Acoustic Ecology : Spatio-temporal Variability in Bioacoustic Space

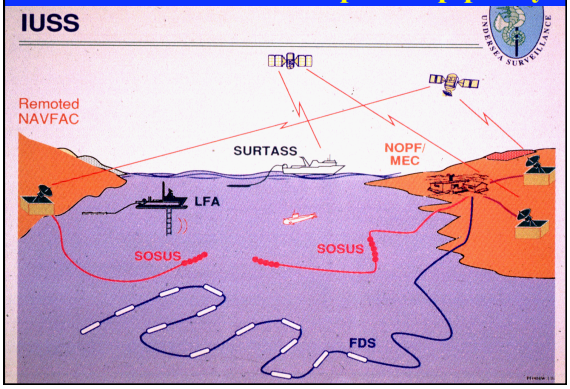
James Reserve Acoustic Monitoring Conference; 15-18 October 2008

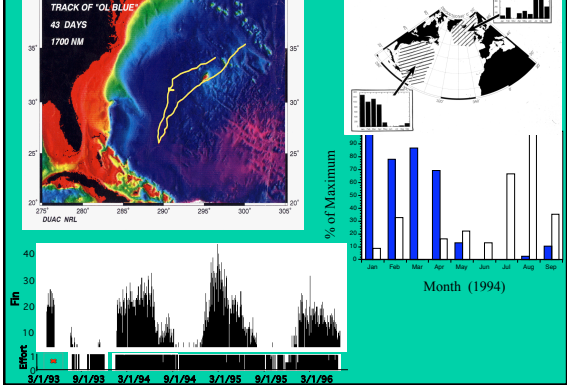
Christopher W. Clark, Cornell Bioacoustics Research Program
Ithaca, NY USA http://www.birds.cornell.edu/brp/

Motivators and Questions

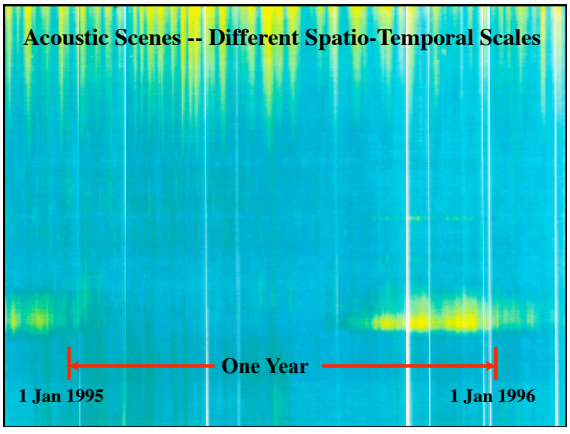
- To better understand the spatial and temporal scales of an animal's world where sound, not vision, is the primary sense [whales as proxy].
- Bioacoustic variability - proximate and ultimate, why & how questions, influence of biotic and abiotic factors etc.
  - presently poor understandings of SLs and TLs, scales of communication, integration times, coupled with a lack of standards and robust tools)
- Bioacoustic habitats, scenes, and ecologies - moving beyond the simple into reality (some animals can multitask)

IUSS – Acoustic Telescopes = Epiphany





Acoustic Scenes -- Different Spatio-Temporal Scales



Whales (an extreme case) adapted to perceive the ocean by listening to and producing sounds

Blue Whale – Deep Water, Cosmopolitan

Atlantic Blue Whale Song -- sped up 30 times

QuickTime™ and a
decompressor
are needed to see this picture.

Fin Whale – Deep Water, Cosmopolitan

Atlantic Fin Whale Song -- sped up 30 times

QuickTime™ and a
decompressor
are needed to see this picture.

Humpback – Shallow & Deep, Cosmopolitan

Humpback Whale Song -- normal speed

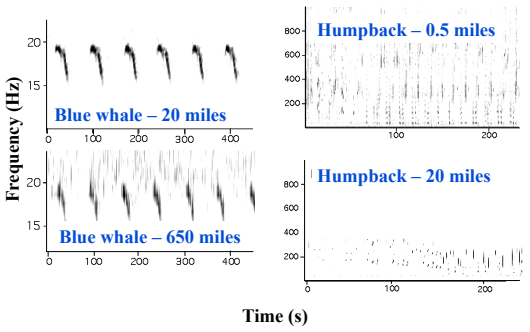
QuickTime™ and a
decompressor
are needed to see this picture.

Bowhead Whale - Shallow, Coastal Arctic

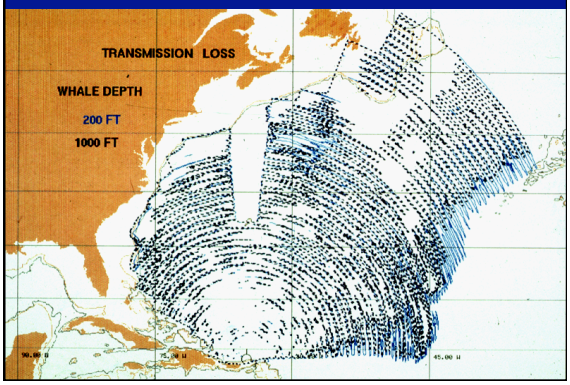
Bowhead Whale Song (two voiced) -- normal speed

QuickTime™ and a
decompressor
are needed to see this picture.

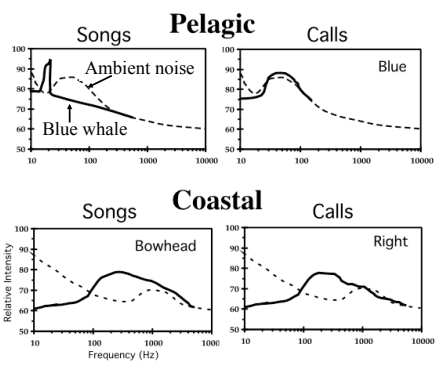
Physics strongly influences what gets through



Some whales can be heard across an ocean basin

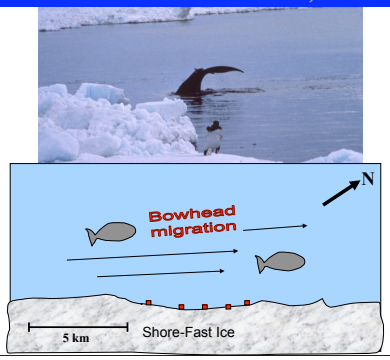


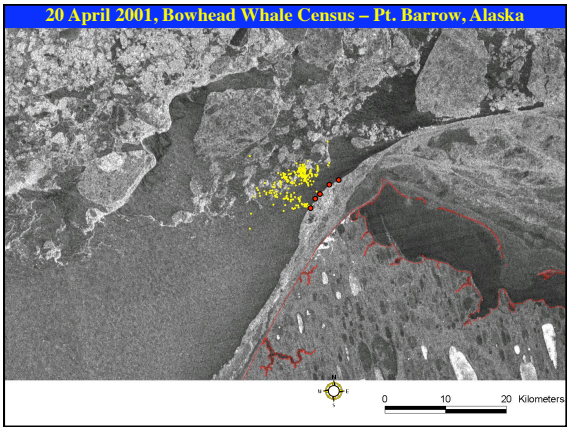
Whales produce sounds in "windows" of low noise

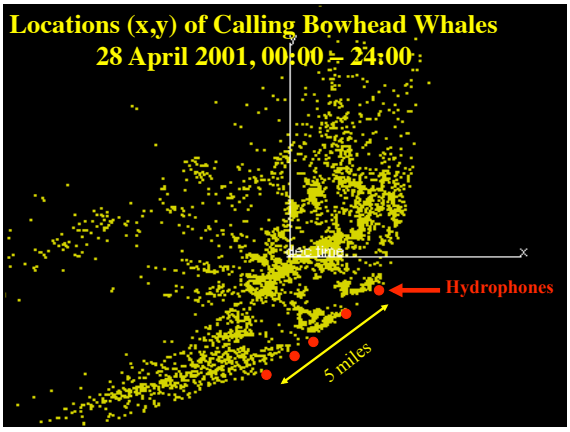


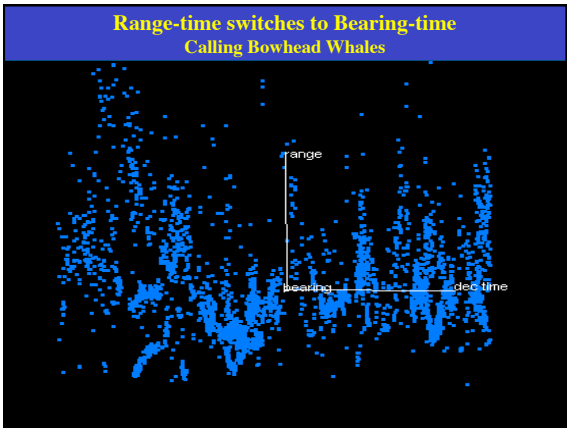
What can monitoring tell us?

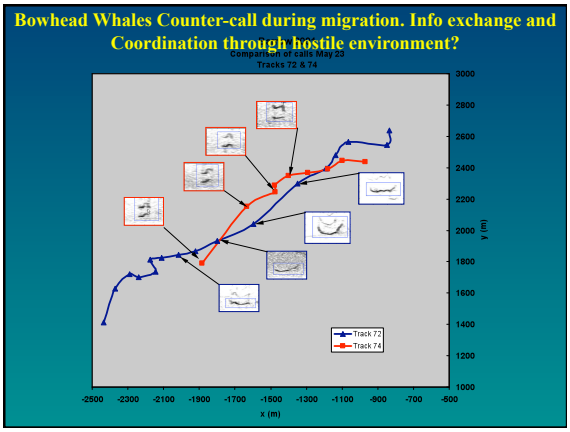
Bowhead Whales - Barrow, Alaska

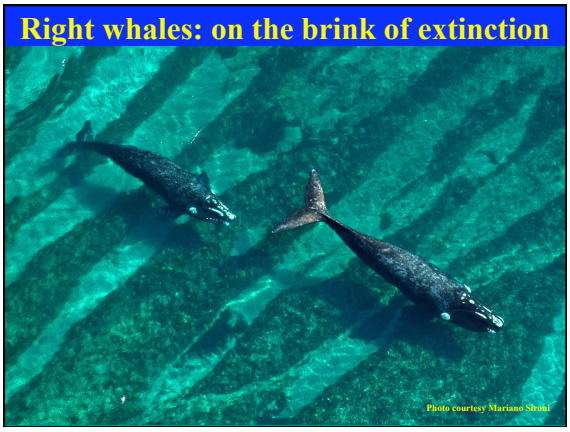


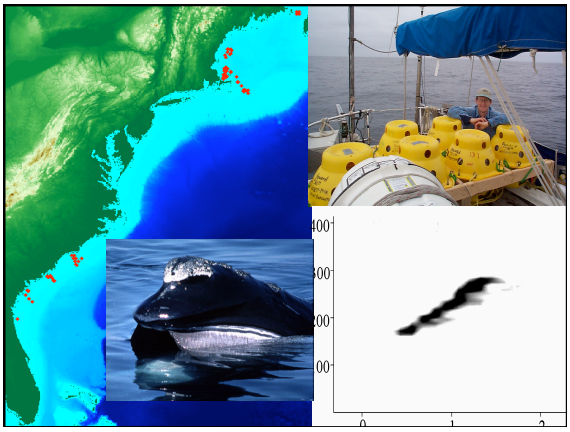

20 April 2001, Bowhead Whale Census – Pt. Barrow, Alaska
0
10
20 Kilometers

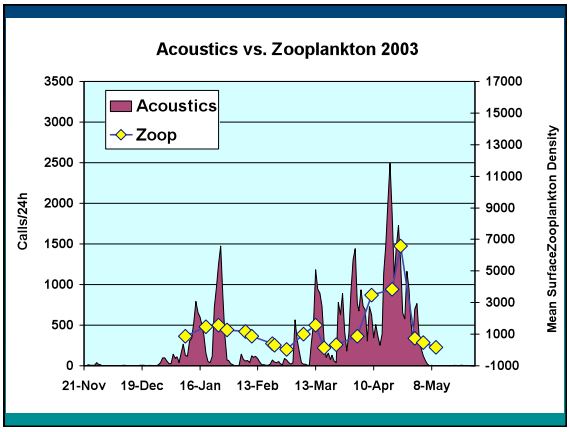

Locations (x,y) of Calling Bowhead Whales
28 April 2001, 00:00 – 24:00
Hydrophones
5 miles

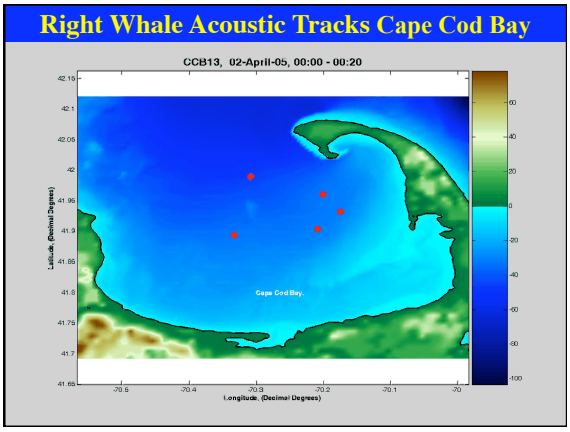

Range-time switches to Bearing-time
Calling Bowhead Whales
range
bearing
dec time

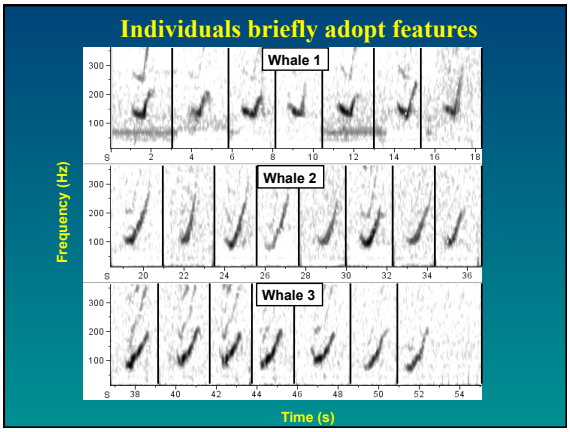

Bowhead Whales Counter-call during migration. Info exchange and
Coordination through hostile environment?
Tracks 72 & 74
Track 72
Track 74
x (m)
y (m)


Right whales: on the brink of extinction
Photo courtesy Mariano Sironi



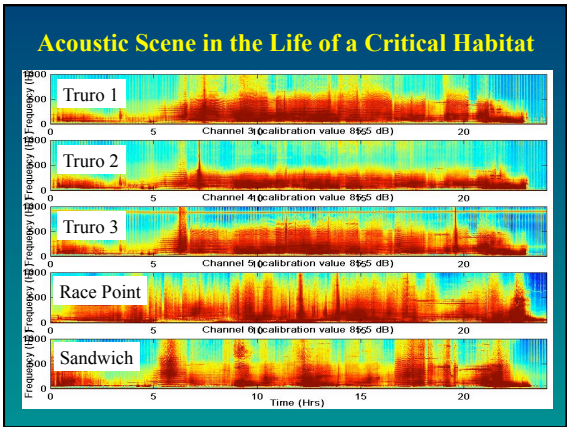


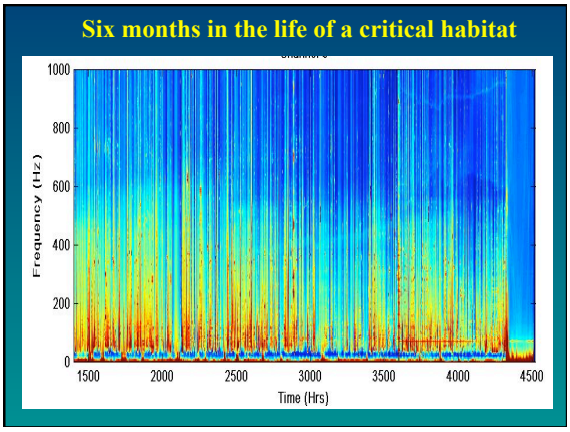


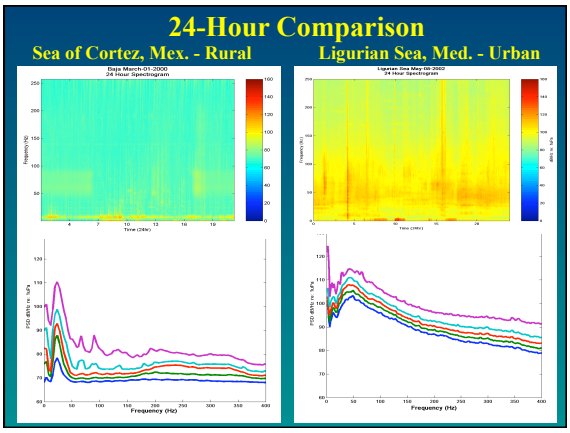


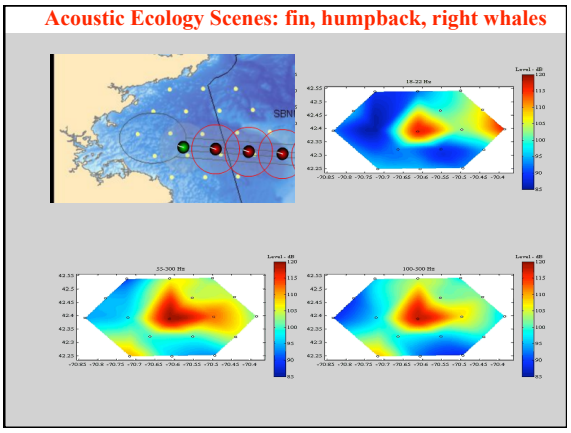
Some Revelations

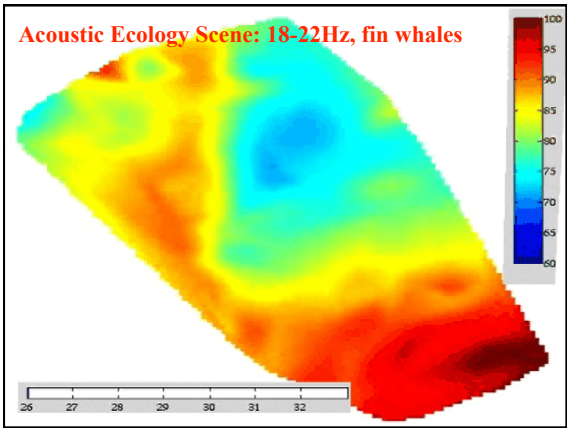
- So what!?
- Insights into different communication scales – sets the boundary conditions, supports hypothesis testing over multiple scales etc.
- Bioacoustic networks, habitats, scenes, ecologies – this is a major field.
- The needs for technical advancements to quantify, describe, interpret and understand.
- Some present directions – bioacoustic mapping

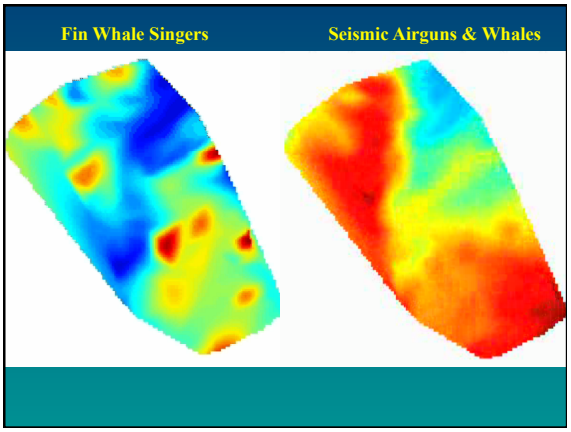


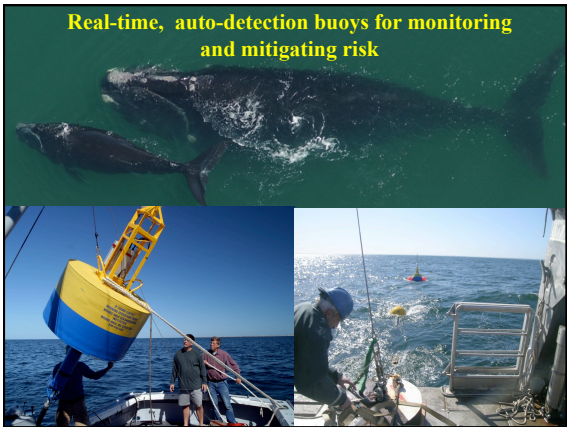


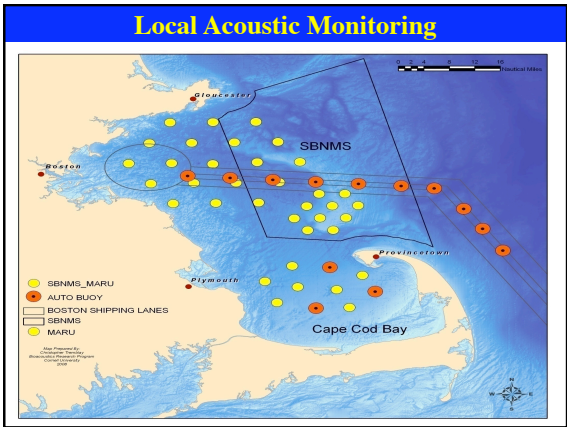

24-Hour Comparison
Sea of Cortez, Mex. - Rural
Ligurian Sea, Med. - Urban

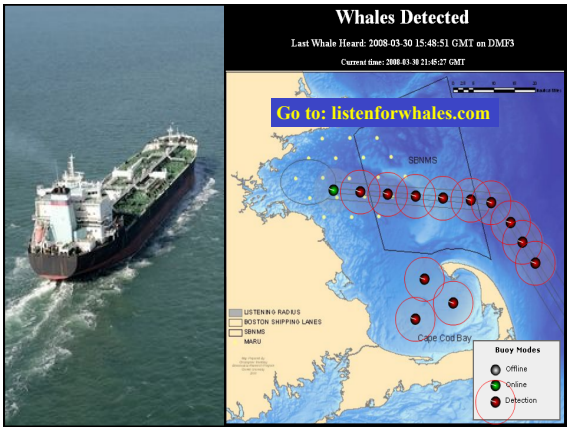

Acoustic Ecology Scenes: fin, humpback, right whales


Acoustic Ecology Scene: 18-22Hz, fin whales


Fin Whale Singers
Seismic Airguns & Whales


Real-time, auto-detection buoys for monitoring and mitigating risk


Local Acoustic Monitoring
SBNMS
Boston
Gloucester
Provincetown
Plymouth
Cape Cod Bay
SBNMS_MARU
AUTO BUOY
BOSTON SHIPPING LANES
SBNMS
MARU



Our Motivators and Questions?

- Understandings of animal acoustic communication systems?
- Over what scales do we need to "monitor" ?
- How can we use IT systems to:
  - monitor for the presence of the animals,
  - study and test assumptions about their communication,
  - evaluate population status,
  - quantify whether or not humans are having an impact?
- How do we evaluate precision and accuracy of methods /results of IT system?
- How do we adequately measure potential impacts on systems that operate over variable scales and are not always amenable to scientific experimentation?
- Ideas about how this group might make a difference?