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

Baumgartner, M.2; Davies, K.1; Durette-Morin, D.1; Gurnee, J.3; Johnson, H.1; Taggart, C.1; van Parijs, S.3

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2. Woods Hole Oceanographic Institution, Biology Dept. Woods Hole, MA
3. NOAA Northeast Fisheries Science Center, Woods Hole, MA

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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-LFDCS) 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-LFDCS 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
Motivation

Autonomous platforms

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

Slocum ocean glider

Wave glider
1. Motivation

2. Enabling technology

3. Does the technology work?

4. Applications
Digital acoustic monitoring instrument

DMON

Features
- Programmable
- Records audio
- Detects sounds

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

Low-frequency detection and classification system (LFDCS)

Detection and classification

Low-frequency detection and classification system (LFDCS)

Detection and classification

Low-frequency detection and classification system (LFDCS)

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
Operation

Analyst reviews:
- Pitch tracks
- Classifications
- Context

Analyst protocol
- "calibrate" analysts
- conservative

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

Julianne Gurnee
NOAA NEFSC
Analyst reviews:

- Pitch tracks
- Classifications
- Context

Right whale upcalls

Robots4whales.whoi.edu

Daily analyst review:

<table>
<thead>
<tr>
<th>Date</th>
<th>Sei whale</th>
<th>Fin whale</th>
<th>Right whale</th>
<th>Humpback whale</th>
</tr>
</thead>
<tbody>
<tr>
<td>09/04/2015</td>
<td></td>
<td></td>
<td>Detected</td>
<td></td>
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<tr>
<td>09/03/2015</td>
<td></td>
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<tr>
<td>08/29/2015</td>
<td></td>
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<td>Detected</td>
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</tr>
<tr>
<td>08/28/2015</td>
<td></td>
<td></td>
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Detected
Possibly detected
Not detected

Julianne Gurnee
NOAA NEFSC
AIS (2018?)

**Daily analyst review:**

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**Text message:**

Fin whales detected on the Nomans Land buoy!

Tap to Load Preview
dcs.whoi.edu

Fin and right whales detected on the NYB buoy!

Tap to Load Preview

**Email message:**

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

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

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 22:09 EST (13.8 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.whoi.edu/nomans0916/nomans0916-0916.html](http://dcs.whoi.edu/nomans0916/nomans0916-0916.html)

**Whale Alert app (fall 2017)**

**Tweet**

Follow @Robots4Whales
1. Motivation

2. Enabling technology

3. Does the technology work?

4. Applications
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

Audio analysis of archived recordings

Right whale
### How well does it work?

<table>
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<th>False occurrence (%)</th>
<th>Accuracy (%)</th>
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<td>55</td>
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*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.
1. Motivation

2. Enabling technology

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4. Applications
Large-scale monitoring across the NW Atlantic

**Slocum gliders**

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<th>Years</th>
<th>2012-17</th>
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<td>Effort (days)</td>
<td>1021</td>
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<td>Right Whale Detections</td>
<td>400+</td>
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**Moored Buoys**

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<th>2015-17</th>
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<td>Effort (days)</td>
<td>1536</td>
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Platform

- **buoy**
- **slocum**

Right whale detection

![Map showing Slocum glider and moored buoy detections](image)
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

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

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

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

1. Satellite uplink whale detections
2. Down link to lab for validation
3. Whale Alert Message

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)
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
Funders

WHOI program

Dalhousie program

And many other supporting agencies