Welcome to the Scoping Meeting for the National Science Foundation (NSF) Marine Seismic Research Program Programmatic Environmental Impact Statement/ Overseas Environmental Impact Statement (EIS/OEIS)

(1) Silver Spring, MD:
Wednesday, October 5, 1 p.m. - 5 p.m.

Silver Spring Metro Center Building 4, Science Center
1301 East-West Highway

(2) Woods Hole, MA:
Thursday, October 6, 5 p.m. - 9 p.m.

J. Erik Jonsson Center of the National Academy of Sciences
Carriage House, 314 Quissett Avenue

(3) College Station, TX:
Wednesday, October 12, 5 p.m. - 9 p.m.

Room C126, 1000 Discovery Drive
Texas A&M University

(4) Anchorage, AK:
Friday, October 14, 5 p.m. - 9 p.m.

Egan Civic and Convention Center, Space 1, 13-14, 555 West Fifth Avenue

(5) La Jolla, CA:
Monday, October 17, 5 p.m. - 9 p.m.

100 Vaughn Hall, Discovery Way
Scripps Institution of Oceanography

(6) Honolulu, HI:
Wednesday, October 19, 5 p.m. - 9 p.m.
Ala Moana Hotel, 410 Atkinson Drive

National Science Foundation Marine Seismic Research Program
Programmatic EIS/OEIS
National Environmental Policy Act (NEPA)

The National Environmental Policy Act guides the environmental impact analysis.

The Programmatic EIS/OEIS will analyze the following resources to determine potential impacts on the marine environment related to the use of seismic sources in support of NSF-funded research by U.S. academic scientists.

Resources Evaluated

Marine Acoustics/ Noise

Essential Fish Habitat

Water Quality

Marine and Terrestrial Flora and Fauna

Threatened and Endangered Species

Air Quality

Hazardous Materials

Hazardous Waste

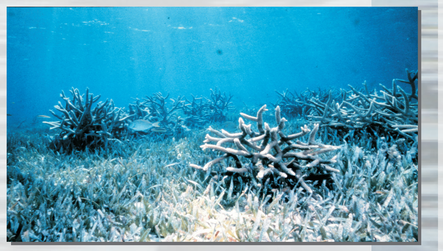
Historic and Archaeological Resources

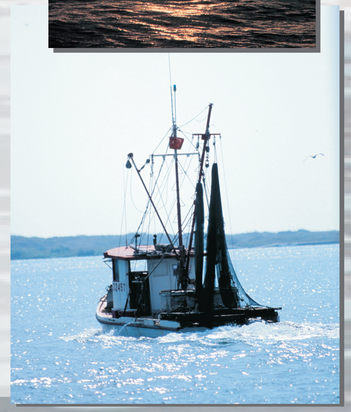
Usual and Accustomed Fishing

Socioeconomics (Private and Commercial Fisheries)

Recreation

Health and Safety





Your involvement is essential to the NEPA process

The EIS Timeline

Notice of Intent Published Sept. 22, 2005

Scoping Sept. 22 - Oct. 28, 2005

Preparation of Draft EIS/OEIS

Notice of Availability of Draft EIS/OEIS

Public Comment Period 45 Days

Public Hearings

Preparation of Final EIS/OEIS

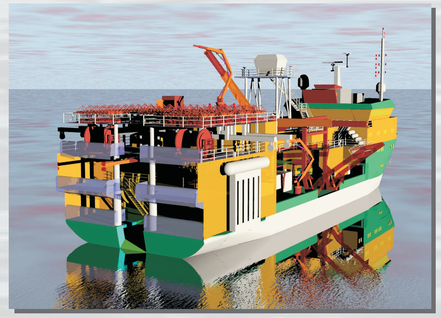
Notice of Availability of Final EIS/OEIS

Public Comment Period 30 Days

Record of Decision

There are many opportunities for your involvement in the Programmatic EIS/OEIS process.

- **Participate** in scoping meetings
- **Assist** NSF in identifying alternatives
- **Identify** community-specific issues and concerns
- **Ensure** you are on the mailing list
- **Read and comment** on the Draft EIS/OEIS
- **Participate** in public hearings
- **Review** the Final EIS/OEIS

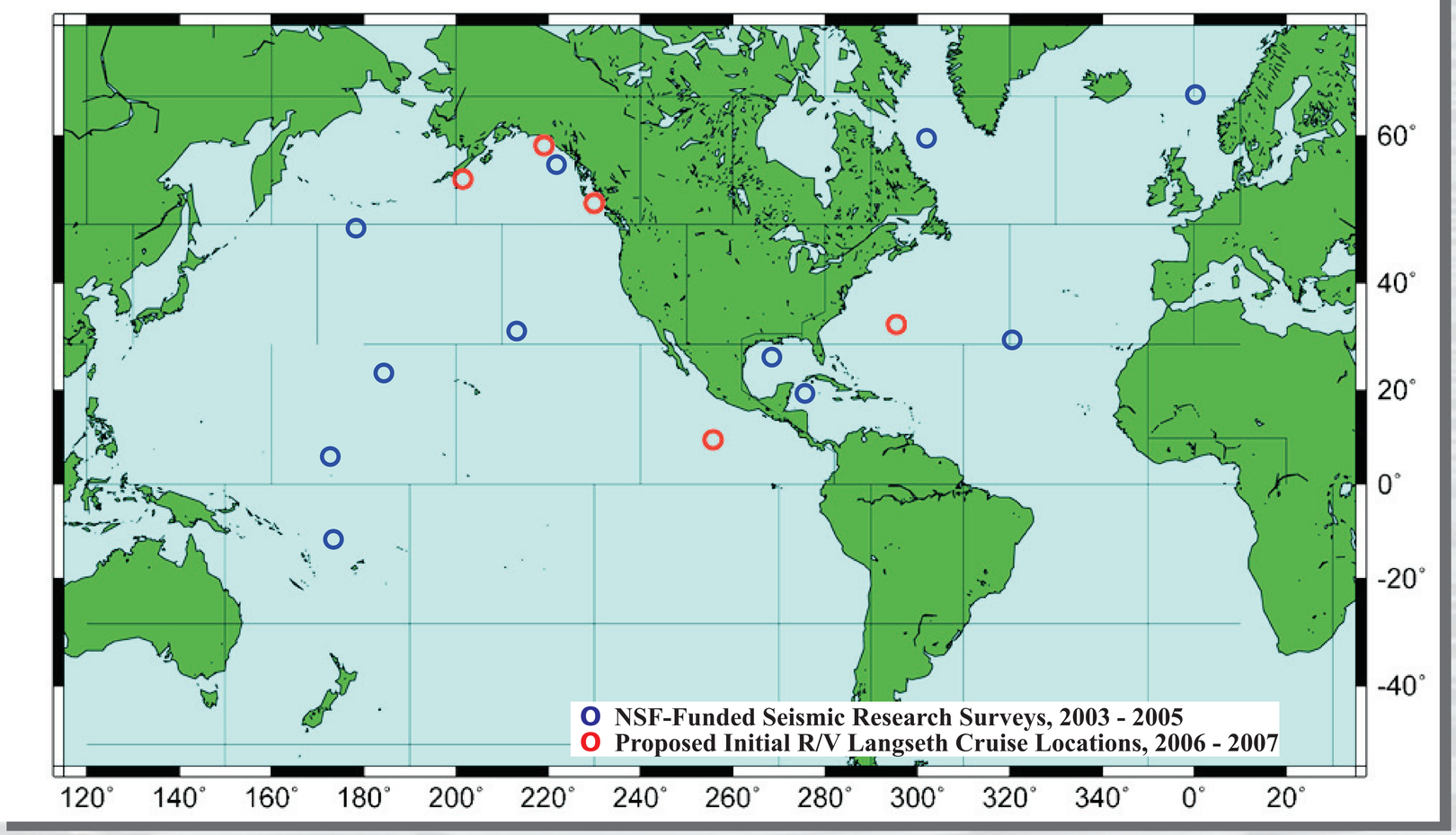


National Science Foundation Marine Seismic Research Program
Programmatic EIS/OEIS
Proposed Action

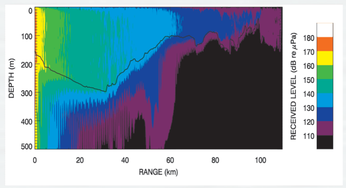
Under the Proposed Action, NSF proposes conducting seismic research operations from its primary seismic research vessel, R/V Marcus G. Langseth. The Programmatic EIS/OEIS will address the variety of airgun configurations operated from the R/V Langseth, as well as other acoustic sources that may be used in conjunction with the standard seismic research equipment. In addition, the Programmatic EIS/OEIS will evaluate impacts of airguns used in NSF-sponsored projects on other research vessels.

NSF-funded seismic research operations can occur world-wide and throughout the year using the R/V Langseth, operated by Lamont-Doherty Earth Observatory, Columbia University, New York, or other vessels. Research projects are carried out during cruises that last from about a week to 2 months in duration. Survey operations may run up to 24 hours per day, for 7 days per week for extended periods.

NSF-funded seismic programs are undertaken by academic researchers and use standard seismic technology to conduct basic research in the oceans. These projects involve scientists and students from throughout the U.S. and around the world. Seismic research projects often address topics such as how and where earthquakes occur, how submarine volcanoes and ridge systems form and the impacts of those undersea eruptions, and how and where undersea landslides and turbidity currents form. Seismic techniques are used to identify locations to sample sediments and rock outcrops of various types, and they are essential to precisely locate targets for coring and drilling, especially for studies of the history of climate and ocean properties.



National Science Foundation Marine Seismic Research Program Programmatic EIS/OEIS



Distribution of the Sound Exposure Levels (i.e., SEL*, or "loudness") made by an airgun array based on water depth, distance from the source (array), and other site-specific conditions. The thin black line represents the sea floor.

*NOTE: received level is color-coded in dB re 1 **m**Pa. SEL is a measure of received sound energy, ≈98 dB re 1 **m**Pa. – 10 dB.

Acoustic modeling of this type will be conducted to assist in the analysis of potential impacts of airgun noise on marine animals.

R/V Maurice Ewing (retired by NSF in 2005) towing an airgun array. The white water areas are where the airgun floats are located in a horizontal row behind and perpendicular to the vessel. The airguns are suspended below the floats under water. The airguns have recently shot a pulse of air as indicated by the large round bubbles at the surface behind the floats.

A close-up of the seismic airgun releasing air bubbles at the water surface immediately after a pulse of air is released.

General Seismic Programs

- Modern seismic surveys normally use airguns as a sound source. The seismic airgun was invented in the early 1960s for academic research. It is a safer alternative (for people and marine life) to dynamite, explosives, and electrical discharge systems that were then used to image the sediments and rocks beneath the oceans.
- Airguns emit strong pulses of compressed air that result in sound pulses ~0.1 sec in duration near the source, lengthening to ~1 sec at a distance. Each pulse is followed by ~6-120 sec of silence.
- Seismic surveys introduce low frequency sound (mostly < 250 Hz) into the marine environment. Airguns are often used in arrays, designed so most of the sound is focused downward, but even arrays transmit considerable energy horizontally. Seismic arrays are normally towed 30 to 50 meters behind the ship.
- The returned acoustic signal (echo) from seismic sources is recorded passively by hydrophones in one to four seismic streamers, each up to 6 kilometers long, or on ocean bottom seismometers (OBSs) that are recovered at the end of a cruise.
- Other sound sources used in conjunction with seismic airguns include: multibeam bathymetric sonars, to provide detailed maps of the bottom; subbottom profiling sonars, to look at the shallow structure of sediments; and acoustic current profilers, to help navigate the vessel in regions of ocean currents. These systems all use sonic 'chirps' of various durations and frequencies.

The R/V Langseth proposed for use during the NSF seismic academic studies. Other vessels deploying smaller sound sources will also be used.

Measuring Sound in Water

- Seismic noise is measured in decibels (dB), a measure of loudness, which is a logarithimic scale. The level can also be measured in terms of pressure or energy. A 10 times increase in pressure produces a 20 dB increase, whereas a 10 times increase in energy produces a 10 dB increase. These are potentially confusing, so it is important to clearly define the terms being used.
- Reported dB levels in air and water are not directly comparable due to differences in standard units and in the density of air vs. water, thus 117 dB *in air* ≈180 dB *in water*
- Frequency: pitch, in number of oscillations per second (Hz)
- An array of several airguns is a distributed sound source. Because of this, the nominal source level (theoretical maximum, from adding all airgun sounds together), overstates the loudest sound that is heard at any point in the water.

An engineer prepares to deploy a single airgun from the vessel as part of an "array" of airguns. Each airgun is suspended about 8 m below the water surface from a white or pink float shown here. The energy to the airguns is compressed air supplied by compressors on board the source vessel.

National Science Foundation
Programmatic EIS/OEIS
Effects of Sounds From Seismic Research Sources on Marine Animals

Range of Potential Effects

- **No response/tolerance** commonly noted
- **Habituation** often occurs (i.e., get used to sound)
- **Masking** or "blocking out" of animal sounds by seismic research sound sources likely minimal because sound sources are not continuous
- ***Possible* hearing impairment and other physical effects** demonstrated for fish close to sound source, not demonstrated in any marine mammal

The R/V Maurice Ewing towing an airgun array during a 2004 marine seismic study. The airgun lines are towed from the two black transverse booms seen in this photo.

Effects and Concerns Differ by Species

- Little information on most species
- Some species studied more than others
- Few systematic studies
- Monitoring during seismic operations shows variable reactions and often tolerance

Toothed Whales (Dolphins, Porpoises)

- Dolphins and porpoises often seen from seismic vessels, including bowriding; evidence of some localized avoidance
- Sperm whales recent comprehensive studies indicate no strong overt responses
- Beaked whales, no data; inhabit deep offshore waters

Concern: beaked whales appear sensitive to sonar sounds, but nothing is known about effects of airgun sounds; dolphins and porpoises do not always avoid the safety zone

Pinnipeds (Seals, Sea Lions)

- Some indication of slight avoidance & behavior changes
- Radio tagging work indicates stronger (but temporary) avoidance than is evident from visual observations

Concern: pinnipeds do not always avoid the safety zone

Baleen Whales (Large whales such as Gray, Blue, and Fin)

Systematic studies of humpback, bowhead, gray whales:

- Most avoid by 3-8 km (migrating bowheads by up to 35 km)
- Some approach
- Most sensitive during migration, but migration/feeding continues
- Respiratory changes
- Avoidance is usually localized, short-term

Concern: most baleen whales are endangered or threatened and are especially sensitive to low-frequency sounds

Sea Turtles

- Increase swimming speed, change behavior, move away from sound based on studies in captivity and at sea

Concern: little quantitative information about sound levels that elicit response

Marine Fish

- Airgun energy <2 m away can damage/kill eggs and larvae (natural mortality of eggs & larvae >99%)
- Airgun pulses >180 dB (rms) can damage snapper ears
- Studies of freshwater species: no lasting damage
- Some move away from seismic sounds

Concern: seismic may impact spawning and migration, scare fish away from fishing areas

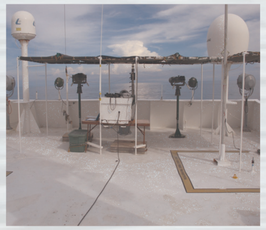
Marine Invertebrates

- Impacts presumed to be low and physiological
- No mortality or impact on crab eggs or females

Concern: effects largely unknown

National Science Foundation Marine Seismic Research Program
Programmatic EIS/OEIS
Monitoring and Mitigation

- Monitoring and mitigation are conducted to minimize and avoid (as possible) potential effects of seismic operations on marine mammals and sea turtles
- Below are examples of how NSF-funded seismic studies have been incorporating monitoring and mitigation into their geophysical research programs conducted from aboard seismic vessels



The observer station on the flying bridge aboard the R/V Maurice Ewing and two observers actively searching for marine mammals and sea turtles. Two "big-eye" binoculars, handheld binoculars, and a data collection "desk" are used by experienced biological observers to monitor and record their observations. When marine mammals or sea turtles are seen in or near the "safety zone", the observers immediately contact the airgunners to implement a power down or shut down of the airguns as required by the National Marine Fisheries Service.

Monitoring

Visual observations

- With naked eye and "reticle" and "big-eye" binoculars
- During all daytime seismic operations
- During some nighttime operations (e.g., ramp up)
- During non-seismic periods to establish baseline data

Passive acoustic monitoring

- Listen for mammal vocalizations during all day & night seismic operations when larger airgun sources are in use
- Software estimates bearings to vocalizing mammals, these bearings are then relayed to visual observers

The passive acoustic listening station used by marine mammal observers below deck in the science lab aboard the R/V Maurice Ewing. The biologist on duty listens for live sounds of marine mammals using headphones while simultaneously watching the computer screen for signs of calling animals. When sounds are heard, the bearing (direction) to those sounds is determined using a computer software program. This information is communicated to the observers located on the flying bridge to aid in locating the animals when they surface.

Noise Criteria for Mitigation

Current NMFS position:

- Cetaceans (whales) should not be exposed to pulsed sounds with received levels ≥180 dB (rms)
- Pinnipeds (seals) should not be exposed to pulsed sounds above 190 dB (rms)
- At higher levels cannot rule out hearing damage, other injury.
- 180 and 190 dB (rms) radii around airgun array vary with airgun configuration, water depth
- 180 dB (rms) criterion sometimes applied for sea turtles

Updated criteria allowing for recent data on auditory effects are being developed for marine mammals, fish, and sea turtles

Mitigation

Program design

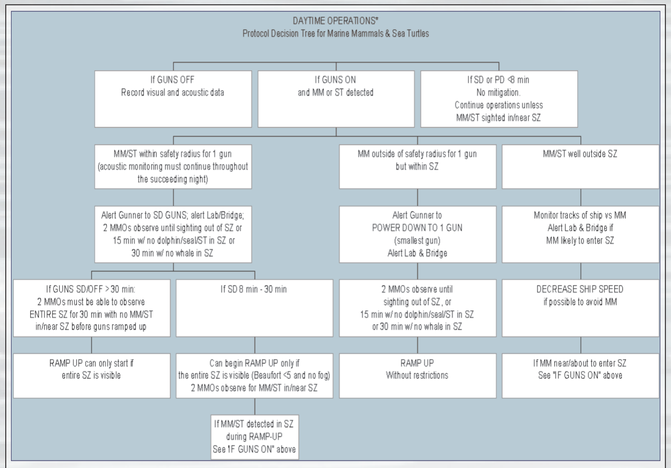
- Timing, location, avoidance of sensitive areas
- Use smallest possible configuration of airguns
- Special mitigations are applied as needed

Ramp-up

- "Soft" prolonged start over 5-20 minutes

Safety radius

- Power or shut down for sightings within the radius
- Whales/dolphins/turtles (180 dB [rms])
- Seals/sea lions (190 dB [rms])



An example of a decision flow chart used to aid in determining what type of mitigation to implement for marine mammals and sea turtles while conducting observations from aboard the R/V Maurice Ewing during a NSF-funded 2004 marine seismic study. A flow chart is developed specifically for each project. Conditions and mitigation requirements differ depending on a number of factors such as water depth, expected species, number and configuration of airguns, etc.

Mitigation Based on Predicting and Modeling Effects

- Goal is to estimate and predict the exposure level of marine mammals and sea turtles to seismic sounds
- This information is used to develop appropriate mitigation to minimize exposure of marine mammals and sea turtles

Predicting sound levels underwater is complicated

- Sound paths and received levels are affected by changes in temperature, salinity, water depth, and bottom conditions
- An animal's exposure to sound is affected by its depth and distance from the seismic source

To address these issues in the EIS/OEIS, sophisticated acoustic propagation models will be used to predict the sound field. These will be combined with models of animal movement that account for differences in behavior among different species.