North Atlantic Right Whale Consortium Annual Meeting

27-28 October 2020

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NARWC
THE NORTH ATLANTIC RIGHT WHALE CONSORTIUM

North Atlantic Right Whale Consortium

Annual Meeting

27-28 October 2020

The times list below indicate timing for the live Q&A sessions with those who have uploaded pre-recorded presentations to the meeting site. Meeting participants will receive a unique site login code and should view these presentations in advance of the meeting. Participants may submit questions/comments for presenters both in advance and during the meeting. The six digit number preceding the presentation title corresponds to the video number on the meeting site. During the meeting, all "presenters" listed within a session will be together live on screen with a moderator to answer pre-submitted and live questions. There will be no live presentations during the meeting.

27 OCTOBER 2020

1000AM **Keynote/Opening:** *Scott Kraus, NARWC Chair*

1015AM **<u>Session 1: Species status and management update</u>**

- **01.01.01:** **North Atlantic Right Whale Catalog Update, Recent Genetic Findings, and Whale Naming Results:** *Philip Hamilton*
- **01.01.02:** **Mortality update:** *Sarah Sharp*
- **01.01.03:** **Entanglement/injury update:** *Scott Landry, Heather Pettis, Allison Henry*
- **01.01.04:** **Fisheries and Oceans Canada: an update on research and monitoring activities for North Atlantic right whales:** *Angelia Vanderlaan*
- **01.01.05:** **Fisheries and Oceans Canada (DFO) update on North Atlantic right whale management measures:** *Adam Burns and Melissa Landry*
- **01.01.06:** **Transport Canada management update:** *Michelle Sanders*
- **01.01.07:** **US management update:** *Colleen Coogan*
- **01.01.08:** **Unusual Mortality Event:** *Deborah Fauquier*

1115AM **Break**

1130AM **<u>Session 2: Anthropogenic Events and Mitigation</u>**

- **01.02.01:** **Ropeless Consortium Meeting Summary**: *Sean Brillant*
- **01.02.02:** **Simulated performance of lobster fishing gear under different gear configurations:** *Amy Knowlton*
- **01.02.03:** **Right whales in shallow waters: a case-study on coastal lobster fishing grounds:** *Lyne Morissette*

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***Time listed are EDT**

- **01.02.04: In the path of North Atlantic right whales: Perspectives of an offshore wind developer:** *Laura Morse*
- **01.02.05: Automatic whale detection from vessels for real-time ship-strike mitigation – current developments and applicability:** *Daniel Zitterbart*
- **01.02.06: Protected species observer (PSO) detections of NARW; significant events for the greater good:** *Craig Reiser*
- **01.02.07: Multi-agency emergency intervention to an injured North Atlantic right whale (*Eubalaena glacialis*) calf**: *Hendrik Nollens*
- **01.02.08: Effectiveness of speed restrictions to protect North Atlantic right whales from ship strikes within Charleston South Carolina and Savannah Georgia Seasonal Management Areas:** *Jon Lang*

1230PM Lunch

100PM **<u>Session 3: Demographics</u>**

- **01.03.01: Incorporating recovery into mark-recapture: another approach to the estimation of abundance and demographic parameters:** *Joshua Reed*
- **01.03.02: Estimation of North Atlantic right whale reproductive dynamics while accounting for uncertainty in female reproductive states:** *Nathan Crum*
- **01.03.03: Estimating the population size of the North Atlantic right whale:** *Vitor Dos Anjos*
- **01.03.04: North Atlantic right whale monitoring and surveillance: report and recommendations of the National Marine Fisheries Service's Expert Working Group:** *Paul Wade*

145PM Break

200PM **<u>Session 4: Distribution</u>**

- **01.04.01: Stable isotope analysis of baleen from North Atlantic right whale (*Eubalaena glacialis*) reflects distribution shift to the Gulf of St. Lawrence:** *Rachel Forbes*
- **01.04.02: Oceanographic processes impact Gulf of Maine foraging ecology and trigger abrupt right whale distribution shift:** *Erin Meyer-Gutbrod*
- **01.04.03: Large changes in right whale density in U.S. waters between 2003-2009 and 2010-2018:** *Jason Roberts*
- **01.04.04: In plane sight: a mark-recapture analysis of North Atlantic right whales in the Gulf of St. Lawrence:** *Leah Crowe*
- **01.04.05: North Atlantic right whales in the New York Bight update: comprehensive findings from monthly aerial surveys Over three years:** *Ann Zoidis*
- **01.04.06: Projecting regions of North Atlantic right whale (*Eubalaena glacialis*) habitat suitability in the Gulf of Maine in 2050:** *Camille Ross*

300PM Break

315PM Breakout Sessions (direct links to each session on meeting landing page)

1. **Right whale politics and law**
   *Moderated by Kelly Kryc (**Anderson Cabot Center for Ocean Life at** NEAq)*
   An informal discussion on the current federal policy landscape for right whale conservation.

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2. **Consortium role and looking forward**
   Moderated by Scott Kraus- NARWC Chair
   Thoughts and discussion for NARWC strategic planning

3. ***Unmoderated Networking #1***
4. ***Unmoderated Networking #2***

5. ***Media Room: Ropeless Debrief for invited media***

400PM Breakout Sessions (direct links to each session on meeting landing page)

1. **Trauma prevention - rope**
Moderated by Michael Moore (Woods Hole Oceanographic Institution)/Amy Knowlton (Anderson Cabot Center for Ocean Life at NEAq)
Continued discussion on the path forward for mitigating right whale entanglements and associated trauma

2. **Climate change impacts on distribution and nutritional stress**
Moderated by Dan Pendleton (Anderson Cabot Center for Ocean Life at NEAq) /Nick Record (Bigelow Laboratory for Ocean Sciences)

3. Unmoderated Networking #1
4. Unmoderated Networking #2

5. Media Room: By invite

445PM Day 1 End Trivia and Cocktails

28 OCTOBER 2020

1000AM **<u>Session 1: Acoustics and Acoustic Detections</u>**

- **02.01.01: Listening for North Atlantic right whales in Nantucket Shoals from 2018 – 2020:** *Nicole Pegg*
- **02.01.02: Characterizing North Atlantic right whale upcalls and ambient noise levels in eastern Canadian waters:** *Clair Evers*
- **02.01.03: Optimizing real-time passive acoustic monitoring from gliders to trigger fishery and shipping dynamic management restrictions that protect North Atlantic right whales:** *Delphine Durette-Morin*
- **02.01.04: Evidence of song production by North Atlantic right whales:** *Hansen Johnson*
- **02.01.05: Near real-time passive acoustic monitoring for right whales on the U.S. east coast – an update:** *Mark Baumgartner*
- **02.01.06: Quantitative comparison of visual and acoustic surveys for the detection and dynamic management of North Atlantic right whales:** *Valentina Ceballos*

1100AM Break

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1115AM **Session 2: Physiology and Feeding Ecology**

- **02.02.01:** **North Atlantic right whale melanopsin pigment and pupil light response:** *Jeffry Fasick*
- **02.02.02:** **North Atlantic right whale bioenergetics reviewed and modelled in the context of changing nutrition and entanglement stress:** *Jasmin Hütt*
- **02.02.03:** **Understanding the cumulative impacts of multiple stressors on North Atlantic right whales: Introducing the PCOMS Working Group:** *Robert Schick*
- **02.02.04:** **Variations in North Atlantic right whale food (Calanus spp.) in the southern Gulf of St. Lawrence:** *Kevin Sorochan*
- **02.02.05:** **Variation in the late summer abundance and nutritional value of stage V *Calanus finmarchicus* in the Bay of Fundy from 2006-2019: implications for North Atlantic right whales and other copepod predators:** *Kristina Guarino*
- **02.02.06:** **Ocean circulation shapes early summer North Atlantic right whale preyscape in the southern Gulf of St. Lawrence: a biophysical Calanus model comparison of Cool vs Warm years:** *Catherine Brennan*

1215PM **Lunch**

1245PM **Session 3: Education/Outreach and New technologies**

- **02.03.01:** ***Entangled***: *David Abel*
  - *A special link to this film will be made available to registered participants on the meeting landing page on 10/27 from 6-10pm EDT.*
- **02.03.02:** ***The Urban Whale* - a documentary impact campaign**: *Nadine Pequeneza and Joanne Jackson*
- **02.03.03:** **New methodology for using a remotely piloted aircraft system to measure body temperature of large whales, especially North Atlantic right whales:** *Gina Lonati*
- **02.03.04:** **Ship Speed Watch: a new tool to monitor and analyze vessel traffic:** *Gilbert Brogan*
- **02.03.05:** **Right Whale AI:** *Christin Khan*
- **02.03.06:** **Automated detection and identification of right whales in the Gulf of St. Lawrence:** *Olivia Pisano*

145PM **Break**

200PM **Breakout Sessions (direct links to each session on meeting landing page)**

1. ***Entangled*** **Film discussion**
   Moderated by David Abel (Boston Globe, Entangled)
   A discussion of the film *Entangled,* which will be available for NARWC participants to view on October 27th from 6-10pm

2. **Trauma prevention - vessels (whale detection, vessel management)**
   Moderated by Amy Knowlton (Anderson Cabot Center for Ocean Life at NEAq)/Jessica Redfern (Anderson Cabot Center for Ocean Life at NEAq)
   Continued discussion on the path forward for mitigating right whale vessel strikes

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3. ***Unmoderated Networking #1***
4. ***Unmoderated Networking #2***

5. ***Media Room: By invite***

245PM Breakout Sessions (direct links to each session on meeting landing page)

1. **Passive Acoustic Monitoring**
   Moderated by Genevieve Davis (Northeast Fisheries Science Center)/Hilary Moors-Murphy (Department Fisheries and Oceans Canada)
   Where are people monitoring now vs outstanding gaps in coverage? Archival vs real-time PAM? What detectors are people using and comparability? 'Reporting' of acoustic detections/NARW acoustic detection database (PAM version of WhaleMap)?

2. **Student/researcher roundtable**
   Moderated by NARWC Members
   An informal opportunity to meet and chat with various Consortium members who represent different areas of expertise. Ask questions about their fields and how they view their role in right whale conservation.

3. **Public awareness (consumer education)**
   Moderated by Anne DiMonti (RI Audubon)/Bob Rocha (New Bedford Whaling Museum)

- What is a North Atlantic Right Whale? How can we save a whale many people have never heard of? Why should people care?
- What does the extinction mean for the Ocean ecosystem?
- How do we get we convey the plight of the North Atlantic Right Whale and still give a message of hope?
- What tangible things can we offer the general public to do to help save the species?
- Thinking outside the box...how can we partner with other maritime, for profit and nontraditional organizations to expand outreach beyond the scientific/conservation community? For example, the NARWC Education Committee *Sharing the Seas: Safe Boating for Sailors and Whales* program.

4. ***Unmoderated Networking #1***
5. ***Unmoderated Networking #2***

6. ***Media Room: By invite***

330PM Meeting wrap up/End

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***Time listed are EDT**

Entangled

Abel, D.[1]

[1]*The Boston Globe, 24 Forbes St, Unit 2, Jamaica Plain, MA 02130, United States (Dabel@globe.com)*

ENTANGLED is a feature-length film about how climate change has accelerated a collision between the nation's most valuable fishery, one of the world's most endangered species, and a federal agency mandated to protect both. The film chronicles the efforts to protect North Atlantic right whales from extinction, the impacts of those efforts on the lobster industry, and how NOAA Fisheries has struggled to balance the vying interests. *Entangled*, from the makers of *Lobster War* and *Sacred Cod*, was named a finalist for a Jackson Wild award, considered the Oscars of nature films. Learn more about the film at www.entangled-film.com.

Near real-time passive acoustic monitoring for right whales on the U.S. east coast – an update

Baumgartner, M.[1]

[1]*Woods Hole Oceanographic Institution, 266 Woods Hole Road, Woods Hole, MA, 02543, United States (mbaumgartner@whoi.edu)*

Together with partners from the NOAA Northeast Fisheries Science Center, Stellwagen Bank National Marine Sanctuary, Wildlife Conservation Society, University of Maryland Center For Environmental Science, U.S. Navy's NAVFAC Atlantic, and Rutgers University, the Woods Hole Oceanographic Institution deployed gliders and buoys in late 2019 and 2020 to conduct near real-time passive acoustic monitoring of baleen whales, including North Atlantic right whales, on the U.S. east coast using the digital acoustic monitoring (DMON) instrument. WHOI deployed DMON-equipped gliders in the Gulf of Maine, in the Stellwagen Bank National Marine Sanctuary, near Cox Ledge (south of Massachusetts and Rhode Island), to the north and south of Cape Hatteras, North Carolina, and on the outer New England Shelf, while Rutgers University deployed a DMON-equipped glider in the nearshore waters off New Jersey. WHOI DMON buoys were deployed in the New York Bight, south of Martha's Vineyard, and off the coast of New Jersey. Two additional DMON buoys will be deployed in the fall of 2020 off the coasts of Maryland and North Carolina. A brief overview of these deployments will be provided and plans for continued monitoring in 2021 will be discussed.

Ocean circulation shapes early summer North Atlantic right whale preyscape in the southern Gulf of St. Lawrence: a biophysical Calanus model comparison of cool vs warm years

Brennan, C.E.[1], Johnson, C.L.[1], Plourde, S.[2], Maps, F.[3], Gentleman, W.C.[4], Lavoie, D.[2], Chassé, J.[5]

[1]*Fisheries and Oceans Canada, Bedford Institute of Oceanography, 1 Challenger Dr., Dartmouth, NS B2Y 4A2, Canada (Catherine.Brennan@dfo-mpo.gc.ca)*
[2]*Fisheries and Oceans Canada, Maurice Lamontage Institute, 850 Route de la Mer, Mont Joli, QC, G5H 3Z4, Canada*
[3]*University of Laval, Department of Biology, 1045 Avenue de la Médecine, Quebec City, QC, G1V 4A2, Canada*
[4]*Dalhousie University, Department of Engineering Mathematics, 5269 Morris St., Halifax, NS, B3H 4R2, Canada*
[5]*Fisheries and Oceans Canada, Gulf Fisheries Centre, Moncton, NB, E1C 9B6, Canada*

Starting in the 2010s, the sudden shift in the distribution of endangered North Atlantic right whales (*Eubalena glacialis*; hereafter NARW) along the eastern American shelf coincided with sizable ocean warming and population decline in *Calanus finmarchicus* and *C. hyperboreus*, the biomass dominant copepods in the area and their preferred prey. Both changes in *Calanus* populations demographics and their transport patterns influence the distribution and availability of the lipid-rich stages of *Calanus*

that NARW crave. We aim to investigate how these crucial mechanistic drivers shaped the NARW preyscape during the cooler, high-abundance 2000's vs the warmer, lower abundance 2010's. Using a coupled biophysical *Calanus* model, we performed "Cool Year" and "Warm Year" simulations to quantify the relative importance of changes in the physical environment and changes in population level. Our analysis is focused first on the southwestern Gulf of St. Lawrence (swGSL), where NARW have been observed foraging in high numbers in recent years, and the NARW mass mortality event occurred in 2017. Our simulations indicate that through early summer, the variability in swGSL *Calanus* distribution is most strongly influenced by transport changes from upstream areas, linked to the influence of river runoff and winds on the behavior of the coastal Gaspé Current. In late summer and fall, it is regional population declines that reduced the delivery of lipid-rich stages of *Calanus* to the swGSL feeding ground. Complementary analyses showed that at Roseway Basin on the Western Scotian Shelf, despite significant circulation variability, the primary driver of lower Warm Year abundance at Roseway Basin is the decline in upstream population level. Our findings offer mechanisms that can be used to inform marine managers about how areas of high *Calanus* abundances critical for NARW feeding may continue to change in the future.

Ship Speed Watch- a new tool to monitor and analyze vessel traffic

Brogan, G.A.[1], Valentine, M.M.[2]

[1]*Oceana, 4 Parkland Drive, Wayland, MA, 01778, United States (gbrogan@oceana.org)*
[2]*Oceana, 1025 Connecticut Ave, NW Washington, DC 20036*

Collisions with vessels is driving North Atlantic right whales (NARW) toward extinction. Research suggests that if vessels slow down to 10 knots or less, they can reduce the risk of death by vessel strikes up to 86 percent. The U.S. and Canadian governments have established mandatory and voluntary slow zones to protect North Atlantic right whales. Oceana developed Ship Speed Watch, to assess cooperation with voluntary speed zones and compliance with mandatory zones. The tool harnesses self-reported data by vessels through Automated Identification System (AIS) transmissions. The AIS data includes vessel identity, speed, direction, location, and other information. With Ship Speed Watch, scientists, regulators, and advocates can analyze ship behavior, identify vessels that exceed speed regulations, and inform future policy. In 2020, Oceana used Ship Speed Watch to determine if vessels were slowing down in the voluntary slow zones in the U.S. south of Nantucket, Massachusetts and in the Cabot Strait in Atlantic Canada. This analysis showed low levels of cooperation with suggested speeds while also highlighting that compliance with mandatory measures was much higher in both countries. Ship Speed Watch gives stakeholders more visibility to what is happening in these areas that were established to protect the North Atlantic right whale. The results of these initial analyses from 2020 suggest that current voluntary measures are not sufficient to reduce risk of vessel strikes to NARWs. As the U.S. and Canada work to develop new measures to keep the North Atlantic right whale from the path to extinction, expanded mandatory speed restrictions with robust enforcement are clearly needed.

Quantitative comparison of visual and acoustic surveys for the detection and dynamic management of North Atlantic right whales

Ceballos, V.[1], Johnson, H.[1], Taggart, C.[1]

[1]*Oceanography Department, Dalhousie University, 1355 Oxford St, Halifax, NS, B3H 4R2, Canada (Valentina.Ceballos@dal.ca)*

Until recently, dynamic management of North Atlantic right whales in Canadian waters was solely based on visual observations, mainly from aircrafts. This changed in early 2020, as the Government of Canada began using gliders and near real-time passive acoustic detections interchangeably with visual detections to trigger risk-mitigation measures. Evaluating the use of

these different survey methods has become critical for the correct interpretation and combination of survey data, as well as for the development of optimal monitoring strategies. This is a difficult task to undergo empirically due to our inability to know how many whale surfacings and calls are actually available for detection, since it is not possible to obtain any unbiased real-world observations. The goals of this study were to develop a simulation-based method to quantitatively compare acoustic and visual surveys, and to use the simulation to inform more effective right whale management measures. We first expanded upon an established whale movement model by adding calling and diving behaviors based on previous observations. We then applied this model to generate a realistic distribution of surfacings and calls available for visual or acoustic detection, respectively. The next step was to simulate glider-based acoustic surveys and plane-based visual surveys of the simulated whales using realistic survey designs, platform movement characteristics, and detection functions. Results from each simulated survey were quantitatively compared using several metrics including daily whale presence, detections per unit effort, and detection per unit cost. The simulation framework is currently operational and capable of modelling virtually any combination of visual and acoustic survey methodologies over a realistic field of moving whales. Here we outline the components of the model and present simple examples to illustrate the extent of its capabilities. We also discuss our plans to apply this model to inform and optimize future right whale monitoring efforts.

In plane sight: a mark-recapture analysis of North Atlantic right whales in the Gulf of St. Lawrence

Crowe, L.M.[1], Brown, M.[2], Corkeron, P.J.[3], Hamilton, P.K.[3], Ramp, C.[4], Ratelle, S.[5], Vanderlaan, A.S.V.[6], Cole, T.V.N.[7]

[1]*Integrated Statistics Under Contract to the Northeast Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, 166 Water St., Woods Hole, MA, 02543, United States (leah.crowe@noaa.gov)*
[2]*Canadian Whale Institute, Welshpool, New Brunswick, Canada, E5E 1B6*
[3]*Anderson Cabot Center for Ocean Life at the New England Aquarium, Central Wharf, Boston MA USA 02110*
[4]*Mingan Island Cetacean Study, Longue-Pointe-de-Mingan, Québec, Canada, G0G 1V0*
[5]*Gulf Fisheries Center, Department of Fisheries and Oceans, Moncton, New Brunswick, Canada, E1C 9B6*
[6]*Bedford Institute of Oceanography, Department of Fisheries and Oceans, Dartmouth, NS, Canada, B2Y 4A2*
[7]*Northeast Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, Woods Hole, MA, 02543, USA*

North Atlantic right whales (*Eubalaena glacialis*) are most commonly observed along the eastern seaboard of North America where protection areas and critical habitats have been established. The decline and observed occupancy shifts occurring after 2009 prompted dedicated survey effort in areas outside of their typical feeding grounds in the Gulf of Maine. This study explores the individual right whales captured photographically from both dedicated and opportunistic sources from 2015 to 2019 in the Gulf of St. Lawrence (GSL), an area previously understudied for right whale presence. A total of 189 individuals, including 12 cow/calf pairs and at least 15 pregnant cows, were identified from all sources over this period, and the demographics of these animals was similar to that in the cataloged population. A high rate of inter-annual return was observed between all study years with 95% of the animals seen in 2019 sighted previously. In years when more substantial survey effort occurred (2017–2019), similar numbers of animals were sighted (mean = 133, SD = 1.5). The dedicated mark-recapture aerial surveys were highly effective at capturing almost all the whales present and Jolly-Seber models estimated 141 animals used the area in 2019. Capture rates indicated residency for several months, and most annual visitors were sighted by mid-July. Observed behavior included increased sightings of visible feeding and socializing as the season progressed.

Most straight-line distances between subsequent sightings equated to <20 km/day, but longer distances (up to 80 km/day) also occurred. Sightings predominately occurred on the western side of the southern GSL, but also extended into the Laurentian Channel and across shipping corridors. The GSL is currently an important habitat for one third of this critically endangered species, which not only highlights how crucial protections in this area are, but also that the rest of the population is somewhere else during the late spring, summer and autumn where protection measures may not be in place.

Estimation of North Atlantic right whale reproductive dynamics while accounting for uncertainty in female reproductive states

Crum, N.[1], Gowan, T.[1], Schick, R.[2], Rolland, R.[3], Pettis, H.[3], Hamilton, P.[3]

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[2]Marine Geospatial Ecology Lab, Nicholas School of the Environment, Duke University, Durham, NC
[3]Anderson Cabot Center for Ocean Life, New England Aquarium, Boston, MA

North Atlantic right whale reproductive dynamics constrain the species' potential to recover. Thus, understanding reproductive dynamics and their drivers is crucial for management of the species, as it can allow for forecasting of population trajectory, setting reasonable recovery goals, and focusing management efforts to assist population recovery. Previous studies of right whale reproduction have focused on counting the number of calves observed each year and the number of years between observed births for each female. These studies explicitly assume that all calves are detected each year, despite varying survey effort over time and multiple cases where a calf was known not to be detected in the primary calving grounds of the Southeastern U.S. This assumption can lead to underestimates of pregnancy and birth rates and overestimates of calf survival. Multi-event modeling provides a framework to build a biologically realistic model of female right whale reproductive dynamics while accounting for uncertainty in a female's reproductive state (e.g. pregnant, nursing, or resting) and the possibility that a calf may go undetected. The model we have developed uses photo-identification data from female right whales, including whether a female was sighted with a calf or not during each sighting, reproductive hormone data from fecal progesterone assays, and visual health assessments. The model estimates numerous reproductive parameters including pregnancy rates, pregnancy success (birth) rates, timing of birth, calf survival, and age at first pregnancy and has the potential to evaluate the effects of covariates on these rates. We will present an overview of our model, results from preliminary model runs, and future directions for our analysis.

Estimating the population size of the North Atlantic right whale

Dos Anjos, V.L.[1], Kim, C.K.[1], Roberts, D.L.[2], Shew, H.J.[1], Thongthai, N.[1], Vernier, T.C.[1], Xu, X.[1] Zhong, L.[3], Wang, S.C.[1]

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[2]University of Kent, Canterbury, UK, CT2 7NR
[3]Cheung Kong Graduate School of Business, Beijing 100738, China

We propose to estimate the population size of the North Atlantic right whale using a Bayesian statistical method. Two challenges in estimating population size are (1) some whales that have been sighted are now dead, and (2) some living whales may never have been sighted. We account for the first issue by estimating the probability that each sighted whale is currently alive, given its sighting record in the NARWC sighting database. Based on these probabilities, we randomly simulate a dataset consisting of whales thought to be alive. We then apply to this dataset a method from statistical ecology for estimating the number of never-sighted individuals. This estimate is added to the

number of whales thought to be alive to arrive at an estimate of population size. We then repeat this process 1000 times total, each time simulating a different dataset of whales thought to be alive and applying the method for estimating never-sighted individuals. We thus arrive at a posterior distribution of estimated population sizes that accounts for uncertainty in both the current status of sighted whales, and the number of never-sighted whales. Our work is in progress, and our team (mostly composed of statisticians and computer scientists, including six undergraduate students) is eager to receive feedback from the North Atlantic right whale community.

Optimizing real-time passive acoustic monitoring from gliders to trigger fishery and shipping dynamic management restrictions that protect North Atlantic right whales

Durette-Morin, D.T.[1], Nolet, V.[2], Taggart, C.T.[1], Davies, K.T.A.[3]

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[2]Transport Canada's Innovation Centre, Ottawa, Canada
[3]Department of Biology, University of New Brunswick, Saint John, Canada

Fisheries and Oceans Canada (DFO) and Transport Canada (TC) have implemented spatial dynamic fishery area closures and vessel speed restriction zones, respectively, to mitigate the risk of entanglement and vessel strikes to North Atlantic right whales (NARW) in the Gulf of St. Lawrence (GSL). In 2020, near-real time passive acoustic monitoring of NARW from underwater gliders was used for the first time to trigger both dynamic fishery and vessel restrictions in Canada, yet these management plans differ in their objectives, scopes and scales. We present a performance study wherein glider flight plan models were designed for two deployments of Slocum gliders, each equipped with a digital acoustic monitoring instrument (DMON). One glider was deployed to support the fisheries management, and the other to support the shipping management. Each glider flight plan was optimized to fit the objectives and scales of each dynamic management plan. Pilot deployments took place between 17 Jul - 26 Aug in the southern GSL NARW habitat, and 17 Aug - 15 Nov in the Laurentian Channel Dynamic Shipping Zone C, respectively. The southern GSL glider detected NARWs on 20 days and triggered 8 fishery area closures, and as of 06 - Sep, the Laurentian Channel glider detected 8 NARWs on 5 days and triggered a 10-knot speed restriction for 16 days. The results of this study show how gliders can be applied as monitoring tools to support dynamic management of NARW under a variety of management scenarios.

Characterizing North Atlantic right whale upcalls and ambient noise levels in eastern Canadian waters

Evers, C.H.M.[1], Xu, J.[1], Moors-Murphy, H.1, Wright, A.[1]

[1]Department of Fisheries and Oceans Canada (DFO), Bedford Institute of Oceanography, 1 Challenger Dr
Dartmouth, NS, B2Y 4A2, Canada (Clair.Evers@dfo-mpo.gc.ca)

Ambient noise levels are increasing across the world's oceans. Collection of passive acoustic data for the purpose of investigating year-round distribution and presence of whales is also increasing. Automated detectors are often used to identify whale calls present within these large acoustic datasets. Noise can influence detector performance by masking whale calls, and can also elicit a behavioural response from the whales. For example, North Atlantic right whales in the Bay of Fundy, Canada were found to shift call frequency as a result of higher noise levels (Parks et. al. 2007). To better understand the effects of noise, this study compares ambient noise levels that occur when right whale calls were detected using the low frequency detection and classification system (lfdcs; Baumgartner et. al. 2011) on bottom-mounted recorders deployed in various locations in Canada from 2015-2019. Upcalls were all were manually validated and the frequency, duration and received levels of

detected upcalls were measured and compared across varying ambient noise levels. Preliminary results from 477 upcalls from Emerald Basin in 2015-17 show that in-band ambient noise levels when calls were detected varied from 85 to 115 dB re 1 µPa and were influenced by shipping traffic and seismic exploration activity. There was 20 db variation in the received levels of the upcalls which was correlated to the varying noise levels. Future work will explore if there is a relationship between noise levels and upcall parameters, as well as variability between locations/years. Finally, we aim to compare our results to existing North Atlantic right whale call literature from Canadian waters, most of which include data recorded over a decade ago, to see if there have been changes in right whale calling behaviour and/or the noise levels to which right whales are exposed in eastern Canadian waters.

North Atlantic right whale melanopsin pigment and pupil light response

Fasick, J.I.[1], Algrain, H.[2], Robinson, P.R.[2]

[1]*The University of Tampa, 401 W. Kennedy Blvd, Tampa, FL, 33606-1490, United States (jfasick@ut.edu)*
[2]*University of Maryland Baltimore County, Baltimore MD USA 21250*

Mammalian retinae possess intrinsically photosensitive retinal ganglion cells that express the photopigment melanopsin. These retinal cells are involved in both non-image forming and image forming light processes including circadian photoentrainment and pupil constriction. The deactivation kinetics of melanopsin have been previously described in mouse with results showing relatively fast pupil dilation after light offset. The phosphorylation sites in cetacean melanopsins responsible for deactivating melanopsin diverge when comparing species possessing a duplex retina (possessing both rods and cones including Delphinidae) and rod monochromats (rod-only retina including Balaenidae), with the latter possessing significantly longer deactivation rates relative to the former. Results from calcium imaging analyses of melanopsin deactivation suggest that the rod monochromat whales, including the NARW, rely on extended pupillary constriction to prevent photobleaching of the all-rod retina when moving back and forth between photopic (bright) and scotopic (dim) light conditions.

2017 – 2020 (as of 13 October) North Atlantic Right Whale Unusual Mortality Event

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An Unusual Mortality Event (UME) was declared by the National Marine Fisheries Service for North Atlantic right whales (*Eubalaena glacialis)* starting in 2017 due to elevated strandings along the Northwest Atlantic Ocean coast, especially in the Gulf of St. Lawrence region of Canada. This is a transboundary event and the investigation includes whales stranding in both the United States and Canada. The event is ongoing with the 31 confirmed dead stranded whales (21 in Canada; 10 in the U.S.) to date. The breakdown by year includes 17 confirmed dead stranded whales (12 in Canada; 5 in the U.S.) in 2017, three whales in the U.S in 2018, nine whales in Canada and one in the U.S in 2019, and one dead whale in the U.S. in 2020 (through 13 October). Of the 31 dead right whales, 21 were necropsied and 18 were determined to have died as a direct result of human activities (either confirmed, probable, or suspect), from entanglements (8) or vessel strikes (10). Additionally, since 2017, 11 live free-swimming non-stranded whales have been documented with serious injuries from entanglements (4 in Canada; 6 in the U.S.) or vessel strikes (1 in the U.S). Therefore, the preliminary cumulative total number of animals currently in the North Atlantic right whale UME is **42** individuals, including 31 confirmed mortalities and 11 seriously injured free-swimming whales. **Thus, given there are only approximately 400 individual North Atlantic right whales remaining, these 42 individuals in the UME represent at minimum 10% of the population, which is a significant impact on such a critically endangered species.**

More information can be found at the National Marine Fisheries Service UME website: (https://www.fisheries.noaa.gov/national/marine-life-distress/2017-2020-north-atlantic-right-whale-unusual-mortality-event).

Stable isotope analysis of baleen from North Atlantic right whale (*Eubalaena glacialis*) reflects distribution shift to the Gulf of St. Lawrence

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The endangered North Atlantic right whale's (*Eubalaena glacialis*) seasonal migration along the eastern seaboard of North America has been well studied, and management efforts have been successful at protecting this species between the right whale calving grounds off the coasts of Florida and foraging grounds in the Bay of Fundy. Since 2010, however, recent sighting data suggests that right whales have been traveling farther north to the Gulf of St. Lawrence for summer foraging, which has increased the mortality rates from fishing net entanglements and ship strikes. There is a need to better understand right whale distribution so we can manage these areas. Stable isotope ratios of Mysticeti whale baleen plates can provide details about an individual's migration and foraging behaviour over a period of several years. We examined whether stable isotopes in baleen could detect the right whale distribution shift that occurred in 2010. $\delta^{13}C$ and $\delta^{15}N$ levels were compared between eight right whales that died in 1992-2005 (pre-2010) and four right whales that died in 2019 (post-2010). The mean $\delta^{15}N$ and $\delta^{13}C$ summer and winter values were higher in the post-2010 whales compared to the

pre-2010 whales, with the largest increase of 9.2‰ to 10.2‰ occurring in the mean $\delta^{15}N$ summer values (t-value=3.51, df=9.70, p-value=$5.87x10^{-3}$). These results indicate that the range shift observed in sighting data is also reflected in the isotope ratios of right whale baleen. Detecting shifts in right whale migration is essential for protecting this species at risk, and stable isotope analyses may be useful in future conservation efforts.

Variation in the late summer abundance and nutritional value of stage V *Calanus finmarchicus* in the Bay of Fundy from 2006-2019: implications for North Atlantic right whales and other copepod predators

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Climate-induced environmental changes are impacting populations across spatiotemporal scales in marine ecosystems. We analyzed a 14-year time series (2006-2019) of summer (August/September) zooplankton samples in the Bay of Fundy (BoF) to understand patterns in the quality and abundance of *Calanus finmarchicus*, how these factors might be impacted by environmental variables, and how they influence right whale occurrence in the region, which has been in decline since 2010. The overall abundance of stage V copepods (C5s) and proportion of total zooplankton made up of C5s (%C5s) declined significantly during this study, while the abundance of other zooplankton species increased significantly. Prior to 2012, C5s represented an average of 74.5±17.6% of zooplankton, while during the second half of the study C5s represented an average of 51.5±17.0%. Individual C5 energy density (J) declined significantly during this study, likely because individuals were ~35% smaller after 2012. Combined with lower overall abundance, the energy available to *Calanus* specialist predators declined significantly, by almost 50% in 2012-2019 compared to 2006-2011. BoF *Calanus* appear to be most influenced by temperature: springtime bottom water temperatures were significantly positively correlated to summer C5 abundance that same year, and warmer summer and annual bottom water temperatures were significantly related to smaller C5 size. The number of whales and percent of mothers with calves entering the bay annually are dependent on quality and abundance of C5s, with both variables being significantly positively correlated to %C5s, individual C5 energy density (J), and zooplankton energy content (J/g). We suggest that fluctuations in temperature and the increase in other species are all leading to lower predictability in the quality and quantity of the *Calanus* prey field for predators in the BoF. Should these declines continue, significant impacts to this region can be expected both ecologically and economically.

North Atlantic Right Whale Catalog Update, Recent Genetic Findings, 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 and new

whales added to the Catalog. 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. The Catalog database and the genetics database at Saint Mary's University are linked and recent genetic findings will also be presented- including the genetic results of three dead whales and three calves recently Cataloged after genotype matches. Thanks to these, and other, genetic results, we've learned that: 1) four calves thought to have died before or during the northward migration actually survived and two of these may have been fully weaned by 7 to 8 months of age and; 2) there were three cases of right whales whose development surprised us- one larger than expected at 8 months and two smaller than expected at 1.5 and 2.5 years. Lastly, the final results of the Consortium whale naming effort will be presented.

North Atlantic right whale bioenergetics reviewed and modelled in the context of changing nutrition and entanglement stress

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Critically Endangered North Atlantic right whales (NARW) risk extinction without substantive reduction of anthropogenic trauma. Recently, decreasing population size and mass mortality events have been correlated with two main issues besides vessel collision: entanglement in fishing gear and shifting food availability due to climate change. Both stressors are known to have energetic impacts on NARW, leading to reduced body condition of individuals, decreased reproductive success, and deterioration of population health overall. To measure the energetic impact of these stressors and their interaction, a bioenergetic model was established for a generic female NARW based on literature values. Additional drag from fishing gear alone was found to add up to 55.1% (mean: 15.1%) to the natural energetic expenses of a female NARW. The literature value for feeding threshold (10^3 individuals m^{-3}) gives an energy income that is 88.8% below natural expenses. Compared to the cost of entanglement, small changes in food availability show a stronger effect on the energy balance. The model predicts an increase in the once normal 3-year calving interval with either or both stressors. When both stressors are combined, they can have a severe impact: the calving interval increases to as much as 12.7 years, which is comparable to recent field observations. Sublethal stressors can seriously affect NARW energy budgets and therefore their health as well as calving interval. Consequently, conservation management has to reduce sub-lethal as well as lethal impacts and must consider the combined effect of stressors rather than treating each as an independent factor.

Evidence of song production by North Atlantic right whales

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Song behavior in cetaceans, broadly defined as fixed patterns of sounds that are repeated, has been observed in many baleen whale species. The function of song remains elusive due in large part to observational limitations, but some evidence suggests it may play a role in reproduction. Here we present the first evidence of song production by North Atlantic right whales (*Eubalaena glacialis*). This study was initiated after an encounter with a lone adult male in the southern Gulf of St Lawrence in August 2020. The whale was engaged in atypical surfacing behavior characterized by repeated head pushing followed by short-duration dives. Acoustic recordings revealed that patterned sequences of gunshots and tonal calls were produced during surfacing and diving intervals, respectively. The highly stereotyped repetition of these patterned sequences met the definition of cetacean song. The potential association between song production and head pushing behavior motivated a review of historical survey data to characterize the spatial and temporal patterns in head pushing behavior as well as the distribution, identity, demography and reproductive success of the whales engaging in said behavior. Preliminary results suggest that head pushing is highly seasonal (August through September) and regional (Northwest Atlantic) and performed almost exclusively by adult males. These insights into song production add a new dimension to our understanding of right whale social and reproductive behaviour that warrants further study and likely have important implications for successful conservation strategies.

Right Whale AI

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NOAA Fisheries continues to advance the use of artificial intelligence for North Atlantic right whales through a broad worldwide collaboration on two initiatives – the continuation of the right whale photo-id work and the launch of a new project to detect whales from satellite imagery. The use of AI for photo-identification began with a Kaggle competition in 2015 to automate the classification of individuals from aerial photographs. The winning deep learning algorithms from Deepsense.ai were retrained and deployed on Flukebook for North Atlantic right whales in October of 2019. The system was expanded to Southern right whales in April of 2020 with catalogs from South Africa, New Zealand, Australia, Argentina, Brazil, and Chile. As expected, accuracy for the Southern right whales was considerably lower at 26% top-1 accuracy (compared to 61.3% for the North Atlantic). Future research is anticipated to make the algorithms more generalizable so that the Southern right whale model can more closely approach the North Atlantic model in accuracy. Machine learning is underway to expand the capacity of the system to recognize whales from vessel based photographs. NOAA Fisheries is

also beginning machine learning work on belugas and gray whales in partnership with WildMe this year. In addition, a new project was recently launched to explore the feasibility of an operational whale detection system using satellite imagery in collaboration with the Naval Research Laboratory and the Bureau of Ocean Energy Management. Very high resolution satellite imagery from WorldView-2 and WorldView-3 satellites have been tasked over seasonal aggregations of North Atlantic right whales and the Cook Inlet beluga and work has begun on automating the workflow with a variety of Python scripts to query Maxar's archive imagery database, address sun glint phenomena and band offset , tile, and detect objects of interest via spectral statistics.

Simulated performance of lobster fishing gear under different gear configurations

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Rope strengths of 1700lb are being considered for fixed-gear fishing, mainly with pot fisheries in the Gulf of Maine, to reduce the severity of large whale entanglements. Using OrcaFlex software, we evaluated hauling effectiveness by developing simulations using measurements of lobster pot weights, lobster gear configurations, hauler speeds, rope diameter, water depth, and weather conditions to measure tension on endlines when hauling gear. The main findings indicate that if only 3 pots of 65lb are suspended in the water column at a given time, then the working load – 340lb - of 1700lb rope will typically not be exceeded in regular wave hauling conditions. When 3.28 ft irregular waves were simulated, tensions could reach up to 700lb. If 6.52 ft irregular waves were simulated, the tensions could reach over 1800lb which would result in line parting. To evaluate whale risk, we mimicked the situation of a whale pulling an endline, OrcaFlex was used to simulate the pull at 4 different points on an endline at 4 and 8 kts of speed and for 5, 15, and 40 pot trawl configurations and at two water depths – 240 and 656 ft. A line with weak links was compared to those with standard rope strengths. Time to part weak links is: 1) faster for inshore gear, 2) faster at higher pull speeds, and 3) faster closest to the seafloor. In all of these simulations with weak links rope tension reached 1700lb except for a 5-pot trawl hauled at 4 kts. Without weak links, 7 out of 12 simulations (58%) failed to reach the standard rope breaking strength of 3720 or 7950lb (inshore vs offshore). Weak links always parted closest to and below the pull point thus more weak points in endline would reduce the amount of line on an entangled whale.

Fisheries and Oceans Canada (DFO) update on North Atlantic right whale management measures

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The Fisheries and Oceans Canada's (DFO) management measures for the 2020 season to reduce the risk of fishing gear entanglements with North Atlantic right whales (NARW) in Canadian waters came into effect on April 24, 2020. As in previous years, all measures were developed in consultation with industry and scientists, and taking into consideration past confirmed NARW detection, the latest science advice, navigational safety, and economic impacts. The 2020 measures build on previous measures but also reflect our increased understanding of NARW in Canadian waters. For example, in addition to the expansion of the area of coverage of the dynamic closure protocol to the entire Gulf of St. Lawrence implemented in 2019, a new season-long closure protocol was implemented in the Gulf of St. Lawrence. Unlike the pre-set (static) season-long closure area used in previous years, season-long closures are implemented under the protocol in areas where

whales are actually detected and will remain closed until November 15, 2020. Additionally, the dynamic closure protocol also applies to the entire Bay of Fundy, inclusive of the North Atlantic right whale critical habitat area in the Grand Manan Basin, as well as, Roseway Basin. In 2020, tools used for detections include aircraft surveillance, on the water vessel surveillance, as well as the introduction of underwater hydrophones and glider technologies to support dynamic and seasonal closure protocols. A gear marking requirement announced in 2019 is now in place for all non-tended fixed gear fisheries, including lobster and crab, in Atlantic Canada and Quebec. Additionally, DFO is working with harvesters and other partners to prepare for new gear modification requirements which include a mandatory requirement for non-tended fixed-gear fisheries to have weak breaking points in their vertical lines by the end of 2021; and measures that may be required after 2021 based on consultations with industry on how to safely and effectively implement maximum rope diameters of 5/8 inch, sinking vertical rope, and rope between pots and traps.

North Atlantic right whale entanglement and serious injury update, November 2019 – October 2020

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Since the last consortium meeting there were seven sightings of right whales carrying gear, involving four individuals: #3466, #3180 (Dragon), WR-2020-02 (an unidentifiable individual with no photo-documentation) and #4680. These sightings ranged from Georges Bank, Nantucket Shoals and the New York Bight. All cases were newly discovered for the time period, with no re-sightings of ongoing cases reported at prior consortium meetings. This is below the average of six during the last decade for newly discovered cases. All but one of the cases was confirmed to be lethal and none of the cases prompted an entanglement response due environmental conditions. In light of this all Atlantic Large Whale Disentanglement Network members are urged to keep watch for these individuals and report any sightings immediately.

In 2020, nine new injured whales were added to the Right Whale Injury Monitoring list. Additions included three whales carrying gear (#3180, WR-2020-02, and #4680), three whales with entanglement wounds but not carrying gear (#1701, #3301, and the 2020 calf of #3101), and three whales with vessel strikes (#1017, #4539, and the 2020 calf of #2360). Of these whales, three were determined to be in declining condition coinciding with their injuries (#3180, #4680, and the 2020 Calf of #2360). Three whales (WR-2020-02, #1701, and #3301 had inconclusive impacts on health, and three whales (#1017, #4539, and the 2020 calf of #3101) appeared to have no negative impacts on health as a result of the injury. An updated report on all injured whales currently on the monitoring list (including new and previously detected injuries) will be released in December 2020.

Effectiveness of speed restrictions to protect North Atlantic right whales from ship strikes within Charleston South Carolina and Savannah Georgia Seasonal Management Areas

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In order to monitor and make timely reports on ship strike risk within the Charleston and Savannah Seasonal Management Areas (SMAs), we have created Atlantic Maritime Whale, a website for daily monitoring and reporting on areas of persistent high risk of ship strikes within areas regulated by seasonal speed restrictions within the seasonal management areas at the ports of Charleston South Carolina, and Savannah Georgia, which both exhibit very low compliance. Our poster presentation for NARWC will illustrate the website's features, including near-real time, interactive vessel traffic maps and recent right whale sighting data maps, in an integrated format, and daily downloads of ship traffic, fastest ships first, in spreadsheet format. Our analysis of the Charleston SMA indicates that the maximum speed over ground during each vessel transit (transit speed) for all months/years in our analysis dataset averaged 15.8 knots with a compliance rate of 0.93%. Our analysis of Savannah indicates that the average transit speed in the entrance channel in our dataset was 14.5 knots, yielding a compliance rate of approximately 0.5%. These two ports comprise the busiest container ship port area on the Atlantic coast, with the highest rates of Post Panamax ship traffic, and the lowest rates of compliance in the SMA system.

New methodology for using a remotely piloted aircraft system to measure body temperature of large whales, especially North Atlantic right whales

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The critically endangered status of North Atlantic right whales (*Eubalaena glacialis*, NARW) warrants close monitoring of individual and population health. Establishing baselines for more immediate health metrics for large whales will aid in these monitoring efforts. Variation in internal body temperature is used as an indicator of health in some mammals, but it is challenging to measure this parameter in free-swimming marine mammals. Remotely piloted aircraft system (RPAS) technology has recently experienced rapid and widespread application in conservation biology, especially in studies of marine megafauna. Here we describe a protocol that we are developing, which uses cameras and sensors mounted on an RPAS to measure relative, and possibly absolute, internal body temperature of free-swimming whales in relation to their body condition. Specifically, we use a dual-gimballed quadcopter equipped with an infrared (thermal) camera, high-resolution RGB camera, and laser altimeter. We use thermal reference points on our research vessel and the ocean surface as well as environmental data to calibrate thermal imagery before and after observing whales. We present preliminary data from our first field season in 2020 in the Bay of Fundy, where we tested and refined the use of concurrent RGB and thermal video to observe humpback whales (*Megaptera novaeangliae*). Using close-up imagery of their open blowholes, we can derive remote estimates of their internal body temperatures. Our goal is to begin flying over NARW in 2021 using this protocol. Ultimately, comparing body condition and temperature across demographics, geographical space, and time will provide important information about the natural fluctuations in NARW health versus changes caused by anthropogenic stressors and poor foraging habitat quality.

Oceanographic processes impact Gulf of Maine foraging ecology and trigger abrupt right whale distribution shift

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Abrupt ocean warming events linked to anthropogenic climate change are impacting the ecology of endangered North Atlantic right whales. During the past decade, the Gulf of Maine/Western Scotian Shelf (GOM/WSS) region has warmed more rapidly than most of the global ocean. Observed warming may be associated with a less favorable foraging environment for the right whale population. These oceanographic processes triggered a significant shift in right whale foraging distribution and indirectly impacted vital rates including mortality and reproduction. We used time series analysis to identify a regime shift in the position of the Gulf Stream and associated increase in slope water temperatures in the GOM/WSS. Newly acquired Continuous Plankton Recorder data demonstrate a concurrent drop in late stage *Calanus finmarchicus* abundance in the GOM/WSS during late summer and fall. Using right whale sightings per unit effort data, we developed models to characterize the change in right whale distribution across critical habitats in the GOM/WSS before and after this oceanographic regime shift. These results are relevant to understanding the recent increase in right whale occupancy in the Gulf of St. Lawrence, and the associated unexpected mortality event. Future management decisions will rely on the identification of oceanographic processes that drive right whale distribution changes.

Right whales in shallow waters: a case-study on coastal lobster fishing grounds

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Since 2017, we are experiencing in the Gulf of St. Lawrence a major crisis related to the North Atlantic Right Whale, a species increasingly present in our waters. Beyond the stakes related to the spatio-temporal distribution of this endangered species in a Gulf, there are some specific, finer scale concerns relative to the zones that overlap fishing areas and the challenges of coexistence that this entails. This is especially true for coastal areas (less than 20 fathoms), where an important lobster fishery takes place, and for which almost no information was available to implement the NARW protection measures. This project is the first of its kind in Canada and is based on the expertise and interdisciplinarity of experts in ecology, economics, social sciences and fishermen. It is a project made FOR and WITH fishers, which contributes greatly to the evolution and adaptation of this industry to a changing and challenging future. In 2019 and 2020, we surveyed the coastal zone of Baie des Chaleurs during the lobster fishing season (under permits QUE-LEP-004-2019 and QUE-LEP-11-2020), covering an area of 1287 km^2. Our results show that over 2 years, a total of 20 species of birds and marine mammals were observed during the vessel-based surveys. No NARW was observed in shallow areas, and no species typically known to be associated to NARW were seen either. These results will improve the level of confidence of fishermen in the management measures (based on better data, involving fishermen), and measures the level of compliance and respect for the measures to protect right whales in this part of the Gulf. Finally, it allows us to identify the gains that could be made by basing these decisions on better scientific knowledge, by involving fishermen in these important steps in the process, and by working TOGETHER to protect our marine resources, both those we fish and the endangered species that live alongside them.

In the path of North Atlantic right whales: perspectives of an offshore wind developer

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Orsted is the global leader in offshore wind development with the stated goals of reducing CO2 emissions and transitioning the world to entirely green energy. In 2016 the company entered the U.S. market and now owns multiple leases along the east coast as well as the Block Island Wind Farm. As an industry leader, Orsted takes seriously its approach to responsible development and operations in the marine environment and maintains a Biodiversity policy that highlights the companies key focus areas which includes mitigating and monitoring impacts to protected species. In the U.S. Atlantic waters, the North Atlantic Right whale (NARW) (*Eubalaena glacialis*) is of significant concern. Recognizing the risks this population faces and our role as a responsible energy developer, we are taking an approach that aligns with our sustainability program. We are focusing on developing and adapting technologically innovative and verifiable solutions to mitigate and monitor our activities impacts in a practical manner. Solutions being considered includes deployment of noise mitigation technology and utilization of real-time visual and acoustic detection systems integrated with data collection software that can be networked across multiple vessels in real time. This data sharing and integration substantially increases the collective situational awareness of protected species in the area of operations, allowing for adaptive mitigation that will optimize development that ultimately benefits the ecosystem. Orsted further sees value in supporting advancement of conservation initiatives that directly target the one of the major sources of mortality, ship strikes. In this talk, I will review initiatives underway and planned to meet these goals as well as summarize right whale sighting contributions to date.

Multi-agency emergency intervention to an injured North Atlantic right whale (*Eubalaena glacialis*) calf

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North Atlantic right whale (*Eubalaena glacialis*) Catalog #2360 and a newborn calf were first observed by the Florida Fish and Wildlife Conservation Commission aerial survey research team approximately 10 Nautical Miles Northeast of Saint Simons Island, Georgia on 08 January 2020. Analysis of photo-documentation determined that the neonate calf had severe injuries on the rostrum and head, indicative of a vessel propeller collision. Upon this finding, NOAA convened a panel consisting of external subject matter experts in right whale strandings, baleen whale anatomy, large cetacean medicine and field biology to review the options, usefulness and considerations for an emergency intervention in the field. Additional photo-documentation of the calf was collected by aerial and on-water research teams on 10 January 2020. On 12 January 2020, response team members converged in Fernandina Beach, Florida to prepare for an intervention. The animal was located again on 15 January 2020. A visual health assessment was performed before the intervention. A long-acting antibiotic was subsequently remote delivered via dart to aid in

managing localized wound infection and to attempt preventing sepsis and death. UAS video was collected during and following the injection. Detailed review of the available documentation across all three sightings later confirmed that the calf's injury likely interfered with mouth closure. Neither the mother nor the calf has been observed subsequently. While the calf is assumed to be deceased, an important foundation has been laid for future emergency interventions. In 2019, a similar emergency intervention was authorized for a killer whale (Gaydos et al, 2019). A review and comparison of considerations, appropriateness, necessary resources, successes and opportunities of these interventions will enhance future emergency interventions with large whales.

Acknowledgement: We would like to acknowledge the contributions and consideration provide by the panel of subject matter experts, which consisted of Alexander Costidis, Deborah Fauquier, William McLellan, Michael Moore, Sarah Sharp, Michael Walsh and Sarah Wilkin.

Listening for North Atlantic right whales in Nantucket Shoals from 2015 - 2020

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Waters south and southeast of Nantucket are increasingly recognized as important habitats for the critically endangered North Atlantic right whale (NARW). With aggregations of NARWs occurring in these shallow, coastal waters in recent years, monitoring these areas is important for continued and future management of this species. It was possible to maintain passive acoustic monitoring (PAM) for NARW presence during recent months when visual surveys were increasingly difficult to conduct. Recorders (MARUs, Cornell University) were deployed along the continental shelf off of Massachusetts and Rhode Island from December 2015 – June 2019, and two recorders (SoundTraps, Ocean Instruments) were deployed in Nantucket Shoals from January 2020 – July 2020. Data from these recorders were analyzed using an automatic Low Frequency Detection and Classification System (LFDCS; Baumgartner & Mussoline 2011) for NARW upcalls. NARW daily acoustic presence were analyzed across seasons and compared between years to look for any inter-annual changes within the region. Results provide insight on when NARWs are using this habitat throughout the year, and whether site usage has changed in recent years. Data collection around Nantucket Shoals is ongoing and will continue into the future in order to sustain long term monitoring efforts in this important habitat.

The Urban Whale - a documentary impact campaign

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With the help of key wildlife conservation partners, HitPlay Productions is planning a strategic film impact campaign to support the growing movement to save NARW. Scheduled for release in September 2021 with film and television partners: CBC, ARTE/SWR (in negotiation), Telefilm Canada and Ontario Creates, The Urban Whale will reach millions of viewers globally in theatres, on television and the internet. Featuring breathtaking 4K footage of the majestic but rarely seen North Atlantic right whale - observed through the eyes of scientists, photographers, rescuers and fishermen - The Urban Whale will resonate with audiences long after the final frame fades to black. With unique access to film the right whale migration from Florida to the Gulf of the St. Lawrence, the film's central character is the rarely seen North Atlantic right whale. The right whale's story is told through the eyes of inspiring people working on the frontlines to protect the 400 remaining animals throughout their 2,500 km migratory route. Each of them has a particular and important role to play in the survival of the

species. Audiences will get to know and love this incredible animal, while learning how they can help save a great whale from extinction. Over the past 10 years documentary films have led the way in shining a light on the most important conservation and environmental issues of our time, helping to move the needle toward greater sustainability. Through the power of storytelling The Urban Whale invites viewers to empathize with right whales and offers the information necessary to turn heart-felt emotion into action. See our power point presentation to learn more about the film's impact campaign.

Automated detection and identification of right whales in the Gulf of St. Lawrence

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North Atlantic right whales are monitored with a variety of survey methods, including vessel and aerial surveys. Still images collected from these surveys can number in the tens or hundreds of thousands and are typically reviewed manually. Analyzing these images is labor-intensive, time-consuming, and prone to error, thereby delaying population assessments and protection measures. Automation techniques, such as machine learning algorithms, can allow for wildlife counts to be made more quickly and at a greater frequency, allowing for more comprehensive population estimates and more effective monitoring. Here we will provide an update on the development of an automated detection and identification method for right whales in the Gulf of St. Lawrence. We will present our updated Convolutional Neural Network (CNN) model and showcase its performance in detecting and identifying right whales and other species in aerial imagery. We will also report on the overall status of the project, our plans for the integration of VHR satellite imagery, and our objectives for the algorithm's expected implementation in 2021.

Incorporating recovery into mark-recapture: another approach to the estimation of abundance and demographic parameters

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North Atlantic right whales (*Eubalaena glacialis*, NARW) are one of the most endangered species of extant whales. Their abundance, and the temporal trends therein, are estimated using two approaches to photo-identification mark-recapture. The simpler methods enumerate a minimum number alive from annual identifications, and incorporate varying assumptions of sightability. Enumeration provides estimates of abundance, but no estimates of, other important demographic parameters for example, survivorship and recapture probabilities. The other abundance estimate, and the only model to estimate survival or recapture, is a Bayesian Jolly-Seber mark-recapture model. This model incorporates information on the live resightings of individuals. However, the combination of resighting and dead recovery data is another approach to deriving estimates for abundance and demographic parameters, especially for small populations. We developed a new model for female NARW as they are the sex of greater interest for conservation, in order to offer another view of the status of NARW. We developed a Bayesian mark-recapture-recovery model to investigate how survival, recapture, fidelity and recapture probabilities vary for female NARW for different age classes, using data collected from 1977-2018. Three age classes were considered, calves (0-1 years), juveniles (1-8 years, unless already breeding),

and adults (breeding individuals, or those > 9 years). Age classes were applied for those individuals of known age (n=199). A hidden-state process was used to classify individuals whose age was unknown for part of, or the entirety of, the study as either juvenile or adult (n=119). Preliminary results are similar to the current model, with NARW numbers slowly increasing to 2010/2011 and declining thereafter, but with point estimates of slightly lower abundance. However, the model estimates lower female survival than estimates that did not incorporate recovery data. This research highlights the value of using both live and dead recapture data where available for the estimation of demographic parameters and abundance estimates, and the value of developing multiple models of the same data.

Protected species observer (PSO) detections of NARW; significant events for the greater good

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Offshore wind development in the US Atlantic Ocean relies on protected species observers (PSOs) to conduct dedicated monitoring and mitigation of all vessel operations. These efforts entail a great deal more than simply satisfying a suite of regulatory requirements and a host of commitments made to local stakeholders. In particular, numerous industry operators have expanded their baseline PSO monitoring and mitigation programs to add considerable value to NARW conservation efforts through data sharing and related reporting measures. Detections of NARW by PSOs are more than just a mitigation moment in time or a dot on a report map; rather, they are significant events that begin long before hundreds of passionate PSOs mobilize to vessels each year, and they extend well beyond completion of a survey. Countless hours are spent vetting, hiring, training, and preparing professional PSOs for the moment when they detect a NARW or an unidentified whale, which is assumed to be a NARW until diagnostic evidence confirms otherwise. PSOs are fortified with a multitude of tools and technologies to assist their real-time assessment of appropriate mitigation measures. These tools include vessel-specific Mysticetus™ System data collection software, configured within a regional network of project vessels to allow for automated sharing of NARW detections between vessel PSO teams as well as automated NARW text and email alerts for onshore project managers. PSOs document all NARW with high definition SLR cameras. Detection data are shared immediately with the NOAA Right Whale Sighting Advisory System via the Whale Alert smartphone application. Photos are shared with NOAA's Northeast Fisheries Science Center and the New England Aquarium. These proactive efforts are made to ensure – first and foremost – all NARW encounters are mitigated to the maximum extent possible, but also to contribute to the overarching goal of advancing NARW conservation for the greater good.

Large changes in right whale density in U.S. waters between 2003-2009 and 2010-2018

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The recent rise and fall of the North Atlantic right whale population has been well documented, with peak abundance occurring in 2010-2011. Concomitant changes in spatial distributions have also been reported for several regions, and broad-scale shifts characterized through analysis of passive acoustic data. Here, we comprehensively detail these changes by modeling and mapping absolute density of right whales (individuals / km^2) for U.S. waters and Nova Scotia at 5 km, monthly scale using visual line transect surveys. Starting with surveys conducted by 10 collaborating organizations from January 2003-May 2019, comprising 2,745,000 km of aerial and 68,000 km of shipboard effort, we built density surface models that linked abundance of whales sighted on

survey transects to environmental covariates obtained from remote sensing and ocean models. We accounted for differences in detection performance between surveys, effects of diving on visual availability of whales, and regional and seasonal differences in species-environment relationships, among other factors. We predicted the models across April 2003-March 2019, and summarized predictions into two eras, 2003-2009 and 2010-2018. Results confirmed large changes between the eras. Mean monthly densities south of Cape Hatteras dropped by amounts ranging from 56-76% in December-March. Between Cape Hatteras and Nantucket Shoals, densities increased more than 1000% in December-April, although survey data were sparse in 2003-2009. In the Gulf of Maine region, not including Cape Cod Bay, densities decreased 43% in March-July, over 1000% in August-September, and by 34-63% in October-February. Within Cape Cod Bay, densities increased, as reported by Ganley et al. (2019). Previous versions of this model have been widely used for U.S. permitting and regulatory activity, including for NOAA's Right Whale Risk Reduction Tool. Given the density changes indicated here, we recommend interested parties use this model's 2010-2018 predictions for future analysis and permitting. Results and documentation are freely downloadable.

Projecting regions of North Atlantic right whale (*Eubalaena glacialis*) habitat suitability in the Gulf of Maine in 2050

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Understanding the role environmental conditions play in North Atlantic right whale, *Eubalaena glacialis*, habitat suitability is key to determining the regions in need of protection for conservation of the species, particularly as climate change shifts suitable habitat. This study uses three species distribution modeling algorithms, together with historical data on whale abundance (1993 to 2009) and environmental covariates to build an ensemble model of past *E. glacialis* habitat suitability in the Gulf of Maine. Then, the model is projected onto the year 2050 for a range of climate scenarios. Specifically, the distribution of the species was modeled using generalized additive models, boosted regression trees, and artificial neural networks, and the environmental covariates included sea surface temperature, bottom water temperature, bathymetry, a modeled *Calanus finmarchicus* habitat index, and chlorophyll. Year-2050 projections used downscaled climate anomaly fields from RCP 4.5 and 8.5. The relative contribution of each covariate changed seasonally, with an increase in the importance of bottom temperature and *C. finmarchicus* in the summer, when model performance was highest. The 2050 projections indicated decreased habitat suitability across the Gulf of Maine during the months assessed relative to the present climatology, across a range of climate scenarios, with the exception of narrow bands of suitability along the Scotian Shelf in August, September, and October. The results suggest that regions outside of the current areas of conservation focus may become increasingly important habitats for *E. glacialis* under future climate scenarios.

Transport Canada (TC) update on North Atlantic right whale vessel management measures

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The Government of Canada's vessel management measures for the 2020 season to reduce the risk of vessel collisions with North

Atlantic right whales (NARW) in Canadian waters came into effect on April 28, 2020. The 2020 measures build off the measures from the previous year, and were developed in consultation with industry and scientists, taking into consideration past confirmed NARW detections, the latest science advice, navigational safety, and economic impacts. New measures have been introduced for 2020, including a restricted area in and near the Shediac Valley to protect an important proportion of the total NARW population that gathers for feeding and surface activity in this area, and a trial voluntary slowdown in Cabot Strait to provide additional protection in an important migratory passageway for NARW, while we build on our understanding of where, when, and how the whales travel through this area and the safety considerations for vessels transiting through this challenging corridor. New surveillance technologies, a Remotely Piloted Aircraft System (RPAS) and an underwater acoustic glider, have also been incorporated into the dynamic management of vessel measures for part of the season.

Understanding the cumulative impacts of multiple stressors on North Atlantic right whales: introducing the PCOMS Working Group

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Historically, the two primary threats to North Atlantic right whales have been ship-strikes and entanglement in fishing gear. While a better understanding of the effects of these disturbances on vital rates is emerging, a) there are many additional threats right whales face, and b) to date, these threats have been considered in isolation. That is, while we know entanglement negatively impacts body condition and survival, we don't know how these impacts may change in times of food limitation, or in areas with increased anthropogenic noise. We introduce the Population Consequences of Multiple Stressors (PCOMS) model, a new multi-institution, multi-species research effort to better understand multiple impacts. The PCOMS project has four goals: 1) to estimate exposure to multiple stressors; 2) to predict changes in behavior and physiology from these stressors; 3) to assess health; and 4) to quantify the relationship between health and vital rates at the individual and population level. We focus on Cape Cod Bay, where data on right whales and their prey have been sampled yearly since the 1980's and sound has been recorded since 2001. We will quantify exposure to entanglements, anthropogenic noise, and evaluate for the presence of entanglement injuries—all in the context of varying prey availability. We will link exposure and entanglement injuries to estimates of health at two temporal scales – retrospective analyses with the PCoD model, and ongoing drone-based studies to measure individual length and condition. Finally, we will link estimates of health to survival through a multi-state mark-recapture analysis with time-varying parameters. We will present an overview of existing stressor databases related to entanglements and vessel strikes, existing databases on sightings and visual health assessments (from planes, ships and drones), current models for right whale health, and future alterations needed to understand how health is linked to the multiple stressors.

North Atlantic Right Whale Mortalities in the United States, 2019 thru September 2020

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In 2019 and 2020 (through September) there were two confirmed North Atlantic right whale (NARW) mortalities within US waters. The first was reported 16 Sept 2019 off Fire Island, New York in advanced decomposition. A multiagency necropsy was conducted on 18 September; significant gross findings indicative of entanglement included multiple linear abrasions and lacerations on the dorsal rostrum, exiting the left gape, wrapping both pectoral flippers, and possibly the flukes (no gear was present). This whale was identified as Catalog #1226, "Snake Eyes," a 40 year old male that was last seen entangled alive in the Gulf of St. Lawrence, Canada on 6 August 2019. The second case (2020 calf of Catalog #3560) was reported 25 June 2020, off Elberon, New Jersey just at the edge of the NY/NJ Seasonal Management Area. A multiagency necropsy conducted on 28 June found evidence of two separate vessel strikes. The first propeller strike on the left head and cranial thorax partially transected the rostrum, was likely significantly debilitating, and occurred weeks prior to death. The second strike on the dorsal peduncle severed vessels and partially severed the spinal cord, causing traumatic hemorrhage, paralysis, and acute death. Another NARW calf with life-threatening injuries from a vessel strike was observed alive off the coast of Georgia in January 2020 and is now presumed dead despite an attempt at medical intervention (2020 calf of Catalog #2360). These three whales and an additional nine NARW carcasses found in Canadian waters in 2019 are included in the ongoing Unusual Mortality Event, bringing the total to 41 documented NARW deaths (31) and serious injury cases (10) since 2017. These cases represent approximately 10% of the population and demonstrate the urgent need for additional mitigation measures to prevent vessel collisions and fishing gear entanglements from driving NARWs to extinction.

Variations in North Atlantic right whale food (Calanus spp.) in the southern Gulf of St. Lawrence

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Mitigation of anthropogenic threats to the North Atlantic right whale (NARW), *Eubalaena glacialis*, is dependent on accurately predicting variations in distribution of this species. On their foraging grounds, the spatial distribution of NARWs is influenced by the concentration of their zooplankton prey, mainly lipid-rich copepods of the genus *Calanus*. Development of suitable foraging habitat for NARWs depends on alignment of mechanisms that supply and aggregate *Calanus* spp. at depths that the whales can access during foraging dives. Our objective

is to investigate these mechanisms and ultimately improve prediction of suitable foraging habitat in the southern Gulf of St. Lawrence (sGSL), an area where NARWs occur from spring through autumn, using empirical observations and model simulations. We quantified horizontal and vertical variations in abundance of *C. finmarchicus*, *C. hyperboreus*, and *C. glacialis* in the sGSL in autumn 2018 and investigated their transport using particle tracks from simulated circulation regimes in late summer and autumn. The observed stage-specific vertical distributions of *Calanus* spp. suggest a mixture of active (*i.e.* upper water column, feeding) and diapausing (*i.e.* lower water column, suspended development) *C. finmarchicus* and primarily diapausing *C. hyperboreus* and *C. glacialis*. Empirical observations and simulations indicate strong potential for recent immigration of active but not diapausing *Calanus* spp., and retention of diapausing *Calanus* spp. in the sGSL. High abundances of *Calanus* spp. do not persist year round in the sGSL. The shallow bottom depth (usually < 80 m) prevents refuge from predation and may contribute to export from the system in autumn and winter when particle tracking simulations indicate enhanced flushing. This analysis emphasizes that the interaction of ocean circulation and vertical migration associated with copepod life history status is a key process influencing NARW foraging habitat in the sGSL.

Fisheries and Oceans Canada: an update on research and monitoring activities for North Atlantic right whales

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Fisheries and Oceans Canada continues to conduct scientific research on the endangered North Atlantic right whale (NARW; *Eubalaena glacialis*) with multiple initiatives underway including aerial surveys, passive acoustic monitoring (PAM), foraging-habitat and prey studies, noise analyses and modelling, and other studies. Systematic line transect surveys flown in 2019 estimated there were 204 individuals (95% CI: 96 – 433) in the Gulf of St. Lawrence (GSL). Surveys were extended in 2020 to include the Scotian Shelf. Photographs and videos of NARWs are being collected during surveys and preliminary individual identification and injury documentation underway. A flexible analytical approach to quantify and compare the activities of commercial fisheries in the GSL is being developed for risk assessments. Processes driving *Calanus* availability in southern GSL foraging areas are being assessed through the analysis of 3-D distributions of *Calanus* spp. and coupled bio-physical *Calanus* model simulations. The Marine Environmental Quality program cruise collected aerial photogrammetry data for health assessment, blow and biopsy samples for hormonal studies, and completed two DTAG deployments. PAM using bottom-mounted acoustic recorders continues at a number of sites in the Atlantic and GSL including the Grand Manan, Roseway, Jordan and Emerald Basins, Cabot Strait, several sites along the edge of the Scotian Shelf, George's Bank, and the Grand Banks, where habitat models suggest NARW might migrate or feed. Additional PAM systems in the GSL include six Viking Buoys with near-real time detection capabilities. NARW detectors include the low-frequency detection and classification system (LFDCS) for the Atlantic stations and a classical time-frequency based detector and a new deep neural network algorithm for the GSL. Research is underway to improve the ability to monitor NARWs in waters subject to high levels of

seismic and shipping noise. This presentation will provide an overview of the NARW focused research undertaken by DFO and its collaborators.

North Atlantic right whale monitoring and surveillance: report and recommendations of the National Marine Fisheries Service's Expert Working Group

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[7]NOAA Fisheries Office of Protected Resources, 1315 East-West Highway. 13th Floor. Silver Spring, MD, 20910
[8]NOAA Fisheries Southeast Regional Office. 263 13th Avenue South. St. Petersburg, FL, 33701

In October 2019, NOAA Fisheries convened an Expert Working Group (EWG) to evaluate current monitoring and surveillance efforts for North Atlantic right whales (NARW) and provide recommendations for a comprehensive monitoring strategy to guide future analyses and data collection. The EWG consisted of five NOAA Fisheries researchers with expertise in marine mammal monitoring, but not directly involved in current NARW monitoring efforts. They were tasked with providing survey design recommendations toward two management objectives: (1) improve our understanding of population status by identifying and tracking essential population metrics, and (2) improve our understanding of distribution and habitat. The report summarized the information shared with them by agency NARW experts on management needs for monitoring data, using mark-recapture analysis to estimate abundance and evaluate trends, current monitoring efforts in the United States and Canada, and current funding levels. The EWG then provided recommendations to improve NOAA Fisheries' overall monitoring strategy for NARWs, with recognition of the significant contribution to NARW research and monitoring carried out by partner institutions and agencies. The recommendations addressed several overarching themes including:

(1) identifying the essential population and individual metrics to be monitored
(2) characterizing analyses that may be conducted with existing data that are critical to fine-tuning and efficiently executing an effective monitoring plan
(3) expanding the North Atlantic right whale species distribution model through data standardization and coordination
(4) establishing an integrated visual and passive acoustic monitoring scheme
(5) evaluating the utility of other research tools

NOAA Fisheries is considering the EWG's recommendations, as well as other relevant information, in its decision-making about right whale research and population monitoring. In doing so, we will work closely with our partners in considering the recommendations to ensure that overall North Atlantic right whale monitoring efforts are effective in helping to recover the species.

Automatic whale detection from vessels for real-time ship-strike mitigation – current developments and applicability

Zitterbart, D.P.[1], Richter, S.[1], Bocconcelli, A.[1], Baille, L.[1], Gomez-Ibanez, D.[1], Thwaites, F.[1], Petitt, B.[1],
Baumgartner, M.[1], Wiley, D.[2]

[1]*Woods Hole Oceanographic Institution, 266 Woods Hole Road, MS#11, Woods Hole, MA, 02543, United States (dpz@whoi.edu)*
[2]*Stellwagen Bank National Marine Sanctuary, NOAA National Ocean Service, Scituate MA 02066 USA*

Ship-strikes are a serious threat to North Atlantic Right Whales. This became particularly clear in 2017, when 17 of the ~470 remaining North Atlantic right whales died. At least 6 of these deaths are believed to be due to vessel collisions. This event clearly showed the need for technologies that can help to mitigate ship-strikes. Ship-strike can be mitigated if the whale is detected from the vessel itself early enough to react (slow-down, change course). Currently, real-time marine mammal detection from vessels prone to ship-strike (e.g. fast ferries) is mainly achieved by human marine mammal observers. Visual observations are only possible during daylight hours and require numerous observers to guarantee continuous observation; therefore, visual observers for mitigation purposes are rarely implemented on smaller vessels or ferries. As autonomous vessels will soon become larger and more numerous, increasing the need for technologies that allow for the detection and avoidance of large whales.
Thermal imaging systems have been increasingly tested during the last decade for their capability to detect and localize whales in real-time. For thermal imaging systems to be effective for ship-strike mitigation, automatic detection of the whale signatures in the video feed is crucial.
Here we present our initial results on the development of low-cost solutions for ship-strike mitigation technologies using thermal imaging camera systems. The systems are designed to be used on any kind of ships and have been tested at speeds of up to 15kn. We show that low-cost thermal imaging solutions provide sufficient detection range for effective ship-strike mitigation. We will furthermore present preliminary modelling results for which kind of vessels and speeds such systems could provide an effective solution for ship-strike mitigation.

North Atlantic Right Whales in the New York Bight Update: Comprehensive Findings from Monthly Aerial Surveys Over Three Years

Zoidis, A.M.[1], Kate Lomac-MacNair[1], Darren Ireland[2], Meghan Rickard[3]

[1]*Tetra Tech, 1999 Harrison Street, Suite 500, Oakland, CA, 94611, United States (ann.zoidis@tetratech.com)*
[2]*LGL Ecological Research Associates, Inc., 4103 South Texas Avenue, Suite 211, Bryan, TX 77802*
[3]*NYS Dept. of Environmental Conservation, 205 N Belle Mead Road, Suite 1, East Setauket, NY 11733*

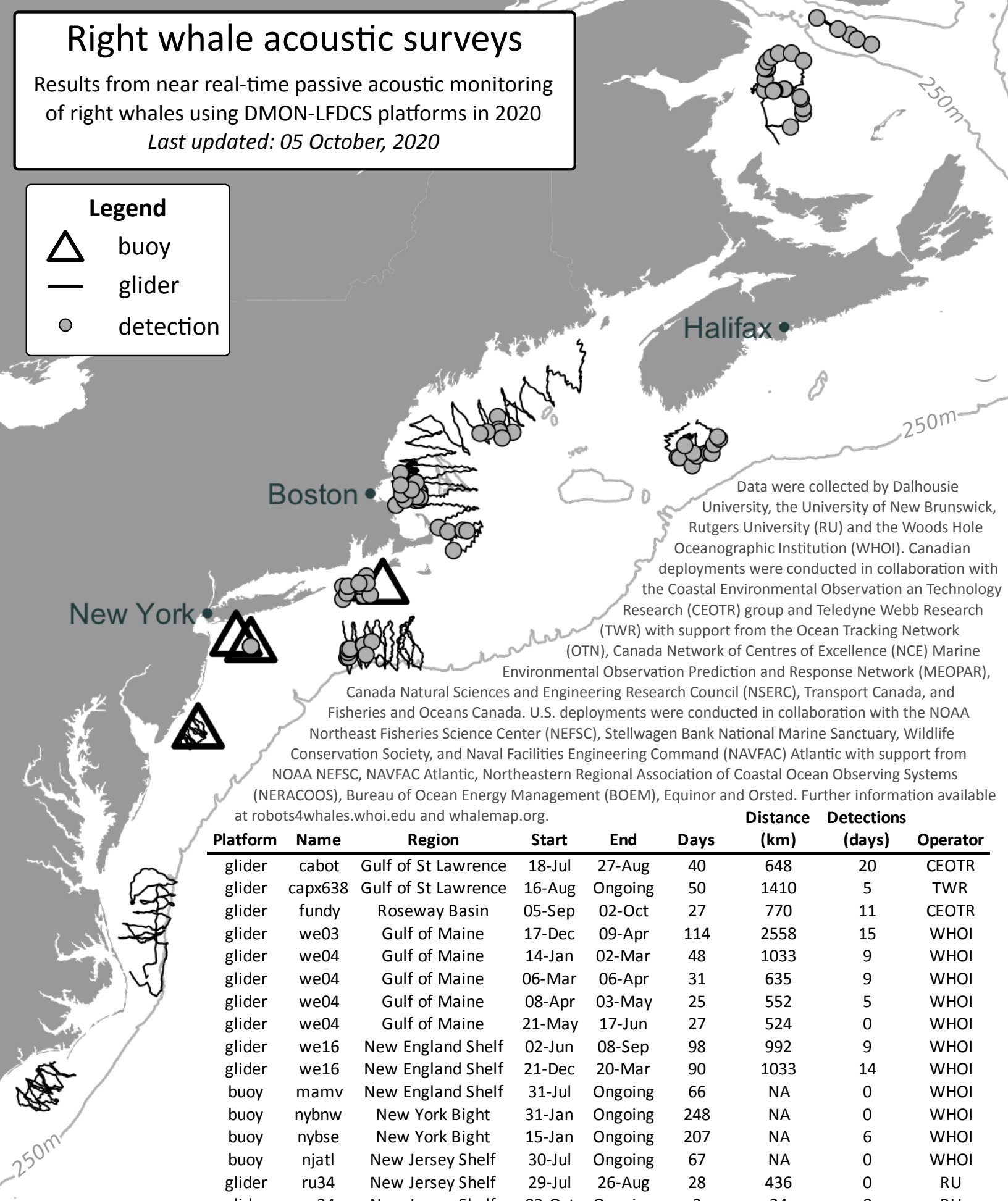
North Atlantic right whale occurrence and distribution were studied in the New York Bight (NYB) during monthly aerial surveys (688.3 hr and 140,359 km effort over water) March 2017-February 2020, as part of a NYS Department of Conservation Large Whale Monitoring Aerial Survey project. The survey area (43,449 km^2) extends from the southern Long Island shoreline just past the continental shelf break. Fifteen sightings of 24 individual NARWs were made. The combined sighting rate across years was 0.17 individuals/1,000 km of effort and an average annual density was obtained (0.107 individuals/1,000 sq km) through line-transect analysis. Mean group size was 1.6 whales. NARWs were sighted during 6 months (November-May; none during summer months). Sighting rates were highest during spring, followed by winter. Abundance estimates corrected for detection bias estimated 26-65 whales present in March-April while 28-52 whales may have been present in November-December. The fifteen NARW sightings were distributed throughout the survey area (three out of four habitat classes) with the highest occurrence in the shelf (0.27 whales/1,000 km effort). No right whales were recorded in the slope. Nearshore sightings (0-25 km from shore) occurred in winter and spring. Behavioral state was predominately travel but also included mill and probable foraging. The foraging individual was sighted in the plain (>1,000 m depth) in spring. Photographs and metadata obtained on each NARW documented (n=15) were sent to

the New England Aquarium Catalog for photo-identification. NEAq confirmed identification of 11 whales: eight during Year 1, two during Year 2, and five during Year 3. One whale (#2160) was sighted twice, in April 2017 and in January 2018. NARWs photographed from April and November 2017 and February 2018 were new to the catalog. These final results contribute to the understanding of the spatio-temporal occurrence and habitat use patterns of NARWs in the NYB.

Right whale acoustic surveys

Results from near real-time passive acoustic monitoring of right whales using DMON-LFDCS platforms in 2020

Last updated: 05 October, 2020



Data were collected by Dalhousie University, the University of New Brunswick, Rutgers University (RU) and the Woods Hole Oceanographic Institution (WHOI). Canadian deployments were conducted in collaboration with the Coastal Environmental Observation an Technology Research (CEOTR) group and Teledyne Webb Research (TWR) with support from the Ocean Tracking Network (OTN), Canada Network of Centres of Excellence (NCE) Marine Environmental Observation Prediction and Response Network (MEOPAR), Canada Natural Sciences and Engineering Research Council (NSERC), Transport Canada, and Fisheries and Oceans Canada. U.S. deployments were conducted in collaboration with the NOAA Northeast Fisheries Science Center (NEFSC), Stellwagen Bank National Marine Sanctuary, Wildlife Conservation Society, and Naval Facilities Engineering Command (NAVFAC) Atlantic with support from NOAA NEFSC, NAVFAC Atlantic, Northeastern Regional Association of Coastal Ocean Observing Systems (NERACOOS), Bureau of Ocean Energy Management (BOEM), Equinor and Orsted. Further information available at robots4whales.whoi.edu and whalemap.org.

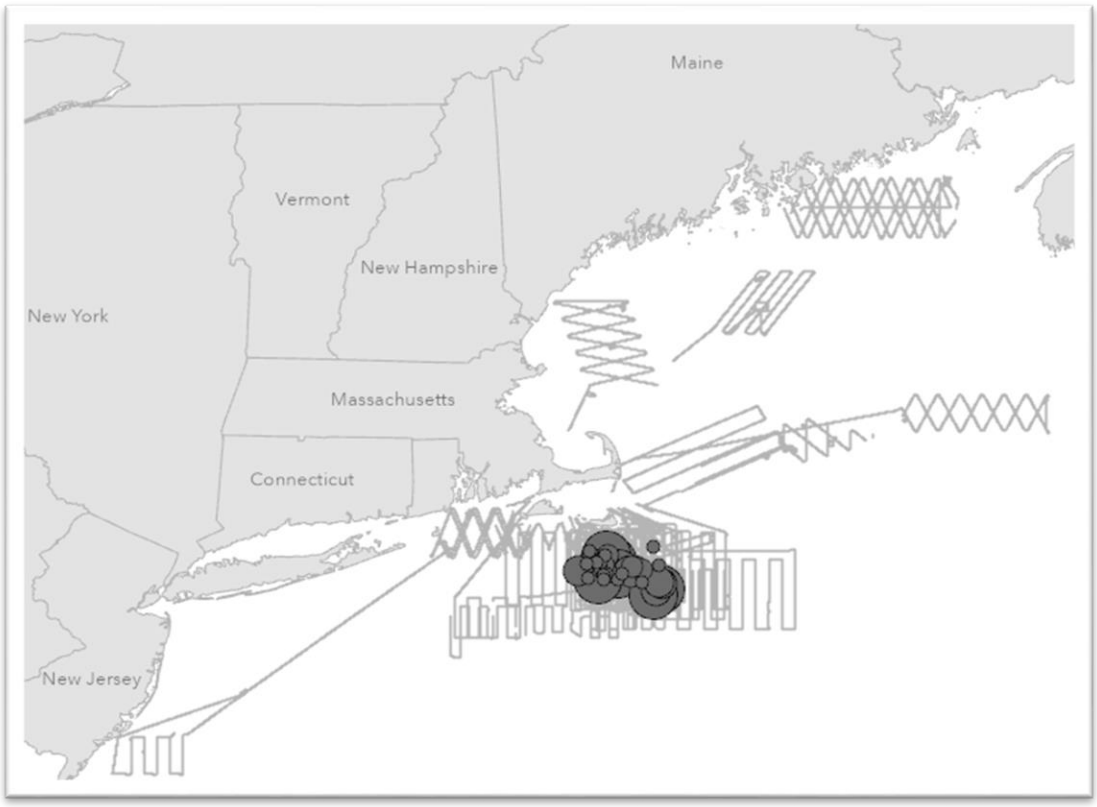
Platform	Name	Region	Start	End	Days	Distance (km)	Detections (days)	Operator
glider	cabot	Gulf of St Lawrence	18-Jul	27-Aug	40	648	20	CEOTR
glider	capx638	Gulf of St Lawrence	16-Aug	Ongoing	50	1410	5	TWR
glider	fundy	Roseway Basin	05-Sep	02-Oct	27	770	11	CEOTR
glider	we03	Gulf of Maine	17-Dec	09-Apr	114	2558	15	WHOI
glider	we04	Gulf of Maine	14-Jan	02-Mar	48	1033	9	WHOI
glider	we04	Gulf of Maine	06-Mar	06-Apr	31	635	9	WHOI
glider	we04	Gulf of Maine	08-Apr	03-May	25	552	5	WHOI
glider	we04	Gulf of Maine	21-May	17-Jun	27	524	0	WHOI
glider	we16	New England Shelf	02-Jun	08-Sep	98	992	9	WHOI
glider	we16	New England Shelf	21-Dec	20-Mar	90	1033	14	WHOI
buoy	mamv	New England Shelf	31-Jul	Ongoing	66	NA	0	WHOI
buoy	nybnw	New York Bight	31-Jan	Ongoing	248	NA	0	WHOI
buoy	nybse	New York Bight	15-Jan	Ongoing	207	NA	6	WHOI
buoy	njatl	New Jersey Shelf	30-Jul	Ongoing	67	NA	0	WHOI
glider	ru34	New Jersey Shelf	29-Jul	26-Aug	28	436	0	RU
glider	ru34	New Jersey Shelf	03-Oct	Ongoing	2	24	0	RU
glider	we14	Mid-Atlantic Bight	30-Jan	19-Mar	49	1115	0	WHOI
glider	we15	Mid-Atlantic Bight	05-Feb	23-Mar	47	874	0	WHOI

18 deployments, 1264 days, 12604 kilometers, and 103 days with detections

NMFS Northeast Right Whale Aerial Surveys
October 2019
Canada

- NOAA Twin Otter conducted surveys in the Canada from October 13, 2019 – October 29, 2019
- Total flight time (including transits) was 44.8 hours
- Observed right whales on 8 of the 9 survey days
- Sighted 158 right whales (including repeats of individuals) with maximum aggregation size of 30

NMFS Northeast Right Whale Aerial Surveys
October 2019 – October 2020
United States



- NOAA Twin Otter conducted surveys in the US from November 9, 2019 - September 17, 2020
- Total flight time (including transits) was 169.7 hours
- Observed right whales on 18 of the 32 survey days
- Sighted 320 right whales (including repeats of individuals) with maximum aggregation size of 42

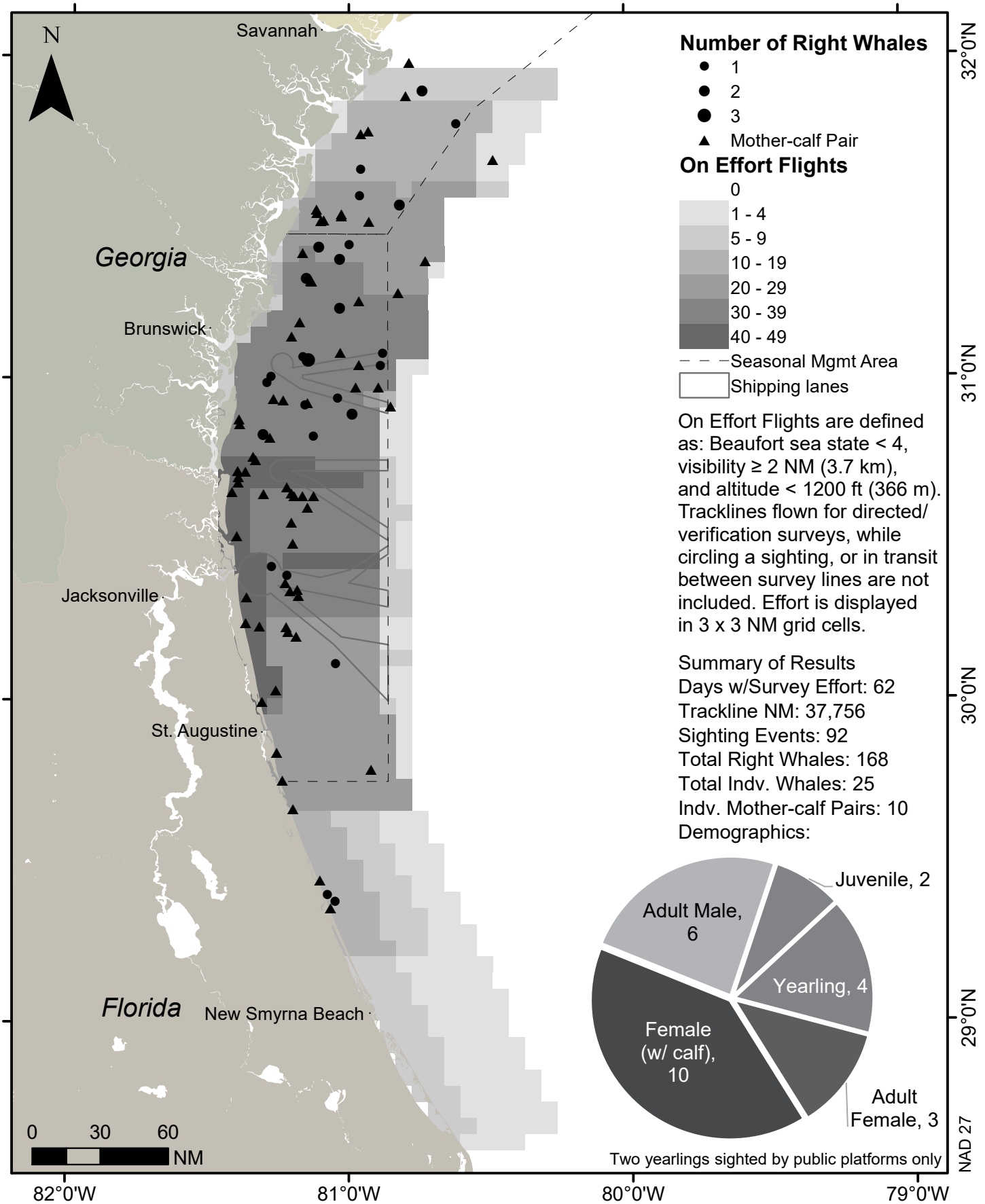
Southeast U.S. Aerial Surveys

December 1, 2019 – March 31, 2020

Clearwater Marine Aquarium Research Institute

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



Summary of 2019-2020 Gulf of Mexico Sightings

Catalog #3560 and Calf, November 2019 - March 2020

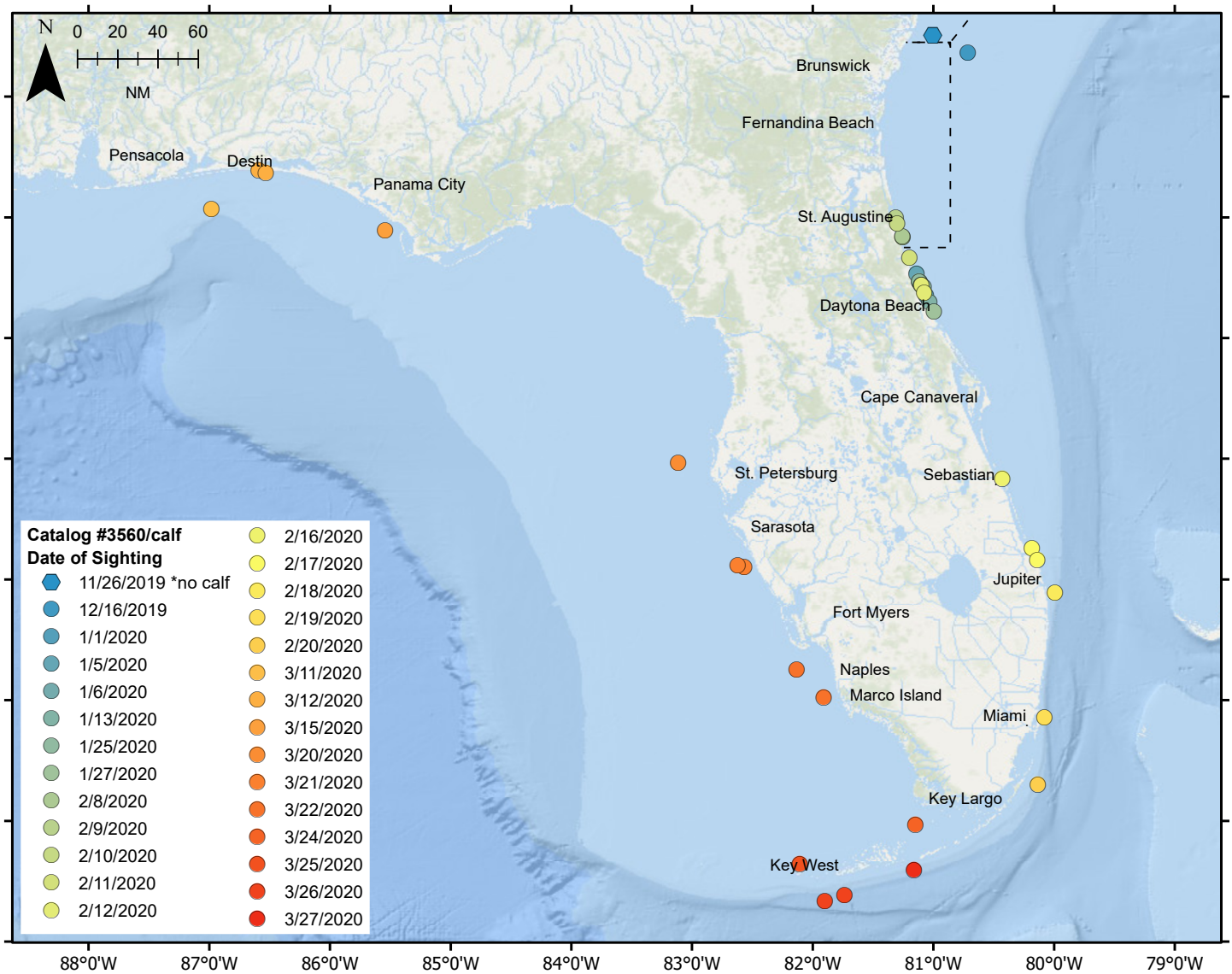
After spending approximately 1.5 months in the primary calving grounds off Georgia and Northeast Florida, Catalog #3560 and calf moved south along the east coast of Florida during February and into the Gulf of Mexico (GoMex). There were 14 confirmed sightings of the pair in the GoMex and the Florida Keys. On March 11, a charter fisherman first reported the pair off Pensacola and the whales were subsequently sighted along the Florida Panhandle from March 11-15. Later, they were spotted making their way south between Clearwater/St. Petersburg and Marco Island from March 20-22, on the Gulf side of the Florida Keys on March 24-25, and in the Straits of Florida on March 26-27. North Atlantic right whale sightings in the GoMex are rare[1,2]. There have been a handful of sighting events: two adults in 1963, a dead calf in 1972, mother-calf pairs in 2004 and 2006, and a juvenile in 2018.

Distribution and habitat use during this event

- No sightings between Key Largo and Pensacola while the whales were inbound to the GoMex in late February and early March.
- Right whales are known to use the Panhandle and west coast of Florida[1,2], but sightings from this event near the Florida Keys are novel and have helped to shed light on possible travel routes. In this case, #3560 and calf navigated shallow waters along the northern extent of the Keys and exited the GoMex west of the Marquesas Keys (west of Key West).
- No sightings along the Atlantic coast while northbound in late March, but this is not uncommon for whales sighted in SE Florida.
- Confirmed sighting of the pair from a charter fisherman off the Outer Banks of North Carolina on April 06.

Sighting sources and response

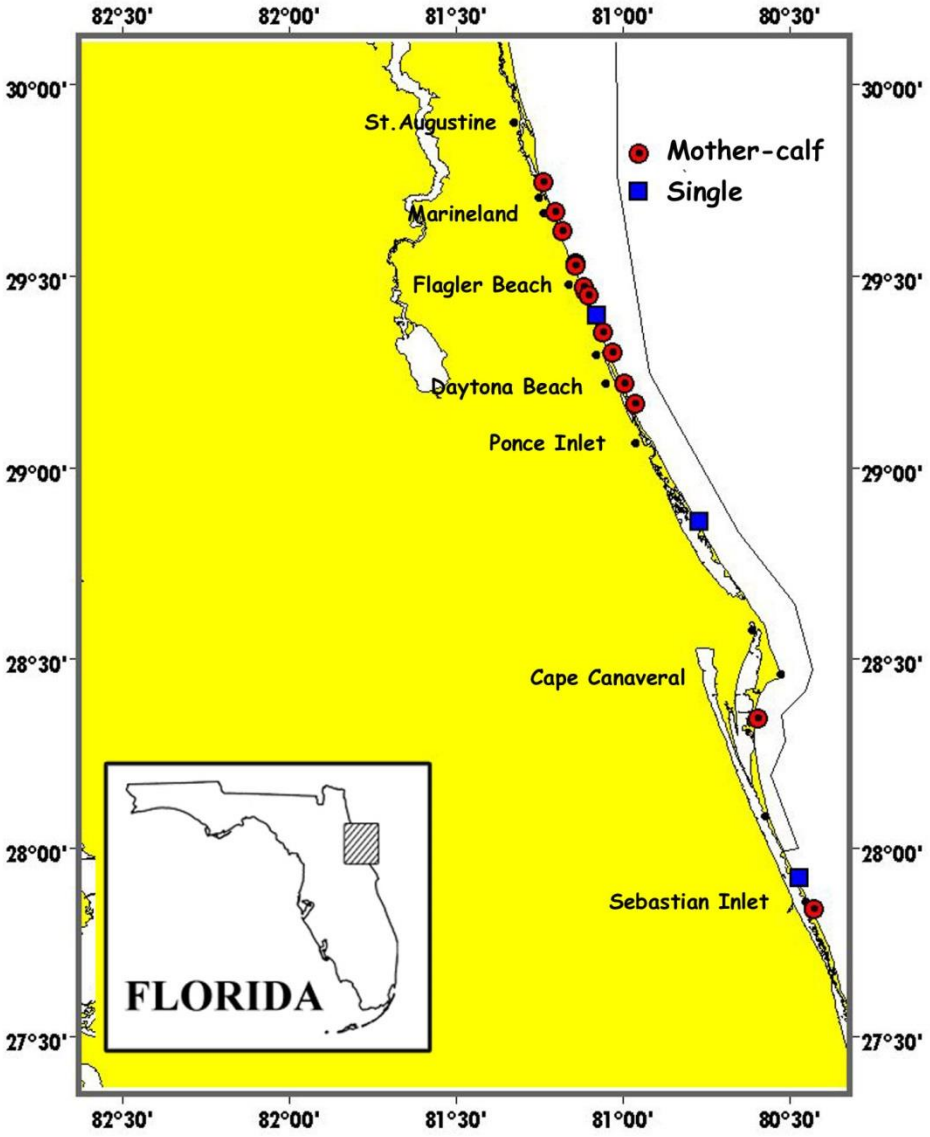
- No dedicated survey effort outside of the primary calving habitat. Sightings in the GoMex were generated by the public.
- FWC, NOAA SERO, FWC Law Enforcement, USCG, and local stranding network partners coordinated to confirm sightings, discourage harassment, and alert mariners, mainly through the use of social media and local news media outlets.



Summary prepared by the Florida Fish and Wildlife Conservation Commission (FWC). Sightings Sources: FWC, Clearwater Marine Aquarium Research Institute (CMARI), Marineland Right Whale Project, Marine Resources Council (MRC), Florida Atlantic University (FAU), and the general public.

[1] Ward-Geiger, L., A. Knowlton, A. Amos, T. Pitchford, B. Mase-Guthrie, and B.Zoosma. 2011. Recent sightings of the North Atlantic right whale in the Gulf of Mexico. Gulf of Mexico Science 2011 (1): 74-78.

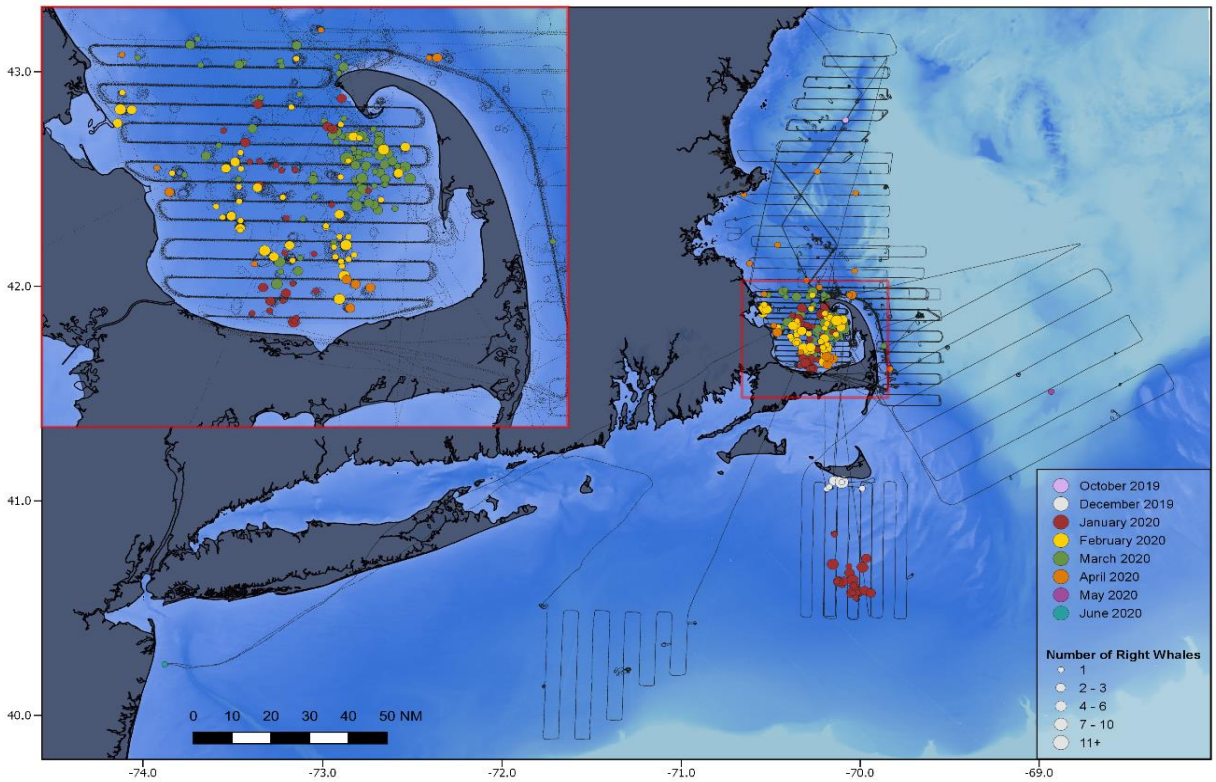
[2] Jackson, K., K. Stone, J. Jakush, T. Pitchford, M. Zani, M. White and B. Mase. 2018. Monitoring the long-distance movement of a North Atlantic right whale in the Gulf of Mexico. North Atlantic Right Whale Consortium Meeting 2018.



Verified right whale sightings by the Volunteer Sighting Network (VSN) during the 2019-20 southeastern U.S. (SEUS) season. Sightings resulted from a collaborative effort between the Marineland Right Whale Project and the Marine Resources Council, and included assistance by the Florida Fish and Wildlife team. The total n = 19. Most sightings were mother-calf pairs, with a handful of singles. There were no groups reported for this area. The thin black line off the coast is the boundary of the right whale critical habitat.

Aerial right whale surveys in Cape Cod Bay and adjacent waters by the Center for Coastal Studies Right Whale Ecology Program

October 2019 to June 2020



Month	No. of aerial surveys*	Trackline miles (nm)	No. of individual right whales	No. of new individuals for season
October	1	266	1	1
November	1	266	0	0
December	5	1157	13	13
January	5	1407	75	71
February	4	957	67	43
March	5	1373	102	42
April	6	1837	21	13
May	4	1432	1	1
June	1	496	1**	1**
	32	**9191**	**281**	**185**

*Due to covid-19 there was a 16 day gap of survey effort (19 March to 04 April)
**Deceased 2020 calf of 3560

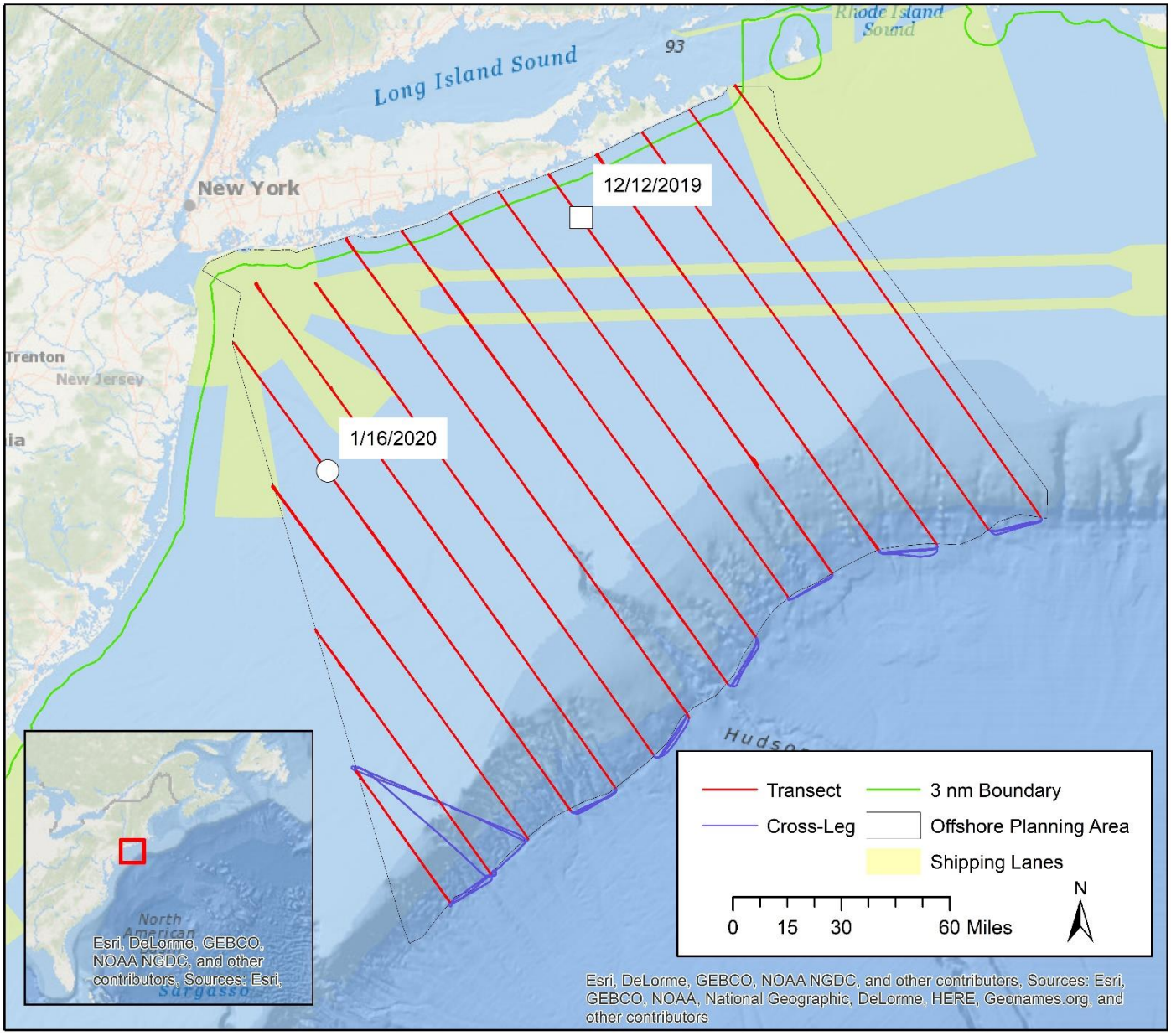
- CCS conducted right whale aerial surveys aboard Cessna 337 and O-2 Skymasters from 20 October 2019 to 25 June 2020
- Observed right whales on 22 of 32 aerial surveys
- Habitat team collected 268 zooplankton samples on 13 research cruises in Cape Cod Bay
- Across all platforms CCS (including opportunistic and shore) documented 198 individual right whales, including:

Age Class	Female	Male	Unknown Sex
Adult	62	94	7
Juvenile	8	9	8
Calf	0	1	3
Unknown	0	0	6

RWEP team: Stormy Mayo, Amy Green, Christy Hudak, Amy James, Emily Kelly, Brigid McKenna, Alison Ogilvie

Research conducted under NMFS Permit #19315-01

NYB Whale Monitoring Aerial Surveys
NYS Dept. of Environmental Conservation & Tetra Tech
November 2019 - February 2020



- 12/12/2019 sighting: 2 whales
  Surface active behavior

  1. #4540, F, 6 years old at time of sighting
  2. #4120, F, 8 years old at time of sighting

- 1/16/2020 sighting: 2 whales
  No photos taken

For more information see the Final Comprehensive Report:
https://www.dec.ny.gov/docs/fish_marine_pdf/mmaeran3.pdf

NYSDEC contact: Meghan Rickard (meghan.rickard@dec.ny.gov)
TT contact: Ann Zoidis (ann.zoidis@tetratech.com)

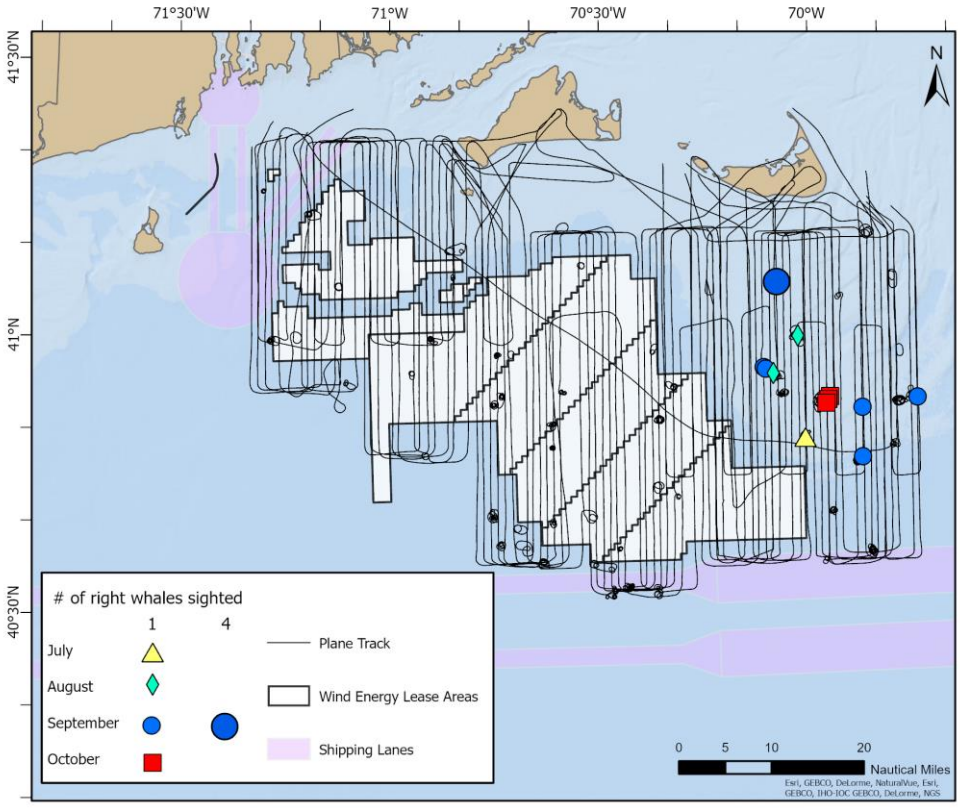
TETRA TECH

NEW YORK STATE OF OPPORTUNITY | Department of Environmental Conservation

New England Aquarium
Protecting the blue planet

Anderson Cabot Center for Ocean Life
at the New England Aquarium

Aerial surveys of the MA/RI Wind Energy Areas: 2020 Field Season
Anderson Cabot Center for Ocean Life at the New England Aquarium



Month	# of survey days	Trackline miles (nm)	# of right whale sightings	# of right whales	# of unique individuals
March	1	289	0	0	0
June	2	784	0	0	0
July	2	586	1	1	1
August	2	582	2	2	2
September	2	681	5	8	8
October	1	392	3	3	3

Right Whale Catalog #	Sex	Age
3150	M	19
3832	M	12
3970	M	11
4095	M	A*
4145	M	9
4360**	U	U
4546	F	5
2019CalfOf 2503	M	1

*Adult of unknown age
**Unknown age or sex

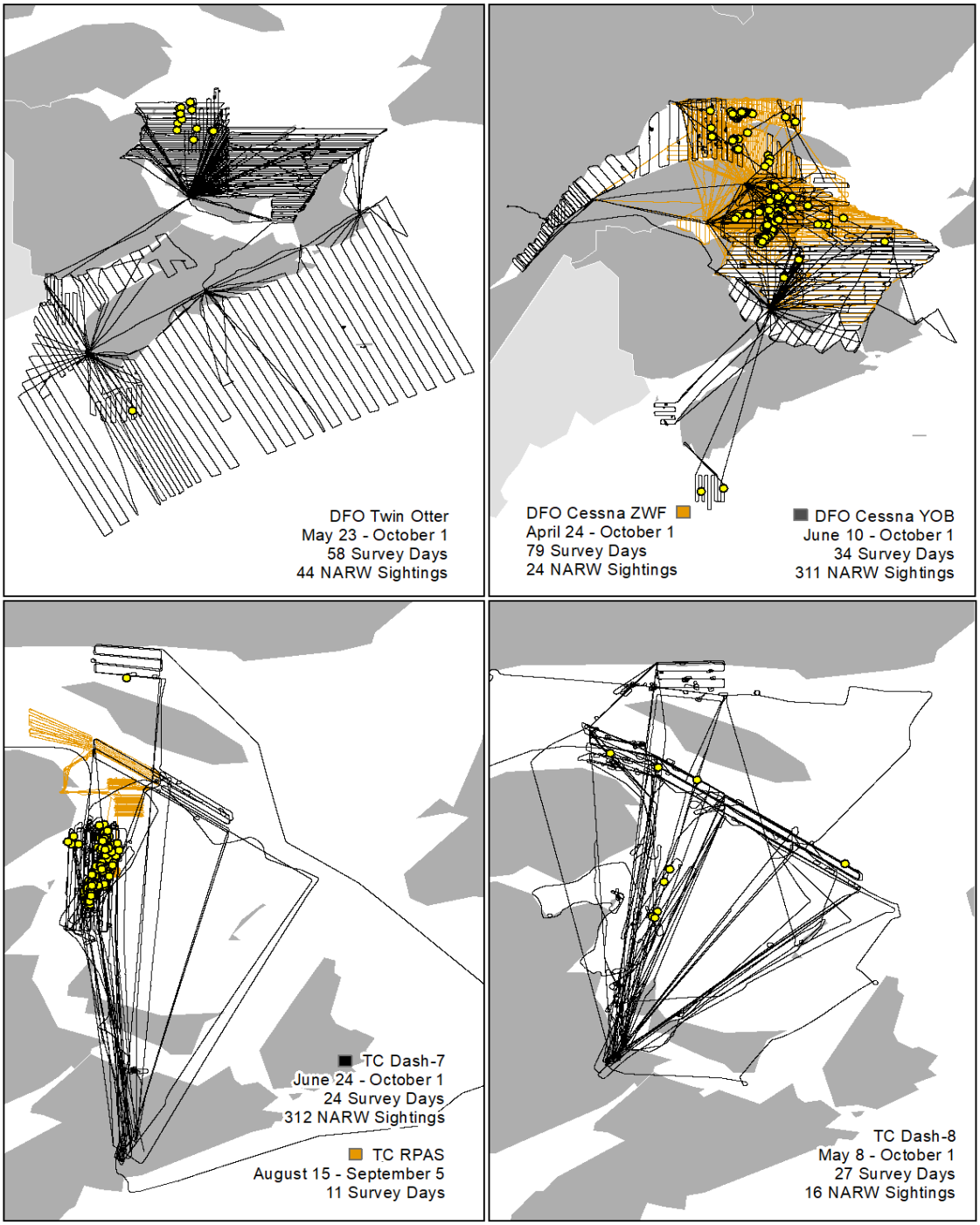
Survey team: Orla O'Brien, Katherine McKenna, Amy Warren, Laura Ganley

Funding by: Massachusetts Clean Energy Center (MassCEC) and BOEM

Surveys conducted under NMFS research permit 19674. Map created by Orla O'Brien.

2020 Marine mammal aerial surveys in eastern Canadian waters

Conducted by: DFO and TC



- All surveys except DFO-Twin Otter (Oct 1) and TC-RPAS (Sept 10) extended beyond October 1.
- Fisheries surveillance flights conducted by DFO- Conservation and Protection not included although NARW sightings were reported (n= 41) and efforts extended beyond October 1.
- Sightings in map (yellow circles) represent either single or multiple individuals.
- Imagery continues to be collected and submitted to the Right Whale Consortium. Photo-identification have not been completed.

Fisheries and Oceans Canada (DFO) Science Program- Twin Otter, Cessna 1 (ZWF) and Cessna 2 (YOB)
TC National Aerial Surveillance Program- Atlantic (Dash-8) and Central (Dash-7)
TC Aircraft Services Directorate - Remotely Piloted Aircraft System (RPAS) *Project*

Fisheries and Oceans Canada | Pêches et Océans Canada

Gulf of St. Lawrence Cruise by Fisheries and Oceans Canada, Maritimes & Quebec: North Atlantic Right Whale Detection, Ecology, Ethology, and Health

After postponement and with a skeleton crew due to Covid-19 restrictions, between 4th and 15th August, 158 hours sightings effort in sea states from 0-6 (mostly 3 & 4) were completed on this cruise, typically with 2 observers on watch at any given time. During this time, we had 21 confirmed (and 3 possible) NARW sightings, comprising of a minimum of 41 animals, including one calf (and 4 more animals in possible sightings), although this includes resightings. We identified 14 animals, plus a calf associated with it's mother, for a total of 15 individuals, which represents the minimum number of individual animals observed during the cruise. These were: 1017; 1209; 1507 (Manta); 1703; 1720; 2503 (Boomerang); 3380 (Lemur); 3579 (with calf); 3680 (Seadragon); 3890; 3823; 4140; 4190; and 4440. None of these encounters were in the Shediac Valley. Instead, the sightings were considerably further to the North, in the mouth of the Chaleur Bay, on the American Bank, and along the Laurentian Channel, with the greatest concentration in or near the ship traffic separation scheme to the Northwest of Anticosti in the Jacques Cartier Strait.

In addition to photogrammetry, we obtained 22 blow samples from right whales as well as 4 biopsies, and a skin sample obtained incidental to tagging. No faecal samples were obtained as there was none observed from the zodiac. 2 DTAGs were deployed (on 1720 & 4190) for a total of around 11 hours. Echosounder data was also collected for plankton studies.

Science crew: Andrew Wright (DFO), Tonya Wimmer (MARS), Christian Ramp (MARS), Josiane Riopel (MARS), Miranda Unger (MARS), Galaxina Renaud (MARS), Liam Olders (Liam Olders Aerial) and Michael Williamson (King's College London). Ground support: Kathleen Buffet (DFO) and Simon Higginson (DFO).

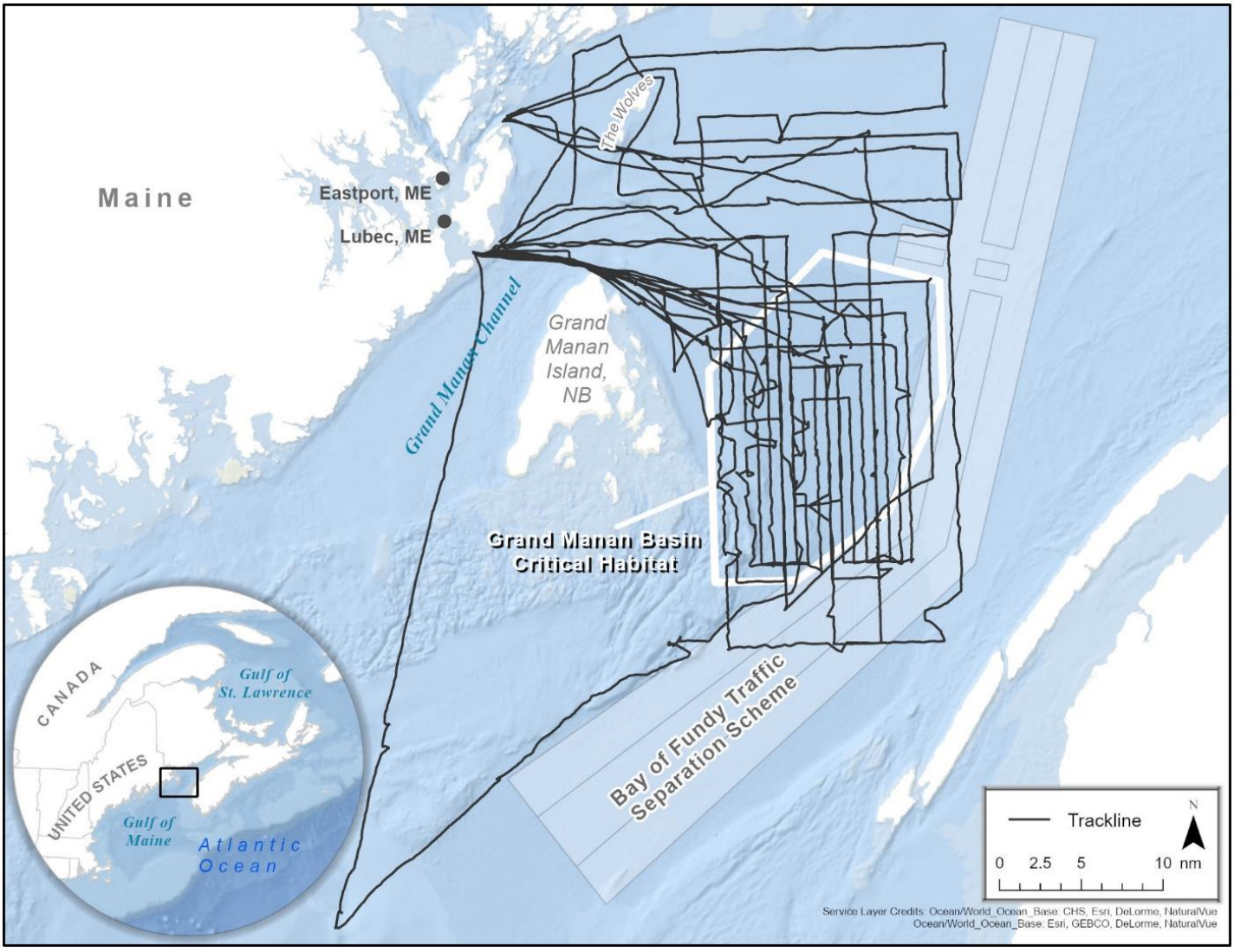
This cruise had extensive support from the Marine Animal Response Society (MARS), who are thanked for their important contributions. Similarly, the small crew are also due much praise as they all worked extremely hard, often interchanging roles seamlessly, to ensure the cruise was a success.

Research was conducted under SARA, FA and MPA permits issued by Department of Fisheries and Oceans Canada aboard the *RV Coriolis II* and *POS Tracy*. Map taken from Whalemap.

Canada

Anderson Cabot Center for Ocean Life
at the New England Aquarium

Vessel-based right whale surveys in the Bay of Fundy, Canada - 2020
Anderson Cabot Center for Ocean Life at the New England Aquarium



Month	No. of survey days	Track line miles (NM)	No. of right whales
August	**9**	**848**	**0**
September	**3**	**366**	**0**
Total	**12**	**1214**	**0**

Survey team: Marianna Hagbloom, Philip Hamilton, Kelsey Howe, Amy Knowlton, Marilyn Marx, Bill McWeeny and Amy Warren

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

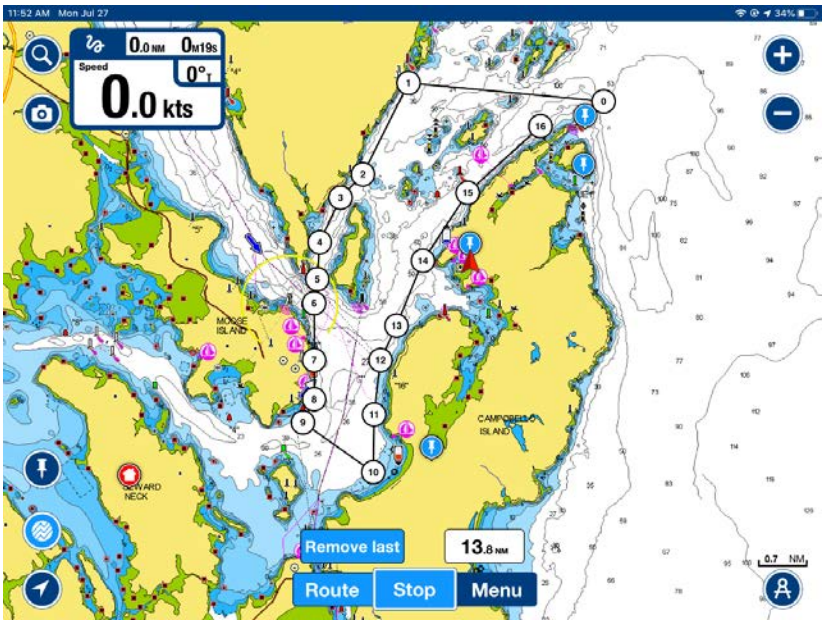
Research conducted under section 73 Species at Risk (DFO-MAR-2016-04) and Section 38 (Marine Mammal Regulations) permits issued by Department of Fisheries and Oceans Canada. Research vessel *Nereid* operated under foreign fishing vessel license 344228. Map provided by Brooke Hodge.

CANADIAN WHALE INSTITUTE

Right whale sighting summary 2020

Vessel-based opportunistic sighting in Head Harbour Passage, western Bay of Fundy, Canada.

Date: 21 July 2020 Number of right whale(s): 1

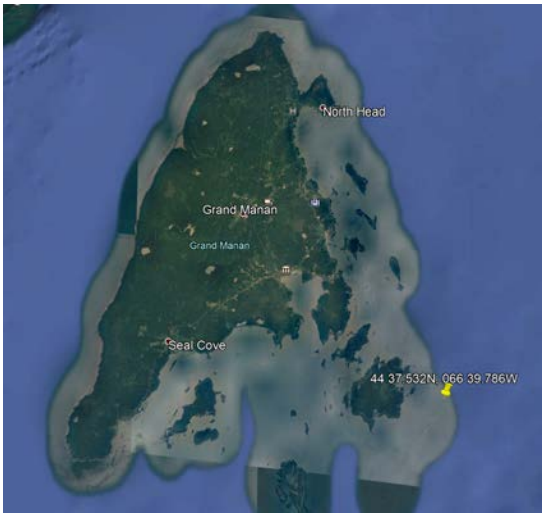


The numbered circles, starting with '0" represent the path of one right whale on 21 Jul 2020 from ~10:00 to ~17:00 ADT.

Identified as the 2019 female calf of right whale number 2791 by the right whale research team at the Anderson Cabot Center for Ocean Life at the New England Aquarium

Work conducted under Species at Risk permit number DFO-MAR-GLF-QUE-2020-18; funding provided by Fisheries and Oceans Canada.

Date: July 27 2020 Number of right whale(s): 1



CWI received a report six days later, on Monday 27 July 2020, of a right whale was observed east of Grand Manan off Whitehead Island, Bay of Fundy, Canada. Position 44°37.532'N, 066°39.786'W. Only a fluke shot was obtained, no identification possible.

Report from NARWC Education Committee
October 2020
Robert Rocha – Chair

Regional (submitted by Anne DiMonti, Monica Pepe, Robert Rocha)

Bob, Monica and Anne continued to meet monthly through February. Meetings have continued via video since then. After the 2019 annual meeting, we revisited and updated all aspects of the NARW curriculum that we created in 2012. This includes an update of the Power Point that accompanies the lesson plans. A link to this curriculum is now available on the Consortium web page. https://www.narwc.org/educational-activities.html

Whale and Dolphin Conservation recruited a former French-speaking intern to translate these activities into French for additional Canadian audiences.

As a means of continuing outreach based on the *Sharing the Seas: Safe Boating for Sailors and Whales* program, we filmed two video interviews with Atlantic Cup Kids. Captain Dave Rearick hosted us via Zoom in April and again in May to discuss whales in general, right whales in specific and interactions between whales and sailboats. The videos can be seen on their Facebook page.

Plans for a second 'Whales on the Lawn' event in June were cancelled.

The Face-ing Extinction Facebook page for the Education Committee gained roughly 270 new followers since the last annual meeting. In January we launched a right whale naming series, introducing our followers to the newly named whales from 2019. A post we published on the death of #3560's calf in June went viral, reaching over 23,000 people with 151 shares.

Rhode Island (provided by Anne DiMonti)
Audubon Society of Rhode Island set up an online page called *Audubon at Home: Nature Play and Learning*, which was posted for Earth Day week. Included in the program offerings was an online learning curriculum for NARWs.

Massachusetts
New Bedford (submitted by Robert Rocha)
The New Bedford Whaling Museum is hosting an exhibit of student art called *Youth Voices for the Ocean*. The artwork was submitted by students in response to the Bow Seat Ocean Awareness Programs annual call for student art.

A planned summer 'Party for the Ocean'-type event that would have included activities about NARWs was cancelled.

Plymouth (submitted by Monica Pepe)

Whale and Dolphin Conservation, in partnership with Brooke Tully, hosted a virtual webinar (in the place of a planned in person workshop in Washington DC) for conservation groups working to campaign for increased protections for right whales. 18 people representing 10 organizations were in attendance.

We redesigned the annual Whale SENSE commercial whale watch company training, which has a focus on right whales, including operating regulations and reporting guidelines. Nearly 100 whale watch naturalists and operators along the Atlantic coast completed the training.

In the absence of in-person events this year, in mid-October WDC hosted a Facebook live virtual tour of their life-size inflatable right whale, Delilah.

WDC shared a total of 101 right whale specific posts across our 3 social media platforms (Facebook, Instagram, and Twitter) between January – September, which have a combined audience of over 317,000.

No Other Reports Were Submitted

Last Name	First Name	Affiliation
Abbitt	Rosemary	Dept of Commerce, NOAA Fisheries
Abel	David	PRESS
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