

Variability in the Gulf of Mexico's Marine Acoustic Environment



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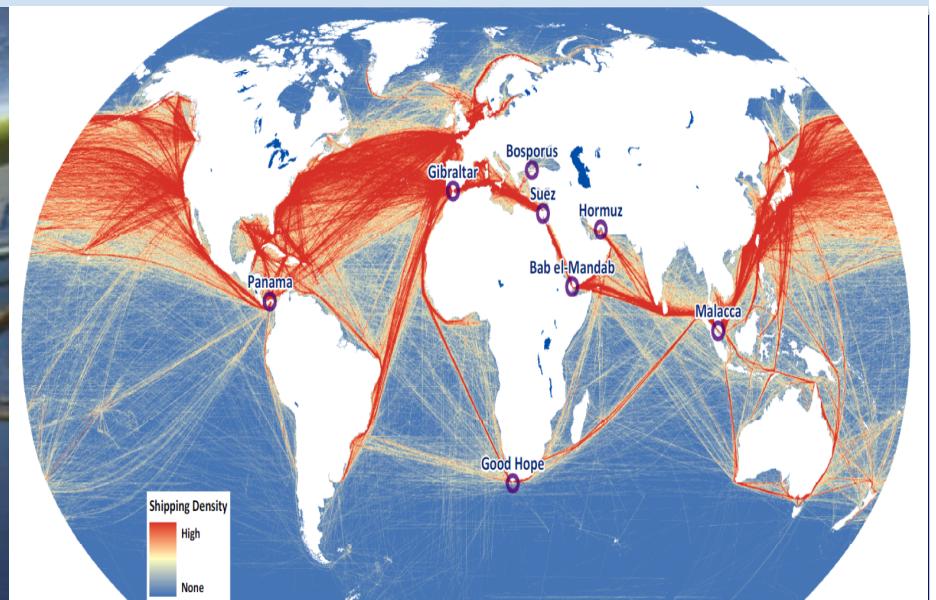
Human activities impose risks to marine health over very large spatial and temporal scales. So What?



Energy



Economics



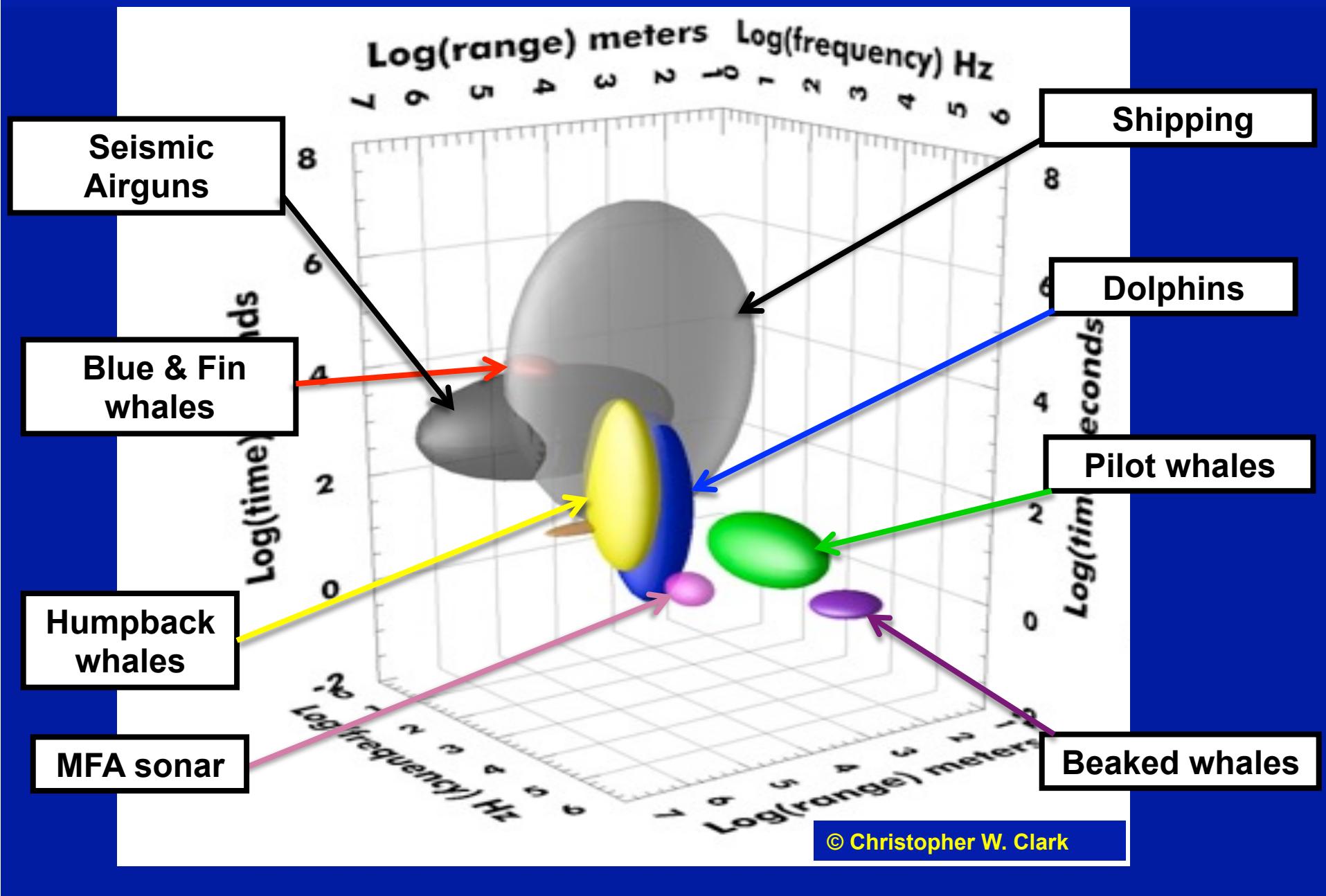
There are no known deaf marine vertebrates, and we're just beginning to learn about the invertebrates.



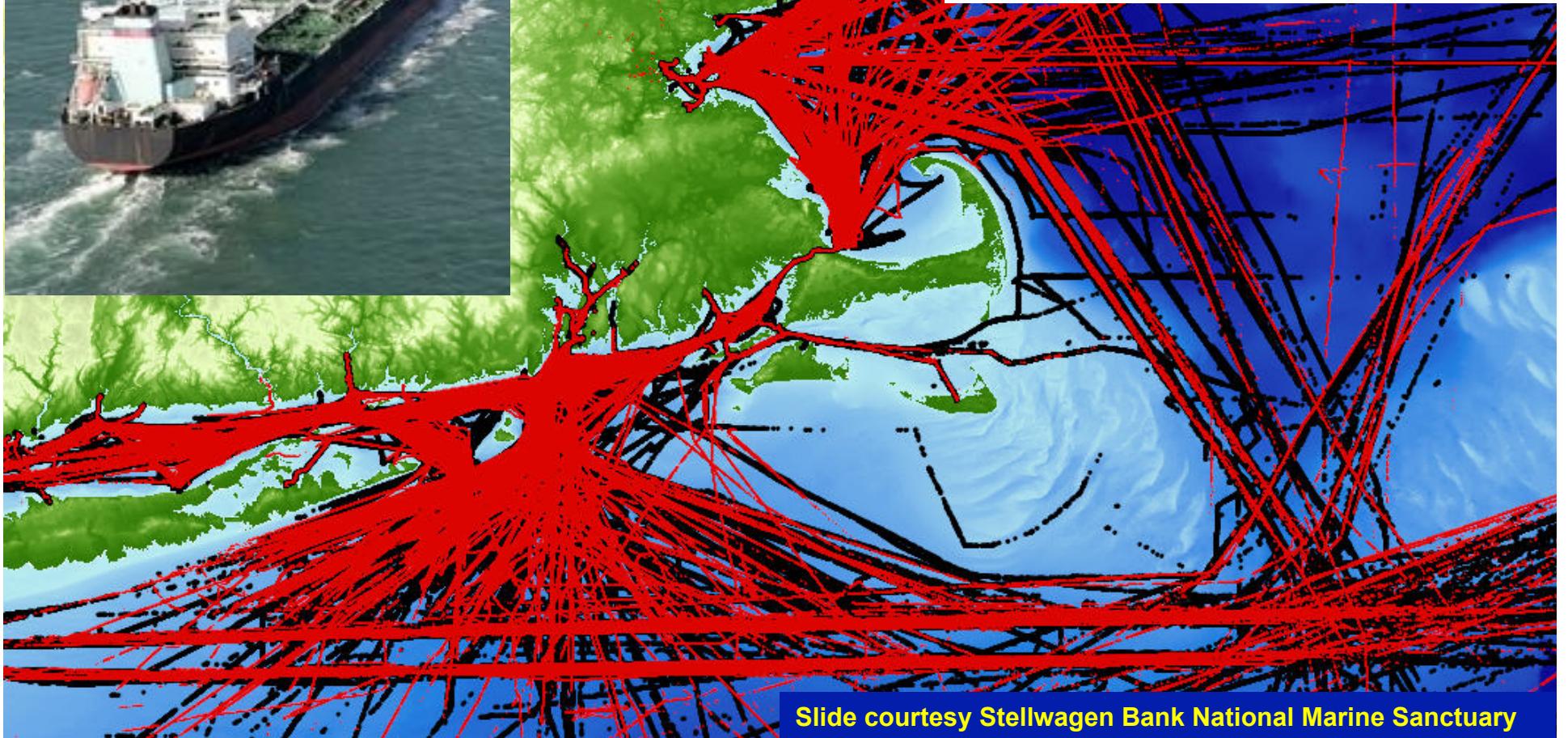
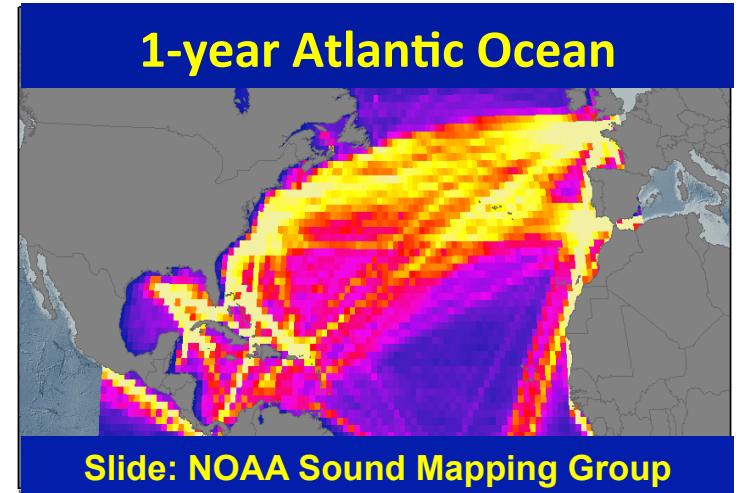
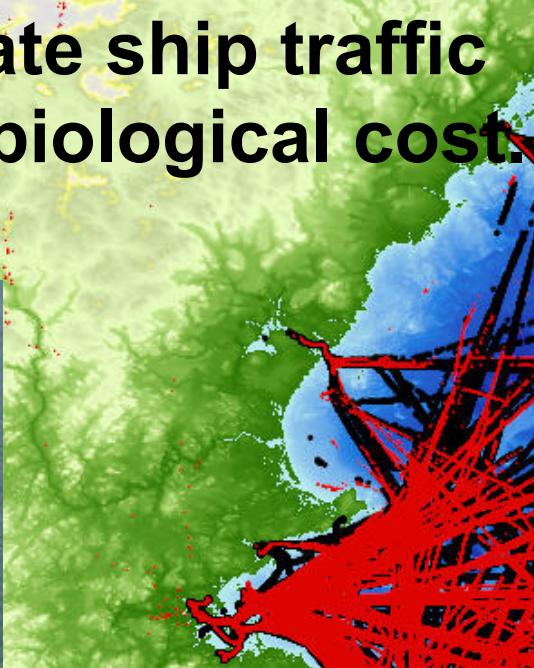
© e-Photography.co.jp



Concept: Marine Mammal & Anthropogenic Production Spaces

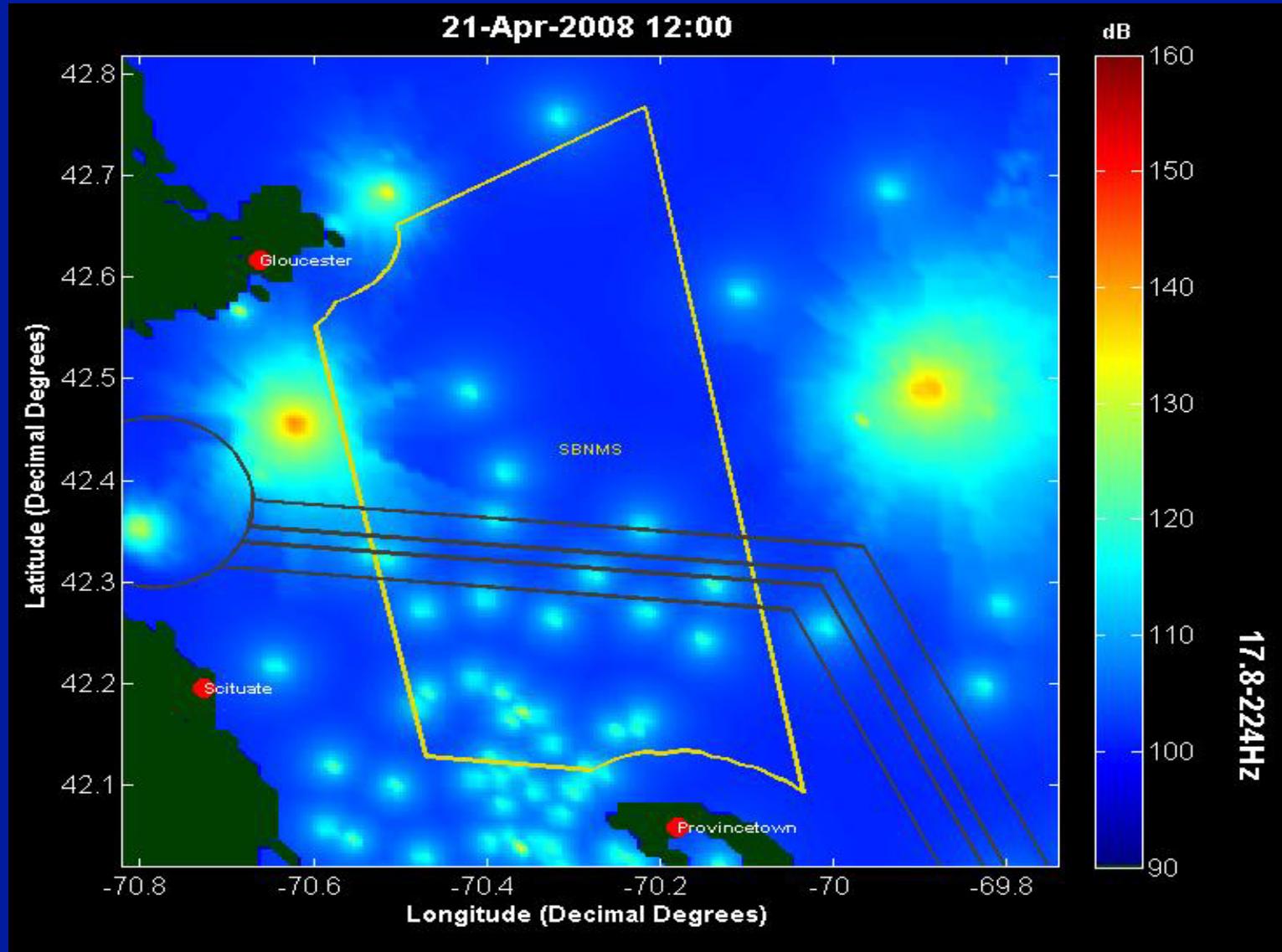


We can aggregate ship traffic noise to predict biological cost.



Translating Scientific-Tech Results into Ecological Risk

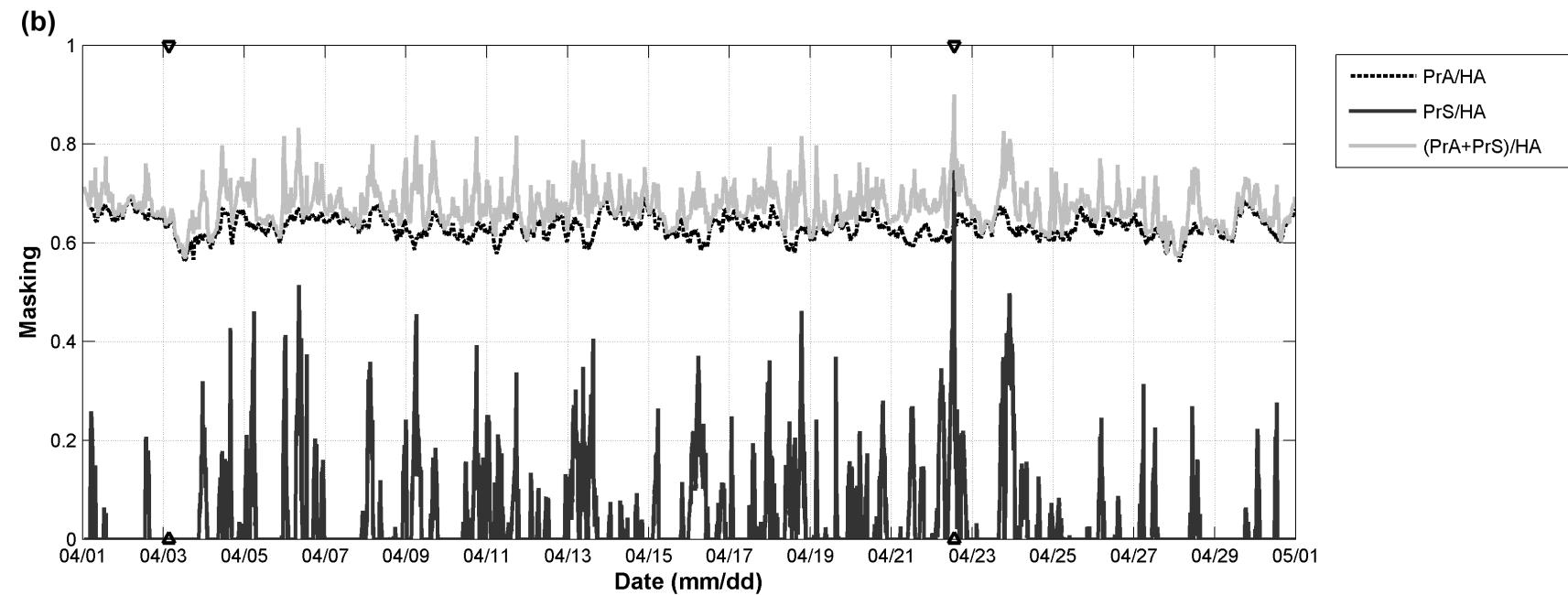
Example: endangered right whales off Boston



NOPP Results = Clark et al. 2009, Ellison et al. 2012, Morano et al. 2012, Hatch et al. 2012

We have a recipe to translate data into estimates of ecological cost.
But some or many of the parameters are not well constrained. Ta Da!

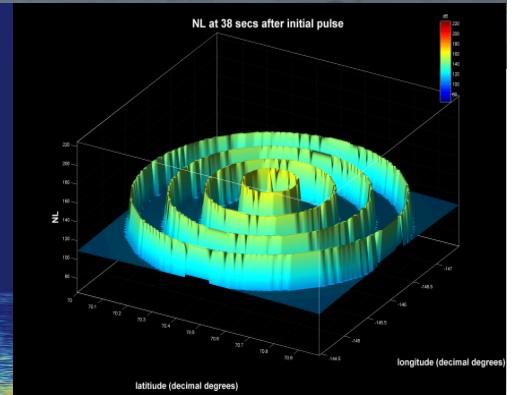
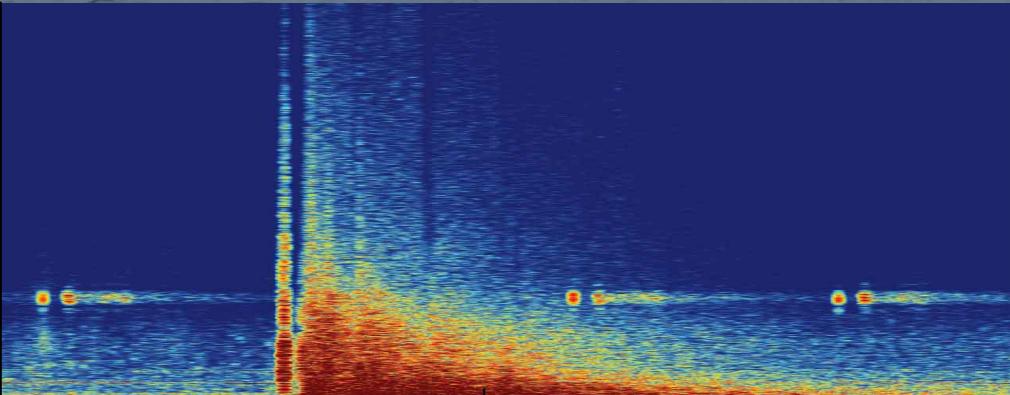
High Chronic Background Noise + Discrete Noise Events = Habitat loss



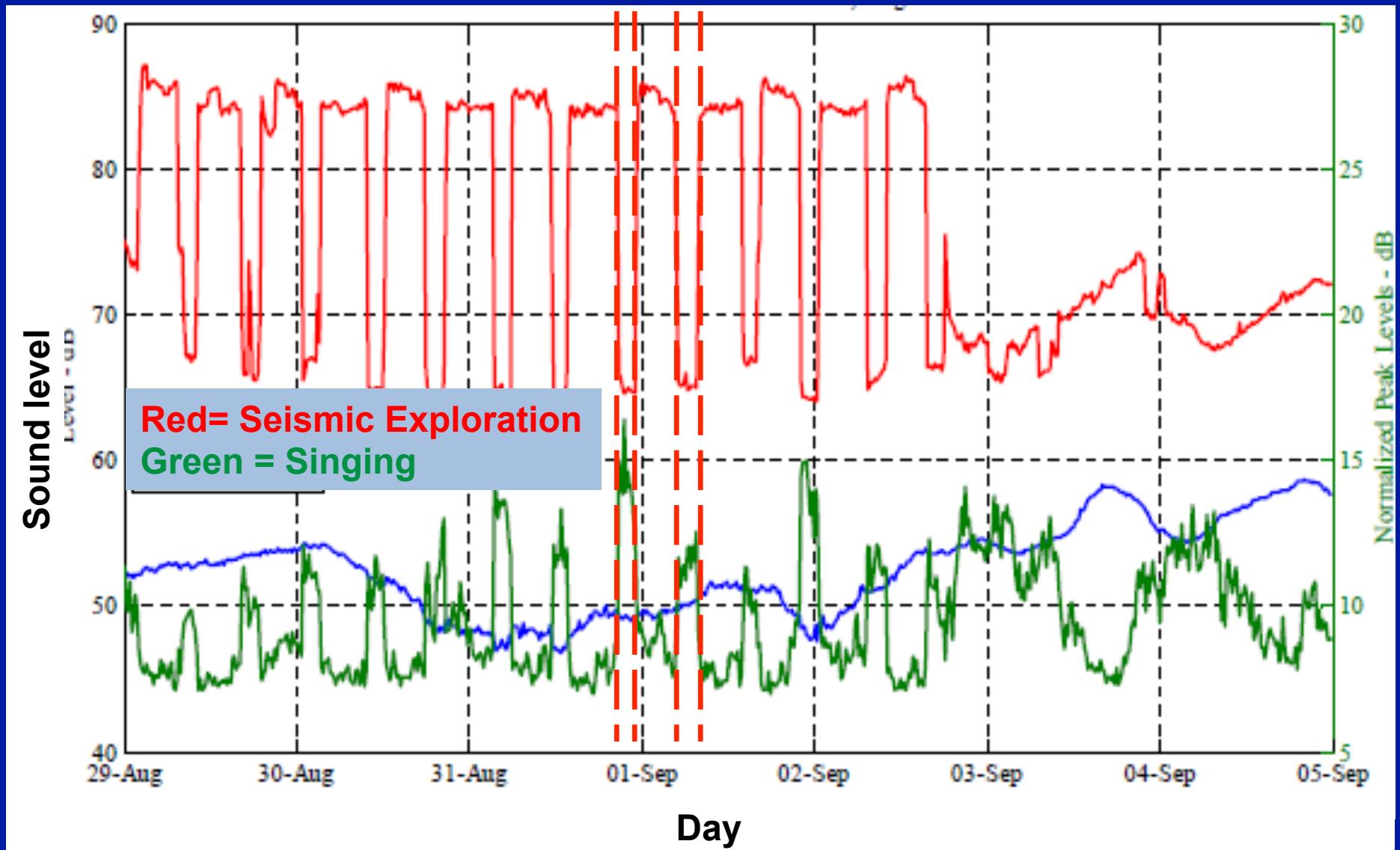
NOPP Results = Clark et al. 2009, Hatch et al. 2012

Seismic Airgun Surveys

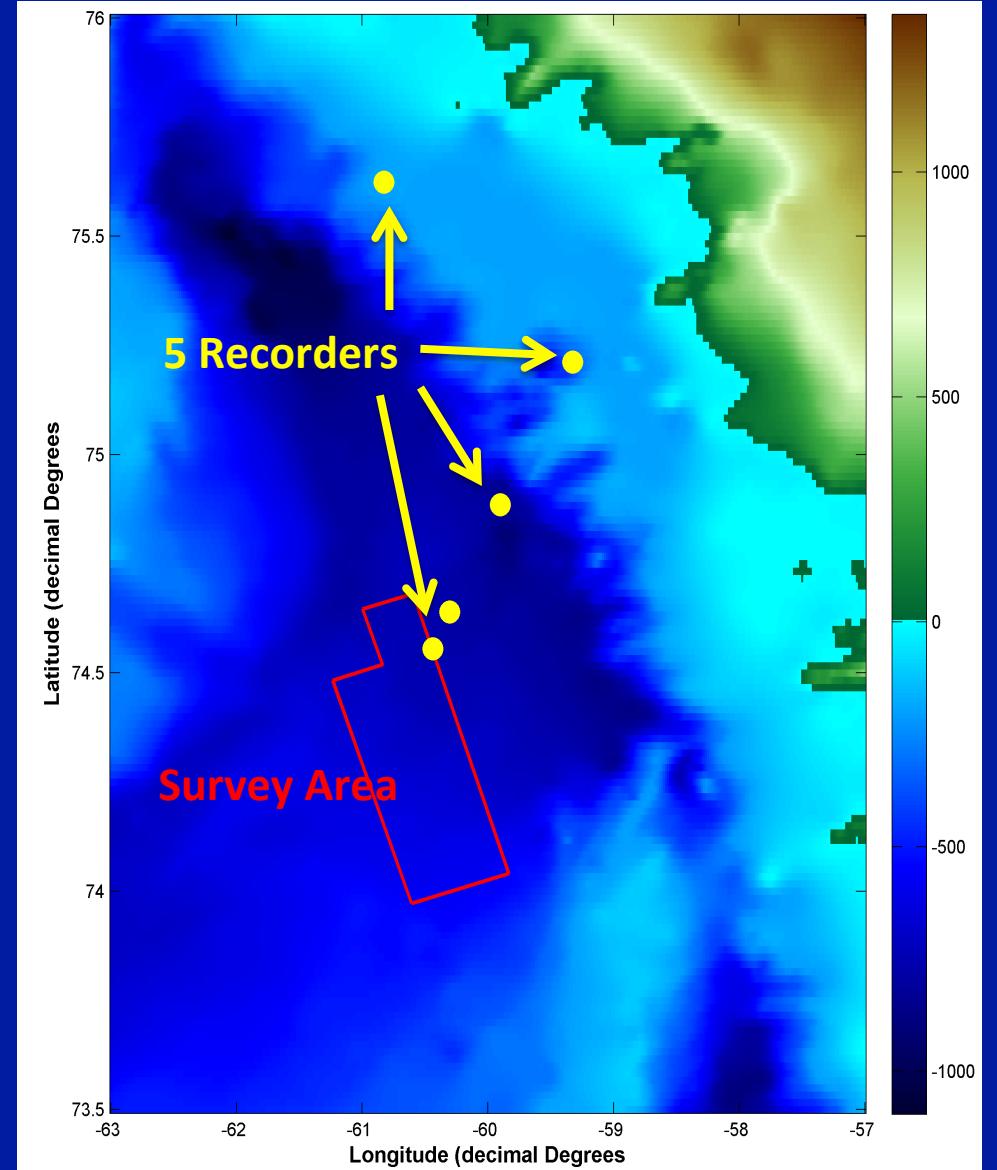
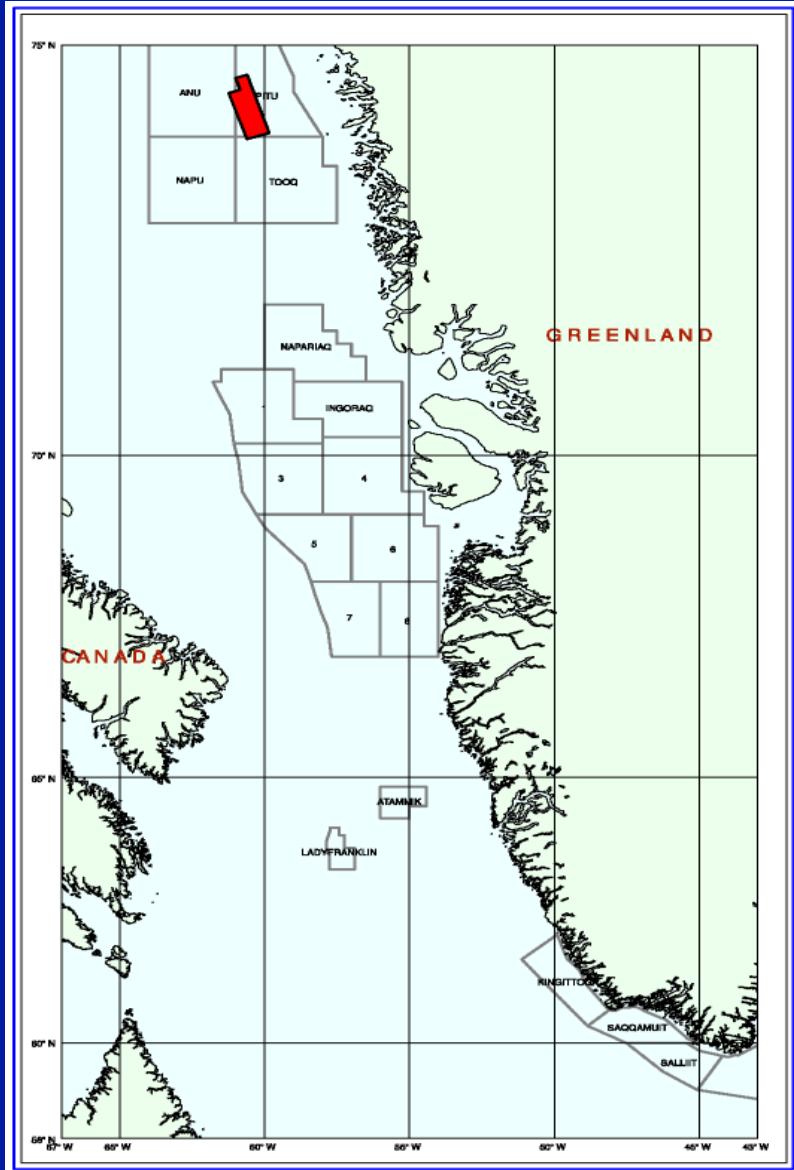
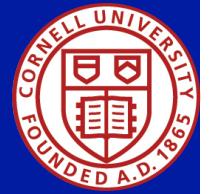
(Intentionally produce a lot of low-frequency acoustic energy, which unintentionally influence acoustic environments over large areas)



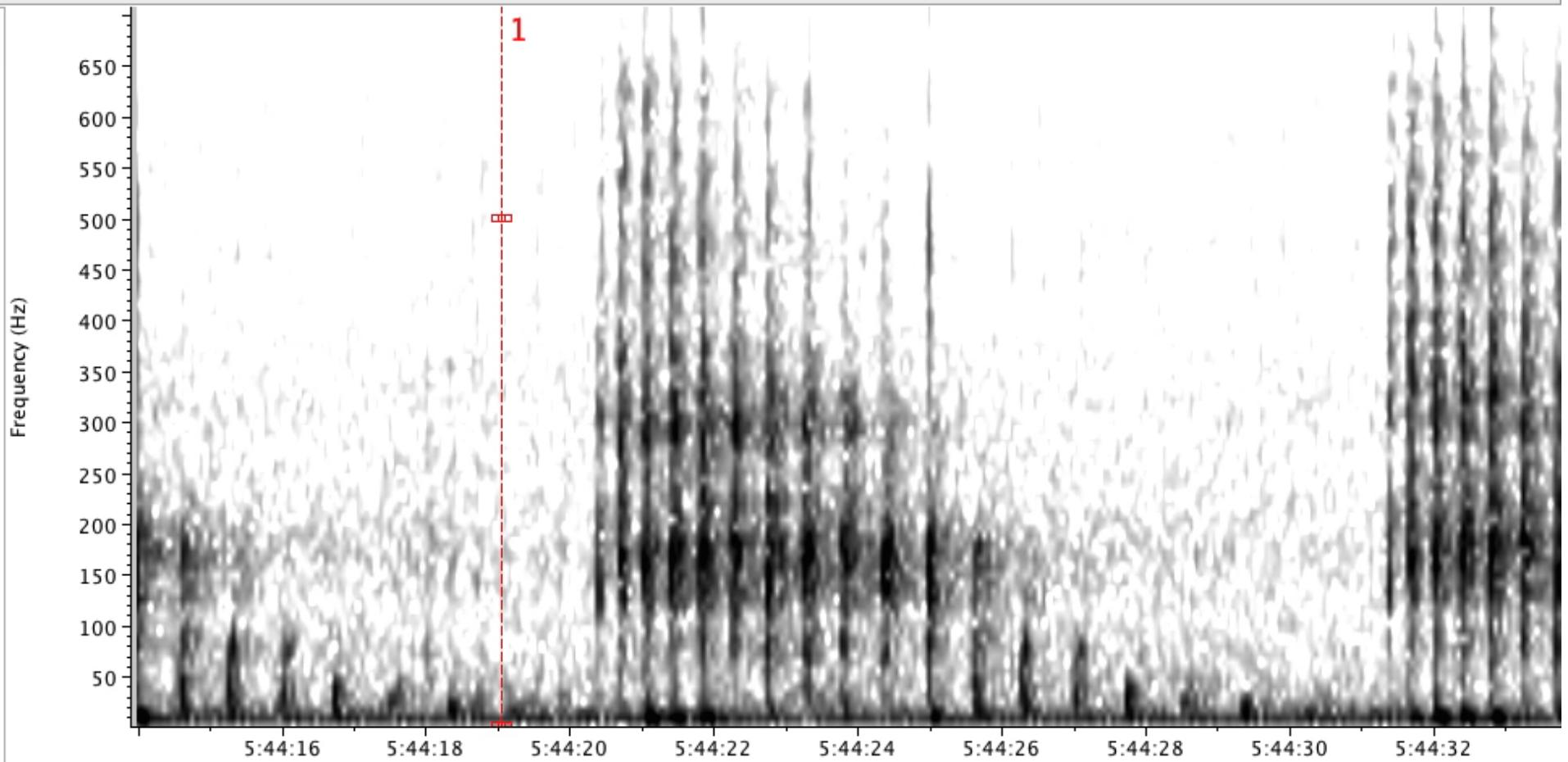
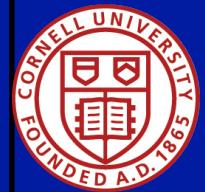
Fin whale singers stop singing when seismic airguns active. Is this response “biologically significant”?



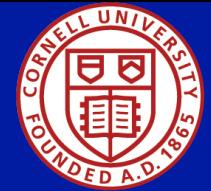
Evaluating the influence of a seismic airgun survey on the acoustic environment in Baffin Bay.



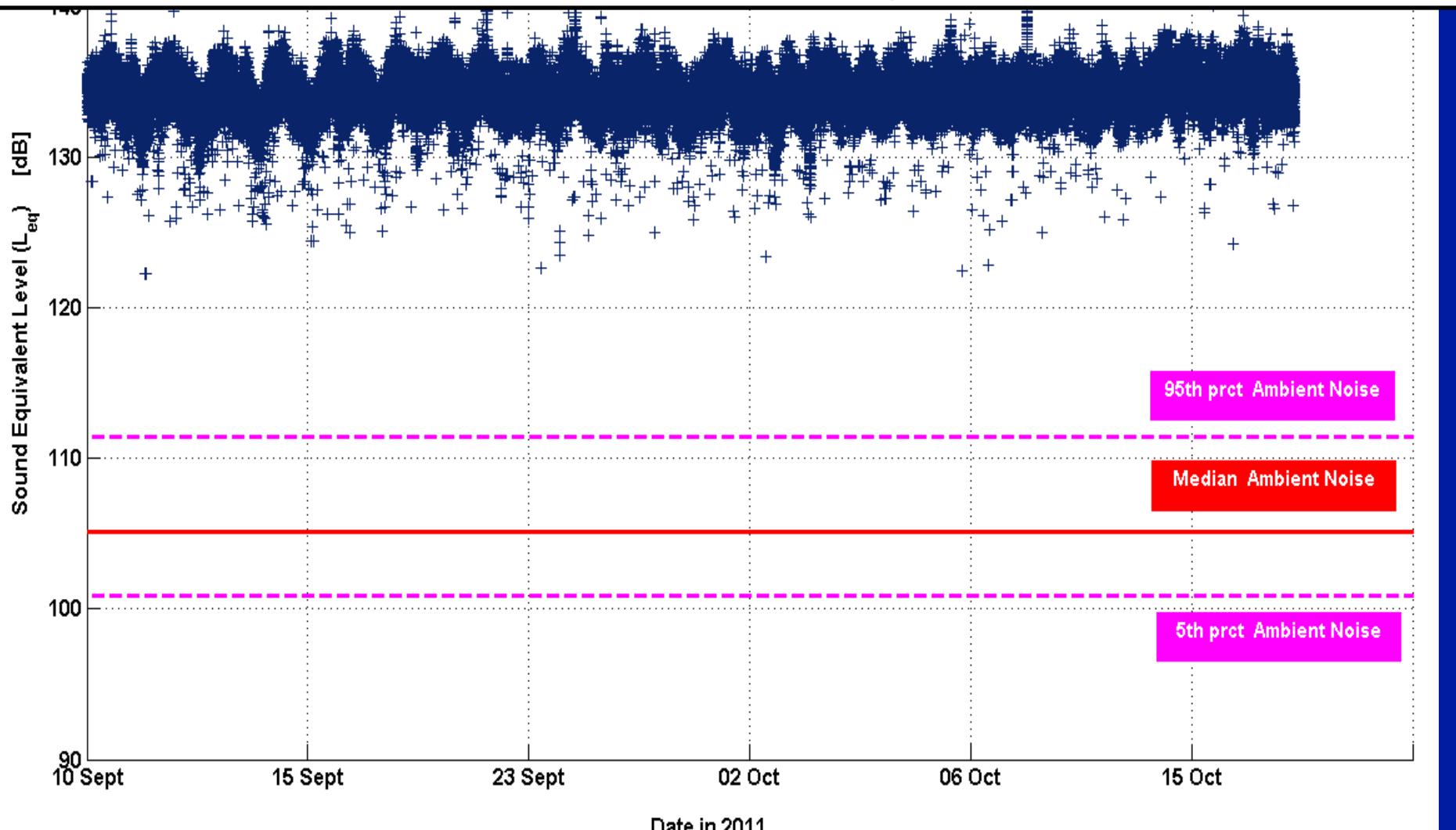
A seismic impulse is NOT just an impulse! It reflects off ocean boundaries, is refracted and reverberates as it propagates through the ocean, and expands into the time gap between impulses.



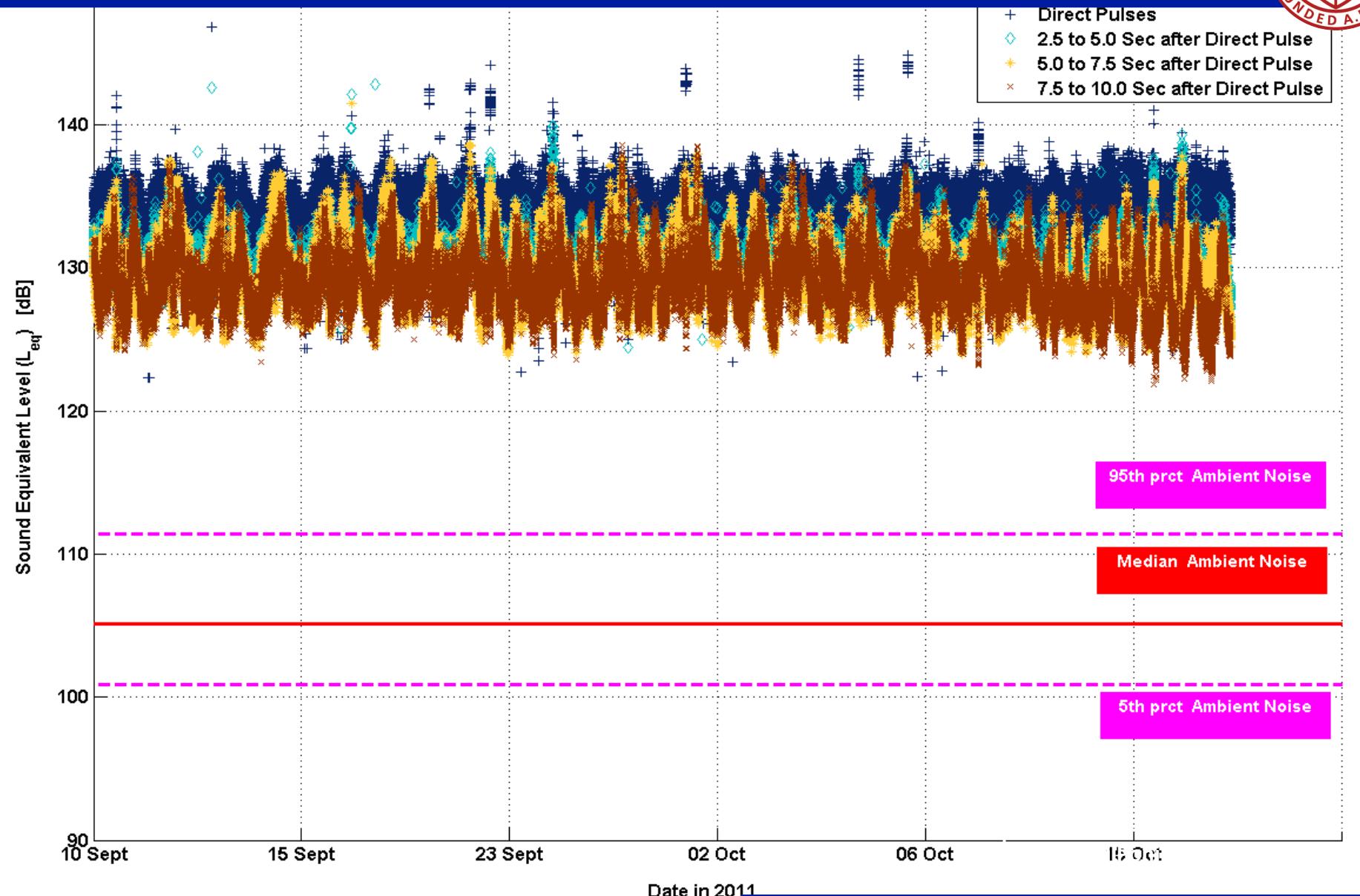
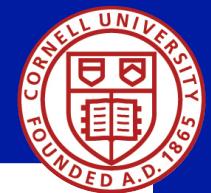
Seismic survey energy persists and significantly raises background noise level, which can result temporal and spatial, species-dependent habitat loss.



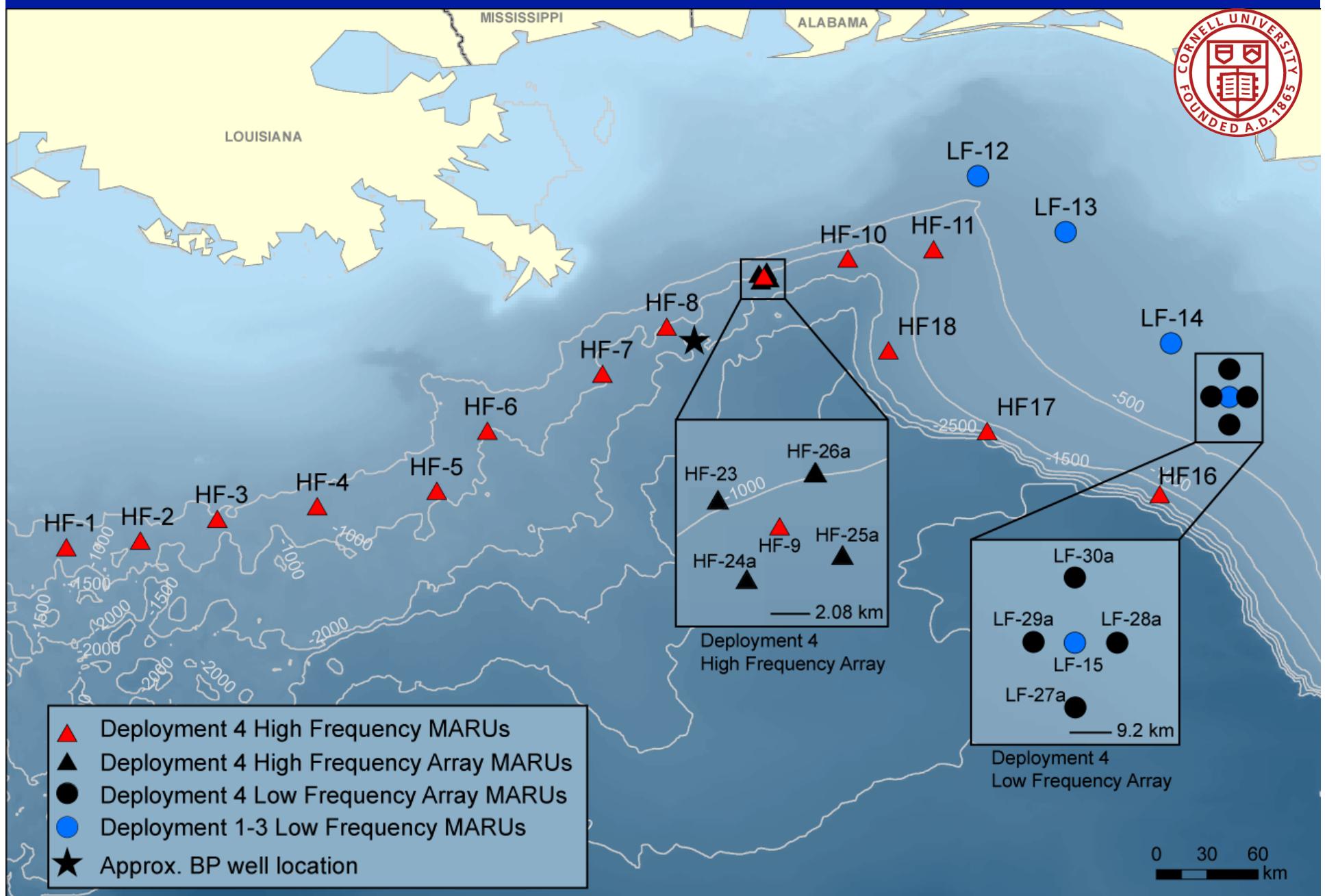
Seismic Impulse levels at 30-100km range from the seismic ship



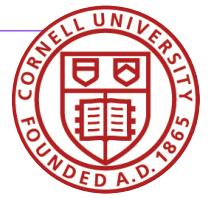
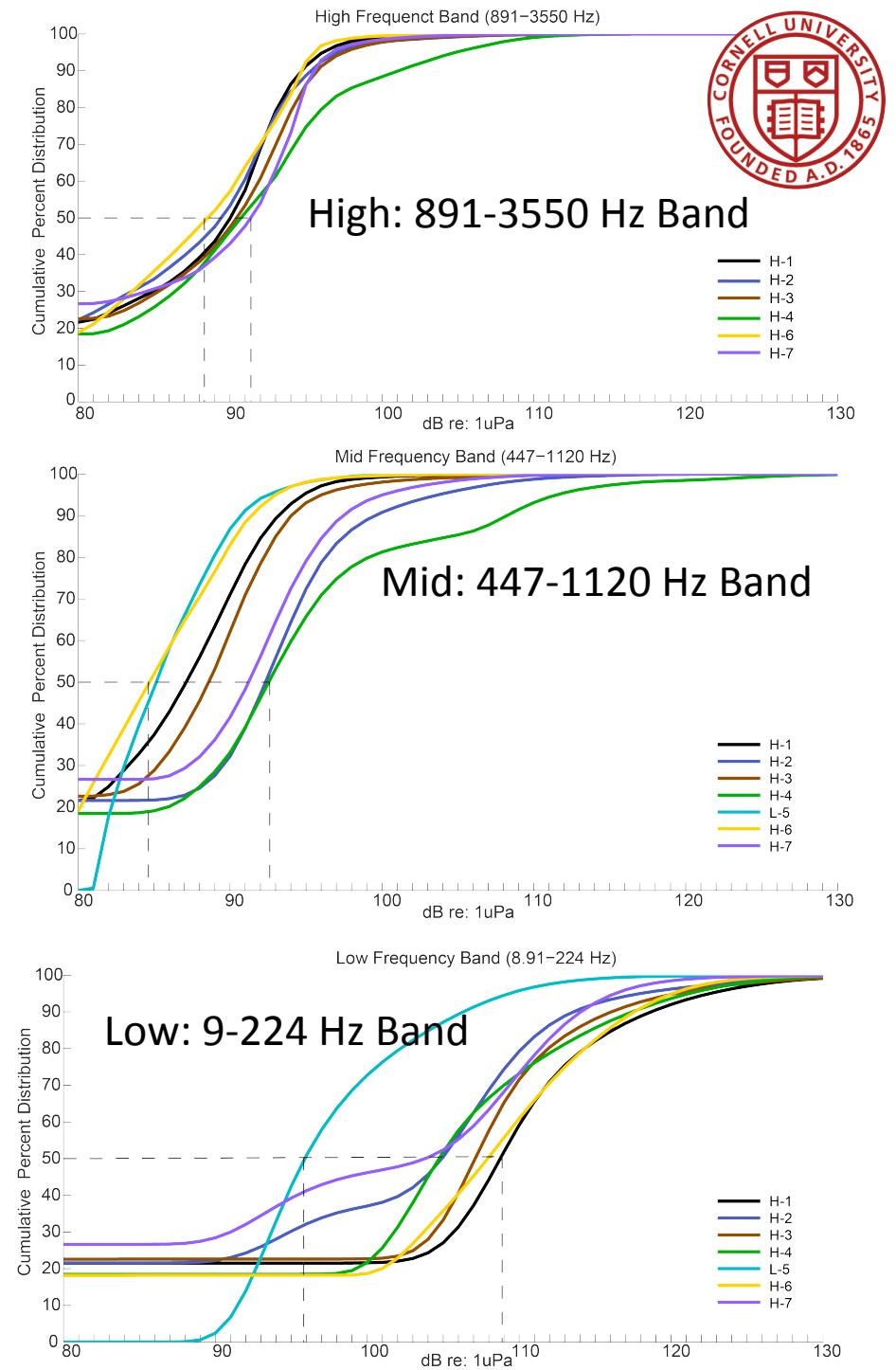
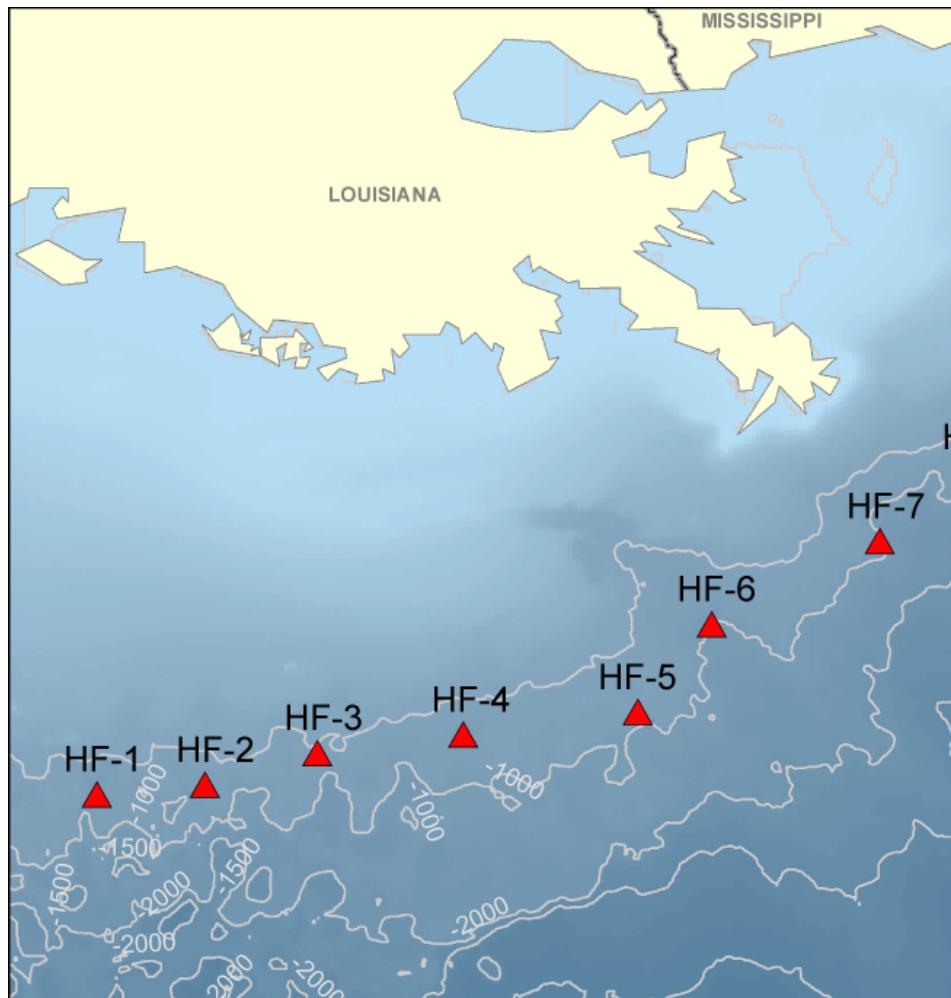
Noise levels 7.5 sec after the impulse at 30-100km range are 25 dB above background throughout the survey period.



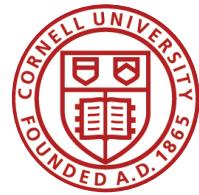
We now collect very large amounts of acoustic data.



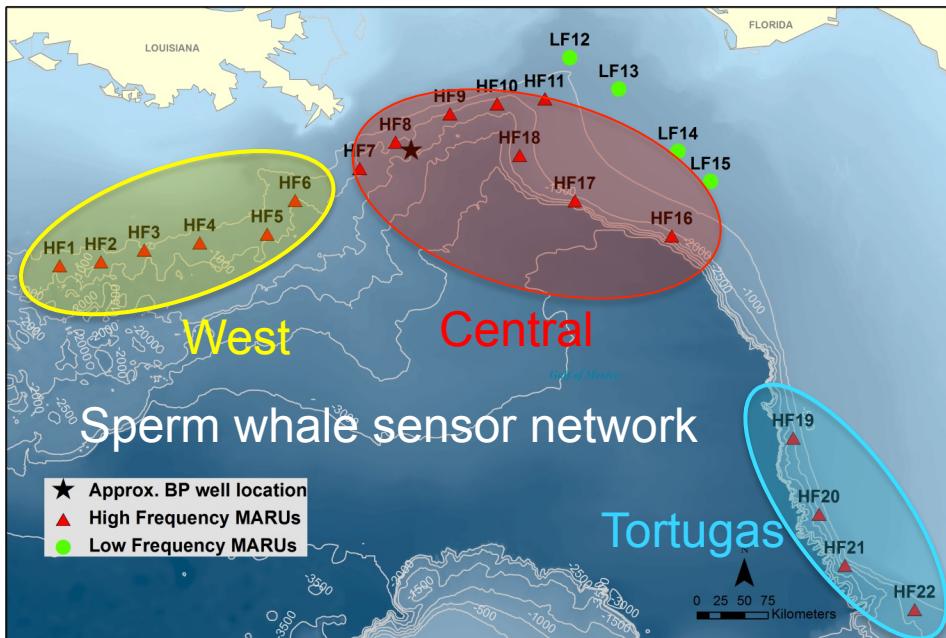
We can spatially characterize features of the acoustic environment.



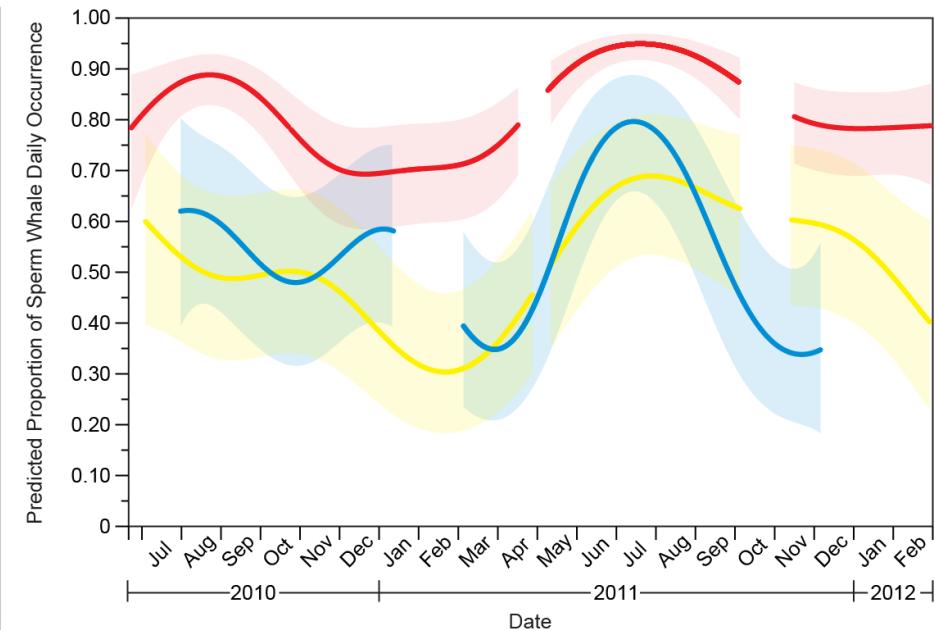
We are always learning how to synthesize and interpret: Passive Acoustic Monitoring in the Gulf of Mexico



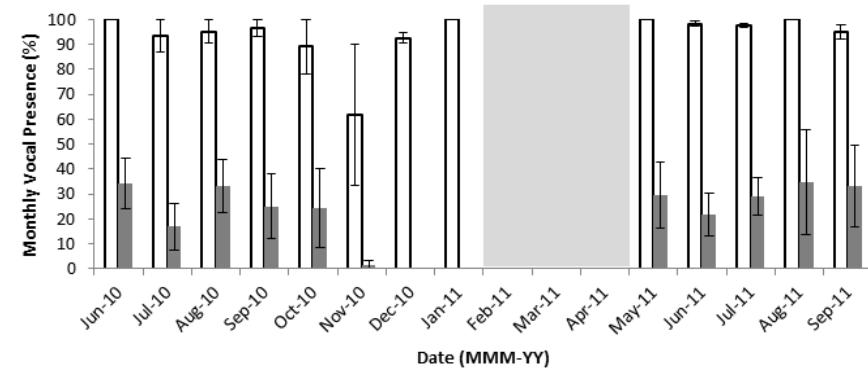
22 MARUs-Recorded June 2010–February 2012



Sperm whale acoustic presence

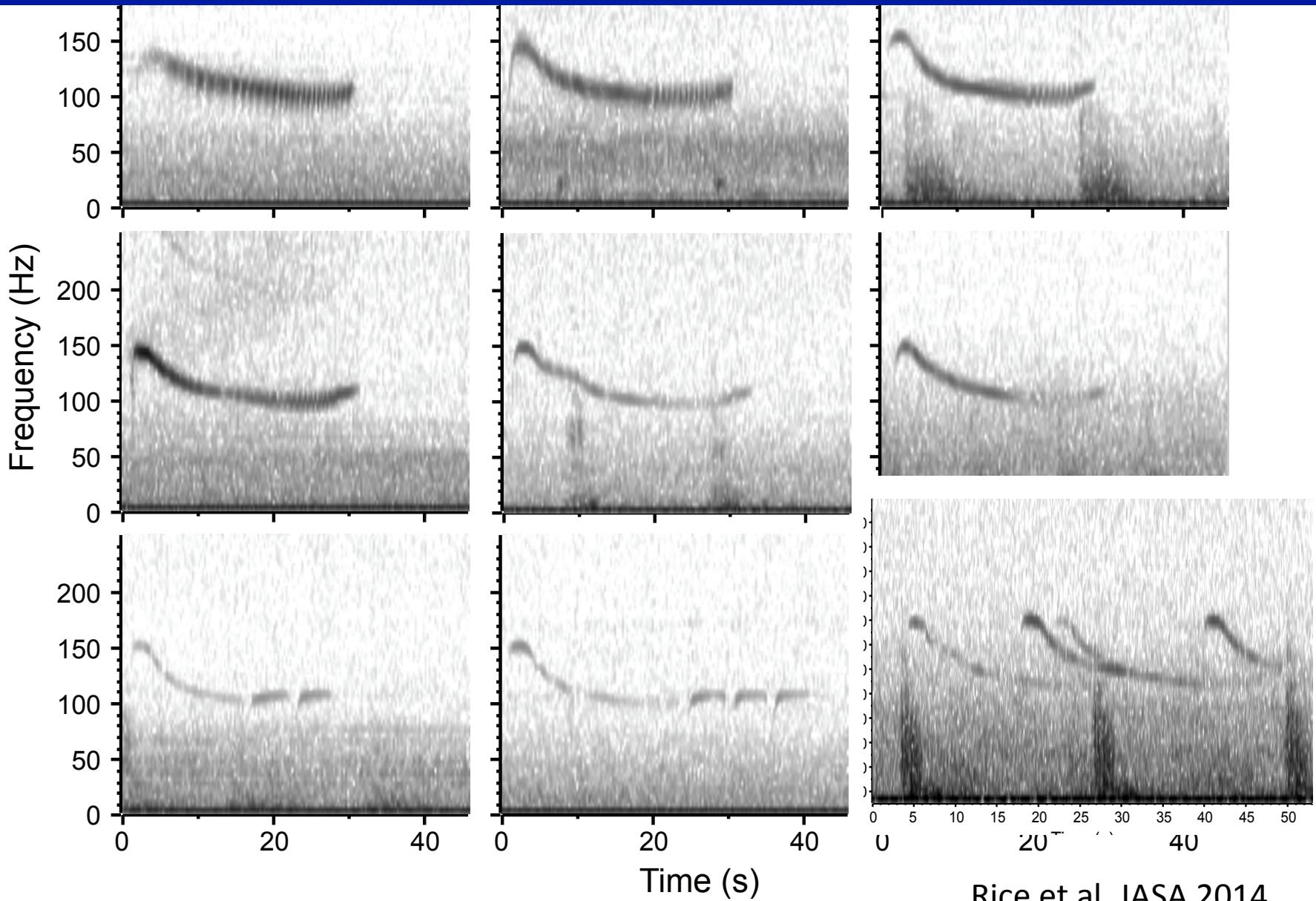


Bryde's whale acoustic presence



For more information, email
Aaron Rice (arice@cornell.edu) or
Christopher Clark (cwc2@cornell.edu)

**Discovery is there in spades.
GoMex Bryde's produce novel call types!**

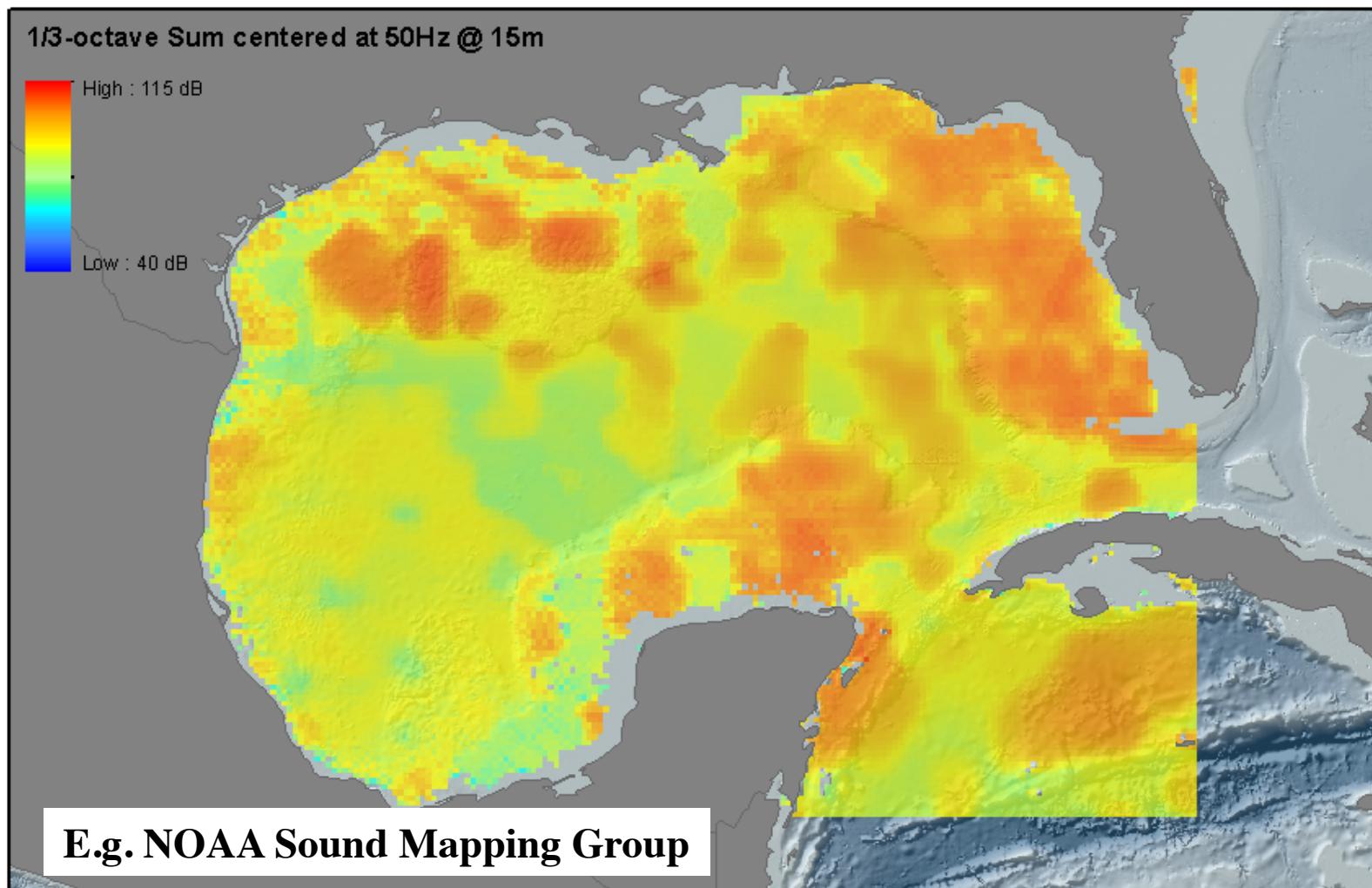


Rice et al. JASA 2014

Progress

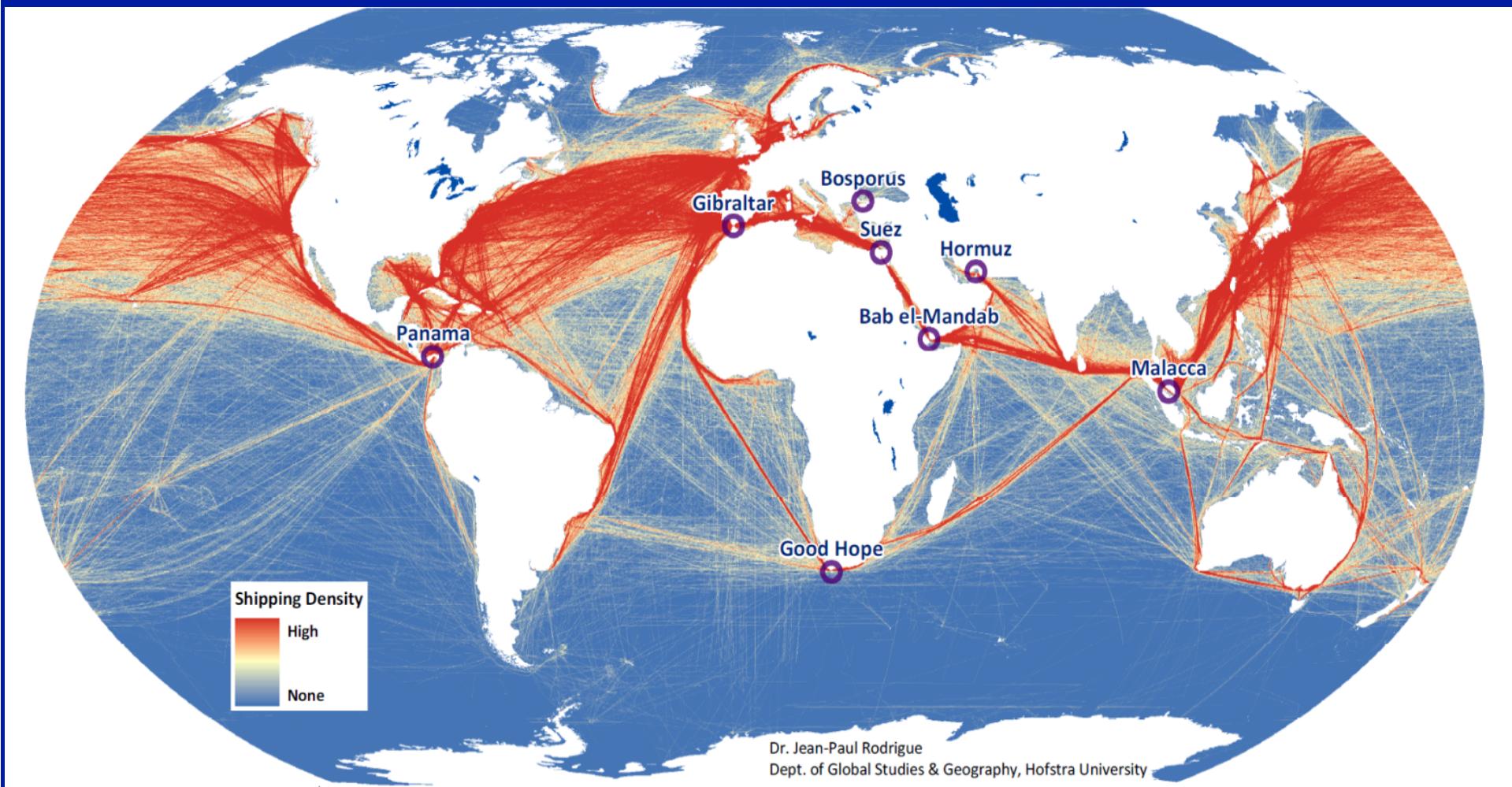
- **Conceptualizations and realities**
- **Mechanisms – the recipes in the cook book are increasing and improving.**
- **The dramatic growth in data**
- **The emerging mindset of OPEN data systems**

We can map noise at ocean scales.

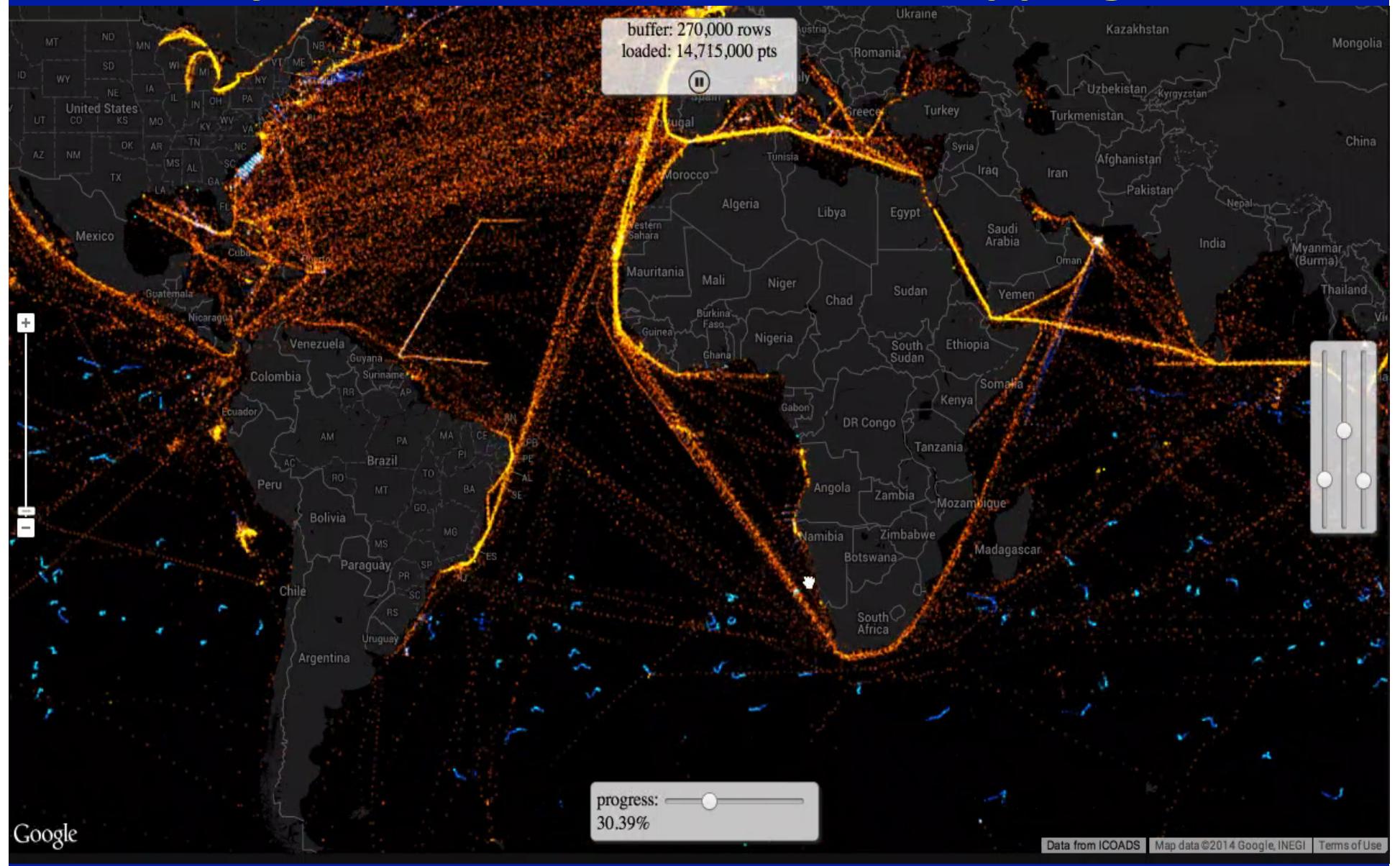


Global Commercial Shipping Traffic

96% of world's commerce

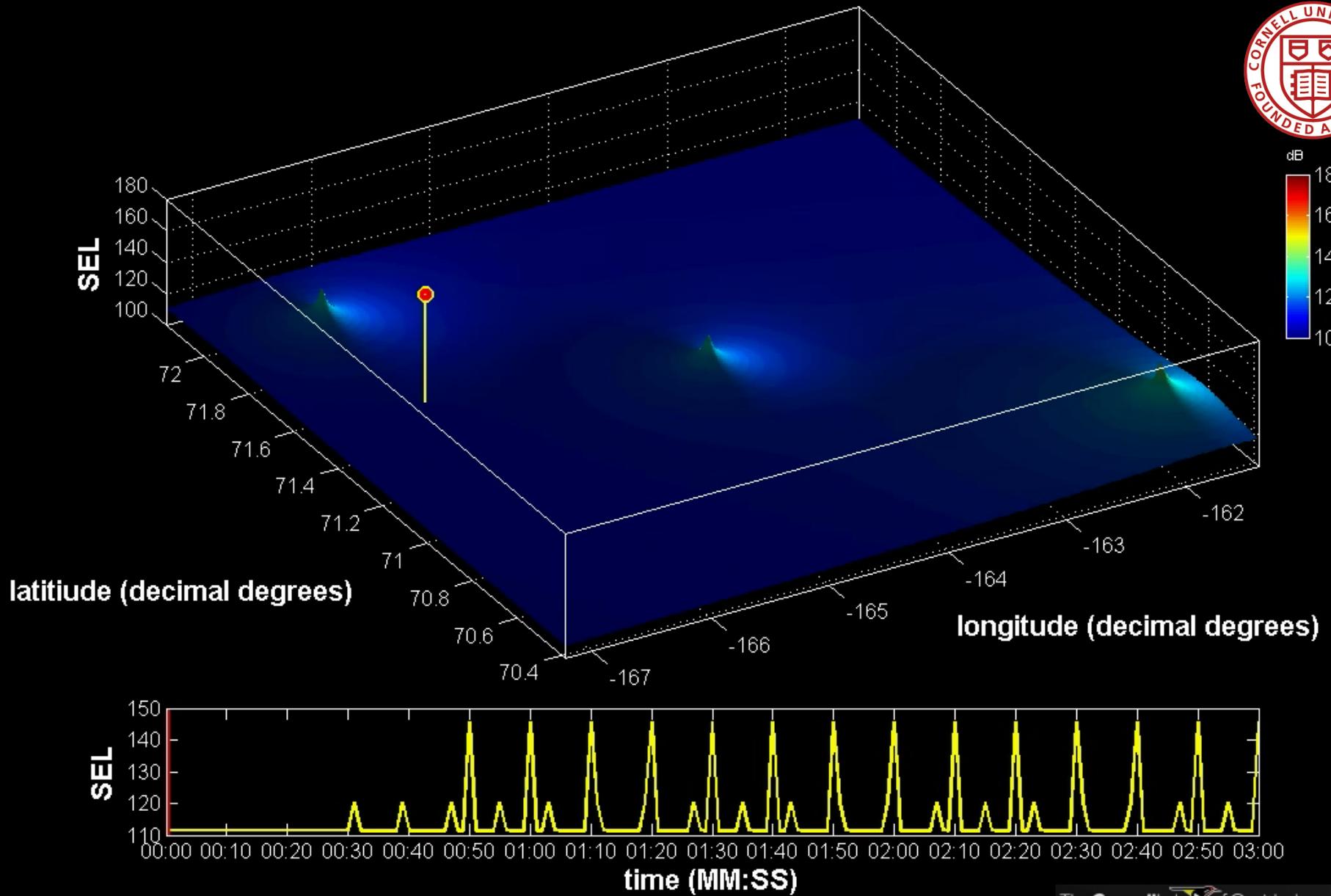
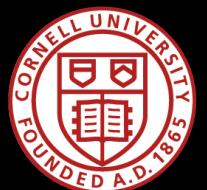


The Dynamics of Annual Global Shipping Traffic

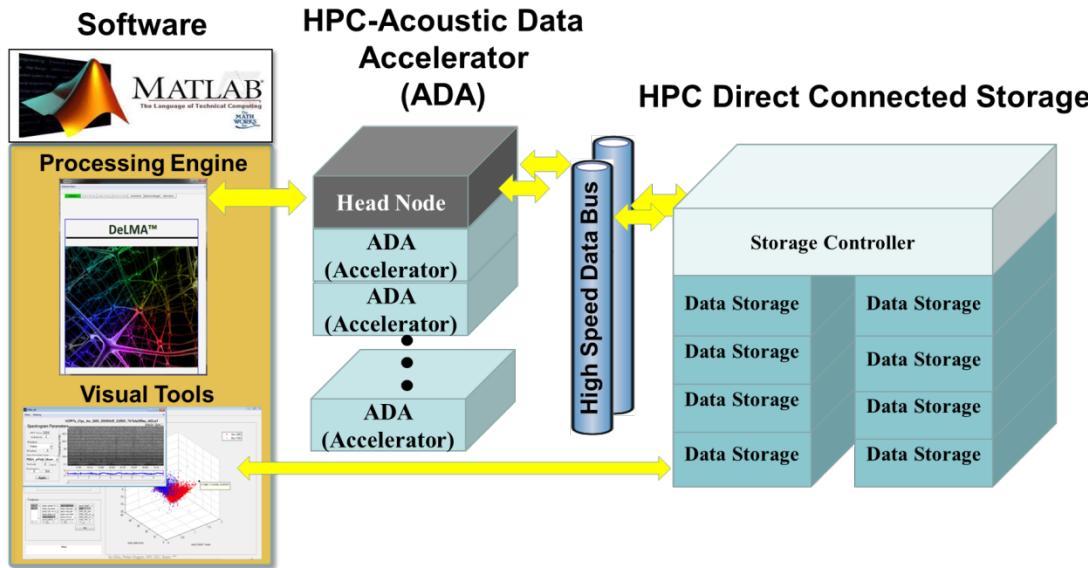
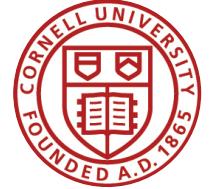


Animation courtesy of Kurt Schwehr, Google Ocean: Google Maps API, SpaceQuest AIS and NOAA ICOADS

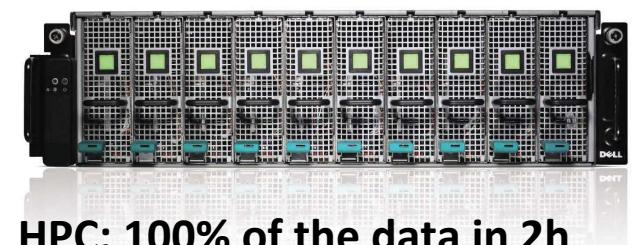
Seismic Airgun Noise Footprint Model – U.S. Arctic.



High Performance Computer (HPC) – Detection Accelerator



GPU C410x expansion



**HPC: 100% of the data in 2h
Vs. 11% of the data in 300h**

Specifications

- C6220 Class, Cloud Server.
- 64 Distributed Nodes, 4 mother boards.
- 192 GB RAM.
- dual Intel® Xeon® E5-2600.
- GPU support, external C410x Rack Server.
- 16 GPU's via dynamic allocation.
- Tesla NVIDIA M2075/M2090 GPUs.
- 18TB NAS with Open Indian, running NAPPit.
- Mirror fast CACHE, SDD drives.

Funding from NOPP - ONR

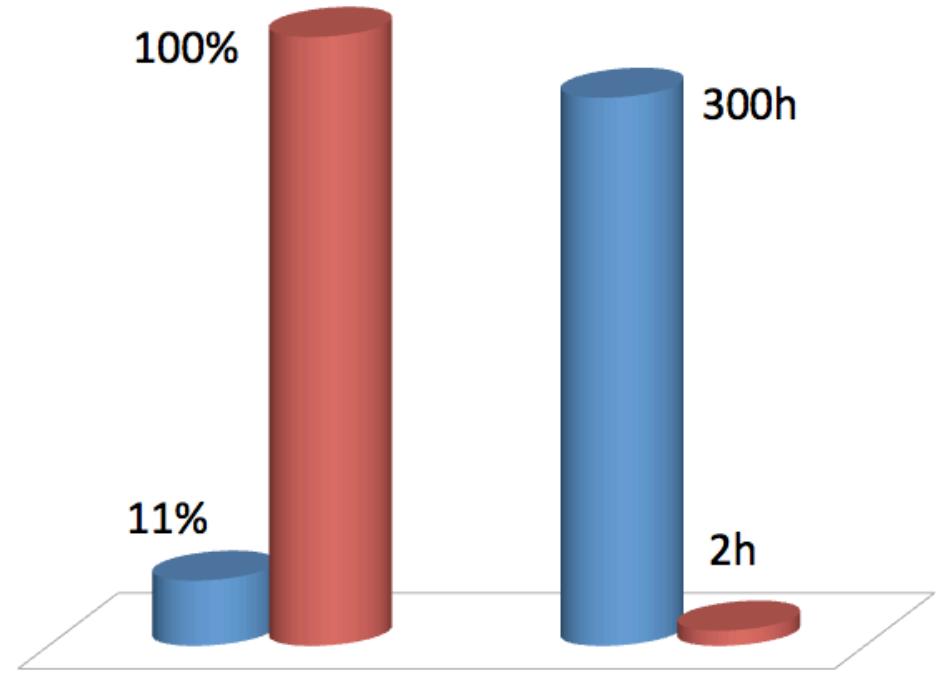


Figure credit: P. Dugan

Process lots of data quickly: Fin whales

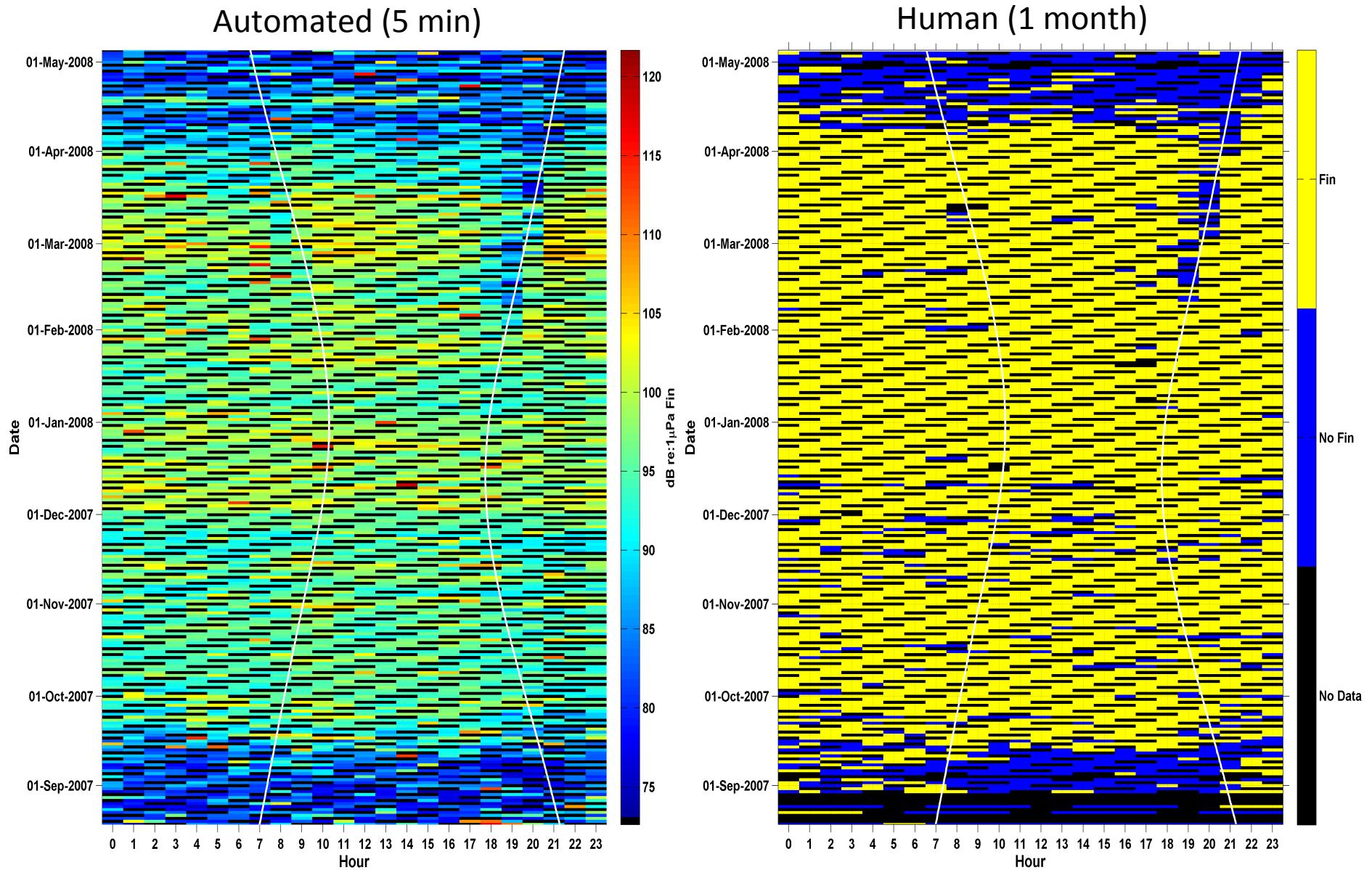
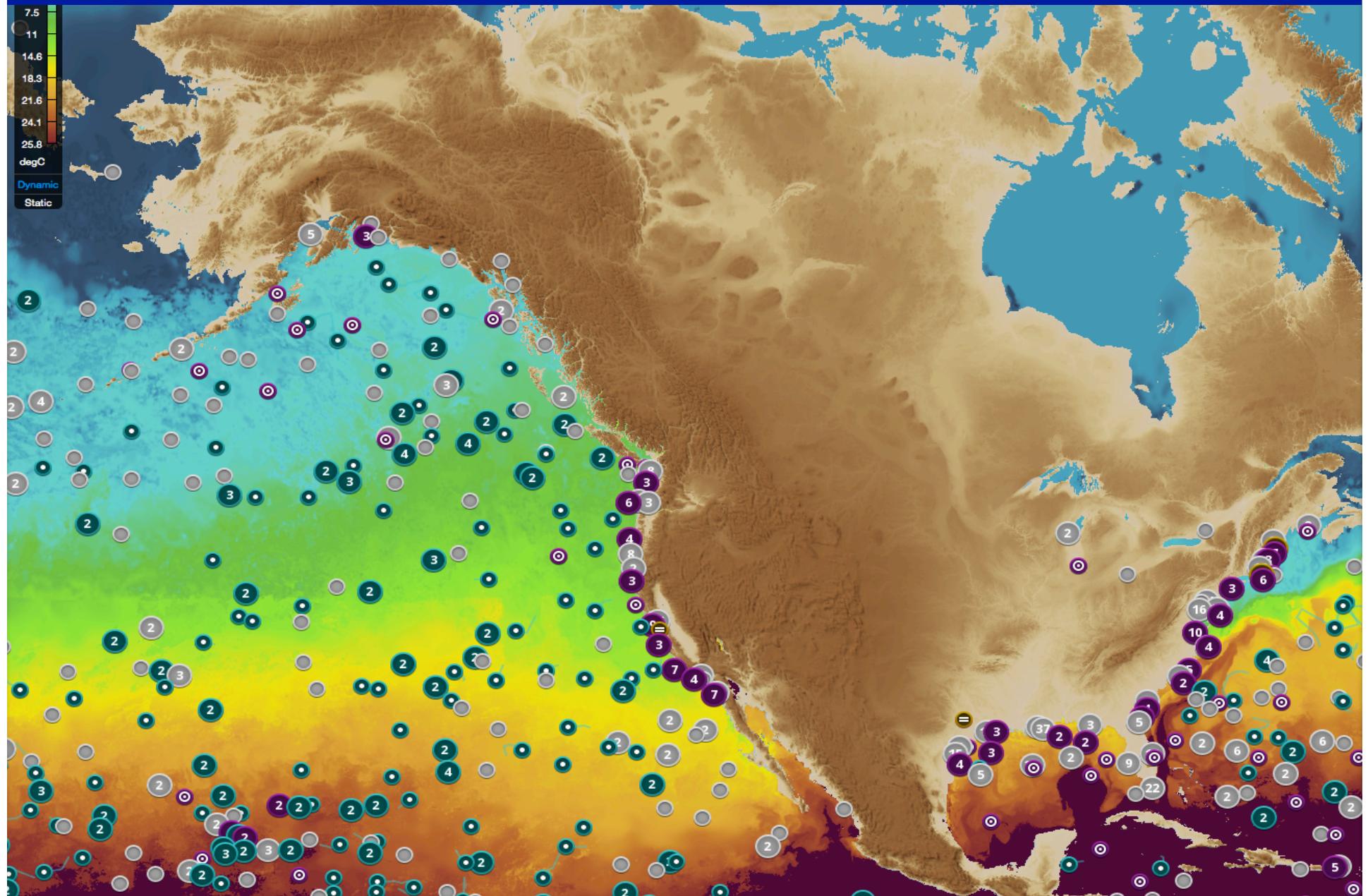


Figure credit: C. W. Clark, A. Earl and D. Ponirakis

Big Data Platforms, Data Analytic Systems, Data Integrations Marinexplore Planet OS



The Challenges

There are advanced technologies for automatically detecting, locating, tracking and counting acoustically active marine mammals: BIG DATA at ecologically meaningful scales.

There are conceptual paradigms emerging that can and do engage best available science and technology as applied to an ecosystem approach.

Going to scale is not an option. It is a fundamental requirement.

“Beam me up, Scottie!”

