

Biological functions of acoustic communication and effects of noise on animals

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Overview

- Provide information for discussion on the biological uses of sound
vis a vis potential effects of noise
- Biological functions of sound
 - Inter and intra specific communication
 - Food finding
 - Navigation
 - Marine animals
 - Fish
 - Mammals
 - Turtles
- What are the possible effects of noise?
 - Masking
 - Signal degradation
 - Reduction of effective range
 - reproductive and foraging implications
 - Physiological effects –
 - temporary or permanent hearing loss
 - stress
 - Documentation must be more rigorous

Examples

- Long range communication in large mysticete whales, i.e. low frequency animals
- Short range communication in another, e.g., right whales
- Reduction of foraging activity in odontocetes

Increasing noise in the NE Pacific

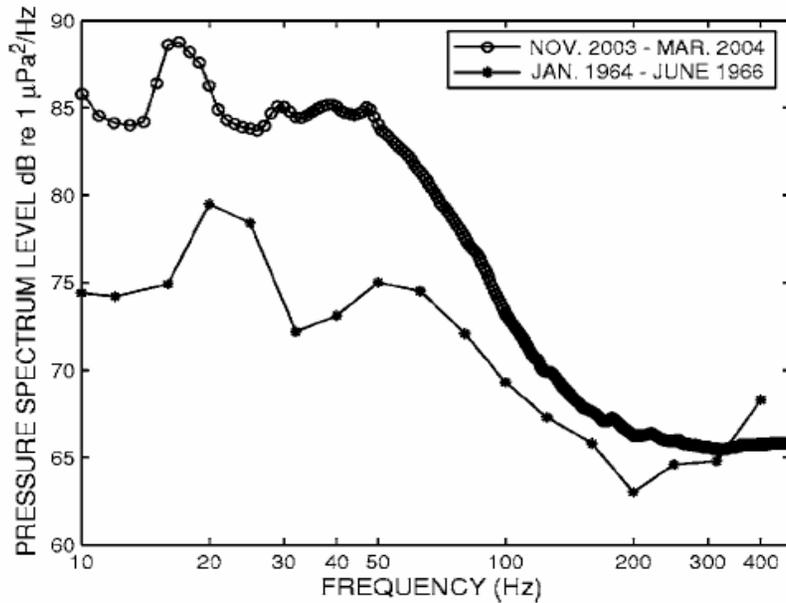


FIG. 2. Mean pressure spectrum levels (1 Hz bins) at the San Nicolas South site for November 2003 to March 2004, compared to January 1964 to June 1966. Band level averages were reported by Wenz (1968a, 1968b) as corrected to units of pressure spectrum level.

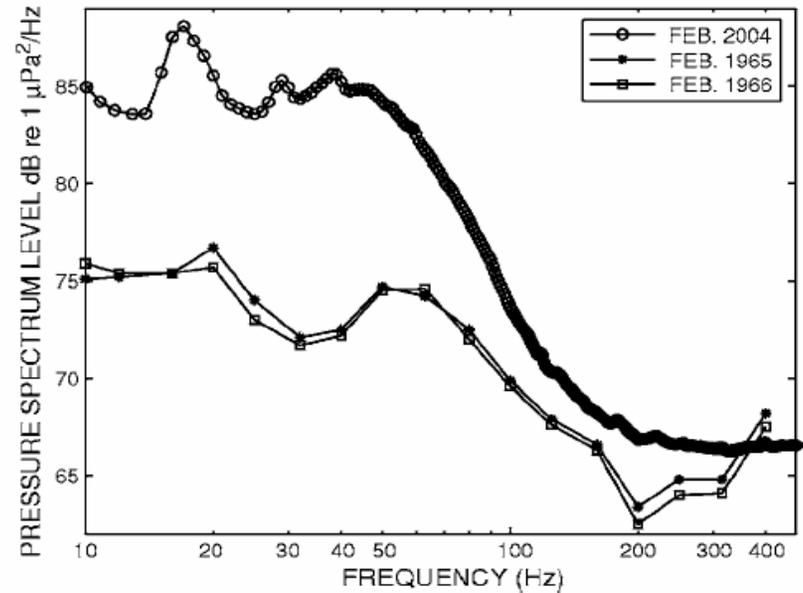
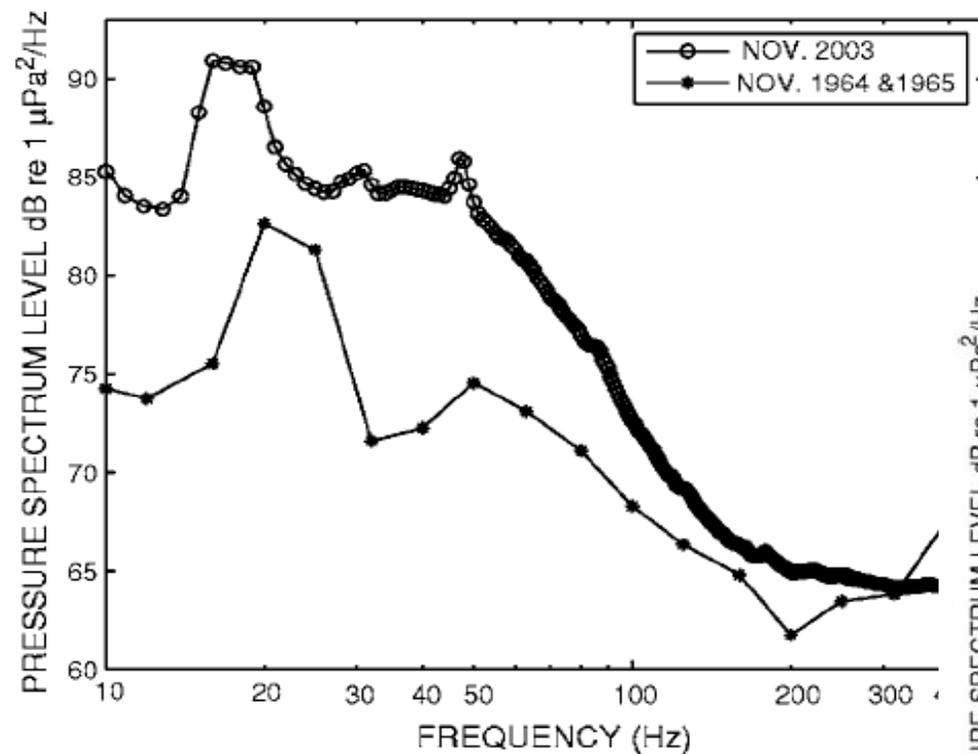
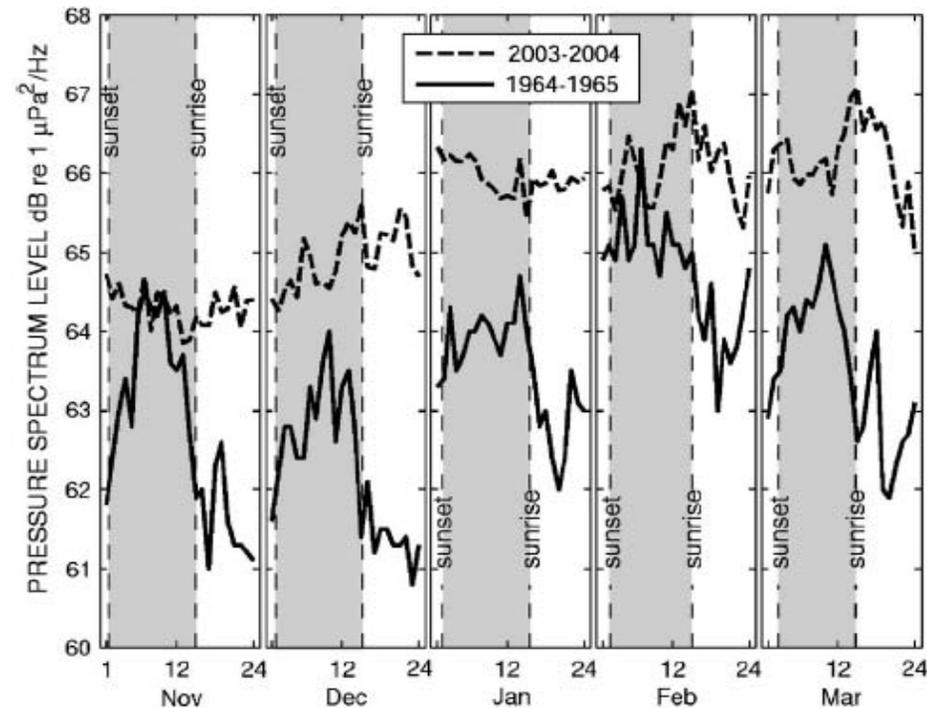


FIG. 3. Sound pressure spectrum levels (1 Hz bins) for the month of February 2004 compared to February 1965 and 1966. During February blue whales are absent from this site and the peak near 17 Hz in 2004 is from fin whale calls.



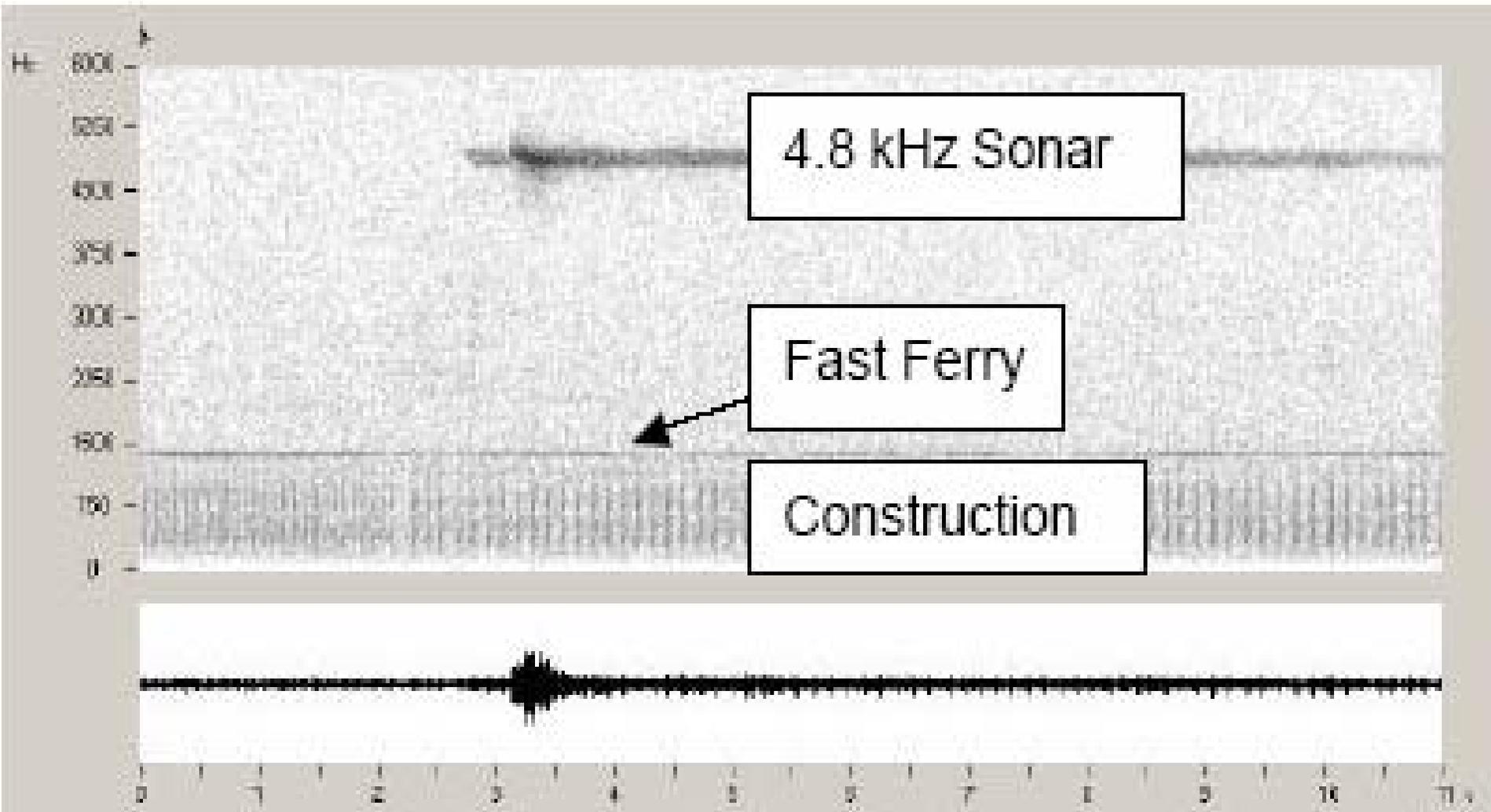
Frequency shift in blue whales?



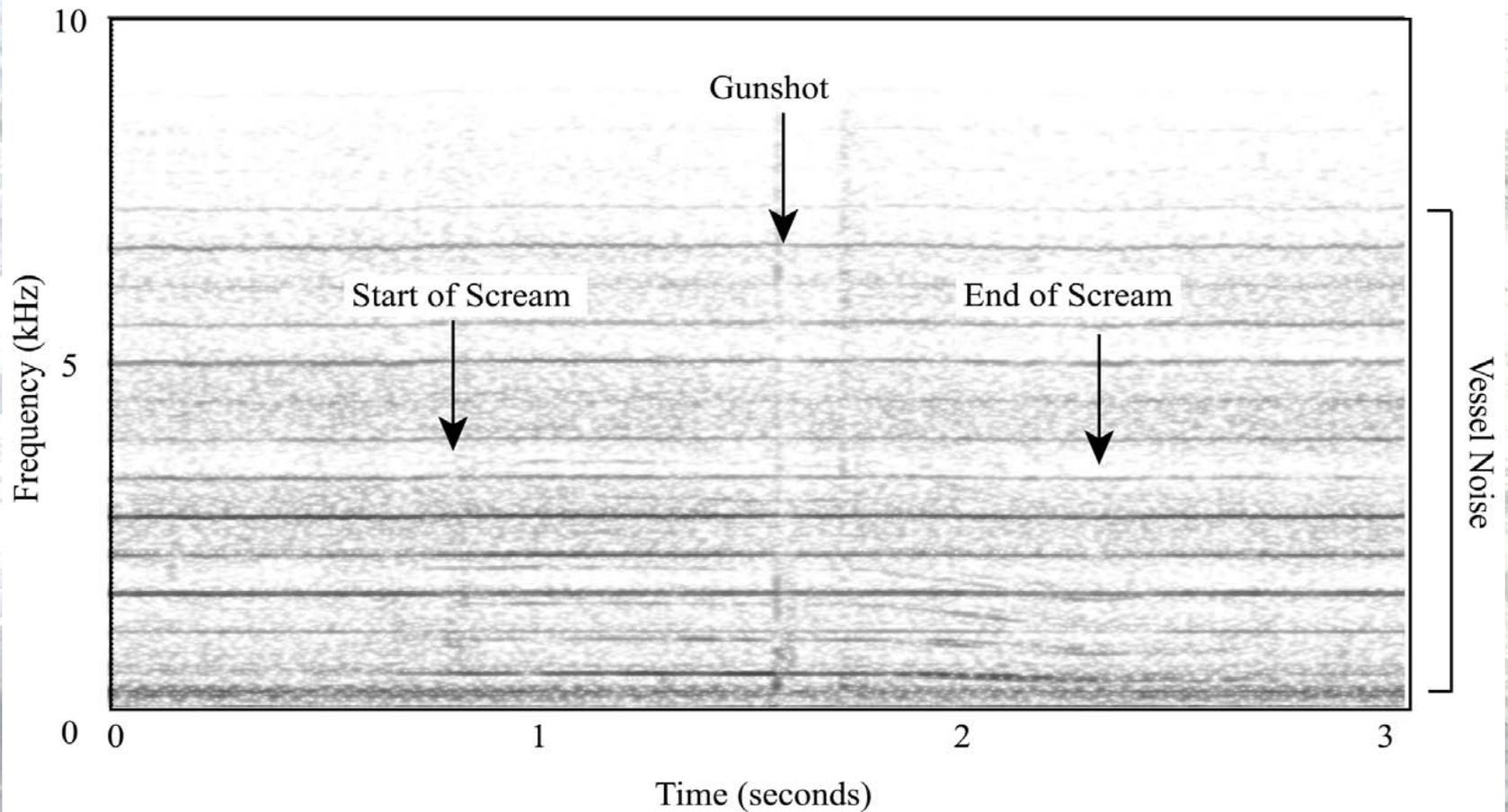
- Is the sample representative?

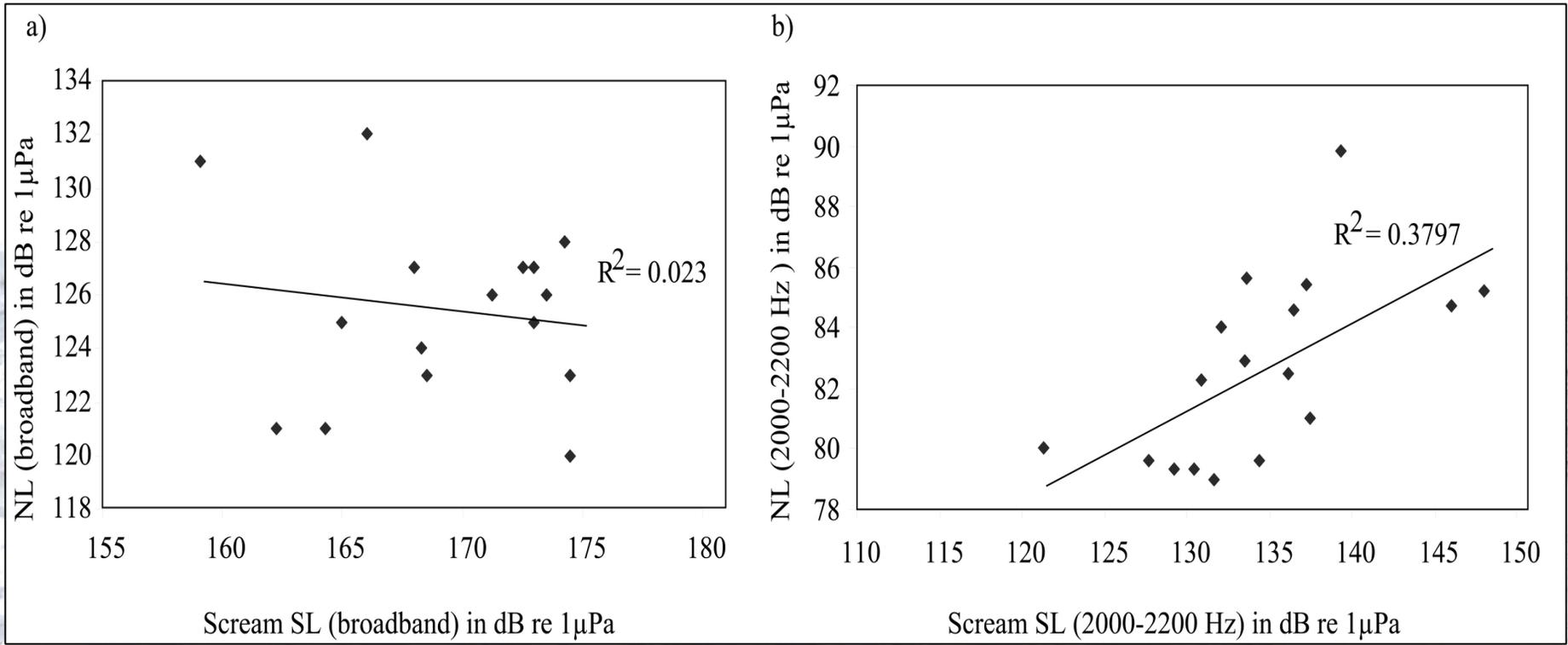
FIG. 5. Monthly averaged pressure spectrum levels at 315 Hz, plotted vs time of day (in GMT). The average band levels from 1964–1965 (solid line) are compared to 2003–2004 (dashed line) with band levels scaled as equivalent pressure spectrum levels. The hours from sunset to sunrise are shaded. Nightly chorusing, presumably from fish, is observed in 1964–1965 and is absent in 2003–2004.

Diversity of Sounds Received in Ligurian Sea



Vessel Noise Masks Right Whale Calls





**Strong relationship between SL and NL in
2000-2200 Hz**

Cargo ship passing tagged beaked whale

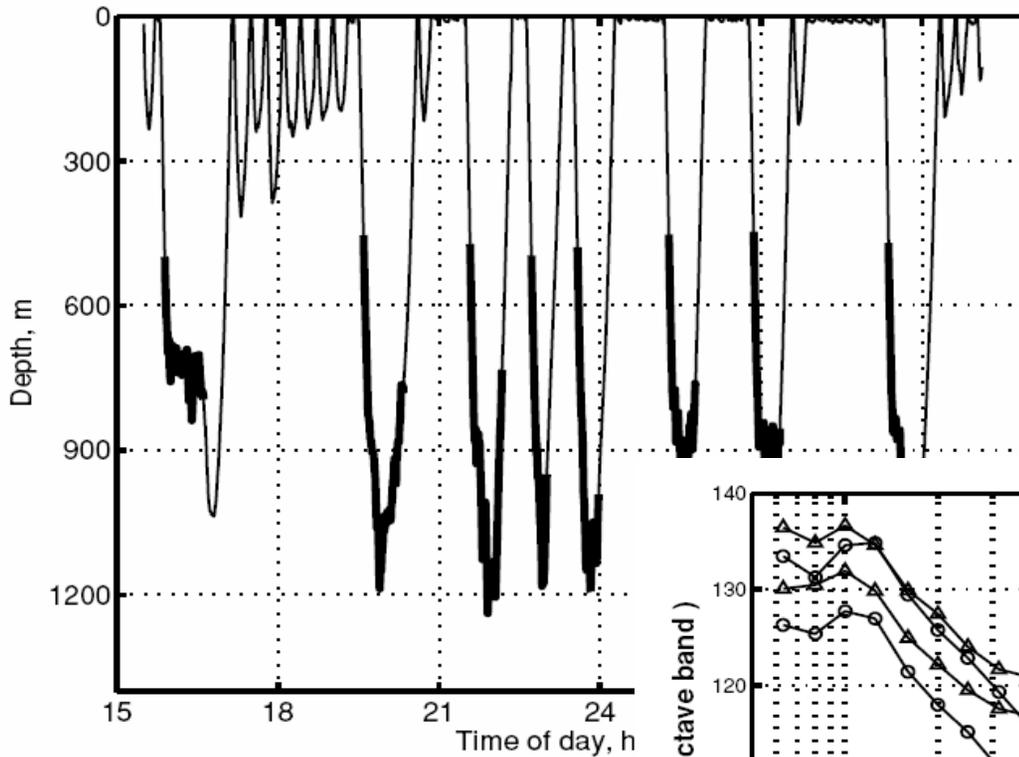
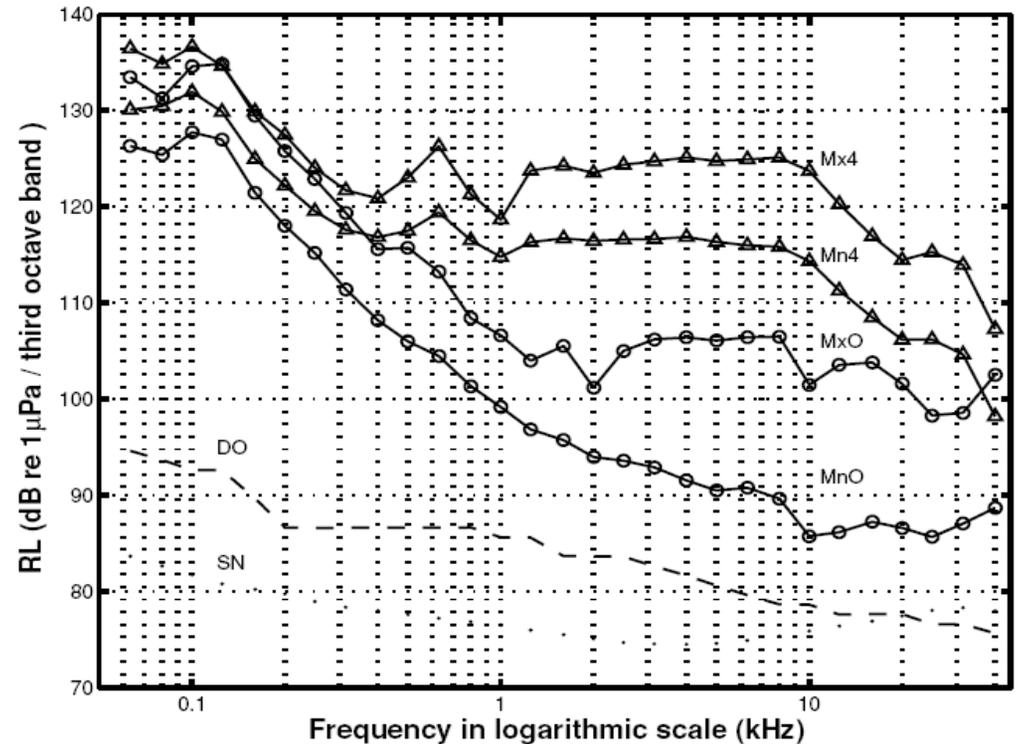
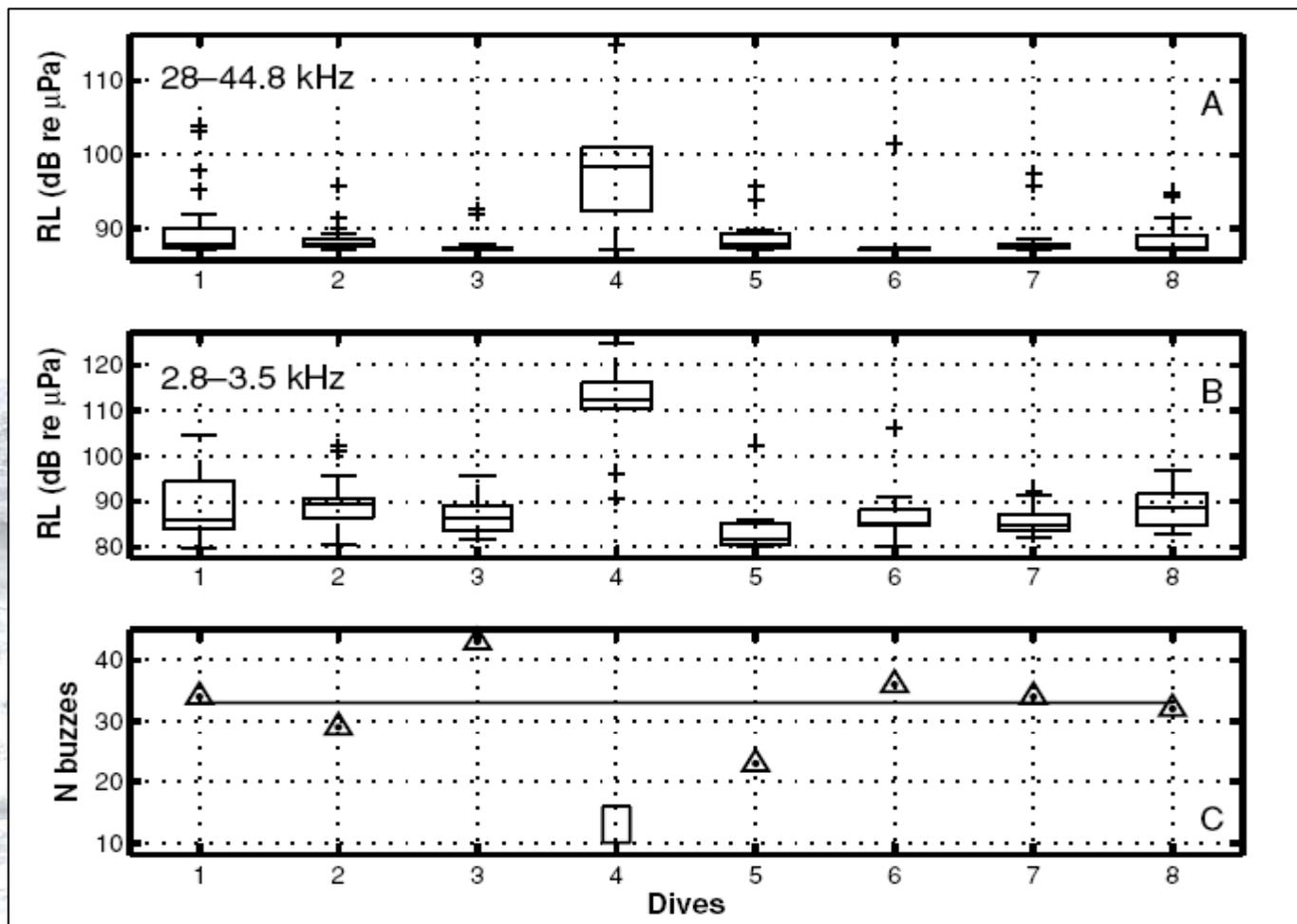


Figure 1. Time-depth profile of a Cuvier's beaked whale of 15.6 h made in September 2003 in the Gulf of Genoa, in each dive is indicated by the thicker line.



Aguilar Soto *et al.* (2006) *Mar. Mam. Sci.* 22(3): 690–699.



$$20 \log_{10}(R_s) + N_s = 20 \log_{10}(R_0) + N_0 \text{ (communication)}$$

$$40 \log_{10}(R_s) + N_s = 40 \log_{10}(R_0) + N_0 \text{ (sonar)}$$

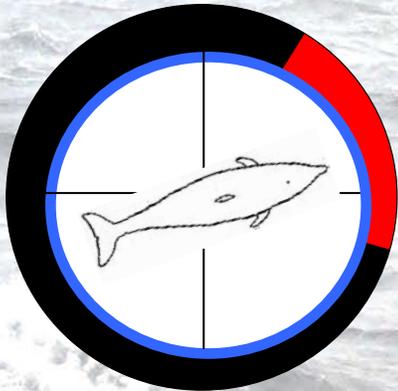
***reduction of sonar range to 42% of normal,
communication to 18% of normal range**

Dolphins respond to sounds produced by prey species

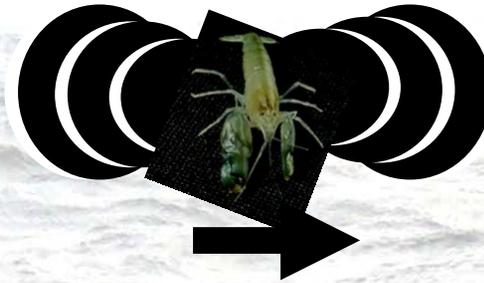
Pre



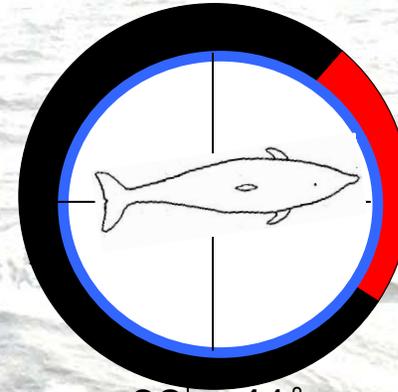
0°



$69 \pm 37^\circ$



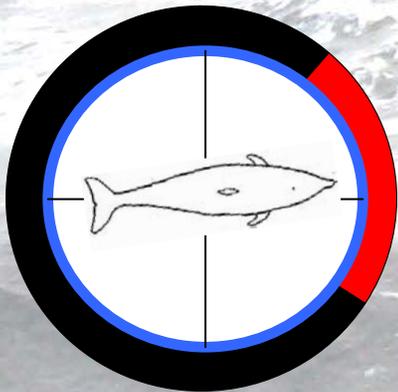
0°



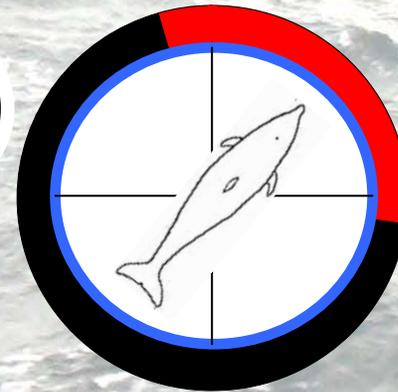
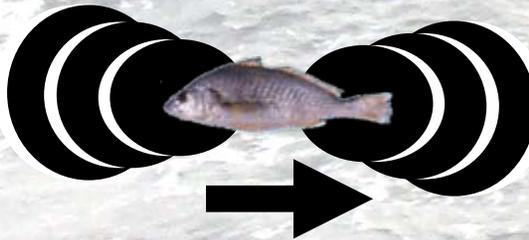
$82 \pm 41^\circ$

$P = 0.17$

Post



$82 \pm 41^\circ$



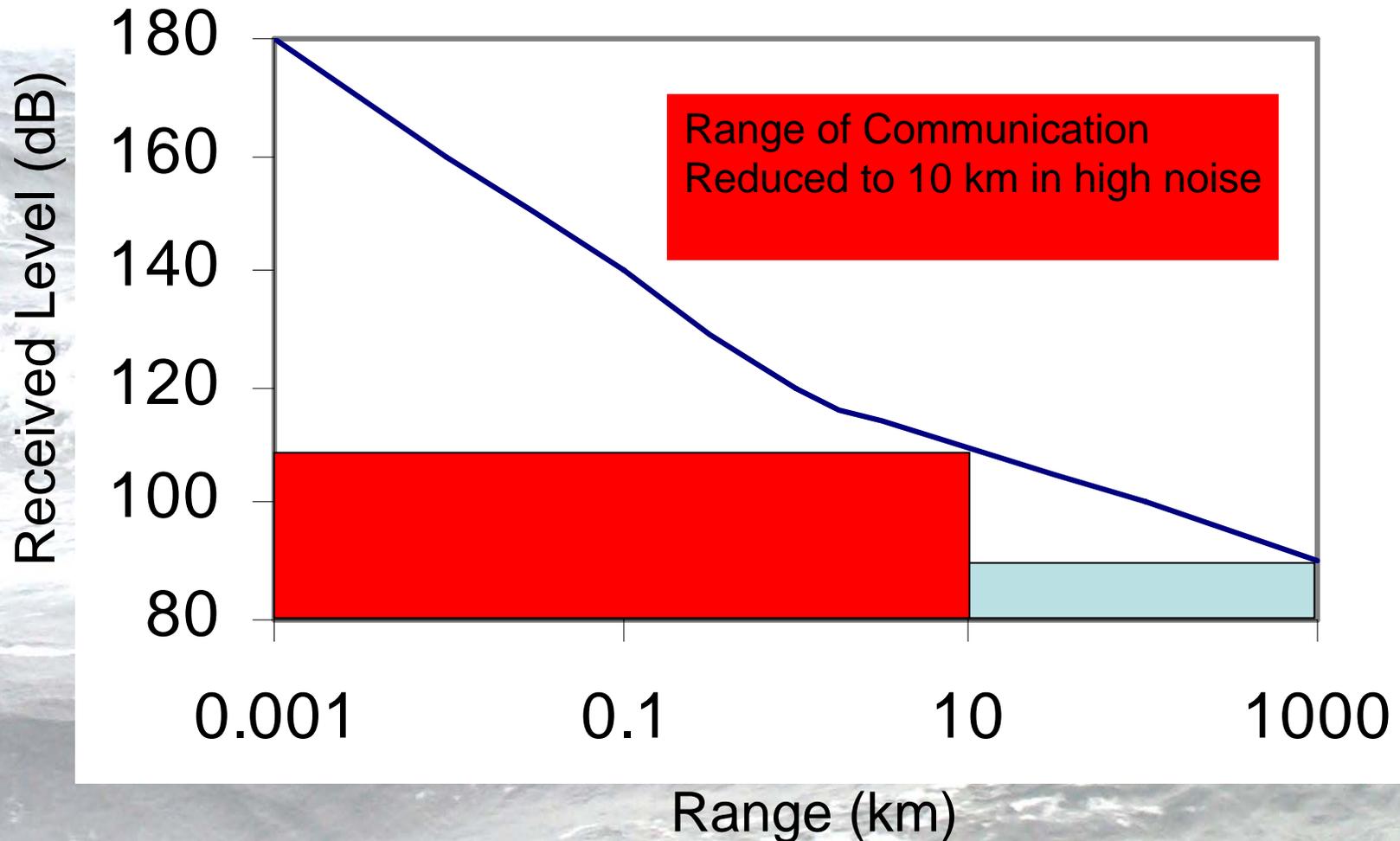
$41 \pm 57^\circ$

$P = 0.02$

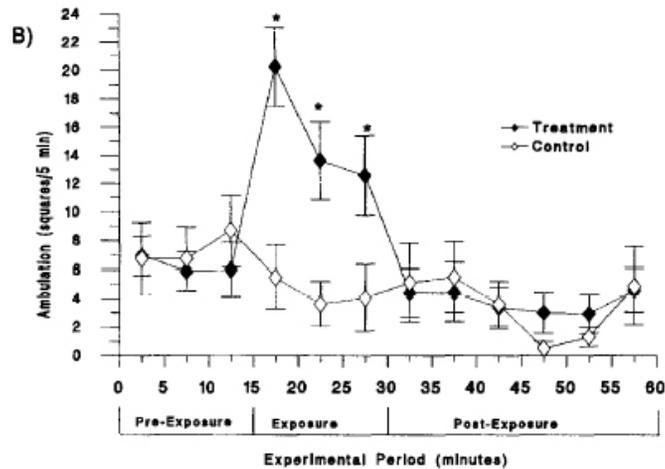
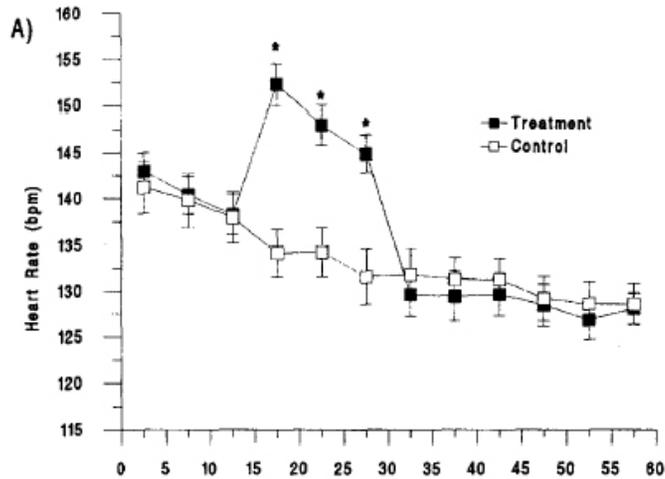
Gannon *et al.* 2005



Increased Noise Can Reduce Effective Range of Communication

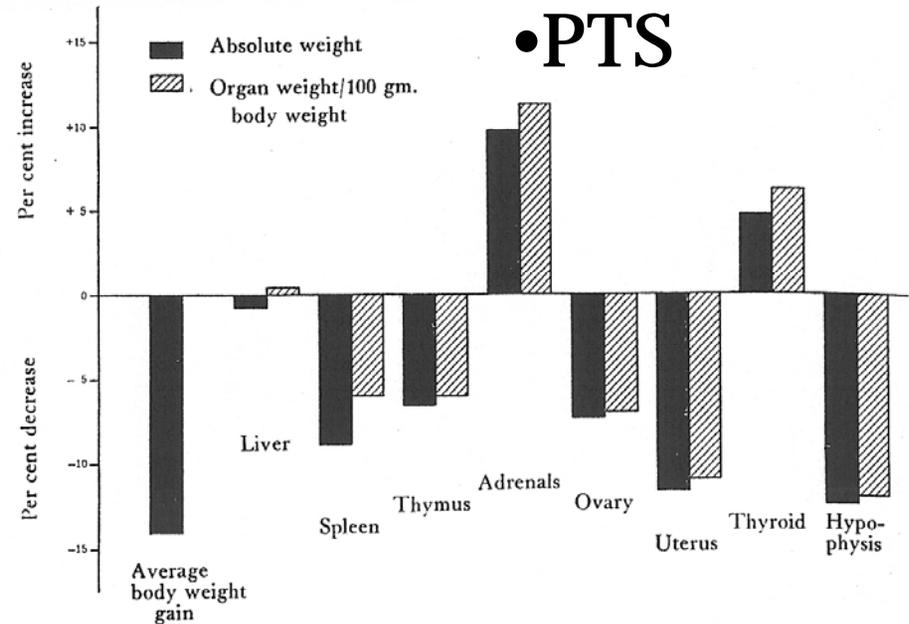


physiological responses to noise



• TTS

• PTS



Conclusions & Points for Discussion

- Temporal and spatial scales for characterizing noise, including resampling of areas
 - Vessels and animals
 - Existing passive acoustic systems
- Species of concern and why they are such
- Outline unknown areas and how they might be affected by noise (a 'sensitivity analysis')
- Might reducing noise provide less acoustic cue for animals in the path of approaching ships?

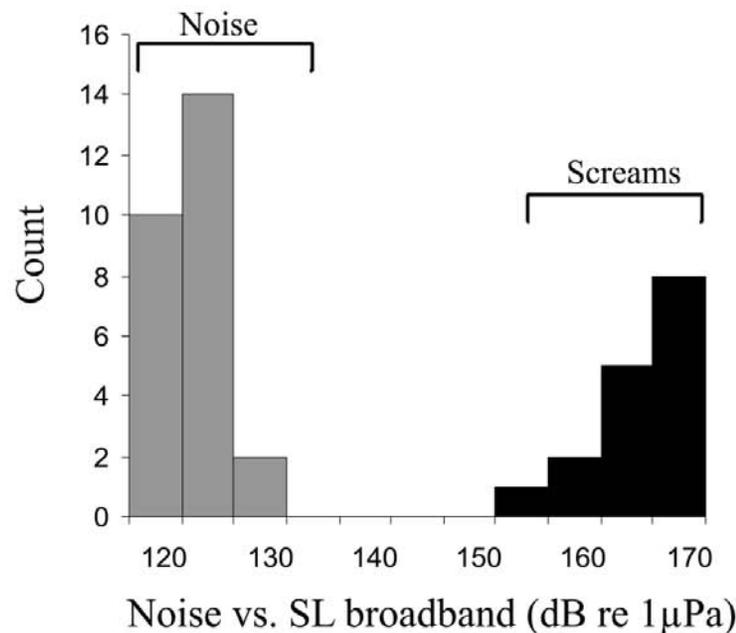
Discussion points for identifying biologically relevant target levels for quieting

- Tonals
- Area-specific goals and monitoring
 - Species
 - Habitats
- Documentation of levels that actually cause disturbance

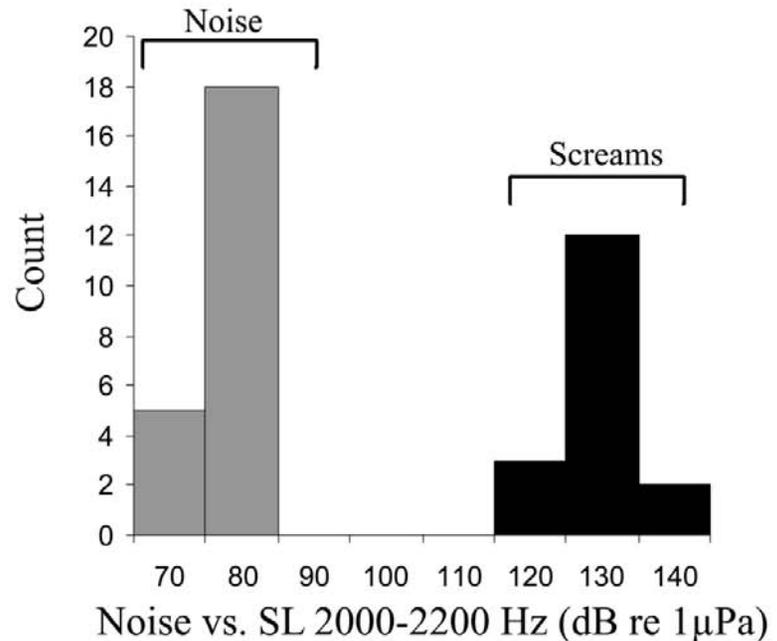


Vessel Noise 40 dB below Right Whale Calls (Parks 2003)

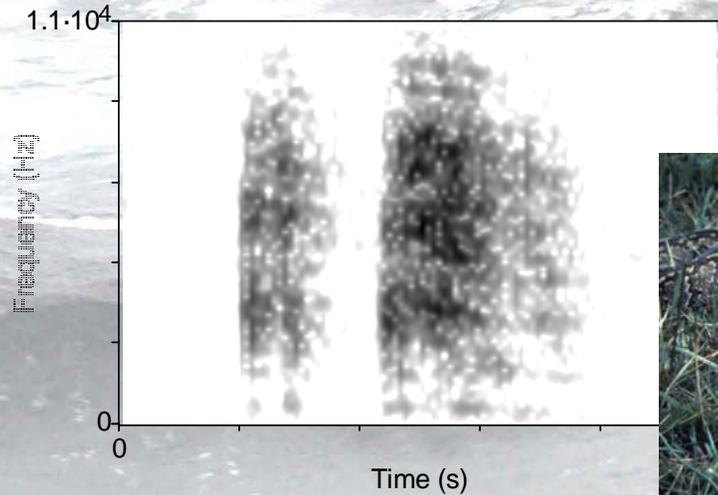
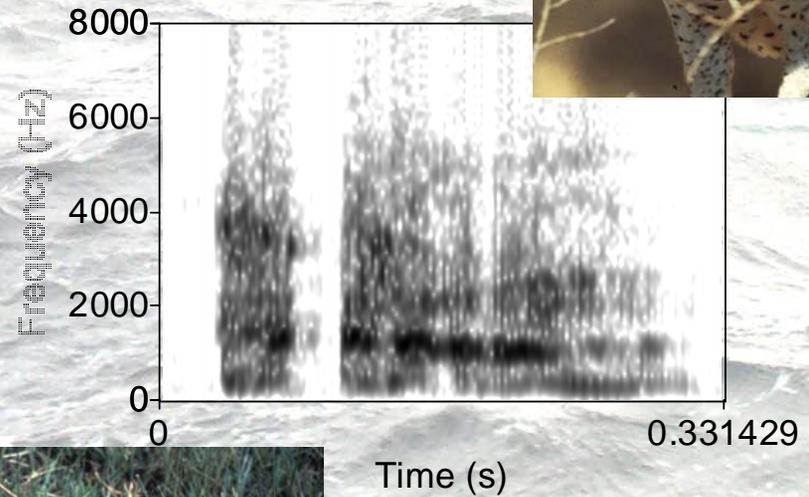
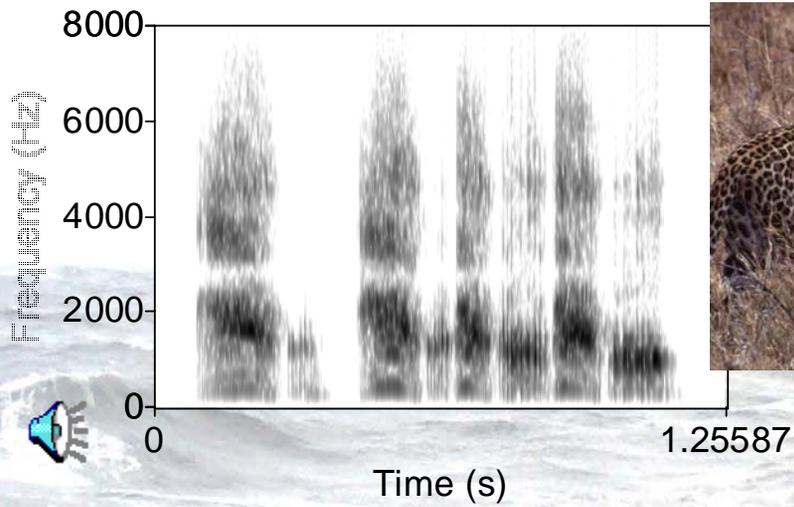
a)



b)



Vervet monkey alarm calls



Cheney and Seyfarth