An Overview of Ocean Ambient Noise

John Hildebrand
Scripps Institution of Oceanography
University of California San Diego

Ocean Noise in Canada’s Pacific
Vancouver, BC

January 31, 2012
Ambient Noise in the Ocean

Hildebrand 2009, following Wenz 1962
Primary Anthropogenic Noise Sources

- Commercial Vessel
  - 180 dB re uPa @ 1m
  - 10-100 Hz
  - Continuous Sound

- ASW Sonar
  - 235 dB re uPa @ 1m
  - 2-8 kHz
  - 2 second Ping

- Seismic Exploration
  - 250 dB re uPa @ 1m
  - 10-100 Hz
  - 40 msec Ping
Ship Noise Sources and Spectral Band

- Propeller Blade Tones
- Turbines
- Diesels
- Auxiliary
- Motor Slots
- Turbulence
- Singing Propellers
- Turbine Blades
- Gears
- Hull Pressure

Frequency (Hz)

(Source: Donald Ross)
Ship Noise Sources: Propellers

Dominant Source of Radiated Underwater Noise for Surface Vessels

- Cavitation Blade Tonals - Blade Passage Frequency and Harmonics
- Propeller Cavitation Noise - Broad Spectral Range
Sources of Ship Noise: Cavitation

Cavitation: rupture of a liquid or a liquid-solid contact

- Reduction of efficiency of hydraulic machinery
- Erosion produced by collapsing cavities
Acoustic Signatures of Ship Types

- Container ship: ~23kts
- Vehicle Carrier: ~17kts
- Bulk Carrier: ~15kts
Ambient Noise at High Frequency

**Whale Watch Vessel - Olympas**
Yacht with 49 passengers
3 Engines
Shipping Lanes from HITS Model

(Courtesy of Richard Heitmeyer - NRL)
West Coast Shipping Ports

Prince Rupert
Vancouver
Seattle
Portland
Oakland
Los Angeles
Long Beach
Propagation of Noise

Shallow Water Continental Shelf

Down-slope Conversion of Sound to Deep Water
A Tale of Two Sites: San Nicolas and Eel Point
Long Term Trends in Ship Noise

San Nicolas SOSUS Array – 1964 (Blue), 2004 (Red)

Shipping noise has increased ~3 dB/decade
North Pacific Ambient Noise at 40 Hz has increased ~3 dB/decade
Shallow Water Noise Including Local Ships
Shallow Water / Deep Water Noise Comparison

San Nicolas

Eel Point
No Local Ships - NO CHANGE in 4 Decades

Shipping noise has increased \(~1\ dB/\text{decade}\)
A Tale of Two Sites: San Nicolas and Eel Point
Monitoring Ship Traffic with AIS

Color indicates direction of travel
Ambient Noise in the Santa Barbara Channel

Frequency (kHz)

Time (Local)

Dolphin Echolocation

Dolphin Whistles

Ships
Changes in Ship Traffic

Economic Downturn

July 2009 Air Quality Rule

http://www.calculatedriskblog.com
Change in Shipping Lanes 2008 vs 2009

McKenna et al. submitted
Trends in Ambient in the Santa Barbara Channel
Deepwater Horizon – Acoustic Monitoring

MC HARP
Deployed May 11

HARP 8 nMiles from DH

Deepwater Horizon
Oil Spill Began April 22
Well Capped July 15
NOAA Oil Trajectory Forecast

Forecast location for oil on 3-July-10 at 1200 CDT

Mississippi Canyon 252

Incident Location

Trajectory
- Uncertainty
- Light
- Medium
- Heavy
- Potential beached oil

this scale bar shows the meaning of the distribution terms at the current time

Extracted from http://response.restoration.noaa.gov/
Oil Index for MC HARP Site

Daily estimate of oil within 3 km radius of HARP
Noise Index for MC HARP Site

Hourly estimate of ambient noise at MC HARP
400 Hz used as proxy for nearby ships
Ambient Noise – Airguns and Echosounders

![Graph showing ambient noise and frequency over time.]
Global Offshore Seismic Exploration

Data for 1994 - 2005
Airgun Noise in Arctic

From Roth et al. 2012
Airgun Noise in Arctic

From Roth et al. 2012
Mid-Frequency Active Sonar

Frequency (Hz)  Time (seconds)
2000  0
3500  3

2/7/07
West Coast Naval Training Ranges
SOCAL Range Complex – Annual Received Sonar

Total Number of Pings = 55740

Number of Pings

Received Level [dB p-p re 1 uPa]
Research Needs for Ocean Noise

- Characterize Noise Source Output
- Determine Locations of Sources
- Model Propagation from Source Area
- Assess Long-Term Trends in Noise
- Develop New Quieting Technologies