

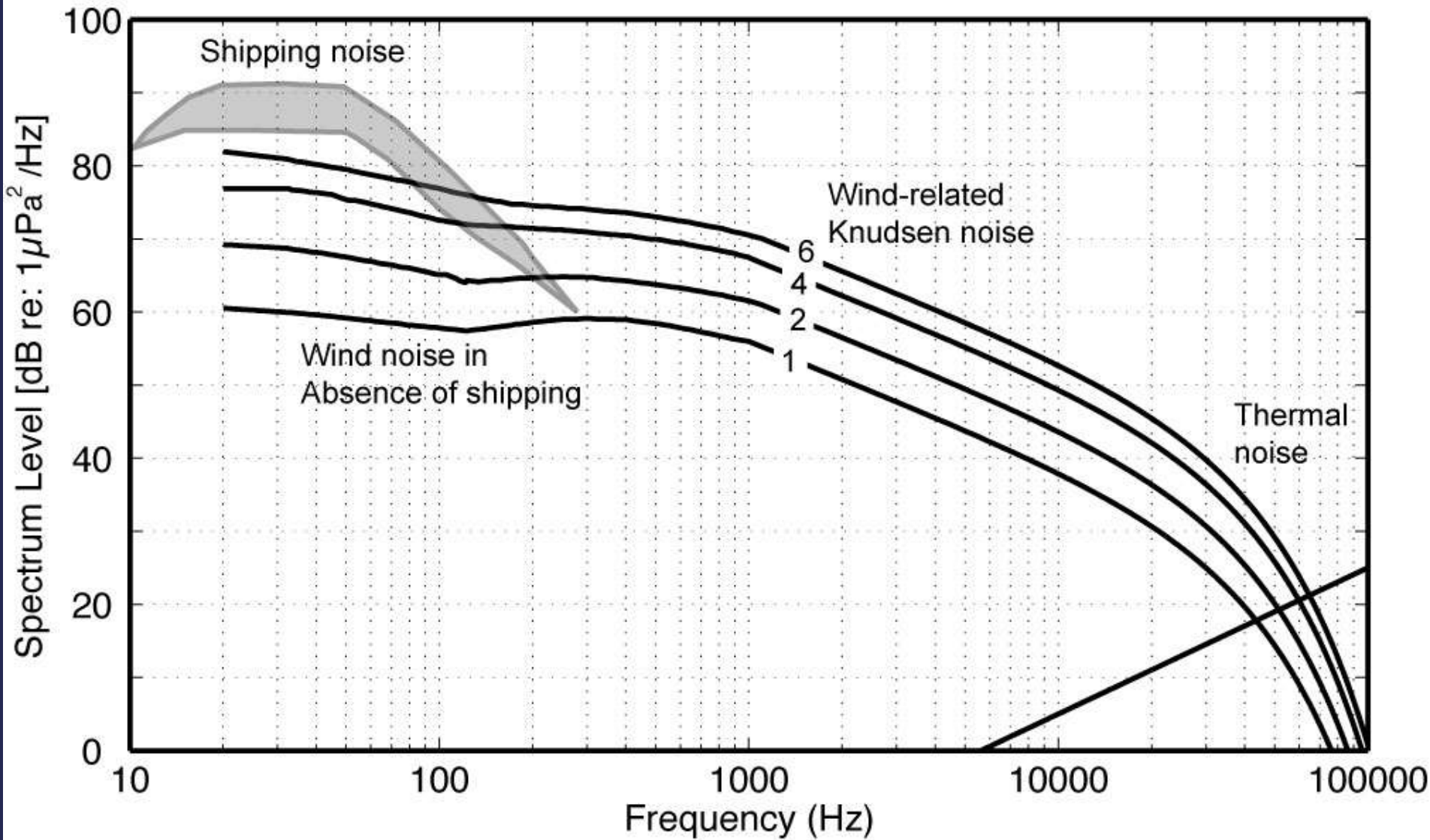
An Overview of Ocean Ambient Noise

**John Hildebrand
Scripps Institution of Oceanography
University of California San Diego**

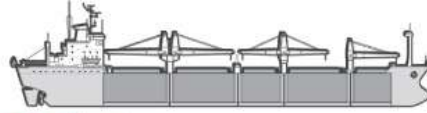
**Ocean Noise in Canada's Pacific
Vancouver, BC**

January 31, 2012

Ambient Noise in the Ocean



Primary Anthropogenic Noise Sources



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

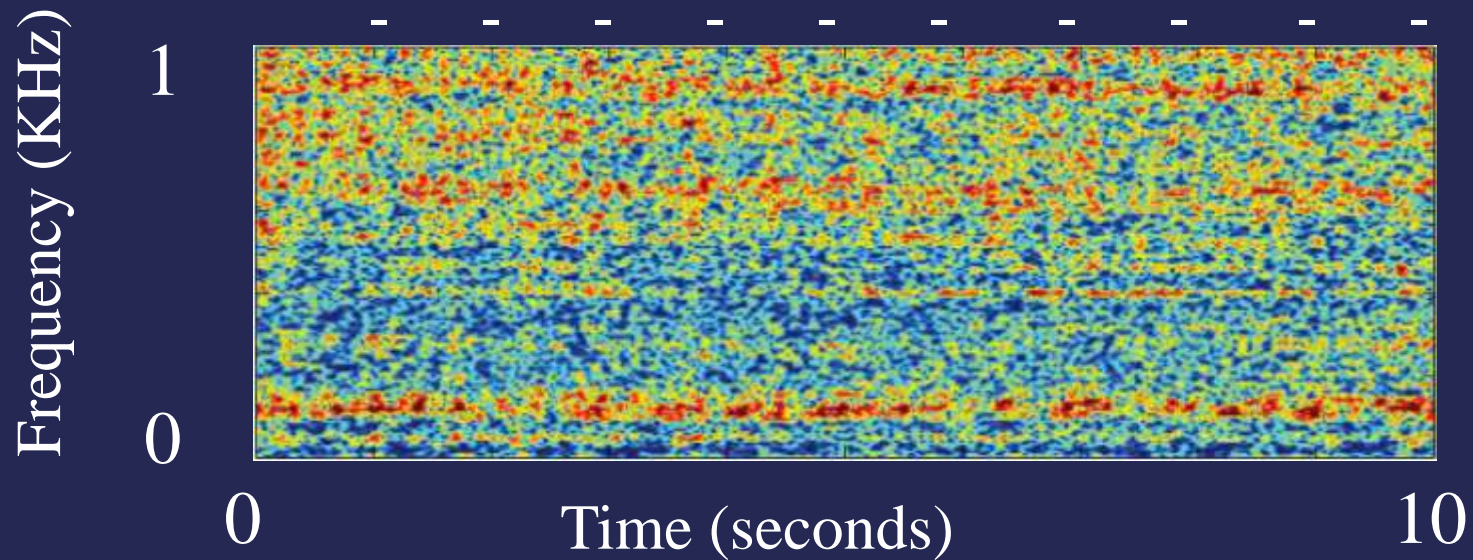


ASW Sonar
235 dB re uPa @ 1m
2-8 kHz
2 second Ping

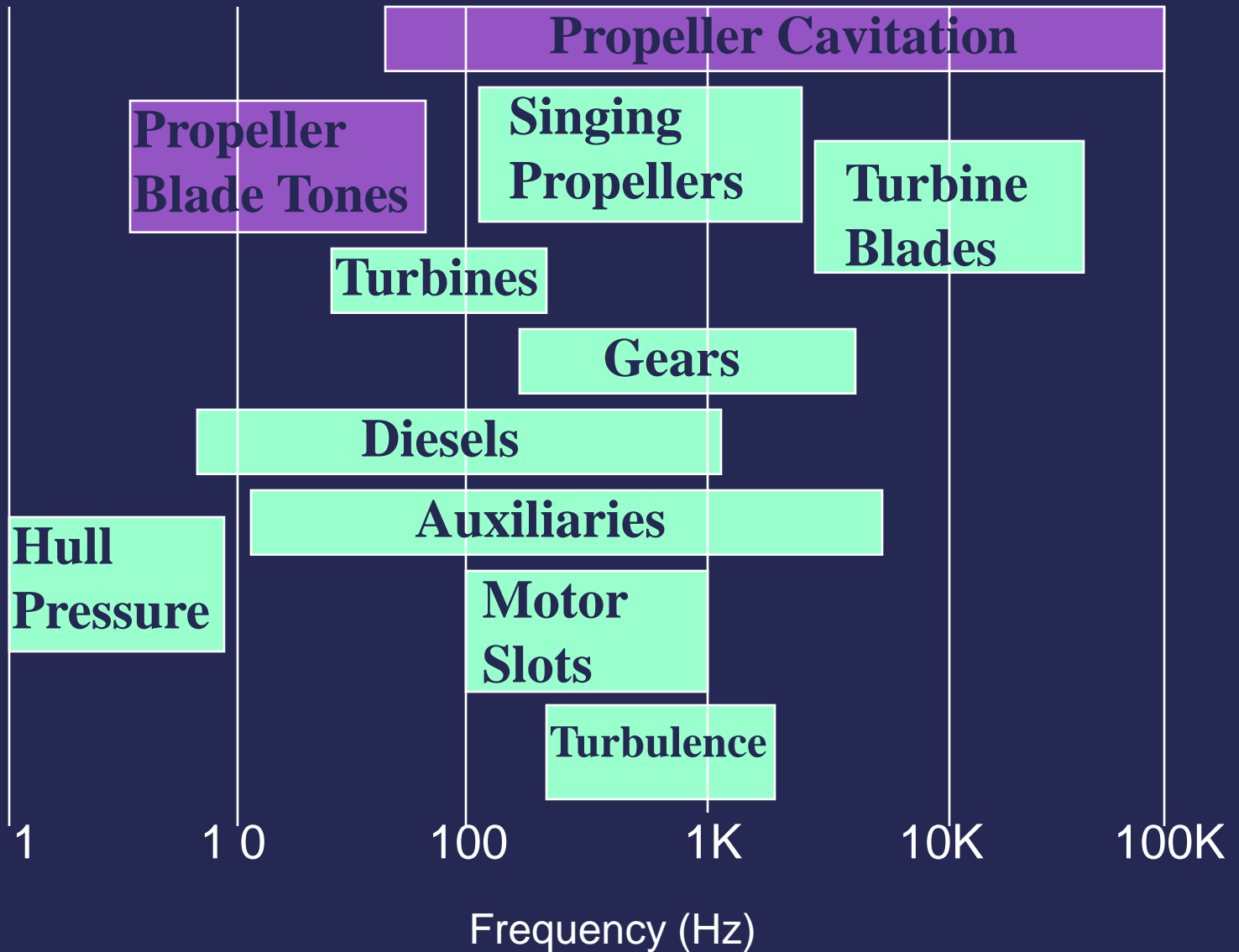


Seismic Exploration
250 dB re uPa @ 1m
10-100 Hz
40 msec Ping

Ocean Noise from Shipping



Ship Noise Sources and Spectral Band



(Source: Donald Ross)

Ship Noise Sources: Propellers

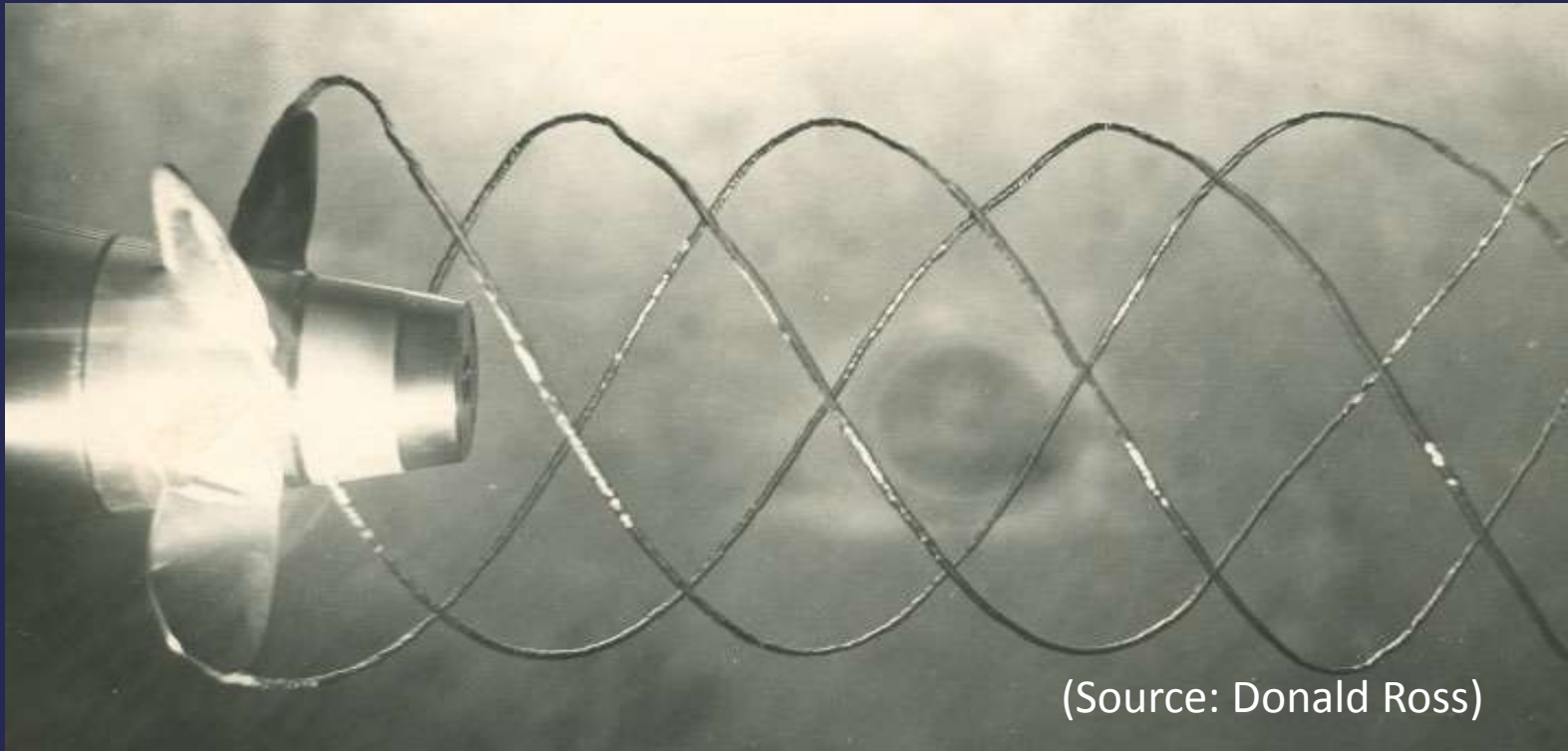
Dominant Source of Radiated Underwater Noise for Surface Vessels

- Cavitation Blade Tonals - Blade Passage Frequency and Harmonics
- Propeller Cavitation Noise - Broad Spectral Range



Sources of Ship Noise: Cavitation

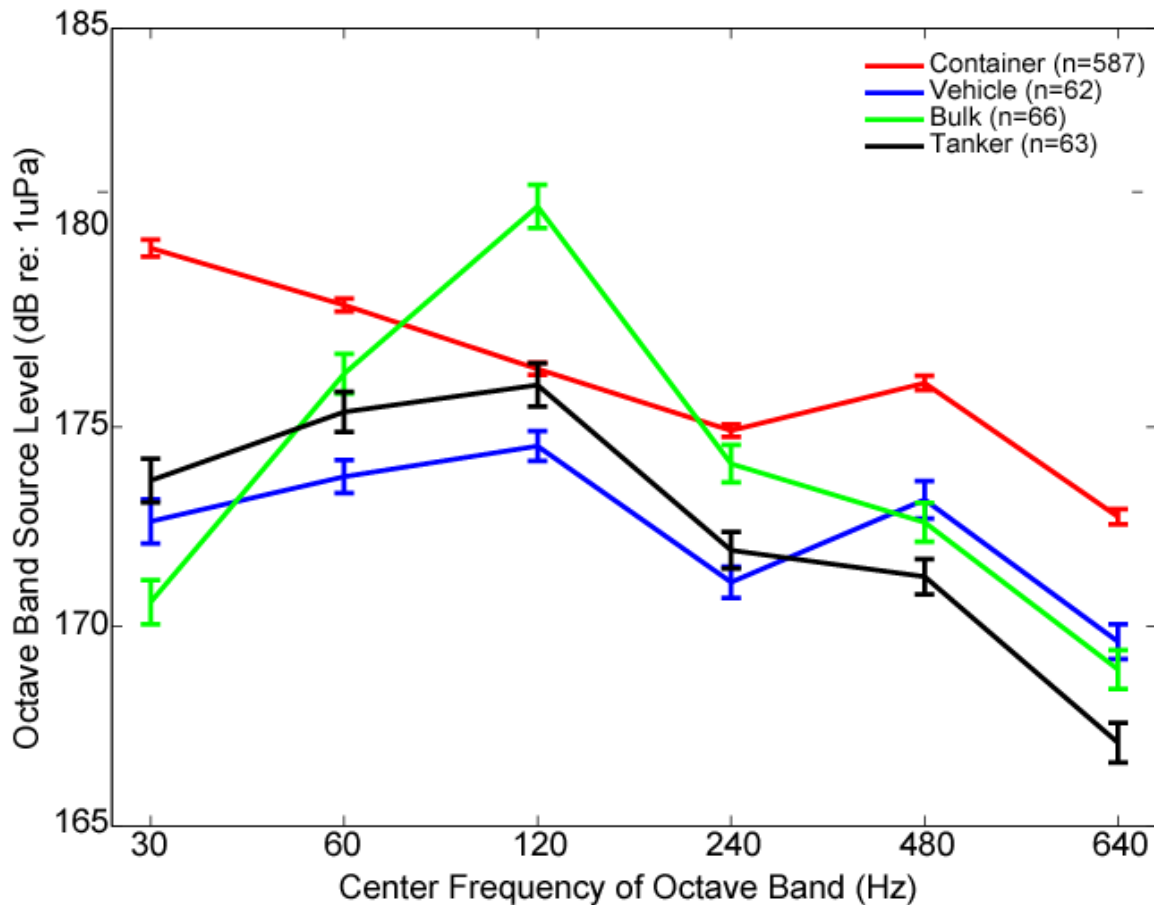
Cavitation: rupture of a liquid or a liquid-solid contact



(Source: Donald Ross)

- Reduction of efficiency of hydraulic machinery
- Erosion produced by collapsing cavities

Acoustic Signatures of Ship Types



Ambient Noise at High Frequency

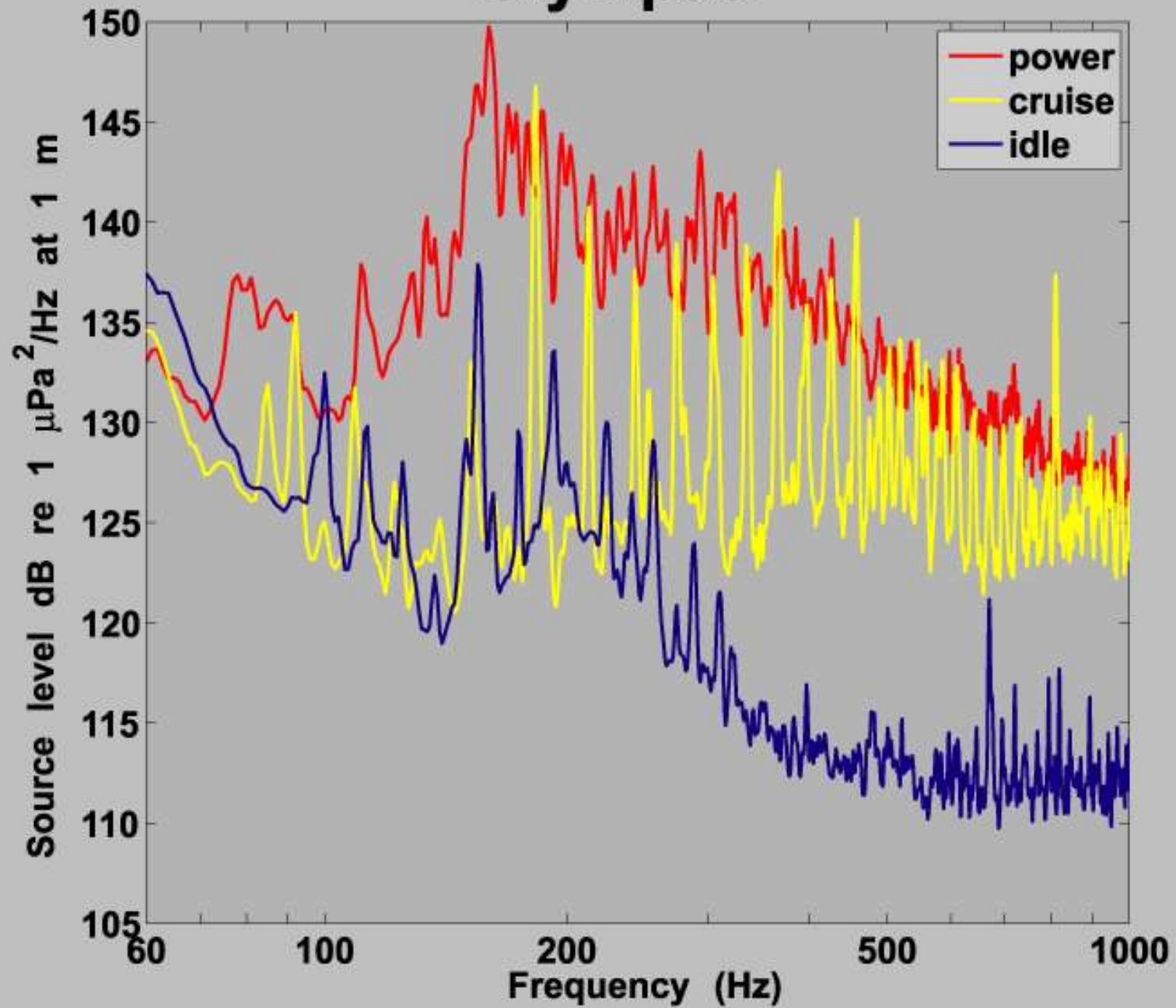


Whale Watch Vessel - Olympas

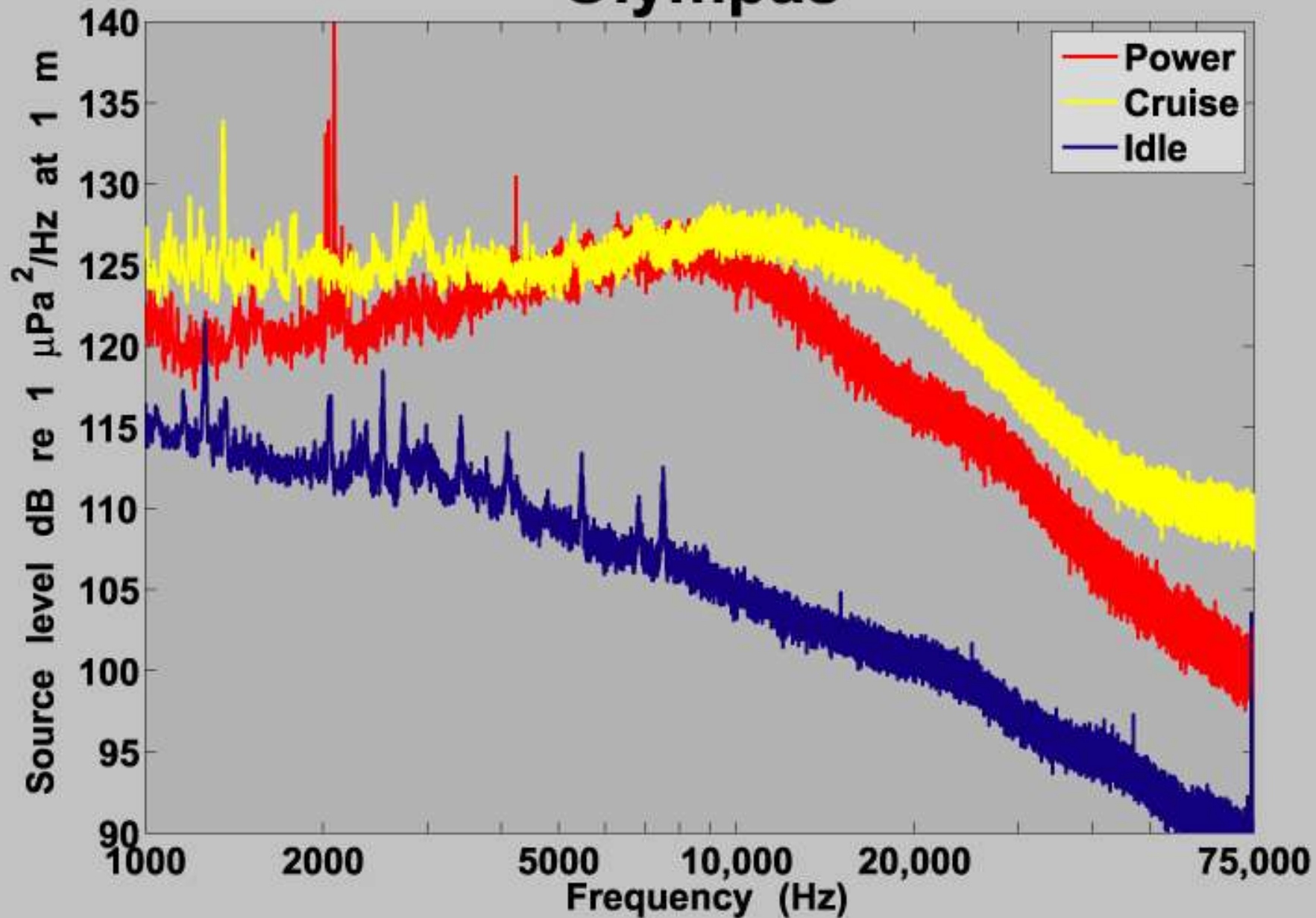
Yacht with 49 passengers

3 Engines

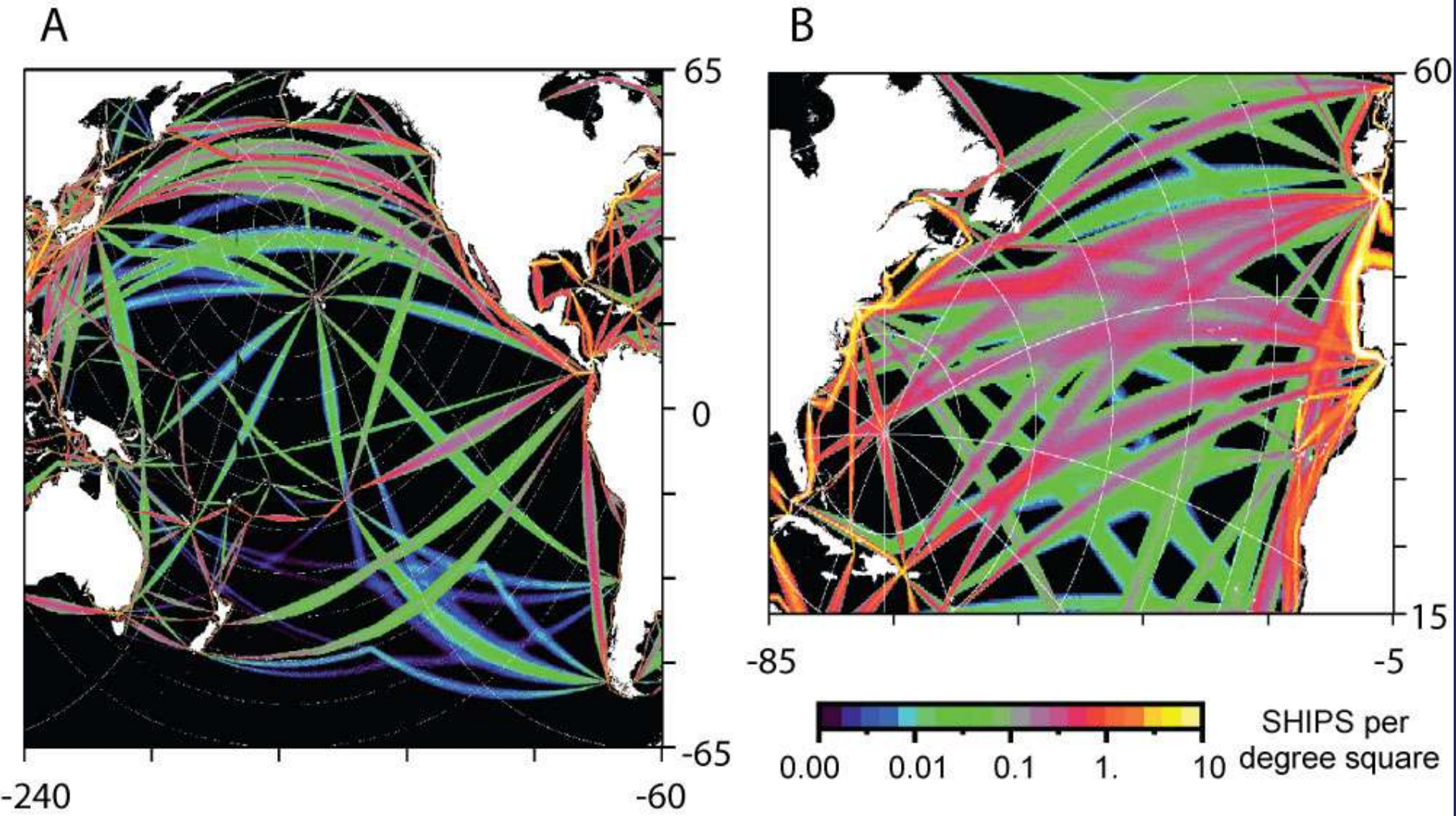
Olympas



Olympas



Shipping Lanes from HITS Model



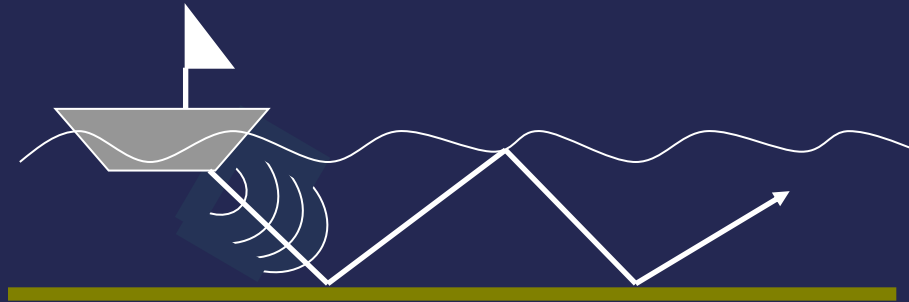
(Courtesy of Richard Heitmeyer - NRL)

West Coast Shipping Ports

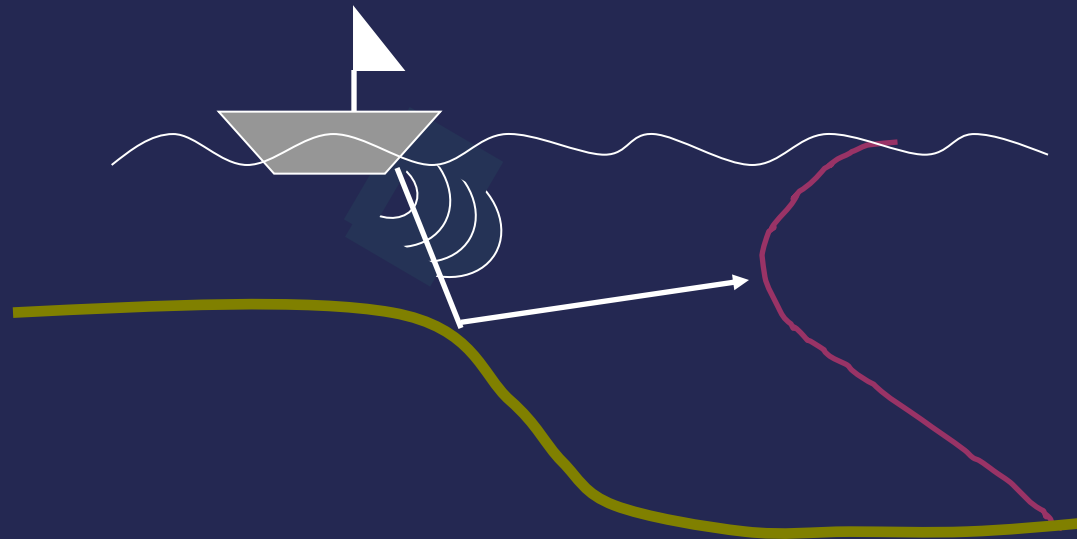


Propagation of Noise

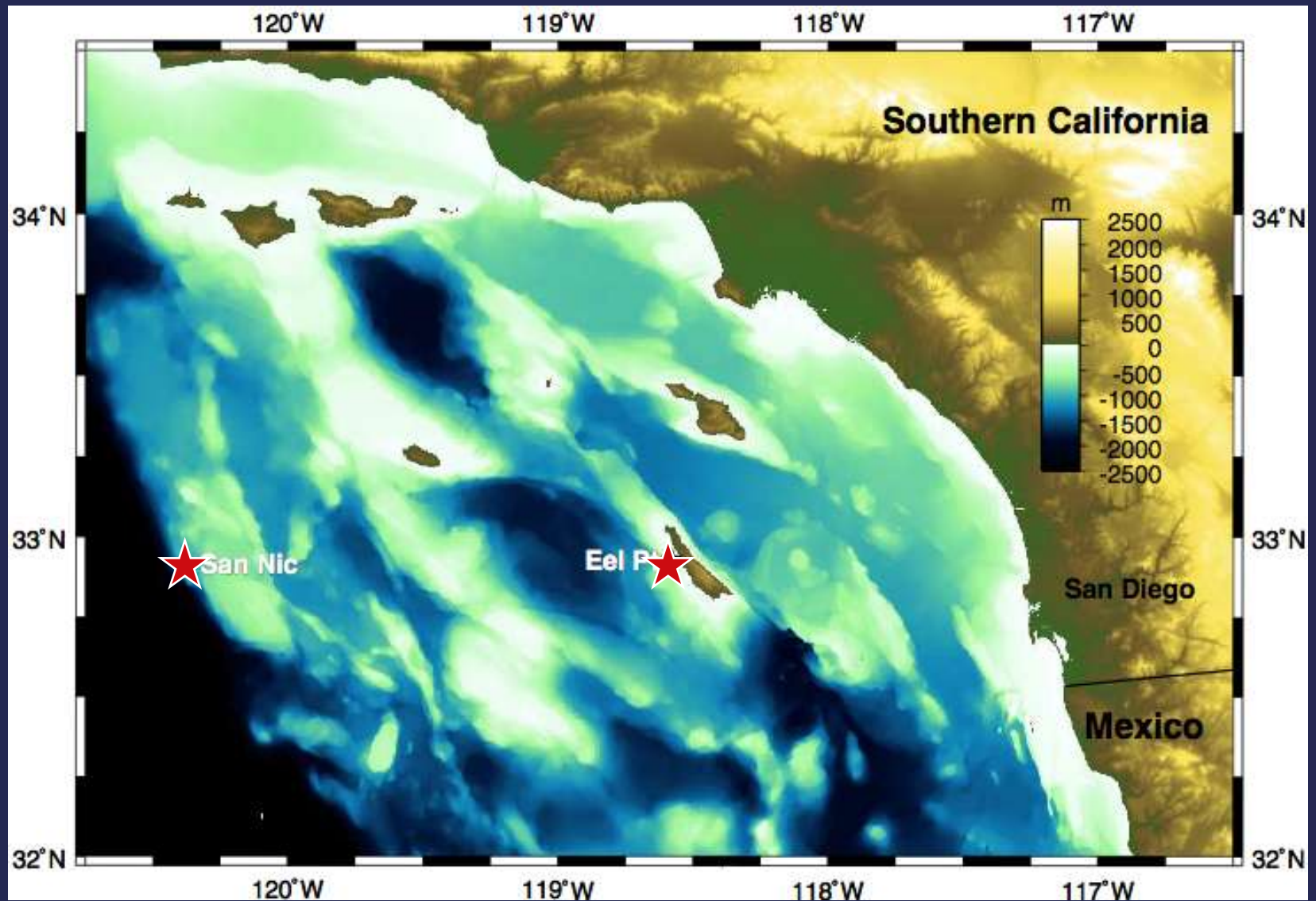
Shallow Water Continental Shelf



Down-slope Conversion of Sound to Deep Water

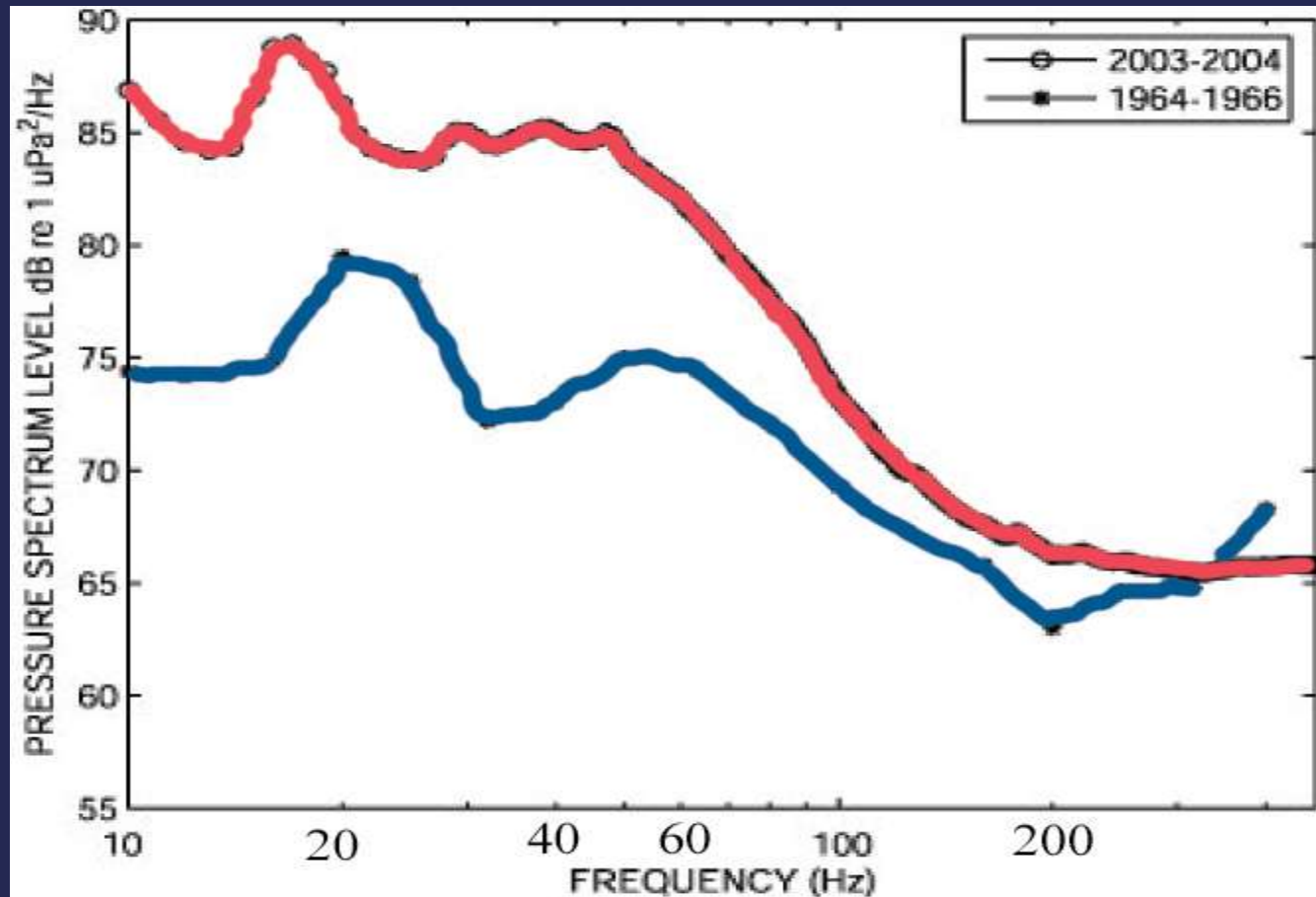


A Tale of Two Sites: San Nicolas and Eel Point



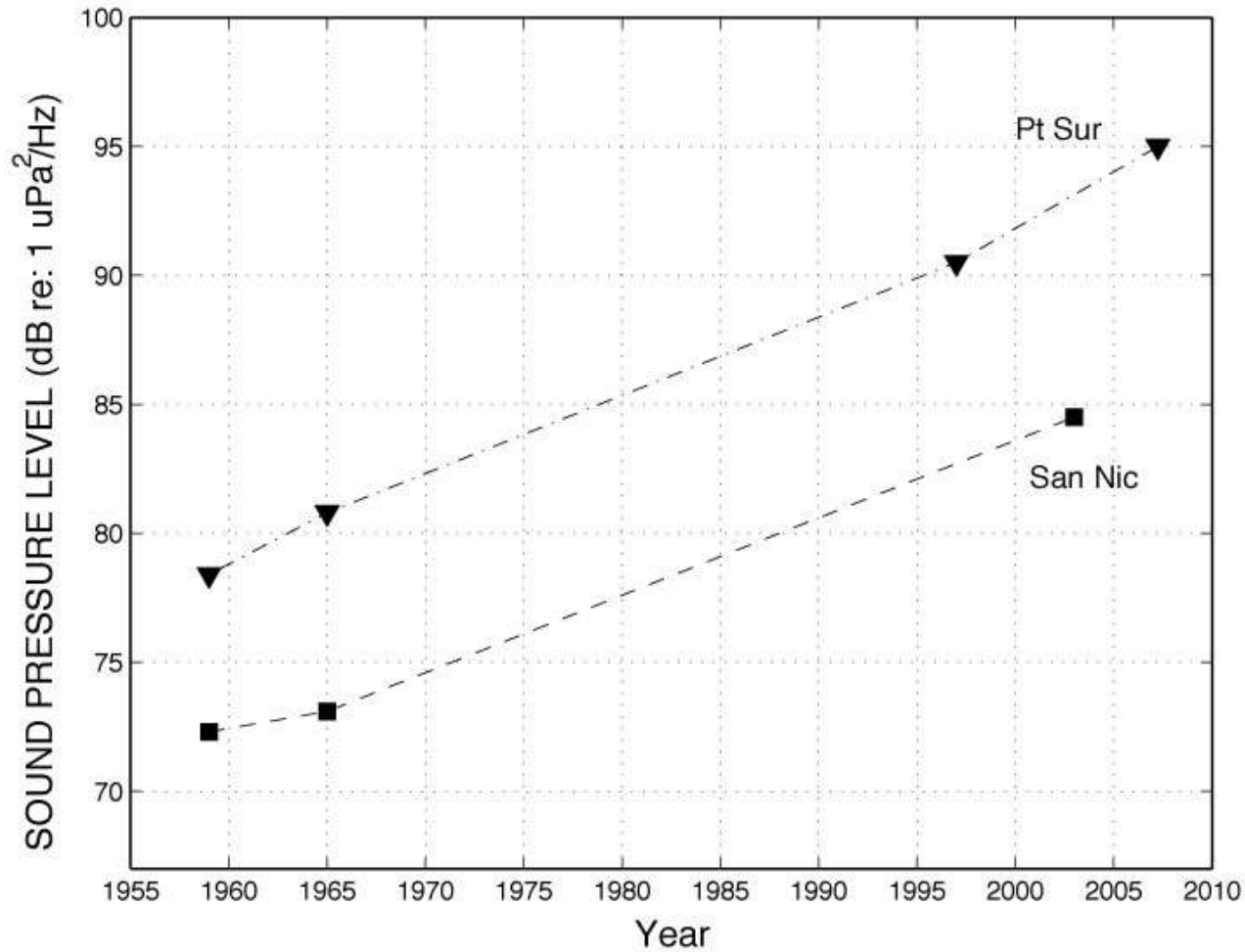
Long Term Trends in Ship Noise

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



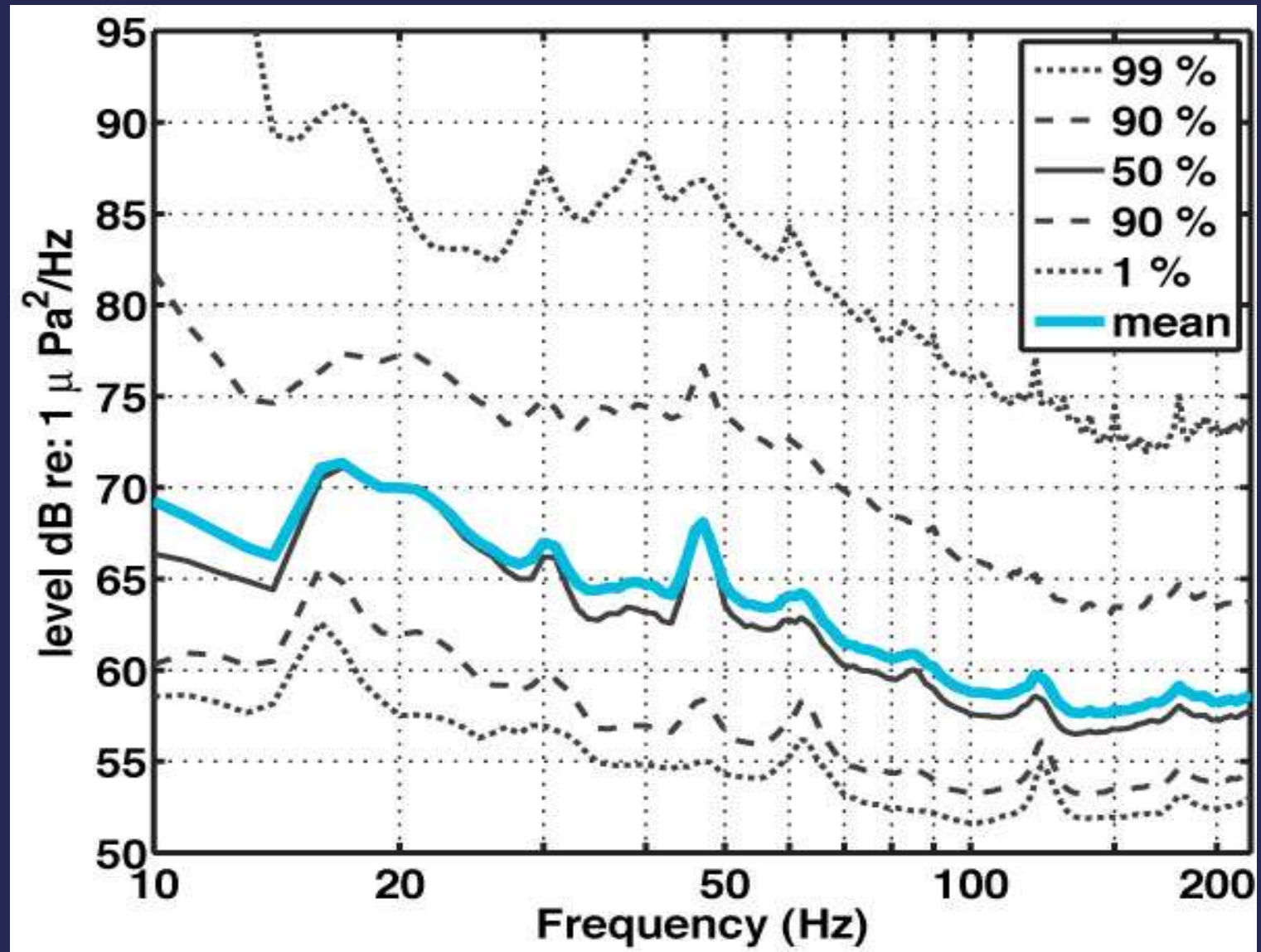
Shipping noise has increased ~ 3 dB/decade

Ambient Noise – Long Term Trends

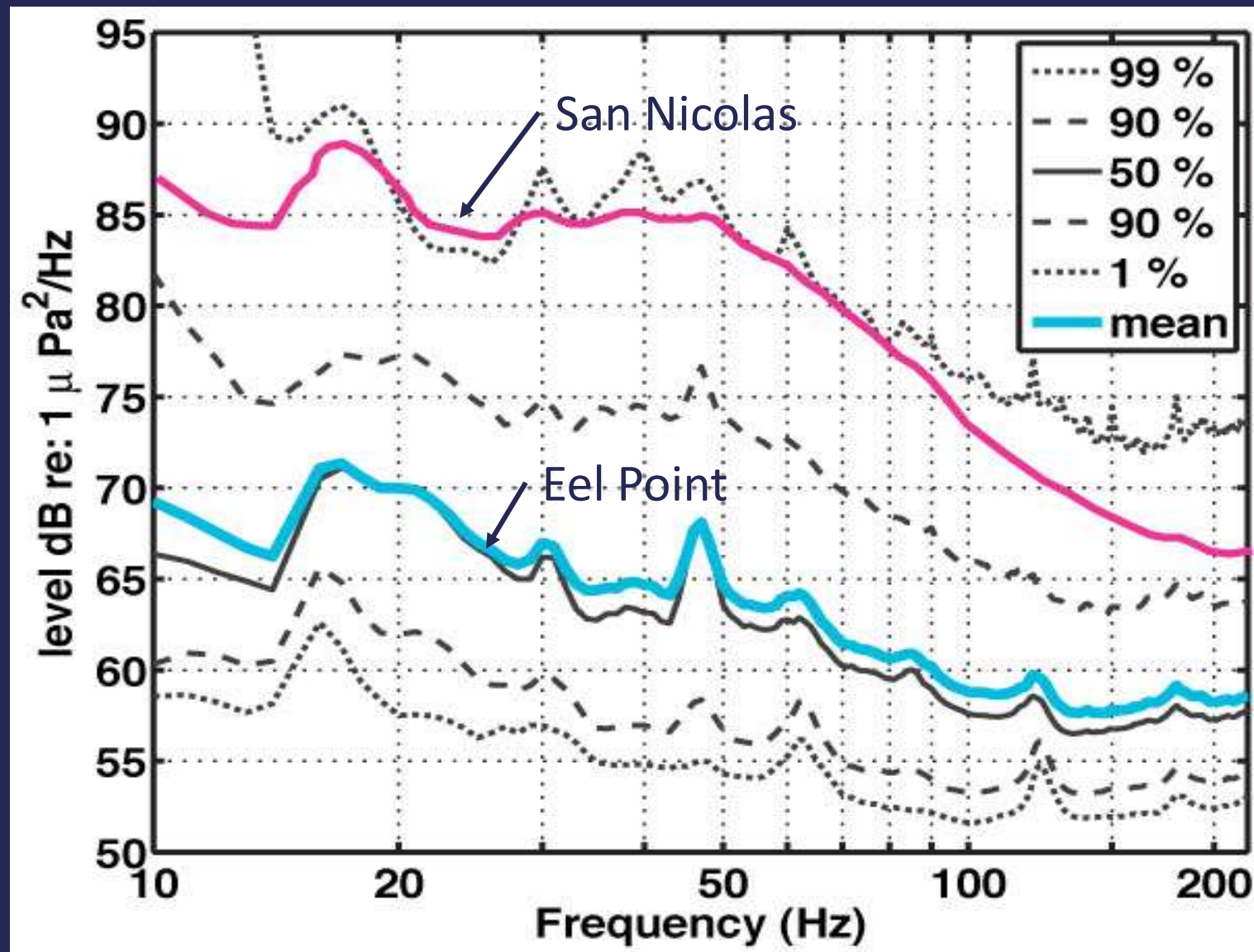


North Pacific Ambient Noise at 40 Hz has increased ~3 dB/decade

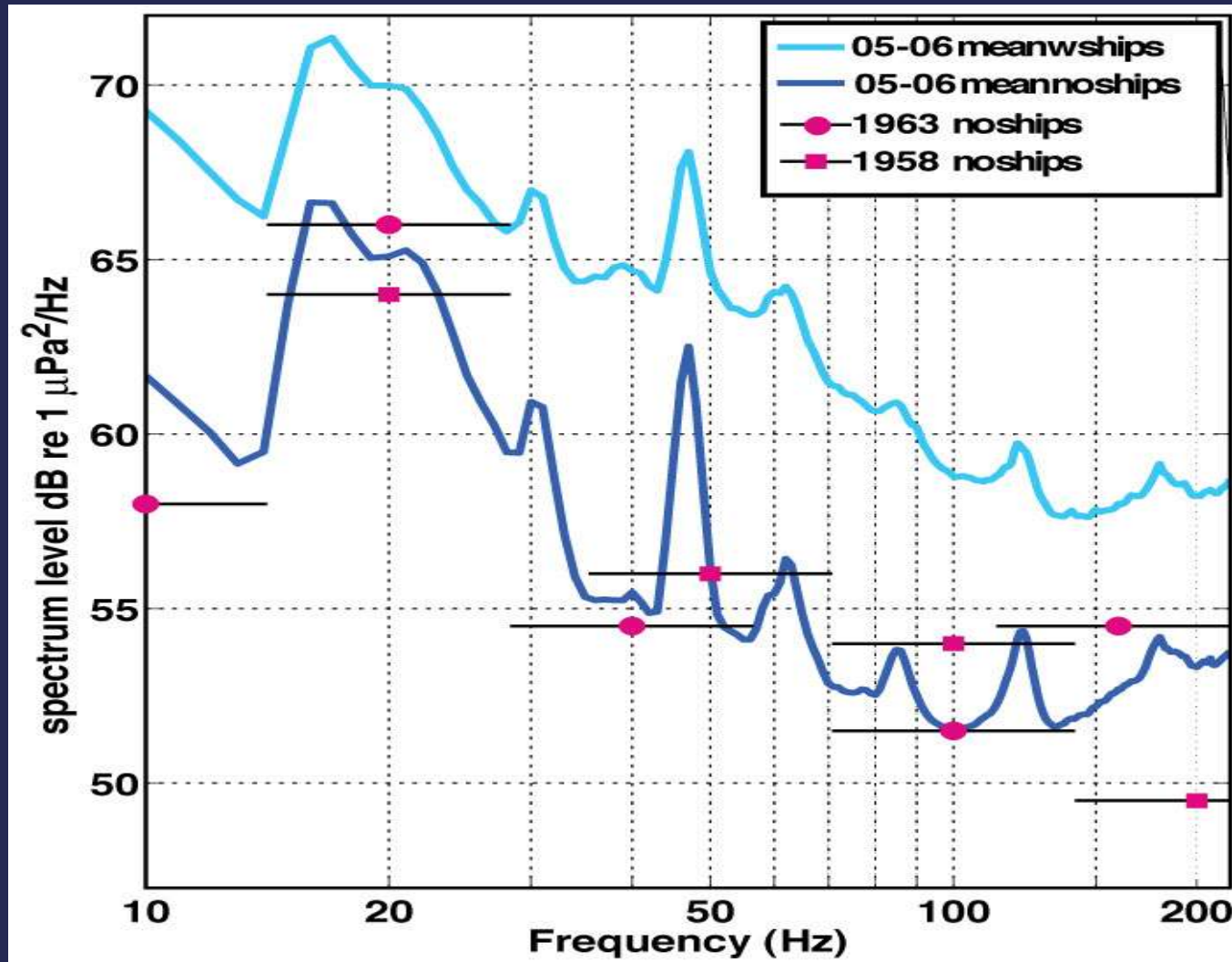
Shallow Water Noise Including Local Ships



Shallow Water / Deep Water Noise Comparison

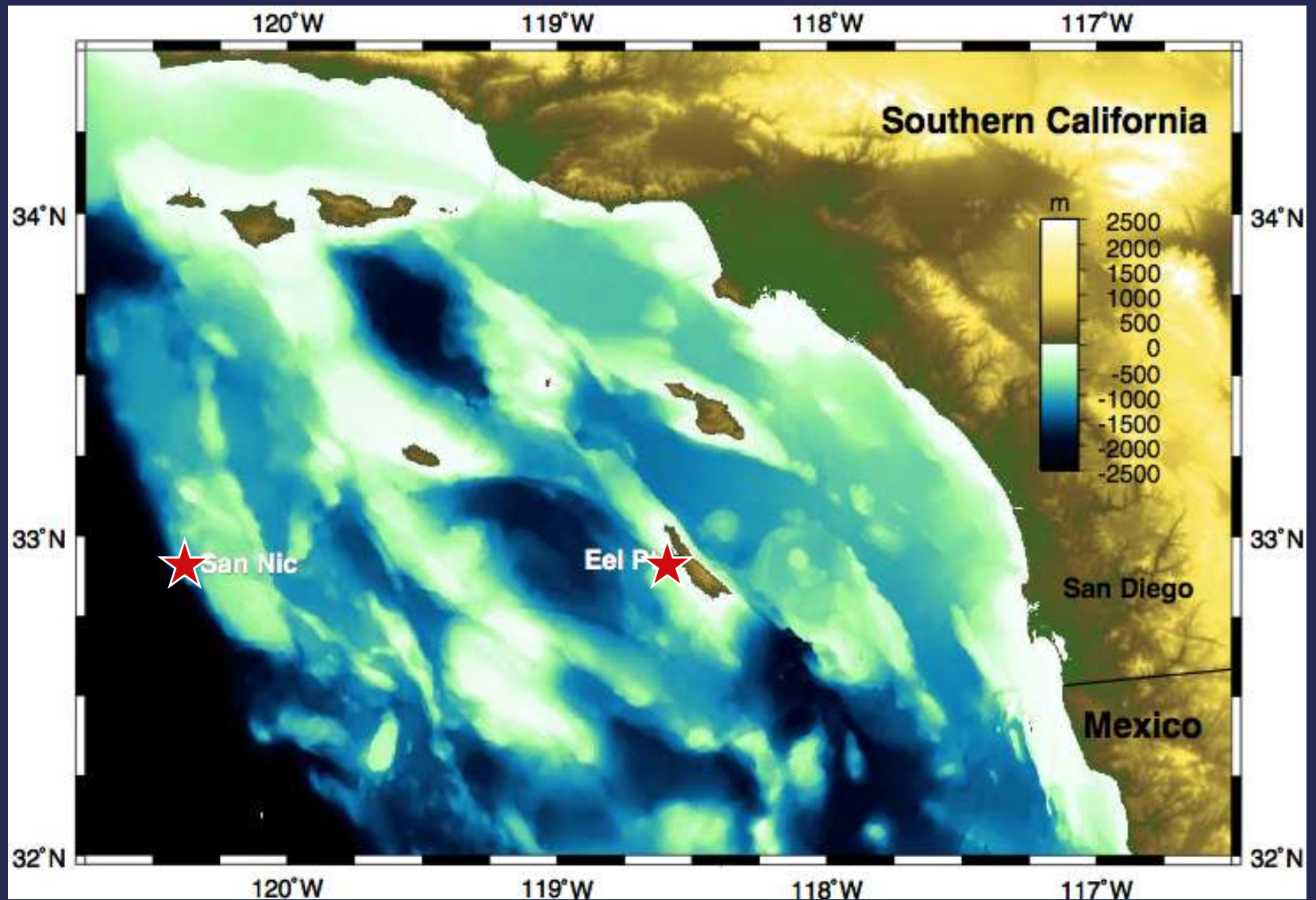


No Local Ships - NO CHANGE in 4 Decades

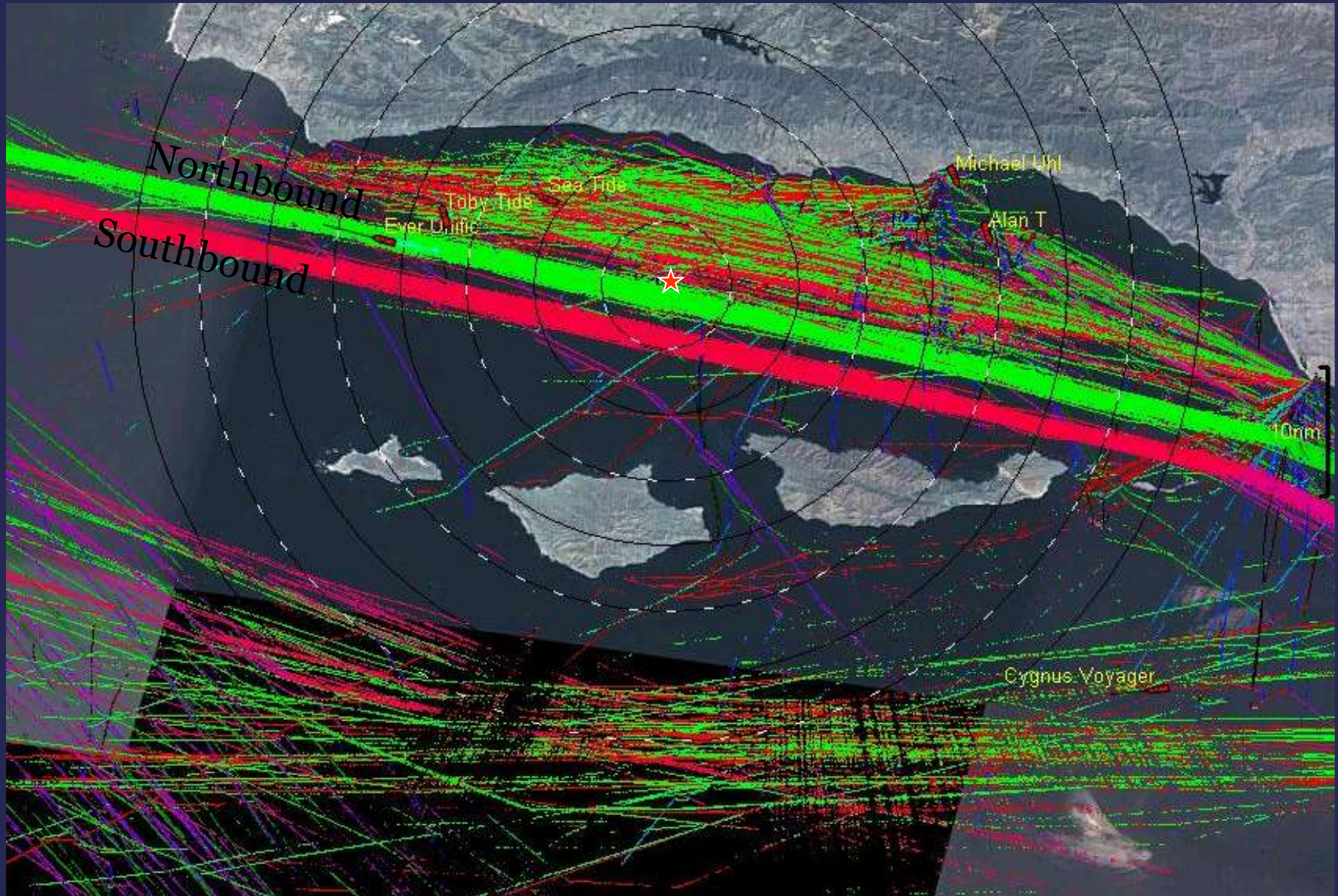


Shipping noise has increased ~ 1 dB/decade

A Tale of Two Sites: San Nicolas and Eel Point

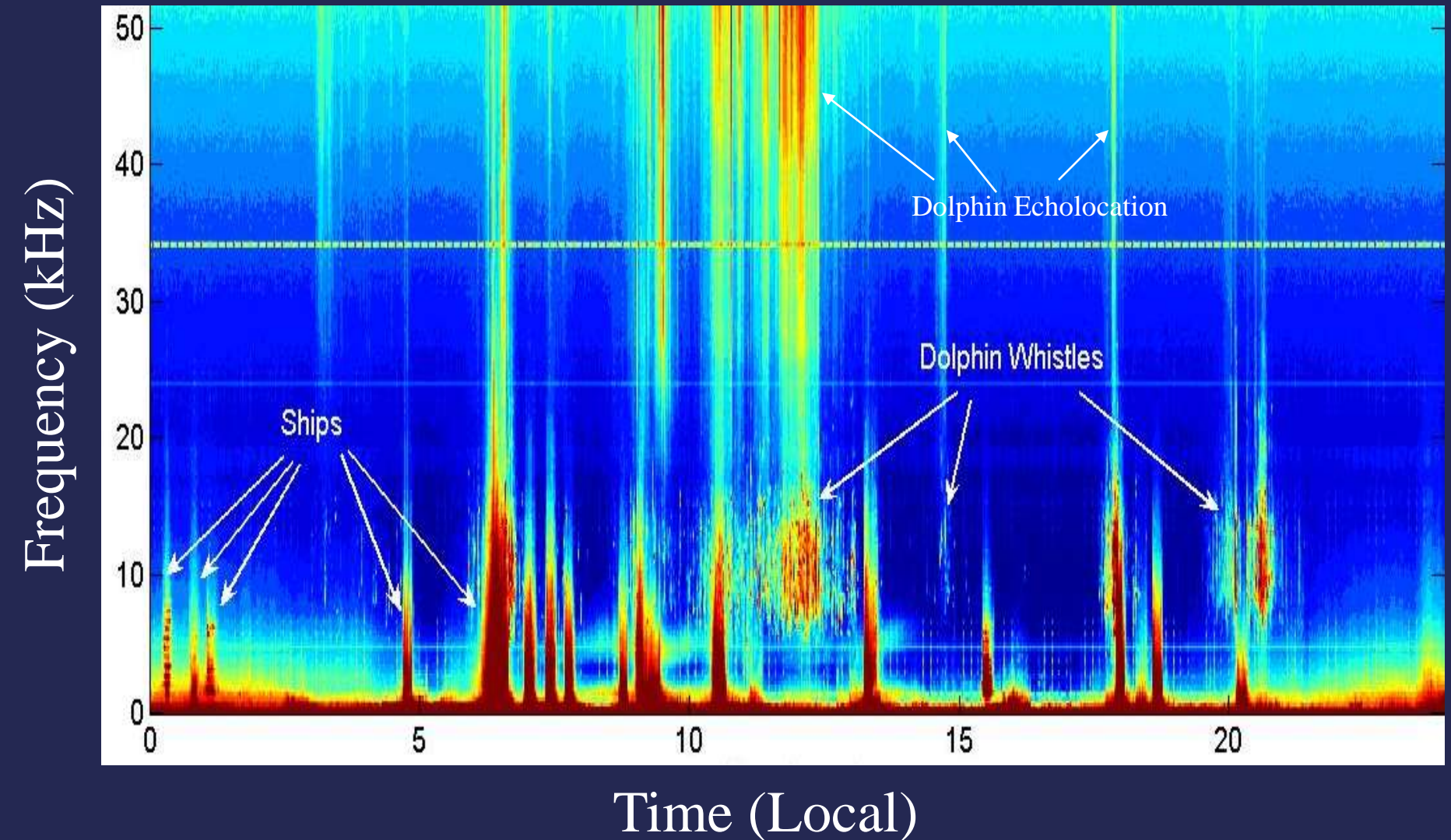


Monitoring Ship Traffic with AIS



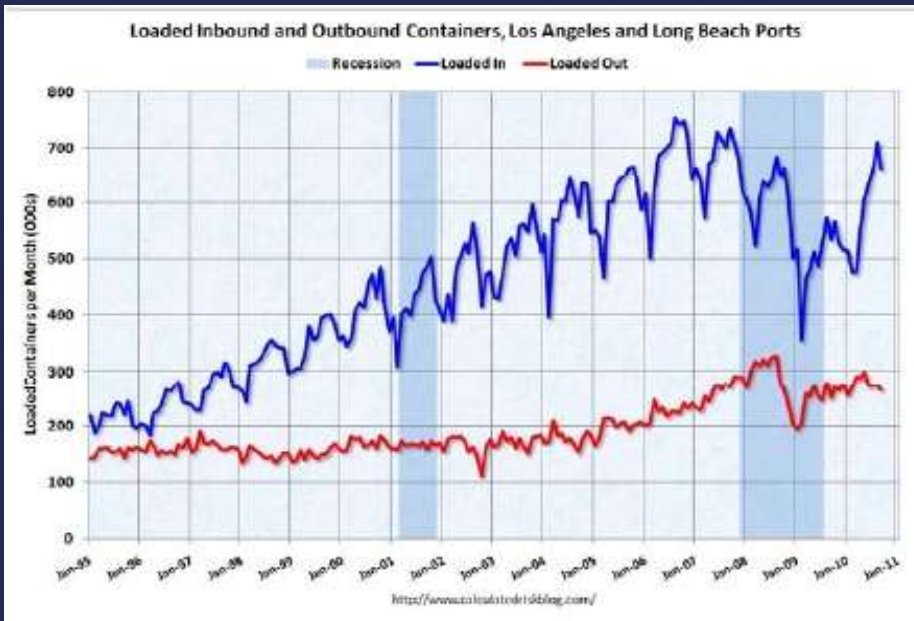
Color indicates direction of travel

Ambient Noise in the Santa Barbara Channel



Changes in Ship Traffic

Economic Downturn

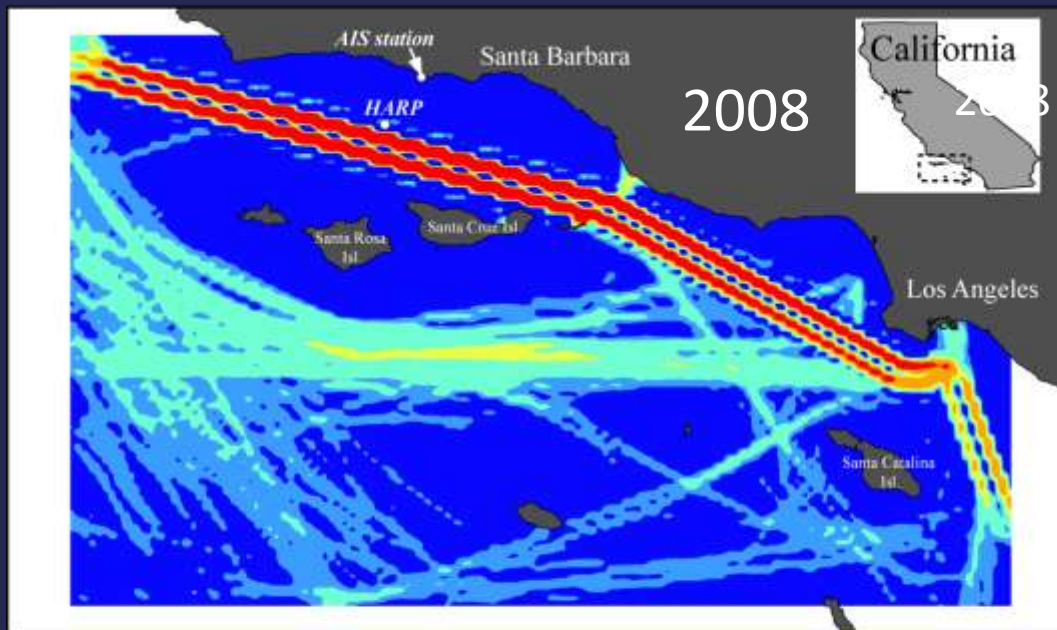


<http://www.calculatedriskblog.com>

July 2009 Air Quality Rule

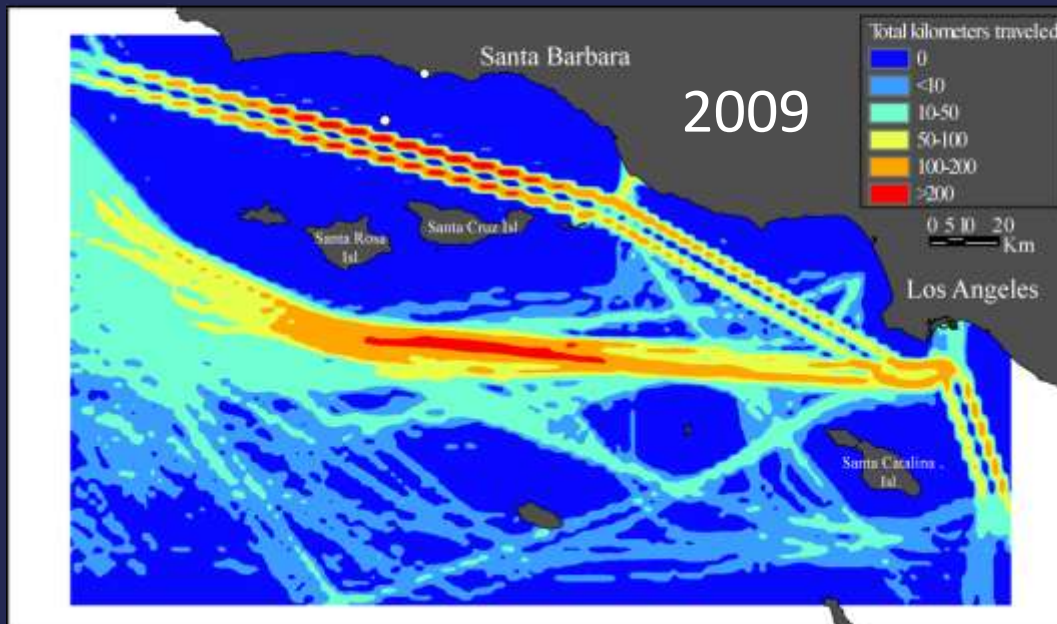


(A) 2008



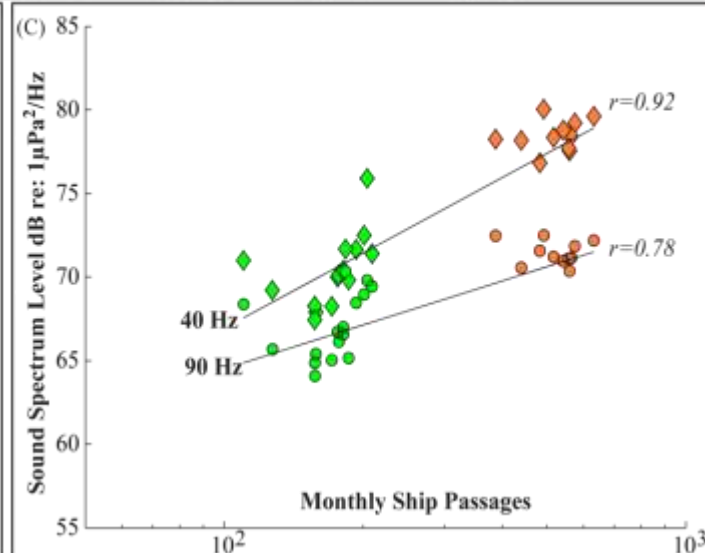
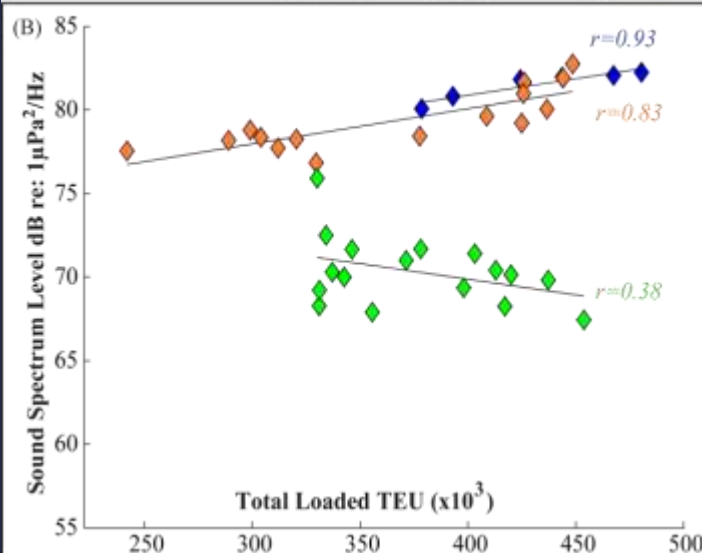
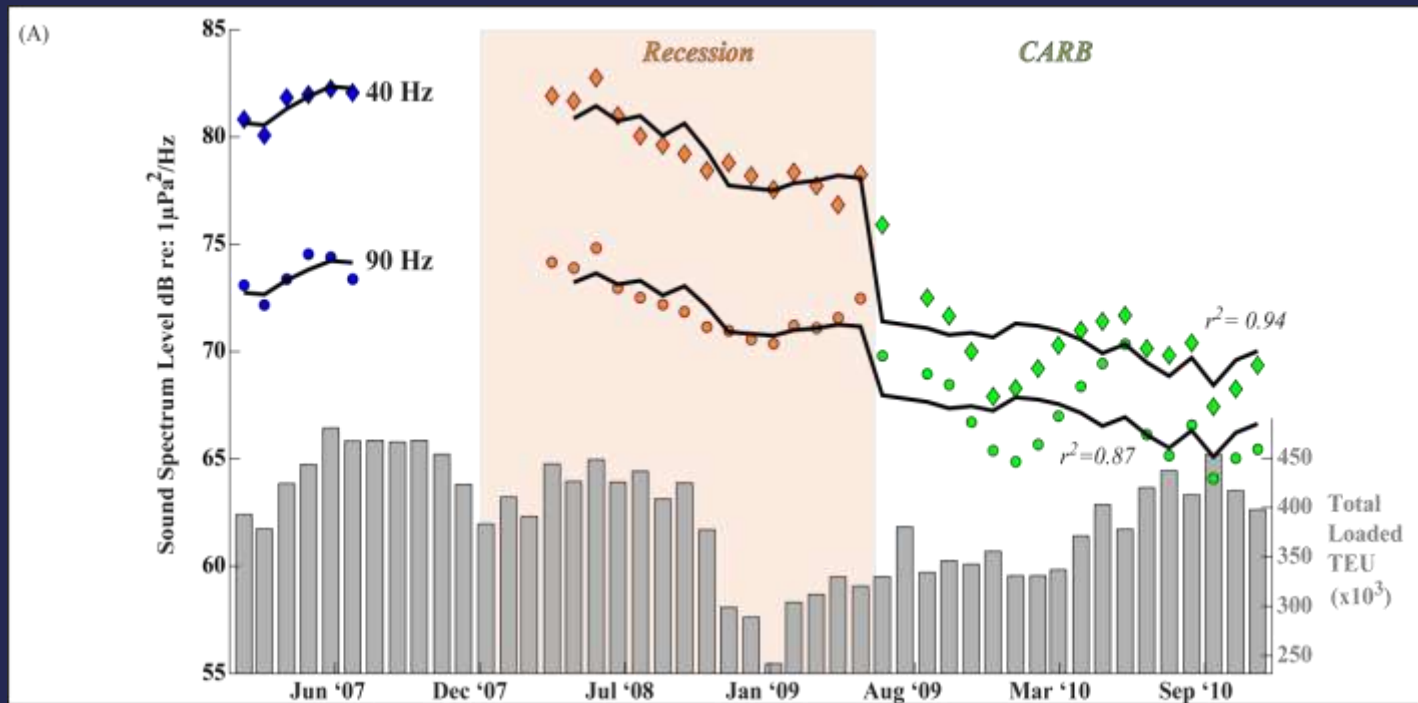
Change in Shipping Lanes 2008 vs 2009

(B) 2009

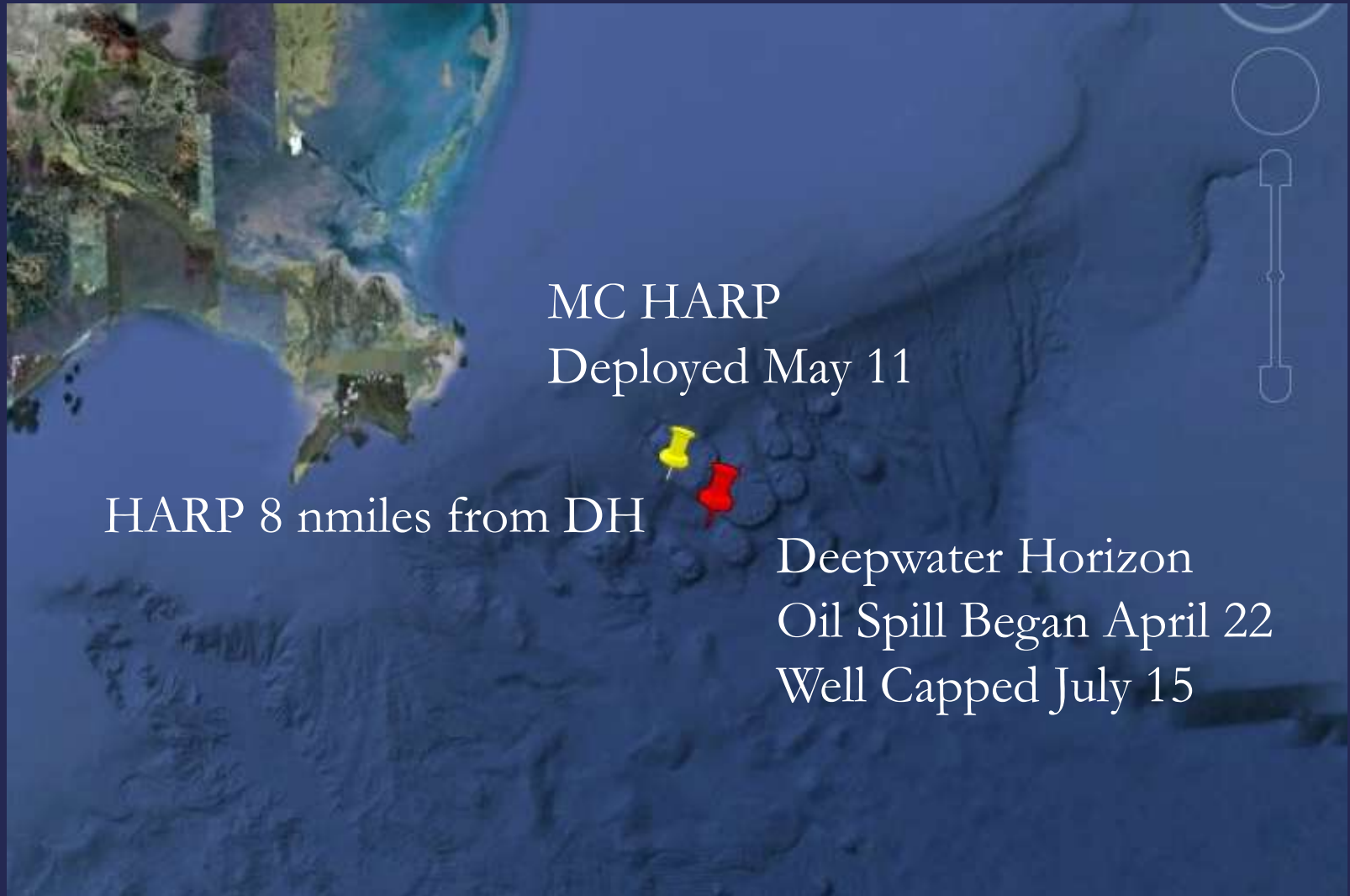


McKenna et al. submitted

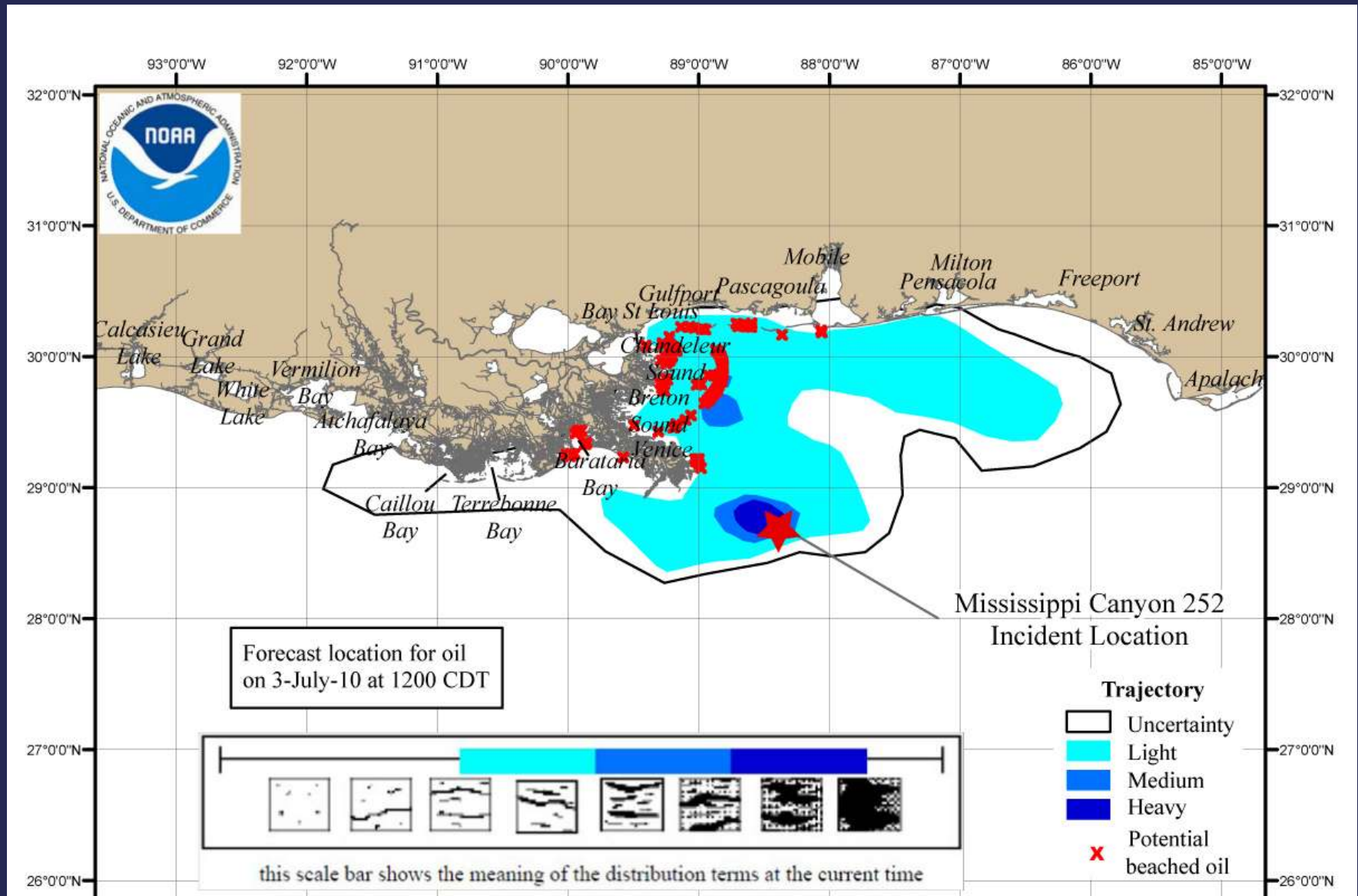
Trends in Ambient in the Santa Barbara Channel



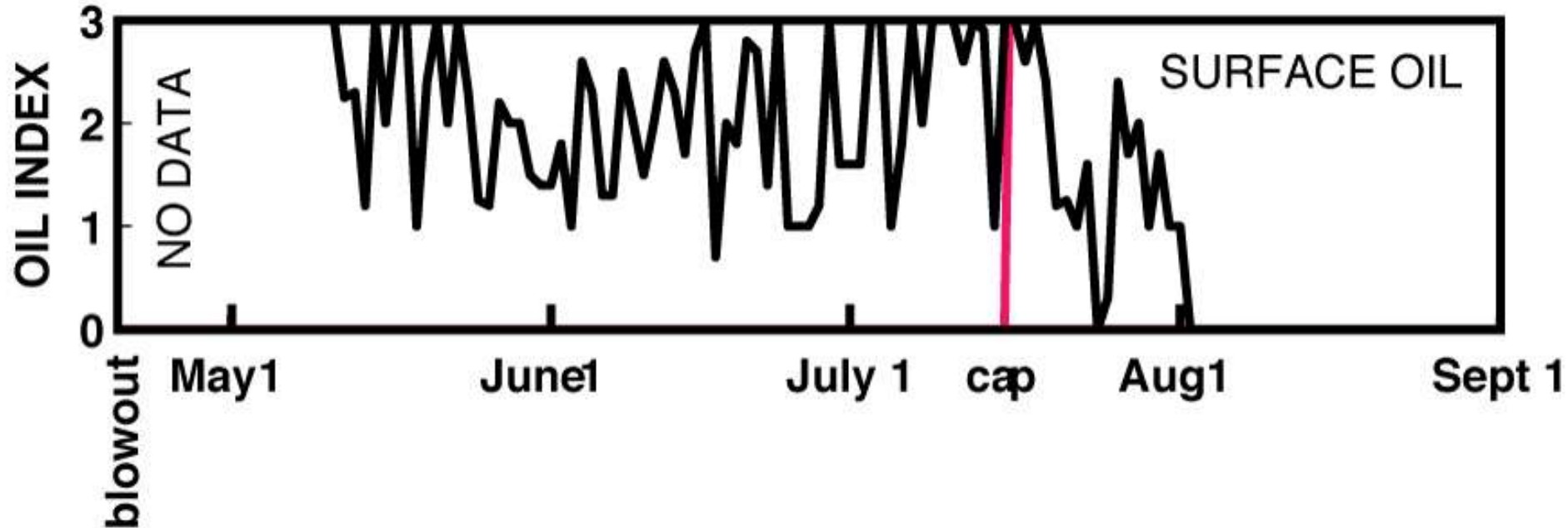
Deepwater Horizon – Acoustic Monitoring



NOAA Oil Trajectory Forecast

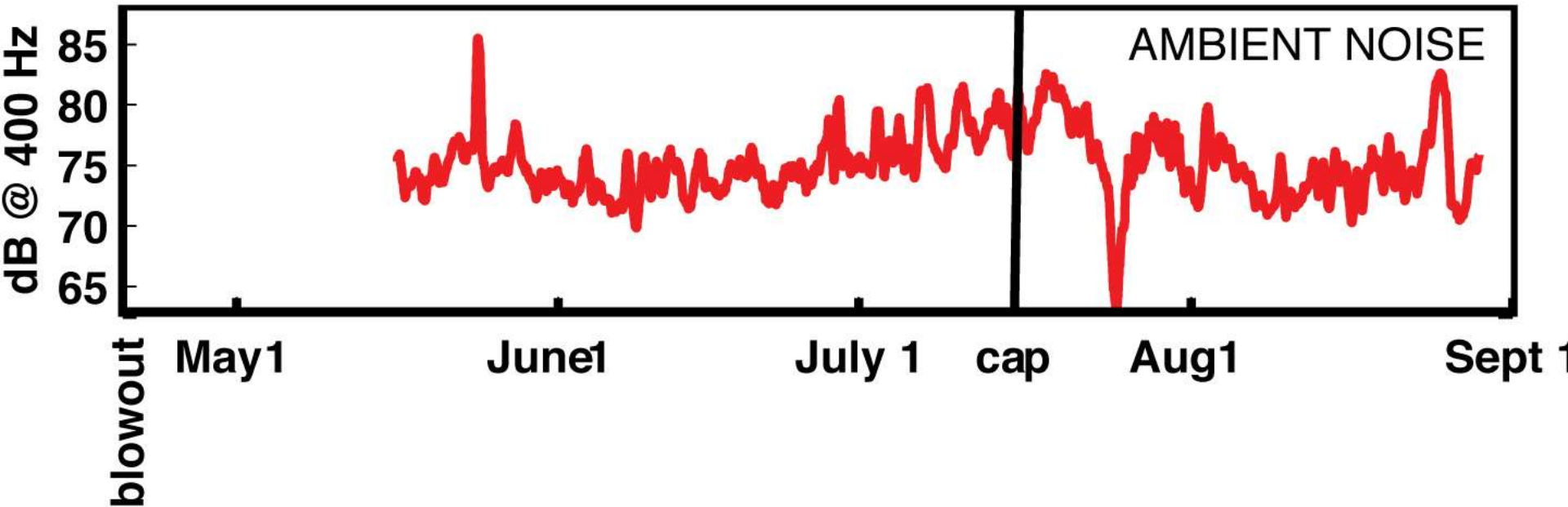


Oil Index for MC HARP Site

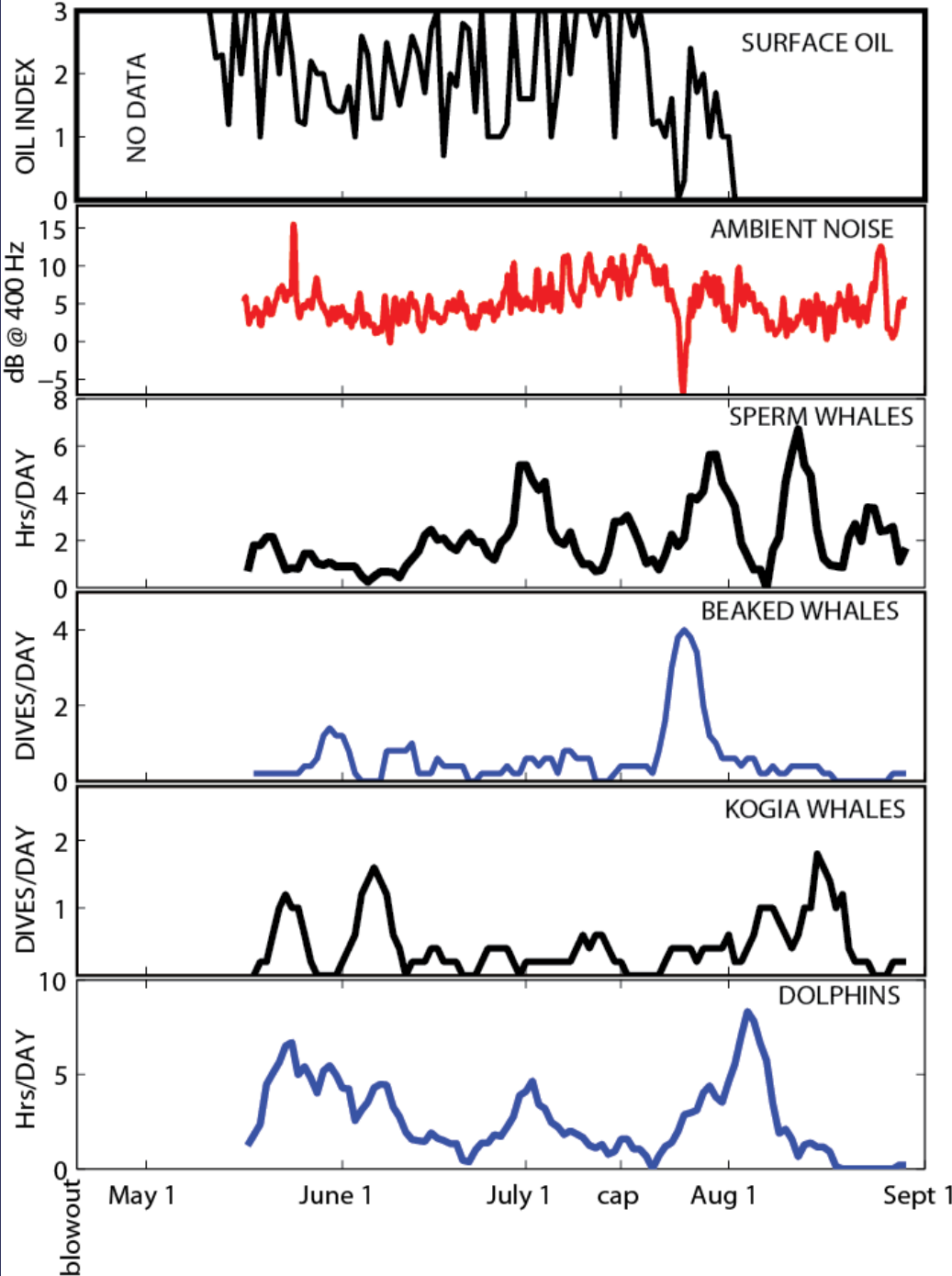


Daily estimate of oil within 3 km radius of HARP

Noise Index for MC HARP Site



Hourly estimate of ambient noise at MC HARP
400 Hz used as proxy for nearby ships

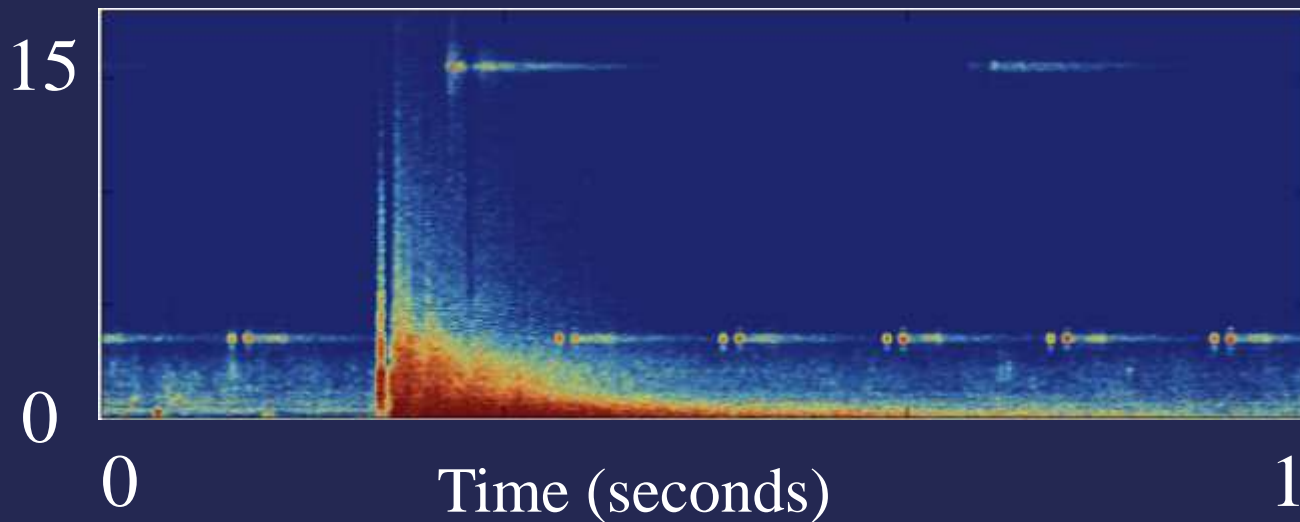


blowout

Ambient Noise – Airguns and Echosounders



Frequency (KHz)

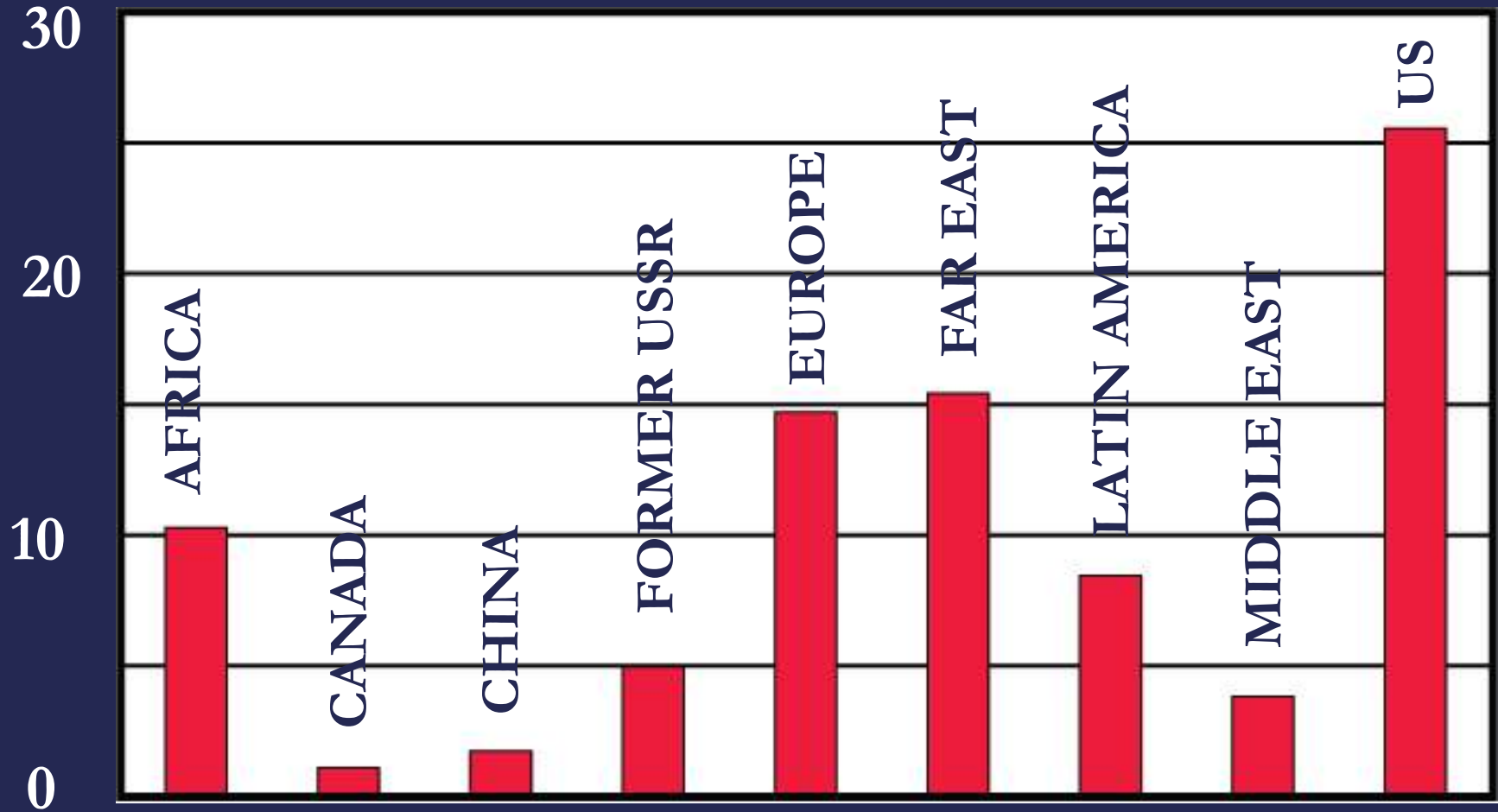


Global Offshore Seismic Exploration



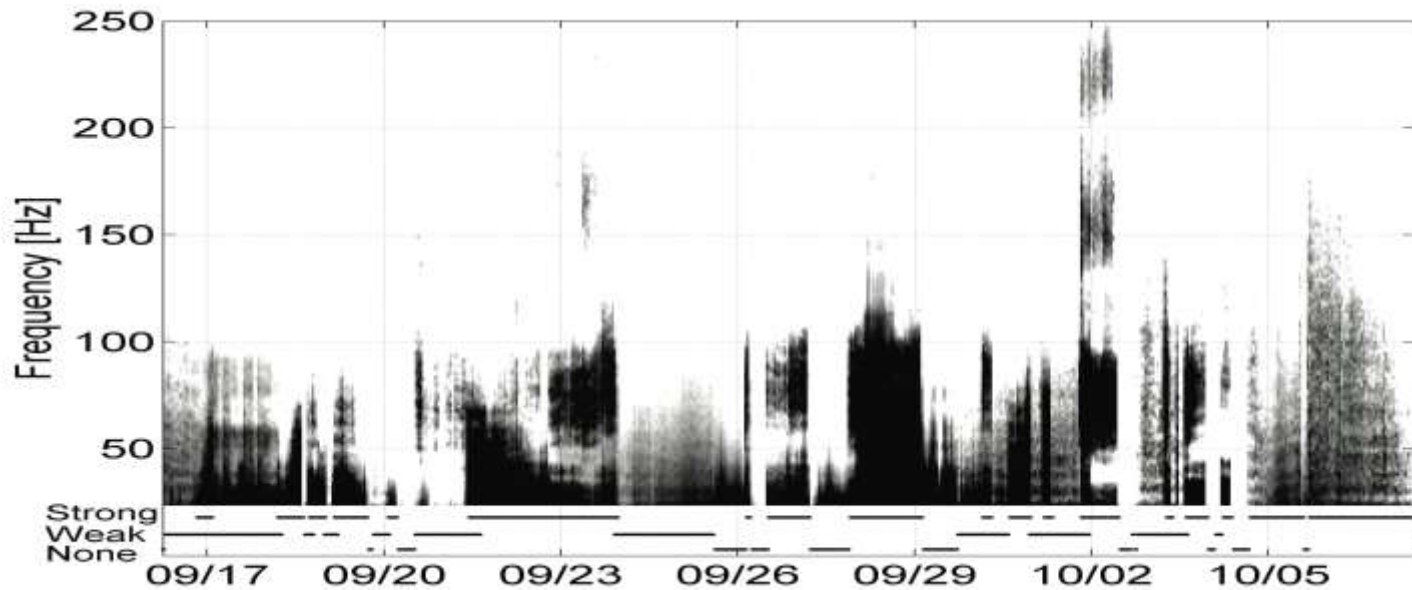
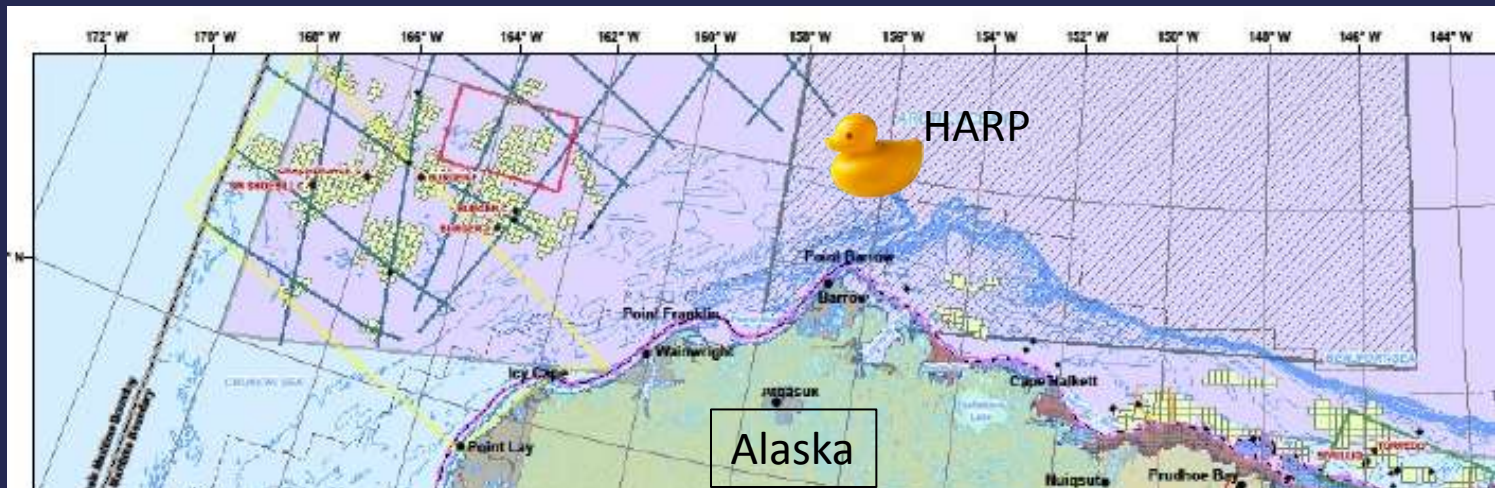
Data for 1994 - 2005

Monthly Average Airgun Usage



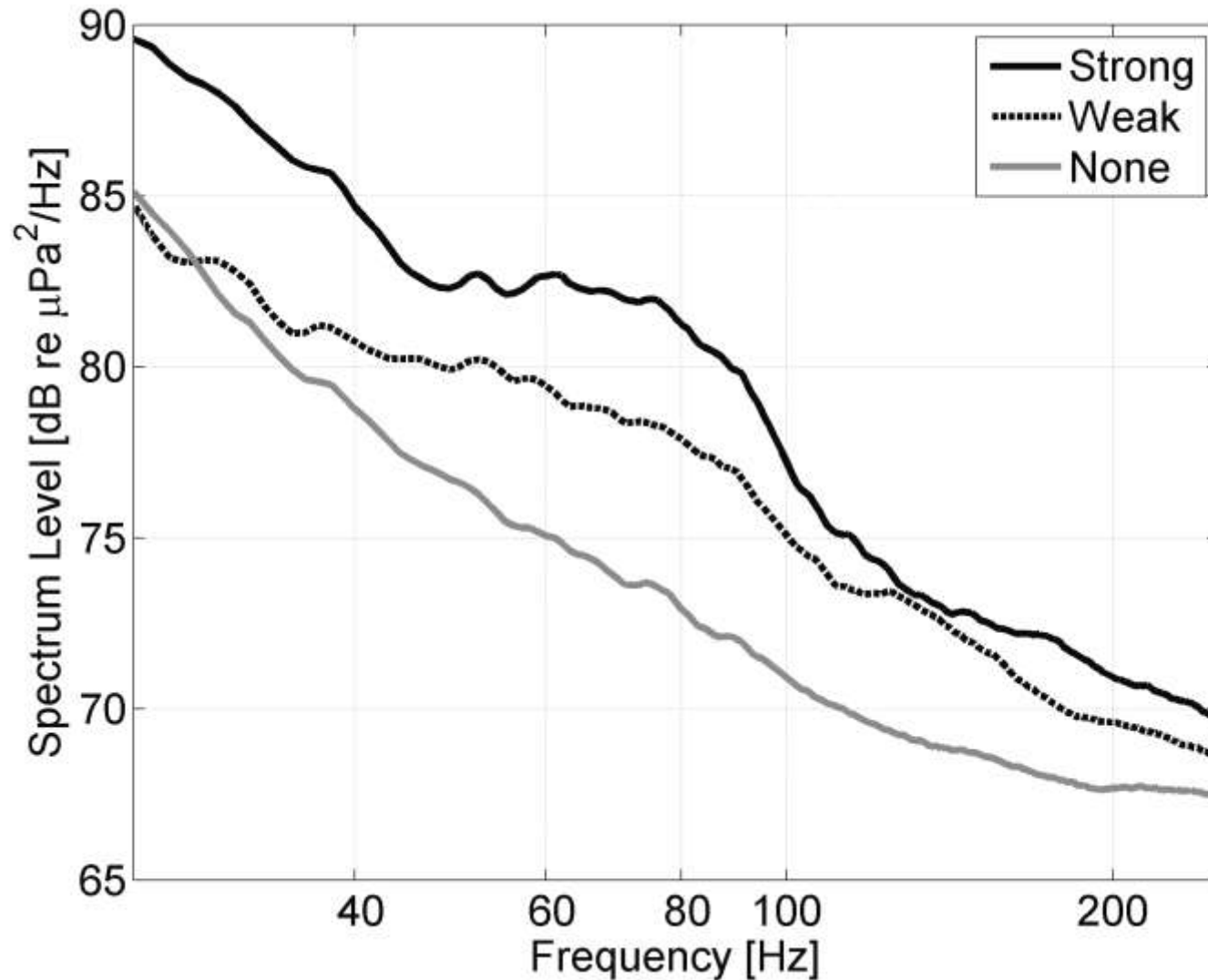
1994 - 2005 Monthly Average Crew-Counts

Airgun Noise in Arctic



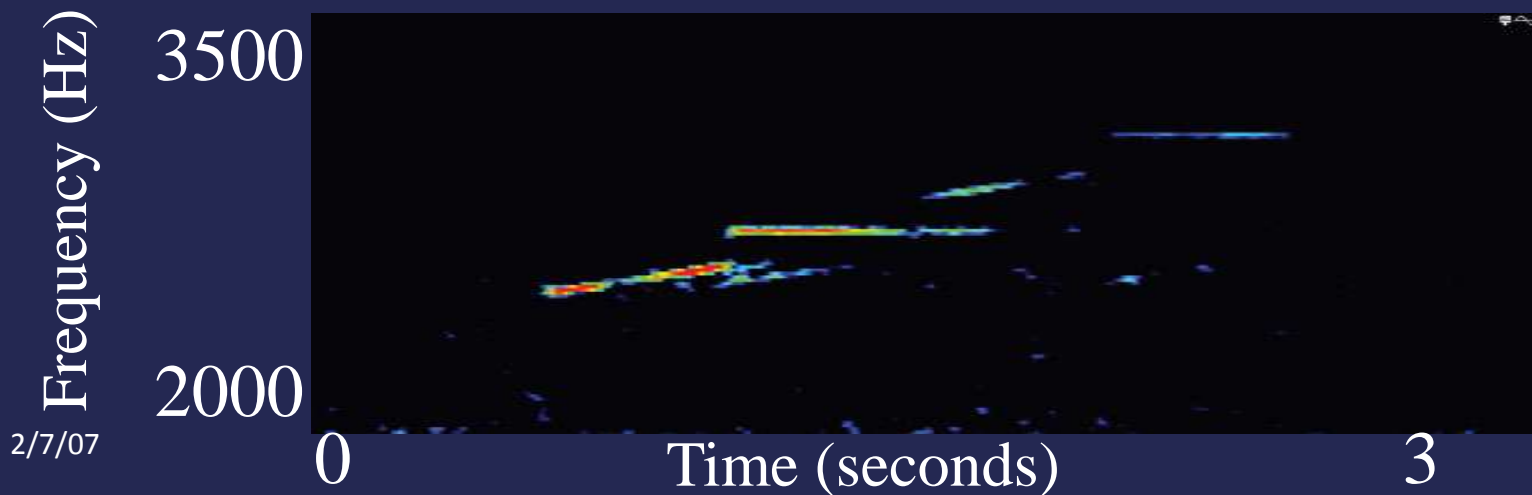
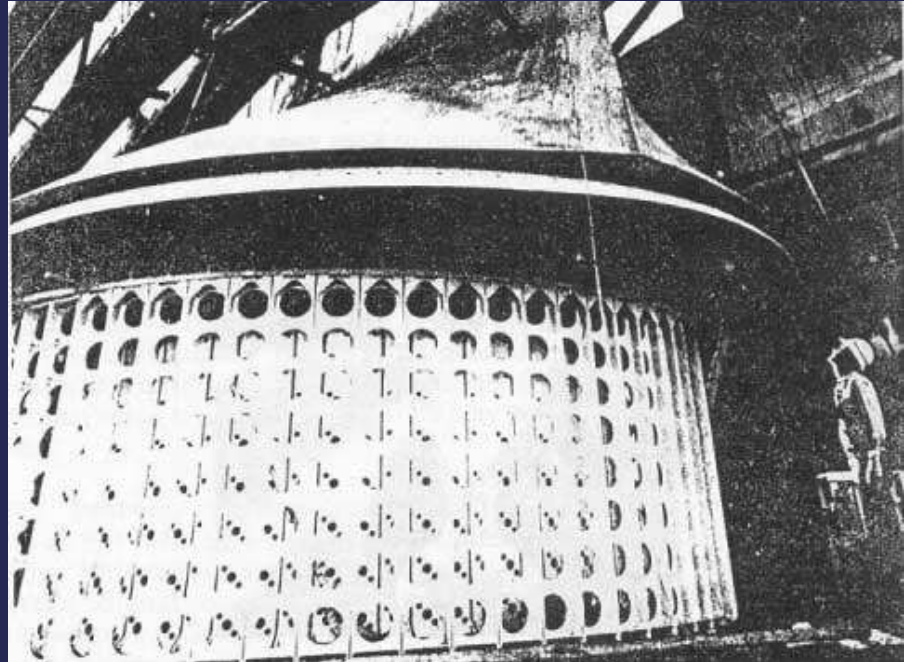
From Roth et al. 2012

Airgun Noise in Arctic



From Roth et al. 2012

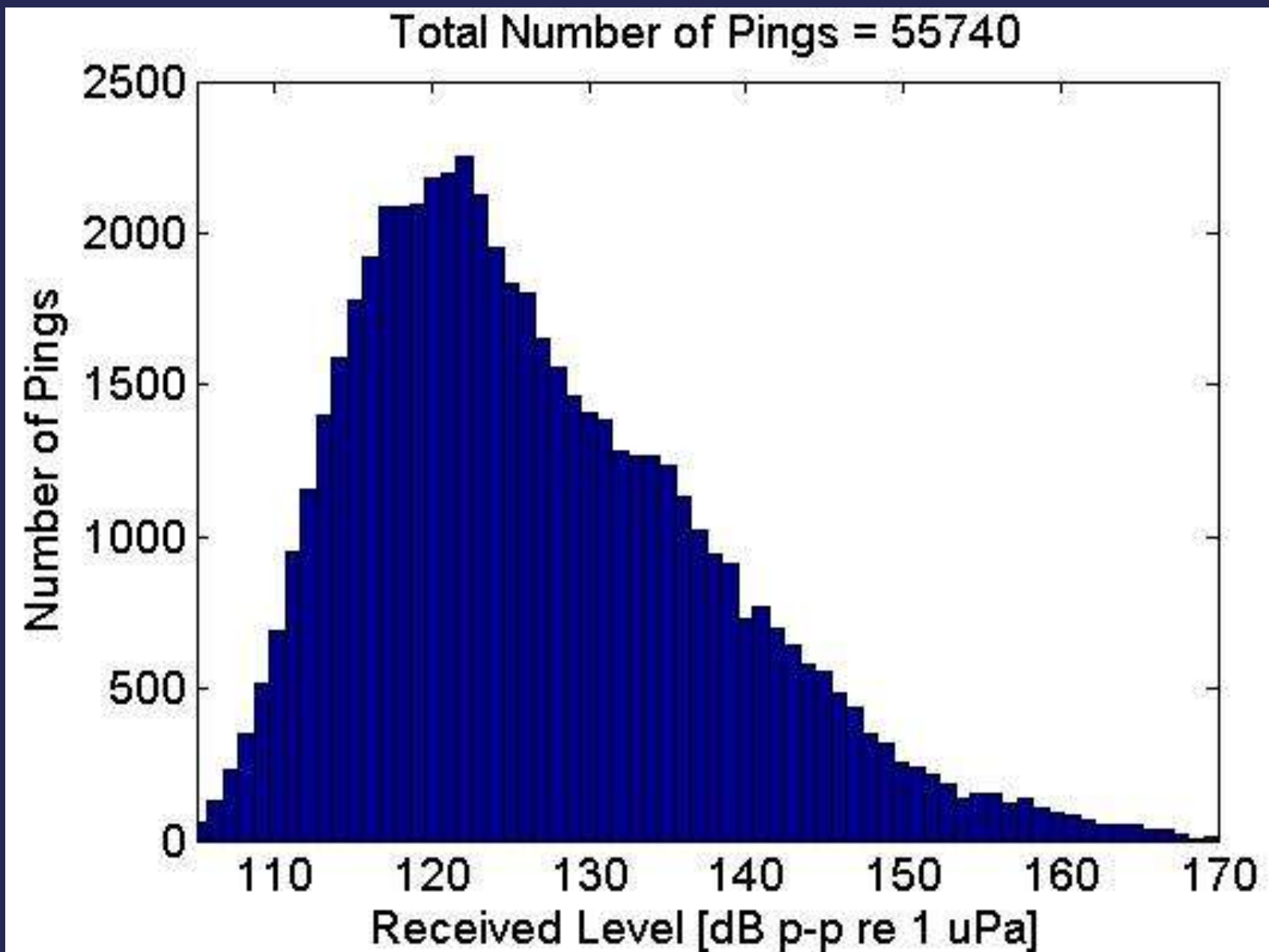
Mid-Frequency Active Sonar



West Coast Naval Training Ranges



SOCAL Range Complex – Annual Received Sonar



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