Acoustic Ecology Institute
Spotlight Report

Ocean Noise:
Science Findings and Regulatory Developments in 2007

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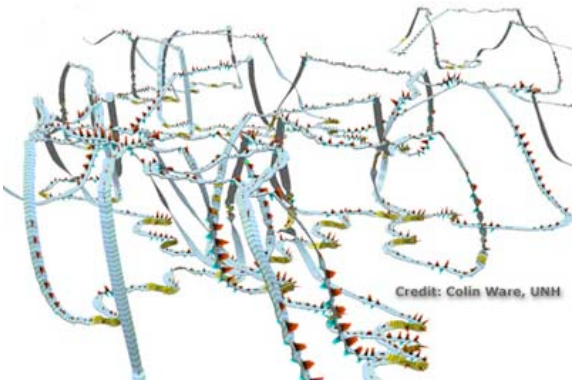

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Ocean Noise:
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The oceans contain over 80% of the earth's total volume of habitat; because of limited light penetration, many ocean species rely heavily on sound for navigation, finding food, and maintaining group relationships. For decades, human activity has been increasing the noise levels in the oceans; over the past few years, we have begun to pause and consider the effects of our sounds on ocean life. The oil and gas industry, navies of the world, and field biologists are all putting more time and money into these questions than ever before. Here's what was learned in 2007.

This year, ocean noise issues were dominated by the continuing legal challenges to Navy use of active sonars (the high-intensity-sound poster child that has caused several whale strandings and likely also unseen mortality over the past 15 years), and more modest but growing efforts to address the effects of chronic exposure to moderate noise in the seas, such as that caused by shipping or long-range propagation of oil and gas exploration noise.

This is AEI's 2nd annual year-end review of ocean noise developments, and as with last year's edition, it's designed as a fifteen-minute overview that offers concrete information in a concise format. You'll find many links to further information, both on the AEI website and on agency and academic sites that provide the full reports and papers discussed here.

We'll start with some highlights of the year, then proceed with coverage of each of the key issues (active sonars, seismic surveys, and chronic moderate noise), and conclude with a few odds and ends of particular importance.

Among the highlights of the year in ocean noise:

- **Marine Mammal Commission report on Noise:** As the final product of a two-year process that involved representatives of academia, agencies, industry, the military, and environmental groups, the US Marine Mammal Commission staff and scientists submitted a report to Congress, entitled **Marine Mammals and Noise: A Sound Approach to Research and Management**. This well-constructed overview of the current state of research, understanding, and challenges also includes, as appendixes, the final "caucus statements" of each of the groups that participated (after failing to reach the hoped-for consensus), a report on a separate workshop held in the UK on international efforts to address noise, and a report on anthropogenic noise and beaked whales. Key MMC recommendations to Congress included the creation of an inter-agency research effort overseen by the MMC, the importance of addressing moderate, sub-lethal effects of noise such as masking and behavioral disruption, and the need to provide unified regulation of ocean noise, including currently unregulated activities such as recreational boating, whalewatching, and use of acoustic deterrents at fish farms. **Download report: [http://www.mmc.gov/reports/workshop/pdf/fullsoundreport.pdf]**
- **DTAGs:** Some impressive research is underway utilizing innovative suction-attached "DTAGs," which record the sounds heard by an animal while also tracking its dive patterns. For the first time, this allows researchers to "observe" behaviors long hidden underwater, and any changes that occur in response to noise. In addition to revealing previously unknown details about normal behavior, the tags also provide a much clearer picture of the effects of moderate noise exposures. The tags, which remain on the animal for 6-18 hours before floating back to the surface for recovery, are used for dive pattern studies without noise being a factor (though sometimes

noise sources happened to occur, providing a glimpse of behavioral effects); in recent years, researchers have moved slowly into "controlled exposure" experiments (CEE), in which airgun, sonar, and predator sounds are played into the water after animals are tagged. These studies start with low intensity sound, and over the course of several years of field work, gradually increase the sound levels only after careful monitoring to assure no injuries are caused. This year will see the second season of a Behavioral Response Study of beaked whales in the Bahamas. Some observers question the value and ethics of intentionally exposing animals to any additional noise or stress, so these studies are closely watched.

DTAG on a humpback whale, and track plot of DTAG data showing several hours of humpback foraging data in 3D. Ribbon shows the track of the animals. Yellow ribbon sections indicate side rolls. Red and blue polygons depict fluke strokes. http://stellwagen.noaa.gov/science/DTAG.html

- **Naval Sonar legal and regulatory activities:** The legal and regulatory arena regarding ocean noise was dominated again this year by issues surrounding the use of mid-frequency and low frequency active sonars by the US Navy. After several years of very limited deployment of low-frequency active sonar (LFAS) in the western Pacific, the Navy released its court-ordered Supplemental Environmental Impact Statement and received NMFS authorization to use the system on two ships (soon to be four), with free rein to travel throughout most of the world's oceans. Meanwhile, mid-frequency active sonar (MFAS)—deployed on roughly 300 US and NATO-ally vessels—has continued to attract legal scrutiny, including court-ordered increased safety measures to protect whales; at the same time, the Navy is proceeding with Environmental Impact Statements meant to address these concerns in a legally-binding way for future exercises in several training grounds around the world.

Chronic Exposure to Moderate Noise

We begin by focusing on the emerging issue of chronic exposure to moderate noise: human sounds that are presumably not intense enough to immediately injure animals, but are loud enough to disrupt communication or cause animals to avoid the sound. It is now well established that the overall background ambient noise in the oceans has increased 10-20dB over the past generation (a 10x to 100x increase in sound energy, which is perceived as a doubling or quadrupling of sound level), with the most dramatic changes in areas close to shipping lanes. The subtle effect of such gradual increases in background noise is that the faintest and/or most long-distance calls and echoes important to fish and whale communication are lost in the rising tide of noise, dramatically shrinking the effective communication range of many animals.

As we stressed in last year's report, research over the past few years has led to the widespread acknowledgement that **chronic exposure to moderate levels of noise is**

likely to be causing more significant biological impacts than occasional exposures to extremely loud noise. Rising ambient background noise levels can mask communication and navigation calls, as well as increase stress. Meanwhile, avoidance of boats and seismic surveys at distances where the noise is audible but not harmful can lead to modest but repeated behavioral disruptions, which may keep animals away from preferred feeding grounds or expend precious energy.

In 2006, NMFS attempted for the first time to protect migrating bowhead cow/calf pairs from exposure to seismic survey noise at levels down to 120dB (the point at which they would be likely to change course to avoid the sound). This was the first time that acoustic protection moved beyond simply avoiding gross physical injury (such as temporary hearing loss, the normal threshold for regulatory protection), and aimed to prevent behavioral disruption. The new standard was challenged in court by Conoco (the case was never heard), but in 2007 one Shell survey proceeded with this exposure standard, which is to be used when conditions warrant, according to the NMFS/MMS Draft EIS (the final EIS will be issued this year).

Bowhead cow and calf Photo courtesy National Marine Mammal Laboratory
http://www.afsc.noaa.gov/nmml/bowhead_iwc.php

Perhaps the most striking report to emerge this year was a study done in Spain which indicated that **two sperm whales that were killed by ferries were apparently deafened to the very frequencies emitted by ships**; the implication is that long-term over-exposure to vessel noise had caused permanent hearing loss at those frequencies. "The inner ear lesions we found in sperm whales came from two resident whales which died after collisions. These lesions affected animals of different ages," said Dr. Michel André of the Laboratory of Applied Bioacoustics, indicating the damage is due to an external factor, not to ageing. The injuries also occurred at a place in the ear's sensitive structure corresponding in frequency with the sounds emitted by shipping. To test whether the wider whale population was affected, his team played the same low-frequency range sounds to 215 sperm whales around the Canaries; the whales failed to react. While it is impossible to be scientifically certain, André felt that the correspondence between the sound frequency emitted by shipping, the area of damage to the whales' ears, and the lack of response by other whales to sound broadcast at the same frequency built a compelling argument: "It is very likely that these lesions are due to a long-term exposure to low-frequency sources." [This research has been presented at conferences, but not yet published in the scientific literature.]

André recently proposed a 5-minute protocol for testing the hearing of live, beached whales and dolphins. Such a procedure would not only help build a richer data set regarding the hearing sensitivity of wild cetaceans, but would also be helpful in determining whether the animal is capable of being released back into the sea. In addition, since in fact most live beached cetaceans end up dying soon after in recuperation facilities, auditory testing at the time of recovery can often be followed up with post-mortem examinations of auditory systems, and so help to shed light on the patterns and physiological causes of hearing loss when it is encountered. [Michel André, Eric Deloy, Eduard Degollada, Josep-Maria Alonso, Joaquin

del Rio, Mike van der Schaar, Joan V. Castell, and Maria Morell. Identifying cetacean hearing impairment at stranding sites. Aquatic Mammals 2007, 33(1), 100-109.]

As an example of moderate noise having a clear effect on behavior, the 2007 IWC Scientific Committee report included mention of a 2006 D-tag study in which a beaked whale cut short a deep foraging dive when a boat passed overhead. The animal experienced broad-band received levels of just 135dB re 1uPa, and mid-frequency levels of 117db re 1uPa. Most regulatory standards consider anything less than 180db to be acceptable sound exposure, since sounds below this level do not tend to cause physical injury. A key finding was that the ship noise included frequency components close to beaked whale clicks; **the 15dB increase in ambient noise levels caused by the ship would decrease the maximum effective range of echolocation by more than half, and the maximum range of foraging coordination vocalizations between whales by a factor of five.** [Aguilar Soto, Johnson, Madsen, Tyack, Bocconcelli, Baorsani. Does intense ship noise disrupt foraging in deep-diving Cuvier's beaked whales (Ziphius cavirostris)? MARINE MAMMAL SCIENCE, 22(3): 690–699 (July 2006)]

Shipping Noise and Vessel Quieting

In May 2007, NOAA hosted a symposium focused on "ship quieting" technologies, as part of an ongoing program that began in 2004 with an international symposium on shipping noise and marine mammals. Among the findings presented:

- The **noise from a passing large ship dominates the soundscape** across a range of low frequencies from 10Hz to 1kHz **for ten to twenty miles around**; as the ship moves further away, the higher end of these frequency components fade out, **leaving a "hump" of ship noise at 50-60Hz that remains until the ship moves beyond about a hundred miles distant**. The aggregated noise of such distant ships creates low frequency background noise that is "prevalent over broad expanses of the world's ocean," only at times overshadowed by nearby storms (wind and rain sounds). [Dr. Roy Gaul, Effects of distant shipping on ambient noise in the open ocean]
- The Acoustical Society of America has begun work on a new professional standard for "Underwater Noise Measurement of Ships," designed to be a shared method for evaluating vessel-radiated noise in water.
- Propeller cavitation (bubbles formed by turning propeller) is a major source of vessel noise. A presentation by Neal Brown examined improved propeller designs, and also **urged that vessels be required to slow down in biologically important areas**, based on data that suggests that cutting cavitation noise will reduce a 10km-wide zone of severe noise impacts to 2km wide. [Neal Brown]

Propeller cavitation Image courtesy: http://www.rcboataholic.com/hardware/prop.htm

- Harbour porpoise populations are increasing in waters around The Netherlands; it is not known whether they are responding to improved conditions or being pushed south due to degrading conditions in Northern European seas (including intensive oil and gas development and shipping noise). Over a hundred porpoises died via beaching in the first four months of 2007; is shipping part of the problem? By measuring radiated ship noise and factoring in the hearing sensitivity of porpoises, it

appears that porpoises will begin to feel discomfort at about 350m, and can hear the ships at up to 3km. In busy coastal waters, ships are often closer than 3km apart, leaving no room to move away from the noise. [Willem Verboom]

For further information on the NOAA vessel quieting symposium:
A pdf of abstracts; offers a good sense of the topics covered:
http://www.nmfs.noaa.gov/pr/pdfs/acoustics/symposium_abstracts.pdf
The full papers are also available, from this page:
http://www.nmfs.noaa.gov/pr/acoustics/presentations.htm
Symposium website:
http://www.nmfs.noaa.gov/pr/acoustics/shipnoise.htm

In 2008, the **US delegation to the International Maritime Organization is planning to submit an information paper on Vessel Quieting**; the next steps at the IMO would be consideration of the issue by the Ship Design and Construction Subcommittee. Kathy Metcalf of the United States Chamber of Shipping, a trade organization, says "This will go a long way in informing the maritime world that this is an emerging issue and bring global expertise into seeing what can be done."

Smaller boats: recreational and whale watching

The **Marine Mammal Commission** report, Marine Mammals and Noise: A Sound Approach to Research and Management, pointedly noted that whale-watching and recreational boating are both largely unregulated, despite the likelihood that marine mammals are directly impacted by their noise.

Likewise, the **International Whaling Commission** (IWC) continued a multi-year effort to better understand the effects of whale watching boat noise on marine mammals.

Numerous studies were discussed at the 2007 IWC meeting that looked at responses to whalewatching in several different locations. Responses included reduction of time spent foraging, increased disturbance with greater numbers of boats, short-range avoidance, and traveling away from the area. Those especially interested in such effects are urged to read the full Whalewatching subcommittee report. **[DOWNLOAD (pdf): http://www.iwcoffice.org/_documents/sci_com/SCRepFiles2007/Annex M Final.pdf]**

At this summer's IWC meeting, **a special workshop will address whalewatching**, with a goal of designing a consistently applied global research methodology. Ad-hoc studies over the past twenty years have raised significant concerns, but are difficult to compare.

A study of recreational boat noise in the intracoastal waterway of North Carolina showed that **less than half as many dolphins were observed on weekends, when boat noise was most intense**. Noise in the range of 5-25kHz, the primary range of dolphin social whistles, was of particular concern. The researchers note that "mean hourly received levels (RLs) exceeded 116 dB nearly every day surveyed, indicating bottlenose dolphins could be at risk for noise exposure on a daily basis. High mean RLs were often recorded over consecutive hours, making high sound levels the rule in this area during the summer, not the exception." Further, they note that since bottlenose dolphins feed mainly on soniferous fishes (fish that make noise), and that fish vocalizations are primarily below 1kHz, the range most dominated by boat sounds, dolphins may well find it more difficult to hear and find prey.
[Haviland-Howell, Frankel, Powel, Bocconcelli, Herman, Sayigh. Recreational boating traffic: A chronic source of anthropogenic noise in Wilmington, North Carolina Intracoastal Waterway. J. Acoust. Soc. Am. 122 (1), July 2007, p.151-160.]

Active Sonars

Legal and Regulatory Developments

The past two years have seen several important legal and regulatory dramas play out involving training mission planning in Hawaii, North Carolina, and California; in addition, the Department of Defense exempted sonar missions from Marine Mammal Protection Act requirements (and thus MMPA-based legal challenges) while Environmental Impact Statements are being written. **Several court orders in recent years have imposed additional safety measures on mid-frequency active sonar training, and the Navy seems concerned that these so-far isolated rulings will shape what are likely to be more wide-reaching legal decisions on the standards the Navy proposes in the EISs they are working on**. Thus, the Navy has continued to push back against additional measures. The Navy argues that current operating procedures offer sufficient safety, pointing at the very low number of incidents with whales, while environmental advocates insist that "common sense" safety measures can provide more assurance of protection while still allowing training to proceed.

In addition to moving forward with EIS preparation on several individual training ranges where they have been active for years, **the Navy is actively planning a new Undersea Warfare Training Range (USWTR) off the US South Atlantic coast**. In September, the Navy announced plans to revise the Draft EIS for the USWTR; as they write the new DEIS, the Navy is working with NOAA Fisheries (formerly NMFS) to implement a better way to analyze the behavioral impacts of noise on marine mammals. NOAA's formal comments on the DEIS had been unusually direct in its critique of the Navy's previous approach, which was based on a simple maximum sound level criterion; over the past couple of years, a "dose response" approach has been developed, which accounts for the impact of lower sound levels occurring over longer periods of time.

For more details on these interweaving story lines, including news summaries of all key events, and relatively brief lay audience descriptions of the differing technologies and current deployment of LFAS and MFAS, see the ***AEI Special Report: Active Sonars***: **http://www.AcousticEcology.org/sractivesonars.html**

Noise-related strandings

No new stranding events occurred in 2007 with any solid evidence of being related to sonar transmissions, though some concerns have been raised in the Persian Gulf, where it appears that cetacean strandings are on the rise, especially along the Iranian coast.

While most cetacean strandings are not noise related in any direct way (being the result of infections or other health stressors), it has become clear that some strandings have taken place after exposure to mid-frequency active sonar transmissions. Much research is underway to determine what, exactly, is causing these strandings. The focus of many studies is better understanding of the normal dive patterns of beaked whales (the family most often found stranded after sonar exposure), and how these normal behaviors may be disrupted by the sounds of mid-frequency sonar, causing physiological injuries that kill the animals.

Some of the most interesting new work is taking a close look at ways that sonar transmissions might be causing beaked whales to alter the ways that they recover from their extraordinarily deep foraging dives, which take them down to a depth of 1000 to 1500 meters and last over an hour. Some sonar-exposed animals that strand have

tissue and organ damage caused by expanding nitrogen bubbles that looks much like the injuries caused by "the bends" in human divers (generally called Decompression Sickness, or DCS; a new term, "gas and fat embolic syndrome" has been coined to describe specific tissue pathologies observed in some beached cetaceans). Early speculation focused on the possibility that, like human divers who suffer the bends, these injuries may have been caused by animals surfacing more quickly than usual. However, marine mammals have a special trick that should protect them from this: as they dive beyond about 70 meters, lungs and other tissues are compressed, removing nitrogen bubbles that could diffuse into the bloodstream and cause such injuries while resurfacing. Still, the extreme depth of sperm and beaked whale dives continues to suggest to some researchers that rapid ascents bear further scrutiny.

Over the past two years, though, researchers have begun to look more closely at a series of near-surface dives that beaked whales perform between their deep foraging forays. This near-surface activity can last up to an hour between foraging dives, and includes both very near-surface dives (to no more than 50m) and resting time at the surface, as well as "bounce" dives down to 500m.

A Cuvier's beaked whale breaches off the coast of Italy.
Credit: Natacha Aguilar Soto/University of La Laguna, Spain with permit from the Canary Islands Government.

While some have speculated that interrupting the recovery period near the surface might cause the whales to dive deep while retaining more nitrogen than is healthy (see **AEI Recent Research lay summaries for 2006** [http://www.acousticecology.org/scienceresearch2006.html]), more recent physiological modeling suggests that nitrogen buildup could occur during the near-surface phase, especially if it is extended beyond the normal duration. [Walter, M.X. Simmer, Peter L. Tyack. Repetitive shallow dives pose decompression risk in deep-diving beaked whales. Marine Mammal Science, Volume 23 Issue 4 Page 888-925, October 2007.] **One current theory is that mid-frequency sonar transmission may be heard as a predator (there is some similarity to orca hunting pulses), thus triggering a predator-response pattern of dives that take them deep enough to avoid orcas and maximize horizontal travel distance, but not deep enough to pressurize tissues and protect them from DCS.** This would be safe for short periods, such as might ensue when avoiding orcas, but if extended for longer periods, due to continued presence of sonar transmissions, nitrogen buildup could occur and cause DCS. The relatively long distances between deep-water feeding areas where sonar exposure presumably begins and shorelines where beaked whales beach also suggests the possibility that beaked whales fleeing a perceived predator

simply run out of room and end up ashore, especially if struggling with DCS injuries. (see **AEI Recent Research summaries for 2007** for more detail: **http://www.AcousticEcology.org/scienceresearch2007.html**) This has led to the suggestion that injury related to mid-frequency sonar exposure might be avoided by keeping sonar transmission periods short enough to not cause nitrogen build up should the whales begin to flee near the surface.

In an effort to better prepare "first responders" to assess possible noise-related physiological injuries in stranded marine mammals (such as tissue lesions and ear damage), NOAA held a workshop in late 2006 on **New Techniques to Diagnose Possible Noise-Related Standings**. In 2007, the workshop participants produced two valuable documents and a great reading list.

- A very cogent short narrative overview of the mechanisms by which noise may cause physiological damage or behavioral responses that lead to tissue damage and stranding: **https://reefshark.nmfs.noaa.gov/pr/mm/sysadmin/nrsworkshop/terms.cfm**
- A detailed final report that includes three protocols for use in responding to stranded cetaceans, aimed at enhancing the ability to differentiate acoustic trauma from other causes of death, including specific protocols for the removal and preservation of ear tissues and diagnostic imaging of marine mammals. **https://reefshark.nmfs.noaa.gov/pr/mm/sysadmin/nrsworkshop/docs/protocols.pdf**
- A reading list of downloadable documents, including key research reports on beaked whale necropsies, gas-bubble lesions, and many other related topics: **https://reefshark.nmfs.noaa.gov/pr/mm/sysadmin/nrsworkshop/background.cfm**

New research this year related to sonar:

LFA sonar uses frequencies (100-500Hz) that many fish can detect, often the range of most sensitive hearing. Trout (standing in for their close relatives the salmon) exposed to LFAS sounds while in cages had some notable hearing loss (17-24db) that lasted for at least 48 hours, the end of the experiment (though researchers note a fair degree of variability, with some study groups showing little hearing loss and such shifts varying widely at different frequencies). The fish did not incur injuries as severe as those previously seen in similar studies using sounds of pile-driving or seismic surveys, both of which caused seemingly permanent injury to ear hair cells. [Popper, Halvorsen, Kane, Miller, Smith, Song, Stein, Wysocki. The effects of high-intensity, low-frequency active sonar on rainbow trout. J. Acoust. Soc. Am. 122 1 , July 2007. p. 623-635.]

First recordings were made of a new kind of beaked whale call, made near the surface and in the same frequency ranges as mid-frequency sonars. These calls are lower in frequency than the better-known beaked whale foraging echolocation clicks, having a tonal sweep not unlike dolphin calls, and observed here between mother/calf pairs. This provides better opportunities for identifying beaked whales in passive listening systems used in conjunction with Naval operations, as well as confirming that beaked whales hear and use the same frequencies used by MFA Sonar. [Rankin, Barlow. Sounds recorded in the presence of Blainville's beaked whales, Mesoplodon densirostris, near Hawai'i. J. Acoust. Soc. Am. 122 (1) , July 2007, p. 42-45.]

LFAS expanded deployment

In August, the **US Navy received the necessary permits to allow re-deployment of low frequency active sonar on its ships in most of the world's oceans**. Since 2003, LFAS deployment had been limited to a remote area of the West Pacific, in accordance with a court-ordered settlement of a challenge to its previous Environmental Impact Statement. This year, the Navy released a Supplemental EIS that aimed to address the shortcomings cited by the court; still, a challenge to the new EIS and permits is possible by the same plaintiffs (NRDC). Two US Navy ships are outfitted with LFAS now, with plans to expand that to four by 2011. In practice, **LFAS transmitters will be operating for roughly 36 hours per month per vessel**; these sounds are designed to locate quiet submarines at ranges of several hundred miles, and can be audible for over a thousand miles from their source. These low-frequency sounds are far below the range used by smaller whales and dolphins, but may have some overlap with the sounds of large whales.

AN/AQS-22 Airborne Low-Frequency Sonar (ALFS) deployed from a US Navy MH-60R multi-mission helicopter (US Navy photo)

Operating rules for LFAS will require sound levels to be less than 180dB (re 1 uPa(rms)) within 22km (12 nautical miles) of coastlines, and within 1km of several designated areas of special biological importance. Interestingly, levels must be kept significantly lower (145dB) within known recreational or commercial dive sites.

In addition, a safety zone around the ships will be monitored so that marine mammals at sea are exposed to no more than 180dB. The Navy will use NMFS-approved visual observers, passive listening devices, and active high-frequency "fish-finder" sonar to watch for nearby whales.

Navy site detailing approved range and restrictions
http://www.surtass-lfa-eis.com/Measures/index.htm

Record of Decision approving expanded deployment
http://www.surtass-lfa-eis.com/docs/FSEIS_ROD__8-15-07.pdf

2007 Supplemental EIS, Executive Summary
http://www.surtass-lfa-eis.com/docs/SEISEXECSUM.pdf

Seismic Surveys

Evidence continues to mount that seismic surveys are audible over long distances, increasing the concern that surveys may mask the faint calls of distant communication or navigation calls of large whales.

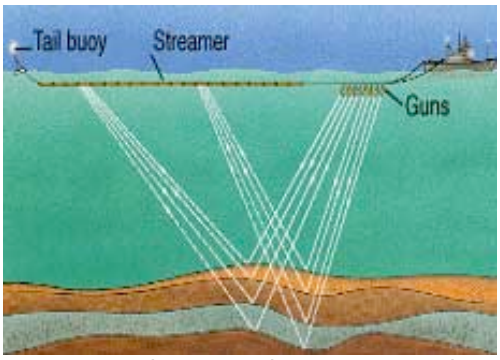

Image: Fisheries and Oceans Canada
Arrays of airguns are towed behind survey vessels as they explore for oil and gas reservoirs, releasing coordinated bursts of pressurized air every 10-20 seconds; hydrophones on cables up to 3km long record the echoes of these high-intensity sounds as they bounce back from sub-seafloor geological formations. Most surveys last for several weeks, with the survey vessel passing back and forth in a fairly limited area of 100-500 square kilomteters. There are hundreds of oil and gas surveys per year worldwide, along with a handful of academic surveys

Little public or advocacy attention was directed toward seismic surveys in 2007, but those closer to the situation are certainly increasing their efforts to understand the scope of these sounds and their impacts. Biologists are analyzing the data contained in various autonomous recorders throughout the world, assessing them for the presence of airgun noise. Meanwhile, **an oil and gas industry-funded research program funded several new studies during 2007**, its first full year, with initial publications and reports due to be released during 2008, including a review of existing data on sound produced by the industry, and a report on a workshop held in 2007 on technology innovations that could reduce the noise produced by oil exploration and production. (see Joint Industry Program Sound and Marine Life website: **http://www.soundandmarinelife.org**)

Academic research using seismic surveys will pick up again this year, thanks to the launch of the *R/V Langseth*, which replaces the *R/V Ewing* as Lamont-Doherty Earth Observatory's flagship vessel. LDEO, Columbia University's highly-regarded earth science program, provides the platform for a wide range of National Science Foundation-funded geology research, and their field measurements of airgun sound propagation has contributed to the recognition that safety zones must often be larger than previously considered necessary, especially in shallow waters. During the last couple years of the Ewing's operational life, LDEO surveys became the target of significant public scrutiny, perhaps in part because of the relatively greater opportunities for public input, compared to industrial surveys. The Langseth's first survey of 2008 will take place off both the Pacific and Caribbean coasts of Panama in February and March.
(**http://www.ldeo.columbia.edu/res/fac/oma/langseth/index.html**)

Industry exploration continues apace, as well, with roughly a hundred seismic survey vessels plying coastlines worldwide. While West Africa, South America, the North Sea, Gulf of Mexico, and Indonesia remain hot spots for new exploration, public and

scientific concern has centered largely on the North Slope of Alaska and Australia. A survey approved off Victoria, Australia this winter (summer locally) has raised local and scientific concern that blue whales may avoid a key feeding ground due to the noise, and native and environmental organizations in Alaska continue to challenge increasing exploration in the Beaufort and Chuckchi Seas.

New Research on Airgun Noise

A new paper presented to the International Whaling Commission Scientific Committee shared data collected over large portions of the Southern Ocean between Australia and Antarctica, which indicated that **surveys taking place over 2500km away, off the coast of Tasmania, were audible in the Southern Ocean**. Another set of acoustic receivers off eastern Antarctica regularly recorded repeated low-frequency pulses similar to seismic shots, but final analysis to confirm that the source was airguns remains to be completed. [SC/59/SH5. Gedamke, J., Gales, N., Hildebrand, J. and Wiggins, S. Seasonal occurrence of low frequency whale vocalisations across eastern Antarctic and southern Australian waters, February 2004 to February 2007. 9pp.]

In addition, preliminary results from a study using data from 22 autonomous recorders deployed in the Chuckchi Sea during the summer of 2006 suggest that airgun noise is often audible along the northwest coast of Alaska, up to 120km offshore. This data compilation project is ongoing and may be more formally published or presented this year.

Airguns firing Photo: Farallones Marine Sanctuary Association

A report from Scotland looked at a 1998 study of fin and sei whale distributions in two areas: **in the relatively quiet Faroe-Shetland Channel, the largest numbers of whales ever seen there were counted, while west of the Hebrides, where seismic survey activity was four times higher, no whales were observed.** Changes in fin and sei whale migration patterns, and changes in abundance of prey could not be ruled out as causes; nevertheless, the authors expressed concern about increasing oil and gas development, including seismic surveys, in areas important to cetaceans. [Macleod, K., M.P. Simmonds and E. Murray. 2006. Abundance of fin (Balaenoptera physalus) and sei whales (B. borealis) amid oil and gas exploration and development off northwest Scotland. J. Cetacean Res. Manage. 8(3): 247-254. Stone, C.J and M.L. Tasker. 2006. The effects of seismic airguns on cetaceans in UK waters. J. Cetacean Res. Manage. 8(3): 247-254.]

Odds and Ends of Special Interest

Recreational scuba divers may become a new force championing quiet seas
In the US, there are about a million active recreational divers, with several hundred thousand more being certified each year (many do not become active divers). Advances in air tank technology are creating much quieter equipment: Closed Circuit Rebreathers emit virtually no bubbles near the divers' head. This both reduces the noise impact of scuba divers on fish (reducing the range at which their noise is audible by fish from over 200m to less than 20m), but also allows divers to hear the underwater acoustic environment for the first time. [presentation at NOAA vessel quieting symposium by Steven H. Sellers, President, American Academy of Underwater Sciences, and Director of Diving and Underwater Safety, East Carolina University]

Current population monitoring methods are unlikely to notice even precipitous declines
An open secret among biologists is that we do not have a solid count of most marine mammal species' global or regional populations. More disturbing is that current population survey techniques do not offer a very good chance of noticing population declines, even precipitous declines (50% over 15 years, the official level at which a stock is considered "depleted"). A new study used statistical analysis to determine that the percentage of precipitous declines that would **not be detected as declines** by current survey techniques and frequency was 72% for large whales, 90% for beaked whales, and 78% for dolphins/porpoises. At the heart of the problem is that the current standard of statistical certainty used to determine management criteria is set very high, so that while we miss many stock declines, there is only a 5% chance that we might "over-protect" a stock (i.e., perceive a decline when none actually is occurring). That is, **the standard is weighted to assure that we do not over-react to phantom stock changes, leaving us in a position of almost always under-responding to real stock declines**. The researchers suggest several practical approaches to rectifying this situation, including more diligent focus on assessing the stocks of indicator species, designing techniques aimed at seeing trends rather than absolute numbers, and, most significantly, loosening the decision-criteria so that we equally over- and under-protect. This would allow us to correctly perceive 80% of stock declines (failing to notice and respond to declines 20% of the time), while correctly identifying 80% of healthy stocks (thus perhaps implementing unnecessary stock protection policies 20% of the time). [Barbara L. Taylor, Melissa Martinez, Tim Gerrodette, Jay Barlow, Yvana N. Hrovat. Lessons from monitoring trends in abundance of marine mammals. Marine Mammal Science, 23(1): 157–175 (January 2007)]

Habituation to noise may be overstated
An important paper presented to the IWC Scientific Committee in 2007 suggested that what is generally termed "habituation" (wherein responses to a noise source decrease over time, so that we assume that whole communities animals are "getting used to it" and going on with their normal activities), is more often an observation of differences in tolerance between individual animals in a population. That is, individuals with low tolerance leave or move further away, while those with higher tolerance are observed remaining nearby, so that the fact that many animals are not be able to tolerate the sound is generally missed. The Scientific Committee "welcomed this new perspective, and further emphasized that the absence of response does not necessarily mean an absence of impacts, i.e., there may be unseen population level impacts due to stress." [SC/59/WW2. Bejder, L., Samuels, A., Whitehead, A. and Allen, S. An ethological framework for defining habituation, sensitisation and tolerance to anthropogenic stimuli. 12pp.]

Marine Conservation on Paper

A commentary by Giovanni Bearzi, Tethys Research Institute, Milano, Italy

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(edits, emphasis added)
Sadly, conservation-oriented research and action plans and the call for more workshops, meetings, studies, and reports risk adding up to nothing more than "conservation on paper." **Scientists and conservationists spend much of their life frantically writing documents and recommendations, but little or nothing happens in the real world.** Is paper, and then more paper, all that governments really want from us? When will the time for action come? **Are we allowing ourselves to be lost in the illusion of doing conservation while in fact we are mostly just producing conservation tools that are rarely used?**

There is always a good reason to call for another report, a more detailed investigation, a new meeting. These are fine initiatives, but only if they lead, eventually, to concrete steps that improve the status of the animals. Unfortunately, this is a rare outcome. Even sanctuaries and protected areas sometimes function as an excuse, as a way of allowing officials to say, "Look, we just created a new protected area—what more do you want?" But the questions we should all be asking are: Did the cetaceans living in the protected area get any benefits from the new designation? Have conservation measures actually been implemented? Has the environment improved? or Is this just one more paper park, a high-profile gesture that will be used to justify another decade of studies, meetings, and inaction?
….
There will always be something left undone. Some evidence may be missing, and a declining trend in a graph may be due to environmental shifts rather than human impact. In response, one does what is needed, but finds—again—the case is not made. Perhaps this time the human impact is clear, but the socioeconomic aspects were not considered or the needs of all the stakeholders were not taken into account.

This seems to be the game today. We are charged with documenting the problem, communicating it to the public and the institutions, proposing mitigation measures, and approaching the right managers and institutions to convince them that they should do something. But the bottom line is that few decision makers are willing to face the big challenge of **affecting people to protect the environment**. ….

This is not to say that government people are all uncaring. Governments have many faces, as do human societies. Some managers, particularly in environmental departments, are highly committed and do care. Still, they must confront the much stronger powers of the fishery, commerce, or defense departments because they are concerned primarily with economic and political issues….

In addition to solid science and well-conceived action plans, **what is desperately needed to promote marine conservation is public pressure**. Politicians and governments are highly concerned with signals coming from their electorate. If the public were more demanding and managed to raise their collective voice in calling for serious efforts on the part of governments to preserve marine ecosystems and animal populations, regardless of the social and economic costs, there would be a **greater chance for the action plans to be removed from the drawer and put back on the agenda**.

What to Listen for in 2008

Active Sonars to Enter New Regulatory Phase

2008 could be the year that clarifies the future operating conditions for Naval active sonar. For the past several years, Federal court challenges have forced the Navy to implement additional safety measures to specific training operations in a piecemeal fashion. In response to such legal pressure, centered on the claim that mid-frequency active sonar operations cause impacts significant enough to require more comprehensive examination, in 2006 the Navy initiated a broad program to do Environmental Impact Statements for all operations, including active sonar use, in long-established and new Training Ranges in US waters.

With these first-ever EISs for mid-frequency sonar operations, the Navy is aiming to make the scientific case for a set of operating procedures that will withstand legal challenge. The first EIS to be released will be for the Hawaii Range Complex, due to be completed early in 2008. Draft EISs will be released for 5 other ranges, with the possibility of finalizing some of those this year as well.

Of course, there is a good chance that environmental watchdogs will press hard for the sorts of additional safety measures that, so far, the Navy has considered unnecessary. The NRDC, the Navy's most consistent challenger, has called for "common sense" measures that they claim will not impinge the military's readiness bit will make a difference in whale safety, such as larger buffer zones, special care (lower power or halts in training) in times of poor visibility or acoustically-enhanced ocean conditions, and avoidance of areas with high concentrations of marine mammals, especially beaked whales. In previous court challenges, the NRDC has either convinced judges to impose such measures (as is currently occurring in California waters), or to demand the Navy and NRDC work out mutually agreeable solutions in settlements (as occurred in Hawaii in 2006 and in relation to Low-Frequency Active Sonar in 2003). **Therefore, the Hawaii Range Complex final EIS, due out in early 2008, will give a sense of how far the Navy will move in its formal proposals**. Any challenges to that EIS will surely shape the ones to follow. The Southern California Range Complex Draft EIS is the next scheduled release, to be followed by Drafts of EISs for four Atlantic Coast Ranges. For more information on the specific Ranges, see AEI's Special Report on Active Sonars: **http://www.AcousticEcology.org/sractivesonars.html**

In addition, the newly expanded LFAS deployment may also be challenged; some observers do not agree that the revised EIS on which current worldwide deployment is based has addressed the legal issues that forced the Navy to constrain training missions to a small portion of the west Pacific from 2003-7.

Shipping

The US delegation to the International Maritime Organization is preparing to initiate discussion at the IMO on the needs and potentials for ship quieting technologies.

This spring's International Whaling Commission meeting will include a workshop on whale watching on May 30 and 31, which may initiate the first global assessment of the impacts of whale watching operations on the targets of their attention.

Seismic Surveys

The main thing to keep an eye on here is further studies looking at long-range propagation of airgun noise, or the sound-footprint in specific areas (i.e. how much of the time airguns are audible). These sorts of papers tend to appear at the IWC Scientific Committee meeting, taking place this year in Chile during June. IWC 2008 Meeting website: **[http://iwcoffice.org/meetings/meeting2008.htm]**

In addition, keep an eye on the Joint Industry Program research papers, which are due to begin rolling out this year as well. See the seismic survey section of this report for more details.

Links for more detailed information

The Acoustic Ecology Institute is the only comprehensive national clearinghouse for information on sound and the environment. We focus largely on ocean noise and public lands management, and also have smaller programs dedicated to education and the interface between science and sound art. AEI's website offers a wide spectrum of reliable information, including links to advocates on all sides of key issues. Our online Special Reports are designed to offer a solid "ten minute version" on key issues, with links to source material and more in-depth information.

To receive occasional news updates (3 or 4 per year), contact cummings@acousticecology.org

http://www.AcousticEcology.org/scienceresearch2007.html
Lay summaries of recent field research Studies from 2007 are summarized; similar pages available for 2004-6.

http://www.AcousticEcology.org/news.html
AEI News Digest The latest updates on continuing issues, new research, and other sound-related news; includes links to original press reports

http://www.AcousticEcology.org/ocean.html
AEI's main Ocean Issues portal Links to government and NGO ocean noise reports, ocean acoustics primer, and overviews of key issues

http://www.AcousticEcology.org/sractivesonars.html
AEI Special Report on naval active sonars Includes information on the differences between systems, news updates, effects on wildlife, and links to government and NGO resources.

http://www.AcousticEcology.org/sr_mmc.html
AEI Special Report on the Marine Mammal Commission's Advisory Committee on Acoustic Impacts on Marine Mammals Including a summary of themes stressed by each "caucus group" in their final statements, and apparent sticking points blocking consensus.

http://www.AcousticEcology.org/specialreports.html
AEI Special Reports index Links to Special Reports on all topics, including snowmobile and OHV management, noise effects of coalbed methane development, and ocean topics, including annual summaries of IWC science reports regarding noise.

http://www.AcousticEcology.org/
AEI's Home Page Coverage of ocean, wildlands, urban issues, as well as recent science and comprehensive resource links (research programs, advocacy organizations, government agencies).