Beaked Whale, California/Oregon/Washington Stock

Baird's beaked whales are found throughout the deep waters and along the continental slopes of the North Pacific Ocean (Balcomb 1989). Baird's beaked whales are seen primarily on the west coast along the continental shelf from late spring to early fall and are presumed to be farther offshore during the colder water months of November through April. The average abundance estimate for California, Oregon and Washington waters based on the 1991-96 three ship surveys is 379 (Barlow 1997). Baird's beaked whales are not listed as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act.

Mesoplodont Beaked Whale, California/Oregon/Washington Stock

There are 5 species of Mesoplodont beaked whales distributed throughout the deep waters and along the continental slopes of the North Pacific Ocean. Because of the rarity of records and the difficulty in identifying these animals in the field there is virtually no species-specific information available (Mead 1989). The 1991-96 average abundance estimates for California, Oregon and Washington waters is 3,738 mesoplodont beaked whales of unknown species plus 360 Blainville's beaked whales (Barlow 1997, with corrected cv). None of the five species is listed as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act.

Cuvier's Beaked Whales, California/Oregon/Washington Stock

Cuvier's beaked whales are distributed widely throughout deep waters of all oceans (Heyning 1989). This is the most common species of beaked whales encountered off the west coast. Sightings of Cuvier's beaked whales along the west coast have been too rare to produce reliable population estimates. The average abundance estimate for California, Oregon and Washington waters based on the 1991-96 three ship surveys is 5,870 (Barlow 1997, with corrected CV). Cuvier's beaked whales are not listed as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act.

Pygmy Sperm Whale, California/Oregon/Washington Stock

Pygmy sperm whales are distributed throughout deep waters and along continental slopes of the North Pacific and other ocean basins (Ross 1984; Caldwell and Caldwell 1989). Along the US west coast sightings have been very rare. The 1991-96 abundance estimate for California, Oregon and Washington waters is 2,933 plus 1,813 pygmy or dwarf sperm whales (Barlow 1997, with corrected cv). Pygmy sperm whales are not listed as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act.

Sperm Whale, California/Oregon/Washington Stock

Sperm whales are widely distributed throughout the North Pacific and into the southern Bering Sea in the summer but the majority are thought to be south of 40degreesN in winter (Rice1974; Gosho et al. 1984; Miyashita et al. 1995). Sperm whales are found year-round in California waters (Dohl et al. 1983; Barlow 1995; Forney et al. 1995), but they reach peak abundance from April through mid-June and from the end of August through mid-November (Rice 1974). Barlow and Taylor estimates sperm whales along the coasts of California, Oregon, and Washington during summer/fall to be 1,407. This number is based on ship surveys in 1993, and 1996. Forney et al. (1995) estimates 892 sperm whales off California during winter/spring based on aerial line-transect surveys. Sperm whales are listed as "depleted" under the MMPA and listed as "threatened" or "endangered" under the Endangered Species Act.

Humpback Whale, California/Oregon/Washington – Mexico Stock

Aerial, vessel, and photo-identification surveys indicate that within the U.S. EEZ, there are at least three relatively separate populations of Humpback whales that migrate between their respective summer/fall feeding areas and winter/spring calving and mating areas (Calambokidis et al. 1997, Baker et al. 1998). The California/Oregon/Washington-Mexico population now identified as the eastern North Pacific stock population is one of them. They are a winter/spring population in coastal Central America and Mexico that migrates to southern British Columbia in summer/fall (Steiger et al. 1991, Calambokidis et al. 1993). The best estimate of abundance of humpback whales for this population is the photographic mark-recapture estimate of 1,024 (Calambokidis et al. 2000). Humpback whales are listed as "depleted" under the MMPA and listed as "threatened" or "endangered" under the Endangered Species Act.

Blue Whale, Eastern North Pacific Stock

This is a population that feeds in California waters in summer/fall (from June to November) and migrates south to productive areas off Mexico (Calambokidis et al. 1990) and as far south as the Costs Rica Dome (10degrees N) (Mate et al. 1999; Calambokidis, pers. Comm.) in winter/spring. The best estimate of blue whale abundance is the average of the

line-transect and mark-recapture estimates of 1,940 , weighted by their variances from surveys done from 1991-96. Blue whales are listed as "endangered" under the Endangered Species Act and as "depleted" and "strategic" stock under the MMPA.

Fin Whale, California/Oregon/washington Stock

There is not sufficient information to accurately determine the population structure of the Fin whale. Whaling records indicate there existence between central California and the Gulf of Alaska. More recent observations show aggregations of fin whales year-round in southern/central California (Dohl et al. 1983; Barlow 1997; Forney et al. 1995), year-round in the Gulf of California (Tershy et al. 1993), in summer in Oregon (Green et al. 1992; McDonald 1994). Acoustic signals from the fin whale are detected year round off northern California, Oregon and Washington, with a concentration of vocal activity between September and February (Moore et al. 1998). The average abundance estimate for California, Oregon and Washington waters based on ship surveys in the summer/autumn of 1993, and 1996 (Barlow, in press) is 1,851. Fin whales are listed as "depleted" under the MMPA and listed as "threatened" or "endangered" under the Endangered Species Act.

Minke Whale, California/Oregon/Washington Stock

Resident Minke whales from California to Washington appear behaviorally distinct from migratory whales further north, minke whales in coastal waters of California, Oregon and Washington (including Puget Sound) will be considered as a separate stock. Minke whales in central California appear to establish home ranges (Dorsey et al. 1990). Minke whales appear year-round in California (Dohl et al. 1983; Forney et al. 1995; Barlow 1997) and in the Gulf of California (Tershy et al. 1990). The estimated abundance is 631 minke whales based on ship surveys in 1991, 1993, and 1996 off California and in 1996 off Oregon and Washington (Barlow 1997). Minke whales are not listed as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act.

Harbor Seal, California Stock

Harbor seals inhabit near-shore coastal and estuarine areas from Baja California, Mexico to the Pribilof Islands in Alaska. The California stock is one of three stocks recognized on the west coast. The population is estimated at 30,293 for the California stock. Harbor seals are not listed as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act.

Northern Elephant Seal, California Breeding Stock

Northern elephant seals breed and give birth in California (U.S.) and Baja California (Mexico), primarily on offshore islands (Stewart et al. 1994), from December to March (Stewart and Huber 1993). Although the seals move around for feeding and molting, most seals return to there natal rookeries when they start breeding (Huber et al. 1991). The California breeding population is considered to be a separate stock. The California stock was approximately 84,000 in 1996. The Northern Elephant Seal is not listed as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act.

California Sea Lion, U.S. Stock

The United States California sea lion stock begins at the U.S./Mexican border and extends northward into Canada. The breeding areas are on islands located in southern California, western Baja California, and the Gulf of California. The population estimate ranges from 214,000 to 204,000. The California Sea Lion is not listed as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act.

Guadalupe Fur Seal

Guadalupe fur seals have been sighted as far north as Blind Beach, California. The population was estimated by Gallo (1994) to be about 7,408 animals in 1993. The Guadalupe fur seal is listed as "depleted" under the MMPA and listed as "threatened" or "endangered" under the Endangered Species Act.

Northern Fur Seal, San Miguel Island Stock

Northern fur seals occur from southern California north to the Bering Sea and west to the Okhotsk Sea and Honshu Island, Japan. During the breeding season 74% of the worldwide population is found on the Pribilof Islands in the southern Bering Sea (Lander and Kajimura 1982). Approximately 1% of the population is found on Bogoslof Island in the southern Bering Sea and San Miguel Island off southern California (NMFS 1993). The most recent population estimate of the San Miguel Island stock is 4,336. The San Miguel Island northern fur seal is not listed as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act.

(5)The type of incidental taking authorization that is being requested (i.e., takes by harassment only; takes by harassment, injury and/or death) and the method of incidental taking;
The seismic survey study might result in incidental harassment only of marine mammals. Biological observers will be employed to ensure the safety of marine mammals.

(6) By age, sex, and reproductive condition (if possible), the number of marine mammals (by species) that may be taken by each type of taking identified in paragraph (a)(5) of this section, and the number of times such takings by each type of taking are likely to occur;
See table above for numbers estimate based on recent experience.

(7) The anticipated impact of the activity upon the species or stock;
Depending upon ambient conditions and the sensitivity of the receptor, underwater sounds produced by acoustic operations may be detectable a substantial distance from the activity. Any sound that is detectable is (at least in theory) capable of eliciting a disturbance reaction by a marine mammal or of masking a signal of comparable frequency. An incidental harassment take is presumed to occur when mammals in the vicinity of the acoustic source (or vessel) react to the generated sounds or visual cues.

When the received levels of noise exceed some behavioral reaction threshold, cetaceans will show disturbance reactions (Richardson et al., 1995). The levels, frequencies, and types of noise that will elicit a response vary between and within species, individuals, locations, and seasons. We anticipate little or no behavioral disturbance and no lasting effects on marine mammals from our proposed activities.

Hearing damage is not expected to occur as a result of this project. While it is not known whether a marine mammal very close to a sound source of modest power would be at risk, a temporary threshold shift (TTS) is a theoretical possibility (Richardson et al., 1995).

(8) The anticipated impact of the activity on the availability of the species or stocks of marine mammals for subsistence uses;
No impact anticipated.

(9) The anticipated impact of the activity upon the habitat of the marine mammal populations, and the likelihood of restoration of the affected habitat;
No impact anticipated.

(10)The anticipated impact of the loss or modification of the habitat on the marine mammal populations involved;
No impact anticipated.

(11)The availability and feasibility (economic and technological) of equipment, methods, and manner of conducting such activity or other means of effecting the least practicable adverse impact upon the affected species or stocks, their habitat, and on their availability for subsistence uses, paying particular attention to rookeries, mating grounds, and areas of similar significance; The USGS's proposed mitigation to reduce the potential for marine-mammal harassment includes:

(1) The survey is planned for June, when Gray whales are not migrating.

(2) The smallest possible acoustic sources have been selected to minimize the chances of incidental harassment.

(3) To avoid potential incidental harassment of, or injury to, marine mammals, safety zones will be established and monitored continuously. Whenever the seismic source(s) approaches a marine mammal closer than the assigned safe distance the USGS will shut them down.

(4) For mysticetes and sperm whales, the marine mammal species near the survey area that are considered to be most sensitive to the frequency and intensity of sound that will be emitted by the seismic sources, operations will cease when members of these species approach within 250 m of the sound source.

(5) For odontocetes, with their lower sensitivity to low frequency sound, operations will cease when these animals approach a safety zone of 30 m from the boomer, minisparker, or sidescan fish, and a zone of 100 m from the airgun. See Appendix 1.

(6) For pinnipeds (seals and sealions): if the research vessel approaches a pinniped, a safety radius of 30 m around the boomer, minisparker, or sidescan fish and 100 m around the airgun will be maintained from the animal(s). However, if a pinniped approaches the seismic source, the USGS will not be required to shut it down. Experience indicates that pinnipeds will come from great distances to scrutinize seismic-reflection operations. Seals have been observed swimming within airgun bubbles, 10 m (33 ft) away from active arrays. More recently, Canadian scientists, who were using a high-frequency seismic system that produced sound closer to pinniped hearing than will the USGS sources, describe how seals frequently approached close to the seismic source, presumably out of curiosity. Therefore, because pinnipeds indicate no adverse reaction to seismic noise, the above-mentioned mitigation plan is proposed. In addition, the USGS will gather information on how often pinnipeds approach the sound source(s) on their own volition, and what effect the source(s) appears to have on them.

(7) During seismic-reflection survey operations, the ship's speed will be 4 to 5 knots so that when the seismic sources are being discharged, nearby marine mammals will have gradual warning of the ship's approach and can move away.

(8) The USGS will have marine biologists onboard the seismic vessel who will have the authority to stop seismic operations whenever a mammal enters the safety zone. These observers will monitor the safety zone to ensure that no marine mammals enter the zone, and record observations on marine mammal abundance and behavior.

(9) Emergency shut-down. If observations are made that one or more marine mammals of any species are attempting to beach themselves when the seismic source is operating in the vicinity of the beaching, the seismic sources will be immediately shut off and NMFS contacted.

(10) Upon notification by a local stranding network that a marine mammal has been found dead where the seismic sources had recently been operated, NMFS will investigate the stranding to determine whether a reasonable chance exists that the seismic survey caused the animal's death. If NMFS determines, based upon a necropsy of the animal(s), that the death was likely due to the seismic source, the survey shall cease until procedures are altered to eliminate the potential for future deaths.

(12)Where the proposed activity would take place in or near a traditional Arctic subsistence hunting area and/or may affect the availability of a species or stock of marine mammal for Arctic subsistence uses, the applicant must submit either a plan of cooperation or information that identifies what measures have been taken and/or will be taken to minimize any adverse effects on the availability of marine mammals for subsistence uses.
We will not be operating in or near Arctic waters.

(13)The suggested means of accomplishing the necessary monitoring and reporting that will result in increased knowledge of the species, the level of taking or impacts on populations of marine mammals that are expected to be present while conducting activities and suggested means of minimizing burdens by coordinating such reporting requirements with other schemes already applicable to persons conducting such activity. Monitoring plans should include a description of the survey techniques that would be used to determine the movement and activity of marine mammals near the activity site(s) including migration and other habitat uses, such as feeding. Guidelines for developing a site-specific monitoring plan may be obtained by writing to the Director, Office of Protected Resources; and
Monitoring of marine mammals while the sparker or airgun sound sources are active will be conducted continuously. Trained marine mammal observers will be onboard the vessel to mitigate the potential environmental impact from either of the two systems and to gather data on the species, number, and reaction of marine mammals to the sources. Each observer will use equipment such as Tasco 7x50 binoculars with internal compasses and reticules to record the horizontal and vertical angle to sighted mammals. Nighttime operations in shallow water will be conducted with a spotlight to illuminate the radius of influence around the minisparker tow sled and observers will have night-vision goggles.

Monitoring data to be recorded during seismic-reflection operations include which observer is on duty and what the weather conditions are like, such as Beaufort Sea state, wind speed, cloud cover, swell height, precipitation and visibility. For each mammal sighting the observer will record the time, bearing and reticule readings, species, group size, and the animal's surface behavior and orientation. Observers will instruct geologists to shut all active seismic sources whenever a marine mammal enters a safety zone.

(14) Suggested means of learning of, encouraging, and coordinating research opportunities, plans, and activities relating to reducing such incidental taking and evaluating its effects.
The U.S.G.S. is collaborating with geologists at University of California Santa Barbara in order to eliminate or reduce their need to conduct a similar seismic-reflection survey in the same work area.

References

Barlow, J., K.A. Forney, J.V. Carretta, M.M. Muto, and J. Baker. 2001. Draft U.S. Pacific Marine Mammal Stock Assessments: 2001. National Marine Fisheries Service Report accessed from www.nmfs.noaa.gov/prot_res/PR2/Stock_Assessment_Program/sars.html.

Forney, K.A., J. Barlow, M.M. Muto, M. Lowry, J. Baker, G. Cameron, J. Mobley, C. Stinchcomb, and J.V. Carretta. 2000. U.S. Pacific Marine Mammal Stock Assessments: 2000. National Marine Fisheries Service Report accessed from www.nmfs.noaa.gov/prot_res/PR2/Stock_Assessment_Program/sars.html.

Gutmacher, C.E., W.R. Normark, S.L. Ross, B.D. Edwards, R. Sliter, P. Hart, B. Cooper, J. Childs, and J.A. Reid. 2000. Cruise report for A1-00-SC Southern California Earthquake Hazards project, Part A. U.S. Geological Survey Open-File Report No. 00-516, 50 p.

Normark, W. R., R.G. Bohannon, R. Sliter, G. Dunhill, D.W. Scholl, J. Laursen, J.A. Reid, and D. Holton. 1999a. Cruise report for A1-98-SC Southern California Earthquake Hazards project. U.S. Geological Survey Open-File Report No. 99-152, 60 p.

Normark, W. R., J.A. Reid, R.W. Sliter, D. Holton, C.E. Gutmacher, M.A. Fisher, and J.R. Childs. 1999b. Cruise report for O1-99-SC Southern California Earthquake Hazards project. U.S. Geological Survey Open-File Report No. 99-560, 60 p.

Richardson, W. J., C.R. Greene Jr., C.I. Malme and D.H. Thomson. 1995. Marine Mammals and Noise. Academic Press. San Diego, CA. 576 p.

Appendix 1

Maximum Sound-Exposure Levels for Marine Mammals

The adverse effects of underwater sound on mammals have been documented for exposure times that last for tens of seconds or minutes, but adverse effects have not been documented for the brief pulses typical of the minisparker (0.8 ms) and the Huntec™ system (typically 0.3 ms). The National Marine Fisheries Service (NMFS) proposed that the maximum SPL to which mysticetes and sperm whales can be exposed is 180 dB re 1 μPa-m RMS, but for odontocetes and pinnipeds, the level is 190 dB re 1 μPa-m RMS. In 1999, the California Coastal Commission limited this maximum sound-exposure level to 180 dB re 1 μPa-m RMS for all marine mammals.

Below we provide two estimates of how closely marine mammals can approach each sound source before it needs to be shut off. The first estimate follows the procedure required by the California Coastal Commission in 1999, in that underwater sound is assumed to attenuate with distance according to 20log(R), and the maximum SPL to which marine mammals can be exposed is 180 dB re 1μPa-m RMS. The alternative estimate of safe distance is proposed for operations in shallow water. In shallow water, sound from the sources will decay with distance more sharply than 20log(R) because some of the sound energy will exit the water and penetrate the sea floor when the source is physically close to the sea floor.

The zone of influence for the sound sources is a circle whose radius is the distance from the source to where the SPL is reduced to 180 dB re 1 μPa-m RMS. In the deeper water (>50 m) areas of the proposed survey, for a 20log(R) sound attenuation, the zone of influence for a 209 dB RMS minisparker source has a radius of 28 m. The 204 dB Geopulse™ and 205 dB Huntec™ boomers yield radii of 16 and 18 m respectively. The 210dB Klein sidescan fish yields a safety radius of 32 m, and the 220dB GI gun yields a safety radius of 100 m. We propose that safety zones of 30 m around the boomers, minisparker, sidescan fish, and of 100 m around the airgun be used in water deeper than 50 m.

In water <50 m deep, underwater sound commonly attenuates more sharply than 20log(R). In 1999 the USGS measured a sound attenuation of 27log(R) off southern California, so we propose that for inshore areas, underwater sound attenuates approximately like 25log(R). Strictly for inshore areas, then, an attenuation of 25log(R) yields zones of influence for the boomers of 10 m, for minisparker 15 m, and for sidescan 20 m.

Because of this short radius of the zone of influence in shallow water, we propose that the minisparker and/or boomers or sidescan can be used at night, using spotlights to illuminate the zone of influence around the source in use.

The Need for 24-hour Seismic Operations

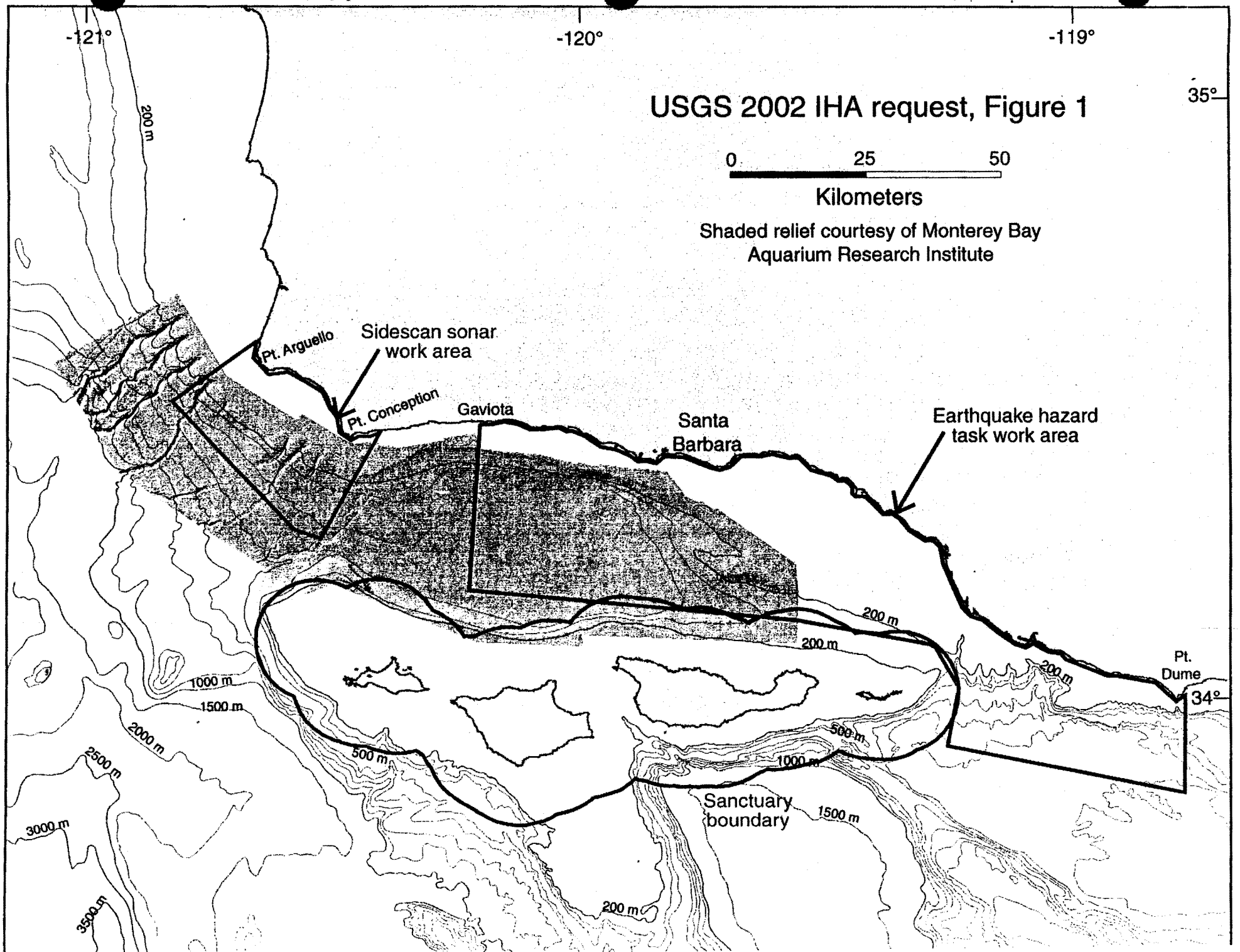
Reasons for around-the-clock operation that benefit the environment are:

1) when the sound sources cease to operate, marine mammals might move back into the survey area and incur an increased potential for harm when operations resume, and

2) daylight-only operations prolong our activities in a given area, thus increasing the likelihood that marine mammals will be harassed. The 2002 survey will require only two weeks, and the ship will be moving continuously through the Santa Barbara Channel, so no single area will see long-term activity. In our view, the best course is to complete the survey as expeditiously as possible.

Operating less than 24 hours each day incurs substantially increased cost for the leased ship, which the USGS cannot afford (Normark et al., 1999b). The ship schedule provides a narrow time window for this project; typically, other experiments are scheduled to precede and follow ours. Thus we are not able arbitrarily to extend the survey time to include large delays for dark or poor visibility.

For these reasons, we request that the Incidental Harassment Authorization allow 24-hour operations. We specifically request permission to operate the minisparker and/or boomers or sidescan at night.


-121°
-120°
-119°
35°
USGS 2002 IHA request, Figure 1
0
25
50
Kilometers
Shaded relief courtesy of Monterey Bay Aquarium Research Institute
Pt. Arguello
Sidescan sonar work area
Pt. Conception
Gaviota
Santa Barbara
Earthquake hazard task work area
Pt. Dume
34°
Sanctuary boundary
200 m
500 m
1000 m
1500 m
2000 m
2500 m
3000 m
3500 m

FINAL REPORT

MARINE MAMMAL OBSERVATIONS AND MITIGATION ASSOCIATED WITH USGS SEISMIC SURVEYS IN THE SOUTHERN CALIFORNIA BIGHT IN 2000

Prepared for

U.S. Geological Survey
345 Middlefield Rd.
Menlo Park CA 94025

Prepared by

John Calambokidis
Todd Chandler

Cascadia Research
218-1/2 W Fourth Ave.
Olympia, WA 98501

December 2000

TABLE OF CONTENTS

ACKNOWLEDGEMENTS

Lisa Baraff, Annie Douglas, JR Veldink, and Dave Ellifrit assisted Todd Chandler as marine mammal observers on the survey. Lisa Schlender computer coded the data gathered in the field. Support for the marine mammal observations was provided by the US Geological Survey. The National Marine Fisheries Service provided a permit for the research. Our thanks to the USGS personnel who assisted including Chris Gutmacher, Jon Childs, Bill Normark, and Mike Fisher. We thank the crew of the *Auriga* for their help.

INTRODUCTION

From 7 to 27 June 2000, the U.S. Geological Survey conducted seismic surveys in the coastal waters of the Pacific Ocean, in the southern California Bight, to investigate earthquake hazards. As a part of this project, Cascadia Research was contracted by the USGS to monitor marine mammals from the survey platform and provide mitigation on impacts on marine mammals by requesting shutdown of the sound sources when marine mammals were close to the operations.

This report summarizes the results of a marine mammal mitigation and monitoring program conducted in conjunction with these USGS surveys and adds information to similar work conducted by Cascadia Research in 1998 and 1999 (Calambokidis et al 1998, Quan and Calambokidis 1999). There were several modifications to observations and mitigation operations in 2000 compared to 1999 and 1998: 1) five observers were on board with at least two on duty during all daylight and nighttime operations, 2) the mitigation safety zone was slightly more complicated and involved multiple sound sources, and 3) airgun operations were conducted during the night time hours if baleen whales had not been seen in the area during the day.

BACKGROUND ON PROJECT AND SOUND SOURCE DESCRIPTION

The following background on the overall project and sound source description was provided by the USGS.

The focus of this project is to identify the landslide and earthquake hazards, as well as related deformation processes, that have great potential to impact the social and economic well being of the inhabitants of the Southern California coastal region--the most heavily populated urban corridor along the U.S. Pacific margin. We are studying Pleistocene-Holocene sedimentation and deformation patterns and related seismicity and strain within the coastal zone and adjacent continental borderland basins. Our findings will help us evaluate the hazard potential for large, destructive earthquakes and identify how deformation is distributed in space and time between onshore and offshore regions. The results of this project will contribute to decisions involving land use, hazard zonation, and building codes in the area.

The FY 2000 field program was conducted using a leased vessel, the 156-ft-long M/V *Auriga*, owned and operated by F/V North Wind, Inc. Three sound sources were used:

Minisparker: The sound source for the multi-channel seismic-reflection (MCS) profiling during the cruise was a 1.5 kJoule (kJ) "SQUID 2000" minisparker system manufactured by Applied Acoustic Engineering, Inc. This minisparker consists of eight sets of discharge electrodes, in two banks, mounted on a small pontoon sled. The pontoon sled that supports the minisparker is towed on the sea surface, generally about 3 meters behind the ship. Source characteristics of the SQUID 2000^{TM} provided by the manufacturer show a sound-pressure level (SPL) of 209 dB re 1 μPa-m RMS. The amplitude spectrum of this pulse indicates that most of the sound energy lies between 150 Hz and 1700 Hz, and the peak amplitude is at 900 Hz. The output sound pulse of the mini-sparker has a duration of about 0.8 ms. For the multichannel seismic-reflection survey, the minisparker was discharged every 2 seconds, and when used with a single-channel streamer, at 400 J, the fire rate varied from 300-750 ms, depending on water depth.

Huntec: A high-resolution Huntec DTS boomer system towed between 20 m and 137 m below the sea surface (depending upon the water depth) was used to image the upper few tens of milliseconds of strata with a resolution of better than 0.5 ms (0.4 m). The SPL for this source is 210 dB re 1 μPa-m RMS. Power output was 375 Joules, with a firing rate that was also dependent on water depth, ranging from 0.5 sec over the shelf and upper basin slopes to 1.67 sec over the deeper parts of the basins.

Geopulse: The sound source consists of two ORE Geopulse 5813A boomer plates mounted on a catamaran sled built in-house. The catamaran was towed from the same deck area as the multichannel sound source, while the short hydrophone streamer was towed from a boom on the starboard side of the vessel. The source level suggested by the manufacturer is 220 dB re 1 μPa-m RMS. Power input was 350 Joules, with a firing rate that was also dependent on water depth: 0.5 or 1.0 second for the geologic hazard part of the survey and 0.25 second in the harbor areas.

OBJECTIVES

The objectives of the marine mammal study were as follows:

1. Mitigate impacts on marine mammals by monitoring the presence of these species from the survey ship and requesting shut-down of the sound source when marine mammals were seen within specified safety zones representing distances close enough to potentially cause physical injury.

2. Document the number of animals of each species present in the vicinity of sound transmissions.

3. Evaluate the reactions of marine mammals to the sound transmissions at different distances from the sound source.

METHODS

General Approach

The research effort consisted of observations made directly from the seismic vessel (*Auriga*) to provide mitigation, document marine mammals exposed to the sound sources, and monitor reactions of marine mammals close to the seismic survey vessel. Observations were conducted from several locations. The primary platform utilized by one of the two on-duty observers during both day and night operations was in front of the bridge and put the observer's eye level at 7.6 m above the water. This external platform provided excellent visibility to the front and sides but obscured visibility to the rear. The platform was near the front of the vessel 6.4 m behind the bow and 47 m from the stern of the vessel. During daylight observations, a second observer used a platform immediately behind the bridge that faced aft and put the observer eye level at about 10m above the water. This station was used to view the area to the rear of the bridge and immediately around the sound source. During night observations the second observer roamed the vessel's main external deck just above water level.

Observations were conducted 24 hours a day when seismic operations were underway. Two observers were on watch at all times on rotating shifts among the total of five observers on the boat. Observers shifted every two hours. During daylight observations, observers used *Tasco 7x50* binoculars with internal compasses and reticles to record the horizontal and vertical angle to sightings. Night-time operations used a commercial night vision goggles (see next section). The roaming observer that was responsible for the sides and rear portion of the ship had the benefit of lights that illuminated the rear deck and aft of the ship.

Data on survey effort and sightings were recorded on a datasheet which included observers on duty and weather conditions (Beaufort sea state, wind speed, cloud cover, swell height, precipitation, visibility, etc.). For each sighting the time, bearing and reticle reading to sighting, species, group size, surface behavior and orientation were recorded. A polaris was used to determine the angle to the sighting in relation to the ship's course.

Distances to sightings were calculated using the vertical angle to the animal (based on either the reticle reading through the binoculars or a hand held clinometer for close sightings) and the known elevation above the water.

Mitigation safety zones

Two safety zones were used for this project. These were:

1. For pinnipeds and odontocetes (all toothed cetaceans except sperm whales) seismic operations would be shut down when an animal was seen close to a distance of 30 m or less.

2. For mysticetes (baleen whales) and sperm whales, the safety zone was 250 m.

To allow a quick determination of status, safety zones were calculated in three arcs around the ship and the safety distance was applied using the closest part of the ship or sound source. Three different cut-off distances (based on distance and angle from the observers) were calculated for off the bow (60 degrees to either side of the bow), to either side of the vessel (from 60 to 120 degrees off the bow and off the stern (120 to 180 degrees off the bow).

Observers were instructed to call for a shut-down when a marine mammal was seen inside the safety zone or close enough to the safety zone that given measurement-error, it could be within the safety zone. Shut-down was also considered when animals were ahead of the vessel path outside the safety zone, but it appeared likely that the direction of travel of the vessel would result in the marine mammal being within the safety zone shortly. If possible, marine mammals were tracked until they were outside the safety zone at which time seismic operations resumed. If animals could not be tracked then seismic operations were resumed after there were no resightings of animals within the safety zone for a period adequate to indicate these animals were not any longer near the ship.

For effective mitigation, the observers needed to know very quickly whether a sighting was within the safety zone. We used a polaris (angle board) for the observers to estimate the angle to the sighting. The cut-off vertical angle, which represented each of the safety zones, was also written on the polaris, allowing quick determination of the proximity of a sighting to the safety zone.

Night Observations

Several modifications were made for night observations during seismic operations. Due to the reduced visibility at night, the two observers focused on sightings of marine mammals in the immediate vicinity of the ship. One observer would observe the forward part of the ship from the platform forward of the bridge and the second would roam the sides and aft portion of the shift primarily observing aft near the sound source. Generation-3 night vision goggles (ITT Industries) were used to assist in sightings primarily by the forward observer. Distances to sightings could not easily be determined with clinometers or binoculars and were instead estimated.

As a mitigation to avoid exposure to mysticete (baleen) or large odontocetes (toothed) whales during night operations, additional precautions were taken. Because sightings of these species out at the mitigation distance of 250 m was not possible, night operations were conducted only if no large whales had been seen in the region during the daylight operations.

RESULTS AND DISCUSSION

Marine mammal sightings

There were a total of 241 sightings (not including re-sightings), representing at least 11 species and comprised of 4,792 marine mammals made during observation operations (Table 1). Small cetaceans were the most numerous and common marine mammal species sighted accounting for 54% of the sightings and 96% of the animals. Common dolphins were the most common small cetacean species with 74 sightings of 3,764 animals. Risso's dolphins, bottlenose dolphins, and Dall's porpoise were also seen in smaller numbers. Pinnipeds accounted for 98 sightings and these were predominantly California sea lions. Smaller numbers of harbor seals and a single elephant seal were also sighted. Four species of large cetacean were sighted in small numbers including blue, fin, humpback, and minke whales. Blue whales were the most common with five sightings of single animals.

Sightings of marine mammals were made during a wide variety of operational states for the various sound sources (Table 2). Rates at which marine mammals were sighted were different among the different operational modes likely due to habitat differences. California sea lion sightings were made almost twice as often during operation of the minisparker than they were during other operating modes. Conversely, common dolphin sightings occurred during Huntec operations at more than twice the rate of other operating modes. These differences likely reflect the differences in where these sound sources were used: minisparker on the shelf and near LA/Long Beach Harbor and the Huntec in more offshore waters.

Marine mammal mitigation – Shut-downs

Shut-down of the sound source was requested in 40 instances (22 daylight and 18 night) (Table 3). Shut-downs were called for during a variety of sound source operations including 19 during Huntec and 12 during Geopulse operation. Shut-downs were called in response to five different species (in one case the dolphin species was not determined). Common dolphins were the most common species triggering a shut-down accounting for 29 instances. Risso's and bottlenose dolphins and California sea lions each accounted for three or four shut-downs each. The only shut-down for a large whale was for a sighting of a blue whale which was still outside the 250 m mitigation zone but which prompted a precautionary shut-down.

The high proportion of shut-downs caused by common dolphins was a result both of their being one of the most common species in the area and their tendency to approach the ship. Common dolphins accounted for 31% of the marine mammal sightings but were responsible for 72% of the shut-downs. California sea lions, which accounted for 36% of the sightings were responsible for only 7% of the shut-downs. Although other dolphin species were less common, both Risso's and bottlenose dolphins had shut-down rates that were similar to common dolphins.

Overall, 30% of small cetacean sightings made while sound sources were operational led to shut-downs compared to only 4% of pinniped sightings (Table 4). A low proportion of large whale sightings led to shut downs. The 11 sightings of whales made during sound source operations led to only the single precautionary shut-down (outside the mitigation area) for the blue whale mentioned above. This low rate is partly the result of the much greater distance at which large whales could be sighted.

The proportion of sightings that led to shut-downs did not seem to vary greatly by what sound source was operating (Table 5). About 20% of small cetaceans sightings during daylight observations lead to a shut-down regardless of sound source operating. Similarly, about 4% of daylight sightings of pinnipeds lead to shut-downs regardless of sound source. These findings suggest that there were not large differences in how marine mammals were attracted to or avoided the ship when different sound sources were operating.

Behavior

Marine mammals were observed in a variety of behaviors regardless of sound source operation (Table 6). Primary behavior was slow or fast travel, hauled out, or milling. Fast travel was the most common behavior for common dolphins during both times sound was transmitting and when it was not. Pinnipeds were most commonly seen hauled out or slow traveling. Breaching was seen in two cases for large cetaceans; a minke whale and a group of two humpback whales. Sound transmissions were occurring only for the minke whale sighting.

Orientation of marine mammals in relation to the boat at initial sighting did not appear to vary by sound transmissions (Table 7). Most marine mammals were not judged to be headed toward or away from the survey vessel but on a tangent. This was the case both during transmissions and when there were none. Of those that were judged to be moving toward or away from the vessel, a slightly higher proportion of animals tended to be headed toward the vessel compared to away. This again held true both when sound sources were on or off. Overall, we could not detect differences in orientation of marine mammals in relation to transmissions.

Night Observations

Some aspects of the night operations were discussed above. Overall there were dramatically reduced numbers of sightings of marine mammals at night (Table 5). Sightings at night were primarily of dolphins that approached the boat closely. In all but one case the animals were 100 m or closer from the boat when initially sighted. The close distance at which marine mammals could be seen at night resulted in shut-downs in 18 of 29 cases where small cetaceans were seen at night during sound transmissions. Sightings of both pinnipeds and larger cetaceans were dramatically reduced at night since these species did not approach the boat closely as often. There were no large cetacean sightings at night and only six pinniped sightings at night (compared to 92 in the day).

Despite the difficulty in sighting marine mammals at night, the observers were successful in sighting marine mammals within the safety on 18 occasions resulting in shut-downs. Despite the low sighting rate, the observers were able to provide some mitigation and reduced the potential exposure of bow-riding dolphins to elevated sound levels. Despite the use of a variety of generation 3 night-vision gear, it was not possible to sight marine mammals at distances

greater than 100 m. Mitigating exposure through the 250 m safety zone for large cetaceans was therefore not practical. We were not able to evaluate whether the precaution of conducting operations at night only in areas where large cetaceans had not been seen in the day was completely effective as a mitigation strategy.

CONCLUSIONS

Overall marine mammal monitoring and mitigation appeared successful in meeting the objectives of the study. There were more shut-downs in 2000 compared to either 1998 or 1999 and even though these provided effective mitigation, they interrupted the objectives of the seismic survey. Most of the shut-downs were from common dolphins, a species that was sighted more often in 2000 than in 1998 and 1999, but this increased sighting rate was not enough to account for the difference. Additionally, the safety zone for pinnipeds and small cetaceans in 1998 and 1999 was 100 m, greater than the 30 m zone used in 2000. Shut-downs at night were a principal reason for the higher number of total shut-downs in 2000. In 1999 there were no night operations. In 1998 there were night operations but only two shut-downs called at night compared to 18 in 2000. Sighting conditions in 1998 were not as good with only one observer on duty and inferior night vision gear to that used in 2000. That combined with a lower presence of dolphins in the study area likely accounted for the difference between 1998 and 2000.

REFERENCES

Calambokidis, J. L. Schlender, and J. Quan. 1998. Marine mammal observations and mitigation associated with USGS surveys in the southern California Bight in 1998. Final Report to U.S. Geological Survey, Menlo Park, California. Cascadia Research, 218-1/2 W Fourth Ave., Olympia, WA 98501. 14pp.

Quan, J., and J. Calambokidis. 1999. Marine mammal observations and mitigation associated with USGS seismic surveys in the southern California Bight in 1999. Final Report to U.S. Geological Survey, Menlo Park, California. Cascadia Research, 218-1/2 W Fourth Ave., Olympia, WA 98501. 16pp.

TABLES

1. Summary of sightings and resightings by species
2. Sightings by species and operational state
3. List of shut-downs called during the survey
4. Percent of sightings resulting in shut-downs during sound transmissions
5. Summary of effort, sightings and shutdowns by operational state and day/night
6. Summary of primary behavior by species
7. Summary of orientation by species

Table 1. Summary of sightings and resightings by species in 2000. Resightings represent groups seen more than one time. Does not include sightings outside study area during transit to and from region.

	Sighting		Resighting	
Species	# of Sightings	# of Animals	# of Sightings	# of Animals
Large whales				
Blue whale	5	5	4	4
Fin whale	1	1	2	2
Humpback whale	1	2		
Large Balaenopterid	1	1	2	2
Minke whale	2	3	2	4
Unidentified whale	2	2		
Total whales	12	14	10	12
Small cetaceans				
Common dolphin (short & long-beaked)	74	3764	20	2047
Risso's dolphin	14	120	4	35
Dall's porpoise	2	2		
Bottlenose dolphin	10	82	4	41
Unidentified dolphin	31	627	1	55
Total small cetaceans	131	4595	29	2178
Pinnipeds				
California sea lion	87	171	4	10
Elephant seal	1	1		
Harbor seal	7	8		
Unidentified pinniped	3	3		
Total pinnipeds	98	183	4	10
Grand Total	241	4792	43	2200

Table 2. Summary of sightings by operational condition and species within study area in 2000.

	None		Geopulse		Huntec		Sparker		Uniboom		Geopulse/ Huntec	
Species	# Sit.	# Anim.	# Sit.	# Anim.	# Sit.	# Anim.	# Sit.	# Anim.	# Sit.	# Anim.	# Sit.	# Anim.
Large whales												
Blue whale			3	3	2	2						
Fin whale			1	1								
Humpback whale	1	2										
Large Balaenopterid					1	1						
Minke whale					2	3						
Unidentified whale					1	1	1	1				
Small cetaceans												
Common dolphin (short & long-beaked)	6	795	18	782	41	1,735	4	146	-	-	5	306
Risso's dolphin			3	19	9	80	2	21				
Dall's porpoise					2	2						
Bottlenose dolphin			5	36	3	14	2	32				
Unidentified dolphin	1	5	7	116	18	371	5	135				
Pinnipeds												
California sea lion	18	32	15	28	23	28	30	76	1	7		
Elephant seal					1	1						
Harbor seal			5	6	2	2						
Unidentified pinniped			1	1	1	1	1	1				
Total sightings	26	834	58	992	106	2,241	45	412	1	7	5	306
Summary of effort												
hours on effort	60		166		162		70		2		3	
nmi covered	241		460		660		230		6		11	

Other effort with no sightings:
Total of .9 h covering 2.5 nmi with both Geopulse and Sparker on
Total of 6 h and 14.3 nmi with both Huntec and Sparker on
Also 15 h covering 144 nmi of effort outside study area with no sources not included above (some sightings)

Table 3. List of shut-downs called for based on sightings of marine mammals during 2000 surveys.

			Time							
Date	Firing	Dy/Nt	Sight	Sht-dn	Resume	Tot. #	Species	Sit. #	Obs	Comments
08-Jun-00	Huntec	D	0902	0902	0950	1	Common dolphin	7	JRV	Fast traveling
10-Jun-00	Geopulse	N	0306	0306	0308	6	Bottlenose dolphin	14	JRV	Slow traveling
10-Jun-00	Geopulse	N	0440	0440	0446	1	Risso's dolphin?	15	ABD	Slow traveling
10-Jun-00	Geopulse	D	1310	1315	1322	60	Common dolphin	21	ABD	Milling then bowriding
10-Jun-00	Geopulse	D	1645	1645	1654	1	California sea lion	23	TEC	Fast traveling, swam under boat
11-Jun-00	Geop./Hunt.	D	1524	1534	1600	50	Common dolphin	36	TEC	Fast traveling
12-Jun-00	Geopulse	D	1515	1515	1530	1	Blue whale	49	ABD	Slow traveling, outside zone
13-Jun-00	Huntec	D	1631	1632	1639	12	Common dolphin	54	ABD	Bow riding
13-Jun-00	Geopulse	N	2240	2240	2252	30	Common dolphin	57	LSB	Fast traveling
14-Jun-00	Geopulse	N	0034	0034	0129	12	Common dolphin	58	DKE	Fast traveling
14-Jun-00	Geopulse	D	2003	2003	2009	30	Common dolphin	65	TEC	Slow traveling then accelerated
15-Jun-00	Huntec	N	0500	0500	0506	12	Common dolphin	66	LSB	Bow riding
15-Jun-00	Geopulse	D	0558	0558	0603	12	Common dolphin	71	LSB	Bow riding
15-Jun-00	Geopulse	D	0631	0634	0636	75	Common dolphin	74	ABD	Fast traveling, part of group approaches boat
15-Jun-00	Huntec	D	0912	0914	0917	28	Common dolphin	79	ABD	Slow traveling
15-Jun-00	Huntec	D	1035	1036	1040	12	Risso's dolphin	81	LSB	Slow traveling
15-Jun-00	Geopulse	N	2328	2328	2335	3	Unidentified dolphin	83	DKE	Fast traveling
16-Jun-00	Geopulse	N	0025	0025	0032	5	Common dolphin	84	TEC	Slow traveling
16-Jun-00	Minisparker	N	2152	2152	2159	1	Common dolphin	89	JRV	Slow traveling
17-Jun-00	Huntec	D	2025	2025	2028	12	Common dolphin	94	JRV	Fast traveling
17-Jun-00	Huntec	N	2118	2118	2121	2	Common dolphin	95	JRV	Bow riding
17-Jun-00	Huntec	N	2146	2146	2155	40	Common dolphin	96	JRV	Fast traveling
18-Jun-00	Huntec	N	0452	0452	0500	6	Bottlenose dolphin?	97	DKE	Slow traveling
18-Jun-00	Huntec	D	0935	0936	0939	10	Bottlenose and Risso's dolphin	109B	LSB	Fast traveling
18-Jun-00	Minisparker	D	1929	1935	1954	20	Common dolphin	119	ABD	Milling
19-Jun-00	Huntec	N	2234	2234	2239	2	Common dolphin	130	TEC	Slow traveling
20-Jun-00	Huntec	D	0647	0650	0653	120	Common dolphin	134	JRV	Fast traveling
20-Jun-00	Huntec	N	2331	2331	2335	1	Common dolphin	141	TEC	Slow traveling
20-Jun-00	Huntec	N	2357	2357	0002	4	Common dolphin	142	TEC/LSB	Slow traveling
21-Jun-00	Huntec	N	0014	0014	0019	3	Common dolphin	143	JRV	Bow riding
23-Jun-00	Huntec	N	0121	0121	0123	2	Bottlenose dolphin	166	JRV	Fast traveling
24-Jun-00	Minisparker	D	0613	0617	0650	1	California sea lion	184	TEC	Slow traveling
25-Jun-00	Huntec	N	2303	2303	2308	3	Common dolphin	204	JRV	Bow riding
27-Jun-00	Huntec	N	0456	0458	0503	20	Common dolphin	219	JRV	Slow traveling
27-Jun-00	Huntec	D	0605	0605	0606	1	California sea lion	222	ABD	Slow traveling
27-Jun-00	Huntec	D	0956	0957	1016	18	Common dolphin	228	TEC	Slow traveling, testing equip delayed restart
27-Jun-00	Minisparker	D	1124	1130	1134	60	Common dolphin	234	DKE	Slow traveling
27-Jun-00	Minisparker	D	1143	1147	1154	65	Common dolphin	235	DKE	Fast traveling
27-Jun-00	Huntec	D	1159	1159	1205	65	Common dolphin	235	DKE	Fast traveling
27-Jun-00	Huntec	D	1220	1220	1222	700	Common dolphin	239	LSB	Fast traveling

Table 4. Percent of sightings resulting in shut-downs during sound transmissions.

Species	Sightings	Shut-downs	% of sightings
Pinnipeds			
California sea lion	69	3	4%
Other pinniped	3	0	0%
All pinniped	72	3	4%
Small cetaceans			
Common dolphin	68	29	43%
Bottlenose dolphin	10	4	40%
Risso's dolphin	13	3	23%
Dall's porpoise	2	0	0%
Unident. dolphin	30	1	3%
All small cetaceans	123	37	30%
Large cetaceans			
Blue whale	5	1*	20%*
Other whales	6	0	0%
All large cetaceans	11	1	9%

* Single large cetacean shut-down was precautionary (outside safety zone)

Table 5. Summary of effort, sightings, and shut-downs by operational conditions and day/night.

Sound operation	Hours	Large cetaceans		Small cetaceans		Pinnipeds	
		# Sit	# S/D	# Sit	# S/D	# Sit	# S/D
Day							
None	47	1		5		18	
Geopulse	102	4	1	26	4	21	1
Huntec	94	6		52	10	25	1
Sparker	50	1		12	3	27	1
Uniboom	2					1	
Geopulse/Huntec	3			5	1		
Other	4						
All day operations	302	12	1	100	18	92	3
Night							
None	13			2			
Geopulse	64			7	6		
Huntec	69			21	11	2	
Sparker	20			1	1	4	
Uniboom	0						
Geopulse/Huntec	0						
Other	2						
All night operations	168	0	0	31	18	6	0

Table 6. Summary of primary behavior of marine mammals sighted (not including resightings). Number in parenthesis indicates portion seen while no sound source was on.

	Primary behavior									
Species	**Breaching**	**Fast travel**	**Slow travel**	**Bowriding**	**Milling**	**Hauled**	**Stationary**	**Dead**	**Unknown**	**Total**
Blue whale			5						1	6
Fin whale			1							1
Humpback whale	1(1)									1(1)
Minke whale	1		1							2
Unid. large whale									2	2
Common dolphin		35(5)	24	6	9(1)					74(6)
Risso's dolphin		1	12		1					14
Dall's porpoise		2								2
Bottlenose dolphin		3	5		2					10
Unid. dolphin		17	10		4(1)					31(1)
California sea lion		8(2)	27		4(1)	38(8)	8(7)	1	1	87(18)
Elephant seal							1			1
Harbor seal		1	3			1	2			7
Unid. pinniped		1	2							3
All species	2(1)	68(7)	90	6	20(3)	39(8)	11(7)	1	4	241(26)

Table 7. Summary of orientation of marine mammals by operational condition during initial sighting and resightings in 2000.

	None		Geopulse		Huntec		Sparker		Other		All	
Orientation	**# Sit.**	**# Res.**	**# Sit.**	**# Res.**	**# Sit.**	**# Res.**	**# Sit.**	**# Res.**	**# Sit.**	**# Res.**	**# Sit.**	**# Res.**
Away	2	4	9	3	11	3	2				24	10
Left	4		17	2	43	6	7	1	1		72	9
Right	6	1	18	2	28	9	5	1	1	1	58	14
Toward	3	2	6		17		6		1	1	33	3
Variable or not determ.	11	4	8	1	7	2	25		3		54	7
Total	26	11	58	8	106	20	45	2	6	2	241	43
As percent of sightings under that condition												
Away	8%	36%	16%	38%	10%	15%	4%	0%	0%	0%	10%	23%
Left	15%	0%	29%	25%	41%	30%	16%	50%	17%	0%	30%	21%
Right	23%	9%	31%	25%	26%	45%	11%	50%	17%	50%	24%	33%
Toward	12%	18%	10%	0%	16%	0%	13%	0%	17%	50%	14%	7%
Variable or ND	42%	36%	14%	13%	7%	10%	56%	0%	50%	0%	22%	16%

Interim Findings on the Stranding of Beaked Whales in the Bahamas
December 20, 2001

NOAA Fisheries and the U.S. Navy today released the interim report on the March 2000 stranding of 17 marine mammals in the Bahamas.

The report states that this stranding event was caused by the unusual combination of several contributory factors acting together: specific oceanographic features, unusual bathymetry, presence of beaked whales and a specific sound source. Review of passive acoustic data ruled out volcanic eruptions, landslides, other seismic events, and explosive blasts. The unusual extended use of Navy midrange tactical sonars operating in the area is the most plausible acoustic source.

On March 15 and 16, 2000, a stranding of seventeen marine mammals of several species was discovered along the Northeast and Northwest Providence Channels on Bahamian Islands. The strandings took place within 24 hours of U.S. Navy ships using active midrange sonar for an unusually extended period, as they passed through the Northeast and Northwest Providence Channels. Six of the whales died after stranding on beaches. One dolphin stranded and died of unrelated causes. Ten whales were returned to the sea alive. Specimen samples were collected from four dead whales. Three whales showed signs of bleeding in the inner ears and one whale showed signs of bleeding around the brain.

An unusual combination of specific physical oceanographic features, bathymetry, presence of beaked whales, and specific sound sources were present. While the precise causal mechanisms of tissue damage are unknown, available evidence points to acoustic or impulse trauma. Review of passive acoustic data ruled out volcanic eruptions, landslides, other seismic events, and explosive blasts. The unusual extended use of Navy midrange tactical sonars operating in the area is the most plausible acoustic source.

The investigation team concludes that the cause of this stranding event was the confluence of these contributory factors acting together. Research should focus on identifying such highly unusual but problematic combinations so they can be avoided. The actual mechanisms by which these sonar sounds could have caused animals to strand, or their tissues to be damaged, have not yet been determined, but research is under way. This research, along with other research on the impacts of sonar sounds on marine mammals, increased knowledge of marine mammal densities, increased knowledge of causes of beaked whale strandings, increased knowledge of beaked whale anatomy, physiology and medicine, and further research on sonar propagation, will provide valuable information for determining which combinations of factors are most likely to cause another mass stranding event. Low Frequency Active sonar had no involvement in this event.

To the maximum extent practical, the Navy will adopt measures in its future peacetime operations and training, including the use of tactical mid-range sonars, to avoid injuring or harassing marine mammals. The report recommends the Navy and NOAA research the mechanisms by which sonar sounds affect marine mammal tissue or behavior (the report lists 15 different projects). The report also recommends the Navy put into place mitigation measures that will protect animals but not jeopardize national security. The Navy will include, when possible, Bahamian scientists and qualified individuals as participants in

future surveys involving marine mammal research in Bahamian territorial waters. Navy and NOAA will also invite Bahamian participation in future marine mammal workshops and conferences.

This is an interim report; Conclusions and recommendations appearing therein could change somewhat as final results become available.

For further information regarding the biological studies contact:

Gordon Helm or Connie Barclay - NOAA Fisheries (301)713-2370

For further information regarding the Navy's use of sonar and the recommended mitigation measures contact:

Lt. Pauline Storum or Lt. Patrick McNally - U.S. Navy (703)692-6705/6706/6707