MARINE MAMMALS & NOISE:

Scientific Overview

Environmental Law Institute
2008 Ocean Seminar Series:
Managing Industrialized Oceans
Seminar 3: ***Noisy Oceans – Beyond Navy Sonar***
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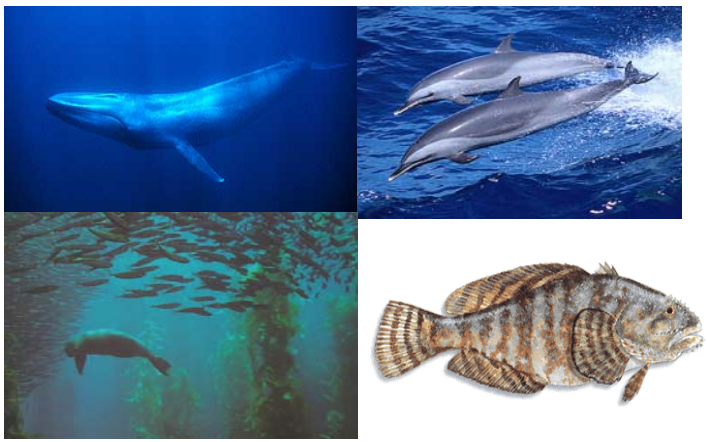
Anthropogenic Sound and Marine Life

Humans produce underwater sound either *intentionally* (sonar, seismic exploration, research, navigation) or *incidentally* (shipping, drilling, construction)



Similarly, marine animals produce sound and listen for environmental acoustic cues. Underwater sound is very important in life history

WHEN IS ANTHROPOGENIC SOUND A THREAT TO MARINE LIFE?

WHAT CAN BE DONE TO MITIGATE IMPACTS WHILE ALLOWING ACTIVITIES VITAL TO NATIONAL & ECONOMIC SECURITY?

Anthropogenic Sound and Marine Life:
Focusing Events and Recent Developments

Focusing Events

- ATOC, mass stranding events
- Series of NRC reports, MM Commission FACA panel

Broadening of the Issue

- Shipping, seismic operations, pile-driving, offshore wind farms, offshore LNG, other active sonars
- Recognition that *chronic sources may be as or potentially more significant for populations of animals than acute ones*

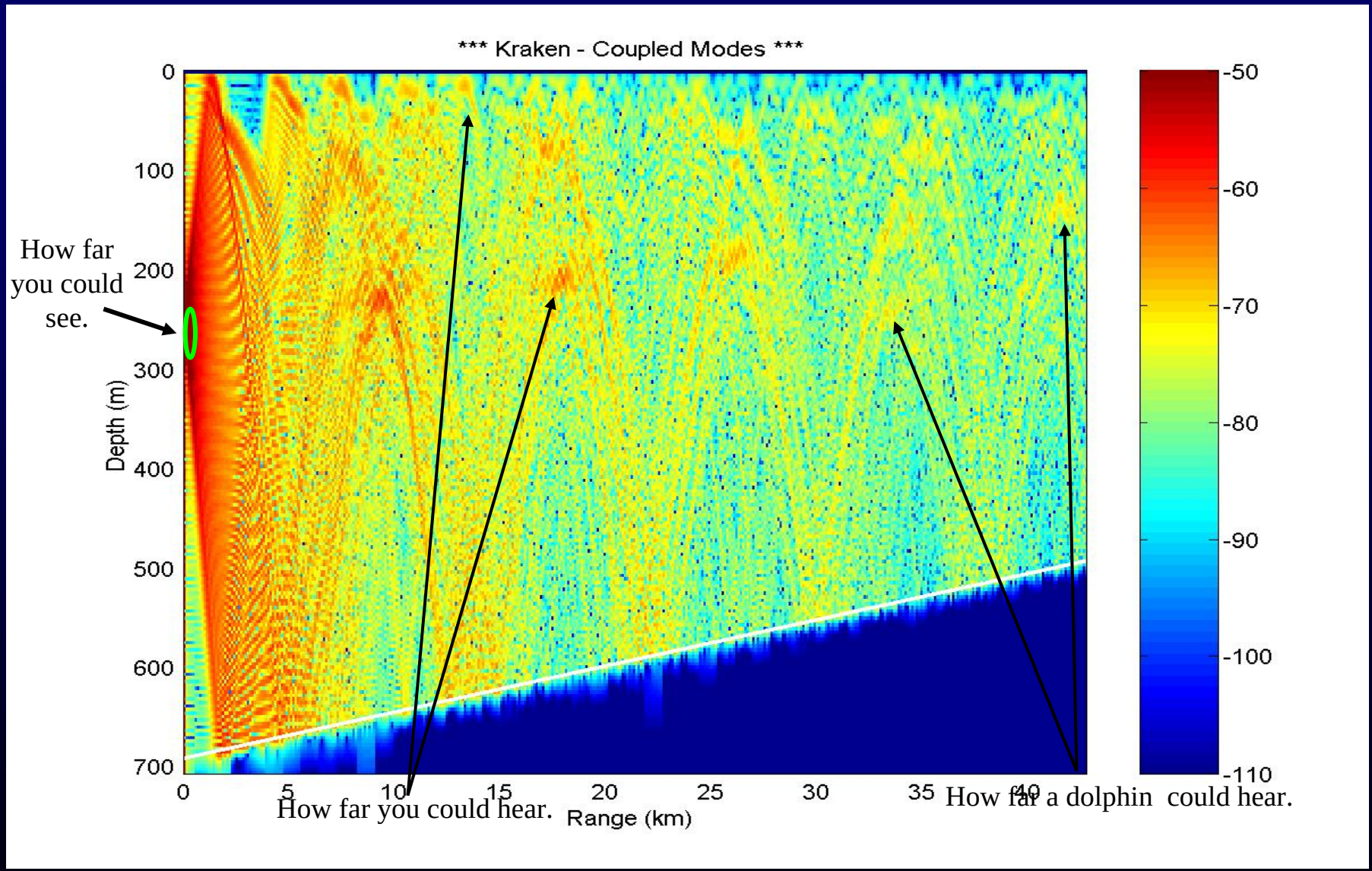
Recent Developments

- Rapid advancement in data-loggers and passive acoustic technology
- Marine mammal noise exposure criteria; fish and sea turtles
- International symposia on vessel-quieting technologies
- Inter-agency Acoustics Task Force (10+ agencies; reports to JSOST)



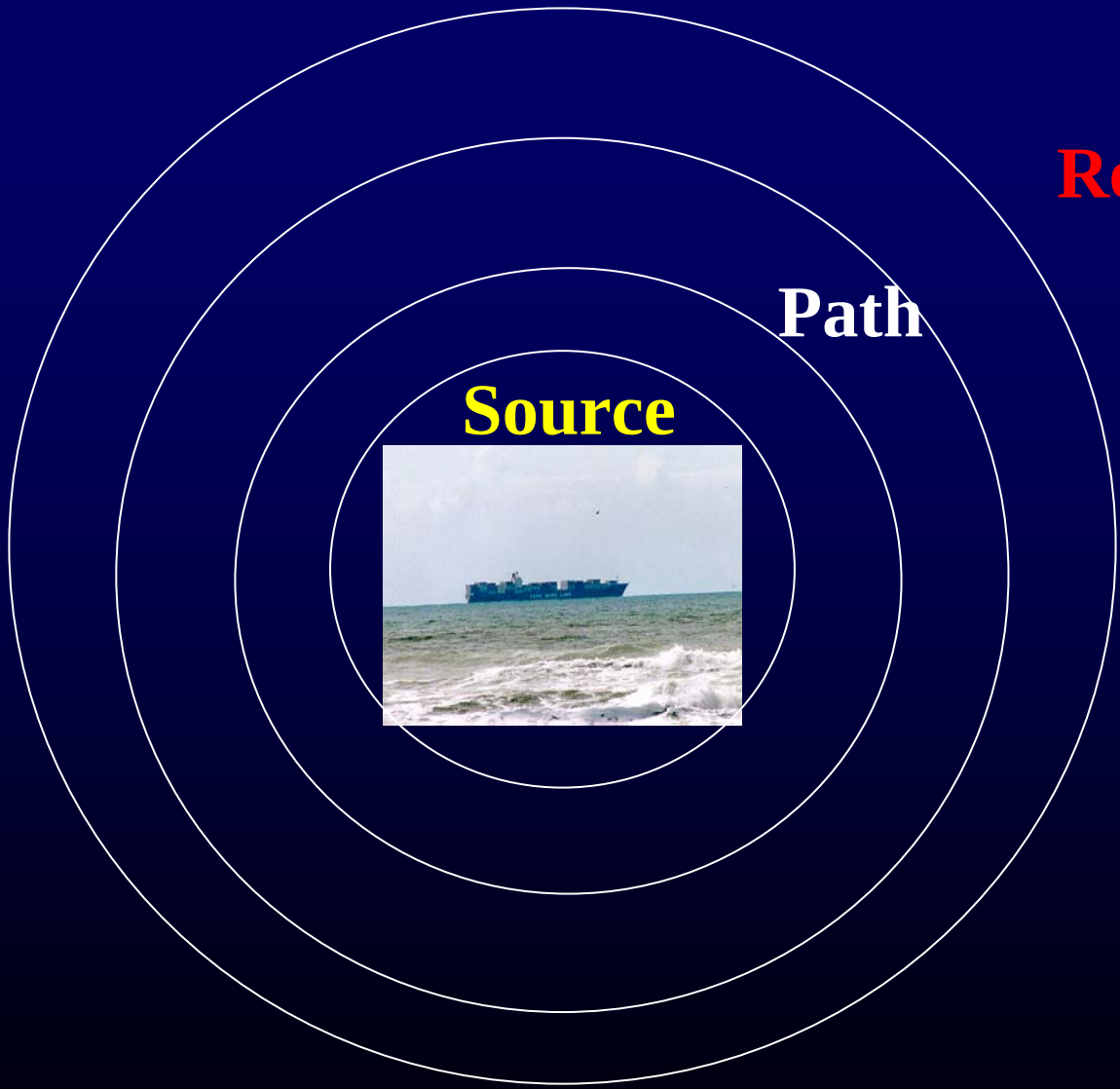



Sound usually travels much farther than light underwater (and it is highly variable)

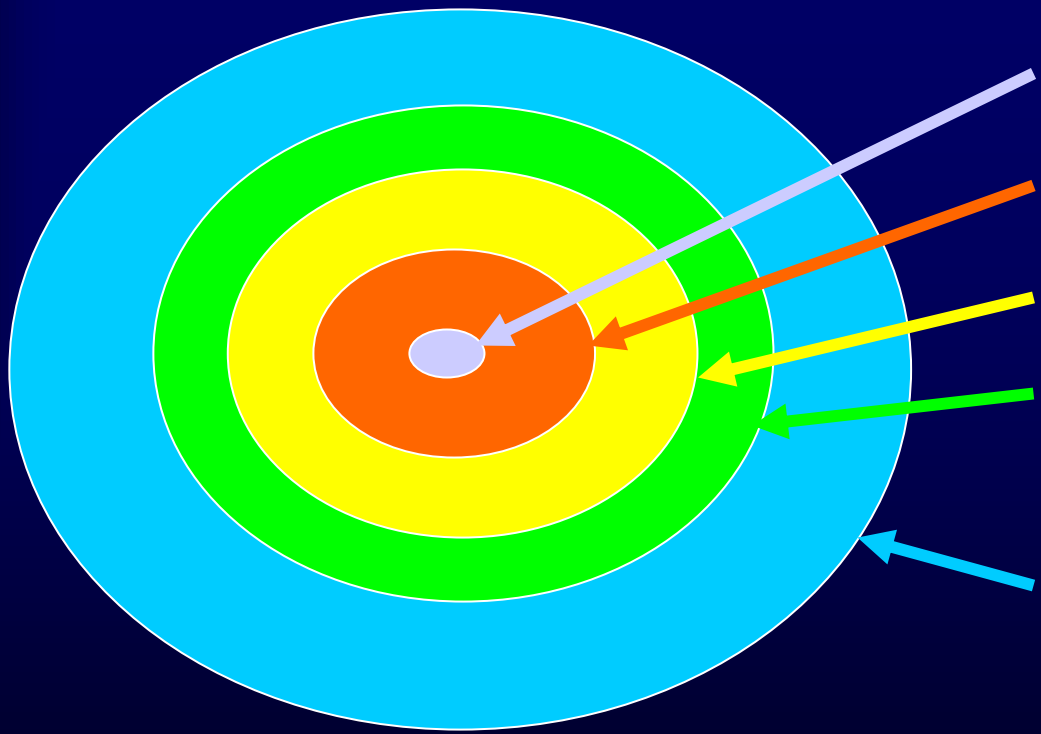


Courtesy: R. Gisiner

Source-Path-Receiver Model for Estimating Noise Impacts



Spatial Zones of Noise Influence



- Injury
- Hearing Loss
- Masking
- Behavioral disturbance
- Audibility
- Non-Auditory effects?

Adapted from Richardson *et al.*, 1995

Source-Path-Receiver Model for Estimating Noise Impacts

Source Parameters

Source Level

Frequency Characteristics

Temporal Patterns

Directivity Patterns

Geographical Location

Depth of Source

Time of Year

Path Parameters

Signal Propagation

Ambient Noise Levels

Noise Frequencies

All Envt. Features

Receiver Parameters

Absolute Hearing

Masked Hearing

Frequency Processing

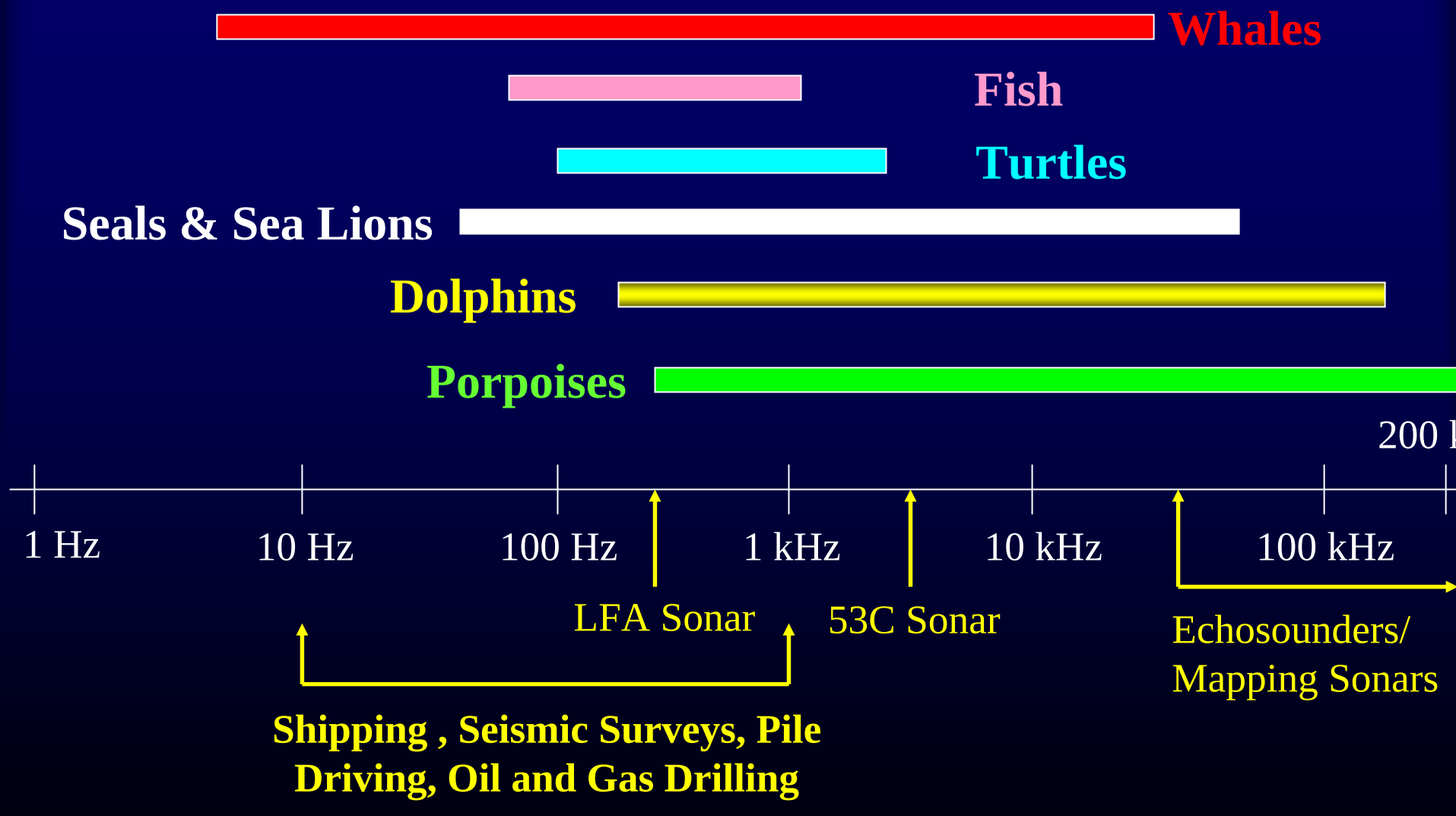
TTS & PTS

Motivational Factors

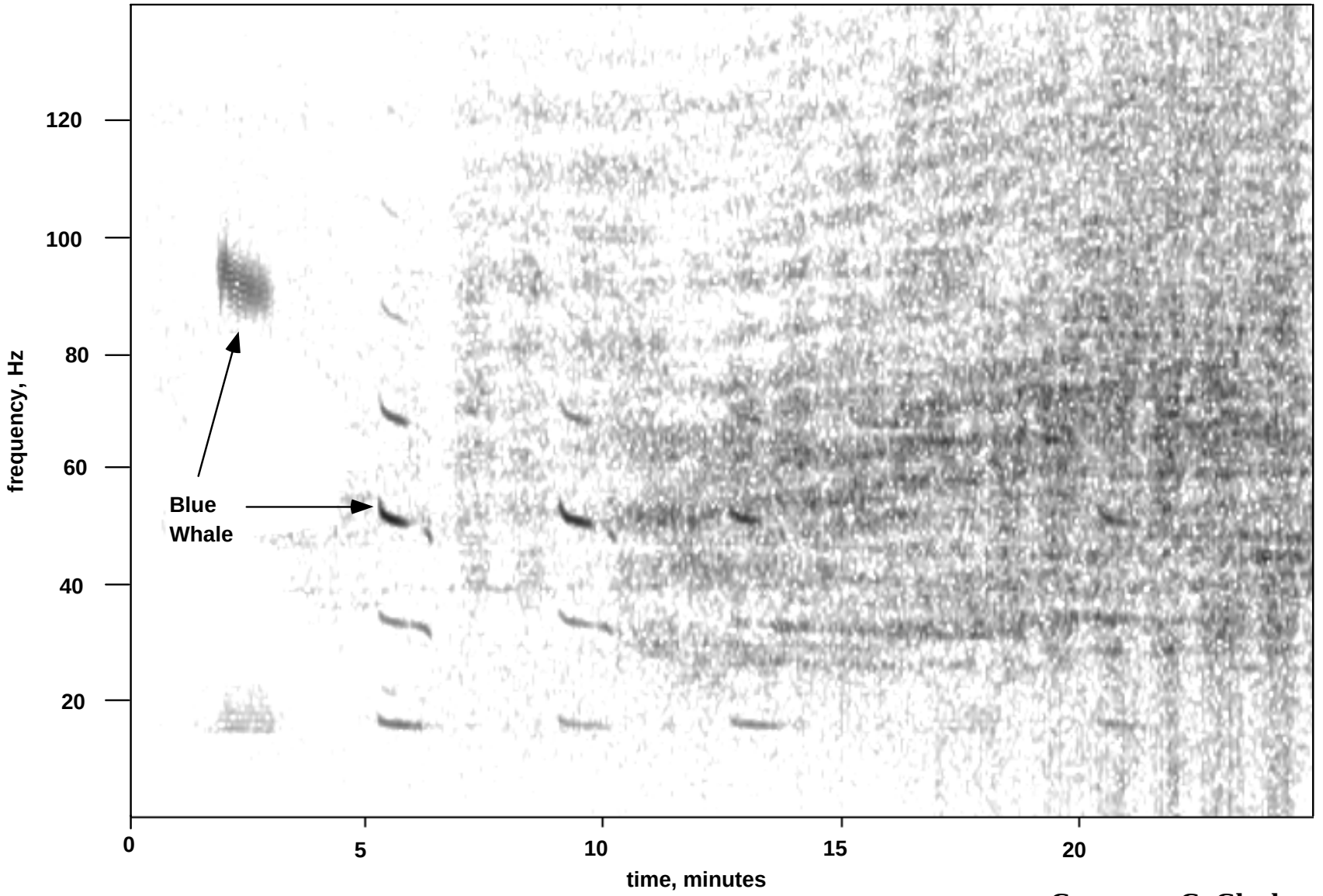
Experiential Factors

All Envt. Features

Frequency Relationships Between Marine Animal Hearing and Human Noise Sources



Marine Mammal Calls and Masking



Courtesy: C. Clark

MARINE MAMMAL NOISE EXPOSURE CRITERIA:

INITIAL SCIENTIFIC RECOMMENDATIONS

B. L. SOUTHALL[1, 2], A. E. BOWLES[3] , W. T. ELLISON[4] , J. J. FINNERAN[5] , R. L. GENTRY[6] , C. R. GREENE JR.[7], D. KASTAK [2], D. R. KETTEN[8,9], J. H. MILLER[10] , P. E. NACHTIGALL[11], W. J. RICHARDSON[12] , J. A. THOMAS[13] , P. L. TYACK[8]

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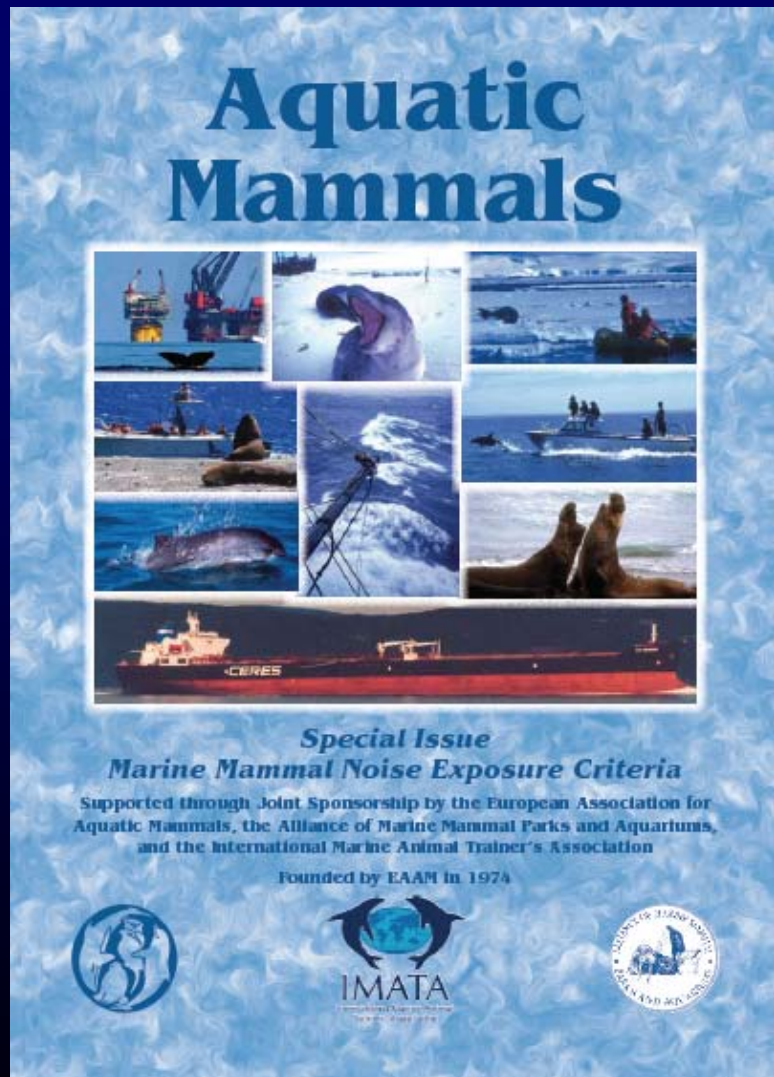
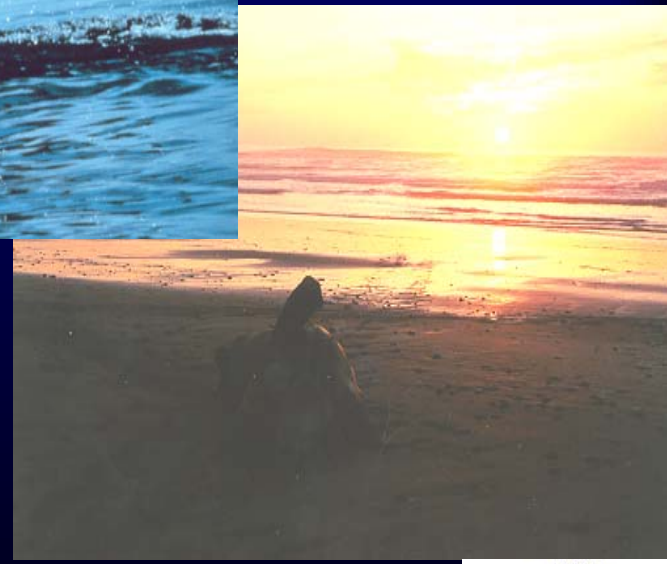
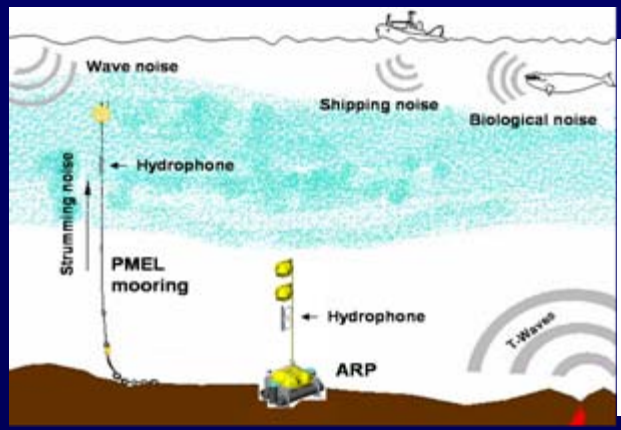


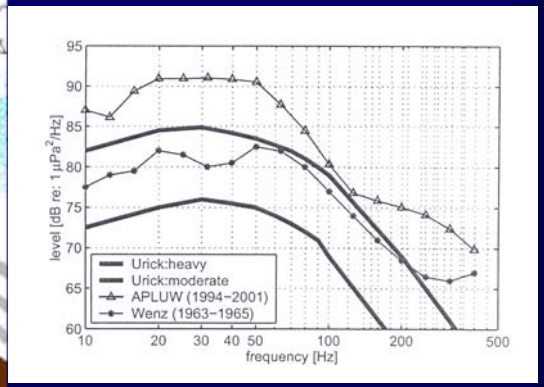
Discussion



Passive Acoustics: Advancing Technologies

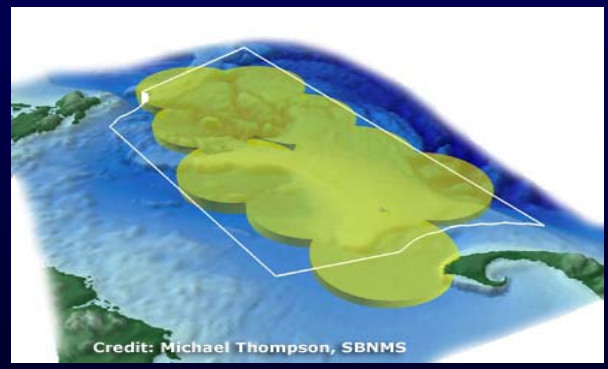
• **Monitoring ambient noise and abiotic sources:** spatial distribution and trends
(NRC & other recommendations)



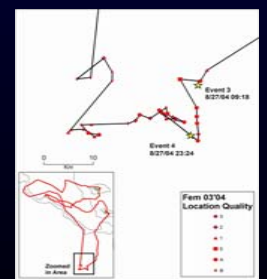


• **Augmenting survey methods**: detection and characterization of LMR
(Stellwagen Bank NMS/NEFSC)

N. Atl. Right Whales: Jan – March 06
4 visual vs. **5149** acoustic detections



• **Acoustic tags**: acoustics, behavior, and physiology (CEEs)



Overall Conclusions and Next Steps

We still know quite little about the effects of noise on marine life, but over the past decade, knowledge has been increasing rapidly.

There are obvious issues on which scientists, users, and managers must focus. More subtle effects must also be considered.

- Expand knowledge of hearing and the full range of noise impacts on individuals
- Develop flexible, noise monitoring networks comprised of local and regional sub-elements (e.g., Stellwagen Bank NMS)
- Quantify the biological significance of behavioral disturbance and **communication masking**
- Develop means of considering noise impacts on populations and entire ecosystems

Behavioral Reactions of Marine Animals to Noise

- None observable - animals can become less sensitive over repeated exposures
- Looking or increased alertness
- Cease feeding or social interaction
- Habitat abandonment: temporary or permanent
- Stranding causing injury or death (via direct response or possibly exacerbated by non-auditory physiological factors)