mammals, there have been TTS measurements in a number of species, including bottlenose dolphins and belugas. These studies compare hearing thresholds before and after subjects are exposed to intense sounds. The results are analogous to data from terrestrial mammals, where TTS depends on the exposure frequency, sound pressure, duration, and temporal pattern. This talk reviews the major findings related to the growth of and recovery from TTS in bottlenose dolphins and belugas and discusses the application of these data to acoustic exposure guidelines.

3:20

1pAB8. Noise-induced permanent threshold shift in a harbor seal. David Kastak (UCSC Institute of Marine Sciences, Long Marine Lab - University of California, 100 Shaffer Road, Santa Cruz, CA 95060, USA, kastak@ucsc.edu), Jason Mulsow (UCSC Institute of Marine Sciences, Long Marine Lab - University of California, 100 Shaffer Road, Santa Cruz, CA 95060, USA, jmulsow@ucsc.edu), Asila Ghoul (UCSC Institute of Marine Sciences, Long Marine Lab - University of California, 100 Shaffer Road, Santa Cruz, CA 95060, USA, asila@ucsc.edu), Colleen Reichmuth (UCSC Institute of Marine Sciences, Long Marine Lab - University of California, 100 Shaffer Road, Santa Cruz, CA 95060, USA, coll@ucsc.edu)

Investigation of auditory temporary threshold shift (TTS) in marine mammals has provided a means of predicting the harmful effects of underwater anthropogenic noise. As complete recovery of hearing is requisite in these studies, they have been considered appropriate in light of subject availability and ethical considerations. In our psychophysical studies of TTS in pinnipeds, we have employed methods designed to safely titrate from sound levels of noise inducing no TTS to levels of significant but completely recoverable hearing loss. In the present study, these methods were used with a harbor seal (*Phoca vitulina*) exposed to an underwater 4.1 kHz pure tone fatiguing stimulus. Sound levels and durations were gradually increased to a maximum received sound pressure of 184 dB re 1 μPa with a duration of 60 s (SEL=202 dB re 1 $\mu Pa^2 s$). Upon the second exposure to this fatiguing stimulus, an initial threshold shift in excess of 50 dB was estimated at a test frequency of 5.8 kHz, a half-octave above the fatiguing tone. Recovery from this unexpectedly large shift occurred at a rate of -10 dB per log(min), with an apparently permanent threshold shift of 7 to 10 dB evident after more than two months following exposure.

3:40-4:00 Break

4:00

1pAB9. Anthropogenic sounds - Potential effects on fish. Arthur Popper (Dept. of Biology, University of Maryland, College Park, MD 20742, USA, apopper@umd.edu), Svein Løkkeborg (Fish Capture Division, Institute of Marine Research, P.O. Box 1870, Nordnes N-5817 Bergen, Norway, svein.loekkeborg@imr.no), Robert McCauley (Curtin University, Centre for Marine Science and Technology, GPO Box U 1987, 6845 Perth, Australia, r.mccauley@cmst.curtin.edu.au)

There is concern that human-generated sounds may have deleterious effects on fish. This paper will review some of what is currently known about these effects, and consider the questions that have to be answered before developing models to enable ″prediction″ of sound effects on particular fish species. A major restriction is that there are few peer-reviewed data on effects of anthropogenic sources on fish. Extrapolation from these results is further confounded since experiments differ in many ways, each of which may alter the resultant impact on fish. For example, studies vary in sounds types tested (e.g., pile driving vs. ship noise), signal parameters (intensity, number of repetitions), species used, fish age, etc. Moreover, a singularly important issue is that while many of the issues and impact mechanisms are potentially amenable to experimental lab study, the ultimate questions regarding the effects of sound on fish behavior need to field based and require long-term observations where behaviour of wild fish is not constrained. Only by observing fish in the wild will we ultimately understand if, and how, anthropogenic sounds impact fish both during exposure and, more importantly, for extended periods after the termination of the sound.

4:20

1pAB10. Characterizing the relative contributions of large vessels to total ocean noise fields: a case study using the Gerry E. Studds Stellwagen Bank National Marine Sanctuary. Leila T. Hatch (US NOAA, Stellwagen Bank National Marine Sanctuary, 175 Edward Foster Road, Scituate, MA 02066, USA, leila.hatch@noaa.gov), Christopher W. Clark (Cornell University Laboratory of Ornithology, Bioacoustics Research Program, 159 Sapsucker Woods Road, Ithaca, NY 14850, USA, cwc2@cornell.edu), Sofie Van Parijs (US NOAA, Northeast Fisheries Science Center, 166 Water Street, Woods Hole, MA 02543, USA, sofie.vanparijs@noaa.gov), Richard Merrick (US NOAA, Northeast Fisheries Science Center, 166 Water Street, Woods Hole, MA 02543, USA, richard.merrick@noaa.gov), Dimitri Ponirakis (Cornell University Laboratory of Ornithology, Bioacoustics Research Program, 159 Sapsucker Woods Road, Ithaca, NY 14850, USA, dwp22@cornell.edu), Kurt Schwehr (University of New Hampshire, Center for Coastal and Ocean Mapping Joint Hydrographic Center, 24 Colovos Road, Durham, NH 03824, USA, kurt@ccom.unh.edu), Michael A. Thompson (US NOAA, Stellwagen Bank National Marine Sanctuary, 175 Edward Foster Road, Scituate, MA 02066, USA, michael.a.thompson@noaa.gov), David Wiley (US NOAA, Stellwagen Bank National Marine Sanctuary, 175 Edward Foster Road, Scituate, MA 02066, USA, david.wiley@noaa.gov)

Understanding and mitigating the effects of underwater noise on marine species requires substantial information regarding acoustic contributions from shipping. In 2006, we used the U.S. Coast Guard's Automatic Identification System (AIS) to describe patterns of large commercial ship traffic within a U.S. National Marine Sanctuary. AIS data were combined with low-frequency acoustic data from an array of nine-ten autonomous recording units deployed throughout 2006. Analysis of received sound levels (10-1000 Hz, root-mean squared decibels re 1 μPascal ± standard error) averaged 119.5 ± 0.3 at high traffic locations. High traffic locations experienced double the acoustic power of less trafficked locations for the majority of the time period analyzed. Average source level estimates (71-141 Hz, root-mean squared decibels re 1 μPascal ± standard error) for individual vessels ranged from 158 ± 2 (research vessel) to 186 ± 2 (oil tanker). Tankers were estimated to contribute two times more acoustic power to the region annually than cargo ships, and over one