

Current Efforts to Mitigate Ship Strikes Using Real-Time Acoustic Monitoring of Right Whales from Autonomous Platforms

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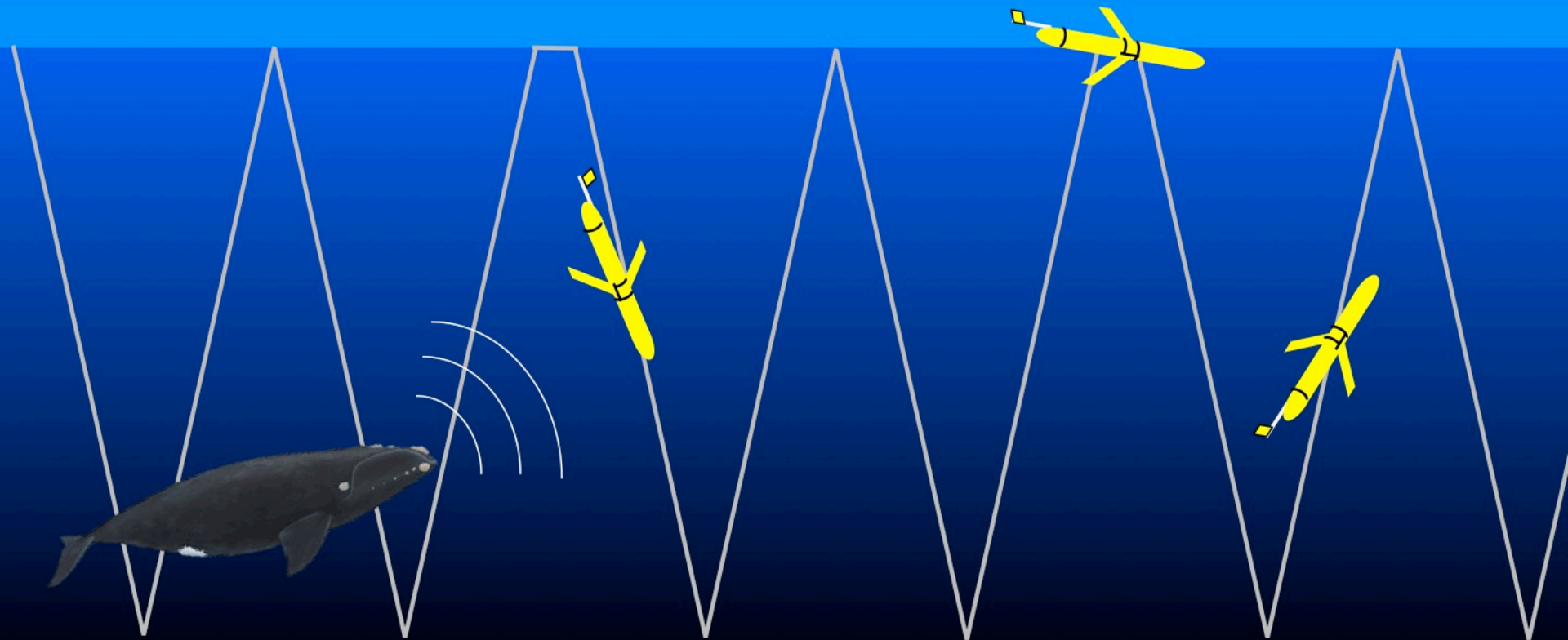
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The location of most of the right whale population is unknown most of the time, and this is a fundamental factor limiting effective ship strike mitigation. To help address this issue, a system was developed to continuously monitor right whales in near real-time from autonomous ocean platforms. The system (DMON-LFDACS) consists of a hydrophone that records low frequency audio and software that detects and classifies right whale sounds from the recorded audio. A subset of ~ 25% of this data is transmitted to a shore station via Iridium satellite, where it is validated by a trained analyst and then disseminated to stakeholders. Since 2014, the DMON-LFDACS has been deployed on Slocum gliders and buoys to monitor right whale presence from the New York Bight to the Gulf of St. Lawrence, which encompasses the core right whale feeding range. Right whales have been detected in near real-time by these platforms over 700 times. Validation of the real-time protocol demonstrates that it correctly detects true right whale acoustic presence with nearly 100% accuracy. Missed detection rates, which are moderate, can be reduced by increasing the subset of data sent via Iridium satellite. We summarize current applications of the technology in Canadian waters, including monitoring during the Gulf of St. Lawrence mortality event, in high-use shipping routes and a seasonal Area to be Avoided. We conclude with a vision for the future of the widespread implementation of this system to conduct real-time monitoring and mitigation of ship strikes in the Northwest Atlantic.

Current efforts to mitigate ship strikes using real-time acoustic monitoring from autonomous platforms

*Mark Baumgartner, Kimberley Davies,
Delphine Durette-Morin, Julianne Gurnee,
Hansen Johnson, Christopher Taggart, Sofie Van Parijs*

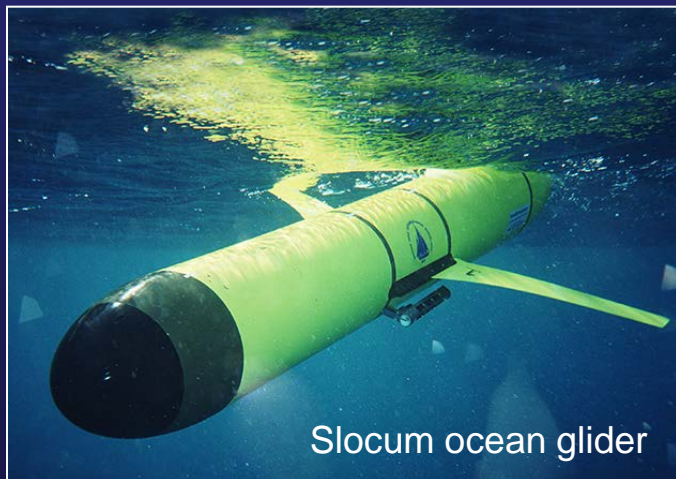




1. Motivation
2. Enabling technology
3. Does the technology work?
4. Applications

Autonomous platforms

- Long endurance
- 24/7 monitoring
- Some are mobile
- Built-in real-time communications
- Comparatively inexpensive
- Quiet for archival/real-time passive acoustics





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Digital acoustic monitoring instrument



DMON



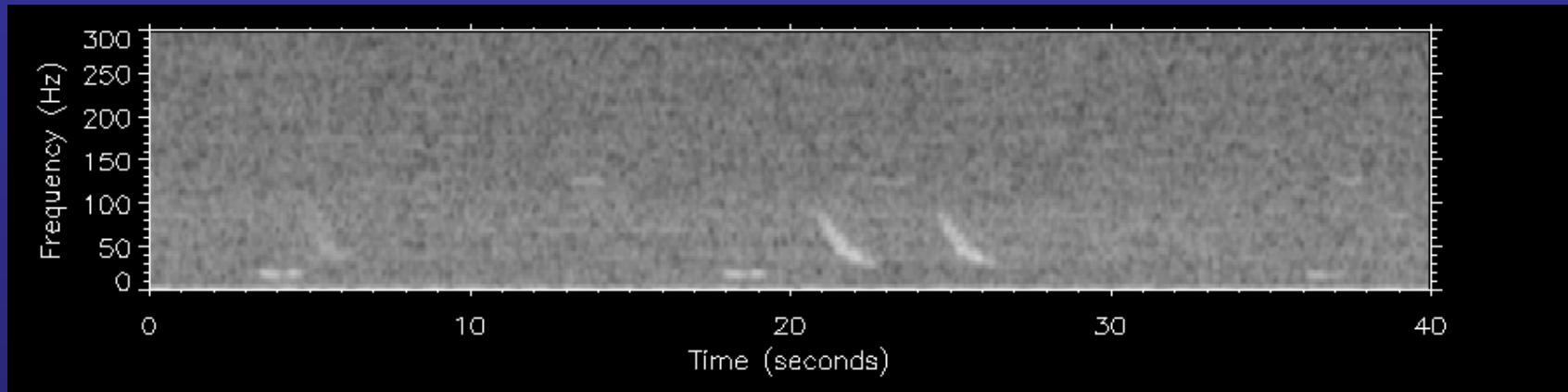
Features

- Programmable
- Records audio
- Detects sounds



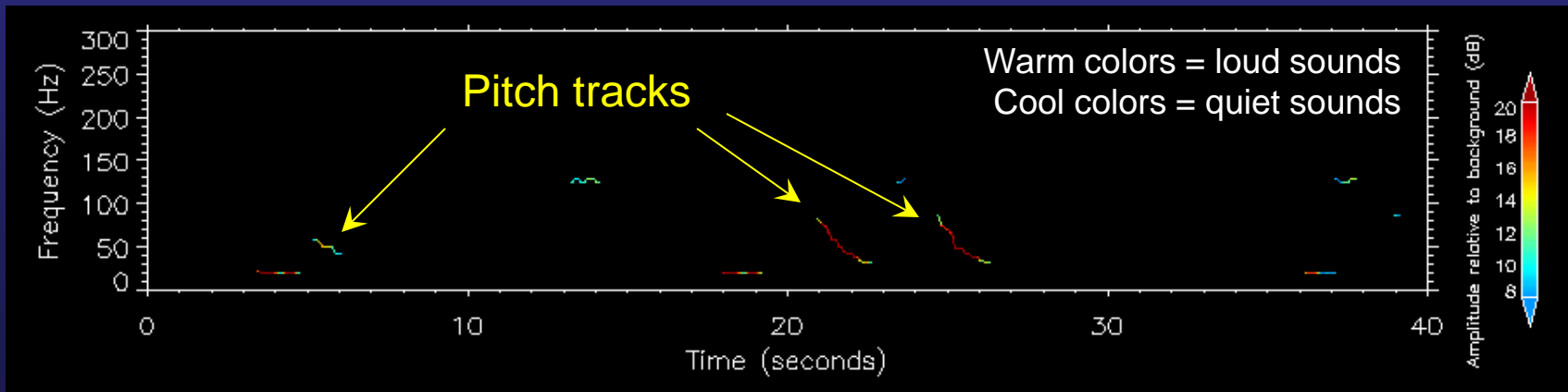
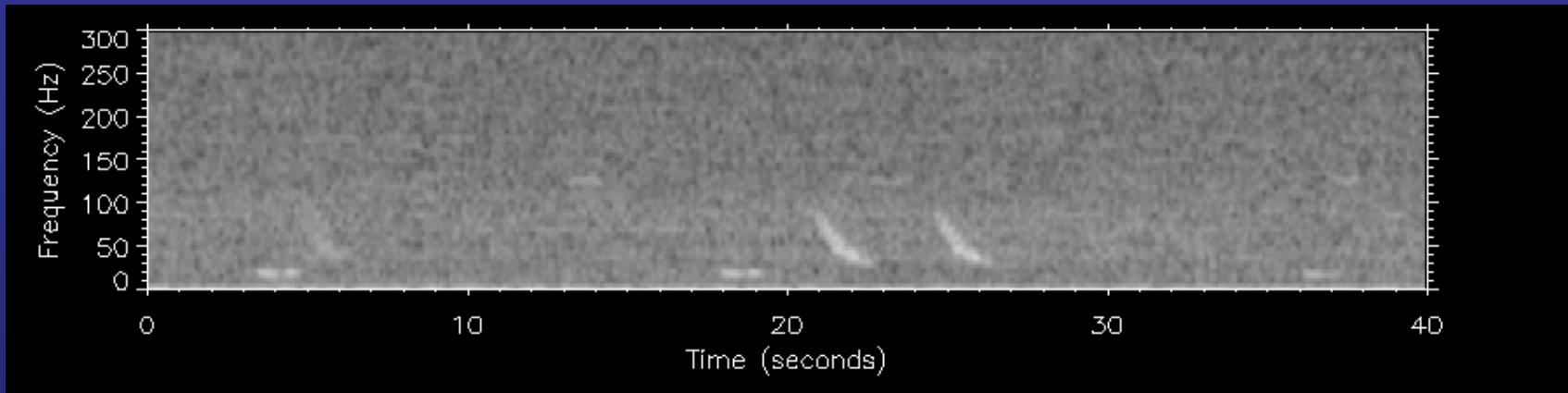
Developed at WHOI by Mark Johnson, Tom Hurst, and Alex Shorter

Low-frequency detection and classification system (LFDCS)



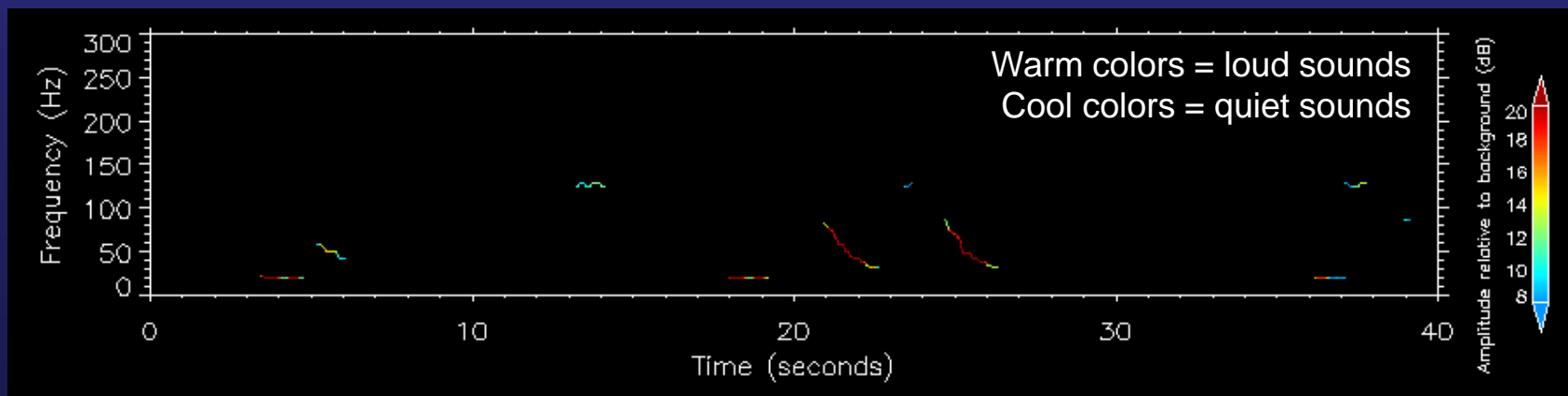
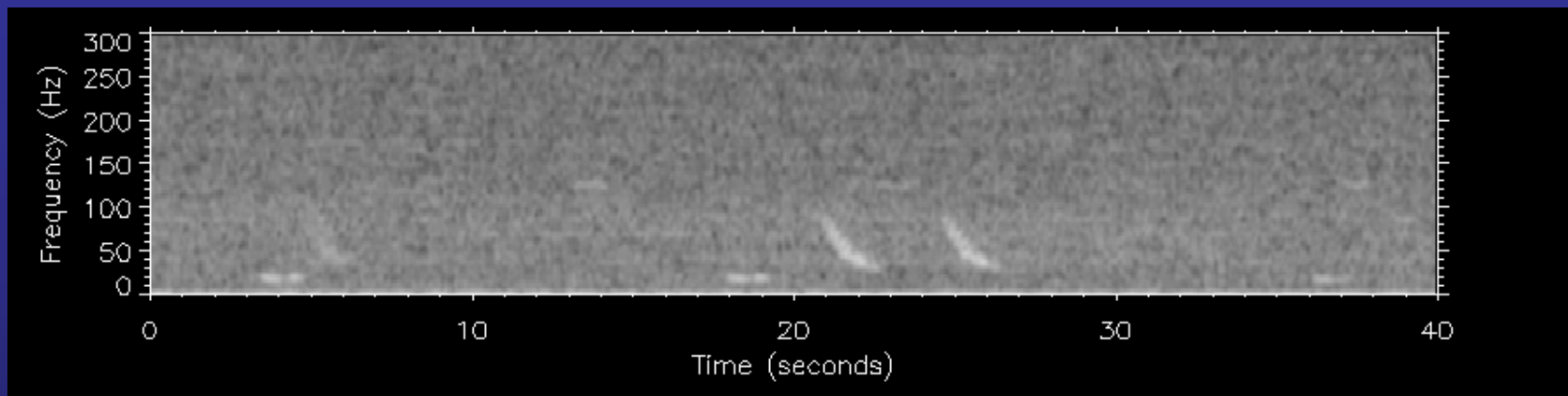
Baumgartner, M.F. and S.E. Mussoline. 2011. A generalized baleen whale call detection and classification system. Journal of the Acoustical Society of America 129:2889-2902.

Low-frequency detection and classification system (LFDCS)



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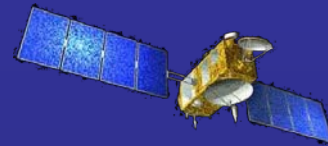
Baumgartner, M.F. and S.E. Mussoline. 2011. A generalized baleen whale call detection and classification system. Journal of the Acoustical Society of America 129:2889-2902.

Operation



Transmit to shore:

- Subset of pitch tracks and classifications
- Background noise
- DMON/LFDCS status
- Platform location
- Platform status



Iridium satellite

Shore-side server

robots4whales.whoi.edu



Slocum glider

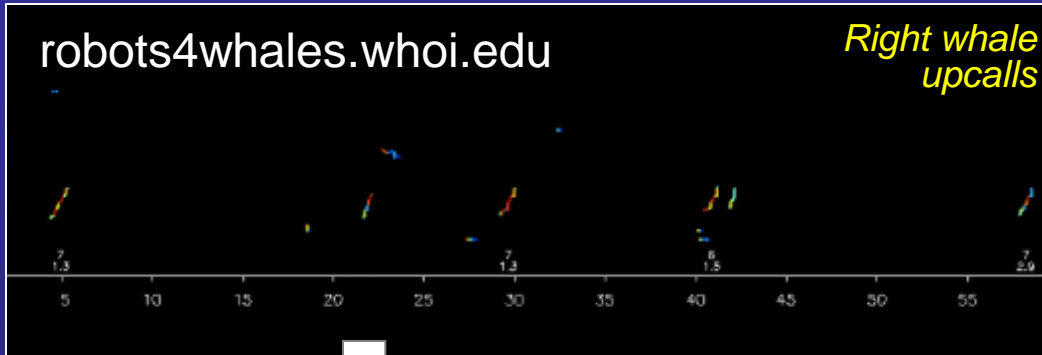


Moored buoy



Wave glider





Analyst protocol

- "calibrate" analysts
- conservative

Analyst reviews:

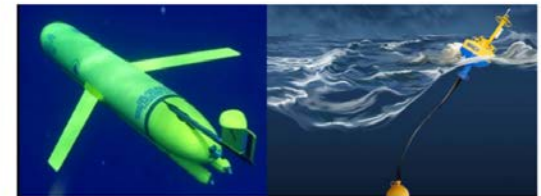
- Pitch tracks
- Classifications
- Context



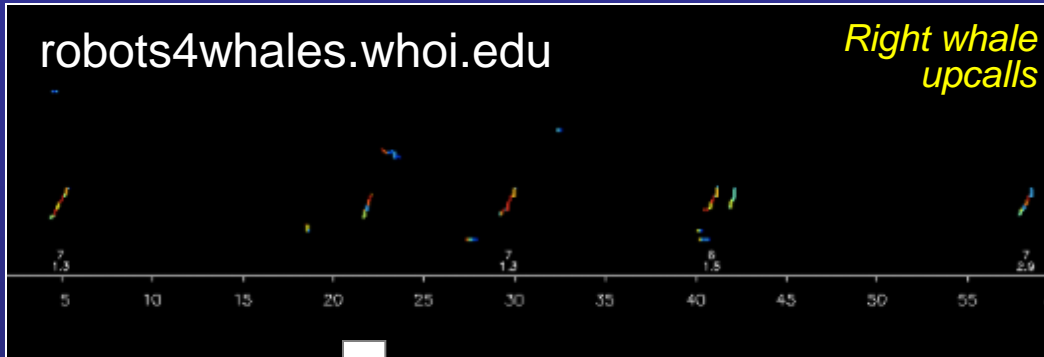
Guide to Monitoring Real-time Marine Mammal Detections using Autonomous Platforms

12/5/2014
(Revised 4/8/2016)
NOAA NEFSC Passive Acoustics Research Group
Annamaria Izzi, Julianne Gurnee

Woods Hole Oceanographic Institution
Mark Baumgartner



Operation



Daily analyst review:

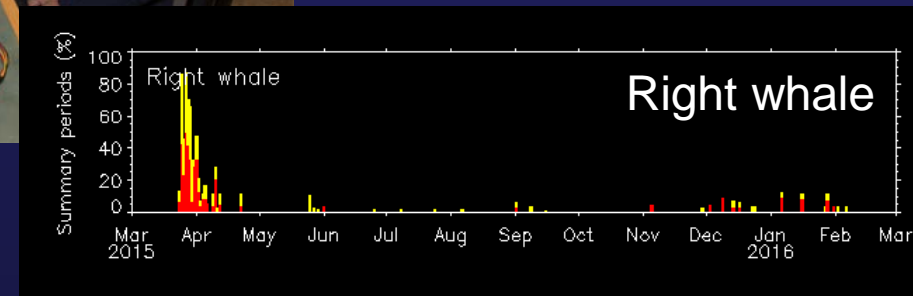
Date	Sei whale	Fin whale	Right whale	Humpback whale
09/04/2015	Detected	Detected	Not detected	Not detected
09/03/2015	Possibly detected	Detected	Detected	Not detected
09/02/2015	Possibly detected	Detected	Detected	Not detected
09/01/2015	Detected	Detected	Possibly detected	Not detected
08/31/2015	Possibly detected	Detected	Not detected	Not detected
08/30/2015	Possibly detected	Detected	Not detected	Not detected
08/29/2015	Detected	Detected	Not detected	Detected
08/28/2015	Detected	Detected	Not detected	Not detected

■ Detected
■ Possibly detected
■ Not detected



Analyst reviews:

- Pitch tracks
- Classifications
- Context



Distribution

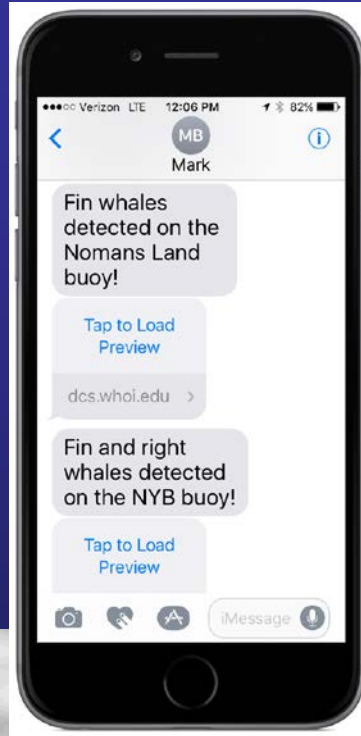


dcs.who.edu

Daily analyst review:

Date	Sei whale	Fin whale	Right whale	Humpback whale
09/04/2015	Red	Red	Red	Grey
09/03/2015	Yellow	Red	Red	Grey
09/02/2015	Yellow	Red	Red	Grey
09/01/2015	Yellow	Red	Yellow	Grey
08/31/2015	Yellow	Red	Red	Grey
08/30/2015	Yellow	Red	Red	Grey
08/29/2015	Red	Red	Red	Red
08/28/2015	Red	Red	Red	Red

Text message



Email message

Mark Baumgartner
 To: undisclosed-recipients;;
 Fin whales detected on the Nomans Land buoy

Time now: 12/13/16 12:00 EST

Fin whales detected on the Nomans Land buoy! Latest detections: 2.8 hours ago.

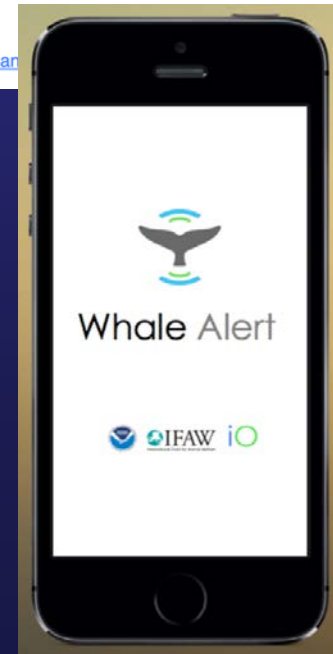
Fin whale detections:
 12/12/16 18:09 EST (17.8 hr ago)
 12/12/16 19:09 EST (16.8 hr ago)
 12/12/16 20:09 EST (15.8 hr ago)
 12/12/16 21:09 EST (14.8 hr ago)
 12/12/16 23:09 EST (12.8 hr ago)
 12/13/16 00:09 EST (11.8 hr ago)
 12/13/16 01:09 EST (10.8 hr ago)
 12/13/16 02:09 EST (9.8 hr ago)
 12/13/16 02:24 EST (9.6 hr ago)
 12/13/16 03:09 EST (8.8 hr ago)
 12/13/16 05:09 EST (6.8 hr ago)
 12/13/16 06:09 EST (5.8 hr ago)
 12/13/16 07:09 EST (4.8 hr ago)
 12/13/16 08:09 EST (3.8 hr ago)
 12/13/16 09:09 EST (2.8 hr ago)

See <http://dcs.who.edu/nomans0916/nomans>

AIS (2018?)



Whale Alert app (fall 2017)



Tweet





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How well does it work?

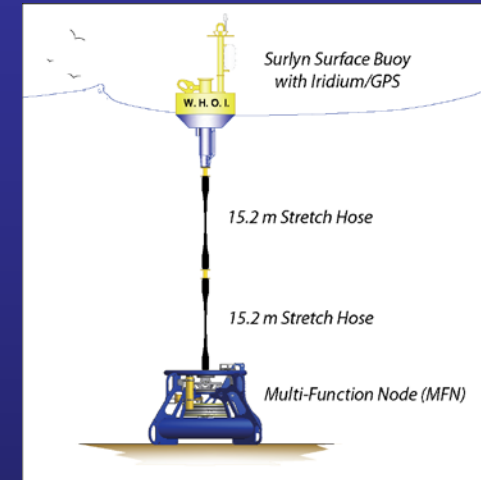
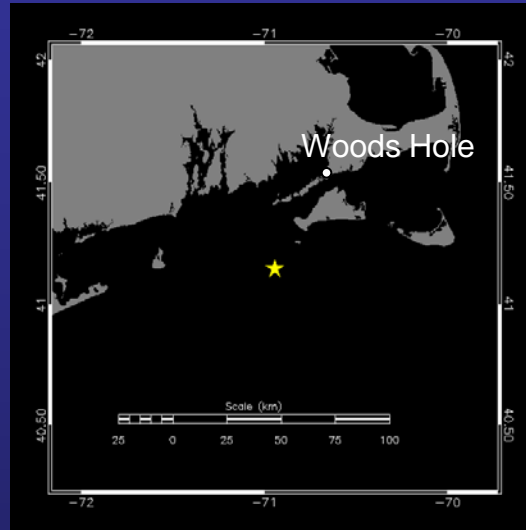


Evaluation datasets

Moored buoy

Noman's Land Island

March 2015 - March 2016

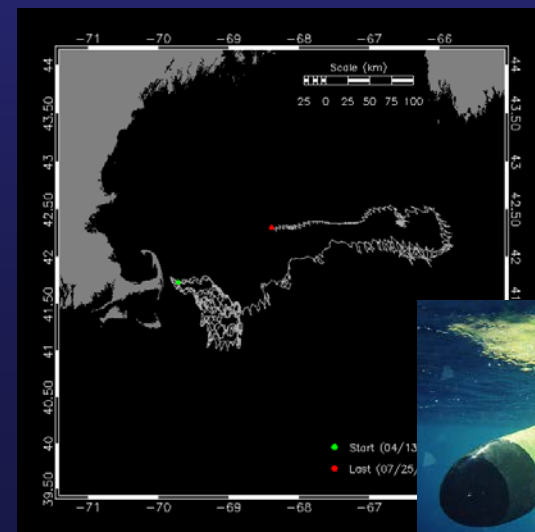
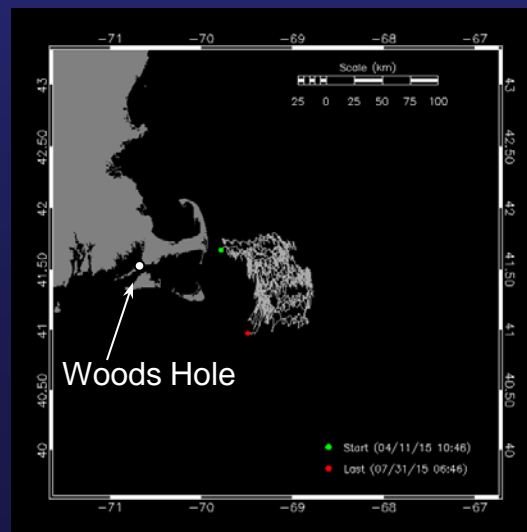


Slocum glider

Great South Channel

April - July 2015

April - July 2016

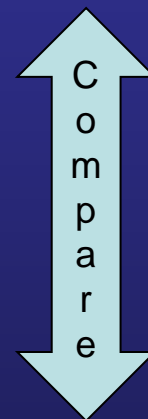


How well does it work?



Near real-time analysis
of pitch tracks

Right whale



Audio analysis of
archived recordings

How well does it work?



	Number of days	Missed occurrence (%)	False occurrence (%)	Accuracy (%)
<i>Slocum glider 2015</i>	85	8.3	0.0	97.6
<i>Slocum glider 2016</i>	55	44.4	0.0	92.7
<i>Moored buoy</i>	141	28.0	0.0	95.0



*Evaluation of near real-time estimates of daily whale occurrence
Truth = analysis of recorded audio*

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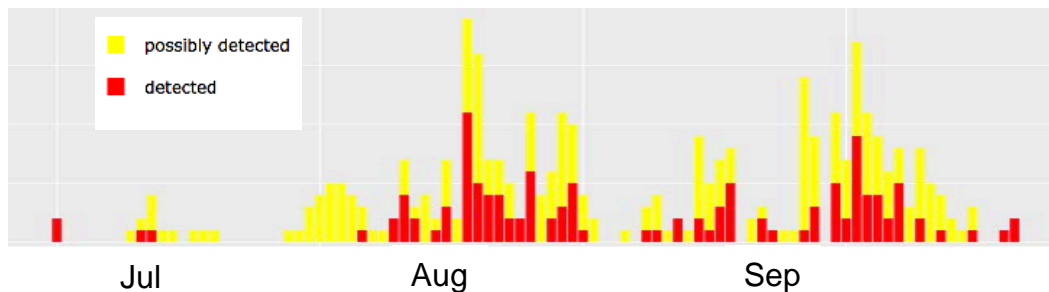
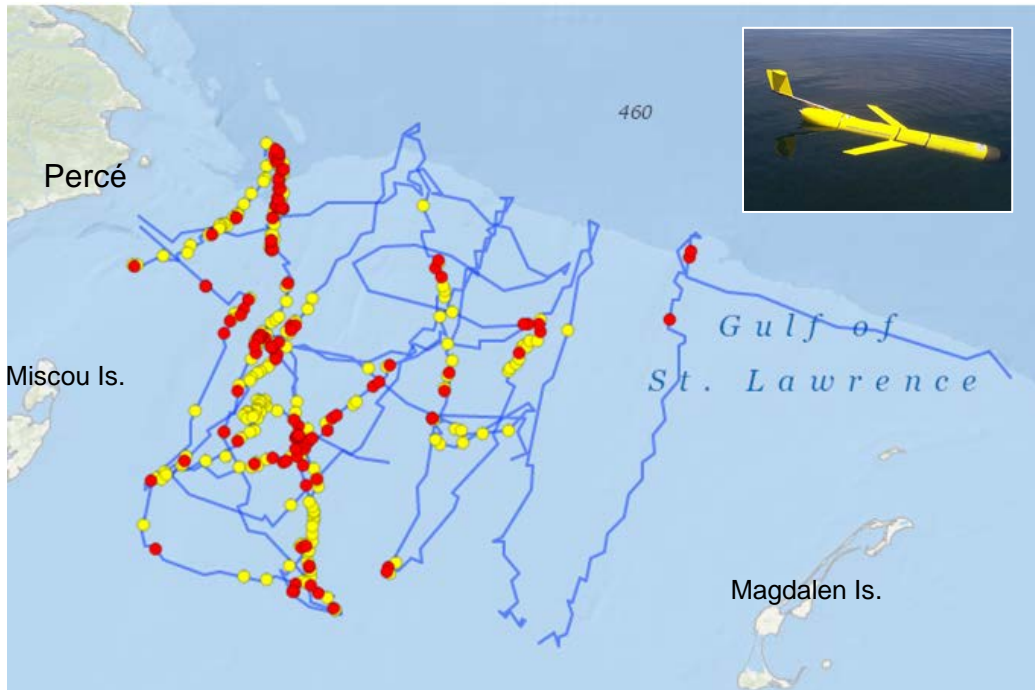


Most missed calls occur during non-monitored periods – missed occurrence can be improved by increasing transmitted data



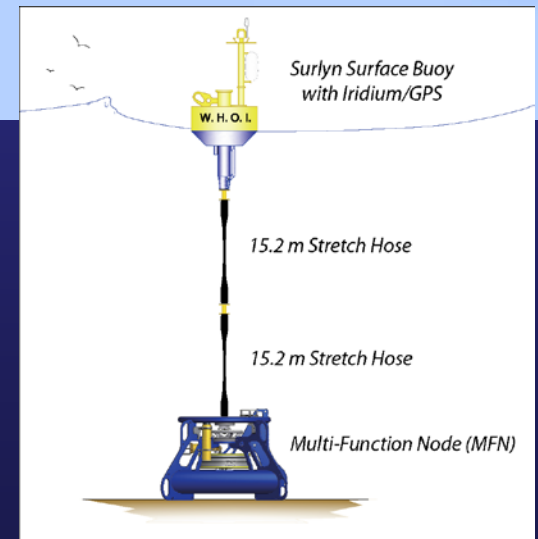
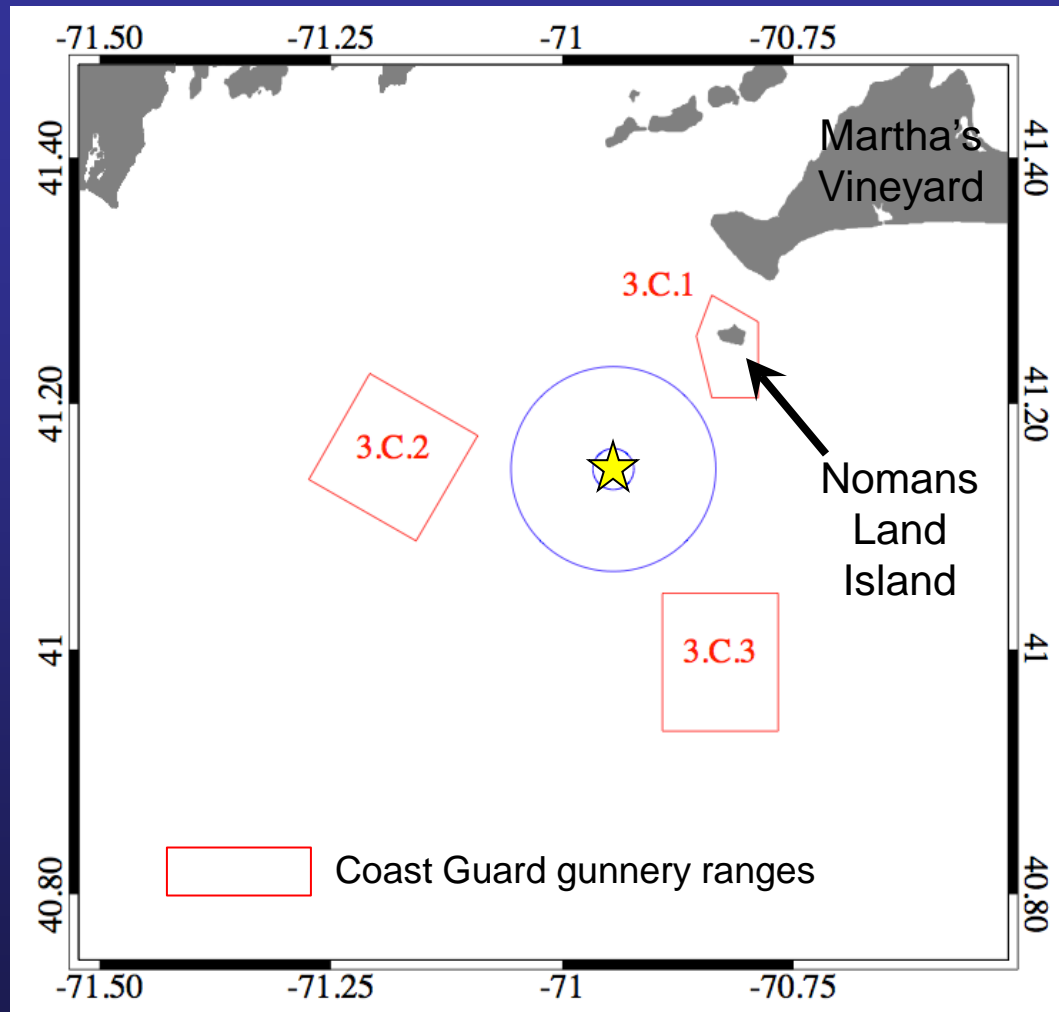
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Monitoring the GoSL crisis



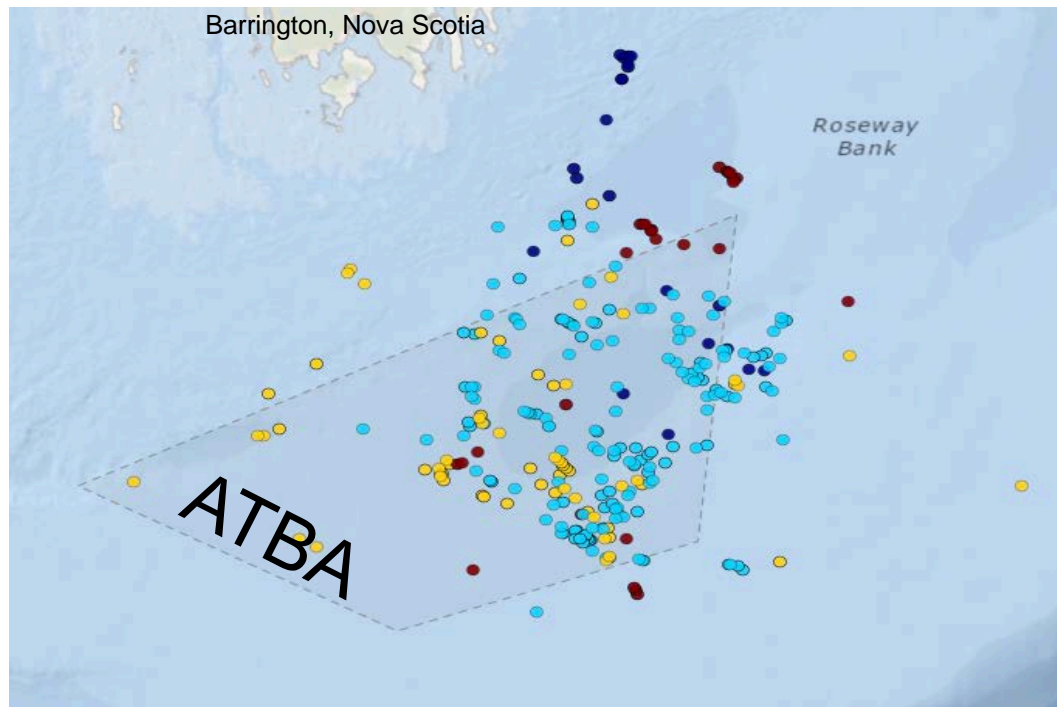
Collaborators: A. Vanderlaan, H. Moors-Murphy (DFO), M. Brown (CWI), Phillip Hamilton, Amy Knowlton (NEAq), Tim Cole (NOAA), Jack Lawson (DFO), NOAA DFO and TC aerial surveillance teams

Monitoring a U.S. Coast Guard gunnery range



Collaborators: Tim Cole, Peter Corkeron, and Sofie Van Parijs (NOAA NEFSC)
Andy Stokes (Coast Guard SE New England)

Monitoring the Roseway Basin Area to be Avoided



■ 2014 ■ 2015 ■ 2016 ■ 2017

Jul

Sep

Nov

Right whales are frequently present in and around the Roseway Basin ATBA

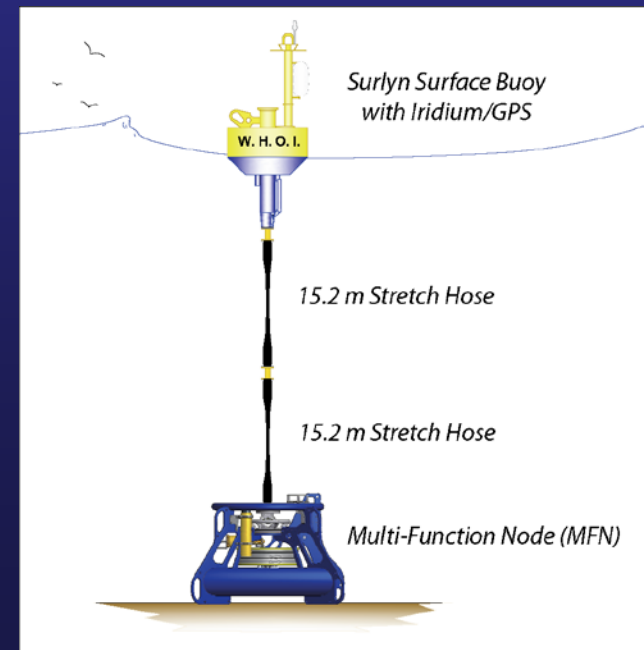
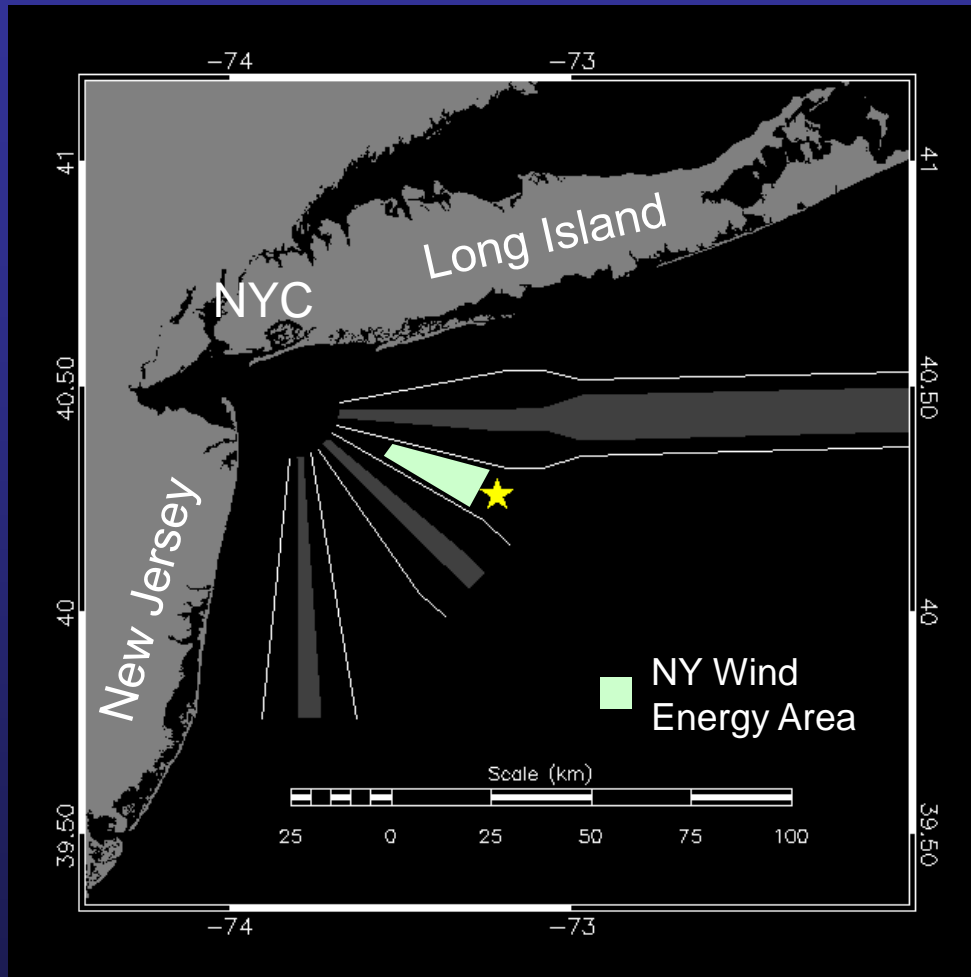
Monitoring & compliance remain critical



Initiate visual survey if whales acoustically present

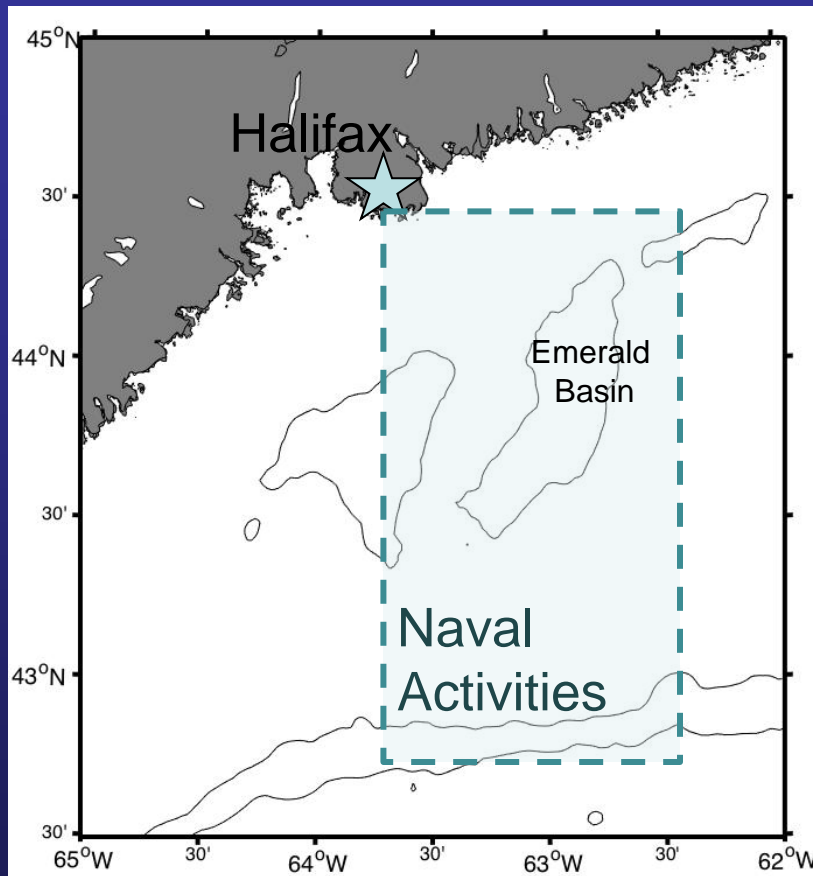
Collaborators: Moira Brown (CWI)

Monitoring shipping lanes in New York Bight



Collaborators: Howard Rosenbaum (WCS)
Sofie Van Parijs (NOAA NEFSC)

Monitoring during Cutlass Fury 2016



Right, sei, fin and humpback whales were detected by the glider

Collaborators: Lt. Erica Rogers, Maj. Norm Scantland (MetOc), Deanna Brewster (MARLANT)

Vision for AIS or NAVTEX Whale Alert



Glider → Iridium → Validation → Aid to Navigation → AIS message

Summary



- Developed system for passive acoustic recording and near real-time detection/classification of marine mammals from autonomous platforms
- System is very accurate for right whales
- Operational for monitoring and mitigation applications with Slocum gliders and moored buoys
- Particularly useful when used together with visual surveys (ship, aerial)

Engineers, technicians, collaborators



WHOI Engineers:

Jim Partan, Keenan Ball, Tom Hurst, Léo-Paul Pelletier, Lee Freitag, Ben Hodges, John Kemp, Don Peters, Kris Newhall, Jeff Pietro

Dalhousie Glider Technicians:

Adam Comeau, Richard Davis, Sue L'Orsa, Jude van der Meer

Collaborators:

Cara Hotchkin (NAVFAC Atlantic), Peter Corkeron, Tim Cole (NOAA NEFSC), Howard Rosenbaum (WCS), Angelia Vanderlaan (DFO), Hilary Moors-Murphy (DFO), Moira Brown (CWI), Jack Lawson (DFO), DFO NOAA and TC aerial surveillance teams, crew of the R/V Shelagh

WHOI program



Dalhousie program



And many other supporting agencies

