Large scale monitoring species distribution patterns across the western Atlantic ocean

Genevieve Davis[1], Danielle Cholewiak[1], Sofie Van Parijs[1], Mark Baumgartner[2], and many others

[1]Northeast Fisheries Science Center

[2]Woods Hole Oceanographic Institute

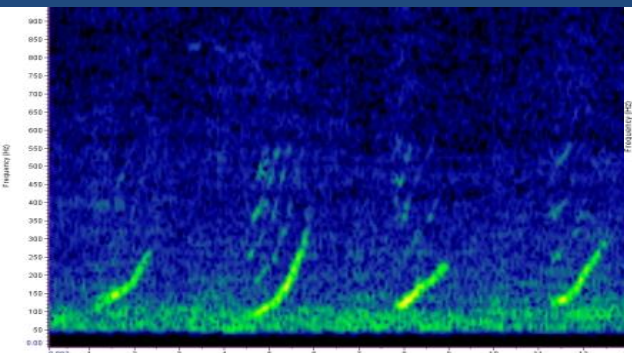
The power of passive acoustics

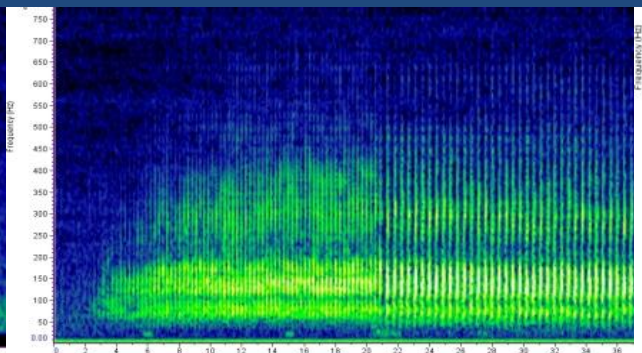
Long term trends in:

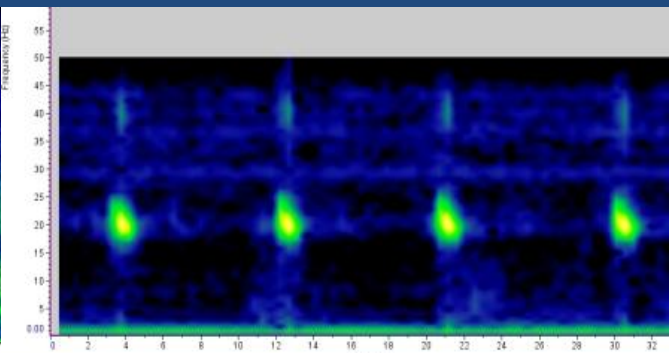
- All acoustically active species
- Movement Patterns
- Timing
- Distance from shore
- Soundscape & ambient noise

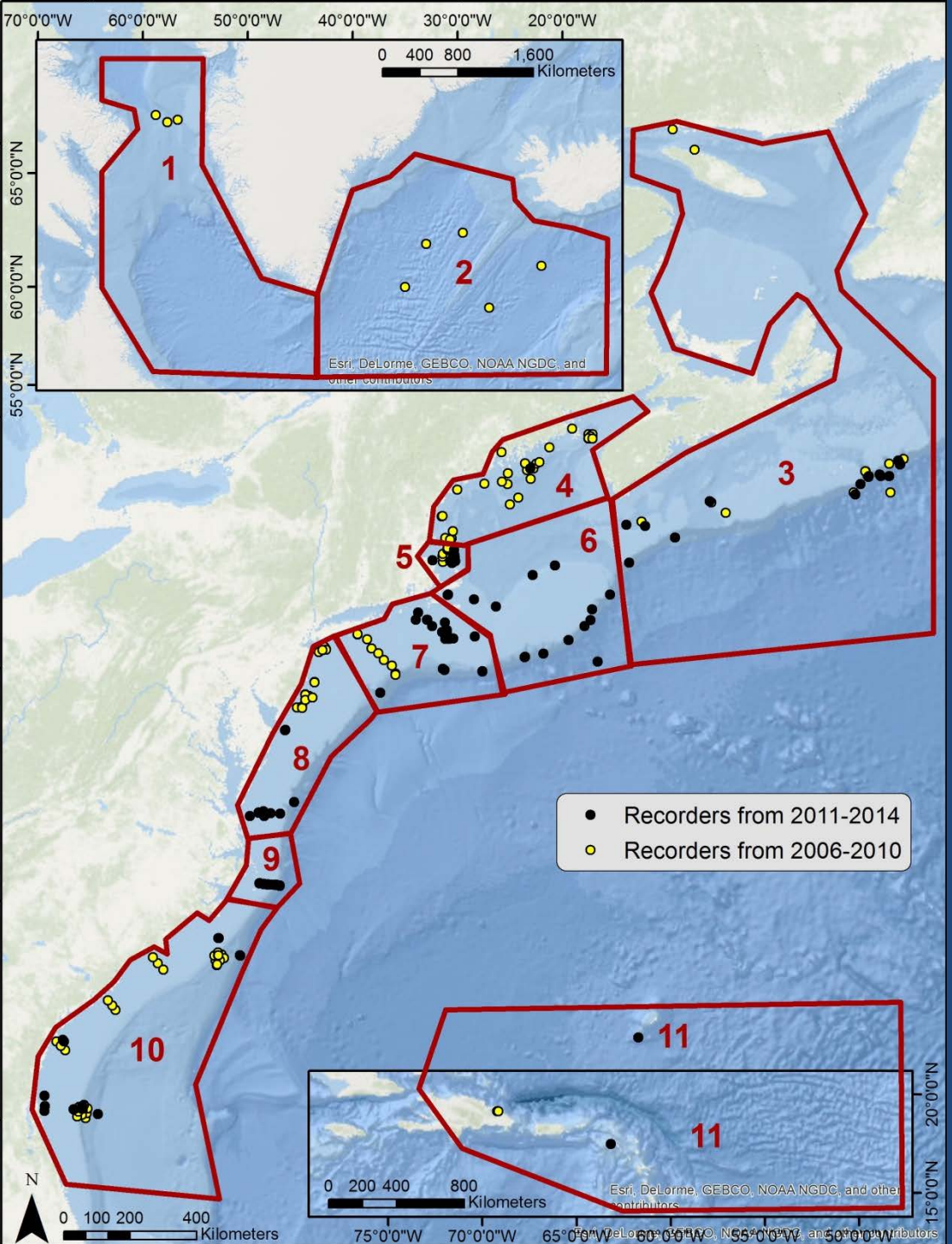
NARW figure: ocean.si.edu

Low Frequency Species









Long Term Changes

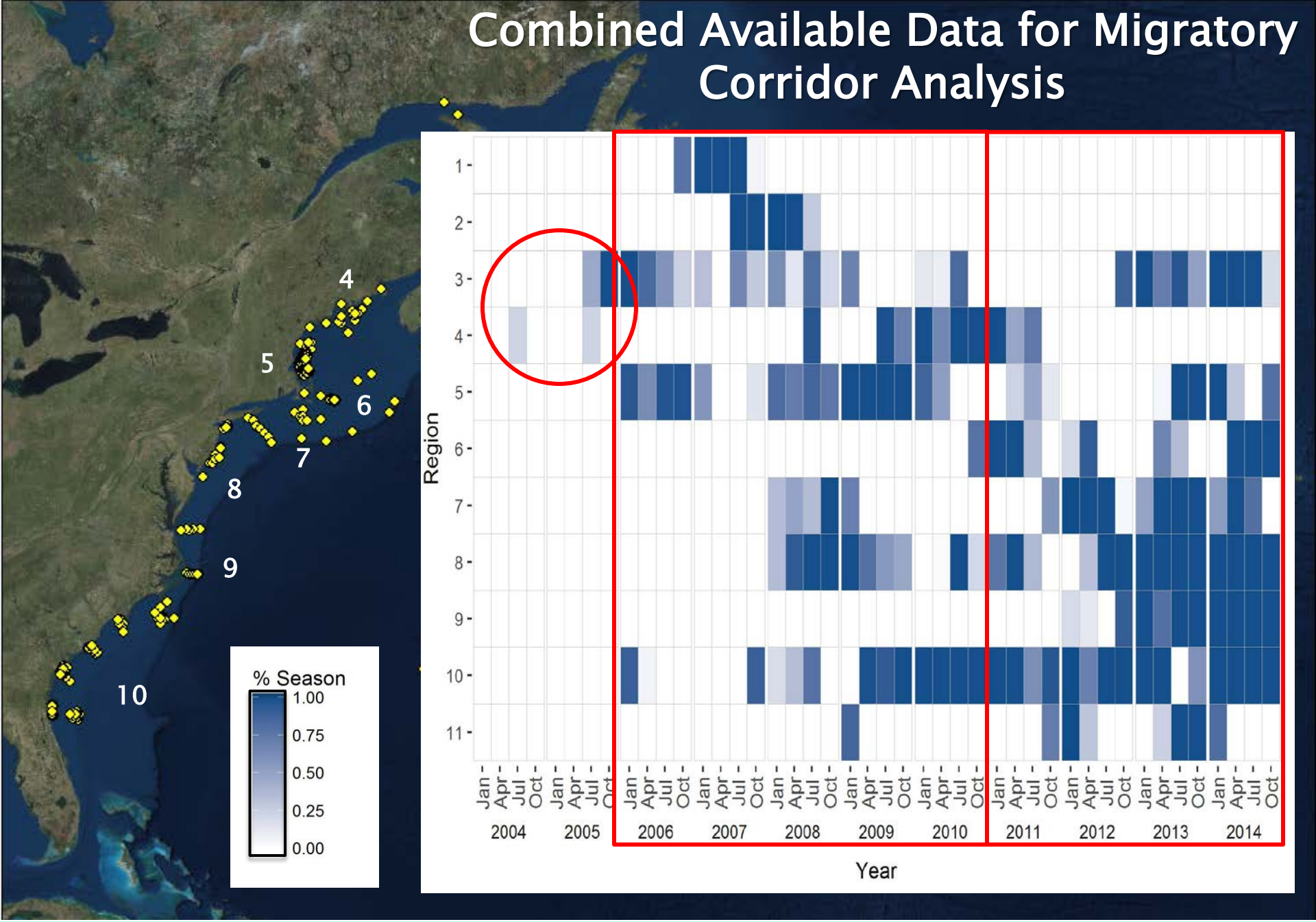
Available Recorders: 2006 – 2014

Data Contributors

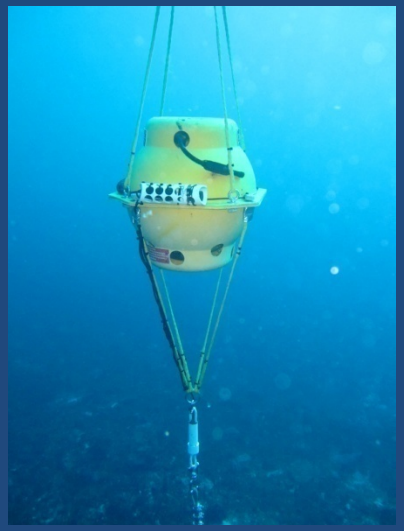
- Sean Todd; College of the Atlantic
- Chris Clark, Russ Charif, Holger Klinck, Aaron Rice, Ann Warde; Cornell University
- Hilary Moors-Murphy; Department of Fisheries and Oceans Canada
- Andy Read, Joy Stanistreet, Lynne Hodge, Doug Nowacek; Duke University
- Kathleen Dudzinski; Dolphin Communication Project
- Julien Delarue, Bruce Martin; JASCO Applied Sciences
- Erin Summers; Maine Department of Marine Resources
- Joel Bell, Jaqueline Bort Thornton, Anu Kumar; NAVFAC Naval Facilities Engineering Command
- Scott Kraus; New England Aquarium
- Gary Buchanan; New Jersey Department of Environmental Protection
- Catherine Berchok; NOAA National Marine Mammal Laboratory
- Lance Garrison, Melissa Soldevilla; NOAA Southeast Fisheries Science Center
- Mike Thompson, David Wiley, Leila Hatch; NOS Stellwagen Bank National Marine Sanctuary
- Dave Mellinger, Sharon Nieukirk; Oregon State University
- Kate Stafford; University of Washington
- Denise Risch, Scottish Association for Marine Science
- Ana Sirovic, John Hildebrand; Scripps Institution of Oceanography
- Susan Parks; Syracuse University

Thank You!

Combined Available Data for Migratory Corridor Analysis



Recorder Types



MARU
(Marine Autonomous Recording Unit)

Cornell University

HARP
(High-frequency Acoustic Recording Package)

Scripps Institution of Oceanography

AMAR
(Autonomous Multichannel Acoustic Recorder)

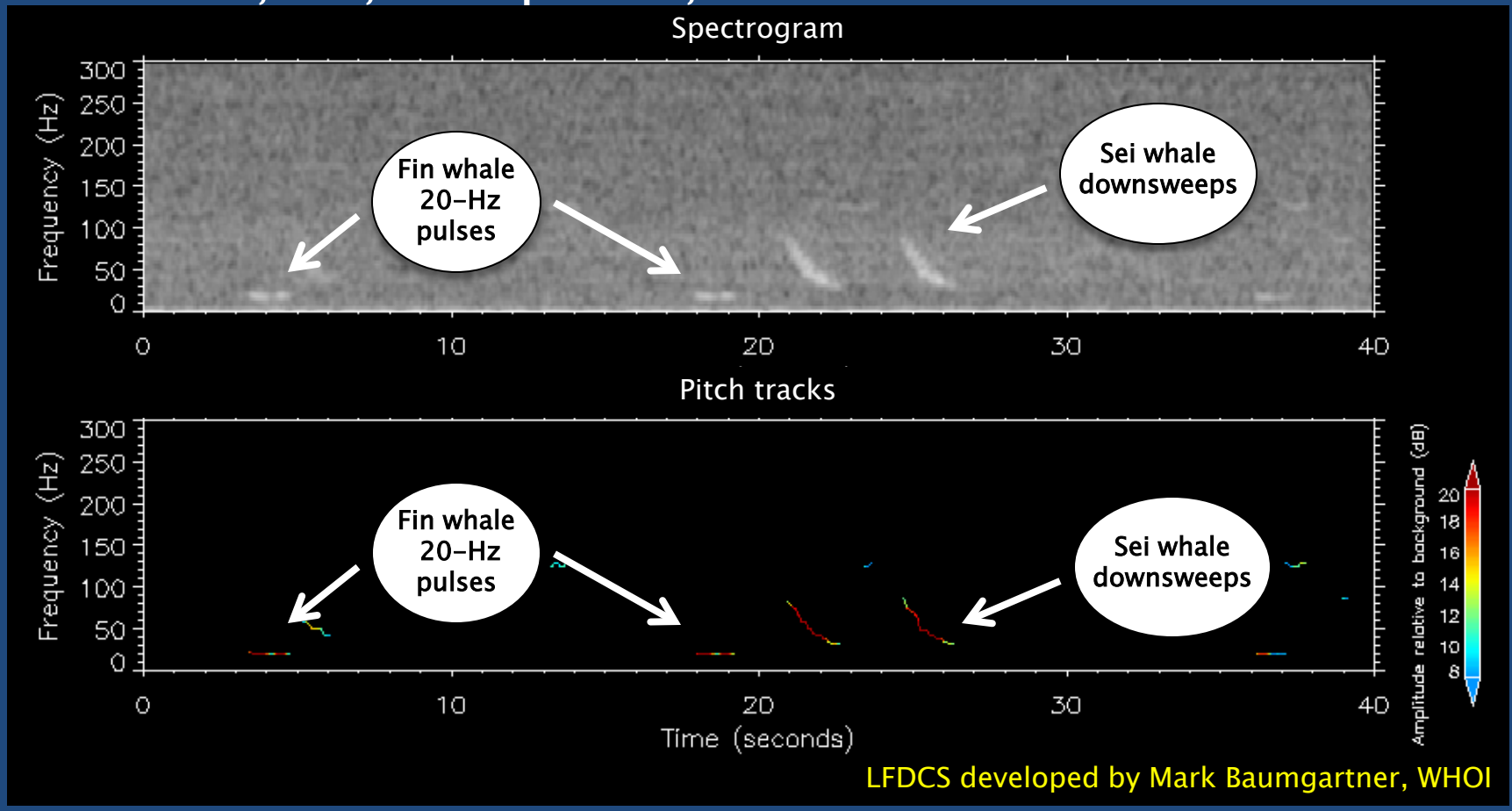
Jasco Applied Sciences

HARU
(Haruphone)

NOAA PMEL &
Oregon State University

LFDCS: Low-frequency detection and classification system

- Creates a spectrogram
- Detects sounds and pitch tracks
- Classifies pitch tracks based on call library
- NARW, fin, humpback, sei and blue



NARW results

- 325 recorders manually reviewed
- ~40,000 days analyzed:
  - Of these, 2,495 days have right whale presence

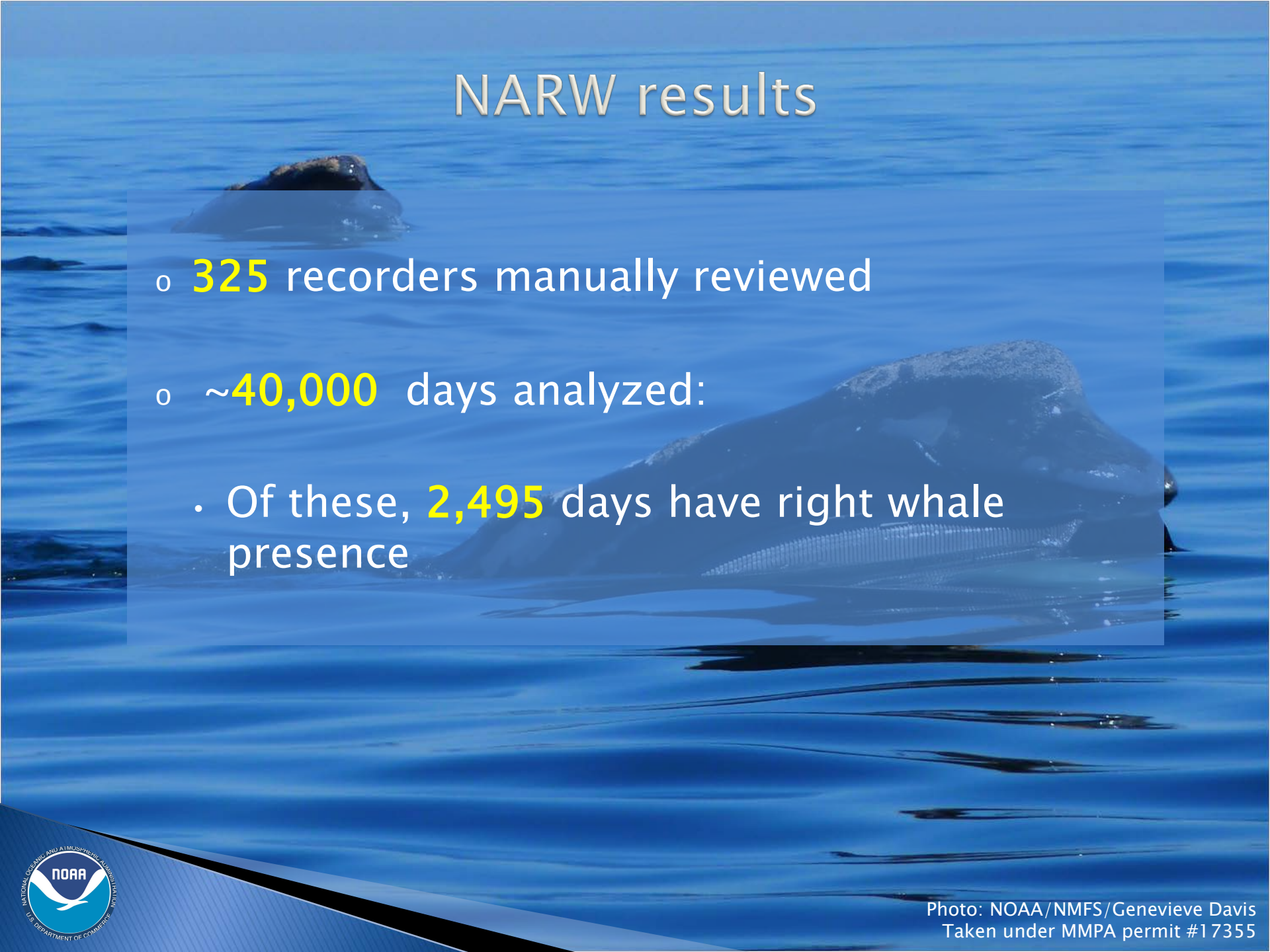
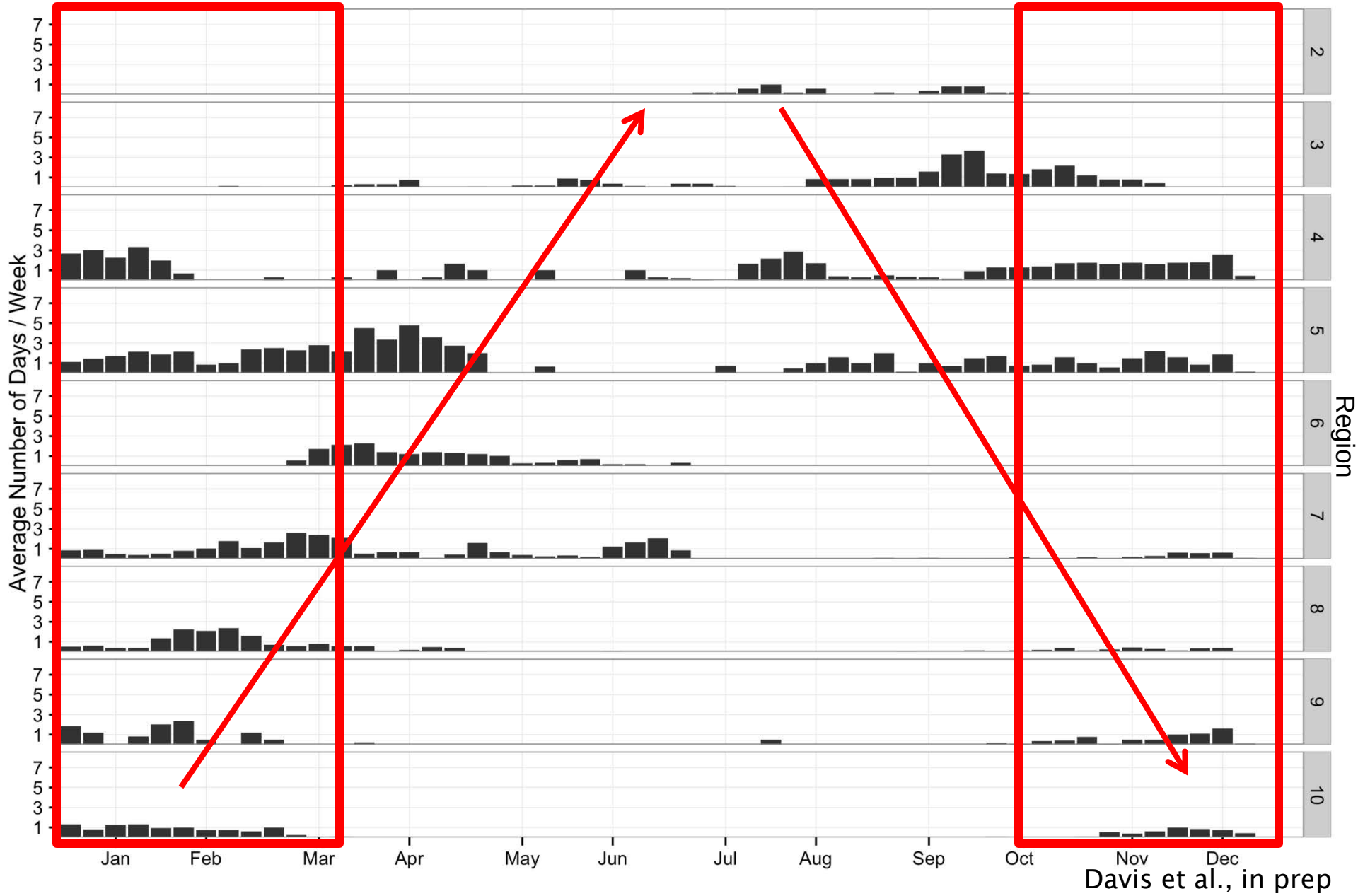


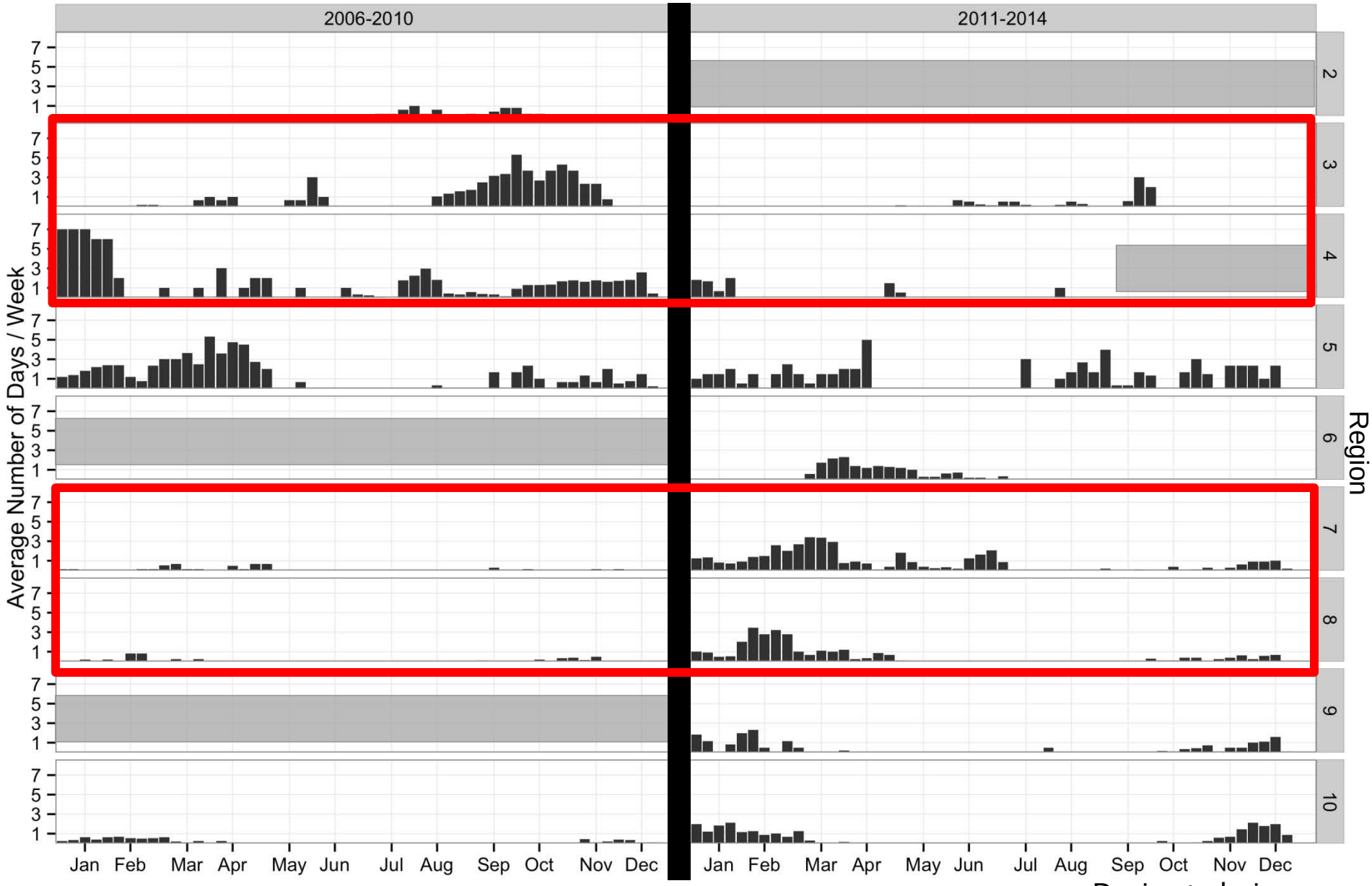
Photo: NOAA/NMFS/Genevieve Davis
Taken under MMPA permit #17355

Daily Presence Results: 2006-2014



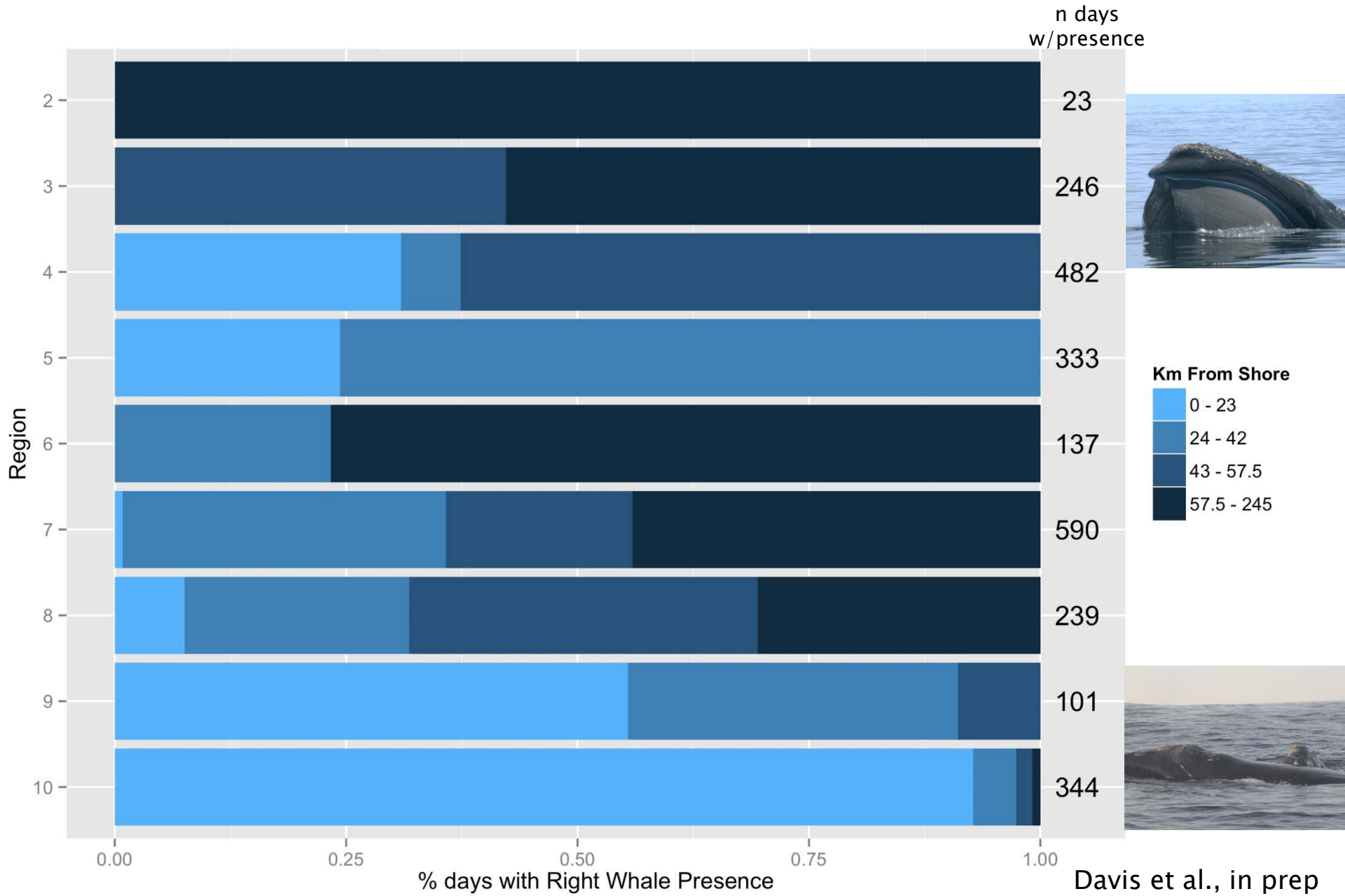
Davis et al., in prep

Daily Presence: comparison over time



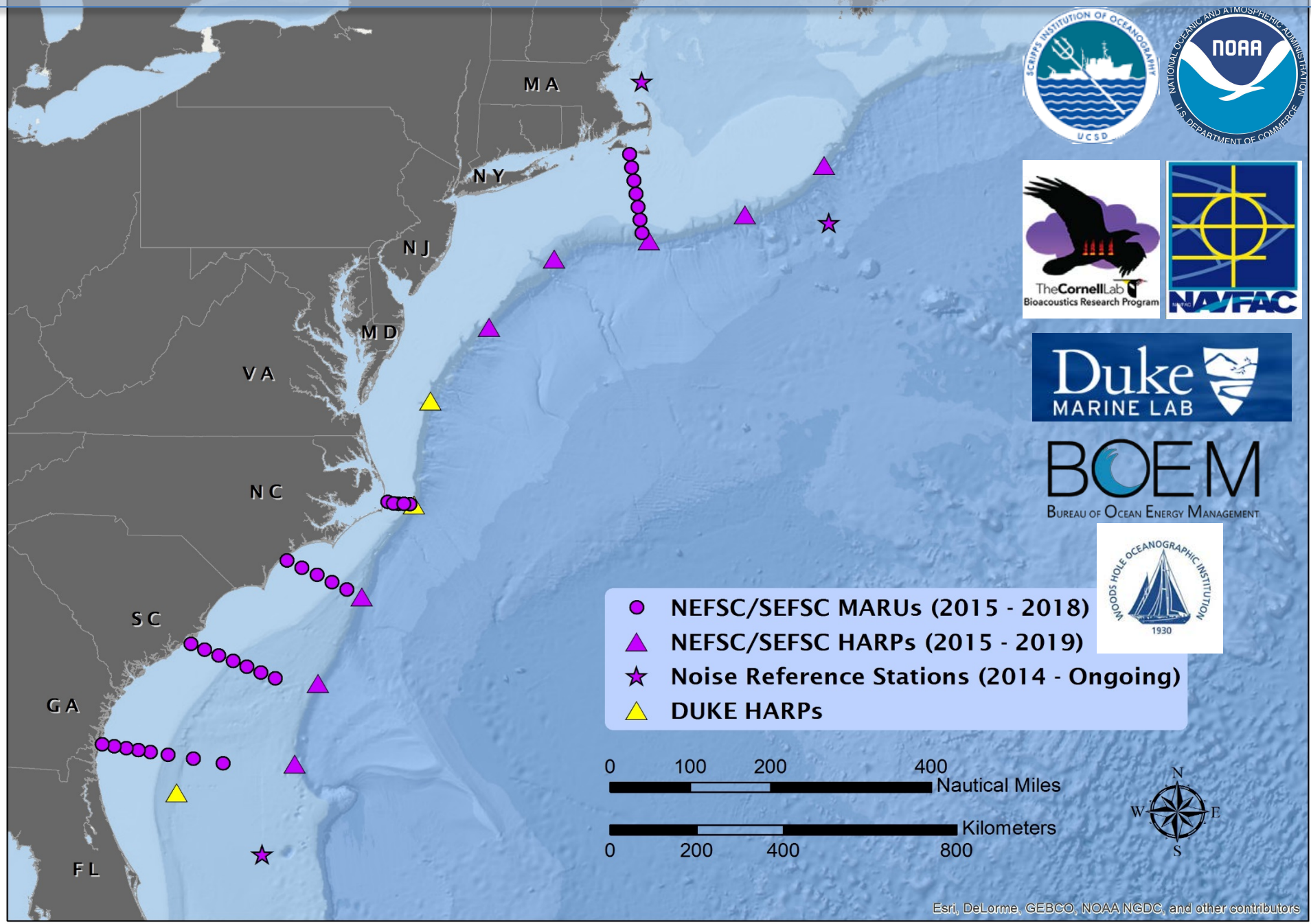
Davis et al., in prep

Distance to Shore Breakdown

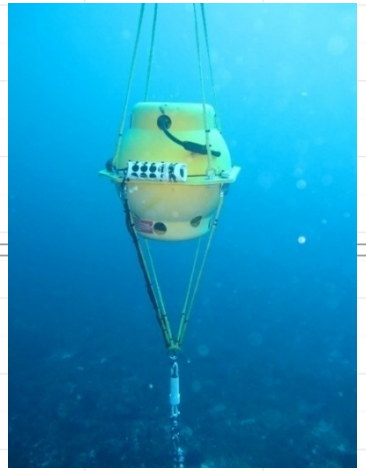


Davis et al., in prep

Current Acoustic Deployments: 2015 – 2018



MARU lines with NARW by Deployment & Site



Days/Week

Cape Hatteras
Cape Fear
Charleston
Brunswick

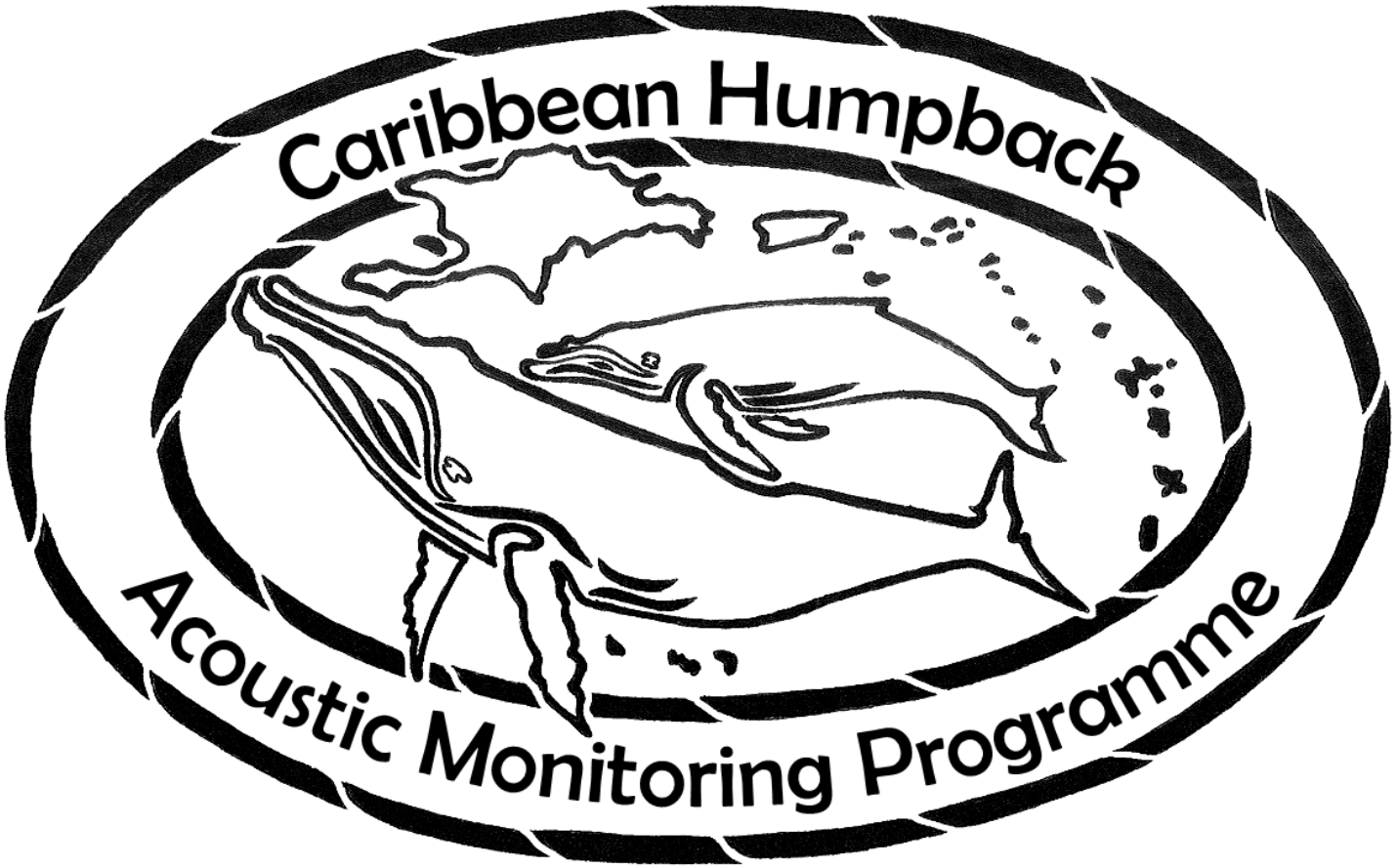
0
5
10
15

Nov
Dec
Jan
Feb
Mar
Apr
May
Jun

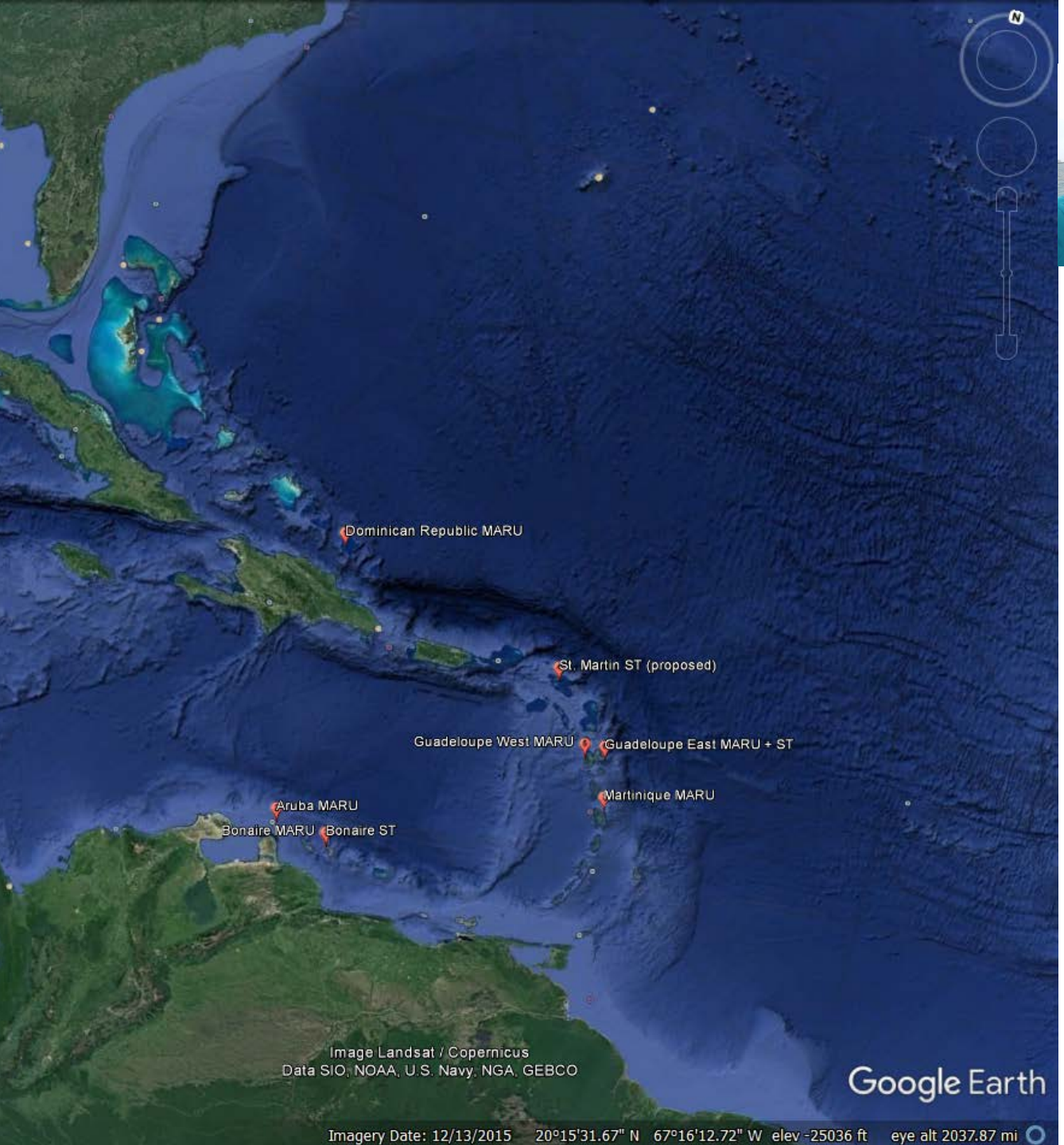
2015 - 2016

Site
1
2
3
4
5
6
7
8

CHAMP Goals: The basic aim of CHAMP is to collaborate with managers, researchers, NGO's, sanctuaries, government officials, and others in the Caribbean to gain a better understanding of the humpback whales that migrate to the area and help establish a robust monitoring program for whales in this region.



Project Investigators: Peter Corkeron, Sofie Van Parijs, Fred Wenzel
Project Coordinator: **Heather Heenehan**
Field Team: Leah Crowe, Genevieve Davis, Heather Heenehan, Joy Stanistreet
Funded by NOAA with in-kind support from many generous collaborators



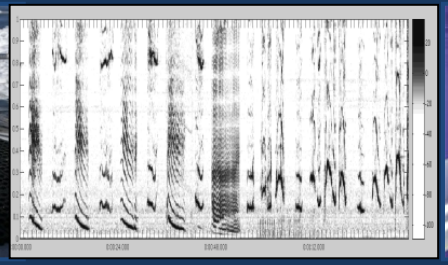
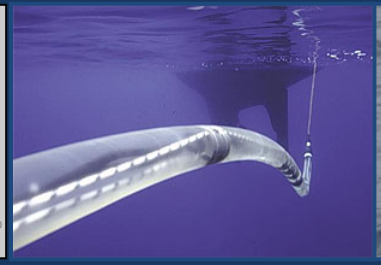
2 Field Teams

6 Islands: DR, Aruba, Bonaire, St. Martin, Guadeloupe, Martinique

7 Sites

3 SoundTraps

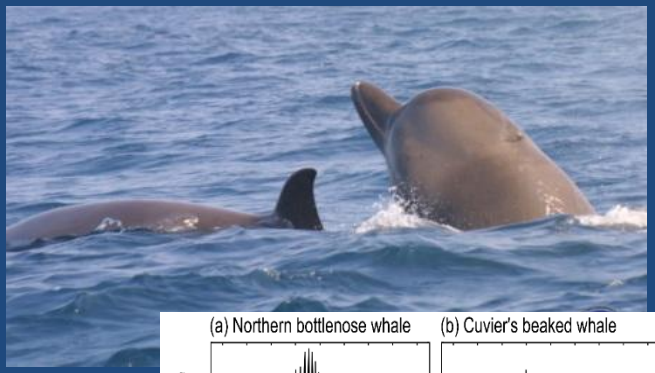
6 MARU's

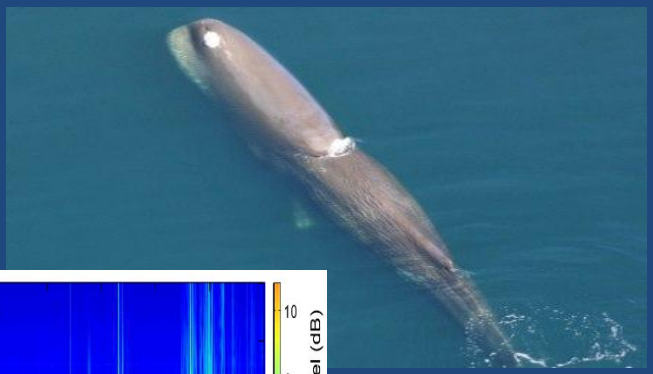



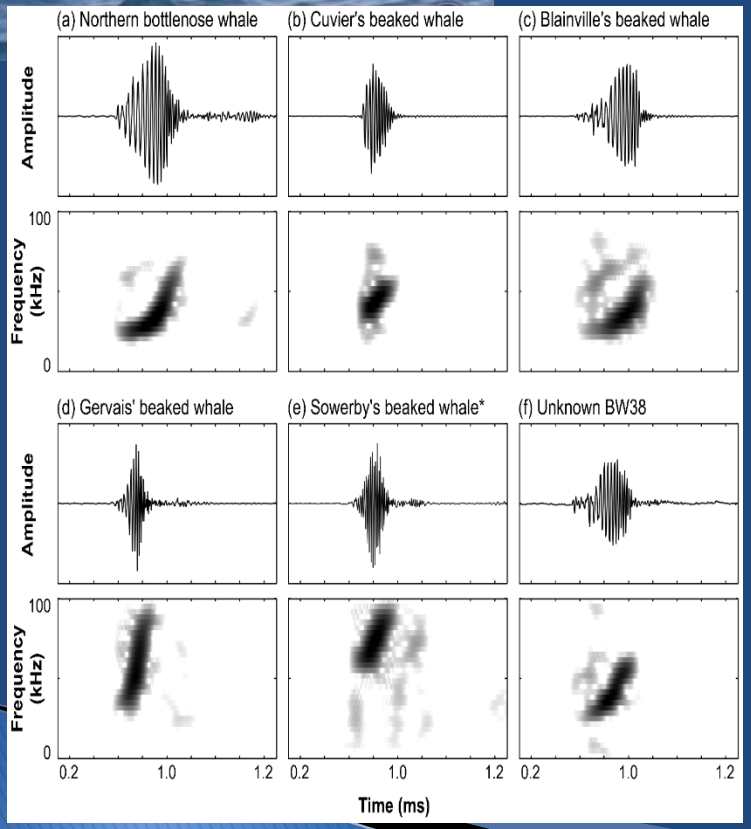
Acoustic Ecology, Abundance, Soundscapes and Ocean Noise

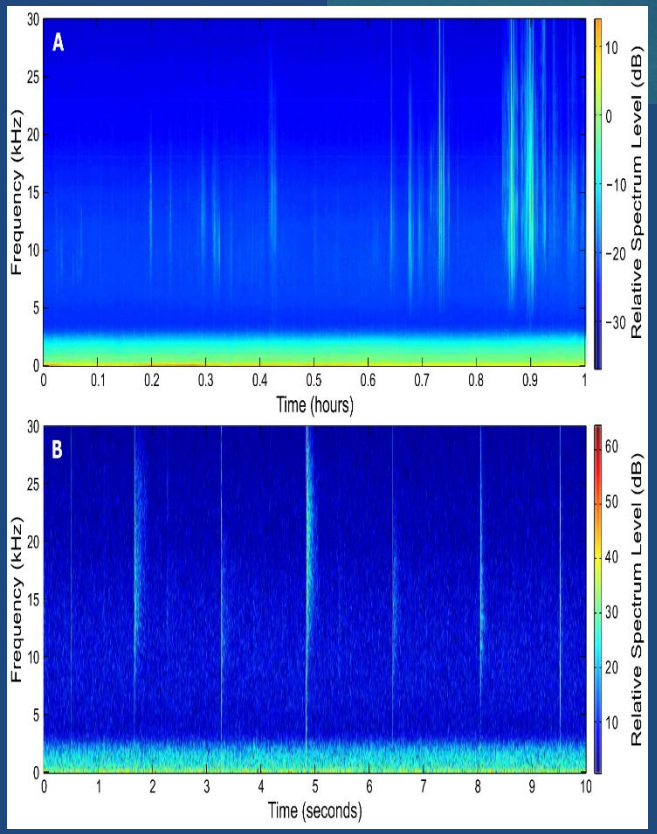
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NOAA
U.S. DEPARTMENT OF COMMERCE

High-frequency species

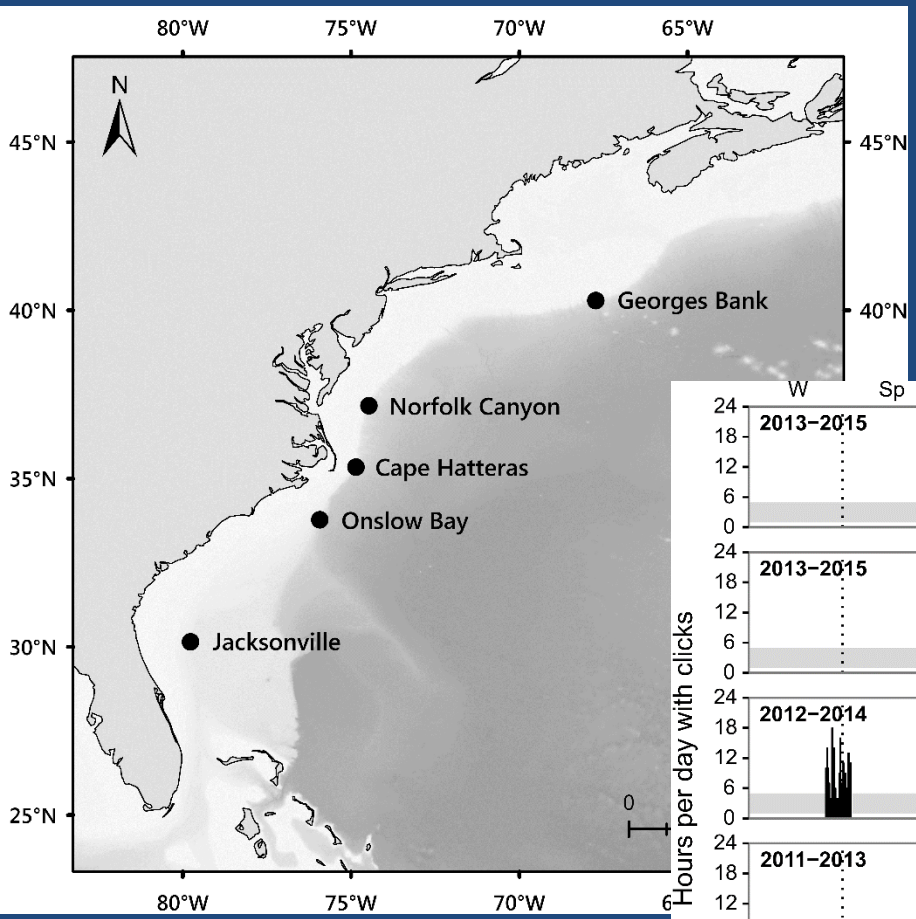




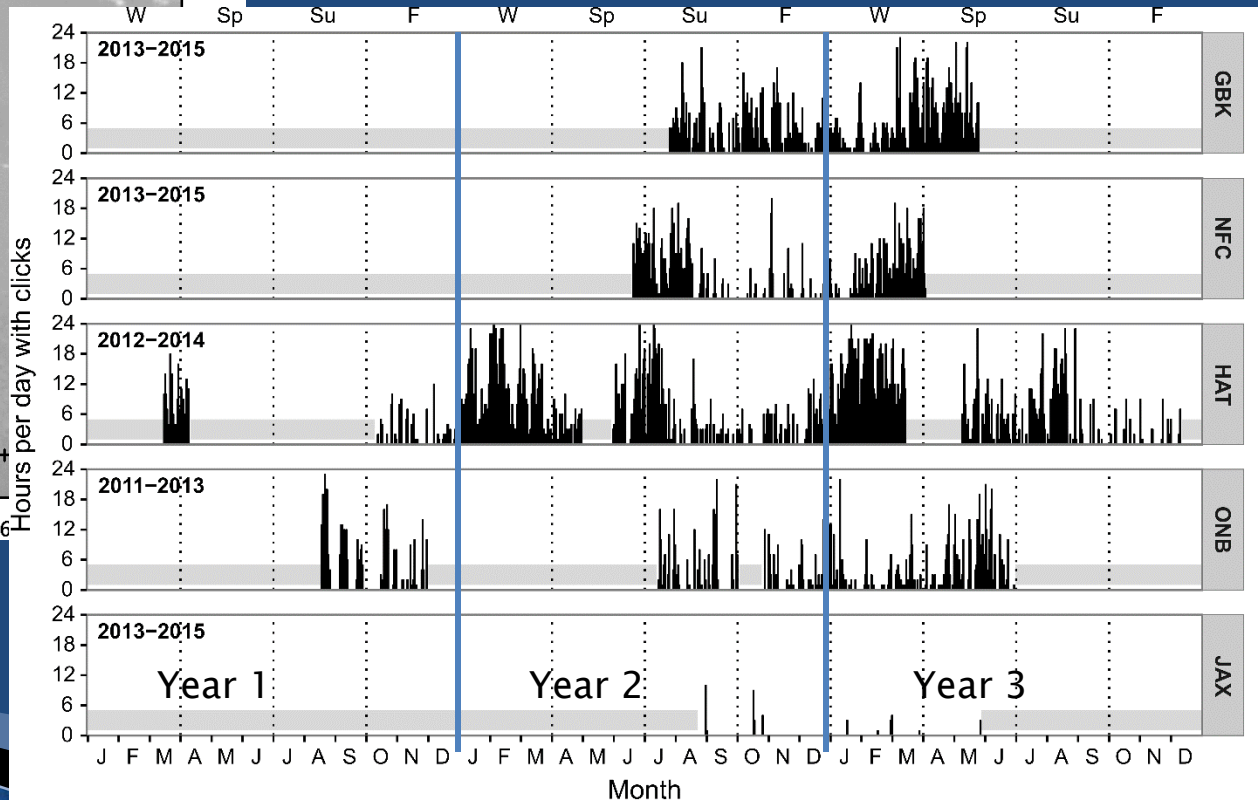




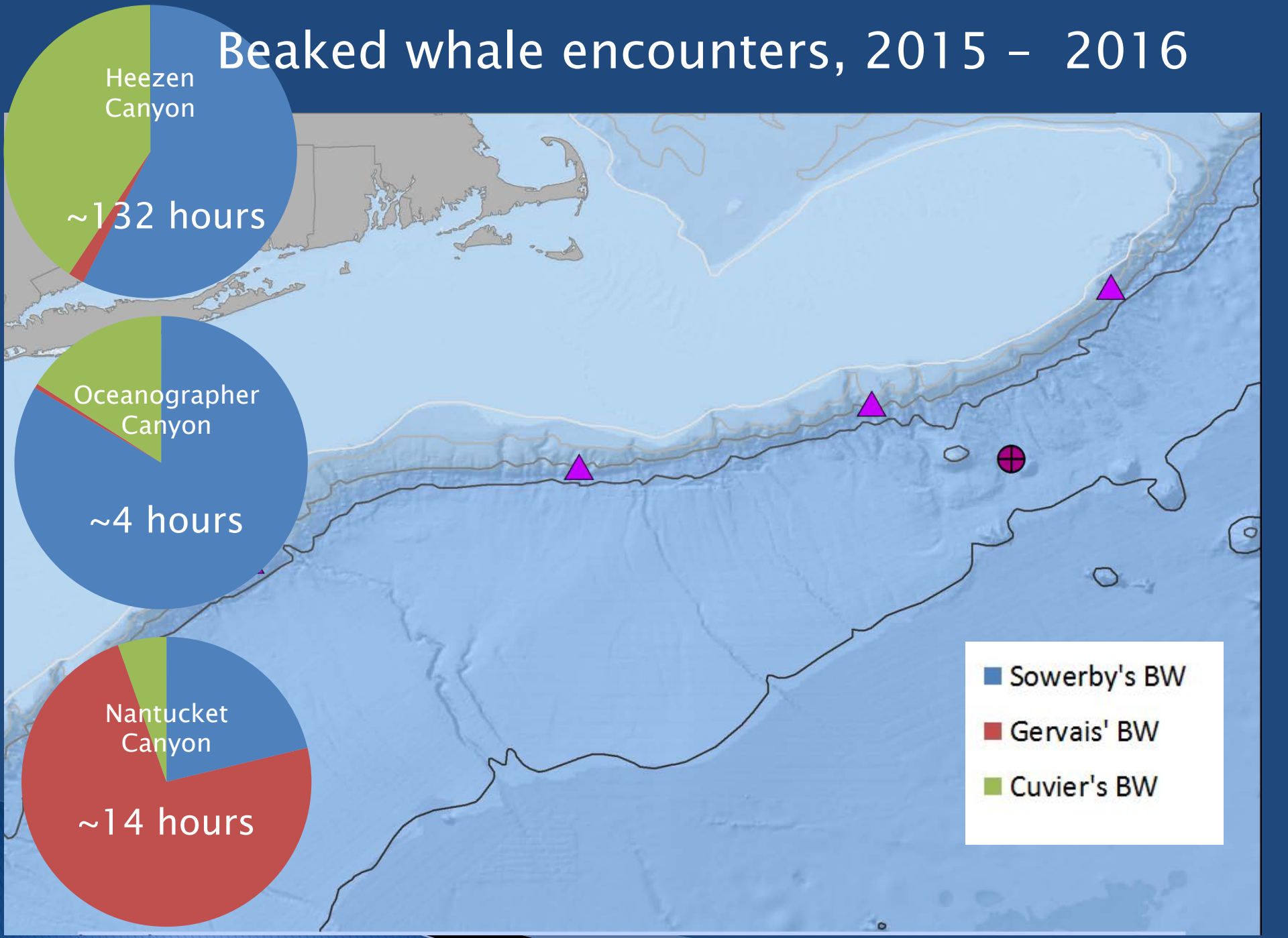
Sperm whales:2011 – 2015



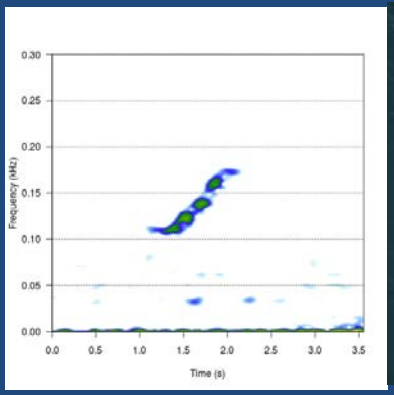
Joy E. Stanistreet, Douglas P. Nowacek, Joel T. Bell, Danielle M. Cholewiak, John A. Hildebrand, Lynne E. W. Hodge, Sofie M. Van Parijs, Andrew J. Read, in review

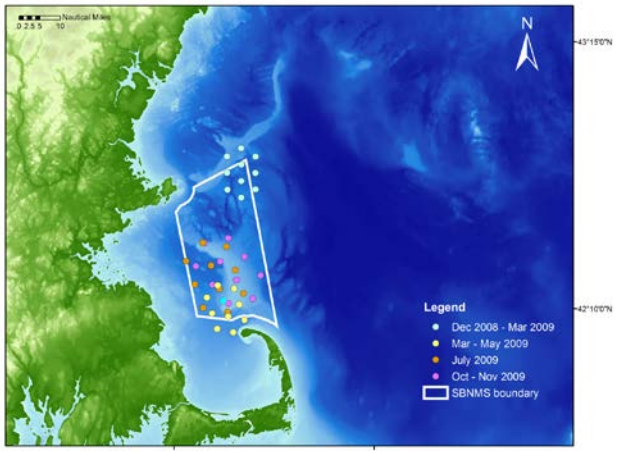


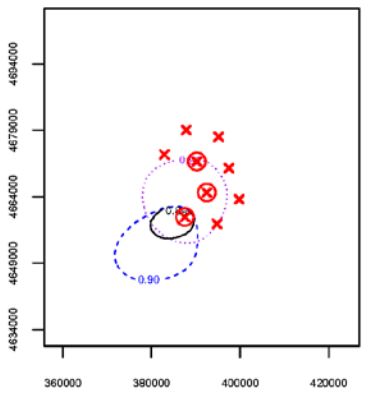
Beaked whale encounters, 2015 – 2016

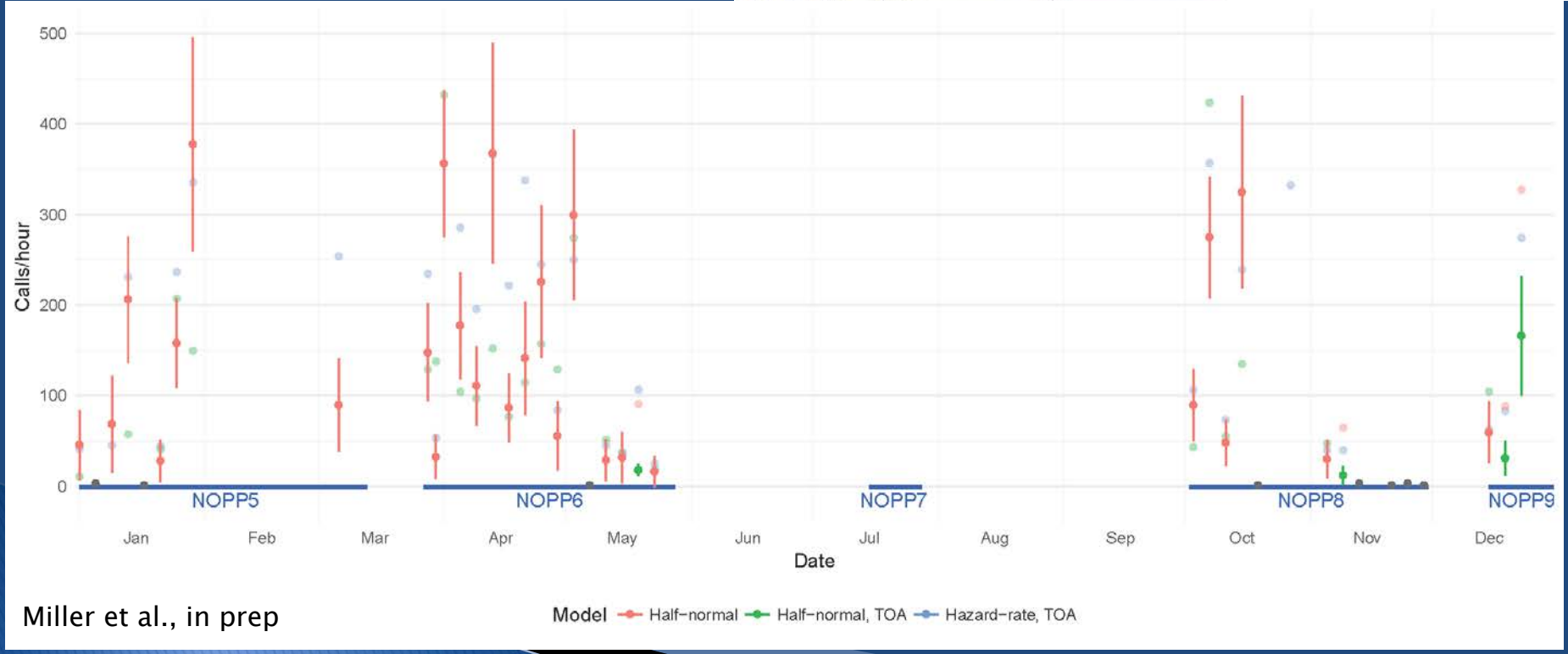


ACOUSTICS FOR ABUNDANCE ESTIMATION: Spatially Explicit Capture-Recapture Methods



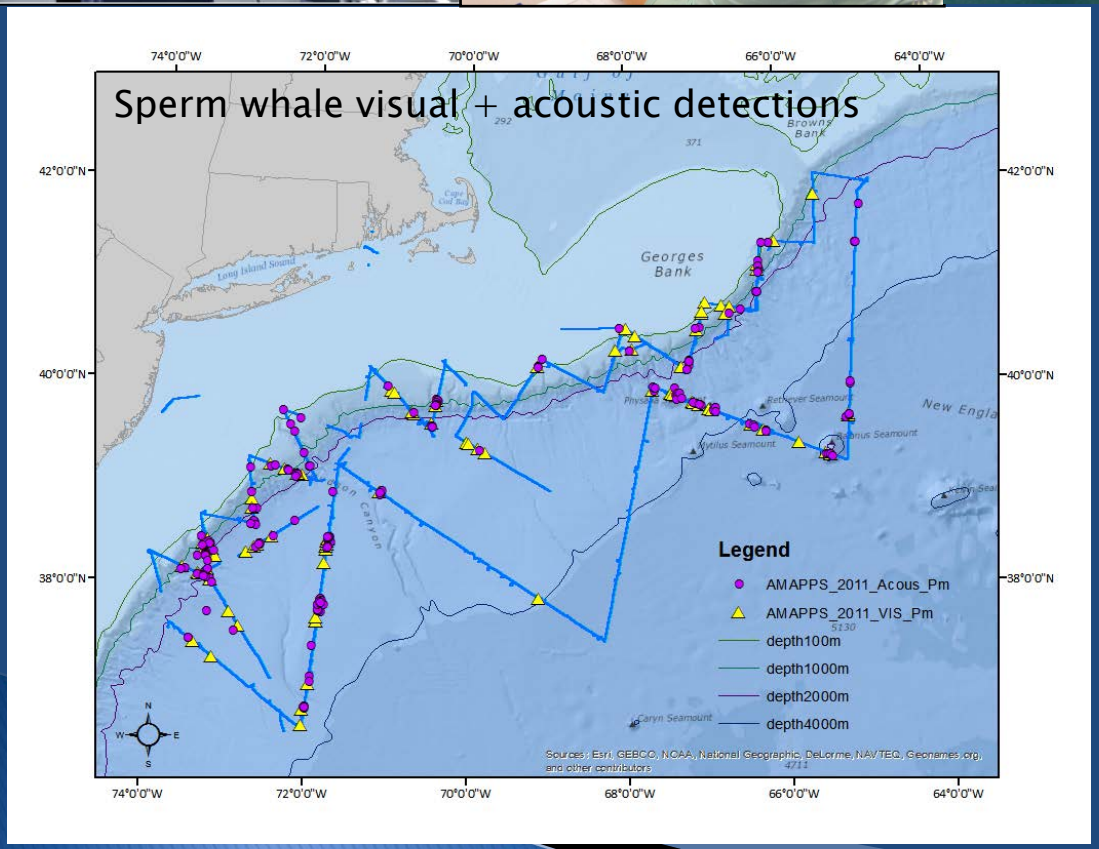


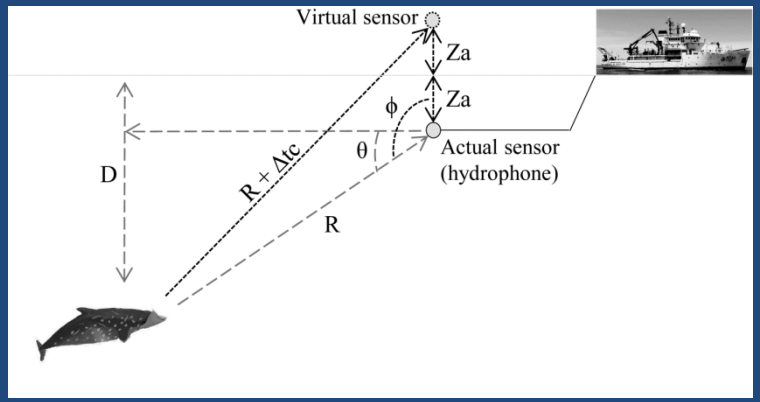




Miller et al., in prep

ACOUSTICS FOR ABUNDANCE ESTIMATION:
Integrating visual & acoustics for sperm whales & beaked whales





3-D localization of beaked whales
DeAngelis et al., in revision

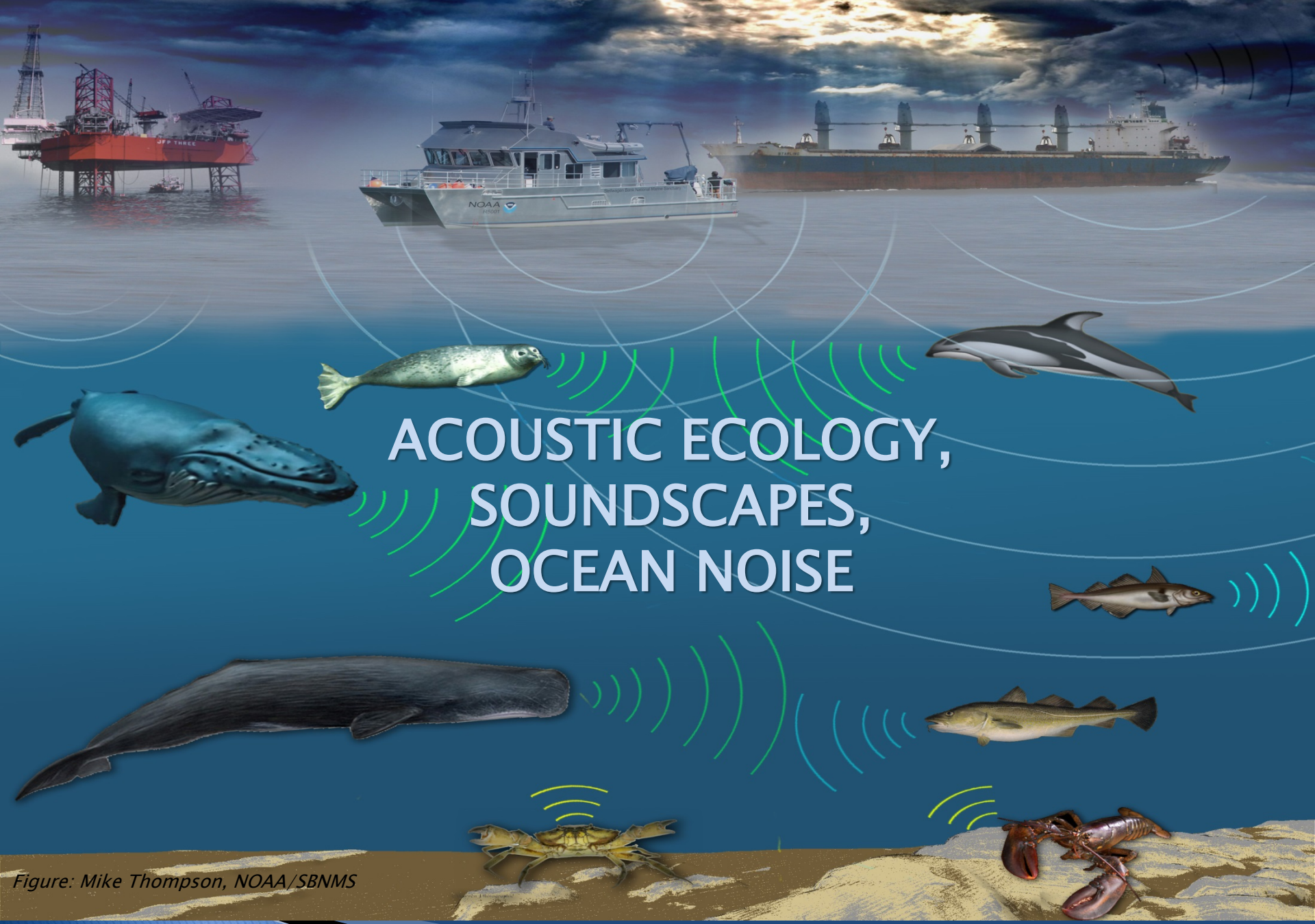
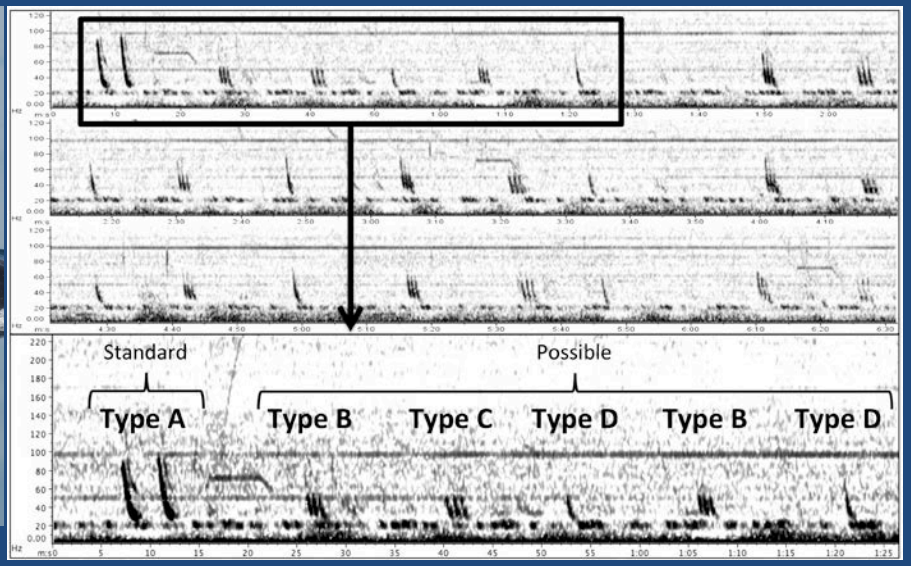


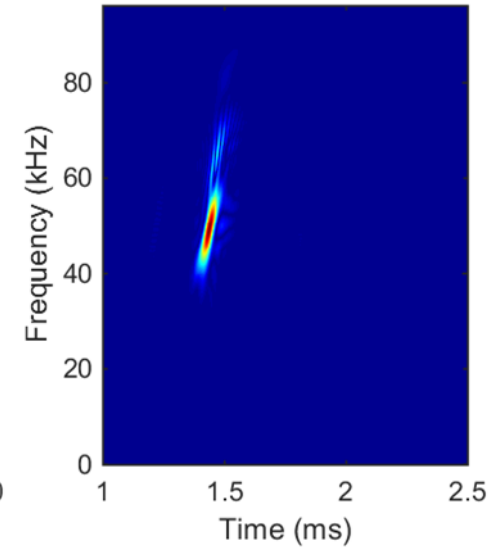
Figure: Mike Thompson, NOAA/SBNMS

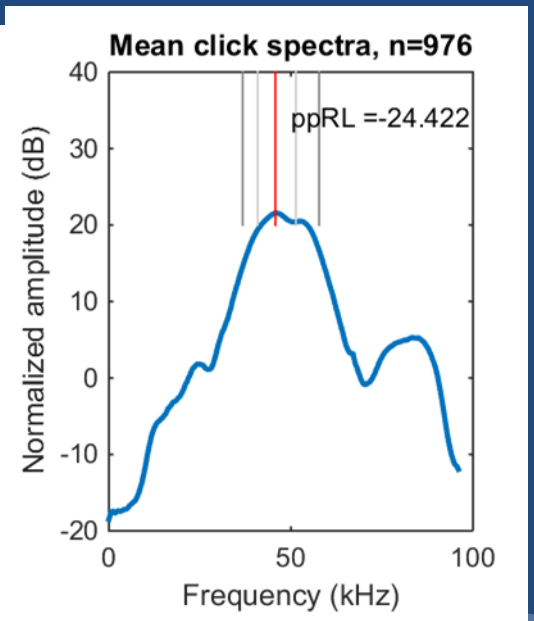
ACOUSTIC ECOLOGY:
Acoustic descriptions for poorly known species



Sei whales

Tremblay et al.
in prep

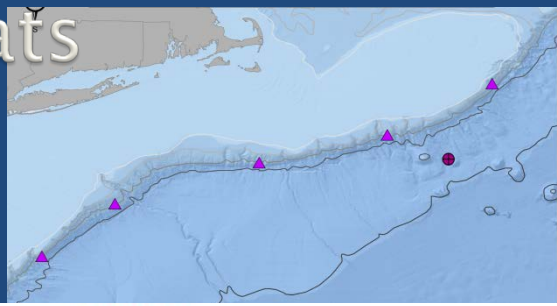




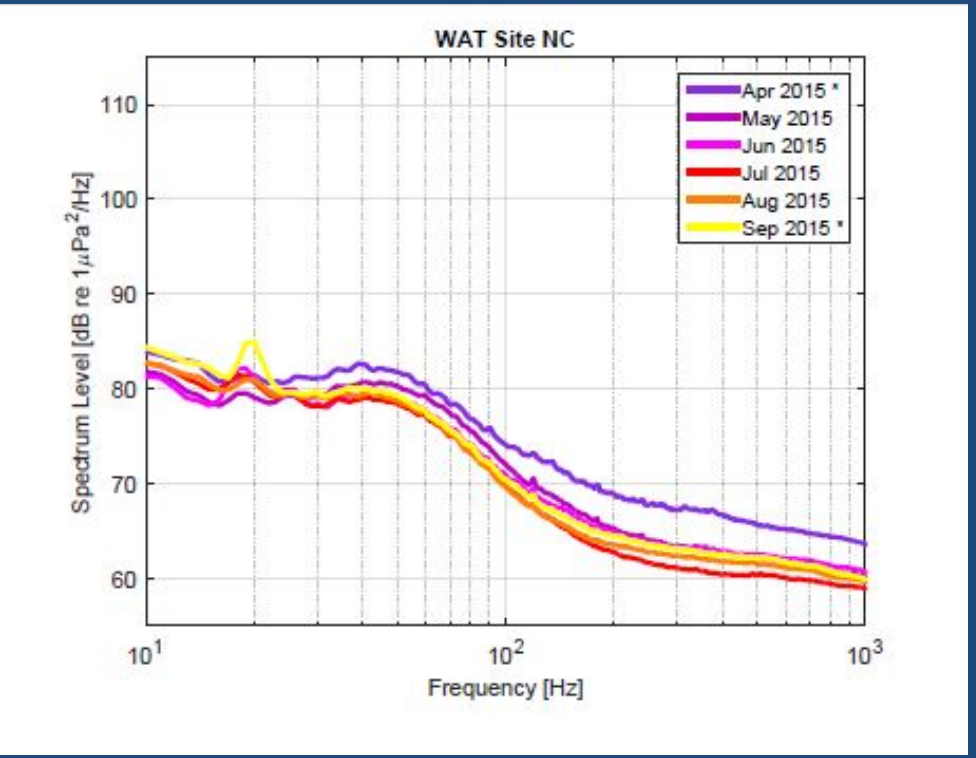
Beaked whales: Sowerby's, True's

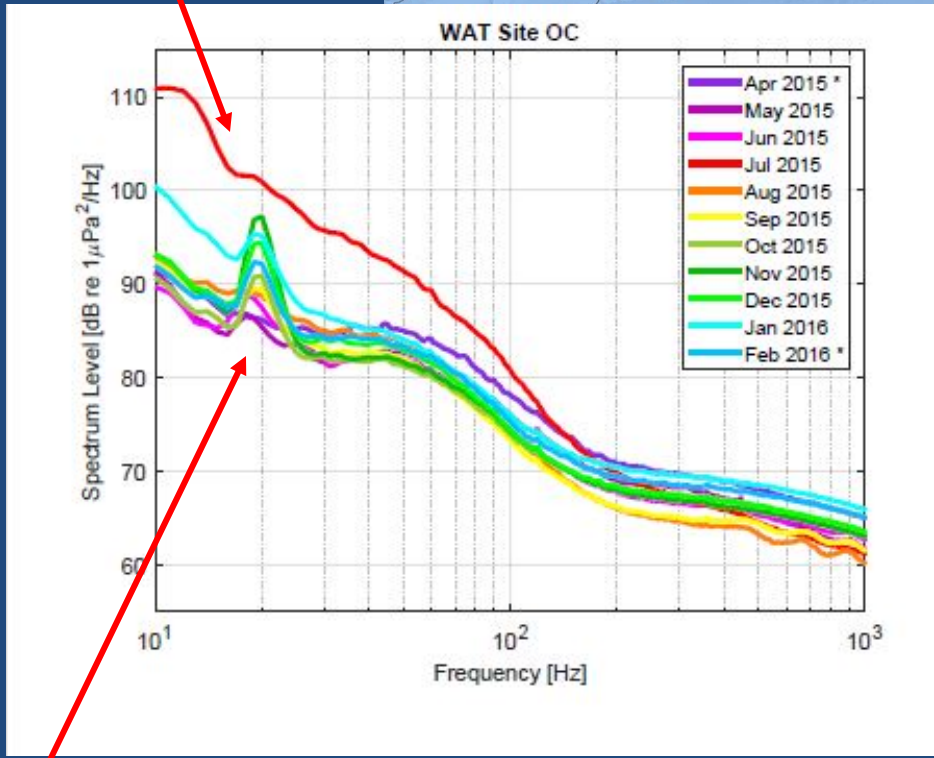
Cholewiak et al., 2013 (Sowerby's)

Monitoring Acoustic Habitats



High currents





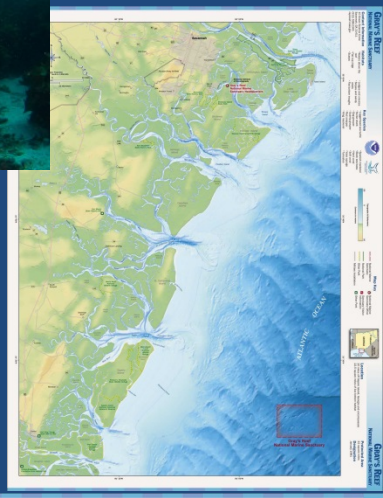
Nantucket Canyon

Oceanographer Canyon

Fin whales

Sound and noisescape ecology of National Marine Sanctuaries

- Four Sanctuaries, four seasons
  - •Stellwagen Bank National Marine Sanctuary
  - •Gray's Reef National Marine Sanctuary
  - •Florida Keys National Marine Sanctuary
  - •Flower Garden Banks National Marine Sanctuary



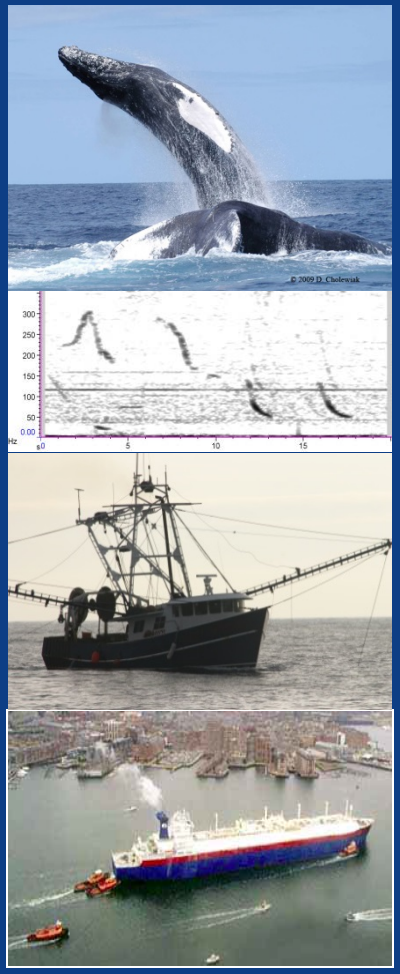
- Sites at each Sanctuary with high & low anthropogenic input

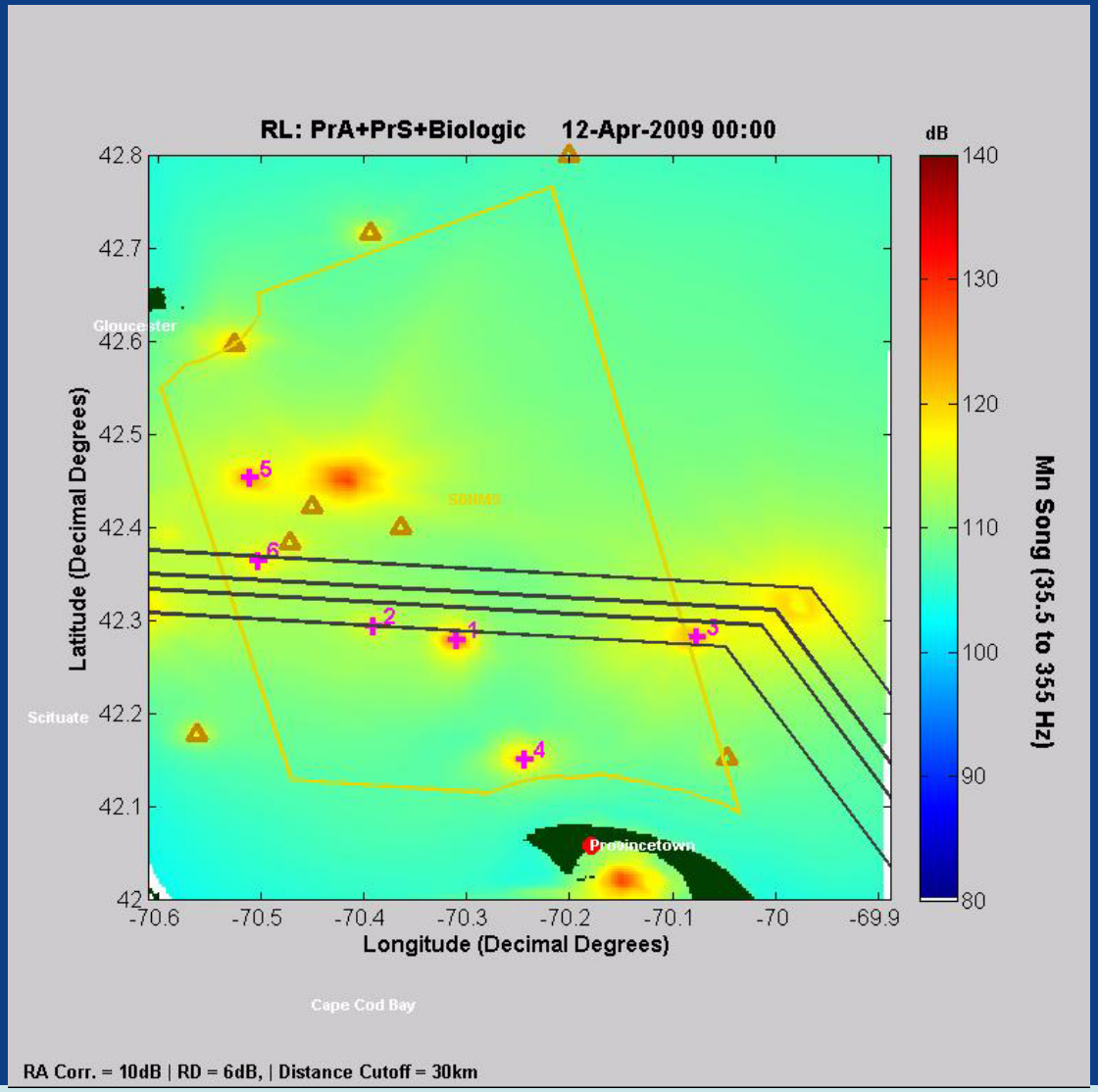
Increasing use of oceans by anthropogenic activities

cetsound.noaa.gov

What did you say?

Modeling the vessel noise on the communication space of baleen whales

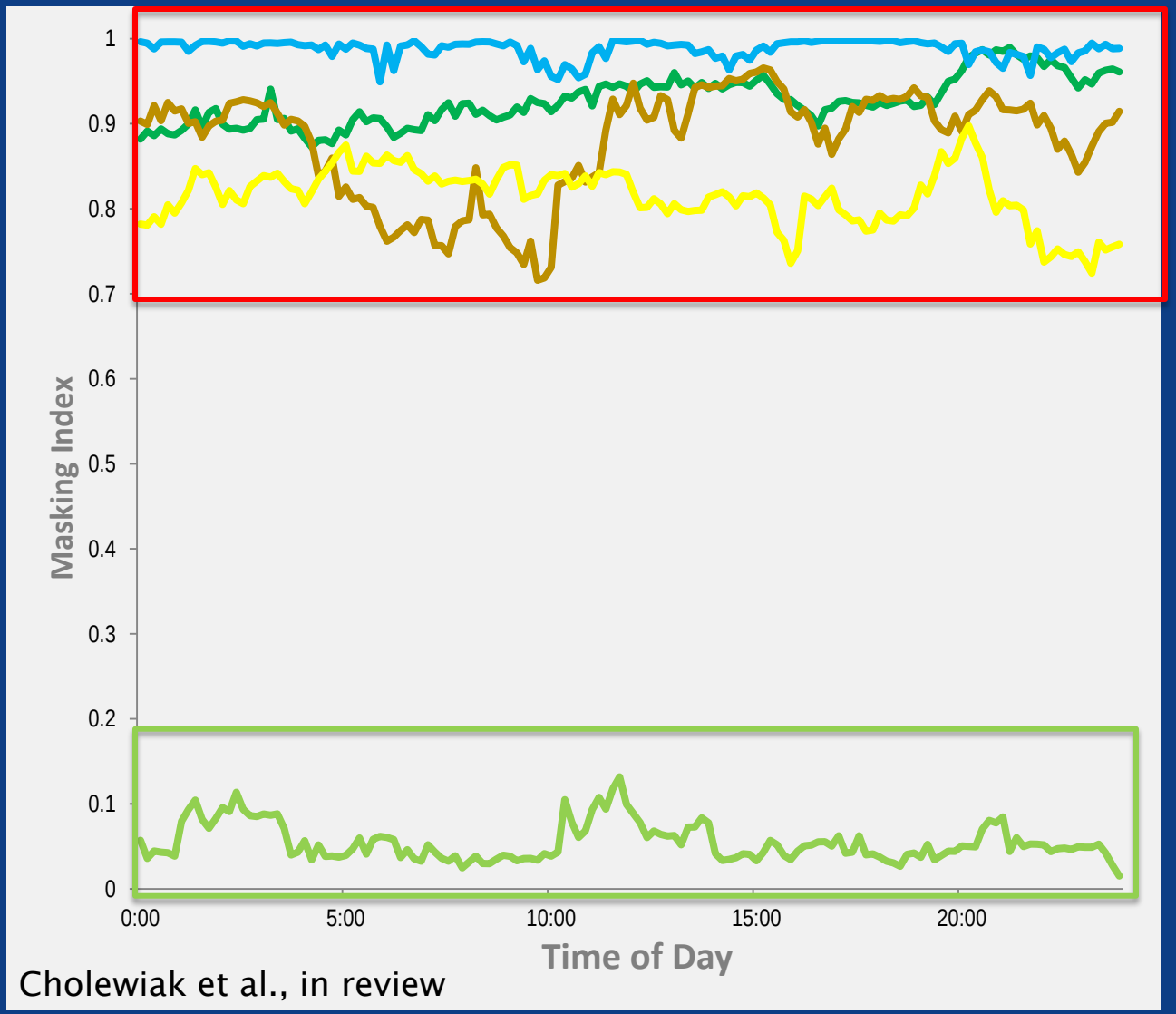




Cholewiak et al., in review

NOAA FISHERIES

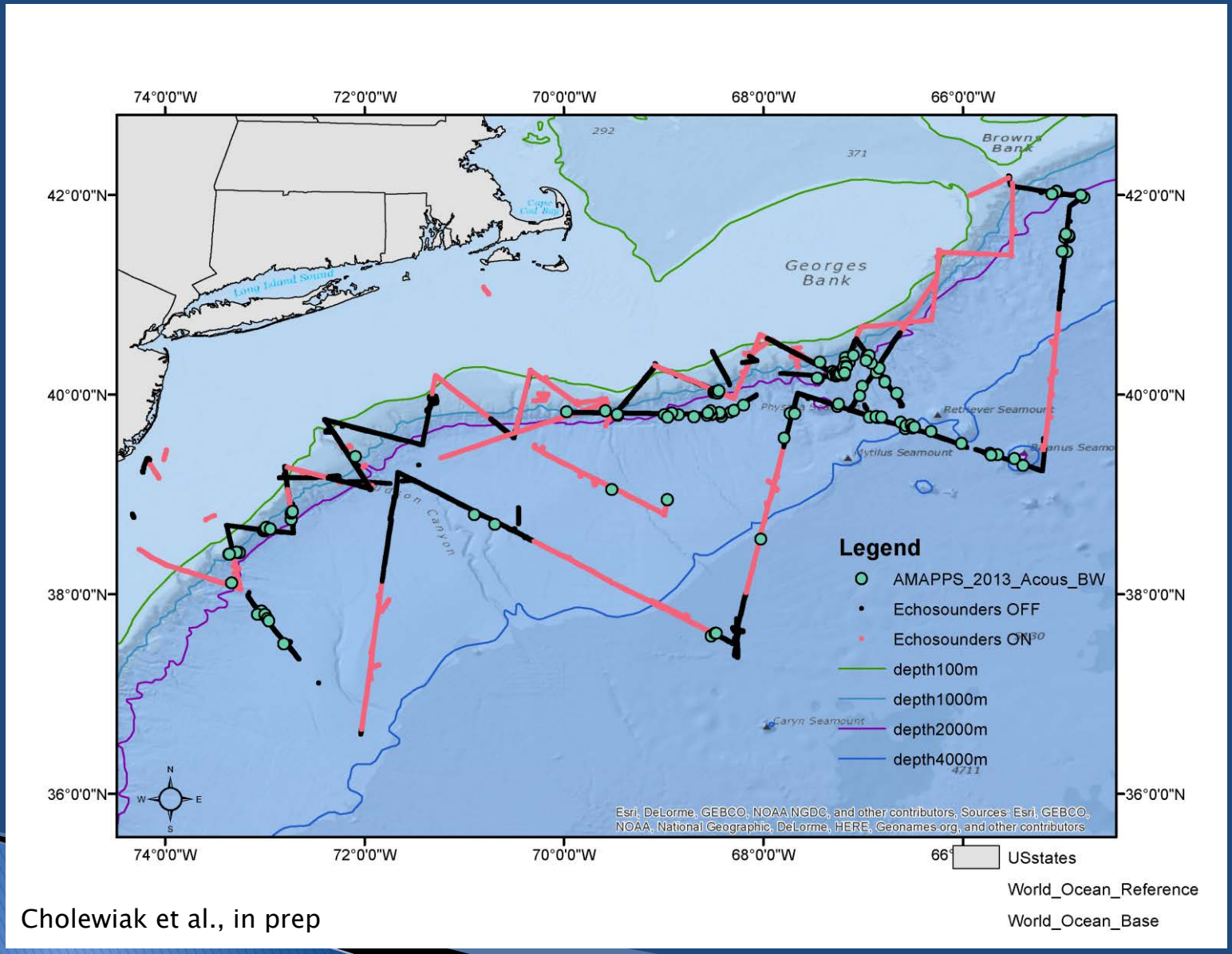
Baleen whales have lost > 80% communication space for many call types/songs



Cholewiak et al., in review

Vessel noise isn't the only issue…

…Sensitive species respond to shipboard echosounders as well



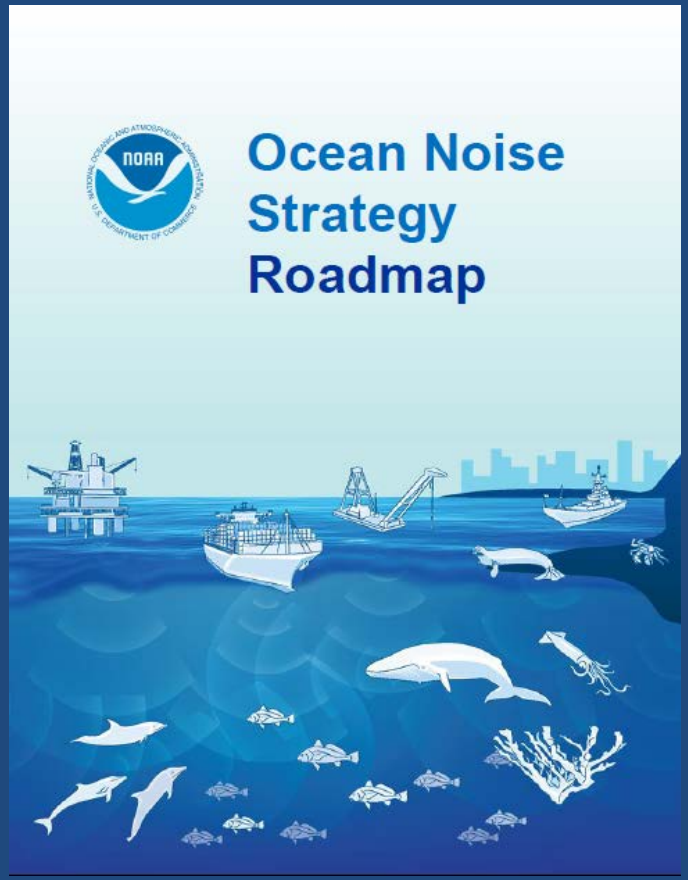
Cholewiak et al., in prep

NOAA Ocean Noise Strategy:

Building a 10 year Vision for Managing Anthropogenic Noise

NOAA is the lead US agency responsible for reducing the impacts of noise on marine species

- Marine Mammal Protection Act
- Endangered Species Act
- National Marine Sanctuaries Act
- National Environmental Policy Act

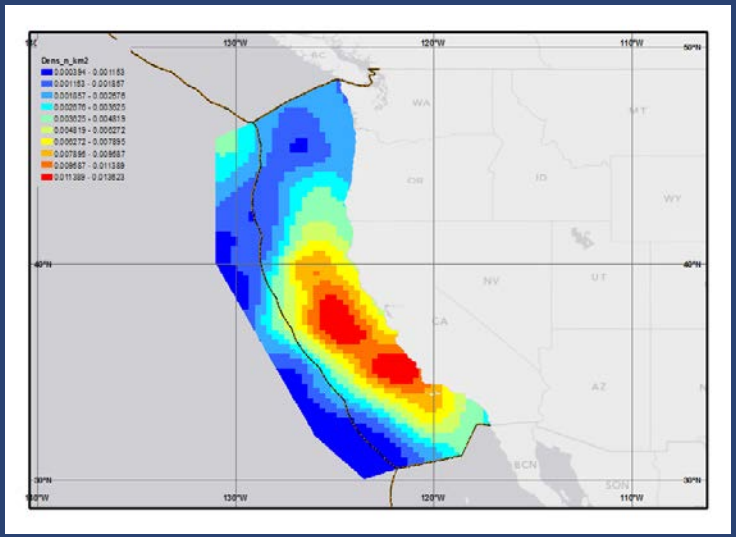


NOAA Fisheries Office of Protected Resources
NOAA Fisheries Office of Science and Technology
NOS Office of National Marine Sanctuaries

Leila Hatch, leila.hatch@noaa.gov
Jason Gedamke, jason.gedamke@noaa.gov
Jolie Harrison, jolie.harrison@noaa.gov

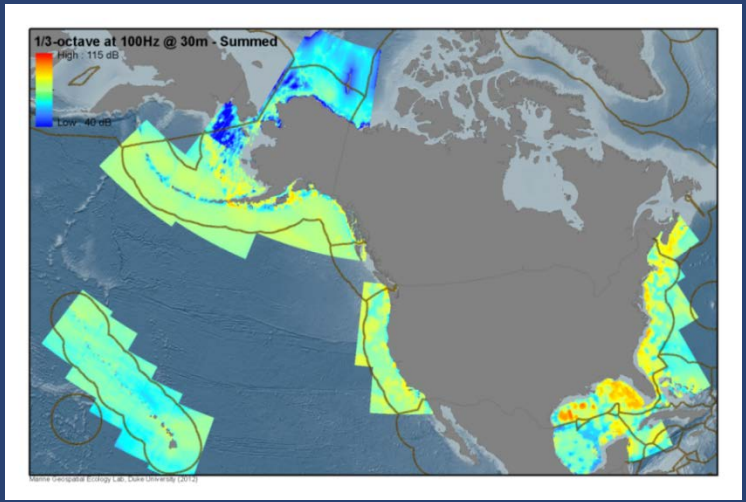
Ocean Noise Strategy
10 Year Vision

Website: cetsound.noaa.gov



Science. NOAA and federal partners are filling shared critical knowledge gaps and building understanding of noise impacts over ecologically-relevant scales.

Management. NOAA's actions are integrated across the agency and minimizing the acute, chronic, and cumulative effects of noise on marine species and their habitat.

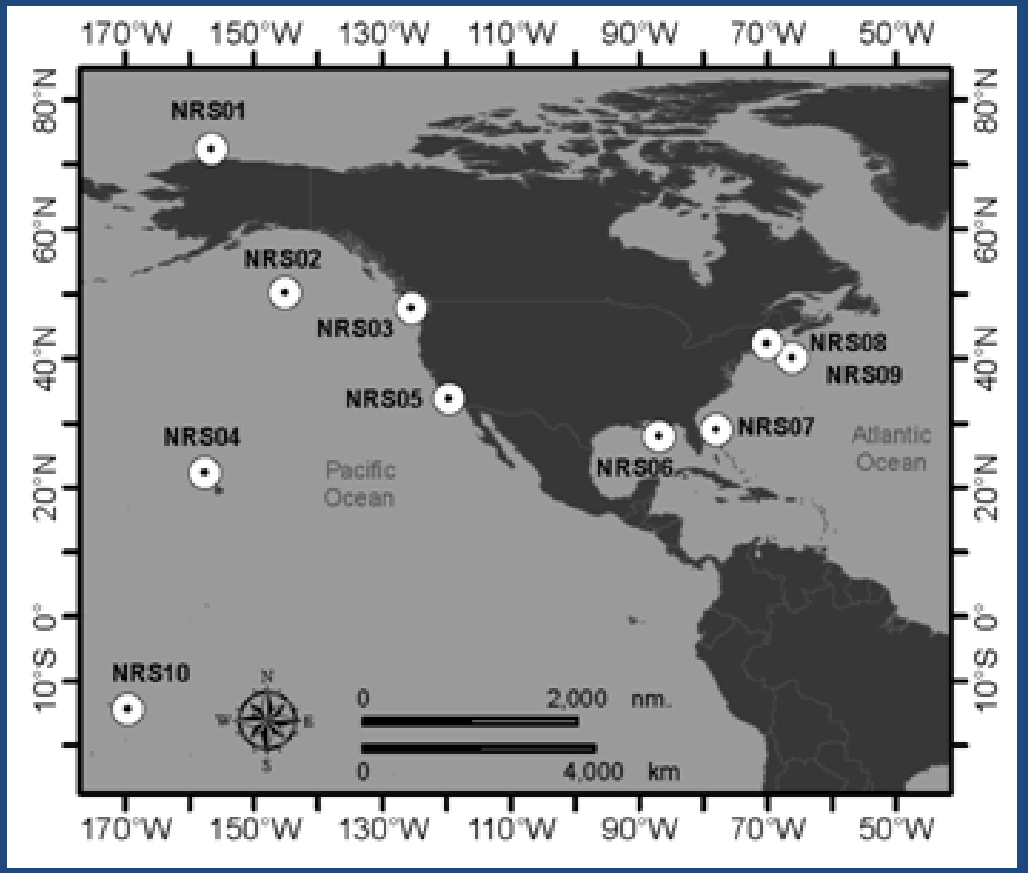


Decision Support Tools. NOAA is developing publically available tools for assessment, planning and mitigation of noise-making activities over ecologically-relevant scales.

Outreach. NOAA is educating the public on noise impacts, engaging with stakeholders and coordinating with related efforts internationally.

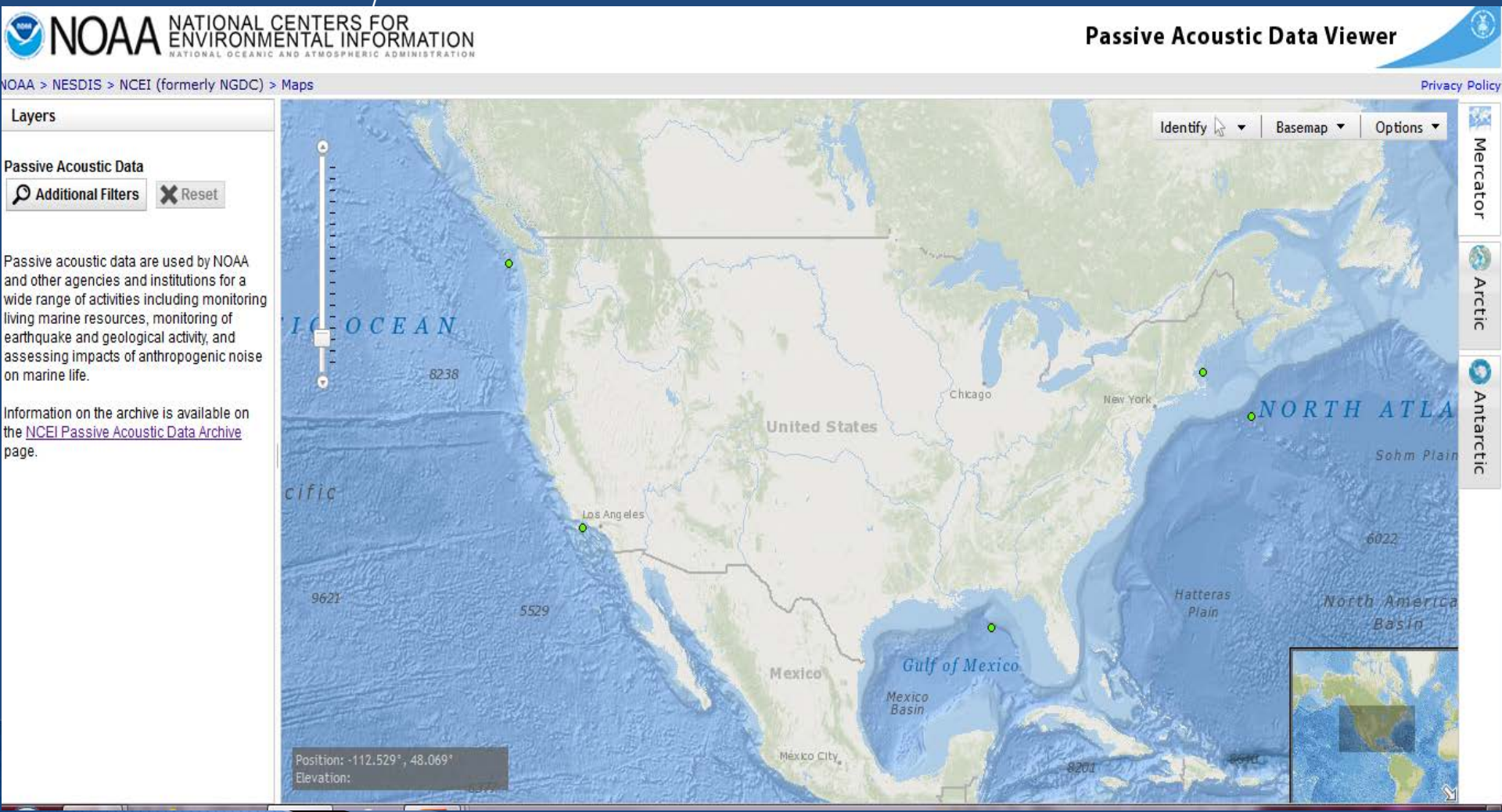
NOAA Ocean Noise Reference Station: Ongoing work: 2015-2017

- Collaborative project amongst all Science Centers & NPS
- Monitoring ambient noise across U.S. waters



NCEI:
Passive Acoustic Data Archive and Accessibility

https://www.ngdc.noaa.gov/mgg/pad/



Biannual Work Plan: Integrating and Tracking Contributions by Participating Programs Across the Agency

PROJECT			CONTRIBUTING NOAA PARTNERS			PARTNERS & STAKEHOLDER ENGAGEMENT			TRACKING & REPORTING		
Project Title & Description (paragraph)	Specific Activities (numbered bullets, roles per contributor)	Link to Strategy Goals (sentences)	Line Office(s)	Program(s)	Lead Contact(s) (name & email per program)	Federal Partners	Non-Federal Partners	Public Input or Targeted Stakeholder Engagement?	Expected Outcomes/Milestones & Timelines (within 2 yrs, sentences)	Progress 2018	Progress 2019
CROSS-LINE OFFICE FLAGSHIP PROJECTS											
NATIONAL ACTIVITIES											
REGIONAL ACTIVITIES											
SUB-REGIONAL ACTIVITIES											

- Offices/Programs identify actions they will commit to
- Within resources, capabilities, authorities, priorities of Offices or Programs
- Coordination, collaboration, integration across programs encouraged

Data Gaps & Future Needs

- Baseline acoustic information still needed for many species
- Few available technologies for long-term monitoring offshore environment limits our ability to monitor pelagic species
- More work needed to integrate presence-only acoustic data into tangible management strategies
- Continued support required to develop broad strategies to manage ocean noise and its impacts

Photo credit: Danielle Cholewiak

NOTE: This presentation contains unpublished data. Many of these datasets are currently being analyzed or are included in manuscript preparation.

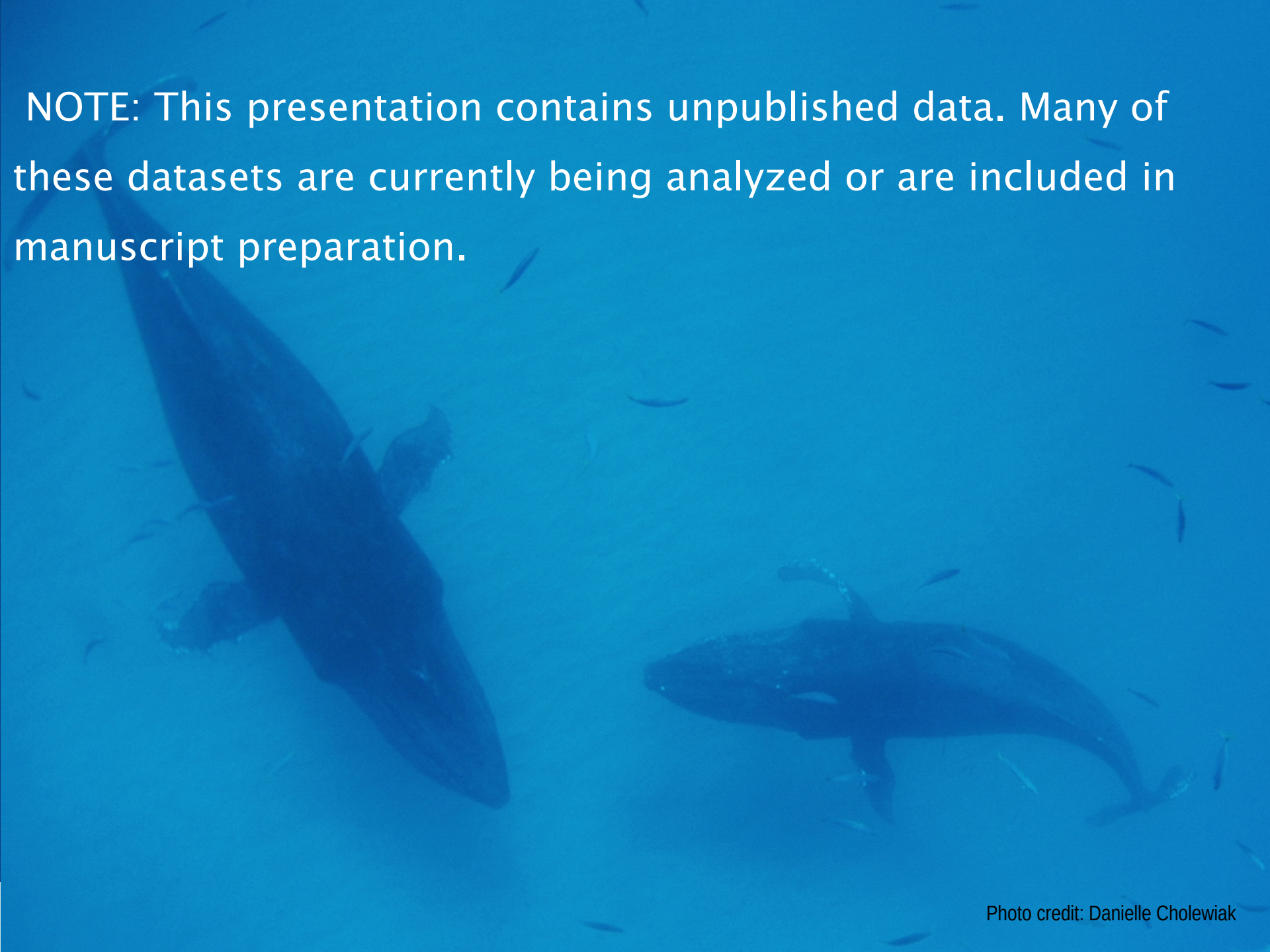


Photo credit: Danielle Cholewiak

Acknowledgements

- P. Corkeron, D. Gerlach, J. Gurnee, H. Heenehan, A. Izzi, E. Matzen, J. Stanley, C. Tremblay-NOAA/NEFSC
- J. Hildebrand, Ryan Griswold - SIO
- Denise Risch - Scottish Association for Marine Science
- Daniel Woodrich - NOAA/AFSC
- Alyssa Scott - University of Washington
- Joy Stanistreet, Taylor Broadhead - Duke University
- Christopher Clark, Chris Pelkie, Chris Tessaglia-Hymes, Margaret Daly - Bioacoustics Research Program, Cornell University
- Leila Hatch, Mike Thompson, R/V Auk and crew (SBNMS)

Funded by:

- NOAA NMFS NEFSC, BOEM, Navy, NOAA NMFS OPR

Thank you!