# North Atlantic Right Whale Consortium Annual Meeting

## New Bedford Whaling Museum

New Bedford, MA USA

07-08 November 2018

www.narwc.org

Anderson Cabot Center for Ocean Life at the New England Aquarium

NARWC THE NORTH ATLANTIC RIGHT WHALE CONSORTIUM

NEW BEDFORD WHALING MUSEUM

**North Atlantic Right Whale Consortium**
**2018 Annual Meeting**

**7-8 November 2018**
**New Bedford Whaling Museum**
**New Bedford, MA USA**

# November 7th

**0800-0830: Check in and breakfast**

**Opening/Updates**

**0830 Opening of Meeting** - *Mark Baumgartner*
0840 North Atlantic Right Whale Catalog update and whale naming results – *Philip Hamilton*
0900 2018 Mortalities – *Bill McLellan*
0915 Entanglements and Serious Injury - *Allison Henry, Scott Landry, Heather Pettis*
0930 Entangled right whale events in 2018 in Atlantic Canada, additional response protocols and plans for increased response capacity – *Moira Brown*
0945 Other efforts: Ropeless Consortium – *Michael Moore*
IAC – *Scott Kraus*
1000 Session Discussion

**1015 Poster Session Introductions**

***1030 BREAK***

**Updates**

1100 Canada management updates – *Cathy Merriman*
1120 U.S. management updates – *Colleen Coogan, Diane Borggaard*

**Population**

1140 Pedigree-informed estimates of abundance and trends for the North Atlantic right whale – *Timothy Frasier*
1155 Gauging management effectiveness in the face of sample noise and a changing environment – *Richard Pace*
1210 The recovery of North Atlantic right whales, *Eubalaena glacialis*, has been constrained by human-caused mortality – *Peter Corkeron*
1225 Session Discussion

***1240 LUNCH***

**Human Caused Mortality**

1345 Gross and histopathological findings from North Atlantic right whale (*Eubalaena glacialis*) mortalities between 2003 and 2017 – *Sarah Sharp*
1400 Right whale encounter rates with crab-pot fishing gear in the Gulf of St. Lawrence – *Angelia Vanderlaan*
1415 An assessment of vertical line use in Gulf of Maine region fixed gear fisheries and resulting conservation benefits for the endangered North Atlantic right whale – *Erin Summers*
1430 Estimating North Atlantic right whale-vessel collision rate using an encounter rate theory framework – *Nathan Crum*

**Underlined talks represent student presentations being judged for the NARWC Endangered Species Print Project Student Presenter Awards*

1445 Relative vessel strike risk to North Atlantic right whales in the Gulf of St. Lawrence – *Meg Carr*
1500 Session Discussion

***1515 BREAK***

**Mitigation Approaches**

1545 Mitigating the risk of ship strikes through a collaborative approach – *Veronique Nolet and Sonia Simard*
1600 Co-existing in the Gulf of St. Lawrence: an integrated approach with crabbers, for whales – *Lyne Morissette*
1615 Development and evaluation of whale release ropes – *Amy Knowlton*
1630 Looking to conservation marketing to strengthen public actions for right whales – *Monica Pepe*

**Acoustics**

1645 Catching up with the times: creating accessible, updated North Atlantic right whale acoustic presence tools – *Genevieve Davis*
1700 Session Discussion

***1730-1930 POSTER SESSION AND RECEPTION – JACOB'S GALLERY***

**Posters**

1. Calvineers reaching out more than ever – *Bill McWeeny and the Calvineers*
2. Can their Pacific cousins be saved? The plight of the North Pacific right whale, and a comparison of two very different populations – *Jessica Crance*
3. Competition and collaboration – *Christin Khan*
4. Development and testing of the lobster raft to reduce entanglement in North Atlantic right whales – *Richard Riels*
5. Dive behavior of North Atlantic right whale on the southeastern U.S. calving grounds – *Julia Dombroski*
6. Integrated ocean-acoustic approach for North Atlantic Right Whale passive acoustic detection range modelling on Scotian Shelves – *Jinshan Xu*
7. Monitoring the long-distance movement of a North Atlantic right whale in the Gulf of Mexico – *Katie Jackson*
8. New technology instantly displays NOAA North Atlantic right whale Dynamic Management Areas for mitigation PSOs – *Paul Donlan*
9. New technology instantly shares sightings and protects North Atlantic right whales in real-time – *David Steckler*
10. North Atlantic right whales in the New York Bight: First-year findings from monthly aerial surveys – *Ann Zoidis*
11. Public misconceptions and stereotypes. Is it hindering conservation efforts for the North Atlantic right whale and other marine mammal species? – *Anne DiMonti*
12. Climate-driven circulation changes threaten conservation of endangered North Atlantic right whales – *Dan Pendleton*

**Underlined talks represent student presentations being judged for the NARWC Endangered Species Print Project Student Presenter Awards*

# November 8th

**0800-0830: Check in and breakfast**

**0830 Business Meeting**
Annual Report Card
Board Elections
Other
**The business meeting is open to **ALL** attendees. Please join us!**

***0915 BREAK***

**Acoustics**

0930 Mapping migratory corridors of North Atlantic right whale in Canadian waters using passive acoustic monitoring – *Delphine Durette-Morin*

0945 Probability of passive acoustic detection of right whales from autonomous platforms equipped with a real-time monitoring system – *Hansen Johnson*

1000 Low amplitude acoustic communication of North Atlantic right whale (*Eubalaena glacialis*) mother-calf pairs on the calving grounds – *Susan Parks*

1015 Right whale research in Canada under the DFO Oceans Protection Plan, Marine Environmental Quality Programme – *Andrew Wright*

**Conservation and Management**

1030 A brief history of NRW conservation and a proposed paradigm shift – *Richard Strahan*

1045 Impacts of Trump's America-First Offshore Energy Strategy on the North Atlantic right whale – *Sierra Weaver*

1100 Block Island Seasonal Management Area: Proposal for expansion to include port approaches – *Jon Lang*

1115 Session Discussion

***1130 LUNCH***

**Ecology**

1245 Examining annual variation in the energy content and relative abundance of Stage V *Calanus finmarchicus* in the Bay of Fundy from 2011-2018: Implications for North Atlantic right whales and other copepod predators – *Kristina Guarino*

1300 Foraging rates of endangered North Atlantic right whales measured with onboard, multi-sensor DTAGs – *Julie van der Hoop*

**Distribution and Monitoring**

1315 Summertime occurrence of North Atlantic right whales in the Bay of Fundy – *Kimberley Davies*

1330 Population structure and residency of North Atlantic right whales in the southern Gulf of St. Lawrence – *Leah Crowe*

1345 Investigation of North Atlantic right whale (*Eubalaena glacialis*) migratory pathways in the Mid-Atlantic region – *Caroline Good*

1400 Department of Fisheries and Oceans Canada: Update on research and monitoring activities – *Hilary Moors-Murphy*

1415 Follow-up of North Atlantic right whales tagged with LIMPET tags – *Russel Andrews*

**Underlined talks represent student presentations being judged for the NARWC Endangered Species Print Project Student Presenter Awards*

1430 Session Discussion

*1445* ***BREAK***
**STUDENT ROUNDTABLES**
**BREAK OUT MEETING TIME**

**Physiology**

1545 Sleepless whales: North Atlantic right whale melatonin receptor and 'clock' genes associated with arrhythmic behaviors – *Jeffry Fasick*

1600 An interactive biophysical model to estimate physical stresses experienced by right whales as a result of vessel strikes – *Sean Brillant*

1615 Computational fluid dynamics simulations of a 10m North Atlantic right whale (*Eubalaena glacialis*) – *Chen-Yi Wu*

1630 Session Discussion

**1645 MEETING DISCUSSION**
**CLOSING REMARKS**

**1715 MEETING CLOSES**

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**THIS IS A DRAFT DOCUMENT AND SHOULD NOT BE SIGHTED. DATA PRESENTED HERE IS NOT YET COMPLETE FOR 2018 AND WILL BE UPDATED WITH YEAR-END INFORMATION ON 31 DECEMBER 2018. ONCE THE REPORT IS FINAL, IT WILL BE POSTED TO THE NARWC WEBSITE AND DISTRIBUTED.**

# North Atlantic Right Whale Consortium
# 2018 Annual Report Card

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## NORTH ATLANTIC RIGHT WHALE CONSORTIUM BACKGROUND

The North Atlantic right whale (*Eubalaena glacialis*) remains one of the most endangered large whales in the world. Over the past two decades, there has been increasing interest in addressing the problems hampering the recovery of North Atlantic right whales by using innovative research techniques, new technologies, analyses of existing databases, and enhanced conservation and education strategies. This increased interest demanded better coordination and collaboration among all stakeholders to ensure that there was improved access to data, research efforts were not duplicative, and that findings were shared with all interested parties. The North Atlantic Right Whale Consortium, initially formed in 1986 by five research institutions to share data among themselves, was expanded in 1997 to address these greater needs. Currently, the Consortium membership is comprised of representatives from more than 100 entities including: research, academic, and conservation organizations; shipping and fishing industries; whale watching companies; technical experts; United States (U.S.) and Canadian Government agencies; and state authorities.

The Consortium membership is committed to long-term research and management efforts, and to coordinating and integrating the wide variety of databases and research efforts related to right whales to provide the relevant management, academic and conservation groups with the best scientific advice and recommendations on right whale conservation. The Consortium is also committed to sharing new and updated methods with its membership, providing up-to-date information on right whale biology and conservation to the public, and maintaining effective communication with U.S. and Canadian Government agencies, state authorities, the Canadian Right Whale Network, the U.S. Southeast Right Whale Implementation Team, the Atlantic Large Whale Take Reduction Team, the Atlantic Scientific Review Group, and members of the U.S. Congress. The Consortium membership supports the maintenance and long-term continuity of the separate research programs under its umbrella, and serves as executor for database archives that include right whale sightings and photo-identification data contributed by private institutions, government scientists and agencies, and individuals. Lastly, the Consortium is interested in maximizing the effectiveness of management measures to protect right whales, including using management models from other fields.

The Consortium is governed by an Executive Committee and Board members who are elected by the general Consortium Membership at the Annual Meeting.

## 2018 ANNUAL NORTH ATLANTIC RIGHT WHALE REPORT CARD

North Atlantic Right Whale Consortium members agreed in 2004 that an annual "report card" on the status of right whales would be useful. This report card includes updates on the status of the cataloged population, mortalities and injury events, and a summary of management and research efforts that have occurred over the previous 12 months. The Board's goal is to make public a summary of current research and management activities, as well as provide detailed recommendations for future activities. The Board views this report as a valuable asset in assessing the effects of research and management over time.

### Essential Population Monitoring and Priorities

In the 2009 Report Card to the International Whaling Commission (IWC), the Consortium Board identified key monitoring efforts that must be continued and maintained in order to identify trends in the population, as well as assess the factors behind any changes in these trends (Pettis, 2009). The key efforts are: (1) Photographic identification and cataloging of right whales in historically high-use habitats and migratory corridors, including, but not limited to, the southeast United States, Cape Cod Bay, Great South Channel, Bay of Fundy, Scotian Shelf,

and Jeffreys Ledge, (2) Monitoring of scarring and visual health assessment from photographic data, (3) Examination of all mortalities, and (4) Continue using photo-ID and genetic profiling to monitor population structure and how this changes over time.

The Consortium Board regards the Consortium databases as essential to recovery efforts for the North Atlantic right whale population. In a review of the federal recovery program for North Atlantic right whales, the Marine Mammal Commission agreed with the Board's sentiment, stating that "both databases play critical roles in right whale conservation" and that the Identification Catalog "is the cornerstone of right whale research and monitoring" (Reeves et al. 2007). The review went on to recommend that both databases ("both" here and above refers to the Identification and Sightings databases; there are several Consortium databases available) be fully funded on a stable basis.

Over the last several years, right whale distribution and patterns of habitat use have shifted, in some cases dramatically. These shifts have been observed throughout the range of North Atlantic right whales and have direct implications on research and management activities, as well as on each of the key efforts identified above. As such, the Board believes that identifying potential extralimital and new critical habitats and developing alternative survey effort strategies to respond to the distributional changes should be a priority. These strategies should include efforts to not only locate and identify individual right whales, but also to ensure that information critical to important monitoring and management efforts (i.e. health assessment, injury and scarring assessments) is effectively and efficiently collected.

An unprecedented **twenty** North Atlantic right whale mortalities were documented in 2017 (17) and 2018 (3), representing more than 4% of the estimated living population. This, coupled with the decline in reproductive output by 40% between 2010-2016 (Kraus et al. 2016) and no documented births in 2018, threatens the very survival of this species. To date, anthropogenic factors, including entanglement in fixed fishing gear and vessel strikes, have been implicated in nine of the 20 mortalities (the remaining 11 have undetermined cause of death, though two of these are suspected as human impact – one entanglement and one vessel strike). It is clear that current management regulations have not been effective at reducing serious entanglement injuries (Pace et al. 2014) and between 2010 - 2016, entanglement related deaths accounted for 85% of diagnosed mortalities. (Kraus et al. 2016). Additionally, entanglements reduce survival probability over time for right whales and moderate and severe injuries from entanglement are increasing (Robbins et al. 2015; Knowlton et al. 2016). Although several large scale management efforts to mitigate vessel strikes have proven to be successful (Laist et al. 2014), including shifts in traffic separation schemes in the Bay of Fundy (2003) and Boston (2007), the designation of the Roseway Basin (2007) and Great South Channel as Areas to be Avoided (2009), and the ship speed restriction rule implemented in 2008,), there is still room for improvement. Vessel strikes have been implicated in two mortalities in and around Cape Cod Bay, U.S. since May 2016. These deaths call into question the effectiveness of existing spatial and temporal seasonal management areas in the U.S. Additionally, at least five right whale mortalities in 2017 were attributed to vessel strikes in the Gulf of St. Lawrence, Canada, leading to a call to action for immediate mitigation plans in Canada.

In the spring of 2018, Canada announced new measures to mitigate both entanglements and vessel strikes in areas in which right whales frequent, including vessel speed reductions, temporary and fixed fisheries management areas and closures, and increased reporting requirements for fishing activity, lost gear, and interactions with marine mammal. The detection of no right whale mortalities in Canadian waters in 2018 suggest that these new mitigation efforts have been successful. There were, however, four entanglements detected in Canadian (3) and U.S. (1) waters in 2018 and two of the three 2018 mortalities in the U.S. were attributed to entanglements (the cause of death for the third is pending). Continued timely and effective efforts to reduce both entanglement and vessel strike mortalities must be a priority for both the U.S. and Canada if this species is to survive.

## Population Status

### Population over Time

Below are assessments of the number of photo-identified right whales within the population over time based on four available methods (Figure 1). The presumed alive (PA) counts whales that have been seen at least once in the last six years. It is a consistently measureable and easily available value, but it assumes that whales remain alive for six years after their last sighting (which is often not the case) and the estimates for recent years may be artificially low due to delays in data processing. The Minimum Number Alive (MNA) is the number used in the NMFS stock assessment reports and counts whales seen in a given year, plus any whale not seen that year- but seen

both before *and* after. The MNA number is more accurate than PA for older years, but is also not accurate for recent years for the same reason as the PA method, plus the fact that there have been fewer "after" years to detect a whale. A forth analysis was added for the 2016 report card and continued this year. This analysis comes from the Pace *et al.* 2017 model which "adapted a state-space formulation with Jolly-Seber assumptions about population entry (birth and immigration) to individual resighting histories and fit it using empirical Bayes methodology." This model estimate includes whales that have not been photographed. The full methodology is available in the paper. It is important to note that the estimates provided by the Pace et al. 2017 methodology represent the estimated abundance at the *start* of the sample period plus all new entries into the population. If one wanted an estimate at the end of the interval, one could subtract the number of known dead (or estimated number of dead if a detection rate for carcasses was available). Finally, the report card number has the weakness of utilizing the PA methodology with its assumptions, but it incorporates animals that have been photographed but are not yet cataloged. The methodology for the report card numbers is provided at the end of this document.

For the graph below, all numbers except the past report card numbers were recalculated using data as of September 4, 2018. The PA number is always artificially high as a comparison to the past year's MNA numbers attest. The difference is largely due to whales that have not been seen since before the year in question. For example, the 30+ animals that the PA number included in 1990 and the MNA did not are whales that have not been seen since 1990 and are thus very likely dead. From 1990 to 2010, the average difference between the PA number and the MNA number was 35 animals. If that difference remained consistent into this decade, the adjusted presumed alive number in 2017 would be 430 whales. The Pace model removes assumptions of when a whale is alive and is likely more accurate. The report card numbers are always higher than the other two methods for the most recent years. However, the fact that the old report card numbers for 2005 to 2009 were close to the eventual MNA numbers suggests that the methodology worked reasonably well through 2009. However, starting in 2010, the two numbers started to diverge. This is partially because fewer whales were seen so the MNA number may be artificially low. But it also appears that the six year assumption for PA whales is increasingly erroneous, whales die sooner than six years after their last sighting. The report card does however capture recent increase in calves that have not yet been cataloged. This delay in cataloging is largely due to the right whale distribution shift which has resulted in fewer calves being seen on the feeding grounds with their mothers, and fewer sightings of them as juveniles anywhere- both of which make cataloging recent calves challenging.

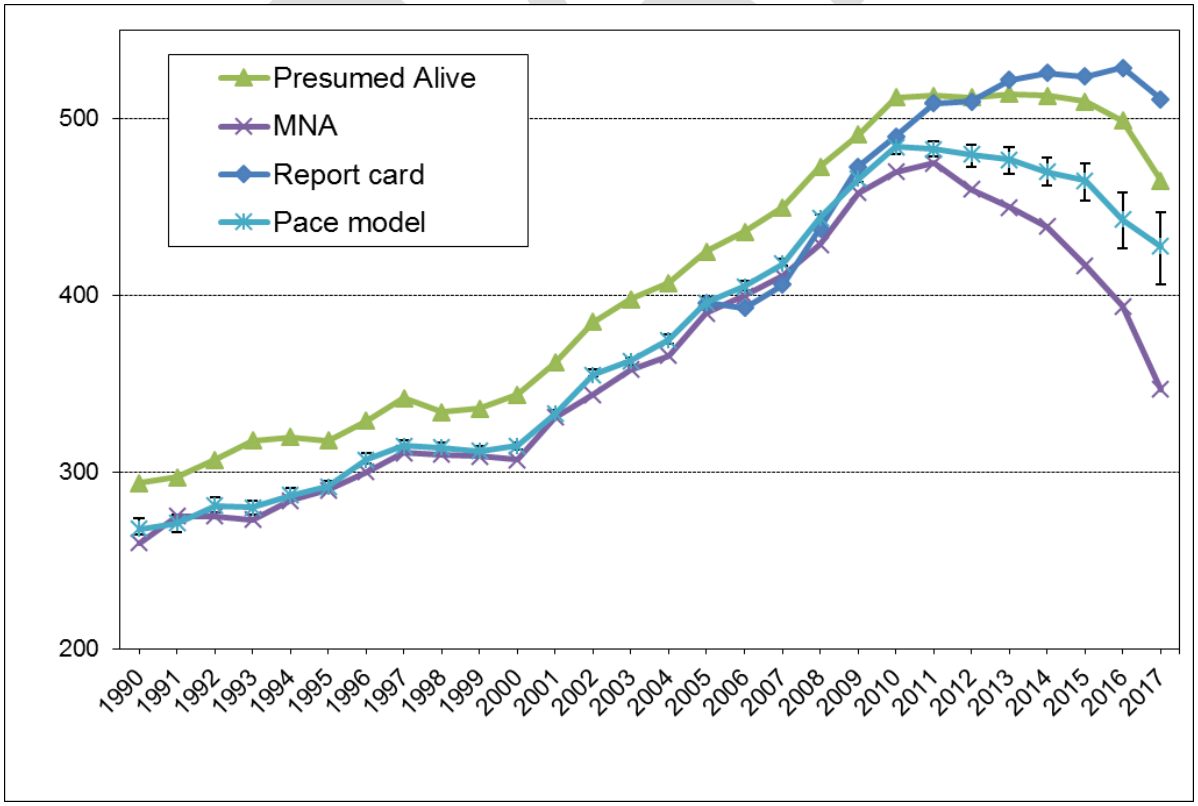


**Figure 1**. Assessments of the North Atlantic right whale population based on four available assessment methods. The Pace model shows a point "estimate" along with error bars which represent 95% of the posteriori probability. That model estimates the number of whale alive *at the start* of each year plus any new whales estimated to enter during that year. To get an estimate of whales alive *at the end* of 2017, we can take the estimate at the start of 2017 (shown above) minus the observed deaths during 2017 (13 cataloged whales and four unidentified), or 428 minus 17 for the best estimate of 411 at the end of 2017. The

most reliable population number for the end of 2017 is 411 right whales (95% confidence range +/- 22 and 19 respectively) from the Pace model. Data through 2017 as of September 4, 2018.

**2017 Assessment of Photographed North Atlantic Right Whales**

The ability to monitor North Atlantic right whale vital rates is entirely dependent on the right whale Identification Database, curated by the Anderson Cabot Center for Ocean Life at the New England Aquarium. As of September 4, 2018, the database consisted of over a million slides, prints, and digital images collected during the 75,142 sightings of 734 individual right whales photographed since 1935. Each year, 2,000 to 5,000 sightings consisting of 20-30,000 images are added to the identification database. Due to the lag time in processing data, an estimate of the catalogued population is only available through 2017. Table 1 shows an assessment of photographed whales using the Catalog and the presumed alive method. The values are based upon the number of photographed whales only; they exclude potential unphotographed whales and therefore should not be considered a "population estimate". The best photo-identification assessment ("Middle") includes 465 cataloged whales that were presumed to be alive in 2017 because they were seen in that year, or any time in the prior five years (Knowlton et al. 1994). The assessment also includes 12 calves from 2016 or 2017 that were considered suitable for eventual inclusion in the Catalog and 34 other whales that did not match the Catalog, but were re-identified in at least one subsequent year (excluding sightings in field seasons that spanned the calendar year). A detailed explanation of these calculations is included at the end of this report.

**Table 1.** The report card assessment represents an assessment of the number of photographed whales in the North Atlantic Right Whale Identification Database. A detailed explanation of calculations can be found at the end of this report. Analysis completed 9/4/18.

| | |
|---|---|
| **Low: 343 individuals** | |
| 343 | Cataloged whales seen in 2017 |
| **Middle: 511 individuals** | |
| 465 | Cataloged whales presumed alive in 2017 |
| 34 | Intermatch whales likely to be added to Catalog |
| 12 | Calves from 2016 and 2017 likely to be added to Catalog |
| **High: 728 individuals** | |
| 676 | All Cataloged whales in 2017 minus those known dead |
| 38 | All active intermatch codes without 2016 & 2017 calves |
| 14 | All uncataloged 2016 and 2017 calves minus dead |

Analysis 9/4/18

The report card assessment resulted in a best value of 511 photographed North Atlantic right whales, but we believe the best estimate of the living population at the end of 2017 is 411 (+/- 22 and 19 respectively) based on the Pace methodology (data through 2017 as of September 4, 2018).

**How Well Are We Monitoring?**

Below is an annual count of sightings, unique individuals, whales presumed alive, kilometers of effort that have been submitted to the sightings database at the University of Rhode Island, and percent of the population that is identified each year from 2000 onward (Table 2). The shift in whale distribution has reduced both the number of sightings contributed to the Catalog and the percent of the population seen annually since 2011. Data as of September 4, 2018.

**Table 2**. Annual counts of sightings, unique individuals, presumed living whales, survey effort, and the percentage of the population seen. Survey effort from dedicated surveys only; opportunistic sightings do not record or report effort. None of the numbers for 2017 are final as not all of the data for that year have been submitted or analyzed. Data as of September 4, 2018.

| Year | Sightings | Unique IDs | Presumed Living Population | Survey Effort (1,000 km) | % of population seen |
|---|---|---|---|---|---|
| 2000 | 3087 | 236 | 344 | 125 | 69% |
| 2001 | 3849 | 282 | 362 | 127 | 78% |
| 2002 | 2718 | 303 | 385 | 252 | 79% |
| 2003 | 2405 | 314 | 398 | 180 | 79% |
| 2004 | 1811 | 286 | 407 | 287 | 70% |
| 2005 | 3399 | 353 | 425 | 357 | 84% |
| 2006 | 2801 | 347 | 436 | 316 | 80% |
| 2007 | 3739 | 379 | 450 | 267 | 84% |
| 2008 | 4147 | 390 | 473 | 254 | 83% |
| 2009 | 4635 | 422 | 491 | 246 | 86% |
| 2010 | 3224 | 421 | 512 | 271 | 82% |
| 2011 | 3464 | 437 | 513 | 234 | 85% |
| 2012 | 2127 | 375 | 512 | 271 | 73% |
| 2013 | 1905 | 296 | 514 | 215 | 58% |
| 2014 | 2399 | 369 | 513 | 200 | 72% |
| 2015 | 1771 | 262 | 510 | 184 | 51% |
| 2016 | 2199 | 319 | 499 | 155 | 64% |
| 2017 | 3014 | 343 | 465 | 126 | 74% |

## Reproduction

There were no documented calves born in 2018 (Table 3).

**Table 3**. Summary of calving events and associated interval times for North Atlantic right whales from 2009-2018. The number of available cows, defined as females who have given birth to at least one previous calf and were presumed to be alive, are followed by the percentage of available cows to successfully calve.

| Year | Calf Count | Available Cows/ % to calve | Average Interval | Median Interval | First time Moms |
|---|---|---|---|---|---|
| **2009** | 39 | 58/67.2% | 4.0 | 4 | 8 |
| **2010** | 19 | 45/42.2% | 3.3 | 3 | 4 |
| **2011** | 22 | 48/45.8% | 3.7 | 3 | 3 |
| **2012** | 7 | 64/10.9% | 5.4 | 4 | 2 |
| **2013** | 20 | 83/24.1% | 4.6 | 4 | 7 |
| **2014** | 11 | 85/12.9% | 4.4 | 4.5 | 1 |
| **2015** | 17 | 80/21.3% | 5.5 | 6 | 4 |
| **2016** | 14* | 81/17.3% | 6.6 | 7 | 4 |
| **2017** | 5 | 71/7.04% | 10.2 | 8 | 0 |
| **2018** | 0 | 76/0 | - | - | - |

*There were 14 mothers seen with calves in the 2015/2016 season, however, due to a three-way calf switch that included the presumed loss of one calf that was never photographed, only 13 calves were photographed.

**Mortalities**

Between 01 January 2018 – 31 December 2018, three right whale mortalities were documented, all in U.S. waters (Table 4). Entanglement was identified as cause of death for two animals. The cause of the most recent mortality is pending assessment. The Consortium Board recognizes necropsies as significant data collection events that provide valuable information on which management and conservation measures can be (and have been) based. The Board views consistent necropsy response and support (both financial and personnel) as critical to monitor both right whale recovery and the efficacy of management actions.

**Live Entanglements, Entrapments, and Vessel Strikes**

*Entanglement and Entrapments*

There were seven active entanglement/entrapment cases reported between 01 January 2018 – 31 December 2018, of which four were new. Table 5 includes newly reported cases as well as pertinent updates to previously reported cases.

*Vessel Strikes:*

There were two non-lethal vessel strike injuries documented between 01 January 2018 – 31 December 2018 (Table 6).

**Table 4.** Documented right whale mortalities 01 January 2018 – 31 December 2018.

| Whale # | Date | Location | Sex | Age | Field # | Necropsied? | Cause | Comments |
|---|---|---|---|---|---|---|---|---|
| 3893 | 01/22/2018 | East of Virginia Beach, VA USA | F | 10 | VAQS20191005 Eg | Yes | Entanglement | Whale was entangled in gear |
| Unk | 08/25/2015 | Martha's Vineyard | M | Unk | IFAW18-224Eg | Yes | Entanglement | |
| Unk | 10/14/2018 | 120nm east of Wellfleet, MA | Unk | Unk | IFAW18-281Eg | No | pending | Photographed and sampled at sea. |

**Table 5**. Right whale entanglements and status updates 01 January 2018 – 31 December 2018. Newly reported entanglements (carrying gear) and updates to previously reported entanglements are in **bold**. Entangled dead whales are not included here.

| Whale # | Date of First Entanglement Sighting | First location | Sex | Age (current) | Comments |
|---|---|---|---|---|---|
| 1142 | 04/01/2014 | 100 miles east of NJ USA | F | Adult | Sighted with rostrum wrap. Identification has not yet been confirmed and likely will not be without additional sightings. **Whale was resighted on 4/10/2018 and 4/12/2018 (Stellwagen Bank), still entangled. A disentanglement team was able to partially cut both lines exiting the right side of her mouth. The hope is that the damage to the ropes will deteriorate the strength of the line over time. Whale was re-sighted on 6/19/2018, 7/12/2018, 7/19/2018 and 7/20/2018 in the Gulf of St. Lawrence, still entangled. Her condition deteriorated markedly between June and July.** |
| 4146 | 04/23/2017 | Cape Cod Bay, USA | F | 7 | Length of yellowish line caught in the left side of the mouth. The line is doubled on itself and trails aft of the flukes by about a body length. There appears to be a jumble of line and/or netting near the end of the trailing gear. Disentanglement response unable to work whale. **Resighted gear free on 4/22/2018 in Cape Cod Bay.** |
| 3245 | 08/28/2017 | ~20miles east of Perce, Gaspe Peninsula, CANADA | M | 16 | Whale entangled in what appears to be heavy line. Type unknown. The whale was essentially hogtied, with line through its mouth, leading to wraps of the peduncle. The whereabouts of any bitter ends are unknown but based on behavior and line impressed into the right flank, it appears the line leads to heavy weight. No disentanglement response permitted. **Whale resighted 10/29/2017 in GoSL skim feeding. Remained unclear whether the whale was gear free at this time. It was, however, apparent that if gear was still present, the configuration had changed as there was no obvious line observed over the back or wrapped around the peduncle. Resighted again in Jan-Feb 2018 in Cape Cod Bay. Whale appears to have shed gear.** |

**Table 5 (cont'd)**. Right whale entanglements and status updates 01 January 2018 – 31 December 2018. Newly reported entanglements (carrying gear) and updates to previously reported entanglements are bolded.

| Whale # | Date of First Entanglement Sighting | First location | Sex | Age (current) | Comments |
|---|---|---|---|---|---|
| **4091** | **05/12/2018** | **60 miles ESE of Chatham, USA** | **F** | **8** | **The whale has line wrapped around its right flipper, at minimum, with about 50ft green line trailing. What appears to be a red, yellow and green buoy is near the right flipper. Due to weather forecast and distance, the CCS response team could not mount a response. Whale has not been resighted.** |
| **3312** | **07/13/2018** | **Gulf of St. Lawrence** | **M** | **15** | **Aerial survey team sighted whale with gear in tow. Whale had been seen by the same team earlier in the day gear free. At minimum, the whale had yellowish line through the mouth and trailing at least a few body lengths behind. One of the trailing lines may sink and the aerial team noticed what may have been floats or tackle subsurface. The whale appeared agitated, and was writhing at the surface and defecating. Raw rope burns were apparent across the back and peduncle. Whale has not been resighted.** |
| **3843** | **07/30/2018** | **Bay of Fundy** | **M** | **10** | **Observed entangled in the Bay of Fundy carrying a buoy approx. one body length aft of the flukes. Whale was very thin and had severe wounds and significant aggregations of cyamids around the peduncle. Whale was partially disentangled on 8/5/2018 (including the attached buoy). There is likely some remaining line on the whale that will hopefully shed over time.** |
| **3960** | **08/20/2018** | **Gulf of St. Lawrence** | **M** | **9** | **Whale observed with multiple wraps of the rostrum, damaged baleen, and no line trailing, although the sighting team felt that there was likely weight attached. Throughout the sighting the whale was thrashing at the surface and the configuration of the entanglement changed often. This behavior, the condition of the whale and changing entanglement configuration, led the team to believe that it was likely a new entanglement. As the team on scene was consulting and documenting the whale, its entanglement configuration continued to change and the whale picked up speed swimming at ~8kts. After more observations, the team felt that the whale might have shed the entanglement. No additional sightings of this whale have been reported. While observers noted that no gear was visible at the end of the sighting, they could not see all body areas and the whale was relatively distant and therefore the whale is considered still entangled.** |

**Table 6**. Right whale vessel strikes (non-lethal) detected between 01 January 2018 – 31 December 2018.

| Whale # | Date of First Injury Sighting | First location | Sex | Age (current) | Comments |
|---|---|---|---|---|---|
| 4145 | 03/1/2018 | Cape Cod Bay | M | 7 | Seen injury free 4/28/2017 (CCB). New injury consists of small prop cuts on dorsal left fluke and left trailing edge. Skeg marks on dorsal left fluke and left body. Wounds do not appear to be fresh. There are no visual indicators that the injury has impacted health thus far. |
| Unk | 07/11/2018 | Gulf of St. Lawrence | Unk | Unk | Prop marks visible behind and across the blowholes. Condition of whale is poor with grey skin, increased orange cyamid load on body, and compromised body condition visible from air. Whale has not been resighted. |

**Monitoring Health of Injured Right Whales**

Efforts to better track and monitor the health of anthropogenic injury of North Atlantic right whales were initiated in January 2013. These efforts aim to support annually mandated human induced serious injury and mortality determinations, to reduce the likelihood of undetected and unreported events, and to better assess both short and long term impacts of injury on right whale health. Previously and newly injured right whales with vessel strikes, attached fixed gear, or with moderate to severe entanglement injuries in the absence of attached gear (see Knowlton et al. 2016 for review of injury types) are flagged for monitoring biannually. Each whale's pre- and post-injury health conditions are evaluated using the visual health assessment technique (Pettis et al. 2004) and a determination of the impact of injury on health is made. Based on the available sighting and health information, whales are assigned to one of four categories: 1) Evidence of declining health coinciding with injury; 2) Inconclusive (this determination was assigned to animals when a: evidence of declining health exists but it was unclear whether or not it was linked to injury and/or b: images/information were inadequate to fully assess health condition visually; and/or c: condition has improved but remains compromised; 3) No indication of declining health caused by injury based on available images/information (these are removed from the monitoring list should subsequent sightings also show no impact of injury on health); and 4) Extended Monitor - no indication of declining health or whale's condition has improved but whale will remain on monitoring list because of injury severity and/or is still carrying gear. This last category was created to capture whales without current health impacts related to injury, but with injuries that have the potential to negatively impact future health condition (e.g. some severe vessel strikes, whales carrying gear, etc.).

Between 01 January and 31 December 2018, nine new injury of interest events were documented, eight of which were entanglement related and one was a vessel strike. Of these nine, two exhibited declining condition coinciding with injury. The impact of injury on the health of four whales was inconclusive. There were no visual indicators of injury impact on health condition for the remaining three newly injured whales. Three whales previously on the monitoring list were removed as they became presumed dead, including two whales that had been in declining condition and one that had inconclusive impact of injury on health at the last sighting. As of 31 December 2018, the Serious Injury/Human Impact list includes 74 whales with 84 injuries documented from March 2004 through 31 December 2018 (Table 7). The majority of the injuries are entanglement related (70/84, 83.3%) followed by vessel strikes (12/84, 14.3%). There are two whales on the list with injuries of unknown origin (Table 8).

**Table 7**. Since the inception of the injured right whale monitoring protocol, the number of injured whales and newly reported injuries has varied by year. The number of whales included on the injured whale list is given for each biannual report and is followed parenthetically by how many of those were newly detected injuries. There are currently ten whales on the injured list with multiple injuries.

| Year | June | December |
|---|---|---|
| **2013** | **33*** | **32 (2)** |
| **2014** | **45 (16)** | **50 (6)** |
| **2015** | **51 (4)** | **59 (9)** |
| **2016** | **60 (4)** | **63(8)** |
| **2017** | **61 (4)** | **70 (10)** |
| **2018** | **74 (9)** | |

*The first injured whale monitoring report was distributed in June 2013 and therefore does not include a comparative number of newly reported injuries.

**Table 8**. Impact of anthropogenic injury on right whale visual health by injury type based on assessments of photographs pre- and post-injury for all North Atlantic right whales on the Serious Injury/Human Impact list as of 31 December 2018.

| | Entanglement | | Vessel Strike | Other | Total |
|---|---|---|---|---|---|
| | Gear Present | No Gear Present | | | |
| **Decline in Condition** | 6 | 13 | 1 | 2 | 22 |
| **Inconclusive** | 14 | 16 | 4 | 0 | 34 |
| **No Decline in Condition** | 2 | 10 | 3 | 0 | 15 |
| **Extended Monitor** | 1 | 1 | 1 | 0 | 3 |
| **Total** | 23 | 40 | 9 | 2 | 74* |

*This represents the number of whales on the monitoring list. Ten of these whales have each had second injuries documented since their initial injury sighting. For purposes of this report, whales are included under the category representing their most recent injury.

**Aerial and Vessel-based Sighting Summary: 2017**

Prior to the 2017 Report Card, sighting information was reported for the time period following the previous NARWC Annual Meeting. However, that reporting included the current year for which not all data has necessarily been received and/or processed. Therefore, beginning with the 2017 Report Card, sighting summaries will be presented for the previous calendar year. Cataloged sighting information for the year 2017 (analysed 04 September 2018) is summarized below and includes survey, research, and opportunistic sightings. Months with sightings and major contributing organizations (>10% total sightings for region) are listed after total number of sightings. Summaries of survey types (if available) are listed below each region.

*Major Contributing Organizations*

BHC: Boston Harbor Cruises
CAWW: Cape Ann Whale Watch
CCS: Center for Coastal Studies
CWI: Canadian Whale Institute
DFO: Fisheries and Oceans Canada
FWRI: Florida Fish and Wildlife Research Institute
GDNR: Georgia Department of Natural Resources
MICS: Mingan Island Cetacean Studies
NEAq: New England Aquarium
NEFSC: Northeast Fisheries Science Center
QLM: Quoddy Link Marine
S2S: Sea to Shore Alliance
TC: Transport Canada
WHOI: Woods Hole Oceanographic Institution

Southeast United States (sightings: 54, January – Feb; FWRI, GDNR, S2S, WHOI)

- Aerial and vessel surveys, biopsy darting, drone

Mid-Atlantic (includes south of Cape Cod) (sightings: 289, February - December; NEAq, NEFSC)

- Aerial surveys and vessel surveys

Great South Channel (sightings: 137, February, April - July; NEFSC, CCS)

- Aerial and vessel surveys

New England (Massachusetts Bay/Cape Cod Bay) (sightings: 1757, January – May, December; CCS, WHOI)

- Aerial and vessel surveys, habitat sampling, drone based photogrammetry, opportunistic

Gulf of Maine (sightings: 10, May, August, October; CCS, NEFSC)

- Aerial surveys

Bay of Fundy (sightings: 68, July - September; NEAq, QLM)

- Vessel surveys

Roseway Basin (sightings: 1, July; NEFSC)

- Aerial surveys

North (Gulf of St. Lawrence) (sightings: 694, May - October; CWI, DFO, MICS, NEFSC, TC)

- Vessel and aerial surveys

Jeffreys Ledge (sightings: 6, May – July; BHC, CAWW)

- Whale Watch, Opportunistic

**Management and Mitigation Activities**

*United States*

- In 2018, NMFS conducted a number of management activities under the Endangered Species Act (ESA) related to recovery plan implementation specific to Section 4(f). this included:
  - convening a new Northeast U.S. Implementation Team (NEIT)
  - forming a U.S. North Atlantic Right Whale Implementation Team (RWIT; composed of the NEIT and Southeast Implementation Team (SEIT))
  - establishing a RWIT Population Evaluation Tool Subgroup.
- NOAA called for 12 Dynamic Management Area (DMA) voluntary speed reduction zones between 01 January 2018 and 31 December 2018:

| **Trigger Date** (date of RW sightings) | **# Right Whales** | **Sightings Source** | **General Location** | **Boundaries** |
|---|---|---|---|---|
| 1/21/2018 | 22 | NE Aquarium Survey Team | 30 Nautical Miles South of Nantucket | 41.15N 070.51W 40.22N 069.37W |
| 1/23/2018 | 4 | U.S. Military Vessel | 86 Nautical Miles east-Southeast of Virginia Beach, Virginia | 36 54N 074 47W 36 12N 073 55W |
| 1/26/2018 | 3 | See-to-Shore Aerial Survey | 54 Nautical Miles east-southeast of Virginia Beach Virginia | 36 53N 075 18W 36 14N 074 29W |
| 3/20/2018 | 6 | Aerial Survey | 11 Nautical Miles southwest of Nantucket | 41 28N 070 45W 40 47N 069 46W |
| 3/29/2018 | 8 | Aerial Survey | 20 Nautical Miles south-southwest of Nantucket, MA | 41 28N 070 45W 40 47N 069 46W |
| 4/9/2018 | 5 | Aerial Survey | 69 Nautical miles northeast of Virginia Beach, VA | 37 41N 075 06W 36 58N 074 13W |
| 4/18/2018 | 5 | Whale Watch Boat | 12 Nautical Miles East of Boston, MA | 42 43 N 071 17W 42 00 N 070 20W |
| 4/24/2018 | 3 | Trained observers aboard the R/V Kommander Iona | 19 Nautical Miles south of Martha's Vineyard | 41 25 N 070 58 W 40 46 N 070 06 W |
| 5/1/2018 | 3 | Aerial Survey | 27 nautical miles East of Boston | 42 32 N 070 57 W 41 53 N 070 04 W |
| 5/2/2018 | 12 | Beachgoer and Photo ID | 21 Nautical miles Northeast of Boston | 42 59 N 071 16 W 42 10 N 070 10 W |
| 5/5/2018 | 3 | Aerial Survey | 8nm east of Race Pt. Provincetown MA | 42 22 N 070 27W 41 44N 069 36W |
| 6/30/2018 | 4 | Aerial Survey | 2 Nautical miles South of Nantucket, MA | 41 32 N 070 29 W 40 54 N 069 34 W |

*Canada*

- In 2018, Fisheries and Oceans Canada (DFO) and Transport Canada (TC) implemented a series of measures to reduce risk to right whales in Canada waters. These include:
  - Static and dynamic vessel speed restriction zones in the Gulf of St. Lawrence;
  - Static and dynamic fishery closure zones in non-tended fixed gear fisheries, in the Gulf of St. Lawrence and in right whale critical habitat areas;
  - An investment of $1 million in annual support for marine mammal response organizations; and
  - Investments in science to better understand threats to right whales, and to inform future management measures.
- The Government of Canada has been consulting with fishing and shipping industry representatives, Indigenous groups and other partners, for feedback on 2018 measures and to support the development of measures for 2019.
- Canada's National Marine Mammal Peer Review Committee will meet in November 2018 to review data and address question related to right whale distribution, habitat use, and risk of interactions with fishing gear and collision with vessels in Canadian waters.
- Extensive surveillance of Atlantic Canadian waters for North Atlantic right whales was achieved using aircraft, vessels, and passive acoustic technology including hydrophones and gliders. DFO, TC and partners are preparing plans for survey and surveillance efforts in 2019.
- DFO has supported a number of fishing gear innovation trials undertaken by industry, in different areas and fisheries in Atlantic Canada. These include "ropeless" fishing systems and gear modifications to reduce the risk of entanglement for whales.
- DFO held a meeting with Marine Mammal Response Program partners on October 24 and 25 to review the 2018 season, as well as discuss capacity building for response moving forward.
- Large vessel speed restrictions were in force in the Gulf of St. Lawrence from April 28, 2018, and will continue until November 15. The dates may change depending on the migration of the North Atlantic right whales.

**Right Whale Project Requests for NARWC Data Use in 2018**

- Create an inventory of cetacean species using the Northeast Canyons National Marine Monument waters and examine distribution and relative abundance
- Right whale international signal flag project
- Increasing Northeast US Marine Aquaculture production by Pre-permitting Federal Ocean Space
- geographic based risk assessment for North Atlantic Right Whale mortalities in traffic dense regions off the east coast of United States
- Distribution of the Giant Oceanic Manta Ray (*Manta birostris*) in the southeastern United States
- Cetacean presence in the Fundian Channel/Brown's Bank area to inform protected area planning
- Investigating hormones in individual right whale baleen
- Gross and histopathological findings from North Atlantic right whale (*Eubalaena glacialis*) mortalities between 2003 and 2017
- Block Island SMA Modification to Protect Right Whales in the Providence/Quonset Port Area
- Growth of North Atlantic Right Whales (*Eubalaena glacialis*) revisited
- Right whale international signal flag project
- Integration of Sightings database in SLGO's web application *Marine Conditions*
- North Atlantic right whale habitat use in the Gulf of St. Lawrence
- Vessel strike risk to North Atlantic right whales in the Gulf of St. Lawrence and comparison of strike risk between right whale habitats of eastern Canada
- Calvin Family Tree
- Computer vision for conservation
- Climate Change and the Conservation Oceanography of the North Atlantic Right Whale Population
- How and why is the timing and occurrence of seasonal migrants in the Gulf of Maine changing due to climate?

- Interactive online platform for studying right whale distribution in Canadian waters
- A bi-hemispheric comparison of right whale body condition reveals poor nutritional state of the North Atlantic right whale
- Assessment of LIMPET tagged whales
- What if there were no fishing? North Atlantic right whale population trajectories without entanglement mortality.
- Using Multispectral Satellite Imagery and Deep Learning to Automatically Detect Marine Mammals from Orbit

## 2018 North Atlantic Right Whale Publications/Reports

Reports and publications that utilized NARWC databases in 2018 and/or those of general interest to the right whale community are listed and hyperlinked below.

### Publications


Burgess, E.A., Hunt, K.E., Kraus, S.D. and Rolland, R.M., 2018. Quantifying hormones in exhaled breath for physiological assessment of large whales at sea. *Scientific reports*, *8*(1), p.10031.

Cholewiak, D., Clark, C.W., Ponirakis, D., Frankel, A. & others. 2018. Communicating amidst the noise: modeling the aggregate influence of ambient and vessel noise on baleen whale communication space in a national marine sanctuary. *Endang Species Res* 36:59-75

Convertino, M., & Valverde, L.J. 2018. Probabilistic Analysis of the Impact of Vessel Speed Restrictions on Navigational Safety: Accounting for the Right Whale Rule. *The Journal of Navigation*, *71*(1), 65-82.

Fernández Ajó AA, Hunt KE, Uhart M, Rowntree V, Sironi M, Marón CF, Di Martino M, Buck CL (2018) Lifetime glucocorticoid profiles in baleen of right whale calves: potential relationships to chronic stress of repeated wounding by Kelp Gulls. Conserv Physiol 6(1): coy045; doi:10.1093/conphys/coy045.

Hayes, S.A., Gardner, S., Garrison, L., Henry, A., Leandro, L. North Atlantic Right Whales - Evaluating Their Recovery Challenges in 2018. 2018. NOAA Technical Memorandum NMFS-NE-247. 30pp.

Hunt KE, Lysiak NSJ, Matthews CJD, Lowe C, Fernández Ajó A, Dillon D, Willing C, Heide-Jørgensen MP, Ferguson SH, Moore MJ, Buck CL (2018) Multi-year patterns in testosterone, cortisol and corticosterone in baleen from adult males of three whale species. Conserv Physiol 6(1): coy049; doi:10.1093/conphys/coy049.

Krzystan AM, Gowan TA, Kendall WL, Martin J, Ortega-Ortiz JG, Jackson K, Knowlton AR, Naessig P, Zani, M, Schulte DW, Taylor CR. 2018. Characterizing residence patterns of North Atlantic right whales in the southeastern USA with a multistate open robust design model. Endang Species Res 36:279-295. https://doi.org/10.3354/esr00902.

Lysiak, N.S., Trumble, S.J., Knowlton, A.R., & Moore, M.J. 2018. Characterizing the Duration and Severity of Fishing Gear Entanglement on a North Atlantic Right Whale (Eubalaena glacialis) Using Stable Isotopes, Steroid and Thyroid Hormones in Baleen. *Frontiers in Marine Science*, *5*, 168.

Mayo, C.A., Ganley, L., Hudak, C.A., Brault, S., Marx, M.K., Burke, E., & Brown, M.W. Distribution, demography, and behavior of North Atlantic right whales (Eubalaena glacialis) in Cape Cod Bay, Massachusetts, 1998–2013. 2018. *Mar Mamm Sci*.

Meyer-Gutbrod, E.L., & Greene, C.H. 2018. Uncertain recovery of the North Atlantic right whale in a changing ocean. *Global change biology*, *24*(1), 455-464.

Meyer-Gutbrod, E.L., C.H. Greene, and K.T.A. Davies. 2018. Marine species range shifts necessitate advanced policy planning: The case of the North Atlantic right whale. *Oceanography* 31(2)

Montes, N., Swett, R., Jacobson, S.K., & Sidman, C. 2018. Factors Influencing Recreational Boaters' Intentions to Comply with Right Whale Regulations in the Southeastern United States. *Society & Natural Resources*, *31*(4), 473-488.

Peel D, Smith J.N. and Childerhouse S. 2018. Vessel Strike of Whales in Australia: The Challenges of Analysis of Historical Incident Data. *Front. Mar. Sci*. 5:69. doi: 10.3389/fmars.2018.00069

Root-Gutteridge, H., Cusano, D.A., Shiu, Y., Nowacek, D.P., Van Parijs, S.M., Parks, S.E. 2018. A lifetime of changing calls: North Atlantic right whales, *Eubalaena glacialis*, refine call production as they age. Animal Behaviour, 137, 21-34.

Wright D.L., Berchok C.L., Crance J.L., Clapham PJ. 2018. Acoustic detection of the North Pacific right whale in the northern Bering Sea. *Mar Mamm Sci*.

**Reports**

Surrey-Marsden, Claire, K. Howe, M. White, C. George, T. Gowan, P. Hamilton, K. Jackson, J. Jakush, T. Pitchford, C. Taylor, L. Ward, and Zoodsma, B. 2017. North Atlantic Right Whale Calving Area Surveys: 2015/2016 Results. U.S. Dept. of Commerce, NOAA. NOAA Technical Memorandum NMFS-SER-6, 13 p

Baumgartner, M., Moore, M., Kraus, S., Knowlton, A., Werner, T. 2018. Overcoming Development, Regulatory and Funding Challenges for Ropeless Fishing to Reduce Whale Entanglement in the U.S. and Canada.

Khan, C. B., Henry, A., Crowe, L., Duley, P., Gatzke, J., & Cole, T. V. 2018. North Atlantic Right Whale Sighting Survey (NARWSS) and Right Whale Sighting Advisory System (RWSAS) 2016 Results Summary.

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Kraus S.D., Kenney R.D., Mayo C.A., McLellan W.A., Moore M.J., Nowacek D.P. (2016). Recent scientific publications cast doubt on North Atlantic right whale future. *Front Mar Sci* 3:137. doi: 10.3389/fmars.2016.00137

Laist, D. W., Knowlton, A. R., Pendleton, D. (2014). Effectiveness of mandatory vessel speed limits for protecting North Atlantic right whales. *Endang Spec Res 23*(2), 133-147.

Pace, R. M., Cole, T. V. N., Henry, A. G. (2014). Incremental fishing gear modifications fail to significantly reduce large whale serious injury rates. *Endang Spec Res* 26, 115–126. doi: 10.3354/esr00635

Pace, R.M., Corkeron, P.J., Kraus, S.D. (2017). State–space mark–recapture estimates reveal a recent decline in abundance of North Atlantic right whales. *Ecol Evo.* 1-12.

Pettis H.M., Rolland R.M., Hamilton P.K., Brault S., Knowlton A.R., Kraus S.D. (2004). Visual health assessment of North Atlantic right whales (*Eubalaena glacialis*) using photographs. *Can J Zool* 82:8-19

Pettis, H.M. (2009). North Atlantic Right Whale Consortium Annual Report Card (01 November 2007 – 30 April 2009). International Whaling Commission Annual Meeting, May 2009. Reference Document *SC/61/BRG1*.

Reeves, R.R., Read, A.J., Lowry, L., Katona, S.K., Bonnes, D.J. (2007). Report of the North Atlantic Right Whale Program Review. Marine Mammal Commission. Bethesda, Maryland.

Robbins, J., Knowlton, A.R., Landry, S. (2015). Apparent survival of North Atlantic right whales after entanglement in fishing gear. *Biol Conserv* 191: 421-427.

**Report Card Population Assessment Calculation**

We have developed standardized criteria that can be applied each year to get a low, middle (best estimate) and upper number of whales in the population as determined from Catalog data. One term needs to be explained to understand these numbers. Whales are given temporary intermatch codes if 1) two or more sightings match each other, and 2) neither have been matched to a catalog whale. Some of these whales will eventually be matched to existing cataloged whales and others will be determined to be "new" to the Catalog and assigned a number. Once an intermatch whale is given a Catalog number, or matched to another intermatch code whale, the intermatch code is made inactive.

LOWER

To determine the lower bound, we simply count the number of unique cataloged whales identified the year before. Because of delays in processing data, this number is lower than the eventual total number of whales seen alive in that year.

MIDDLE

The middle bound is determined by summing three categories:

1) All whales presumed to be alive in that year (i.e. seen in the last six years),
2) Intermatch whales that are likely to be added to the Catalog. This is calculated by first finding all intermatch codes that span two or more years (both those that are active and those that were matched and made inactive), removing all calves and any SEUS whales whose sightings span two years only because they are seen in December and January of the same field season. Then, we determine which of those intermatch whales have Catalog numbers and what percent of those were new to the catalog (i.e. had not been matched to an existing cataloged whale). The remaining, unidentified intermatch whales are then multiplied by that fraction to determine how many are likely new to the Catalog (e.g. if only 20% of the matched intermatch whales were new, then 20% of the unmatched intermatch whales are likely new). That number is then added to the count of calves born more than two years earlier that are unmatched with active intermatch codes (indicating there is enough information to potentially match them in the future). Process changed Oct. 2009.
3) Calves from the last two years that have not been cataloged. We make an assessment of whether there is enough photographic information to likely be able to match them to future sightings and thus eventually assign them a Catalog number. We then sum those that will likely be cataloged.

UPPER

The upper bound is also the sum of three categories:

1) All Cataloged whales minus those whose carcasses were identified. Even whales missing for 30 years included.
2) All active intermatch whales minus calves from the last two years.
3) All calves from the last two years minus those known to be dead.

## Follow-up of North Atlantic right whales tagged with LIMPET tags

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Detailed movement data from North Atlantic right whales are needed to manage anthropogenic impacts, while avoiding overly broad restrictions on human activities. We sought to develop a minimally invasive satellite tag for use on right whales that could provide sufficient tag attachment duration to track whales migrating north from calving grounds through the Mid-Atlantic. We began by deploying LIMPET tags, with slightly modified anchoring darts. In 2015 and 2016, we deployed tags on seven whales in the Southeast U.S. Three tags transmitted for approximately one day or less. Transmission durations for the others were 3.1, 5.5, 14.7, and 50.1 days, respectively. Researchers in the Southeast, Mid-Atlantic and in the Northeast U.S were provided with a guide to the photographic documentation of tagged or previously tagged whales to encourage post-tagging follow-up. Photographs from all confirmed and unconfirmed sightings submitted to the NARWC Identification Database as of September18, 2018 were reviewed. Two of the whales were observed after the tag deployment day with the tag still attached. All seven whales were observed at least once after the tag stopped transmitting. For six of the whales, the most recent observations were at least 1.5 years after tagging, while one has been seen only once post-tagging, 2.1 months after tag loss. For all whales, the tag site is clearly visible in at least one photograph after tagging, but for most whales there are multiple good photographs on multiple days. No unexpected wound responses were observed, and in the most recent photographs, all wounds appeared well-healed. Two whales showed no recognizable scar, and the others had two small white spots (~ 1-2 cm) at the dart implant sites. No swellings or depressions were observed. Post-tagging follow-up will be conducted annually as new photographs are submitted to the Identification Database.

## NOAA Fisheries Service (NMFS) update on North Atlantic Right Whale Recovery Plan Northeast U.S. Implementation Team

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NOAA's National Marine Fisheries Service (NMFS) Greater Atlantic Region will provide an update on management activities under the Endangered Species Act (ESA) related to recovery plan implementation specific to Section 4(f). NMFS will include updates on: 1) convening a new Northeast U.S. Implementation Team (NEIT); 2) forming a U.S. North Atlantic Right Whale Implementation Team (RWIT; composed of the NEIT and Southeast Implementation Team (SEIT)); and 3) establishing a RWIT Population Evaluation Tool Subgroup. These activities and updates relate to recommendations in the ESA Five-Year Review for North Atlantic Right Whales completed in October 2017, and the latter also relates to an SEIT recommendation.

## Entangled right whale events in 2018 in Atlantic Canada, additional response protocols and plans for increased response capacity

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[2] *Anderson Cabot Center for Ocean Life at the New England Aquarium, Central Wharf, Boston, MA, USA 02110*

The July 2017 ban on entangled right whale response in Canadian waters was lifted on March 28, 2018. Resumption of entanglement response activities was permitted with additional protocols instituted by Fisheries and Oceans Canada (DFO) including specified minimum safety equipment, consultation

with named expert whale disentanglers and regional DFO marine mammal coordinators following on scene assessment and prior to disentanglement activities. Additionally, DFO produced a document stipulating entanglement response procedures for large whales (larger than a minke whale) in Atlantic Canada which includes communication protocols and decision tree among DFO marine mammal coordinators, regional managers and third party responders, minimum data collection, and establishment of third party responder needs from DFO Conservation and Protection for standby and logistics. DFO has also provided additional funding for operations to some response groups, is enhancing response capacity through funding for equipment improvements and training and is working with responders to build a national program.
In 2018, there were six confirmed sightings of four entangled right whales: three new cases were confirmed (#3312, #3843, #3960); one case was ongoing from 2014 (#1142). Three cases were discovered by researchers in the southern Gulf of St. Lawrence and one in the Bay of Fundy. There were no responses to entanglements in the Gulf; one of these whales (#3960) shed the gear while being observed by researchers, the other two are at large. In the Fundy case (#3843), ~10 fathoms of ¾" sink line and a buoy were removed. Finally, we will review existing, and plans for enhanced, response capacity in Atlantic Canada and summarize a redacted Transport Canada investigation released to journalists through an Access to Information and Privacy request. Subsequently, DFO made public the results of their internal review, a redacted DFO Hazardous Occurrence Investigation Report and their Management Acknowledgement and Response http://dfo-mpo.gc.ca/species-especes/publications/mammals-mammiferes/narightwhale-baleinenoirean/index-eng.html.

## Relative vessel strike risk to North Atlantic right whales in the Gulf of St. Lawrence

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Vessel strikes are among the leading sources of North Atlantic right whale (NARW) mortality. In response to an unprecedented NARW mortality event in the Gulf of St. Lawrence (GoSL) during 2017, the Government of Canada established a mandatory 10 kt maximum speed zone encompassing the western GoSL. This study uses satellite-derived Automated Identification System (AIS) vessel traffic information in conjunction with NARW sightings and effort data to develop models that evaluate the effectiveness of the slowdown zone in reducing vessel strike risk. Risk maps and statistics are presented before (1 April - 10 August 2017) and during (11 August – 31 December 2017) the implementation of the slowdown zone and used to identify changes in the relative risk of vessel strike and relative probability of lethal encounter resulting from this management action.

## NOAA Fisheries update on the Atlantic Large Whale Take Reduction Team

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The 61 member Atlantic Large Whale Take Reduction Team, composed of fishermen, scientists, conservationists, and state and federal officials, was first established under the Marine Mammal Protection Act in 1996 as an advisory group to NOAA Fisheries. Their role is to recommend measures to NOAA Fisheries to mitigate serious injuries and mortalities of large whales due to incidental entanglement in commercial fishing gear. After the last modifications to the Atlantic Large Whale Take Reduction Plan were implemented in 2015, the Team had shifted to a largely monitoring role. This year, due to the downward trajectory of the North Atlantic right whale population since 2010 and the death of 20 right whales since early 2017, the Take Reduction Team has been preparing to develop recommendations to further reduce the impacts of fixed gear fisheries on right whales. Two subgroups of the Team met in the Spring to explore the feasibility of "weak" or "whale release" rope, gear marking, and "ropeless" or buoy lineless fishing technology. In October, the full Team met to review options and to develop work plans to guide NOAA Fisheries in analyses of proposal elements. The Team will select recommended modifications to the

Atlantic Large Whale Take Reduction Plan at the March 2019 meeting.

## The recovery of North Atlantic right whales, *Eubalaena glacialis*, has been constrained by human-caused mortality

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North Atlantic right whales (NARW), *Eubalaena glacialis*, were nearly exterminated by historical whaling. Their abundance slowly increased up until 2010, to a maximum of fewer than 500 whales, and since then they have been in decline. We assessed the extent to which the relatively slow increase demonstrated by NARW was intrinsic, and how much could be due to anthropogenic impacts. In order to do so, we first compared calf counts of three populations of Southern right whales (SRW) *E. australis*, with that of NARW, over the period 1992-2016. By this index, the annual rate of increase of NARW was approximately one-third of that of SRW. Next we constructed a population projection model for female NARW, using the highest annual survival estimates available from recent mark-resight analysis, and assuming a four-year calving interval. The model results indicated an intrinsic rate of increase of 4% per year, approximately twice that observed, and that adult female mortality is the main factor influencing this rate. Necropsy records demonstrate that anthropogenic mortality is the primary cause of known mortality of NARW. Anthropogenic mortality and morbidity has limited the recovery of NARW, and baseline conditions prior to their recent decline were already jeopardizing NARW recovery.

## Can their Pacific cousins be saved? The plight of the North Pacific right whale and a comparison of two very different populations

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Right whales in the eastern North Pacific (*Eubalaena japonica*, NPRW) were once abundant, and were widely distributed throughout the Bering Sea and Gulf of Alaska. After becoming the target of extensive whaling, this population now likely numbers in the tens of animals, and genetic analysis indicates it has a 2:1 male-biased sex ratio. Recent surveys and opportunistic sightings have led to the addition of eight new individuals to the photo-ID catalog since 2012, though this still results in a total of only 24 confirmed unique animals. Despite their Critically Endangered status, there has been little dedicated funding for NPRW research in recent years, and very little is known about this population, including the location of their breeding grounds or migration routes. The remote location and low numbers pose substantial challenges, from both a research and a public awareness standpoint. This presentation will focus on the current status of NPRW and contemporary anthropogenic threats. Our goals are to foster discussion with those who have been instrumental in raising awareness about the NARW, and to solicit ideas that may be applied to the remote, lesser known NPRW.

## Population structure and residency of North Atlantic right whales in the southern Gulf of St. Lawrence

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In recent years there has been increased survey effort in the Gulf of St. Lawrence to monitor and understand North Atlantic right whale use of the area. In 2018, NOAA in collaboration with DFO focused survey effort in the southern Gulf of St. Lawrence from June 4th through August 12th conducting 26 aerial surveys. During this period, 135 unique right whales were photographed (49% adult males, 27% adult females, 7% juvenile males, 4% juvenile females, and 13% of unknown sex and/or age), of which 91 had been sighted in 2017. The discovery curve of new males ($n$ = 76) plateaued briefly, but increased overall throughout the study, while the rate of discovery for new females ($n$ = 43) leveled off in the middle of July. The 'emigration + reimmigration' model fit the data best using maximum likelihood methods, demonstrating that animals were unavailable for a period of time before subsequent capture. The lagged identification rate showed that the probability of resighting an individual decreased after the first two weeks indicating that different animals were being captured between successive surveys as the study progressed. Individuals were captured on one ($n$ = 9) to 14 surveys ($n$ = 1), and the time between resightings was 1 – 63 days. The calculated residence time was 34 days within the study area and 12 days outside of it with high uncertainty, while the time between the initial and final sighting ranged from 0 to 69 days. Mark-recapture models indicate that our methods effectively captured most individuals in this region during this period. This study does not represent the entire scope of right whale presence in the southern Gulf, but the findings here suggest movement in and out of this region, individual capture heterogeneity, and a high rate of return between seasons.

## Estimating North Atlantic right whale-vessel collision rate using an encounter rate theory framework

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Encounter rate theory provides a framework to estimate the rate at which the paths of moving objects intersect. The framework is process-based, decomposing encounter rate into its underlying elements, including an object's size, speed, and distance traveled. We applied this framework to estimate the risk of collisions between North Atlantic right whales (*Eubalaena glacialis*) and vessels under three vessel speed scenarios in the southeastern U.S. Using this framework, we accounted for critical factors in the collision process that have been omitted from previous studies of whale-vessel collisions, including spatiotemporal variation in vessel traffic patterns and right whale abundance. Collision risk was highest during times of the year when right whale abundance was highest and in areas adjacent to major ports, where vessel traffic was highest. Consequently, the impact of the vessel speed scenarios on risk varied across time and space. Evaluating the risk of vessel collisions across the right whale's range can inform management actions such as the timing and location of vessel speed restrictions and the placement of shipping lanes. This framework is spatiotemporally flexible, process-oriented, and computationally efficient, making it an ideal approach to evaluate such management actions and identify data gaps.

## Summertime occurrence of North Atlantic right whales in the Bay of Fundy

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In recent years North Atlantic right whale occurrence has changed dramatically in the Gulf of Maine during spring and summer. Quantifying the nature and extent of this change is key to finding an explanation, as well as planning conservation strategies. To help achieve these goals, we characterize right whale occurrence in a summer feeding habitat, Grand Manan Basin in the Bay of Fundy, using a dataset derived from ca. 4 700 hours of search effort over 31 summers (1987 – 2017), yielding >21 700 sightings and individual photo-IDs. Eight independent occurrence descriptors were derived from these datasets to quantify variation in daily right whale presence, daily individual encounter rates and time of arrival. Principal components analysis showed two important modes that explained 58% and 14% of the temporal variation in occurrence, respectively. The first mode captured a significant decline in daily right whale presence and encounter rates beginning in 2010. The second mode captured decadal variation in the seasonal timing of occurrence; the 1990s were characterized by early time of arrival (1-August or earlier) and higher encounter rates early in August, whereas the 2000s were characterized by later time of arrival and higher encounter rates in September. Since 2010, right whales have again begun arriving earlier in the summer, coincident with a shift in the abundance pattern of local food (*Calanus finmarchicus*) toward earlier in the year. Surveys undertaken earlier than usual during July 2016 and 2017 found right whales present on the Basin slope north of the protected Critical Habitat boundary. This analysis illustrates several key patterns in summertime right whale occurrence at the seasonal, annual and decadal scales that can be compared with time series of environmental descriptors to better explain processes driving the recent distributional shift in the Gulf of Maine.

## Catching up with the times: creating accessible, updated NARW acoustic presence tools

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The last decade of North Atlantic right whale (NARW) science and management has sparked many discussions and collaborations, strengthening the right whale community as a whole. Passive acoustic monitoring (PAM) continues to show its long-term, continuous broad-scale monitoring and remote reconnaissance capabilities, providing added value to existing methodologies. Given the crisis that the population is facing, there is a need for timely access to information on right whale acoustic detections as it becomes available. In order to meet this need, we are developing a password-protected, interactive map of daily NARW acoustic presence since 2004. This builds on the same framework as Dalhousie University's WhaleMap, with the intent to include all passive acoustic detections of NARWs along the eastern seaboard as they are analyzed. This tool will collate all available detection data contributed by collaborating researchers, and make it available to US and Canadian managers and scientists to help inform decisions that minimize impacts on a species in crisis. We would like to use the NARWC as a springboard for discussing and building an acoustic detection database modeled after the consortium sightings or photo ID databases. We envision this curated acoustic detection database joining the family of NARWC databases, with access to the database subject to the same data request, approval, and attribution processes as all other consortium databases. We have formed an acoustic database committee to develop the database and visualization

tools and are seeking input and feedback from the NARWC.

## Public misconceptions and stereotypes. Is it hindering conservation efforts for the North Atlantic right whale and other marine mammal species?

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As we are all aware, conservation efforts to protect the North Atlantic right whale continue to face great difficulties and, in some cases, have managed only marginal improvements. Since the launch of *Sharing the Seas: Safe Boating for Sailors and Whales* in spring 2015, local members of the Consortium's Education Committee, the Audubon Society of Rhode Island (ASRI), New Bedford Whaling Museum (NBWM) and Whale and Dolphin Conservation (WDC), have had unique opportunities to interact with members of the sailing and boating community through a variety of maritime venues. These include, but are not limited to, the 2018 Volvo Ocean Race, the 2016 and 2018 Atlantic Cup, the 2017 US Sailing National Sailing Programs Symposium and the 2017 and 2018 Vineyard Cup. During this time, a concerning trend has repeated itself: the surprising lack of knowledge about marine mammals, as well as a host of misconceptions about marine mammal behavior and conservation, by regular ocean users such as professional sailors. Sharing the Seas helps the scientific community to bridge the gap by providing a better public understanding to make ocean users aware that they can support conservation efforts and assist in locating and documenting endangered whales, like the right whale, while following regulations and guidelines.

## Dive behavior of North Atlantic right whales on the southeastern U.S. calving grounds

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Diving and active swimming can be energetically costly for right whales. On the feeding grounds, right whale dive behavior is driven by locomotor costs and prey density distribution both horizontally and with depth. On the calving grounds, right whale dive behavior is less well understood and in the absence of prey, we hypothesize that whales dive primarily to avoid drag and to increase swimming efficiency during active swimming. Hence, we predict that whales would actively swim at depths greater than 9m where wave drag is significantly reduced than at shallower depths. To test this hypothesis, data were collected using digital acoustic recording tags (DTAG) non-invasively attached to right whales during January and/or February of 2006, 2014, 2015 and 2016 on the southeastern U.S. calving grounds. Data from 15 deployments (3 juveniles, 2 pregnant females and 10 lactating mothers) totaling 102.2 hours from 14 separate individuals were included in the analysis. Active swimming for travel was defined based on the rate of heading change, a stroke-and-glide swimming pattern, and overall body acceleration during the bottom phase of dives. Dive profiles obtained from calibrated pressure sensors were used to obtain the percentage of time spent at depth and descriptors of diving behavior including the number of dives per hour, the average dive cycle duration and the average surface interval. Results are consistent with the hypothesis that swimming efficiency was likely the main driver of diving behavior of juveniles and pregnant whales, but not lactating whales. Juvenile and pregnant whales were often actively swimming during the bottom phase of dives deeper than 9m while mothers rarely showed active swimming behaviors at depth. These differences are likely associated with differences in body condition, the motivation for diving and calf presence/absence among tagged whales.

## New technology instantly displays NOAA North Atlantic right whale dynamic management areas for mitigation PSOs

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Protected Species Observers (PSOs) working on wind farm construction projects face a challenging task: protect marine mammals and other endangered species in the face of sound levels potentially exceeding federally-mandated sound exposure thresholds. As the provider of mitigation software/real-time mapping technology (Mysticetus) used by many PSOs, and in coordination with NMFS and offshore wind developers, we have incorporated real-time display of NMFS' North Atlantic right whale (NARW) Dynamic Management Areas (DMA) into our software system. As soon as NOAA puts an alert on the web for a DMA, a corresponding red box encompassing the DMA and any specific restrictions are displayed on all PSO on-board computer systems in the field. This instant, internet driven heads-up map display assists PSOs in making critical mitigation decisions such as shutdown, delay operation, vessel course diversion/slow down, etc. Situational awareness of DMA's is nearly instantaneous increasing situational awareness at a level previously unavailable to PSO's. Heightened PSO and ship's crew situational awareness provides for optimization of industry activities while reducing environmental risks to North Atlantic Right Whales and operational risks to wind farm construction permits.

## Mapping migratory corridors of North Atlantic right whales in Canadian waters using passive acoustic monitoring

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The northern extent of the North Atlantic right whale (NARW) range and Canadian migratory corridors are unknown due to lack of monitoring along more remote areas of our coastline. Unmitigated risks in the Gulf of Saint Lawrence (GoSL) led to an unprecedented mortality event in 2017, but a rapid, dramatic response by regional regulators have thus far prevented any deaths in the region in 2018. Despite an increase in visual survey efforts over the last two years, the movement and timing between known northern habitats remain poorly understood, yet fisheries and ship traffic are dense in many of these areas. This emphasizes the critical importance to identify the spatio-temporal extent of the species' occurrence in Canadian waters for future regulations and risk mitigation. This study uses a comprehensive analysis of passive acoustic monitoring (PAM) data comprised of 63 moorings and 14 glider deployments across the Atlantic Canadian and Labrador Shelves collected over two years (2015-16 and 2016-17). Daily NARW acoustic presence was assessed using manual validation of auto-detected upcalls directed by the Low Frequency Detection and Classification System, Davis et al (2017). Preliminary results highlight NARW presence in Canadian waters from mid-April through mid-January. This assessment of range-scale variability in NARW vocal presence will refine our understanding of NARW movement and residency in Atlantic Canada, and potentially help identify previously unknown habitat areas of increased management importance.

## Sleepless whales: North Atlantic right whale melatonin receptor and 'clock' genes associated with arrhythmic behaviors

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The North Atlantic right whale, along with other Balaenidae species, appears to be behaviorally arrhythmic based on previously studies. To elucidate the underlying molecular mechanisms that would result in arrhythmic behavior, the melatonin receptors, MTNR1A and MTNR1B, as well as the circadian 'Clock' family of genes, were examined for mutations. MTNR1A/MTNR1B-knockout mice studies have shown free-running arrhythmic behavior

when both melatonin receptors are lost, while 'Clock' gene losses in the suprachiasmatic nucleus (SCN) range from phase-shifting to a lack of circadian behavior rhythmicity. Sequence analyses from published cetacean genomes strongly suggests nonfunctional melatonin receptors in the North Atlantic right whale, but functional 'Clock' genes. Based on the previously reported mouse models, the loss of a melatonin response should result in arrhythmic behavioral patterns in whales as the SCN circadian 'Clock' genes are no longer repressed under the control of the melatonin receptors. Previously reported telemetric data of North Atlantic right whale behavioral patterns supports this hypothesis.

## Pedigree-informed estimates of abundance and trends for the North Atlantic right whale

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Although much recent progress has been made in obtaining statistically robust abundance estimates for the North Atlantic right whale based on photo-identification data, there remain questions about how many individuals remain unidentified, and therefore are not included in such estimates. Evidence that a substantial number of "missing" (i.e., not photo-identified) individuals may exist comes from two key sources. The first are the "irregular" whales that have long gaps in their sighting histories. These individuals indicate that for every time of year there must be key habitats that we don't know about, and raise questions regarding how many individuals only use unidentified habitats and are therefore never photo-identified. The second line of evidence is the paternity analyses which identified fathers for surprisingly few calves given the proportion of known males that were genotyped, suggesting that many "unknown" males must exist. We have developed a new method of abundance estimation that provides a means to incorporate the inference of individuals via pedigrees into the photo-identification data to result in a single estimate of abundance for a given time period, and have developed an R package for its implementation. Simulations show that this method provides unbiased estimates of abundance, regardless of the proportion of the population sampled. When applied to the North Atlantic right whale data, the photo-identification estimates all fell within the 95% highest density intervals of the pedigree-informed estimates, suggesting that the number of "missing" whales is not large enough to make the photo-identification estimates inaccurate.

## Investigation of North Atlantic right whale (*Eubalaena glacialis*) migratory pathways in the Mid-Atlantic region

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In recent years, it has become clear that the Mid-Atlantic region functions both as a migratory corridor and multi-use habitat frequented by right whales year-round. Whales traveling through this area, particularly during the winter calving season, do not appear to follow shortest distance routes as they move to and from the primary right whale calving grounds. This raises the question of how these whales are selecting their routing. We examined the habitat preferences of "likely migrating" whales to investigate if the whales are using discrete routes for travel. Using data from the fall and spring migration periods, we compared right whale sightings with shortest distance pathways and examined the oceanographic conditions associated with whale presence. Right whales did not follow shortest distance migratory routes in most areas along the Mid-Atlantic. Furthermore, the whales avoided warm

surface waters especially south of Cape Hatteras, NC and appear to have sought out travel routes with favorable ocean currents. Interestingly, mother/calf pairs demonstrated different patterns from other demographic groups and frequently were found in areas characterized by weak ocean currents, which may correspond to resting behavior during their northward migration. Given these findings it may be possible to develop real-time models of optimal migratory corridors.

## Examining annual variation in the energy content and relative abundance of Stage V *Calanus finmarchicus* in the Bay of Fundy from 2011-2018: Implications for North Atlantic right whales and other copepod predators

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The calanoid copepod *Calanus finmarchicus* is the most abundant zooplankton the North Atlantic, making it the base of marine food webs in the region. It exhibits multiple life stages, with the lipid-rich stage V (C5) being of high nutritional value to many animals feeding in the Bay of Fundy, Canada, especially the critically endangered North Atlantic right whale, *Eubalaena glacialis*. Right whales have historically been most concentrated in the Bay during the late summer and early fall, when the concentration and energy content of C5 copepods has been high. Recently, there has been a shift in the distribution of right whales along the east coast of the U.S. and Canada and a decline in calf production, which is likely linked to variation in the quality and abundance of C5 copepods. The quality of C5s has been shown to change throughout the summer months and annually in the Bay, with energy content ranging from 5820-6770 J/g wet weight, varying by up to 30%, between 2006-2010. Between 2011-2016, energy content ranged from 5300 J/g to 6640 J/g, varying by up to 20%. More worrisome, recently the relative abundance of C5s has become more variable, with C5s representing 36-72% of total zooplankton in the last 5 years as opposed to consistently representing 80% of the population between 2006-2011. Other species, including *Centropages* spp., *Pseudocalanus* spp., and *Metridia longa* have been present in higher numbers when C5s have been low. Examining the annual variation in energy content and relative abundance of C5 copepods in the Bay between 2011-2018 will aid in understanding how the major prey of North Atlantic right whales are changing and how this may relate to recent habitat shifts and declines in calf production.

## North Atlantic Right Whale Catalog update and whale naming results

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Each year the New England Aquarium provides an update of the status of the photo-identification Catalog which they manage for the Consortium. This update will include: the number of animals currently in the Catalog, their age and sex, and whether they are presumed alive or dead; the number of sightings and images contributed in the last year; new animals added to the Catalog; the matching status of the data by year; and an overview of recent births, mortalities and entanglements (although details of the latter two will likely be provided by other presenters). Also, comparisons of data submission and number of whales alive historically will be presented. To ensure that the most up-to-date data are provided, these numbers will be calculated in mid-October and therefore the results are not provided in this abstract. Given the large number of researchers that utilize the Catalog data, it is important to provide annual summaries of the status of available data so that these researchers can determine appropriate research objectives. Lastly, the final results of the Consortium whale naming effort will be presented.

## Monitoring the long-distance movement of a North Atlantic right whale in the Gulf of Mexico

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The rare occurrence of a lone North Atlantic right whale (*Eubalaena glacialis)* in the Gulf of Mexico (GOM) presented several challenges for researchers to follow its long-distance movement far from the principal winter calving area. With no dedicated survey effort in the GOM and very little historical sightings data to inform movement patterns, researchers were dependent on public reports and social media "sleuthing" to track the whale. Between December 26, 2017 and March 17, 2018, 14 public right whale sightings were reported along the west coast of Florida from Panama City to Naples: five photo-confirmed, seven probable, and two low confidence. Throughout this timeframe, the FWC, NOAA Fisheries, and other partners used their social media platforms to request that the public be on the look-out for the whale and to report all sightings in real-time. Several attempts by aircraft and boat were launched to investigate sighting reports, assess and mitigate potential risks, and to obtain photographs and a genetic sample. The whale was never relocated by research teams, largely due to delayed communication with the original sighting source and the novel nature of this type of response effort in the GOM; however, we gathered information about current potential threats along the west coast of Florida (e.g. vessel traffic, harassment, and fixed fishing gear) and increased situational awareness throughout the GOM. Our efforts also produced enough documentation to determine the whale is a juvenile, possibly a yearling, but not enough to positively identify the individual. Identifying various tools (e.g. social media) and maintaining response flexibility to monitor extralimital movements is important as right whale distribution has shifted in recent years, sightings have declined in the southeastern U.S., and individual identification remains a priority for population survival analyses and health assessment.

## Probability of passive acoustic detection of right whales from autonomous platforms equipped with a real-time monitoring system

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Mitigation of anthropogenic impacts on North Atlantic right whales and other at-risk species is critical, but challenging given the cryptic nature of whale behaviour and the limitations of conventional visual surveys. Using passive acoustic monitoring (PAM) to alert ocean users to whale presence in near real-time can provide an effective mitigation option. The Woods Hole Oceanographic Institution (WHOI) has developed the digital acoustic monitoring (DMON) instrument and low-frequency detection and classification system (LFDCS) to detect and classify baleen whales in near real-time from autonomous platforms (e.g., buoys and gliders). A limitation of many PAM systems, including the DMON/LFDCS, is the uncertainty in acoustic detection range from the PAM platform.
Our goal was to determine the range-dependent probability of detection of the DMON/LFDCS on mobile and fixed platforms. Over a 4-week period in spring of 2017, we concurrently deployed a 4-element vertical line array (VLA), an 8-element horizontal line array (HLA), a DMON/LFDCS-equipped Slocum glider, and a DMON/LFDCS buoy at a shallow (~30m) site ~15 km southwest of Martha's Vineyard, Massachusetts, USA. We used a normal mode back-propagation technique with the HLA/VLA data to localize right whale upcalls, and then conducted a call-by-call comparison among calls detected on the HLA/VLA and those detected by the glider and/or buoy to determine the range dependent detection probability among platforms. The results help us to better quantify and improve the performance of the DMON/LFDCS on different

platforms, which in turn allows us to disseminate more accurate information about whale distribution and near real-time locations to research, government, and industry stakeholders.

## An interactive biophysical model to estimate physical stresses experienced by right whales as a result of vessel strikes

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Studies of right whales struck by ocean-going vessels often focus on large vessels (> 20 m), and much of the attention on reducing the risk to right whales has been on altering the patterns and speeds of large vessels. There are, however, many smaller vessels that co-occur with these whales (e.g. coastal fishing vessels) and can be (or have been) involved in whale strikes. Necropsies of whales killed by blunt trauma typically find extensive subcutaneous hemorrhages that may extend through the blubber and into the underlying tissues, but it is not uncommon for these investigations to report no fractured bones. We wanted to evaluate if the stresses involved in collisions by small vessels could be large enough to cause lethal (or serious) injuries to right whales. Using knowledge of right whale anatomy, and Newtonian mechanics, we constructed simple models to do this. Results from these models reasonably simulate results reported in other studies, and observations of whales killed by blunt trauma. We use this tool to evaluate several case studies of whale strikes and necropsies to determine the potential outcome of collisions, and to evaluate different-sized vessels that could have caused the observed injuries. The models suggest that in many situations, small coastal vessels have a reduced potential to cause serious injuries, but there are situations where collisions by these vessels can produce serious injuries. The model we have developed is flexible enough to handle a variety of situations, such as strikes by vessels of different masses and speeds upon whales of different sizes and physical condition. It is also fast enough to be used in an interactive GUI-based tool (as an R package) that we will provide to facilitate both scientific analysis and policy discussion.

## Competition and collaboration

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Photo identification plays an important role in endangered species research and conservation. However manually matching photographs to known individuals is very time-consuming, and the field of automated image recognition has made tremendous strides in recent years. Motivated by the desire to increase efficiency, NOAA Fisheries hosted a data science competition on the crowdsourcing platform Kaggle to automate the identification of endangered North Atlantic right whales. This proved to be a very challenging image recognition problem as even knowing which part of the photograph contained a whale was not always clear, and we were seeking to identify not just how many whales were in the photograph, but the individual identity of each particular whale. The winning solution developed by deepsense.ai was able to automatically identify individual whales with 87% accuracy using a series of convolutional neural networks to identify the region of interest, rotate, and crop the images, create standardized 'passport' photographs, and finally identify the correct individual whale. With such a promising solution in hand to a very challenging image recognition problem, we began collaborating with WildMe, the developers of Flukebook, to create a seamless website platform for biologists with no experience in machine learning to be able to harness the power of these algorithms to identify whales. Our work also has tremendous potential to cross-match between existing catalogs of the closely related Southern right whale and are working with Curtin University to bring in images from Australia. Data contributions from the New England Aquarium and Murdoch University are an essential part of this work, and an example of just how much can be achieved when researchers from different institutions collaborate and share data. We hope to encourage others to utilize computer vision for applications in

conservation biology for increased understanding of wild populations.

## Development and evaluation of whale release ropes

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Based on previous work, the use of 1,700 lbf ropes could reduce entanglement severity. During the past 18 months we have been developing and evaluating this option, focusing on assessment of a braided sleeve rope. We tested the sleeves with seven fishermen in Massachusetts and New Hampshire in lobster, sea bass and whelk fisheries. Sleeves were integrated every 40 feet into their endlines and these endlines were compared to control endlines of normal strength of ~3,400 lbf. During a season of use, a comparison of rope breakage between sleeved and control endlines showed similar levels of breakage - 11.8% (8 of 68) of experimental endlines were reported broken/missing in comparison to 8.5% (4 of 47) of reported broken/missing control endlines. Using results of at-sea testing integrated into customized software, the drag coefficient and the weight of gear in the water column had the most influence on endline rope tensions as water velocity and wave height increased. Although rope tensions were well below the typical loads experienced by fishermen, operational changes such as increasing the groundline distance between the first and second pot, reducing hauler speed in high sea states and keeping the vessel over the top of the gear during hauling were all approaches that could be used to minimize rope tension. The Whale Entanglement Simulator, developed by BelleQuant Engineering and New England Aquarium scientists to measure rope tensions when a whale gets entangled and rolls in response, showed similar findings in that the weight of gear attached and the speed of the whale increased the simulated tensions in the three scenarios tested. Based on these results, the use of 1,700 lbf rope sleeves could be a practical option for fishermen to help reduce the severity of entanglements.

## Right whale entanglement and injury events 2018

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A total of six right entanglement cases were sighted rangewide since the last consortium, down from 11 as of the 2017 consortium. Two of the six cases were ongoing from prior years, including 1142 (still entangled despite three disentanglement attempts in 2018) and 4146 (confirmed to have shed the gear). The four new cases included three whales first discovered off Canada (3312, 3843, 3960) and one off the US (4091). A disentanglement operation on 3843 may have been successful but network members are urged to keep an eye out for the whale and assess as much as possible. The three other new cases may still be active.

Injured whale monitoring efforts identified twelve new injuries of interest for twelve right whales, including new injuries to two whales already on the monitoring list. Eleven new injuries were entanglement related, including four whales with attached gear. There was one new vessel strike injury. Three whales with new injuries were determined to be in declining condition coinciding with injury. There were no visual indicators of injury impact on health condition for three newly injured whales and the impact for the remaining six whales was determined to be inconclusive. Twenty three previously injured whales had additional sightings to assess and as a result, eight whales were upgraded in impact condition. Three whales were removed from the monitoring list as they became presumed dead, including two whales that had been in declining condition and one that had inconclusive impact of injury on health at their last sighting.

For this time period, preliminary NMFS Serious Injury determinations identified four serious injuries, two prorated injuries, two non-serious injuries, and four that do not meet the NMFS criteria to be

included in the dataset. For the two ongoing cases, 1142 has been downgraded from serious to non-serious injury and 4146 is classified as a non-serious injury. All determinations are subject to change. Official NMFS Serious Injury determinations on 2018 events will not be made until late 2019.

## Block Island Seasonal Management Area: Proposal for expansion to include port approaches

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Based on our analysis of right whale sighting data and ship traffic data in Rhode Island Sound, we propose the expansion of the Block Island Seasonal Management Area (BISMA) to include the area bounded by the following coordinates:
41º16.395'N 071º57.054'W
41º32.290'N 070º55.570'W
41º04.269'N 071º51.380'W
41º20.755'N070º50.348'W
The Seasonal Speed Restrictions enacted in 2008 to protect North Atlantic right whales from ship collisions are focused around the major port areas on the migration route to and from the calving area. The single exception to this emphasis on protection around ports is the Block Island SMA (BISMA), 12 miles off of Rhode Island's coast, which does not have a port-area component. It is the only SMA in the system that does not provide ship strike protection around the relevant port approaches, in and around the Traffic Separation Scheme (TSS) and related shipping lanes serving three states. We compared the NARWC sighting data inside BISMA with sighting data inside the proposed expansion area and found that 28% of the sightings are located in and around the TSS, north of BISMA's boundaries. Automatic Identification System (AIS) ship-speed data indicate that 49% of the ships crossed the expansion area at speeds of 12 knots and higher; 36% of the ships traveled at speeds from 14 to 21 knots. The TSS and shipping lanes funnel ships into the ports of Providence and Davisville, Rhode Island, New Bedford, Massachusetts, New London and New Haven, Connecticut, with frequency rivaling other port areas in the SMA system that do have seasonal speed restrictions in place. The proposed expansion of BISMA will extend that protection to an additional 28% of the seasonal migration as it passes Rhode Island, and should be considered when NMFS undertakes any future review of the Speed Rule.

## Fisheries and Oceans Canada (DFO) update on North Atlantic right whale management activities and recovery planning

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Fisheries and Oceans Canada (DFO) will provide an update about activities underway in 2018 to support North Atlantic Right Whale recovery under the Species at Risk Act, and management measures that have been put in place to reduce risk to right whales in Canadian waters. Monitoring programs were put in place supporting management measures to reduce entanglement and vessel collision risk to right whales, and industry consultations in 2018 are summarized.

## Department of Fisheries and Oceans Canada: An update on research and monitoring activities

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Fisheries and Oceans Canada leads and collaborates on many research and monitoring projects relevant to cetaceans in the Northwest Atlantic, including activities focused on increasing our understanding of North Atlantic right whale distribution, movement patterns and habitat use in eastern Canadian waters. In particular, a substantial number of aerial surveys were conducted in the Gulf of St. Lawrence and off Newfoundland and Nova Scotia throughout 2018 to support management measures aimed at reducing the risk of right whale ship strikes and entanglements. This presentation will provide an overview of recent science and monitoring activities that have been or are being conducted by Fisheries and Oceans and our partners that will contribute to our knowledge of right whale occurrence in Canadian waters. These activities include visual survey and surveillance

efforts, passive acoustic monitoring projects, prey studies and other work.

## Co-existing in the Gulf of St. Lawrence: An integrated approach with crabbers, for whales

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North Atlantic right whales are thought to be more and more present in the Gulf of St. Lawrence. Occupying this new territory led to new interactions with other users of the marine environment, and thus new conservation challenges in this area. Following the important mortality event in 2017, different management measures were enforced for crab fishermen in 2018, in an urgent attempt to reduce mortality of this species in the Gulf of St. Lawrence. These radical measures had an important, although unfortunately unconsidered, impact on fishing communities. Willing to increase our efficiency to "co-exist" in the Gulf of St. Lawrence and inspired by the long-time efforts developed by our US neighbours, we present here a two-step approach to protect the North Atlantic right whales in our region: first, an inclusive management/mitigation system, where fishermen are involved in early stages of the process, to reduce overlap between whales and fisheries in Crab Fishing Area 12; and second, the development of new technologies in snow crab fishing gear to reduce entanglements or fatalities when fishermen and whales are occurring in the same area and at the same time. Proposed solutions include a system to track whale entanglement, ropeless traps, ropes with reduced breaking-strength, electronic monitoring for real time transmission of data related to whale sightings and entanglements, regulatory monitoring activities, new coding technologies for traceability of fishing gear, and rehabilitation of the natural infrastructure of the seabed. Crabbers for whales is an example of how we can work together to find efficient conservation solutions for the North Atlantic Right Whale, at a time where concertation and co-existence are the key to make a significant difference.

## Mitigating the risk of ship strikes with commercial vessels in the Gulf of St. Lawrence through a collaborative approach

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The endangered North Atlantic Right Whales (NARW) have had a hard time in 2017 in Canadian waters with 12 dead right whales found in the Gulf of St. Lawrence and another five found in US waters. In August 2017, in reaction to these events, the shipping industry quickly realized that they were facing an abnormal situation and that it was urgent to team up with all relevant stakeholders, including government representatives, in order to find a way to reduce the risk of ship strikes between a commercial vessel and a whale in this area of the Gulf. This presentation will discuss the collaborative approach chosen by the industry and the implementation of a dynamic management measures in the Gulf of St. Lawrence

## Gauging management effectiveness in the face of sample noise and a changing environment

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The North Atlantic Right Whale (*Eubalaena glacialis*) population is in decline, both in abundance and in an increasingly male-biased sex ratio. Although total abundance was slowly increasing at least from 1990-2010, the U.S. National Marine Fisheries Service recognized that the population was subject to excessive levels of anthropogenic mortality associated with commercial fisheries operation. Because the agency permits many of those activities while simultaneously being responsible for whale conservation, it began to develop regulations in hopes to reduce the damaging influence commercial fishing activities perceived to be impacting the recovery potential for this endangered species. Stakeholders in the permitted activities subject to regulation, NGO's interested in the recovery of right whales, and the

agency itself are highly interested in the effectiveness of these rules with regard to improving the right whale's prospects for continued existence. A metric frequently chosen to evaluate the effectiveness of rules enacted in hopes of reducing serious injuries and mortalities due to gear entanglement (SIME) has been the annual count of SIME. Unfortunately, considerations of variation in this metric are often viewed without proper regard to the sampling and stochastic processes that generate them. Herein, I evaluate the SIME count and vessel-related SIM in common framework for accounting for their inherent noisiness. I show that there has been a significant signal in these data, detectable above the noise, and that observed SIME has increased since the ground line and subsequent rules were put in place. I use this observation as a springboard to pontificate on the plentiful perils pursuant to evaluating management effectiveness in a setting that lacks replicates or controls of influences unrelated to the management action.

## Low amplitude acoustic communication of North Atlantic right whale (*Eubalaena glacialis*) mother-calf pairs on the calving grounds

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Passive acoustic monitoring is used to aid in detecting right whale presence in particular habitat areas. A single tonal call type, the 'upcall', is typically used to identify presence of right whales in a habitat. Limited data are available on the acoustic behavior of reproductive female right whales with their calves, particularly in the first three months after parturition on the calving grounds. This data gap leads to uncertainty in the effectiveness or potential biases in passive acoustic monitoring to detect this vulnerable segment of the population in this habitat. In this study, we utilized the attachment of non-invasive suction cup acoustic recording tags to assess the sound production behavior of right whales on the calving grounds in the southeastern United States between 2006-2016. Seventeen tags were attached to 15 individual right whales, including 11 lactating females with calves, two pregnant females, two juvenile males and one juvenile female for a total of 108 hours of acoustic data. Given the proximity of the hydrophone on the back of the whale, we were able to identify a category of previously undescribed, low amplitude, short broadband signals produced primarily by nursing females. The production of higher amplitude tonal calls, including the 'upcall' occurred at very low rates for females accompanied by calves when compared to the juveniles or pregnant females, with one 23 hour tag recording resulting in zero 'upcalls' from a mother-calf pair. We suggest that these quiet signals allow for close range communication between the mother and calf, without alerting conspecifics or potential predators to their presence. These data suggest that passive acoustic monitoring may be less effective in detecting right whale mother-calf pairs given their relatively cryptic acoustic behavior in this critical habitat area.

## Looking to conservation marketing to strengthen public actions for right whales

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Many of the causes about which the general public is passionate have a villain, leading to a relatable story and simple concrete actions. Despite being the main causes of right whale mortality, deaths resulting from entanglements and vessel strikes are accidental with no "bad guy" to blame and few simple actions through which the public can directly engage. According to MacDonald et al. 2016, social media and web campaigns are increasingly used as a platform to empower the public to engage in political, conservation, and social issues. But how do we inspire that support for right whales, a species for which there is no intentional harm? We examined several studies on conservation marketing to consider what attributes may help to raise the profile of

endangered North Atlantic right whales and empower the public to take action.

## Climate-driven circulation changes threaten conservation of endangered North Atlantic right whales

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As variance around mean environmental conditions increases, ecosystems will be pushed rapidly into new states, where conservation strategies are less effective. In the Gulf of Maine, climate-driven changes have restructured the ecosystem rapidly over the past decade. Changes in the Atlantic meridional overturning circulation (AMOC) have altered the deep-water, late-summer abundance of the copepod *Calanus finmarchicus*, which is a critical food supply for the endangered North Atlantic right whale (*Eubalaena glacialis*). The oceanographic changes have driven a deviation in the seasonal foraging patterns of *E. glacialis* upon which conservation strategies depend, making the whales vulnerable to ship strikes and gear entanglements. The links between the AMOC shift and a species of high conservation concern undermine assumptions about species response to change and the current management paradigm

## Development and testing of the Lobster Raft to reduce entanglement in North Atlantic right whales

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SMELTS developed and tested line-less fishing gear called Lobster Raft in Cape Cod Bay and on Stellwagen Bank Massachusetts, to reduce entanglement of North Atlantic right whales in active fishing gear. SMELTS has designed and built three models of the Lobster Raft varying in size and load capacity that have been tested over 300 times in Cape Cod Bay and on Stellwagen Bank. Testing priorities were the integration to existing lobster fishing operations and lifting a variety of gear systems. The Lobster Raft was tested lifting negatively buoyant ground line, commercial lobster pot with negatively buoyant ground line, and trawl anchor. Tests included extensive data collection and video recording of deployments and recoveries to analyze descent and sea floor lift off function.

## Gross and histopathological findings from North Atlantic right whale (*Eubalaena glacialis*) mortalities between 2003 and 2018

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Seventy mortalities of North Atlantic right whales (*Eubalaena glacialis*) occurred between 2003 and 2018 (15 October) from Florida, U.S.A. to the Gulf of St. Lawrence, Canada. Twenty-eight adults, 15 juveniles, 10 calves, and 17 unknown age class individuals were documented. For cases in which both age class and sex could be determined, adult females comprised the largest demographic, representing 35.3% (18/51) of all mortalities and 66.7% (18/27) of adult deaths. Examinations were performed on 56 carcasses with necropsies conducted in 44 cases. The cause of death was determined in 43 cases, of which, 88.4% (n=38) was due to anthropogenic trauma; specifically, 22 *E. glacialis* died due to entanglement (8 female, 10 male, 4 unknown sex) and 16 to either blunt or sharp trauma from a vessel strike (9 female, 7 male). Notable gross and histopathological findings in entanglement cases included: constrictive wraps and deep lacerations caused by line primarily around flippers, flukes, and head/mouth (including into the oral rete); exuberant periosteal proliferation, lytic lesions, and osteopenia from chronically impinging line; comminuted vertebral fractures and traumatic scoliosis in a calf leading to compromised mobility; poor body condition and heavy cyamid load in chronic cases; and baleen plate disruption. Blunt force trauma vessel strike findings included: fractures (skull, vertebrae); well-defined regions of blubber and muscle contusion including undulating regions of hemorrhage within the blubber (shock wave pattern); and suspected blood clots along the vertebrae, sites of fracture, and within body cavities. Sharp trauma included extensive lacerations in blubber, muscle, viscera and bone. These results demonstrate not only the profound physical trauma and suffering inflicted by human activities on individual North Atlantic right whales, but also the unsustainable cumulative impacts at the population level. Urgent and aggressive mitigation efforts throughout their range are needed to end anthropogenic mortality in this critically endangered species.

## Calvineers reaching out more than ever

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The mission of the CALVIN Project is "Endangered Species Recovery Through Education." A big part of an effort to educate people is outreach to stakeholders in the field. The Calvineers have attended many conferences and meetings where they not only learn from the experience, but they also reach out to various groups to discuss problems and solutions. The Calvineers have learned how to splice weak sleeves into fishing line and are making spools of line with the sleeves installed that will be sold to fishermen in Maine at cost. The Calvineers are currently reaching out to Maine fishermen to help them understand the problem and the solutions available. In addition, the Calvineers continue to present an up to date, 40-minute PowerPoint to schools and other organizations to help people understand the crucial situation the North Atlantic right whales now find themselves in. The new information in this presentation is that the Calvineers are engaging with fishermen and they are producing weak sleeved rope spools to help fishermen.

## New technology instantly shares sightings and protects North Atlantic right whales in real-time

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Wind farm (pre)construction is ramping up along the east coast. At any given time, multiple vessels off the northeast United States coast could be involved in sub-bottom profiling, various sonars, pile-driving, jack-up rig coring and other activities producing sounds exceeding NMFS-regulated noise exposure thresholds. Such sounds can overlap the acoustic range used by the NARW for communication. Thus,

federal regulators typically require 2-6 Protected Species Observers (PSOs) per vessel to watch for animals and take prescribed mitigation action when necessary (e.g. shutdown and delay of sound sources, change course, etc.). Extant technology for sharing NARW locations (e.g. NMFS SAS and WhaleAlert) facilitates broad public input, requiring vetting by authorities; sightings can take over 24 hours to propagate into the field. As creators of the software (Mysticetus) used by many PSOs, we developed a system that instantly shares NARW sightings between vessels and projects. PSOs are highly-trained marine mammal observers; their sightings can safely be assumed to be correct, needing no vetting. When a PSO on one vessel sights a NARW, it is instantly displayed on the computers of all other nearby PSOs. An alarm sounds and the location, range and bearing is highlighted on a real-time map. This system dramatically decreases latency and provides recipients of these alerts (PSOs) greater detail to inform their mitigation decisions, and provide real-time, improved protection of NARW. Improved situational awareness can serve as a tool for real time adaptive mitigation, allowing for optimization of industry activities while reducing environmental risks.

## A brief history of NRW conservation and a proposed paradigm shift

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It is good to review the historical record of efforts to protect the NRW and its efficacy. From there it is good to propose an agenda for future efforts to insure this species will not go extinct. By the middle of the twentieth century the NRW was considered extinct from whaling. But William Watkins rediscovered NRW off the Massachusetts coast in the 1960's — which now lists it as a resident endangered species. The NRW was listed as endangered under the ESA in 1973. Federal agencies, required to conduct environmental reviews, started funding field surveys for NRW along the US coast in 1980's. Few NRW were sighted. Despite the NRW as a charismatic species, virtually nothing was done to protect these whales until the mid-1990's when NOAA and the US Coast Guard were sued for killing NRW. Imposed ship traffic management schemes and modifications to commercial fisheries practices have not stopped the killings of NRW by these industries. Despite modest increases in the population since 2000, the birth rate fell. In 2018, the birth rate collapsed with no newborns sighted during the winter birthing season nor any since. Extinction is about lack of births. The complete failure of a macrofauna species to reproduce in a single year is a diagnostic feature for its irreversible future extinction. NOAA's inability to stop entanglements of NRW and ship strikes in over two decades of regulatory effort is indicative of the inability of the current paradigm to stop the NRW extinction. A new paradigm for the conservation of the NRW is proposed and that offers a more pragmatic and effective path to insuring the survival of this species than is offered by the current one.

## An assessment of vertical line use in Gulf of Maine region fixed gear fisheries and resulting conservation benefits for the endangered North Atlantic right whale

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The population of endangered North Atlantic right whales, *Eubalaena glacialis*, has recently been found to be in decline, with mortalities outpacing a declining birth rate and increasing calving intervals. A large portion of these mortalities is related to anthropogenic causes, namely entanglements in fixed fishing gear. New regulatory measures for fixed gear fisheries aimed at reducing the rate of serious injuries and mortalities due to entanglements are on the horizon. However, information gaps on how vertical lines are utilized in these fisheries have hindered those discussions. To address these gaps, we formed a regional collaborative including the states of Maine, New Hampshire, Massachusetts, Rhode Island, and Connecticut, as well as industry associations, and a neutral third-party consulting firm. This collaborative is collecting data in three separate data streams. The first includes a voluntary industry survey that documents vertical line fishing practices spatially. The second collects used vertical lines throughout the region and documents the functional breaking strengths of those lines. Lastly, load cells record the hauling strain on the vertical line while deployed on fishing vessels. We will present the preliminary results for each of the three data streams, discuss the

next steps of utilizing these data in a model that can be used to assess proposed management measures, and discuss the results with respect to potential conservation measures that could reduce the risk of entanglement for right whales.

## Foraging rates of endangered North Atlantic right whales measured with onboard, multi-sensor DTAGs

van der Hoop, J.M.[1]; Nousek-McGregor, A.E.[2]; Johnson, M.[1,3]; Nowacek, D.P.[4]; Parks, S.E.[5]; Tyack P.[3]; Madsen, P.T.[1]

[1] *Department of Bioscience, Aarhus University, 8000 Aarhus C, Denmark (jvanderhoop@bios.au.dk)*
[2] *School of Life Sciences, University of Glasgow, Glasgow, UK*
[3] *Sea Mammal Research Unit, Scottish Oceans Institute, University of St. Andrews, St. Andrews, Fife, UK*
[4] *Nicholas School of the Environment and Pratt School of Engineering, Duke University, Beaufort NC 28156 USA*
[5] *Biology Department, Syracuse University, Syracuse NY 13244 USA*

North Atlantic right whales (NARW) spend their summer months foraging on high-density, lipid-rich prey, which allows for rapid accumulation and storage of energy within a few months to support future migrations and buffer against unanticipated energetically costly events (e.g. entanglement). As recent changes in population health, reproduction and distribution have coincided with changes in prey distribution, quantification of the rates and dynamics of food acquisition in this critically endangered, capital breeding species is critical to evaluate the energetic consequences of changing habitats and human stressors. Our understanding of the volume of prey-laden water filtered by NARW in a dive or foraging bout, and what information they use to decide to forage or not, has been limited by the difficulties of measuring when NARW feed at depth, how fast they swim while filtering, and how often they might swallow accumulated prey. We used 10 DTAG deployments from NARW in the Bay of Fundy, Canada, to quantify swimming speeds and estimate the volume of water filtered per dive. We used the tag's inertial sensors to detect frequent biomechanical changes that indicate the truncation of a continuous filtration event, and assess whether the timing of these fluking bouts lead to longer feeding dives or other foraging decisions. We found consistent pauses in fluking behavior every 49(±18 SD) seconds. Whales filtered on average 70(±28) $m^3$ of water per bout, and 620(±210) $m^3$ per dive. The relationship between relative fluking amplitude during bouts generally increased with speed during consistent foraging, but switching between foraging and non-foraging modes often occurred during high speed and low fluking effort, suggesting lower drag and perhaps prey density. Refined estimates of NARW filtration rates improve estimates of energy acquisition in this prime feeding habitat, and can be compared with DTAG-based estimates from other foraging habitats or in different years.

## Right whale encounter rates with crab-pot fishing gear in the Gulf of St. Lawrence

Vanderlaan, A.S.M.[1,2,3]; van der Hoop, J.M.[4]; Davies, K.T.A.[2]; Taggart, C.T.[2]

[1] *Bedford Institute of Oceanography, Fisheries and Oceans Canada, Dartmouth, NS, B2Y 4A2 (angelia.vanderlaan@dfo-mpo.gc.ca)*
[2] *Department of Oceanography, Dalhousie University, Halifax, NS, B3H 4R2*
[3] *Canadian Whale Institute, Wilson's Beach, NB, E5E 1S9*
[4] *Department of Bioscience, Aarhus University, 8000 Aarhus C, Denmark*

Fishing-gear entanglements are a substantial source of mortality and injury to endangered North Atlantic right whales (NARWs). NARWs occupying a high-use area in the southern Gulf of St. Lawrence have been observed swimming and feeding near high and concentrated snow-crab fishing effort. The number of NARW observations has increased since 2015, coincident with an increase in the number of reported NARW entanglements in snow-crab and unidentified gear. As many whales appear to shed gear or self-disentangle, we used a modeling approach to estimate the number of times NARWs encounter snow-crab gear, as each represents potential entanglement. We combined snow-crab gear deployment data with an observationally based NARW movement model to estimate spatial and temporal encounter rates between gear and NARWs. In 2017, a total of 578,271 snow-crab traps were reported fished in the southern Gulf of St. Lawrence over the season (20 Apr – 05 Aug) with an average soak time of 82 hours (± 50 hours SD). The simulation model was initiated with one NARW (28 Apr) swimming through the area. The number of whales were increased every 10

days over the fishing season, with a total of 127 whales by mid-August. Preliminary analyses estimated 330 instances where NARWs encountered gear, including 129 unique encounters with different traps. On average, the encounter rate was 0.04 traps per day (±0.02 SD) and only two encounters were estimated after a large area was closed mid-July. As 2017 had an unusually high quota in the snow crab fishery, we plan to compare the same metrics for fisheries data from 2015 and 2016 to estimate how fishing effort changes the encounter rates. These models can inform decision-making and policy design as well as examine the effectiveness of conservation measures implemented for the snow-crab fishing season.

## Impacts of Trump's America-First Offshore Energy Strategy on the North Atlantic right whale

Weaver, S.[1]; Whaling, M.[1]; Hildebrand, B.[1]

[1] *Southern Environmental Law Center, Chapel Hill, NC 27516 (sweaver@selcnc.org)*

In 2017, President Trump launched his America-First Offshore Energy Strategy, and in 2018, Interior Secretary Ryan Zinke pushed forward with the largest proposed offshore oil and gas leasing program in U.S. history, potentially opening all U.S. waters inhabited by North Atlantic right whales to offshore drilling. At the same time, the Trump administration has proposed to roll back critical safety measures put in place following the *Deepwater Horizon* oil spill, increasing the threat of this already risky activity. Waters off the southeast coast (including the waters off Virginia, North and South Carolina, and Georgia) appear to be of particular interest to both the oil and gas industry and the Trump administration. This area is also the target for seismic exploration, which has been a significant concern for the North Atlantic right whale, both because of its own impacts and because it is the precursor to offshore drilling. While the Obama administration rejected seismic permits for this area, the Trump administration is poised to reverse that decision and issue permits any day. We'll explore what these developments could mean for the highly endangered right whale and its migratory and critical habitats. We'll also discuss the legal requirements for making these decisions and the role of Consortium members in ensuring that the best available science on the status of the species and threats to its survival are incorporated into the decision making process.

## Right whale research in Canada under the DFO Oceans Protection Plan, Marine Environmental Quality Programme

Wright, A.J.[1]; Evers, C.[1]; Xu, J.[1]

[1] *Ocean and Ecosystem Sciences Division, Maritimes Region Fisheries and Oceans Canada, Dartmouth, Nova Scotia, Canada B2Y 4A2 (andrew.wright@dfo-mpo.gc.ca)*

Fisheries and Oceans Canada has been developing a research program to better understand and address the cumulative effects of shipping noise on North Atlantic right whales (NARW), coordinated by the cetacean research group in the Maritimes Region. This includes work to establish baselines for noise in eastern Canada, examine potential overlap with NARW occurrence, and increase understanding of noise impacts on NARW. To achieve this, we are deploying multiple bottom mounted passive acoustic monitoring (PAM) recorders to collect information on the marine soundscape that will support our noise-modelling efforts. These recorders will also provide information on NARW distribution and movements that will be used in habitat suitability models. Additionally, we will deploy a multi-element vertical line PAM array in order to collect ship signature data to produce an additional layer for the noise models. This PAM effort will ultimately be combined with hormonal and body condition information gathered by drones and biopsies on the health and wellbeing of the NARWs to try to isolate the influence of noise on NARWs at the sub-lethal level. Similarly, it is hoped that DTAG studies will reveal any behavioural responses to passing ships that might have consequences for the whales. While this upcoming work does include some novel studies, we realise that there is a large amount of work that is already ongoing or planned for NARW that advances our knowledge in these areas. Rather than duplicating existing efforts, we are looking to build collaborations and share data. One way we are looking to do this is by providing other research teams with additional funding and/or logistical support to extend the temporal or spatial coverage of relevant NARW related data collection. We hope that this presentation will facilitate such collaborative efforts.

## Computational fluid dynamics simulations of a 10m North Atlantic right whale (*Eubalaena glacialis*)

Wu, C.[1]; Howle, L. E.[1,2,3,4]; Nowacek, D. P.[1,5]

[1] *Duke University Marine Laboratory, Beaufort, NC 28516 (chen.yi.wu@duke.edu)*
[2] *Mechanical Engineering and Materials Science, Duke University, Durham, NC 27710*
[3] *Radiology, Duke University Medical Center, Durham, NC 27707*
[4] *BelleQuant Engineering, PLLC, Mebane, NC 27302*
[5] *Electrical and Computer Engineering, Duke University, Durham, NC 27710*

Drag occurs when an object moves through a fluid due to the viscosity of the fluid. Accurate estimations of drag on marine animals are required if one wants to investigate the locomotive cost, the propulsive efficiency, and, in our case, the impacts of entanglement while the animal is carrying fishing gear. In this study, we performed computational fluid dynamics (CFD) analysis over a 10m (length of animal, LOA) static right whale model in a commercial flow solver (SolidWorks Fluid Simulation 2015) to obtain baseline measurements of drag across the animal. Swimming speeds covering known right whale speed range (0.125 m/s to 8 m/s) were tested. We found a weak dependence between drag coefficient and Reynolds number. At a swimming speed of 2 m/s, we analyzed the boundary layer thicknesses, the flow regimes, and drag components. We found the thickest boundary layer at the lateral sides of the peduncle whereas the boundary layer thickness over the outer part of the flukes were less than 1.7cm. Laminar flow occurred over the anterior ~0.6 LOA and fully turbulent flow from ~0.8 LOA to the fluke notch. On surfaces of the flukes outside of the body wake region, flow was laminar. Our most significant finding is that the drag coefficient (0.0071-0.0059) of a right whale, which is associated with the morphology of the animal, for swim speeds ranging from 0.25 m/s to 2 m/s is approximately twice that of many previous drag coefficient estimates for cetaceans.

## Integrated ocean-acoustic approach for North Atlantic right whale passive acoustic detection range modelling on Scotian Shelves

Xu J.[1]

[1] *Bedford Institute of Oceanography, Dartmouth, Nova Scotia, Canada B2Y 4A2 (Jinshan.xu@dfo-mpo.gc.ca)*

Under the Ocean Protection Plan (OPP), the Government of Canada is committed to take action to better understand and address the cumulative effects of shipping on marine mammals, including the southern resident killer whales, belugas and the North Atlantic right whales. In the Atlantic Maritime region, this includes work to carry out long-term monitoring of the North Atlantic right whale presence on the Scotian Shelves. To understand the limitations of passive acoustic monitoring (PAM) detection range of NARW is critical for acoustic system design and deployment, as well as the data analysis for animal presence and population density estimation. The detection range of PAM systems is determined by the sound source level, transmission loss, ambient noise level, and hydrophone system sensitivity. On the Scotian Shelf, with a dynamic ocean environment, the sound propagation conditions vary greatly over time The inclusion of dynamic ocean environmental effects in sound propagation modeling is often challenging due to lack of information. Therefore, climatological data is commonly used in this approach, which represents poorly the real ocean environment, especially on the shelves. In this work, we focus on transmission loss modelling integrated with ocean circulation modelling, and combined with in situ ambient noise measurement to provide an estimate of detection range as a function of time. We recommend these modelling methods should be used for (not limited to) PAM data analysis of the presence and population density s estimation of the North Atlantic right whale.

## North Atlantic right whales in the New York Bight: First-year findings from monthly aerial surveys

Zoidis, A.M.[1]; Smultea, M.A.[2]; Lomac-Macnair, K.[1]; Jefferson, T.A.[3]; Andrews, M.E.[1]; Rickard, M.E.[4]

[1] *Tetra Tech, 1999 Harrison Street, Suite 500, Oakland, CA 94611 (ann.zoidis@tetratech.com)*
[2] *Smultea Environmental Sciences, P.O. Box 256, Preston, WA 98050*
[3] *Clymene Enterprises, Yerba Valley Way, Lakeside, CA 92040*
[4] *NYSDEC, New York State Department of Environmental Conservation, 205 N Belle Mead Rd, Ste 1, East Setauket, NY 11733*

North Atlantic right whale (NARW) occurrence and distribution were studied in the New York Bight (NYB) during monthly aerial surveys (49,514 km of observations) in March 2017-February 2018, as part of a NY State Department of Conservation (NYSDEC) Large Whale Monitoring Aerial Survey project. The NYB survey area (43,449 km$^2$) extends from the southern Long Island shoreline just past the continental shelf break, matching NY's Offshore Planning Area (OPA). Eight sightings of 13 individual NARWs were made. The sighting rate was 0.26 NARW individuals/1,000 km of effort and an initial density was obtained (0.184) through line-transect analysis. Mean group size was 1.63 (S.D. 0.52). NARWs were sighted during 5 months (November-April; none during May-October). Sighting rates were highest during spring, followed by winter and fall, with none seen during summer. The eight NARW sightings were distributed throughout the survey area in relatively shallow shelf waters ~10-100 km from the closest shoreline of Long Island, with none past the 200 m isobath. All were observed traveling. Photographs (n=241) and metadata obtained on each NARW were sent to the New England Aquarium (NEAq) Catalog for photo-identification matching analysis. NEAq confirmed individual re-identification of 3 individuals: two sightings in March and one in January. In March, both whales sighted were previously-identified reproductive females: Eg #1970 (28 years old) and #3020 (first sighted in 2000). NARWs photographed from April and November 2017 and February 2018 were new to the catalog. The January 2018 whale #2160 had recent, severe entanglement scars. The February 2018 whale, not previously identified, was estimated to be 2–3 years old. This is the first year of an ongoing three-year study focused on understanding spatio-temporal occurrence, distribution and habitat-use patterns of the Endangered NARW and other large endangered or threatened whale species in the NYB.

**Aerial survey based large whale, including right whale, surveys in the New York Bight by the New York State Department of Environmental Conservation (NYSDEC), conducted by Tetra Tech with support from Smultea Sciences and Aspen Helicopters.**
**Year 1, March 2017 – February 2018**

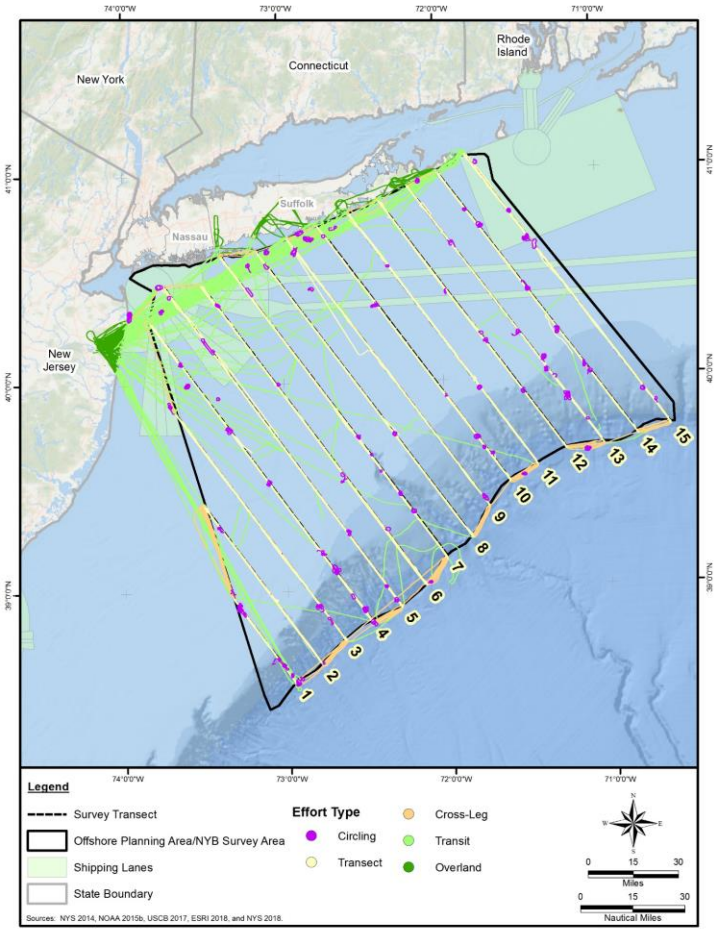



Figure 11. Year 1 Survey Lines Flown by Effort

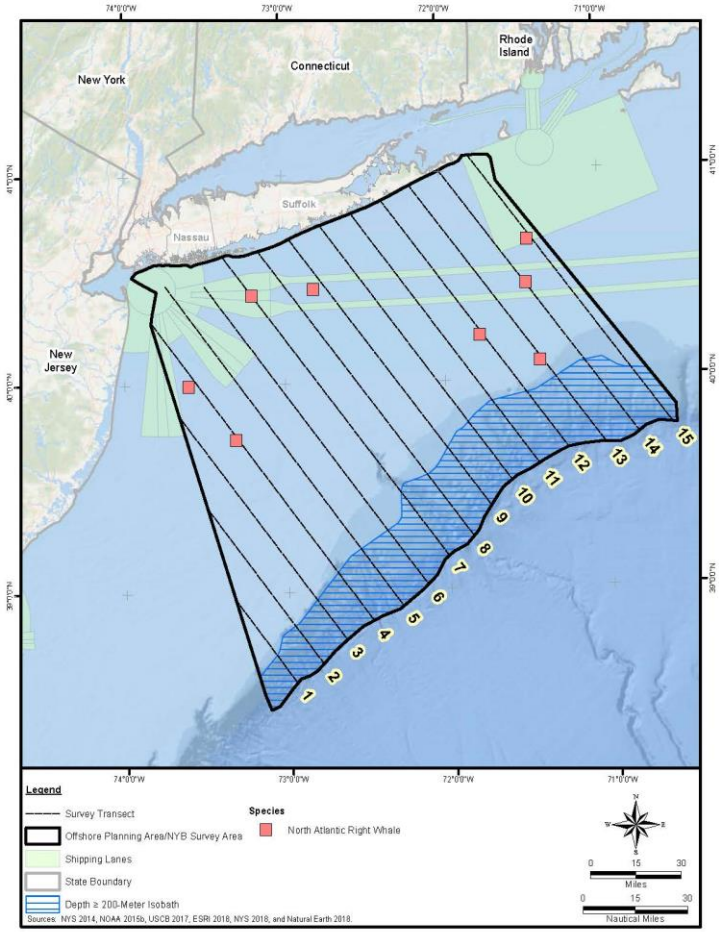
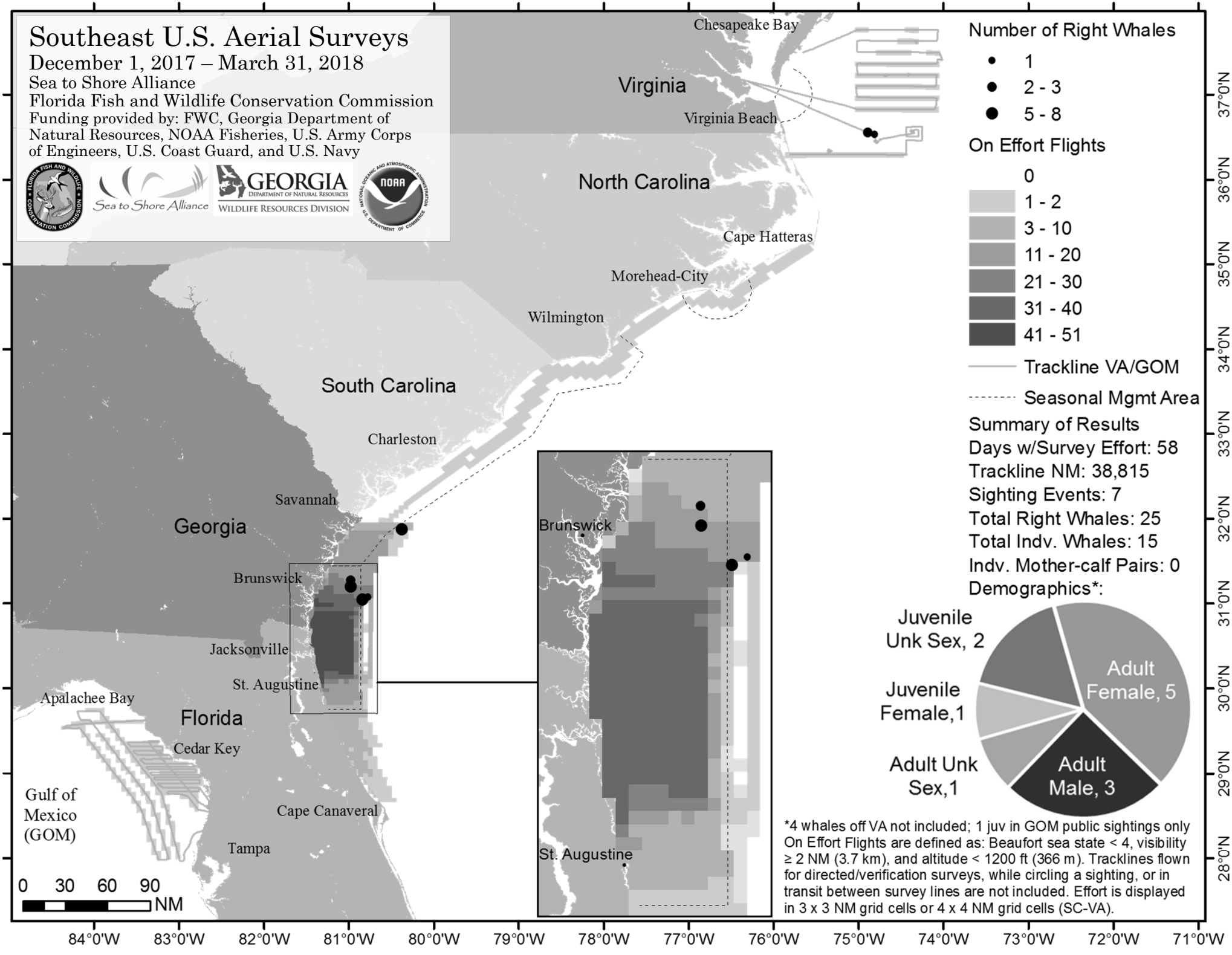



Figure 32. Locations of All North Atlantic Right Whale Sightings

Surveys are flown monthly at 1000 feet. A total of eight sightings (estimated 13 total individuals) of North Atlantic right whales were recorded. North Atlantic right whales were observed during winter (two whales in January and one whale in February), spring (three whales in March and five whales in April) and two whales during fall (November). No North Atlantic right whale sightings occurred during summer months. Sighting rates for North Atlantic right whales were highest during spring (0.69 whales/1,000 km effort) followed by winter (0.24 whales/1,000 km effort) and fall (0.13 whales/1,000 km effort). All North Atlantic right whales were observed exhibiting Travel behavior; eight whales exhibited Rest/Slow Travel; three whales exhibited Medium Travel; and two whales exhibited Fast Travel.

***Survey team:***
Kate Lomac MacNair, Mari Smultea, Mitch Poster, Matt Esposito, Andrew Buchy, Ann Zoidis. Aircraft and pilots provided by Aspen Helicopters.
***Funding provided by:*** NYSDEC ***Maps provided by:*** Tetra Tech
***Software provide by:*** Mysticetus, Inc.


Southeast U.S. Aerial Surveys
December 1, 2017 – March 31, 2018
Sea to Shore Alliance
Florida Fish and Wildlife Conservation Commission
Funding provided by: FWC, Georgia Department of Natural Resources, NOAA Fisheries, U.S. Army Corps of Engineers, U.S. Coast Guard, and U.S. Navy
Sea to Shore Alliance
GEORGIA
DEPARTMENT OF NATURAL RESOURCES
WILDLIFE RESOURCES DIVISION
NOAA
Chesapeake Bay
Virginia
Virginia Beach
North Carolina
Cape Hatteras
Morehead-City
Wilmington
South Carolina
Charleston
Savannah
Georgia
Brunswick
Jacksonville
St. Augustine
Apalachee Bay
Florida
Cedar Key
Gulf of Mexico (GOM)
Cape Canaveral
Tampa
0 30 60 90
NM
Number of Right Whales
1
2 - 3
5 - 8
On Effort Flights
0
1 - 2
3 - 10
11 - 20
21 - 30
31 - 40
41 - 51
Trackline VA/GOM
Seasonal Mgmt Area
Summary of Results
Days w/Survey Effort: 58
Trackline NM: 38,815
Sighting Events: 7
Total Right Whales: 25
Total Indv. Whales: 15
Indv. Mother-calf Pairs: 0
Demographics*:
Juvenile Unk Sex, 2
Adult Female, 5
Juvenile Female,1
Adult Unk Sex,1
Adult Male, 3
*4 whales off VA not included; 1 juv in GOM public sightings only
On Effort Flights are defined as: Beaufort sea state < 4, visibility ≥ 2 NM (3.7 km), and altitude < 1200 ft (366 m). Tracklines flown for directed/verification surveys, while circling a sighting, or in transit between survey lines are not included. Effort is displayed in 3 x 3 NM grid cells or 4 x 4 NM grid cells (SC-VA).
37°0'N
36°0'N
35°0'N
34°0'N
33°0'N
32°0'N
31°0'N
30°0'N
29°0'N
28°0'N
84°0'W
83°0'W
82°0'W
81°0'W
80°0'W
79°0'W
78°0'W
77°0'W
76°0'W
75°0'W
74°0'W
73°0'W
72°0'W
71°0'W

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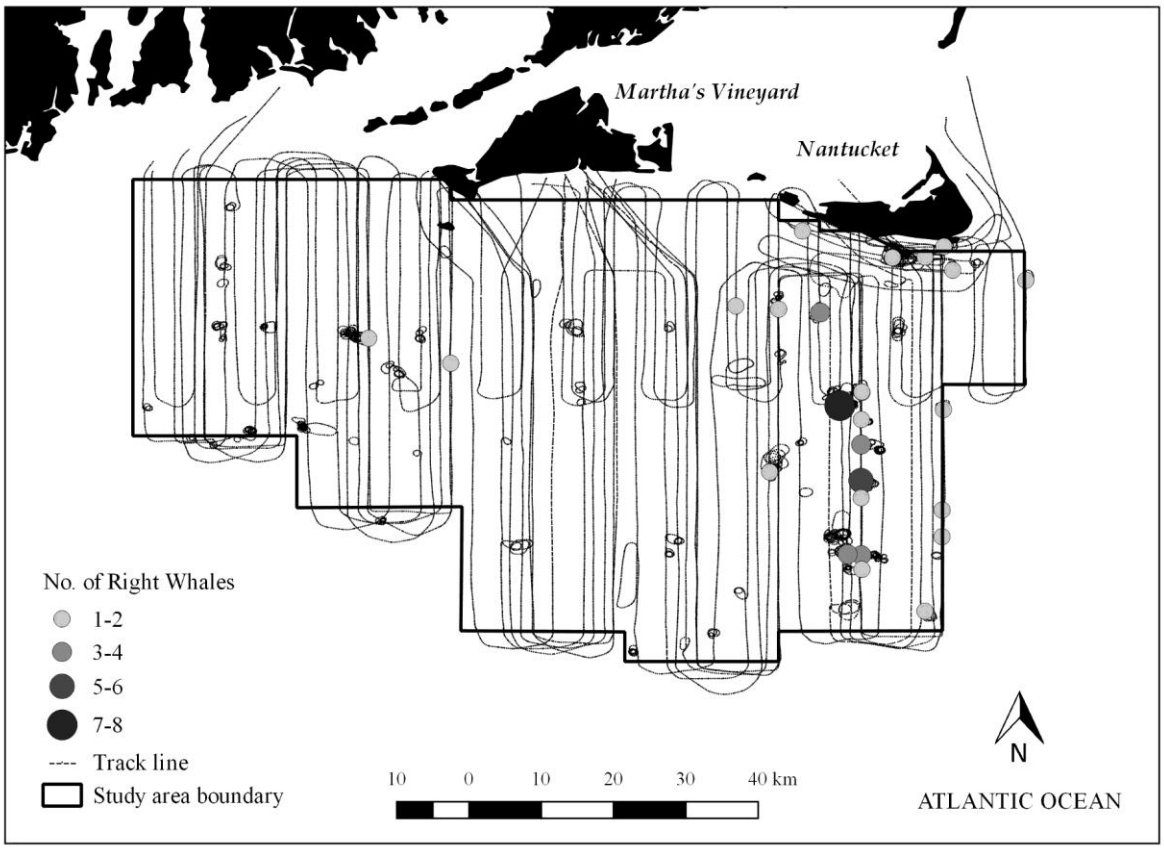
Anderson Cabot Center for Ocean Life
at the New England Aquarium

**Right whale sightings recorded during aerial surveys conducted in the wind energy areas off Massachusetts and Rhode Island by the Anderson Cabot Center for Ocean Life at the New England Aquarium**

January to July 2018



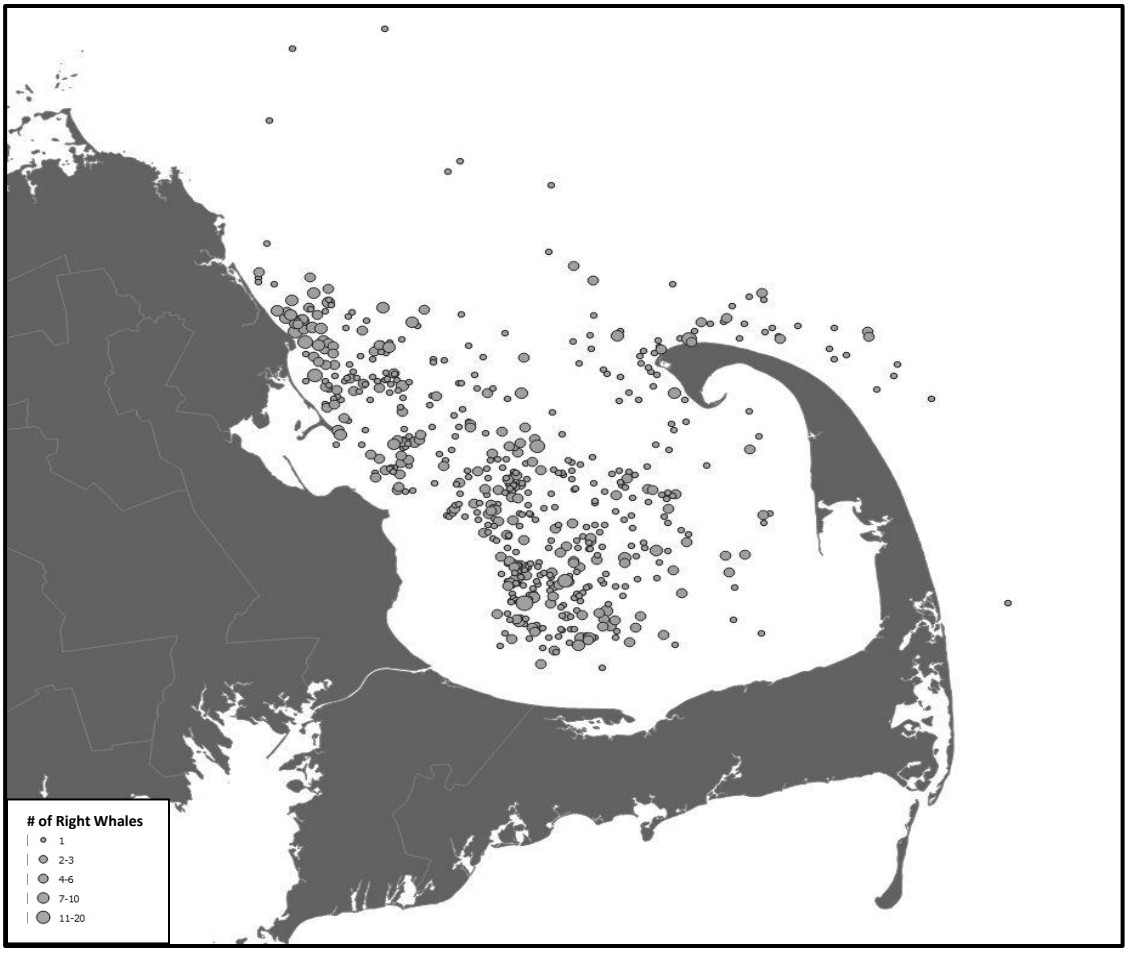

Survey effort and results: 61 right whales were observed.

| Month | General surveys | | | Supplementary surveys | | |
|---|---|---|---|---|---|---|
| | Total | HOBBS hours | Km | Total | HOBBS hours | Km |
| January | 1 | 6.9 | 986.93 | NA | | |
| February | 1 | 7.1 | 1,031.56 | NA | | |
| March | 1 | 6.7 | 1,018.79 | 1 | 4.6 | 880.63 |
| April | 1 | 6.1 | 997.67 | 2 | 7.0 | 1,176.76 |
| May | 1 | 6.9 | 1,028.79 | NA | | |
| June | 1 | 7.6 | 1,035.82 | NA | | |
| July | NA | | | 1 | 2.2 | 395.96 |
| Total | 6 | 41.3 | 6,099.56 | 4 | 13.8 | 2,453.35 |

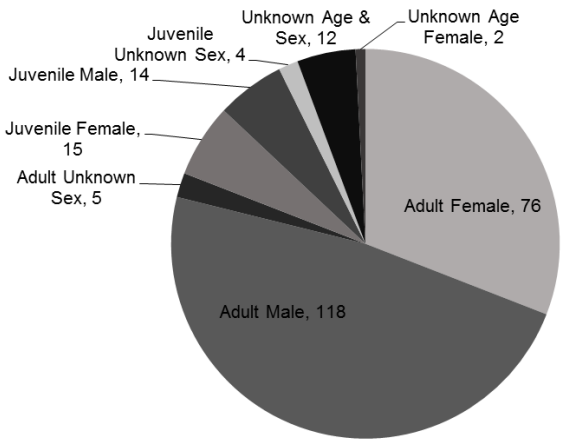
Survey team: Chief scientist: Ester Quintana; Observers: Paul Nagelkirk and Marianna Hagbloom.
Funding sources: Massachusetts Clean Energy Center and the Bureau of Ocean Energy Management.

# Center for Coastal Studies
# Right Whale Ecology Program
# Aerial Surveys

Stormy Mayo, Amy James, Brigid McKenna, Alison Ogilvie,
Lauri Leach, Christy Hudak, Lauren Goodwin

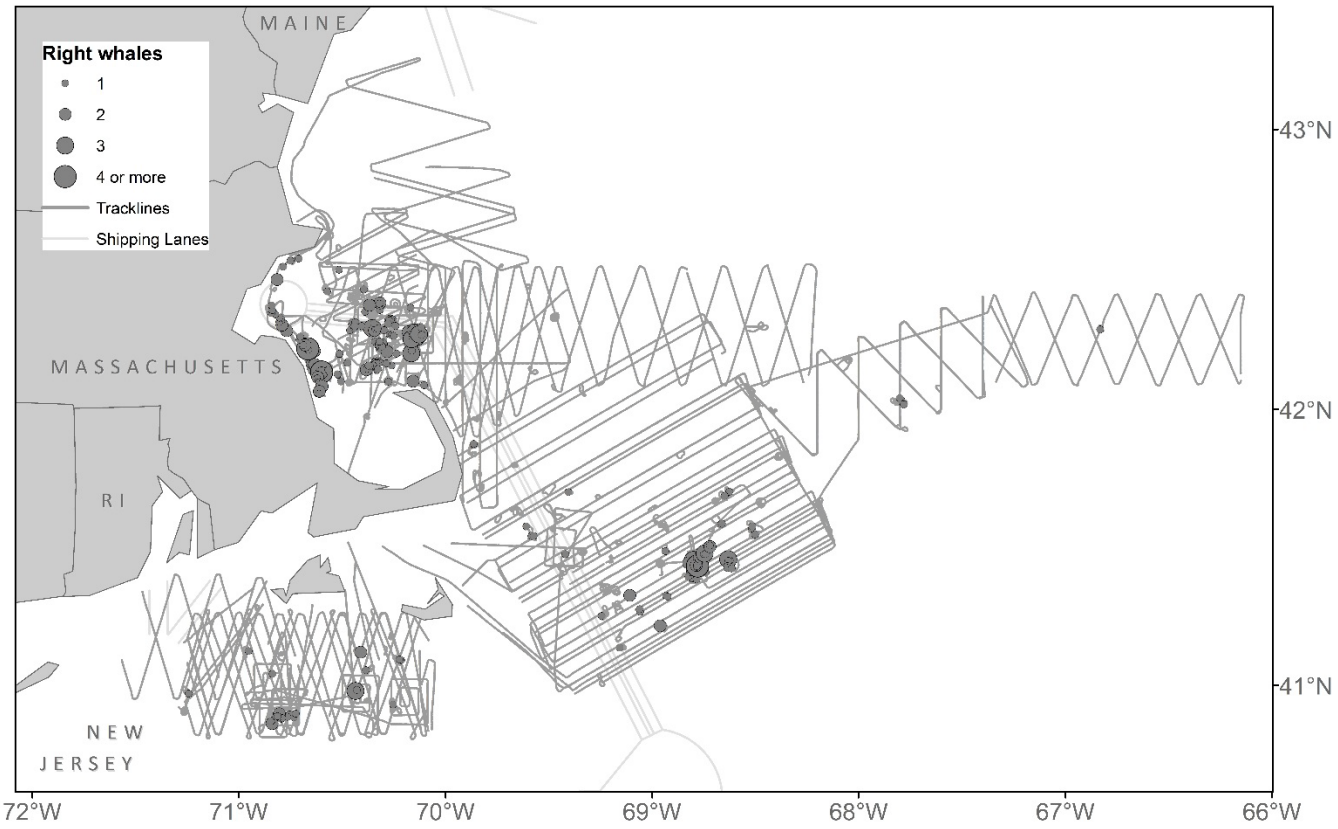



- Conducted 29 flights from January 6, 2018 – May 14, 2018 aboard Cessna Skymaster
- Surveyed 7,410 nautical miles in Cape Cod Bay and adjacent waters
- Peak of the 2018 season was on the April 27th flight with 137 individuals documented
- Sighted at least 246 individual right whales throughout the season (including all CCS platforms)



# North Atlantic Right Whale Sighting Survey

Northeast Fisheries Science Center
United States Surveys
March – May 2018



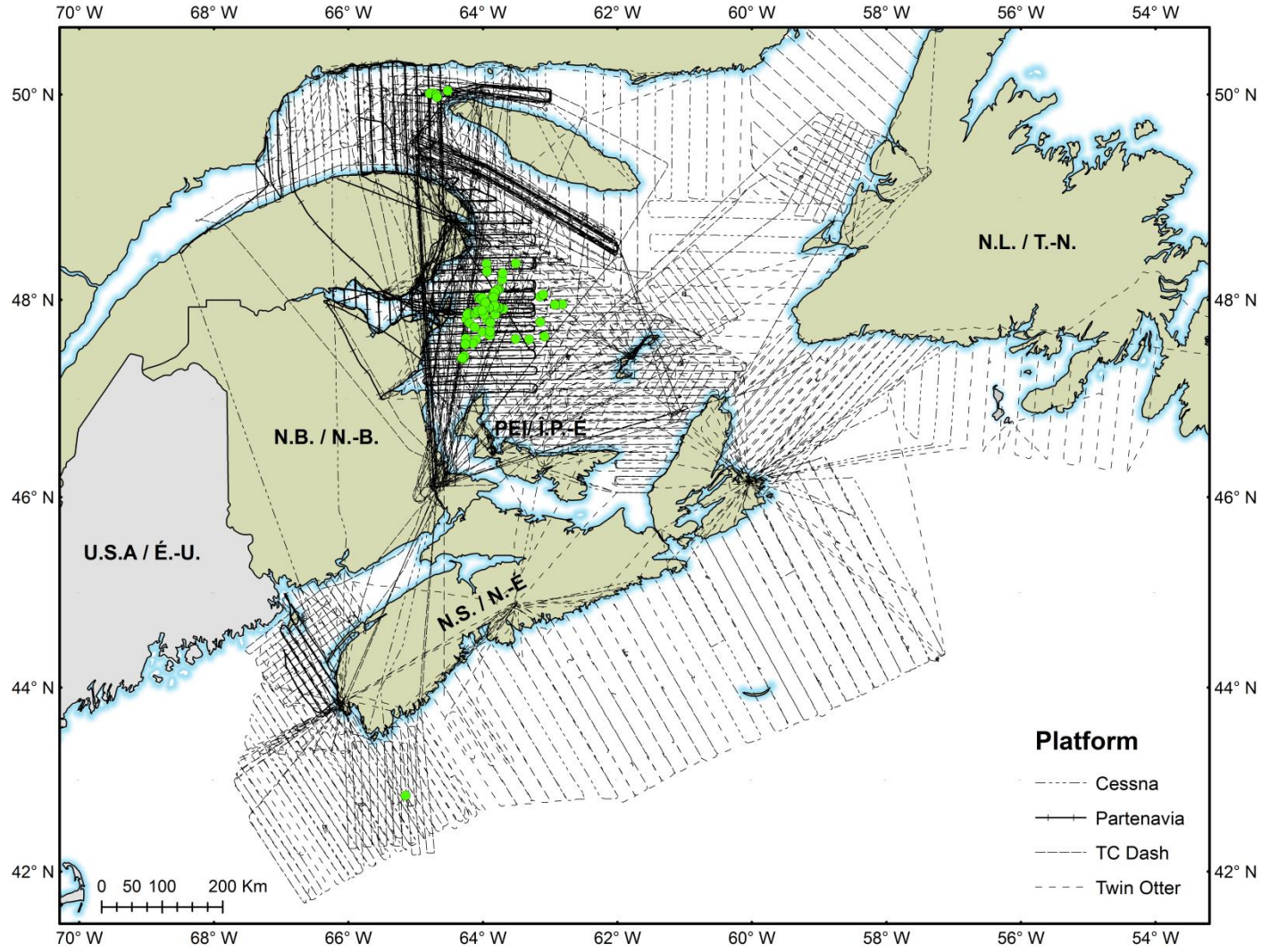

- Completed surveys aboard the NOAA Twin Otter from March 20 through May 30
- Total flight time (including transits) was 149.3 hours
- Observed right whales on 22 of the 29 survey days
- Sighted 410 right whales (including repeats of individuals) with maximum aggregation size of 36
- Resighted 22 whales being monitored for health
- Matched 208 unique individuals including:

| | Adults | Juveniles | Calves | Unknown age |
|---|---|---|---|---|
| Females | 63 | 11 | 0 | 0 |
| Males | 106 | 10 | 0 | 0 |
| Unknown gender | 6 | 1 | 0 | 11 |

Fisheries and Oceans Canada
Pêches et Océans Canada

Transport Canada
Transports Canada

# Aerial marine mammal surveys in Canadian waters conducted by Fisheries and Oceans Canada and Transport Canada




## Platforms

**DFO Twin Otter**
03 Apr – 10 Oct
Survey days = 92
NARWs observed = 90
Surveys Ongoing

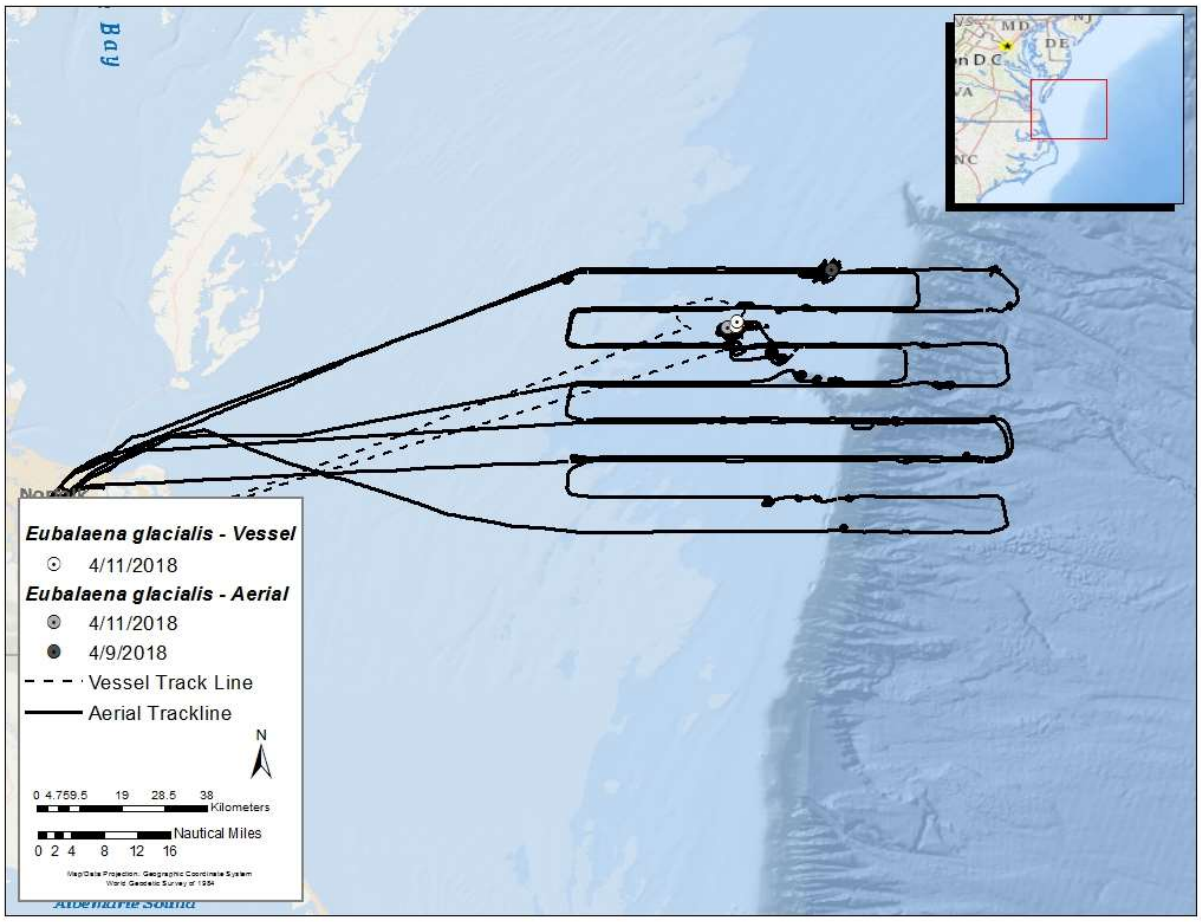
**DFO Cessna 337**
19 May – 31 Aug
Survey days = 15
NARWs observed = 15

**DFO Partenavia**
21 Apr – 15 May
Survey days = 11
NARWs observed = 0

**TC Dash 7 and Dash 8**
15 Jan – 10 Oct
Survey days = 50
NARWs observed = 17
Surveys Ongoing

*NARWs observed = number of animals observed; not all animals were photographed and photo-identifications have not been completed for all flights.

HDR Inc. *Eubalaena glacialis* sightings during aerial transect surveys and vessel surveys - April 2018




| Date | Survey Type | Trackline distance (km) | # Sightings | Total # Individuals | ID-ed Individuals |
|---|---|---|---|---|---|
| 4/9/2018 | Aerial | 344 | 1 | 5 | 3343, 3350, 3611, 3714, 4120 |
| 4/11/2018 | Aerial | 685 | 1 | 3 | 2602, 3360, 3714 |
| 4/11/2018 | Vessel | 275.9 | 2 | 2 | 2602, 3360 |

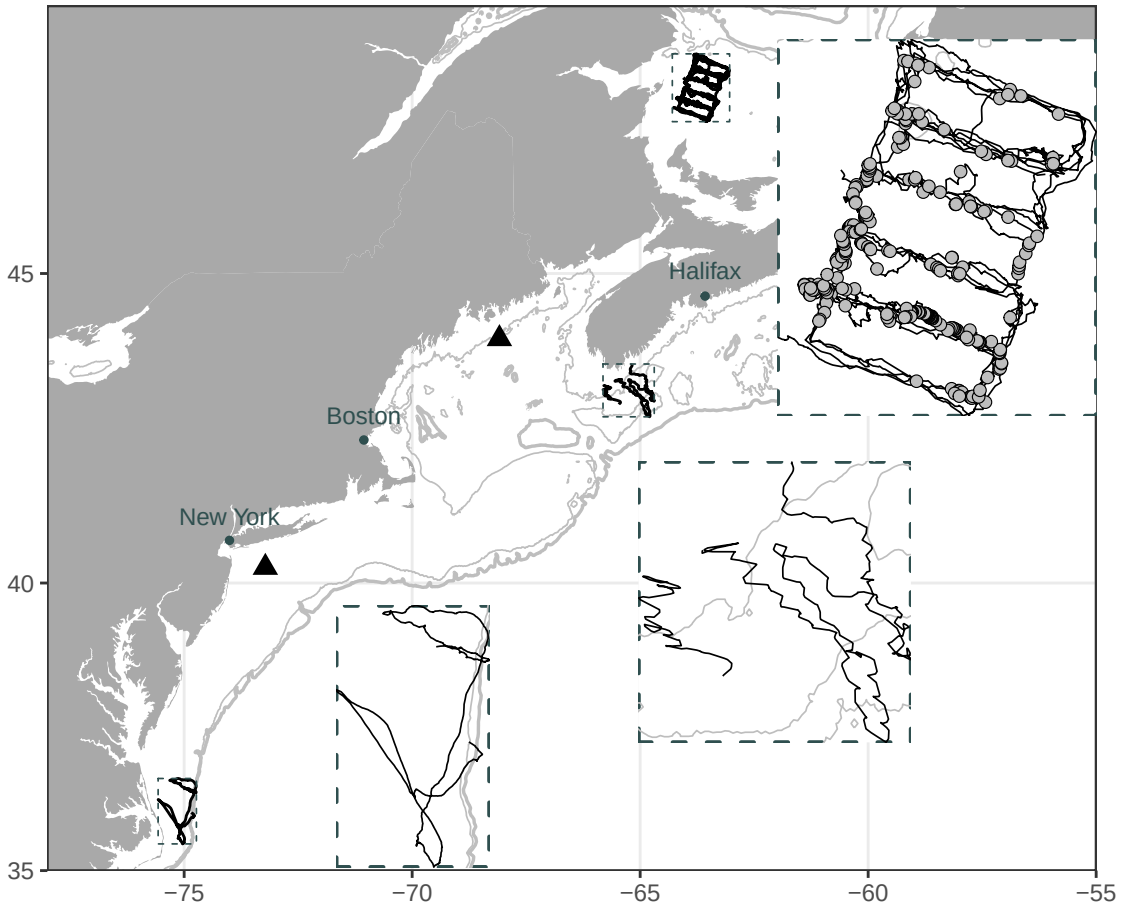
Aerial Survey Team: Mark Cotter and Todd Pusser

Vessel Survey Team: Jessica Aschettino, Dan Engelhaupt, Amy Engelhaupt, and Michael Richlen

This project is funded by U.S. Fleet Forces Command and managed by Naval Facilities Engineering Command Atlantic (NAVFAC LANT) as part of the U.S. Navy's marine species monitoring program.

Research conducted under National Marine Fisheries Service Scientific Research Permit No. 16239, issued to Dan Engelhaupt / HDR.

# Near real-time passive acoustic monitoring for right whales




*Slocum glider tracks and moored buoy positions are shown as black lines and triangles, respectively. Inset maps show glider tracks in greater detail, with grey circles indicating locations of definite detections.*

| Platform | Name | Region | Start Date | End Date | Days | Track Distance [km] | Detections |
|---|---|---|---|---|---|---|---|
| slocum | fundy | Gulf of St Lawrence | Jun-09 | Jul-18 | 39 | 669 | 18 |
| slocum | dal556 | Gulf of St Lawrence | Jun-10 | Sep-30 | 112 | 1658 | 66 |
| slocum | scotia | Gulf of St Lawrence | Jul-20 | Sep-13 | 55 | 677 | 141 |
| slocum | fundy | Gulf of St Lawrence | Sep-13 | Ongoing | 32 | 527 | 51 |
| slocum | otn200 | Roseway Basin | Aug-15 | Sep-07 | 23 | 498 | 0 |
| slocum | otn200 | Roseway Basin | Sep-18 | Sep-22 | 4 | 176 | 0 |
| slocum | we03 | Mid-Atlantic Bight | Feb-22 | Mar-17 | 23 | 411 | 0 |
| buoy | nybight | New York Bight | Feb-13 | Ongoing | 244 | NA | 7 |
| buoy | mdr | Gulf of Maine | Oct-04 | Ongoing | 11 | NA | 0 |

**TOTAL: 9 deployments, 543 days, 4616 kilometers, 283 detections**

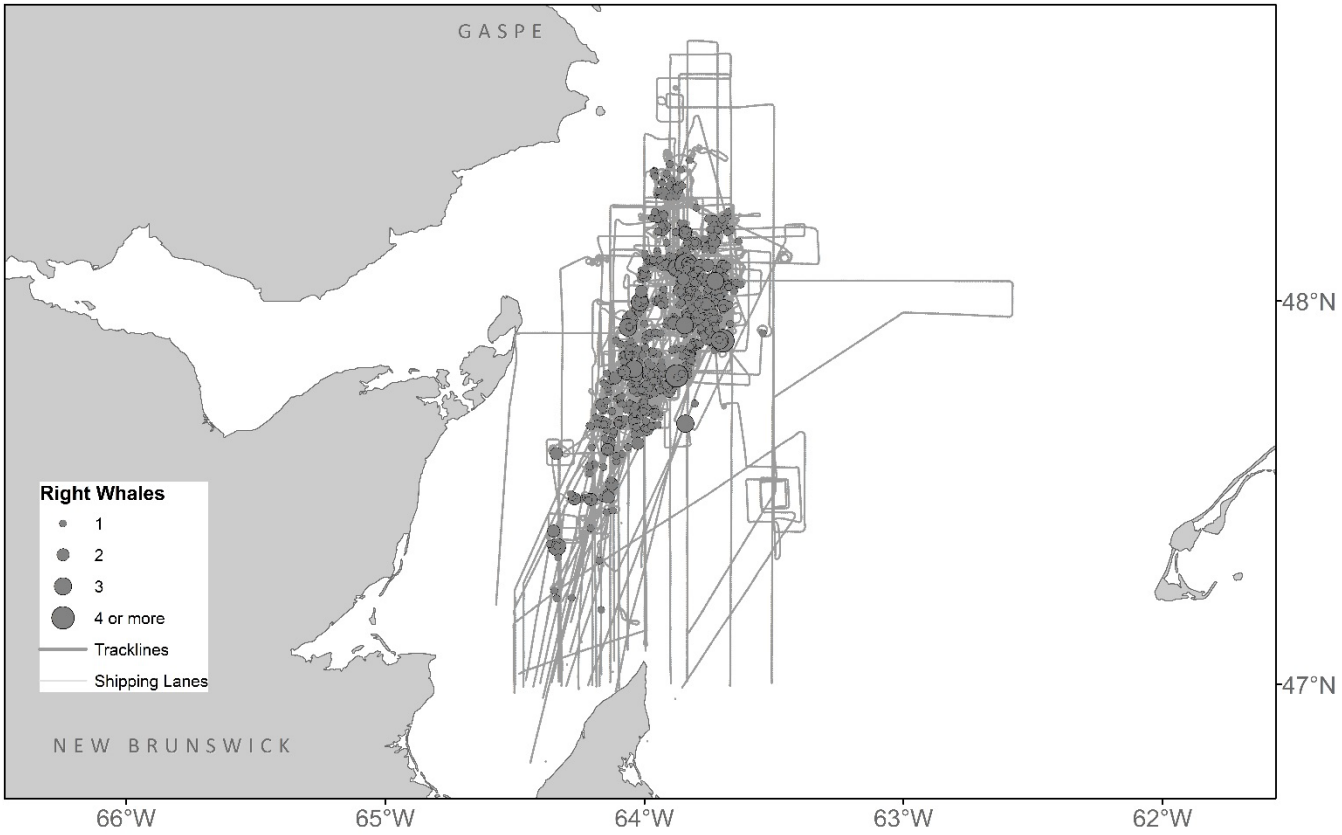
Data were collected by Dalhousie University and the Woods Hole Oceanographic Institution (WHOI) in collaboration with the Ocean Tracking Network (OTN), NOAA Northeast Fisheries Science Center (NEFSC), Wildlife Conservation Society, and others. Support was provided by WHOI, OTN, NEFSC, the Marine Environmental Observation Prediction and Response Network, Fisheries and Oceans Canada, the World Wildlife Federation, Canadian Steamship Lines, the Benioff Ocean Institute, the G Unger Vetlesen Foundation, and Naval Facilities Engineering Command Atlantic. Further information available at http://dcs.whoi.edu/.

# North Atlantic Right Whale Sighting Survey

Northeast Fisheries Science Center

Canadian Surveys

June – August 2018




- Completed surveys aboard the NOAA Twin Otter from June 4 through August 12
- Total flight time (including transits) was 152.5 hours
- Observed right whales on all 27 of the 27 survey days
- Sighted 898 right whales (including repeats of individuals) with maximum aggregation size of 62
- Resighted 25 whales being monitored for health
- Matched 135 unique individuals including:

| | Adults | Juveniles | Calves | Unknown age |
|---|---|---|---|---|
| Females | 37 | 5 | 0 | 1 |
| Males | 66 | 10 | 0 | 0 |
| Unknown gender | 4 | 2 | 0 | 10 |

New England Aquarium

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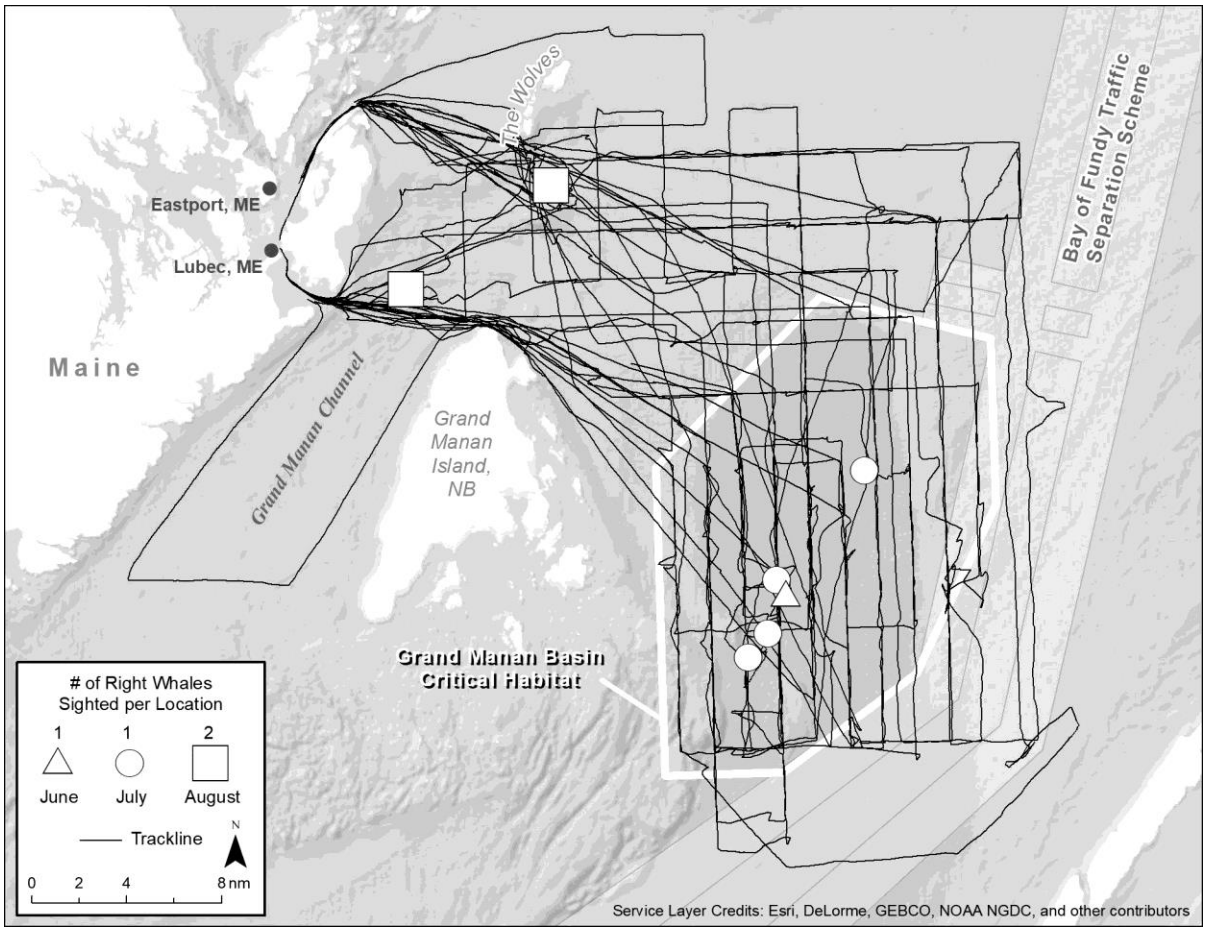
Anderson Cabot Center for Ocean Life at the New England Aquarium

# Vessel-based right whale surveys in the Bay of Fundy by the Anderson Cabot Center for Ocean Life at the Ne w England Aquarium




| Month | No. of survey days | Track line miles | No. of right whale sighting events | No. of right whales | No. of unique individuals |
|---|---|---|---|---|---|
| **June** | 3 | 318.8 | 1 | 1* | N/A |
| **July** | 5 | 391.1 | 4 | 4 | 3 |
| **August** | 7 | 678.8 | 2 | 4 | 2 |
| **September** | 6 | 492.9 | 0 | 0 | 0 |
| **Total** | 21 | 1,881.6 | 7 | 9 | 5 |

*Not individually identified/not included in total count of individuals.

| Right Whale No. | Sex | Age |
|---|---|---|
| #3150 | M | 17 |
| #3570 | M | 8 |
| #3701 | M | 11 |
| #3843 | M | 10 |
| #3991 | F | 9 |

**Survey team:** Johanna Anderson, Moe Brown, Marianna Hagbloom, Philip Hamilton, Kelsey Howe, Celia Jellison, Amy Knowlton, Marilyn Marx, Anne McGhie, Megan McOsker, Brigid McKenna and Heather Pettis

**Funding provided by:** Irving Oil (St. John, New Brunswick, Canada) and Island Foundation (Marion, MA, USA).

Research conducted under section 73 SARA permit issued by Department of Fisheries and Oceans Canada - permit number DFO-MAR-2016-04. Research vessel *Nereid* was operated under foreign fishing vessel license 344228. Map provided by Brooke Hodge.

Mingan Island Cetacean Study (MICS) 2018 field summary

37 days on the water (average 50) between June 11 and September 30
10,701km (13,000km average) covered in the Jacques Cartier Passage and adjacent waters

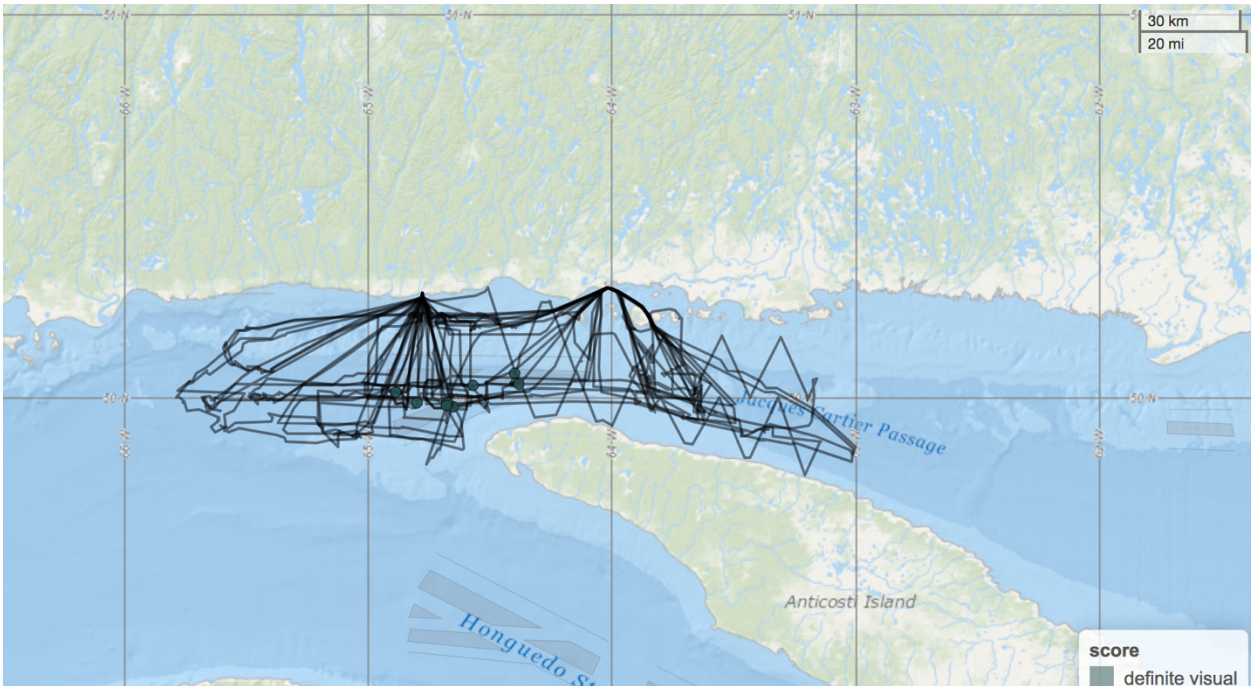


Figure 1: Boat tracks, Spatial effort (10,701km) in 2018

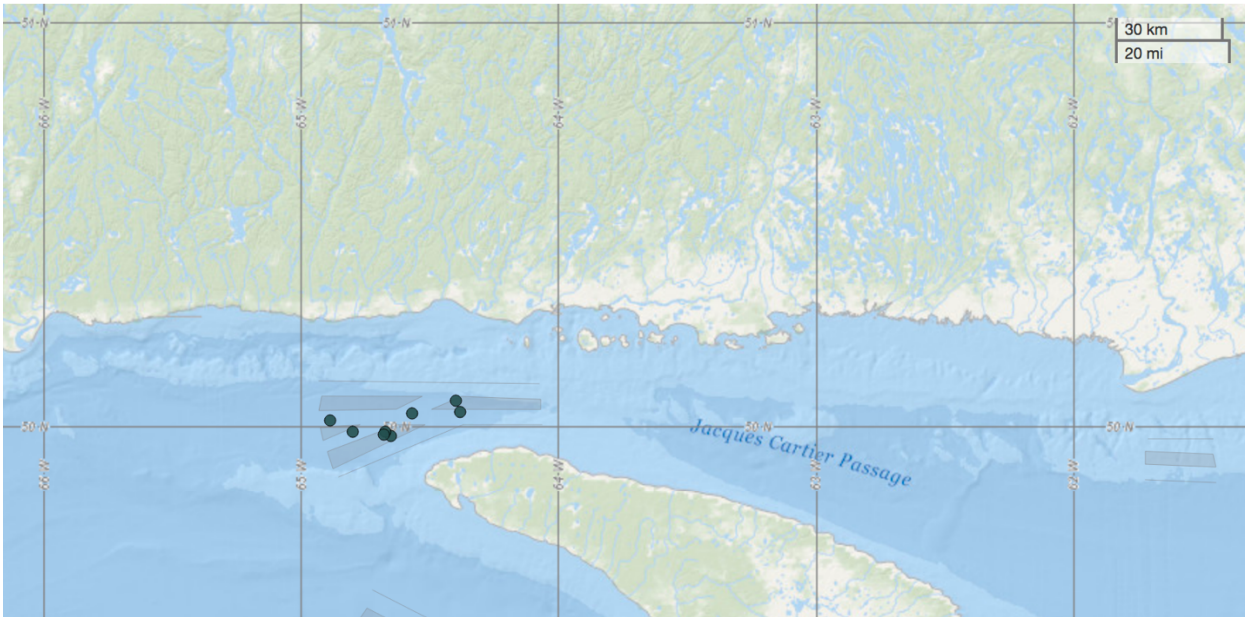


Figure 2: Right whale sightings 2018 (Maps taken from http://whalemap.ocean.dal.ca/)

Right whales were sighted on 6 days from July 19th to September 20th. Altogether 6 individuals were identified by NEAq/ACCOL. 3 stayed the entire two months.

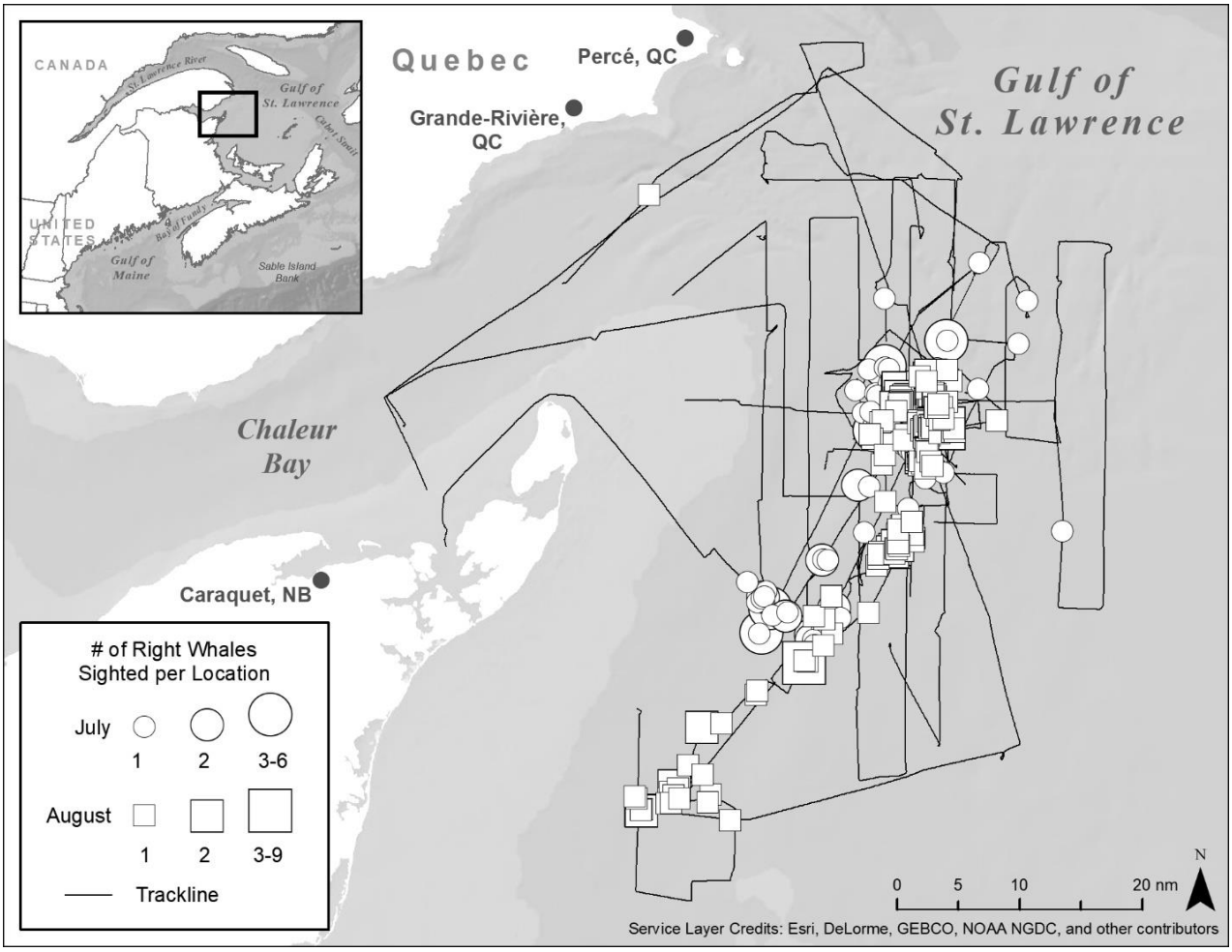
Research under SARA License QUE-LEP-003-2018

Anderson Cabot Center for Ocean Life
at the New England Aquarium

DALHOUSIE UNIVERSITY

CANADIAN WHALE INSTITUTE

# Vessel-based right whale surveys in the Gulf of St. Lawrence by Canadian Whale Institute, Dalhousie University and the Anderson Cabot Center for Ocean Life at the New England Aquarium




| | Cruise 1 | Cruise 2 | Total |
|---|---|---|---|
| Cruise Dates | July 18 – 31, 2018 | August 11 -22, 2018 | |
| No. of survey days | 12 | 11 | 23 |
| Track line Miles (nm) | 842.1 | 570.9 | 1413 |
| *No. of right whales photo-documented (not photographed) | 101 (46) | 313 (19) | 414 (65) |

*No. of right whales photo-documented is not a count of unique individuals.

**Dalhousie University** – Meg Carr, Kimberley Davies, Delphine Durette-Morin and Hansen Johnson

**New England Aquarium** - Marianna Hagbloom, Amy Knowlton, Megan McOsker and Monica Zani

**Funding provided by:** Habitat Stewardship Program of Environment and Climate Change Canada and Irving Oil.

Research conducted under section 73 SARA permit issued by Department of Fisheries and Oceans Gulf Region (permit no. DFO-GLF-2017-01) and Quebec Region (permit no. QUE-LEP-004-2018). Map provided by Brooke Hodge.

**Report from NARWC Education Committee**
**November 2018**
**Robert Rocha – Chair**

## Regional

Bob Rocha, Monica Pepe and Anne DiMonti continued to meet monthly throughout the year. We continued to work on outreach based on the *Sharing the Seas: Safe Boating for Sailors and Whales* program, which was initiated in 2016. Staff and volunteers from all three organizations worked at our booth in the One Ocean Exploration Zone at the Volvo Ocean Race. There were 31 exhibits from 24 organizations inside a huge tent at Fort Adams in Newport, RI. More than 100,000 visitors, including nearly 2,000 local school children, attended the event. The poster that event organizers created for us is on display during this conference.

A proposal to present at the National Sailing Program Symposium, Jan. 31 – Feb. 2, has been submitted.

The Education Committee's Facebook page, *Face-ing Extinction: The North Atlantic Right Whale*, has 1582 likes, an increase of 247 since the 2016 NARWC meeting.

## Florida

*Right Whale Month Proclamation*
The Mayor of Fernandina Beach, Florida, John Miller, proclaimed November as Right Whale Month in a ceremony in front of City Hall on Friday, November 2, 2018. NOAA Fisheries leadership accepted the proclamation and presented the Mayor with "Celebrate Right Whales" flags to be flown throughout the community during the month of November. At this ceremony, the Mayor also announced that Fernandina Beach will be the new location of the Right Whale Festival starting in November 2019. To request information on how to purchase a "Celebrate Right Whales" flag to fly at your business or home, contact: CelebrateRightWhalesFlag@gmail.com

*10th Annual Right Whale Festival/ Plans for the Future of the Festival*
ALL HANDS ON DECK!!! The 10th Annual Right Whale Festival was held in Jacksonville Beach, Florida on Saturday, November 3, 2018. Each fall, the Right Whale Festival celebrates the North Atlantic right whales and their annual return to the waters off Florida and Georgia. Because last year was so tragic for the right whale population, this year's festival theme was "All hands on Deck" to encourage everyone to do their part in protecting the remaining whales. The Right Whale Festival brings together non-profit organizations, artists, musicians, marine mammal scientists, as well as state and federal agencies with the common goal to raise awareness for this critically endangered species and promote ways to protect them from extinction. Attendees enjoy live music, food, kid's activities, arts & crafts, a beach clean-up, 5K run/ 1 mile walk and educational exhibits and lectures. Exhibits highlight all areas of right whale conservation, including research, volunteer opportunities, and recovery efforts. Educational activities at the festival encourage attendees of all ages to

learn more about right whales and how they can help protect them. The festival has attracted over 8000 people annually.

On November 2 & 3, 2019, the 11th Right Whale Festival will be held at a new location in Fernandina Beach, Florida. Fernandina Beach is about 30 miles north of Jacksonville Beach. For more information and updates, follow us on Facebook or visit us at:
**http://rightwhalefestival.com**

**Maine**
The Calvineers have continued to educate themselves about the current right whale situation. Not only did they attend last year's Consortium meeting but they also attended the SMM Biennial in Halifax. The many talks they attended and scientists they spoke with added to their knowledge. The Calvineers have a new PowerPoint Presentation with up to date information about right whales. The new presentation emphasizes the need for more strict regulations for fishing gear that drastically lower the risk of right whales being entangled. They are presenting at local schools this fall and will continue throughout the winter and spring.

The highlight of last year for the Calvineers was their involvement in co-hosting the New England Right Whale Festival with the Education Department at the New England Aquarium. The Calvineers had seven tables of activities for the public to partake in. One activity showed people how the weak sleeves are spliced into rope for fishing where Chloe Sheahan prepared a spool of 3/8th rope for a lucky fisherman to be announced.

**Massachusetts**
*Boston*
The 5th Annual New England Right Whale Festival was held at the New England Aquarium on May 6. Thirteen organizations hosted activities, told stories, shared information, made bones available for touching and advocated for the NARW.

*Gloucester*
*NOAA - GARFO*
We ran a summer educational/outreach program that reached over 1000 kids in underserved communities in MA and southern NH. We generally worked with Boys and Girls Clubs and Girls, Inc. We've been running the program for 4 years, but this year we reached a record number of kids reached in one summer.

The focus of the program was endangered species and showing how the health of rivers and oceans are connected, but right whales were highlighted. We had activities on bioacoustics, migration, and feeding adaptations but our newest (and most popular) activity with a right whale focus, was about disentanglement. We would entangle our inflatable right whale calf, let the kids dress in some of the gear disentanglement crew would wear, and have them "disentangle" the whale. In that activity the key talking points were about threats to right whales, how complicated entanglement issues are, and how there are many different career paths that can help protect marine wildlife.

I do believe it's the first time a whale has ever been disentangled in a conference room (we had to be flexible on a severe thunderstorm day where campers were bused to a new location).

*New Bedford*
The New Bedford Whaling Museum began printing, in 2017, an NARW story or report in its *Bulletin from Johnny Cake Hill*, the Museum's magazine. The Spring 2018 issue featured a story from Scott Kraus of the NEAq. Each story serves as an important facet of our expanding Whales Today exhibit. This exhibition will continue to feature the NARW as a central species.

The NBWM hosted its 8th annual Right Whale Celebration Day on April 16. More than 400 people attended this free event. WDC, Cheryl Lawton Malone, New England Coastal Wildlife Alliance, NOAA, and the Museum's high school apprentices all led crafts, activities, story times and set up inflatable whales, all to help bring greater awareness about the North Atlantic right whale and other marine mammals.

The Museum finished its first year of an MOA with New Bedford Public Schools to provide 'Whales – Giants of the Ocean' to all grade four classrooms in the City. A professional development workshop was held for teachers, Museum staff visited classrooms, teachers led activities in their classroom and the classes visited the Museum for a two hour program that focused on various aspects of whale biology, feeding and communication.

*Plymouth*
WDC hosted the first New England Whale Festival in Quincy, MA on July 15. The focus was marine conservation and boater education, with special attention given to understanding whales in our coastal waters.

WDC created a NARW Story Map for one of our campaigns that can be found here: https://www.arcgis.com/apps/Cascade/index.html?appid=feee6f70237d42d7b10363893809038b

Through our Whale SENSE program, around 200 whale watch operators and naturalists received annual training, which included information on right whale approach regulations, basic biology, and recent research.

WDC's inflatable right whale, Delilah, visited nearly 800 school students in 2018.

*Provincetown*
The Center for Coastal Studies hosted WHALE WEEK from July 29 – August 4. The activities included a 5K run, family activities, lectures, guided walks and a home-made boat race.

**NORTH ATLANTIC RIGHT WHALE CONSORTIUM**
**November 7-8, 2018**

ANNUAL MEETING STUDENT ROUNDTABLE RESEARCHER PROFILES

**Tim Cole** is a biologist with NOAA Fisheries Northeast Fisheries Science Center in Woods Hole, MA. Tim leads NOAA's Northeast right whale aerial survey team. His work focuses on right whale population monitoring and integrating conservation tools for US Coast Guard operations. He is currently involved in assessing different visual and acoustic methods for monitoring for right whales in the US and Canada.

**Sean Hayes** became Chief of the Protected Species Branch, NOAA NEFSC in 2016. As Branch Chief, Sean works with Branch and center staff to support sound science geared at quantifying the relative impacts of various limiting factors preventing the recovery of endangered species, as well continued ecological research, population assessment and study of anthropogenic impacts such ocean noise and bycatch on protected marine species. Sean believes the principal goal of the Protected Species Branch science is to further our understanding of our animals and their ecological needs/challenges in order to remove the ambiguity around areas of stake holder concern. Whether clarifying the relative impact of shipping, fishing or climate change on endangered species, or understanding the impacts of recovering pinnipeds on a food web that includes human consumers, PSB's purpose is to enable managers and stakeholders to make scientifically informed decisions towards sustainable human uses of marine resources in the North Atlantic.

**Hansen Johnson** is PhD student at Dalhousie University, and a guest student at the Woods Hole Oceanographic Institution where he works with Dr. Chris Taggart and Dr. Mark Baumgartner respectively. Hansen studies baleen whale acoustics and habitat ecology in the Northwest Atlantic. A few research projects he's currently involved in include quantifying right whale acoustic detection range, characterizing right whale habitat in the Gulf of St Lawrence, and developing online tools to collate and disseminate baleen whale survey information (whalemap.ocean.dal.ca)

**Michael Moore** grew up in England, where he trained as a veterinarian. He began his career as a marine mammalogist in Newfoundland and the Caribbean. Dr. Moore then moved to New England. He spent two years as a veterinary clinician, before moving to Woods Hole in 1985, where he was first at the Marine Biological Laboratory and then at the Woods Hole Oceanographic Institution (WHOI). His research includes man-made impacts on marine vertebrates such as anthropogenic trauma on right whales and other marine mammals. He is now a Senior Scientist at WHOI. He is also a consulting veterinarian for the International Fund for Animal Welfare, which responds to single and mass strandings of marine mammals on Cape Cod.

**Lyne Morissette**
Lyne Morissette is an ecologist specialized in the marine mammal ecology and ecosystem functioning, using different approaches (from field work to ecosystem modeling) to study the structure and function of marine system in order to ensure their conservation and long-term

sustainability. She holds a Ph.D. in marine ecology from the Fisheries Center at the University of British Columbia, and has two postdocs: one in marine mammal conservation at Arizona State University and another one in biodiversity from University of Guelph, which provides her a world-renowned expertise in marine mammal ecology, fisheries science, and ocean conservation. She has published her work in the most prestigious journals such as Science and Nature, mostly on topics such as marine mammals - fisheries interactions, food webs, and migrations of large cetaceans in the Atlantic. As an environmental mediator, she serves on a number of advisory committees related to marine mammals and fisheries in different countries. Dr. Morissette is highly involved and well respected in the fishing communities and have ongoing projects and partnerships with many Canadian fishing associations. She is also committed in the entanglement group of Québec Marine Mammal Emergency Network (RQUMM). Finally, she has great outreach skills and she is developing many education programs for schools, tv shows, and documentaries in North America. In all her projects, she advocates an approach that links research, conservation, education and partnership with industry as the best way to manage and protect the oceans for future generations. Lyne is highly dedicated to right whale fired work and research in the Gulf of St. Lawrence. She is developing for 2019-2020 an important concertation program on right whale conservation for the GSL, involving research, management, conservation, socioeconomics, and in concertation with scientists, the industry, managers, and environmental groups. She served a 3-year mandate at the NARWC.

**Capt. Richard Riels** is the Executive Director/VP of Research and Development, SMELTS.org. He is an engineer, trained member NOAA large whale disentanglement team, and a member of the Pinniped Entanglement Group (PEG). Additionally, he invented the Lobster Raft/Crab Raft, Line-Less fishing technology to end entanglement of marine life in active bottom set fishing gear.

**Dave Steckler** is an inventor, coder and high-tech entrepreneur. His lifelong focus has been the creation of technology to drive real change for humanity and this pale blue dot we live on. After obtaining a computer science degree sometime around the Pleistocene epoch, Dave has spent his career alternating between shoestring-budget software startups and well-funded computer science organizations. In the 1990's his startup invented modern computerized navigation of boats. In the 2000's, he was member of a small team in Microsoft Research pioneering big-data/small-device innovations that lead to systems such as Microsoft Cortana and Apple Spotlight. His current startup is Mysticetus - where he has created a comprehensive set of modern tools for marine mammal biologists to gather data from land, sea, air and space; analyze their data using a custom GIS; and coordinate/manage/share these activities over the internet. Most recently, he added a number of instantaneous, automatic data-sharing options to Mysticetus to help mitigate potential impacts of wind farm construction on North Atlantic Right whales. Dave does not know his astrological sign, owns six dogs and one horse, thinks non-mouser cats are "meh", and is easily distracted if you start talking about awesome things like laser particle/wave duality, sub-orbital drones, and/or gaited horses.

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