North Atlantic Right Whale Consortium Annual Meeting

University of Southern Maine

Portland, ME USA

14-15 November 2019

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NARWC
THE NORTH ATLANTIC RIGHT WHALE CONSORTIUM

North Atlantic Right Whale Consortium

Annual Meeting
14-15 November 2019
University of Southern Maine, Portland

THURSDAY - 14 NOVEMBER 2019
0800-0830 Check in

0830 Opening of Meeting - *Mark Baumgartner*

0840 2018 North Atlantic Right Whale Report Card – *Heather Pettis*
0850 North Atlantic Right Whale Catalog update and whale naming results – *Philip Hamilton*

Entanglement and Mortality Updates
0905 North Atlantic right whale (*Eubalaena glacialis*) mortality event in the Gulf of St. Lawrence, 2019 - *Laura Bourque and Tonya Wimmer*
0925 2019 Entanglements and Serious Injury – *Scott Landry, Heather Pettis and Allison Henry*
0940 Whale release and strandings Newfoundland – Disentanglement response of North Atlantic right whale #3125. *Wayne Ledwell*
0950 An update on right whale entanglement interactions: 2010-2019 *Amy Knowlton*

1005 Session Discussion

1030 **BREAK**

1100 Other efforts: Ropeless Consortium – *Michael Moore*
IAC – *Scott Kraus*
1125 MLA withdraws support for agreement reached during the April 2019 TRT meeting – *Patrice McCarron*
1135 Scientist response to MLA withdrawal - *Scott Kraus*

Population Assessments and Data Management
1145 Estimating latent mortality of North Atlantic right whales *Richard Pace*
1200 Are there fewer North Atlantic right whales than we think? *Peter Corkeron*
1215 Quantifying fitness in North Atlantic right whales - *Timothy Frasier*

Special Announcement
1230 Species in the Spotlight – *Donna Wieting*

1240 Session Discussion

1310 **LUNCH/BREAK OUT MEETINGS**

Fisheries Interactions and Mitigation

1415 Evaluating the economic impacts of reducing effort in the U.S. lobster fishery to prevent North Atlantic right whale entanglements- *Hannah Myers*

1430 Decisions to implement spatio-temporal fisheries closures to reduce entanglement threats to whales must also consider how those closures can change the nature of a fishery- *Alexandra Cole*

1445 Functional breaking strength of vertical lines in the Gulf of Maine - *Erin Summers*

1500 An assessment of vertical line use in Gulf of Maine region fixed gear fisheries and resulting conservation benefits for the endangered North Atlantic right whale - *Nathaniel Willse*

1507 Fishers helping whales: inspiration, innovation and solutions for co-existing in the Gulf of St. Lawrence - *Lyne Morissette*

Vessel Interactions and Mitigation

1515 An assessment of seasonal speed restrictions to protect right whales from ship strikes at the port of Charleston, South Carolina - *Jon Lang*

1522 Protecting one endangered species at the expense of another? Evaluating the impacts of vessel speed restrictions on blue and right whales in the Gulf of St. Lawrence - *Meg Carr*

1530 Session Discussion

1600 **BREAK**

Management

1630 Estimating uncertainty in whale location following visual or acoustic detection: Implications for dynamic management of North Atlantic right whales - *Hansen Johnson*

1645 Fisheries and Oceans Canada: An update on research and monitoring activities for North Atlantic right whales – *Valérie Harvey and Angelia Vanderlaan*

1700 Canadian management efforts – *Michelle Sanders and Adam Burns*

1715 U.S. management efforts – *Michael Asaro*

1730 U.S. Navy marine Mammal Compliance and Mitigation Program in the Atlantic: A review - *Jacqueline Bort*

1737 Session/ Day 1 Discussion (Press excused)

Reception

1930 End Day 1

FRIDAY - 15 NOVEMBER 2019

0830 **BUSINESS MEETING**

The business meeting is open to **ALL attendees. Please join us!**

0930 **BREAK**

Genetics

1000 Genetic and collagen examination of historic North Atlantic right whale bone specimens from the Eastern North Atlantic: insights into species history, transoceanic population structure, and genetic diversity - *Brenna Frasier*

Distribution

1015 An update on the population structure, residency, and movements of North Atlantic right whales in the Gulf of St. Lawrence - *Leah Crowe*

1030 Density surface models for the North Atlantic right whale in U.S. waters - *Jason Roberts*

1045 Integrating the Identification and Sightings databases with spatial capture-recapture models to estimate right whale density and movement - *Timothy Gowan*

1100 Predicting right whale responses to rapid oceanographic changes - *Nicholas Record*

Education, Outreach, and Conservation

1115 "The Calvineers Movie" - Documenting the power of conservation through education. *Thom Willey*

1125 Year of the Right Whale 2020 - *Cynde McInnis*

1132 Why don't people fall in love with right whales? *Michelle Collins*

1140 Weep no more whales: The inevitable extinction of the right whale - *Richard Strahan*

1147 **Session Discussion**

1230 **LUNCH/BREAK OUT MEETINGS**
STUDENT/RESEARCHER ROUNDTABLES

Acoustics and Acoustic Detections

1415 PAM monitoring in the Gulf of Maine: 2009 vs 2019 - *Genevieve Davis*
Near real-time passive acoustic monitoring of right whales along the U.S. east coast - *Mark Baumgartner*

1430 Using sonobuoys and visual surveys to describe North Atlantic right whale acoustic ecology in the Gulf of St. Lawrence - *Kimberly Franklin*

Health and Physiology

1445 Report of the Workshop on North Atlantic Right Whale Health Assessment: June 24-26, 2019 Silver Spring, MD – *Michael Moore*

1500 Blubber hormones: Adding to the toolbox for physiological assessment of North Atlantic right whales - *Katherine Graham*

1515 Noise dosage regimens: Can physiological noise impacts on North Atlantic right whales be managed temporally? *Andrew Wright*

New Technologies/Data Collection Techniques

1522 Using technology to protect observers (PSO/MMO) while they protect North Atlantic right whales - *David Steckler*

1530 Developing a blubber-implanted satellite tag for right whales - *Alexandre N. Zerbini*

1545 Surveying right whales in the Gulf of St. Lawrence using VHR satellite imagery - *Olivia Pisano*

1600 From competition to collaboration: Automated identification of right whales - *Christin Khan*

1615 **Session Discussion**

1645 **Meeting wrap up**

1700 **Meeting Close**

The 2019 NARWC Annual Meeting Agenda includes speed talks, indicated by underline.

Near real-time passive acoustic monitoring of right whales along the U.S. east coast

Baumgartner, M.F.[1]

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Like aerial surveys, near real-time passive acoustic monitoring can be used to understand the distribution and occurrence of right whales and to support dynamic management efforts. The Woods Hole Oceanographic Institution has developed and evaluated an operational near real-time whale detection system for long-endurance ocean gliders and buoys based on the digital acoustic monitoring (DMON) instrument and the low-frequency detection and classification system (LFDCS). Gliders equipped with the DMON/LFDCS have been used to monitor right whales in Canadian waters annually since 2014. The use of gliders and buoys for right whale monitoring has been sporadic on the U.S. east coast to date, but expanded and more regular monitoring is planned for coming years, spurred in large part by wind energy development activities. I will review glider survey effort and buoy deployments from the past year that took place in the Gulf of Maine, New York Bight, and near Cape Hatteras, and will discuss plans to conduct several more glider surveys and to install five more DMON/LFDCS buoys in the coming year along the U.S. east coast.

U.S. Navy Marine Mammal Compliance and Mitigation Program in the Atlantic: A review

Bort, J.E.[1], Nissen, J.[2], Bell, J.[3]

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The U.S. Navy's Atlantic Fleet conducts training and testing activities within the Northwest Atlantic Ocean and Gulf of Mexico, including the use of active sonar and explosives. While training and testing activities have the potential to impact the environment, the Navy employs every means available, without jeopardizing the safety of sailors or impacting military readiness, to mitigate the potential environmental effects of these activities. Prior to training and testing activities, the Navy consults extensively with environmental regulators to determine appropriate mitigations to protect marine species, particularly marine mammals. Additionally, in order to evaluate the impacts of naval activities on marine mammals and other protected species, the Navy has implemented a monitoring program to collect data on baseline animal presence, as well as exposure and response to Navy training and testing activities. This presentation will provide an overview of Navy environmental compliance in the Atlantic, including monitoring efforts, the tools and processes that the Navy uses to assess the potential impacts of activities, how mitigation is used to reduce those impacts, and protective measures such as the restrictions employed in the North Atlantic right whale critical habitat areas. The Navy remains committed to marine stewardship and responsible management of the potential impacts of training and testing activities on protected species.

North Atlantic right whale (*Eubalaena glacialis*) mortality event in the Gulf of St. Lawrence, 2019

Bourque, L.A.[1], Lair, S.[2], Jalenques, M.[2], Wimmer, T.[3], Jones, M.[1], Daoust, P.Y.[1]

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[2]*Canadian Wildlife Health Cooperative, Québec region*
[3]*Marine Animal Response Society*

Between June 4 and August 8, 2019, a total of eight dead, endangered North Atlantic right whales (NARWs) were observed either stranded on shore, or drifting in the waters of the Gulf of St. Lawrence, Canada. Five of the dead whales were towed to shore for complete necropsy at four different locations. The remaining three NARWs were not examined, either due to carcass inaccessibility (#3329 on Anticosti Island) or due to advanced decomposition (#3815 and an unidentified NARW). A presumptive cause of death was determined for three NARWs: two (#1514 and #3450) had lesions consistent with blunt force trauma and one (#1281) had lesions consistent with sharp trauma. Vessel collision was considered probable in all three cases. These conclusions were

derived based on the weight of pathologic evidence compiled in each case, which included massive internal hemorrhage, superficial contusions, bone fractures, and focally extensive laceration of the body wall. A cause of death for the remaining two necropsied whales (#4023 and #3421) has not yet been determined. An incidental finding in #3421 was a severe periosteal proliferation causing ankylosis of the lumbar L12 - L13 intervertebral joint which was presumed secondary to either chronic infection or past traumatic injury. As in the mortality event of 2017, the preliminary results of this investigation indicate that the main issues threatening NARWs in the Gulf continue to be vessel strikes and fisheries entanglement. The dramatic increase in NARW deaths in 2019, as compared to 2018, during which no NARW deaths were reported, is worrisome and may be related to changes in NARW distribution and/or in the management of fishing activities and vessel speed in the Gulf. Research on right whale habitat use in the Gulf of St. Lawrence is urgently required to inform dynamic management efforts to curtail further injury and mortality events.

Protecting one endangered species at the expense of another? Evaluating the impacts of vessel speed restrictions on blue and right whales in the Gulf of St. Lawrence

Carr, M.K.[1], Vanderlaan, A.S.M.[2], Ramp, C.[3], Hilliard, C.[4], Sears, R.[3], Taggart, C.T.[1]

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[2]Bedford Institute of Oceanography, Fisheries and Oceans Canada, Dartmouth, NS, B2Y 4A2 Canada
[3]Mingan Island Cetacean Study, St. Lambert, QC, J4P 1T3 Canada
[4]Institute for Big Data Analytics, Dalhousie University, Halifax, NS, B3H 4R2 Canada

North Atlantic right whales (NARWs; *Eubalaena glacialis*) and blue whales (*Balaenoptera musculus*) are listed as endangered under the Canadian Species at Risk Act. NARWs have long been recorded in the Gulf of St. Lawrence (GSL) but were not observed in large numbers until surveys began in 2015. Surveys have reported consistent blue whale presence in the GSL since they began in 1979 and individuals have been recorded in elevated vessel traffic areas, including the GSL shipping lanes. Shipping traffic has been identified as a threat to both these species in their respective recovery strategies.
Since the 2017 NARW unusual mortality event, where 57% of necropsied carcasses showed evidence of vessel collision, vessel-strike mitigation in much of the GSL has consisted of seasonal speed restrictions aimed at reducing the probability of lethal vessel strikes for NARWs. Necropsy evidence has not initiated protection for blue whales as their carcasses sink after death and are less likely to be necropsied. Despite the NARW (est. 411 individuals) and Northwest Atlantic blue whale populations' (est. <250 adults) endangered statuses, current GSL vessel strike mitigation focuses exclusively on NARWs. Though blue whales are sighted in the GSL shipping lanes, speed restrictions are not triggered by their presence. Additionally, the extent of the speed restriction zone does not include high density blue whale aggregation areas such as the St. Lawrence Estuary. This study evaluates the efficacy of the static speed restriction zone and dynamic shipping sections in reducing lethal vessel strike risk to blue and right whales using Automated Identification System (AIS) vessel traffic information, whale sightings, and visual survey effort data. This is achieved through identifying areas of elevated risk for each species, evaluating changes in risk, and assessing whether risk to blue whales increased as a result of the current management scheme for NARWs.

Decisions to implement spatio-temporal fisheries closures to reduce entanglement threats to whales must also consider how those closures can change the nature of a fishery

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Spatio-temporal fisheries closures to protect whales aim to exclude fishing effort (i.e. sets or gear) from areas where there are large observed densities of whales, and thus areas of high probability of entanglement. This goal is based on the assumption that the displaced fishing effort (i.e. effort that was

previously inside the closures) will contribute less risk of entanglement in their new locations than within the closed area. There are, however, two ways displaced effort may still contribute to entanglement risk: 1) they can surround the fishery closure, and thus threaten to entangle whales transiting to or from the area; or 2) displaced effort may move to a location that produces more risk than their original location. These concerns, along with the increased socio-economic costs to fishers, are often held as arguments against the use of spatio-temporal closures. We used snow crab logbook data from the southern Gulf of St. Lawrence to test these assumptions and developed a model to predict fishing effort displacement. Closures were predicted to displace 29% of fishing effort, increasing effort outside the closed areas by approximately 41%. While 14% of effort occurred in areas not historically fished, displacement did not further enclose the perimeter of the closures as predicted; however, fishing effort in those areas increased. We estimated that closures and the movement of effort increased the socio-economic cost to displaced fishing by 23%, while the overall increase to the fishery was 8%. Ultimately, spatio-temporal closures can alter the nature of a fishery such that patterns of fishing effort, and thus patterns of risk, can change. This study provides a tool to help predict how closures may change a fishery and the effect of those changes on both the fishery and the effort to mitigate entanglement risk.

Why don't people fall in love with right whales?

Collins, M.[1], Tully, B.[2], Asmutis-Silvia, R.[1], Braunlich, S.[1], Pepe, M.[1]

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[2]BrookeTully.com

Since 2017, right whales have made the news more than ever, increasing the profile of the species with the public. Yet Whale and Dolphin Conservation (WDC) found that, while recognition of the species may have increased, the public's affinity for right whales continued to lag behind species such as humpbacks, orcas, and dolphins. But why? Psychologists have determined that emotional storytelling triggers our brains to look for patterns, increases our attention to a subject, and creates stronger emotional connections, which is why storytelling is an underlying concept used in marketing. In the past year, WDC has embarked on a conservation marketing project dedicated to looking at how we communicate with different audiences about North Atlantic right whales and what can be improved. We examined our message frames, the language used, and the tone of our right whale communications to find out why people have a hard time connecting with right whales and how we can strategically increase the public's affinity for them as a step toward public action to protect them. By taking what we have learned, we can conserve right whales by telling their story better.

Are there fewer North Atlantic right whales than we think?

Corkeron, P.[1], Crowe, L.[2]

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[2]Integrated Statistics under Contract to the Northeast Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, 166 Water Street, Woods Hole, MA, 02543, USA

The right whale report card includes several estimators of the abundance of North Atlantic right whales (NARW), but only one includes estimates of survival. In order to review survival estimates, we ran multiple mark-recapture models on photo-identification data from 1990 to 2017. Models run included a classical Jolly-Seber (JS) model, Schwartz-Arnason variants of JS models in the *openCR* library of R, and Cormack-Jolly-Seber (CJS) models in *marked*. Initially we ran models from 1990 to 2017. All models were fit in a likelihood framework and showed the same general pattern of abundance increasing until 2010/2011 and declining thereafter. Annual survival showed a decline in later years, so we then re-ran the models for 2000-2017. Model selection on this truncated time series invariably selected best-fit models with survival and probability of capture varying by time. All models concluded with abundance estimates around 10% less than those of Pace et al 2017. Annual estimates of calf production from JS models were similar to actual calving. For a CJS model that included sex as a covariate, best-fit models included sex differences in survival and probability of capture.

Finally, we fit this form of CJS model in a Bayesian framework. Males' survival declined from a mean estimate of 0.994 in 2008 to 0.960 in 2016, and females from 0.988 to 0.929 over the same period, a six-fold increase in annual mortality. We generated a time series of abundance from this CJS model using a Horvitz-Thompson estimator. For the start of 2017, this estimated 392 whales: 152 females, 223 males, and 17 whales of unknown sex. Whether this model is biased low requires further investigation, but all models indicate that there may be fewer NARWs than current estimates suggest.

An update on the population structure, residency, and movements of North Atlantic right whales in the Gulf of St. Lawrence

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

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Survey effort in the Gulf of St. Lawrence (GSL) during 2017, 2018, and 2019 has provided insight into North Atlantic right whale (*Eubalaena glacialis*) habitat use and movement in the area. Here we present findings from all photographic captures in 2017, as well as individual captures from dedicated mark-recapture aerial surveys in the 2018 and 2019 summer seasons. Within these data, 159 individuals visited the GSL and 97% of the animals sighted in 2019 (n=125, calves excluded) were seen in the prior two seasons. In 2017, a total of 131 unique right whales were sighted from 14 platforms in the GSL in all months between June and December. Of the animals seen alive (n=123), 97% were first sighted prior to the end of August. Within the year, individuals were sighted on 1 to 15 different survey days, and the maximum time between an initial and final sighting was 163 days. Dedicated aerial surveys designed to maximize capture of individuals were flown from 23 June to 29 July 2017 and sighted 83% of the total individuals for the year. While most resightings of individuals in 2017 occurred in the southern GSL, three individuals were sighted only off of Anticosti Island and four were seen in both locations. Results indicate that the mark-recapture flight methods effectively captured most individuals in this region, animals are exhibiting a high rate of inter-annual return, there is capture heterogeneity of individuals, and whales are moving around this region, including within and across shipping lanes and fisheries management areas.

PAM monitoring in the Gulf of Maine: 2009 vs 2019

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The Gulf of Maine is recognized historically as an important habitat for the North Atlantic right whale (NARW), identified as both feeding and mating grounds. Despite this, very little acoustic monitoring effort has occurred in this area. Passive acoustic monitoring recorders were deployed in 13 locations along the inner coast of Maine during 2009-2010. Most recorders were out for an average of 3 months, some 6 months, during the winter. Recordings were analyzed using an automatic low frequency detection and classification system (LFDCS; Baumgartner & Mussoline 2011) for NARW upcalls and results were included in a long-term acoustic analysis looking at right whale presence along the entire western North Atlantic coastline (Davis et al. 2017). We took a closer look at this data, manually screening all sound files by hand for upcalls and other NARW call types,

to further determine when NARWs were present along Maine's coast. Future plans of deploying recorders in the same locations as the 2009-2010 recorders are starting in fall/winter 2019 for a continuous year of coverage. Simultaneously, a real-time glider will survey along the Gulf of Maine from December 2019-April 2020 and another glider in Stellwagen Bank National Marine Sanctuary from January- April 2020, furthering acoustic coverage offshore and extending into waters off Massachusetts. These recorders will all undergo similar, fine-scale analyses to gain a better understanding of NARWs' use of inshore Maine waters and how this might compare to previous NARW distributions.

Using sonobuoys and visual surveys to describe North Atlantic right whale acoustic ecology in the Gulf of St. Lawrence

Franklin, K.J.[1], Johnson, H.D.[1], Cole, T.V.N.[2], Cholewiak, D.M.[2], Duley, P.[2], Crowe, L.[3], Taggart, C.T.[1]

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[2]NOAA Northeast Fisheries Science Center, Woods Hole, MA USA, 02543
[3] Integrated Statistics under contract to the Northeast Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, 166 Water Street Woods Hole, MA 02543 USA.

Passive Acoustic Monitoring (PAM) is an established method to identify the presence of vocally-active North Atlantic right whales (NARW). The appropriate use and interpretation of PAM data relies on knowledge of the NARW sound repertoire and how it varies relative to variation in RW behaviour in time and space. Such information is difficult to obtain given the challenges of collecting acoustic and visual data simultaneously. Further, such relationships have not been quantified in the Gulf of St. Lawrence (GSL) NARW habitat, an area of considerable management importance given the NARW mortality events in 2017 and 2019. To assess possible acoustic and behavioural relations we deployed sonobuoys in the presence of three or more aggregated NARWs during aerial and vessel-based photo-ID surveys in 2017 (n=8), 2018 (n=25), and 2019 (n>=40). Acoustic data from each sonobuoy deployment were manually reviewed for all known NARW vocalizations, including upcalls, gunshots, and various other tonal sounds. The identified NARW vocalizations were then quantitatively compared to NARW behavioral-state variables derived from visual observations and individual NARW photo-ID data in the southern GSL. This information was then used to determine how much of the acoustic repertoire variation may describe NARW seasonal, behavioral, and demographic variation. These results will aid in the interpretation of NARW PAM in the GSL and can help inform effective management in this high-risk habitat.

Genetic and collagen examination of historic North Atlantic right whale bone specimens from the Eastern North Atlantic: insights into species history, transoceanic population structure, and genetic diversity

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The North Atlantic right whale historically had a much wider distribution across the North Atlantic Ocean, including areas such as the northwest coast of Africa, the Bay of Biscay, Iceland, and Norway. As part of a larger study assessing historical utilization of marine mammals throughout the North Atlantic over the past 1200 years, we identified and analyzed 21 North Atlantic right whale bone and archaeological bone specimens. These specimens date from the 4th - 20th centuries and were collected from sites in Orkney (n=2), the Faroe Islands (n=5), and Iceland (n=6) dating to the Middle Ages (~800 - 1500CE); a 17th century Basque/Dutch whaling

station in Iceland (n=3); a 19th century Norwegian whaling station in Iceland (n=1), and from a variety of early 20th century sites around Scotland (n=4). Following species identification using both sequencing of mtDNA (control region and cytochrome b gene) and collagen fingerprinting (ZooMS), we obtained 10-locus nuclear microsatellite profiles from a subset of bones. These profiles were compared to contemporary data from the population remaining in the western North Atlantic. While some historic specimens share mtDNA haplotypes with the contemporary population, four new haplotypes were also found. Nuclear profile probability of identify values (POI) fell within the distribution of values for the population today, suggesting that these historic individuals were genetically very similar to those remaining today. We discuss the implication of these findings in light of what is currently known about the history and distribution of the species.

Quantifying fitness in North Atlantic right whales

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Appropriately quantifying fitness is a crucial requirement for accurately identifying what factors are influencing the health of a population and the degree to which they are doing so. Such information is particularly important for endangered species, where proper conservation initiatives cannot be implemented, or their effects monitored, until the limiting factors have been identified and their effects quantified. Fitness can be broken down into two components: survival and reproductive success. In many short-lived species survival is often quantified as the number of years an individual was alive and reproductive fitness quantified as lifetime breeding success (LBS). However, such metrics are not possible for long-lived species, where many individuals survive and reproduce for longer than the study period. Moreover, individual effects can be masked by larger ecological changes that affect the population as a whole. A method for quantifying individual fitness that overcomes these obstacles is called the "de-lifing" approach, which quantifies the relative contribution of each individual to overall population growth (via surviving and/or reproducing) in each year. This value can then be summed across the desired number of years for each individual. We have implemented this calculation for North Atlantic right whales and show that it appropriately captures patterns in survival and reproductive success. We propose that this approach could be a very useful tool for testing hypotheses regarding factors impacting individual survival and reproductive success in this species, and for monitoring any changes therein over time.

Integrating the Identification and Sightings databases with spatial capture-recapture models to estimate right whale density and movement

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Estimates of abundance and an understanding of processes that drive its variation across space and time are critical to assessments of population status and risks. Spatial capture-recapture models combine elements of distance sampling and conventional capture-recapture models to estimate abundance and its variation across space (i.e., density). These models utilize information on the identities of detected individuals (e.g., from the NARWC Identification database) and on the locations of these detections and survey effort (e.g., from the Sightings database). Spatial capture-recapture models overcome limitations of alternative approaches to estimating abundance by relaxing the assumption that all animals on the survey line are detected, by explicitly defining the spatial extent for which abundance is estimated, by permitting the movement of individuals into and out of the survey area, and by formally accounting for heterogeneity in detection probabilities due to differences in the location of individuals relative to the location of survey effort. In addition to estimating abundance, these models can be used to understand the distribution of animals across space, movement patterns, how density varies with environmental covariates, and how population processes (movement, recruitment, survival) drive

changes in abundance over time. We will present an overview of this modelling framework and how it integrates sighting locations, survey effort, individual identifications, and environmental data using aerial surveys in the southeastern US as a case example.

Blubber hormones: Adding to the toolbox for physiological assessment of North Atlantic right whales

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Given serious threats to the population viability of North Atlantic right whales (*Eubalaena glacialis*; Eg), it is important to continue developing tools to monitor the physiological state and health of Egs. Blubber tissue is an alternative sample-type that may represent a unique timescale of endocrine data not captured by other currently validated matrices (feces, blow, baleen) and can be collected in association with biopsy darting for genetic identification or during necropsy investigations. We tested two extraction protocols on Eg blubber: (a) an extended protocol widely used in other cetacean blubber studies, and (b) a simplified extraction to reduce time and cost. Standard assay validation tests (parallelism and accuracy) confirmed testosterone, progesterone, and cortisol were measurable in Eg blubber using commercially available enzyme immunoassays. The simplified extraction protocol produced similar results to the extended protocol, enabling a more efficient technique for sample analysis. We conducted a preliminary analysis of reproductive and stress hormones in 28 archived samples from known Egs (n=21 biopsy samples and n=7 necropsy samples). Mean (±SE) blubber testosterone concentrations in adult males (2.5±0.5 ng/g) were approximately two times greater than juvenile males (1.3±0.3 ng/g) and over three times greater than females (0.7±1.2 ng/g). The highest progesterone value (60.3 ng/g) was measured in a confirmed pregnant female and was 13 times higher than mean progesterone of all other females (4.4±1.0 ng/g). In living (biopsied) whales, cortisol averaged 0.7±0.2 ng/g (range: 0.2-3.51 ng/g), while blubber cortisol in deceased whales with evidence of entanglement (n=5) averaged 5.2±3.0 ng/g. The highest blubber cortisol concentration (18.0 ng/g) was measured in a dead female with a severe chronic entanglement. These results suggest differences in reproductive and stress hormones are detectable in Eg blubber, offering another approach for monitoring reproduction and adrenal responses to anthropogenic threats.

North Atlantic Right Whale Catalog update and whale naming results

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

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

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Fisheries and Oceans Canada (DFO) is invested in scientific research to protect and support the recovery of the endangered North Atlantic right whale (NARW; *Eubalaena glacialis*) with multiple initiatives underway in Canadian waters, including aerial surveys, passive acoustic monitoring (PAM), prey studies, and other studies. Systematic line transect surveys flown in 2018 estimated 190 (cv = 0.72, 95% CI: 52-692) individuals in June in the Gulf of St. Lawrence (GSL). In 2019, surveillance and systematic flights were maintained and extended to include Newfoundland and southern Labrador. Deployments (max. 6.5 days) of satellite-linked-time-depth recorders on nine NARWs in the GSL provided data on dive behaviour and locations that will be used to inform collision and comprehensive entanglement risk models under development. Shipping noise level 3D probability in the GSL was mapped over a complete annual cycle to assess its masking impact on whale calls and PAM detection probability. The PAM network was densified and five real-time NARW detection buoys were added. Outside the GSL, progress made includes analysis of existing and new acoustic deployments for NARW presence with multiple acoustic detectors, ongoing noise and detection-range modelling, and collection of data to support future noise impact analyses (blow samples, photogrammetry, and digital acoustic recording tags). Several technologies are also being tested to inform the development of real-time detection systems. Prey studies include analysis of interannual variation in *Calanus* spp. biomass on western North Atlantic shelves (1999-2016). This study revealed shifts to lower prey biomass in the Gulf of Maine-Georges Bank and Scotian Shelf areas in the 2010s, coinciding with observed changes in NARW spatial distribution and a reduced calving rate, but did not indicate a shift to higher prey biomass in the GSL. This presentation will provide an overview of the research undertaken by DFO and its collaborators that focuses on NARWs.

Estimating uncertainty in whale location following visual or acoustic detection: Implications for dynamic management of North Atlantic right whales

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The USA and Canada employ dynamic management strategies to improve conservation outcomes for the endangered North Atlantic right whale. The tactics rely on near real-time knowledge of whale distribution generated from visual surveys and opportunistic sighting reports. Although near real-time passive acoustic monitoring systems have been operational for many years they have, for the most part, not been incorporated in dynamic management due to concerns over uncertainty in the location of acoustically-detected whales. This rationale does not consider whale movement or its contribution to location uncertainty following either visual or acoustic detection. The goals of this study were to estimate uncertainty in right whale location following acoustic and visual detection and identify the timescale at which uncertainties in the location of acoustic and visual detections become equal owing to post-detection whale movement. We simulated whale movement using an auto-correlated random walk model parameterized to approximate three common right whale behavioural states (traveling, foraging, and socializing). We then used a Monte Carlo approach to estimate whale location over a 96-hour period given the initial and evolving uncertainties arising from the acoustic and visual detection

methods and whale movement. The results demonstrated that for either detection method the uncertainty in whale location increases rapidly following initial detection and can vary by an order of magnitude after 96 hours depending on behavioural state. The uncertainty in whale location became equivalent between visual and acoustic detections within 24 to 48 hours, depending on right whale behavior and acoustic detection-range parameterization. The results imply that using both visual and acoustic detections provide enhanced information for the dynamic management of this visually- and acoustically-cryptic and highly mobile species.

From competition to collaboration: Automated identification of right whales

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Photo identification plays a major role in endangered species research and conservation and recent developments in artificial intelligence promise to increase the efficiency of matching photographs to known individuals. At the last Society for Marine Mammalogy conference, we presented on the Kaggle data science competition to automate the identification of endangered North Atlantic right whales based on 7,000 aerial images. The winning algorithms developed by deepsense.ai were able to identify individuals with 87% accuracy using a series of convolutional neural networks. Since that time, we have brought in many more collaborators as we move from prototyping to production. Leveraging the existing infrastructure by Wild Me, the developers of Flukebook, we are creating a website platform that allows biologists with no machine learning expertise to automatically identify right whales. New models will be generated using both the winning deepsense.ai algorithms and the Wild Me HotSpotter algorithm (used for humpbacks, jaguar, giraffe, and other species). Given the morphological similarity between the North Atlantic right whale and closely related Southern right whale, our goal is to create an automatic identification system that will benefit right whale researchers worldwide. The updated dataset will incorporate the largest long-term photo-identification catalogs; including over 400,000 images from the United States and Canada curated by the New England Aquarium; 12,311 images from Australia from Curtin University; 8,461 images from South Africa from the University of Pretoria; 8,952 images from Argentina from the University of Utah; 5,473 images from Brazil from Instituto Australis; and 2,913 images from New Zealand from the University of Otago. We hope to encourage researchers to embrace data collaboration and computer vision to increase our understanding of wild populations.

An update on right whale entanglement interactions: 2010-2019

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Annual assessments of entanglement interactions based on scarring and attached gear indicate at least 412 events from 2010 through 2019 (2017-2019 scarring not completed so this is a minimum tally) involving 19.5-39.7% of the annually sighted whales. A comparison with entanglement data published from 1980-2009 indicate an increasing rate of what New England Aquarium refers to as "serious entanglements" – i.e. whales with attached gear or

severe entanglement-related injuries. From 2010-2016, the proportion of the sighted population involved in serious entanglements ranged from 1.4% to 3.8% per year, higher than the average documented from 1980-2009 of 1.2% (range 0-3.0%). Additionally, adults are experiencing a higher rate of entanglements with ~2/3 of annual entanglement interactions involving adults beginning in 2013. Lastly, nearly half of the annual entanglement interactions are now resulting in moderate and severe injuries, which lead to reduced fecundity and survival. All of these findings indicate the entanglement problem has worsened in this past decade. An assessment of where a subset of entanglements may have originated by country indicates that they are continuing to occur in both countries and throughout their range. To focus just on retrieved gear as an indicator of where events are occurring can only give a limited idea of the extent of the problem. Of the 1469 events documented via scar coding from pre-1980 to 2016, only 110 (7.5%; plus five cases not matched to an individual) had attached gear and only 39 of those cases had retrieved gear. Managers and fishing industries in both the U.S. and Canada need to continue efforts to address this existential threat to the continued survival of this species. Deflection of this responsibility will reflect poorly on both countries, as well as the fixed-gear fishing industries that operate in the western North Atlantic and overlap with large whale populations, especially endangered right whales.

North Atlantic right whale entanglement and serious injury update, November 2018 – October 2019

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Since the last consortium meeting eight right whales were seen carrying gear, with 28 sightings from the Gulf of St. Lawrence (GoSL) to New York. Of these eight cases, three were from prior years (3843, 4091 and 3960) and five were newly discovered (2310, 1226, 4423, 4440 and 3125). Of the three ongoing cases, all first sighted in 2018, two were confirmed to have shed their entanglements (4091 and 3960) and one is ongoing as of last sighting (3843). Of the new cases, all five were discovered alive upon first sighting. Three of these cases were discovered in the GoSL, and two off Massachusetts. Disentanglement efforts were conducted on four of the five new cases, (2310, 4423, 4440, and 3125). Right whale 1226 was eventually found dead off of New York with no gear attached and necropsy results are pending. In two cases disentanglement efforts led to the animals shedding their entanglements (4440 and 4423). In the case of 3125 disentanglement operations led to the removal of some gear but the whale may still be lethally entangled. This whale had a telemetry buoy tied into his entanglement to facilitate responses and was tracked for two weeks (July 19 to August 2), traveling over 750nm out of the GoSL to the waters east of Cape Cod. Of the five new cases, all had line through the mouth, at minimum, and all but one (2310) had limited mobility due to the robust characteristics of the entangling gear. The network is urged to keep an eye out for 3843, 2310, and 3125 and report any sightings immediately to the Atlantic Large Whale Disentanglement Network. Monitoring of whales with entanglement-related injuries, but not seen carrying gear, continued and reaffirms that entanglement effects a larger proportion of the population than represented by entanglement sightings alone.

An assessment of seasonal speed restrictions to protect right whales from ship strikes at the Port of Charleston, South Carolina

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The Charleston Entrance Channel is located entirely within the Mid-Atlantic Seasonal Management Area, and funnels ships into the third-busiest containership port on the east coast; port calls are forecast to increase 66% from 2022 to 2037, with a commensurate increase in Post Panamax vessels. We are undertaking a detailed analysis of AIS vessel data from 60,896 position reports for February and March, 2017 through 2019, which indicate that ship speed in the entrance channel averages 15.1 knots, approximately 97.7% of the time, during the active SMA time-frame. The speed rule's "deviation provision" is intended to give masters and pilots

leeway in adverse conditions. ACOE specified three conditions that, when combined, form unusual, adverse conditions in the Charleston entrance channel: 1. two Post Panamax ships, one inbound and one outbound, 2. meeting in the channel, 3. with wind speed 30 miles per hour or more. In reality, the Charleston pilots make excessive speed in settled conditions, in one-way traffic, with all vessels, every day, all the time. Detailed analysis of AIS position data indicate 24.5% of transits in our study involved two ships meeting in the channel; the remaining 75.5% involved solitary ships. Any reasonable standard for the deviation provision would distinguish between one-way and two-way traffic, and might be based on the ACOE ERDC/CHL TR-19-5 simulation analysis of the Charleston entrance channel. A reasonable standard for deviation might be defined as any two ships, irrespective of size, in "two-way traffic," with a minimum of 20 mph wind speed. By that standard, 10.55% of February 2019 transits would have qualified for a speed exception. The difference between that deviation rate and the actual February 2019 deviation rate of 98.2% suggests that speed may be better managed to protect right whales from ship strikes.

Whale Release and Strandings NL: Disentanglement response of North Atlantic right whale #3125

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The Whale Release and Strandings Group (WRS), a professional large whale disentanglement group from Newfoundland and Labrador, was seconded by the Department of Fisheries and Oceans (DFO—NL and Gulf region) to attempt to intercept and disentangle satellite tagged and heavily entangled North Atlantic right whale #3125 travelling towards the west coast of Newfoundland, and eventually Nova Scotian (NS) waters, on July 23, 2019. The group was similarly seconded in 2015 to Nova Scotian waters, by the Nova Scotia DFO, where they completely disentangled North Atlantic right whale #3160 (White Cloud). This talk outlines the complex logistics involving multiple agencies in tracking and intercepting North Atlantic right whale #3125 travelling southwards along the NS coastline while also outlining WRS techniques and tools used during the disentanglement effort, what went right and what went wrong, and recommendations for future response to such incidents. This talk will also provide insight on how WRS specializes in such incidents while working together with both federal agencies, such as the Department of Fisheries and Oceans, Canadian Coast Guard, and fishers, as well as WRS' ability to reach entangled whales in offshore waters with assistance from these groups.

Year of the Right Whale 2020

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The Year of the Right Whale is a project whose mission is to protect the North Atlantic right whale through celebration, education, and action. There are approximately 411 North Atlantic right whales in the world, of which around 100 are breeding females. The time to act for this species is now. The project will focus our actions in 2019 and 2020, but components of it could continue after that. Year of the Right Whale consists of in-person educational events, social media outreach and fundraising initiatives to engage the public in learning about right whales, and supporting recovery efforts. PROJECT COMPONENTS Booth in a Box: A key strategy used in this campaign is the innovative "Booth in a Box," which includes tools to educate the public about right whales and engage them in protection efforts. The box can be borrowed by schools, organizations, etc., throughout the US to be used in educational programs, fairs, festivals and aboard sightseeing boats. This tool is freely available to organizations, whale watch companies, students, parents, etc. to be used in fairs, festivals, schools, and other venues. This will enable these "ambassadors" to provide an interactive, educational booth that can be staffed by a volunteer or other interested party. It provides booth visitors with concrete actions they can take to protect right whales. Social Media Outreach: Through social media posts on Facebook, Twitter, and Instagram, we will educate people about the plight of the right whale, highlight events that are happening, and highlight people and projects that are working hard to protect these amazing animals. Curriculum: Another key audience for Year of the Right Whale is children. Children have the power to

make a difference and when inspired, can do amazing things. Year of the Right Whale will have an annotated curriculum available on our website. There are amazing curriculums out there already, along with books, that we would distribute to teachers through this project. Our presentation for the Right Whale Consortium will be a brief overview of the project and how people can be involved.

Report of the Workshop on North Atlantic Right Whale Health Assessment: June 24-26, 2019 Silver Spring, MD

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Presented by Michael Moore, Woods Hole Oceanographic Institution, Workshop Moderator (mmoore@whoi.edu)

This Workshop was held under the auspices of the Working Group on Marine Mammal Unusual Mortality Events (Working Group) in response to the ongoing North Atlantic Right Whale (*Eubalaena glacialis)* Unusual Mortality Event and the endangered status of the species. The main goals of the workshop were: 1) to assess current health information data, including associated data gaps, and 2) identify appropriate available and needed tools and techniques for collecting standardized health data that can be used to understand health effects of environmental and human impacts (e.g. entanglement) and inform fecundity and survivorship models to ultimately guide population recovery of North Atlantic right whales.

Health is the result of interacting biologic, social, and environmental determinants that interact to affect the animal's or population's capacity to cope with change. Health cannot be measured solely by what is absent, but rather by characteristics of the animals and their ecosystem that affect their vulnerability and resilience. Wildlife health is not a biologic state but rather a dynamic social construct based on human expectations and knowledge. This includes the need to study interrelated conditions and factors that influence population health over time and apply the resulting knowledge to actions to improve health. Therefore, the determinants of health include those affiliated with animal biology and ecology and those associated with human actions influencing animals.

Over the course of three days, the workshop participants helped the National Marine Fisheries Service summarize North Atlantic right whale population status and existing health-assessment information; identified several ways to prioritize health data collection, tools, and methods; and prioritized ways to increase the use of this health data to aid in monitoring individual health, informing population health, and identifying the population consequences of multiple stressors, including the connection between human activities (e.g., entanglement) and health.

Some of the highest health priorities identified included new or continued support for the following activities:

1. Continue to support the photo-identification catalog that provides the ability to track health at the individual level.
2. Continue to support the development of the Population Evaluation Tool model and support development of a population-level state-space model with integrated health metrics.
3. Continue and expand vessel and aerial photo-identification efforts to acquire population-level seasonal distribution and demographic data. Revisit and optimize survey effort based on our current understanding of the changing seasonal distribution of whales.
4. Evaluate seasonal presence of whales in new or unknown habitats, by further development of acoustic surveys of potentially important areas, potentially informed by current habitat modelling.
5. Continue and expand collection of health assessment data (e.g., biopsy, photos, photogrammetric length

and width measurements, blow, feces) and continue longitudinal studies. Specifically, visual health assessment and scarring assessments should continue; photogrammetry should be expanded, standardized, and inter-calibrated with the visual health assessment data and other measures of health.

6. Necropsy response efforts should be continued and enhanced, including continued support for training of large whale necropsy techniques. Several trans-boundary activities should be established including a necropsy case review committee; a necropsy sampling workshop; and development of a comprehensive plan for North Atlantic right whale sample collection and management.

Fishers helping whales: Inspiration, innovation and solutions for co-existing in the Gulf of St. Lawrence

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The presence of North Atlantic right whales (NARW) has been increasing in the Gulf of St. Lawrence since 2015. Occupying this new territory leads to new interactions with other users of the marine environment, and thus new conservation challenges in this area. In order to reduce the risk of entanglement, fishermen developed, in partnership with scientists, engineers, conservation NGOs, and governmental agencies, different approaches to adapt their operations and fishing gear to the presence of NARWs on fishing grounds and try to co-exist in the Gulf. This level of commitment for whale conservation and collaboration between different associations is unprecedented. The efforts and involvement of fishermen helping whales focus on three main aspects: first, an inclusive management/mitigation system, where they are involved in early stages of the process, to reduce spatial-temporal overlap between whales and fisheries in the Gulf of St. Lawrence; second, the development of new technologies of fishing gear to reduce entanglements or fatalities when fishermen and whales are occurring in the same area and at the same time; and third, involvement in scientific research on NARWs in the Gulf. New solutions explored include a system to track whale entanglement, ropeless traps, weak links, trawls of traps, electronic monitoring to whale sightings and entanglements, new coding technologies for traceability of fishing gear, gear retrieval, surveys of whale presence and behavior on fishing grounds, plankton sampling for determination of food availability for NARWs, and the involvement of fishermen in whale-rescue teams. These advances are developed for coastal and offshore fisheries, by crabbers and lobstermen from different provinces, and are great examples of how we can work together to find efficient conservation solutions for the North Atlantic right whale, at a time where concertation and co-existence are the key to making a significant difference.

Evaluating the economic impacts of reducing effort in the U.S. lobster fishery to prevent North Atlantic right whale entanglements

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North Atlantic right whales (*Eubalaena glacialis*) feed and migrate in areas of the inshore and offshore trap fishery for American lobster (*Homarus americanus*) in the northeast U.S. In addition to a recent increase in lethal and sub-lethal interactions with Canadian snow crab gear, entanglement in both Canadian and U.S. lobster trap gear threatens the continued existence of this critically endangered species. The U.S. National Marine Fisheries Service is considering a number of measures to prevent right whale entanglement bycatch that could impact lobster fishing effort. The U.S. lobster fishery in Maine expends approximately six times as much effort as the Canadian lobster fishery in the Nova Scotia Maritimes, where fishers catch 2.5 times more lobster per trap than Maine fishers. In Maine, a 10.3 percent reduction in the number of traps used from 2006 to 2016 correlated with a 76.1 percent increase in lobster landings. The state of Massachusetts has achieved record high landings since trap/pot seasonal closures have been implemented to protect right whales, especially within the Statistical Reporting Areas affected by the closures. Therefore, a negative economic impact should not be assumed with effort reduction. In fact, reducing effort may serve to increase fishing profits while supporting protection of critically endangered right whales and the long-term sustainability of the lobster fishery.

Estimating latent mortality of North Atlantic right whales

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For years, the National Marine Fisheries Service has relied upon the observed counts of dead large whales as one measure of their population status. At the Right Whale Consortium, the observed deaths of North Atlantic right whales (*Eubalaena glacialis)* have been enumerated and described at length on an annual basis. However, for two whale populations using U.S. Atlantic waters, North Atlantic right whales and Gulf of Maine humpback whales, recently developed mark-recapture based abundance models allow for the direct estimation of the total number of deaths occurring annually. To estimate abundance in what are classed as open population models, it is necessary to estimate the number of new animals to the population along with survival and capture rates. Then, with a small amount of algebra, the number of deaths between any two capture intervals can be derived. We produced annual estimates of total mortality for the period 1990-2017 for North Atlantic right whales and compare these to the total observed mortality. The estimate of the fraction of mortality will vary depending on how one calculates it and over what period; body counts only accounted for about 45% of the estimated mortality. With the recent exception of high counts in 2017, estimated mortality also appears much more variable than the observed counts. In order to translate this into estimated cause-specific mortality, assumptions are necessary about the detect ability of carcasses resulting from different causes. To this end, we provide a range of estimates of total entanglement-related mortality derived from the observed fraction of entanglement-related deaths and sets of assumptions on detectability of entanglement-related deaths.

Surveying right whales in the Gulf of St. Lawrence using VHR satellite imagery

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With only around 400 individuals remaining globally, North Atlantic right whales are in urgent need of protection from anthropogenic sources of injury and mortality, such as vessel strikes and fishing gear entanglement. However, traditional survey methods are financially and logistically restricted in their ability to detect and monitor right whales across their total range. VHR satellite imagery and machine learning techniques have been successfully used to detect and count a variety of marine and terrestrial taxa and are promising new tools for wildlife assessment and conservation. Our project is concerned with the development of an automated census method that uses aerial and VHR satellite imagery analyzed with convolutional neural network (CNN) algorithms to detect, identify, and count whales in the Gulf of St. Lawrence. Here we report on the progress of this new methodology in the automated detection and counting of right whales in the Gulf of St. Lawrence and how this will be applied to two case studies: identifying seasonal right whale movement patterns in the Cabot Strait and overlaying them with non-fishing vessel tracks, contributing to our emerging understanding of seasonal and interannual change in critical habitats for right whales in Eastern Canada.

Predicting right whale responses to rapid oceanographic changes

Record, N.R.[1], Runge, J.A.[2], Pendleton, D.E.[3], Balch, W.M.[4], Davies, K.T.A[5], Pershing, A.J.[6], Johnson, C.[7], Stamieszkin, K.[1], Ji, R.[8], Feng, Z.[8], Kraus, S.D.[3], Kenney, R.D.[9], Hudak, C.A.[10], Mayo, C.A.[10], Chen, C.[11], Salisbury, J.[12], Thompson, C.[13], Ross, C.[14]

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[2]*University of Maine, Orono ME USA*
[3]*Anderson Cabot Center for Ocean Life, New England Aquarium, Boston MA USA*
[4]*Bigelow Laboratory for Ocean Sciences, East Boothbay ME USA*
[5]*University of New Brunswick, St. John NB Canada*
[6]*Gulf of Maine Research Institute, Portland ME USA*
[7]*Fisheries and Oceans Canada, Bedford Institute of Oceanography, Dartmouth NS Canada*
[8]*Woods Hole Oceanographic Institution, Woods Hole MA USA*
[9]*University of Rhode Island Graduate School of Oceanography, Naragansett RI USA*
[10]*Center for Coastal Studies, Provincetown MA USA*
[11]*University of Massachusetts, Dartmouth MA USA*
[12]*University of New Hampshire, Durham NH USA*
[13]*Institute of Marine Research, Bergen Norway*
[14]*Colby College, Waterville ME USA*

As climate trends accelerate, ecosystems will be pushed rapidly into new states, reducing the potential efficacy of conservation strategies based on historical patterns. In the Gulf of Maine, climate-driven changes have restructured the ecosystem rapidly over the past decade. Changes in the Atlantic meridional overturning circulation have altered deepwater dynamics, driving warming rates twice as high as the fastest surface rates. This has had implications for the copepod *Calanus finmarchicus*, a critical food supply for the endangered North Atlantic right whale (*Eubalaena glacialis*). The oceanographic changes have driven a deviation in the seasonal foraging patterns of *E. glacialis*, upon which conservation strategies depend. In southern New England, in contrast, whales have responded to new feeding grounds that had been previously forecast based on copepod distributions. In cases like these, where mechanistic links between oceanographic changes and right whale movements are known, there is some potential for developing predictive tools, from simple correlations to complex models, that can guide early warnings of when and where right whales are at increased risk.

Density surface models for the North Atlantic right whale in U.S. waters

Roberts, J.J.[1], Schick, R.S.[1], Halpin, P.N.[1]

[1]*Duke Marine Geospatial Ecology Lab, A324 Lev Sci Res Ctr, Box 90328, Durham, NC, 27708 USA (jason.roberts@duke.edu)*

Beginning in 2010, we initiated a multi-institution collaboration to build density surface models for U.S. waters of the western North Atlantic and Gulf of

Mexico, for all extant cetacean species, from all available visual line transect surveys conducted with distance-sampling compatible protocols over the past two decades. This initial effort culminated in 2016 in the publication of models and associated absolute density maps (estimating individual animals per km^2) for 26 species, including North Atlantic right whales, and 3 multi-species guilds (Roberts et al. 2016). The models were used first by the U.S. Navy, the primary funder of the effort, for the development of an Environmental Impact Statement that estimated marine mammal takes for Navy training and testing activities. Over the 2016-2018 period, we prepared several updates that expanded the number of collaborators and incorporated newly-available survey data and NOAA went on to use these results for various management activities, including the permitting of offshore energy development and geophysical surveying and the development of regulations for oil and gas leasing. Most recently, NOAA proposed to use the right whale model as a component in a Risk Reduction Decision Support Tool to be used to develop new regulations for U.S. trap and pot fisheries, with the intent of reducing risk that right whales become entangled in vertical fishing lines. NOAA presented initial results from this exercise at the April 2019 meeting of the Atlantic Large Whale Take Reduction Team. An important limitation of those results is that our right whale model available at that time, known as the v8 model, only incorporated data through mid-2016. Since then we have worked to prepare another update, the v9 model, which incorporates data through the end of 2018 and is intended for use in NOAA's final analysis. This presentation will update the community on our progress.

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

Sanders, M.[1]; Burns, A.[2]

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[2] Fisheries and Oceans Canada, 200 Kent Street, Ottawa, Ontario, Canada, K1A 0E6 (Adam.Burns@dfo-mpo.gc.ca)

The Government of Canada's management measures for the 2019 season to reduce the risk of vessel collisions and fishing gear entanglements with North Atlantic right whales (NARWs) in Canadian waters came into effect on April 28, 2019. The 2019 measures build off the measures from the previous year and were developed in consultation with industry and scientists, taking into consideration past confirmed NARW detection, the latest science advice, navigational safety, and economic impacts. The management measures for 2019 were re-evaluated mid-season in response to the deaths of several NARWs in Canadian waters, with enhanced management measures announced on July 8, 2019. This included increasing the size of the management areas, including area closures to fisheries when whales are sighted, slowing down more ships, investing in the Marine Mammal Response Program to increase capacity to respond to NARW entanglements, providing additional funding to further support NARW recovery, and increasing aerial surveillance throughout the Gulf of St. Lawrence.

Using technology to protect observers (PSO/MMO) while they protect North Atlantic right whales

Steckler, D.J.[1], Donlan, P.A.[1], Smutea, M.A.[2]

[1]Mysticetus, P.O. Box 256, Preston, WA, 98050 USA (davesteckler@mysticetus.com)
[2]Smultea Sciences, 30606 SE 64th St, Preston, WA 98050

With Atlantic wind farm pre-construction and construction in full swing, hundreds of trained and NMFS/BOEM-approved marine biologists are serving as Protected Species Observers (PSOs) on numerous work boats. Their job is to watch for protected marine life – particularly North Atlantic right whales; document animal presence and behavior; and direct appropriate mitigation action (e.g. shutdown, divert course, slow down, etc.). Every employer in the chain, from PSO provider through workboat operator through wind farm developer, has strict, zero-tolerance anti-harassment Human Resources (HR) policies. Still, reality is that the majority of PSOs are female and spend a month+ at sea per rotation, often in relative isolation from onshore management. The Mysticetus app is the most-used technology for PSOs to record data, audit mitigation decisions, and watch heads-up map displays of other nearby boats and animal sightings. In 2019, Mysticetus added a discrete button (with a life preserver image) to the app's touch-screen

display. This button is labeled, "I Feel Unsafe or Uncomfortable". When pressed, the Mysticetus app discretely and instantly notifies selected on-shore management personnel with text messages and email, who can then initiate appropriate formal response protocols per HR guidelines. We at Mysticetus strongly believe in using technology to not only protect endangered animals such as the North Atlantic right whale, but also to protect the dedicated humans engaged in NARW protective efforts. We present this new feature in the hopes it inspires others to push technology forward in similar manners.

Weep no more whales: The inevitable extinction of the right whale

Strahan, R.M.[1]

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After decades of being killed and injured from the commercial development of their critical coastal habitat, right whales have recently experienced the extinction tipping point. The remaining population's failure to produce newborn calves in 2017-2018 breeding season is diagnostic to an irreversible decline to extinction. A scientific assessment is done of existing laws, government agencies, commercial practices, and likely conservation activities to quantify the likelihood of the imminent extinction of the right whale. The result of this study indicates that there will be no likely change in the status quo sufficient to prevent the extinction of the right whale before the end of the century. Alternative scenarios are examined to establish which ones might prevent the right whale's extinction.

Functional Breaking Strength of Vertical Lines in the Gulf of Maine

Summers, E.[1], Cleaver, C.[2], Russell, R.[1], Bell, F.[3], Gavin, A.[3]

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[3]*FB Environmental Associates, Portland, ME 04101 USA*

The population of endangered North Atlantic right whales, *Eubalaena glacialis*, is in decline and new federal regulatory measures for fixed gear fisheries aim to reduce the rate of serious injuries and mortalities due to entanglement. In 2018, the Maine Department of Maine Resources (DMR) was awarded funding through the Section 6 Species Recovery Grants to State program to develop a baseline of information for vertical line distribution, functional breaking strength, and hauling strain. To assess the functional breaking strength of ropes used in the Gulf of Maine, project partners collected and broke over 200 vertical line samples from fishermen throughout the Maine, New Hampshire, Massachusetts, Rhode Island, and offshore lobster fisheries. The manufacturers and types of rope varied and the average age of the rope ranged from three to six seasons. Preliminary findings show that rope diameter, age, and modifications (presence of knots and splices) significantly affect rope breaking strength. Project partners also hosted a rope breaking workshop in summer 2019, where lobster license holders tested the functional breaking strength of more than 20 vertical line modifications that might meet 1700lb breaking strength requirements. After the workshop, DMR identified seven rope modifications for further development and tested 10 samples of each. We will present the findings of the functional breaking strength of new and used rope in the Gulf of Maine and how these data, along with the outputs of the rope workshop, can be integrated into the regulatory measures to reduce vertical line entanglements.

"The Calvineers Movie": Documenting the power of conservation through education

Willey, T.A.[1], Flood, L.E.[2]

[1]*Thom Willey Film, P.O. Box 4, Southwest Harbor, ME, 04679 USA (thomfilm13@yahoo.com)*
[2]*Maine Maritime Academy, Battle Avenue, Castine ME USA 04420*

In the documentary film "The Calvineers Movie", a STEM conservation group of youth educates and informs the public and world of the challenges faced by the North Atlantic right whale. The Calvineers are a successful example of a pilot rural Maine STEM project in action. Currently in production, "The Calvineers Movie" documents the decade-plus work of principle investigator Bill McWeeny and his group The Calvineers, a North Atlantic right whale conservation group from the Adams School in Castine, Maine. The Calvineers are not only featured in this film as doing educational outreach, but also as student investigators interviewing key scientists and industry leaders about their related works via "Calvincast" podcasts. "Calvincast" podcasts amplify voices of the young people who are now, more than ever, speaking out to educate the world at large of the dangers to our fragile planet, including those to the North Atlantic right whale.

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

Willse, N.J.[1], Summers, E.[2], Cleaver, C.[3], Chen, Y.[4]

[1]*University of Maine, Libby Hall, Room 219, Orono, ME 04469 USA (nathaniel.willse@maine.edu)*
[2]*Maine Department of Marine Resources, Boothbay Harbor ME 04575*
[3]*FB Environmental Associates, Portland ME 04101*
[4]*University of Maine, School of Marine Sciences, Orono ME 04469*

A large threat to North Atlantic right whales is entanglement in fixed gear fishery vertical lines, but the current spatial distribution and variability in vertical line strength across the Gulf of Maine is poorly defined. Spatial variation in the threat lobster gear poses to whales is expected, corresponding to overall vertical line strength, type, and depth. Management measures that limit the strength of vertical lines used in the American Lobster fishery are likely to negatively impact the economic resilience of New England fishing communities, but the line strength requirements of these communities are not well characterized. Analyzing the spatially explicit variables that affect vertical line strength requirements allows nimble management strategies that meet biological management goals while mitigating socio-economic disruption. We will spatially model the breaking strength of lines used by commercial lobster fisheries spatially across the Gulf of Maine. We will measure the load put on lines used in typical American Lobster fishery operations to determine the minimum strength necessary to fish safely and effectively. We will provide guidelines for the minimum rope strength necessary for fishery operation to inform management decision goals that include a sustainable lobster fishery and conservation of right whales.

Noise dosage regimens: Can physiological noise impacts on North Atlantic right whales be managed temporally?

Wright, A.J.[1], Parrella, A.M.[2], Moors-Murphy, H.[1], Evers, C.[1], Deak, T.[2]

[1]*Maritimes Region Fisheries and Oceans Canada, Ocean and Ecosystem Sciences Division, 1 Challenger Drive, Dartmouth, NS B2Y 4A2 Canada (andrew.wright@dfo-mpo.gc.ca)*
[2]*Behavioral Neuroscience Program, Department of Psychology, Binghamton University—SUNY, Binghamton NY 13902-6000, USA*

Changes to the temporal structure of noise production (i.e., the noise dosage regimen for exposed animals) may help alleviate impacts of noise on North Atlantic right whales (NARW) and other marine mammals. However, we know little about how the resulting trade-offs affect individuals (e.g., slowing ships reduces peak noise levels, but prolongs transit time). Accordingly, we reviewed available literature on physiological effects of noise exposure in model laboratory species (e.g., rats). Many generalized aspects of stress responses were noted, including periods of heightened activity of the Sympathetic Nervous System, Hypothalamic-Pituitary-Adrenal axis, and other stress-related neuropeptide signalling systems, such as corticotrophin-releasing hormone. Importantly, each of these systems exert broad, immediate influences on behaviour and physiology of

the organism (e.g., reduced social and sexual behaviour), while also contributing to long-term adverse health consequences (e.g., disruptions in cognitive or affective function). Many classic effects of chronic stress were reported following days to weeks of exposures, including alterations in hippocampal function (reduced dendritic branching and spines, reduced neurogenesis, etc.) that contribute to cognitive dysfunction (e.g., impaired learning and memory). Reported metabolic changes escalated with the duration of noise exposure and behavioural indices of increased anxiety. Elsewhere, increased tau phosphorylation in the prefrontal cortex may contribute to noise-related vulnerability to neurodegenerative processes. Similarly, inflammatory processes in the Central Nervous System likely contribute to enhanced pain sensitivity (hyperalgesia). Although, a broad spectrum of behavioural and neural alterations were evident in models exposed to noise on an acute, subacute, or chronic basis, studies examining long-term chronic noise exposure at more moderate sound levels were lacking. This gap limits the use of terrestrial models to inform effective management decisions for NARWs and other marine mammals. However, repeated acute and subacute exposures over even relatively brief periods of days would be expected to have enduring physiological and cognitive impacts.

Developing a blubber-implanted satellite tag for right whales

Zerbini, A.N.[1,2], Rajachar, R.[3], Uhart, M.[4,5], Clapham, P.J.[6], Crandall, N.[7], Leask, A.[7], Holland, M.[7], Zoodsma, B.[8]

[1] *Marine Mammal Laboratory, Alaska Fisheries Science Center, NOAA, Seattle, WA, USA (alex.zerbini@noaa.gov)*
[2] *Marine Ecology and Telemetry Research, Seabeck, WA, USA.*
[3] *Engineered Biomaterials Laboratory, Department of Biomedical Engineering, Michigan Tech University, Houghton, MI, USA.*
[4] *Karen C. Drayer Wildlife Health Center, School of Veterinary Medicine, University of California, Davis, Davis, CA, USA*
[5] *Southern Right Whale Health Monitoring Program, Puerto Madryn, Chubut, Argentina.*
[6] *Seastar Scientific, Vashon, WA, USA.*
[7] *Wildlife Computers, Redmond, WA, USA.*
[8] *NOAA Southeast Regional Office, Fernandina Beach, FL, USA.*

Right whales (genus *Eubalaena*) were severely reduced by whaling. While recovery has been observed in the Southern Hemisphere, populations of North Pacific and North Atlantic right whales (NARW) are still small and listed as endangered. The status of the NARW is of particular concern due to declining health and fecundity and high mortality rates associated with ship strikes and entanglements. Effective management depends on knowledge about how right whales are using their habitats, the extension of overlap of these habitats and anthropogenic activities, and how distribution and behavior are shifting in response to changes in the environment. Satellite tagging is an effective method to describe movements, habitat use and migration of whales and to understand how animals overlap with and respond to anthropogenic threats. Long-term tags applied to large whales typically require anchoring below the blubber/muscle interface, but these tags are not currently allowed for use with some endangered populations because of concerns about their effects on the health of the animals. The goal of this study is to develop a new, shorter, and less invasive satellite tag with electronics embedded in the blubber for use with right whales. A total of eight implantable "blubber" tags (130mm in length and 24mm in diameter) were deployed in Southern right whales near Península Valdés, Argentina in September 2019. Tag duration ranged from 12.6 to 30.4 days, with an average of 19.8 days (SD = 7.3 days). These numbers are still preliminary because one tag was still transmitting by the time this abstract was prepared. Follow-up of tagged animals is ongoing to assess potential effects of tags to individual whales and should continue until whales depart from their wintering grounds in Argentina by late November/early December. Future modifications of this tag for deployment on the same population in 2020 should include an anti-microbial coating and a new texture for the surface of the tag housing, which are expected to improve tag duration.

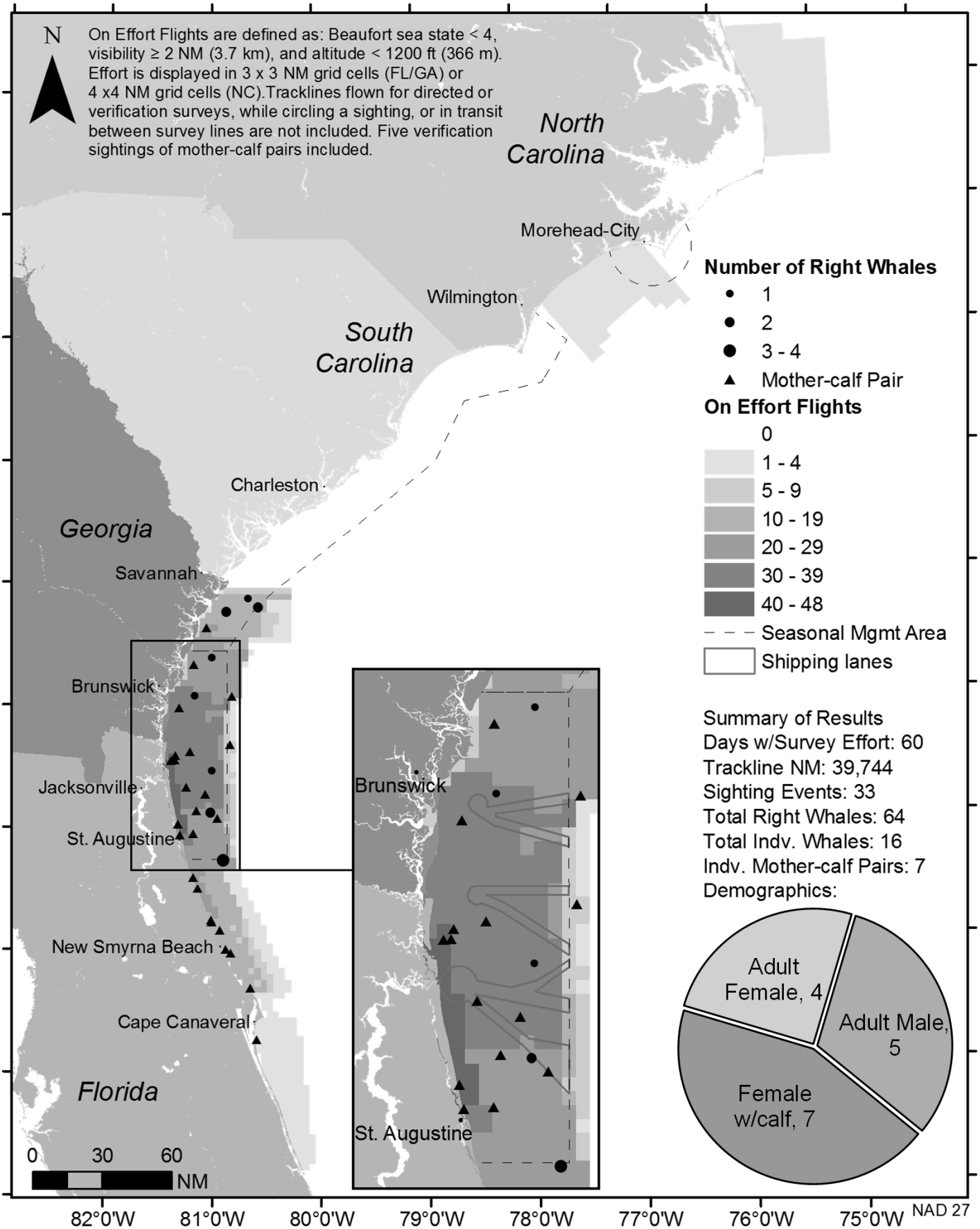
Southeast U.S. Aerial Surveys

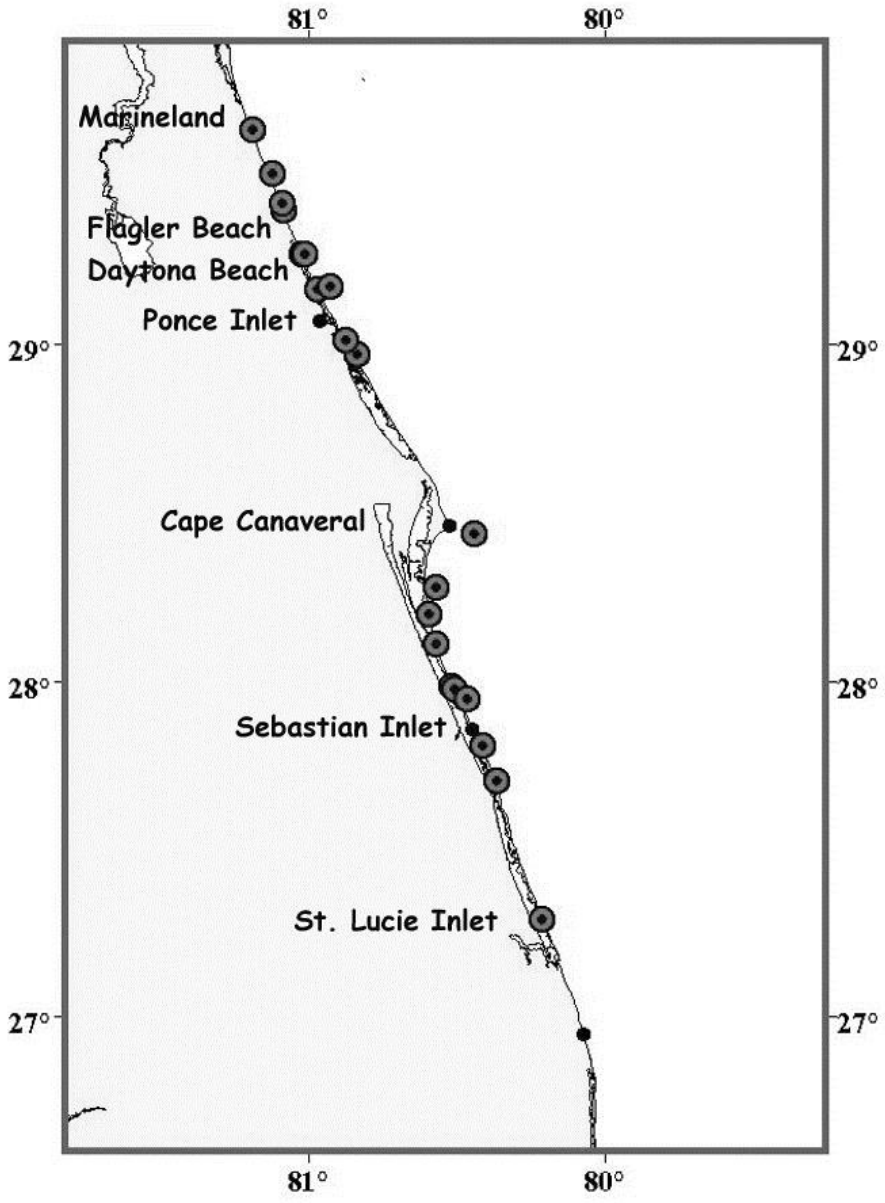
December 1, 2018 – March 31, 2019

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

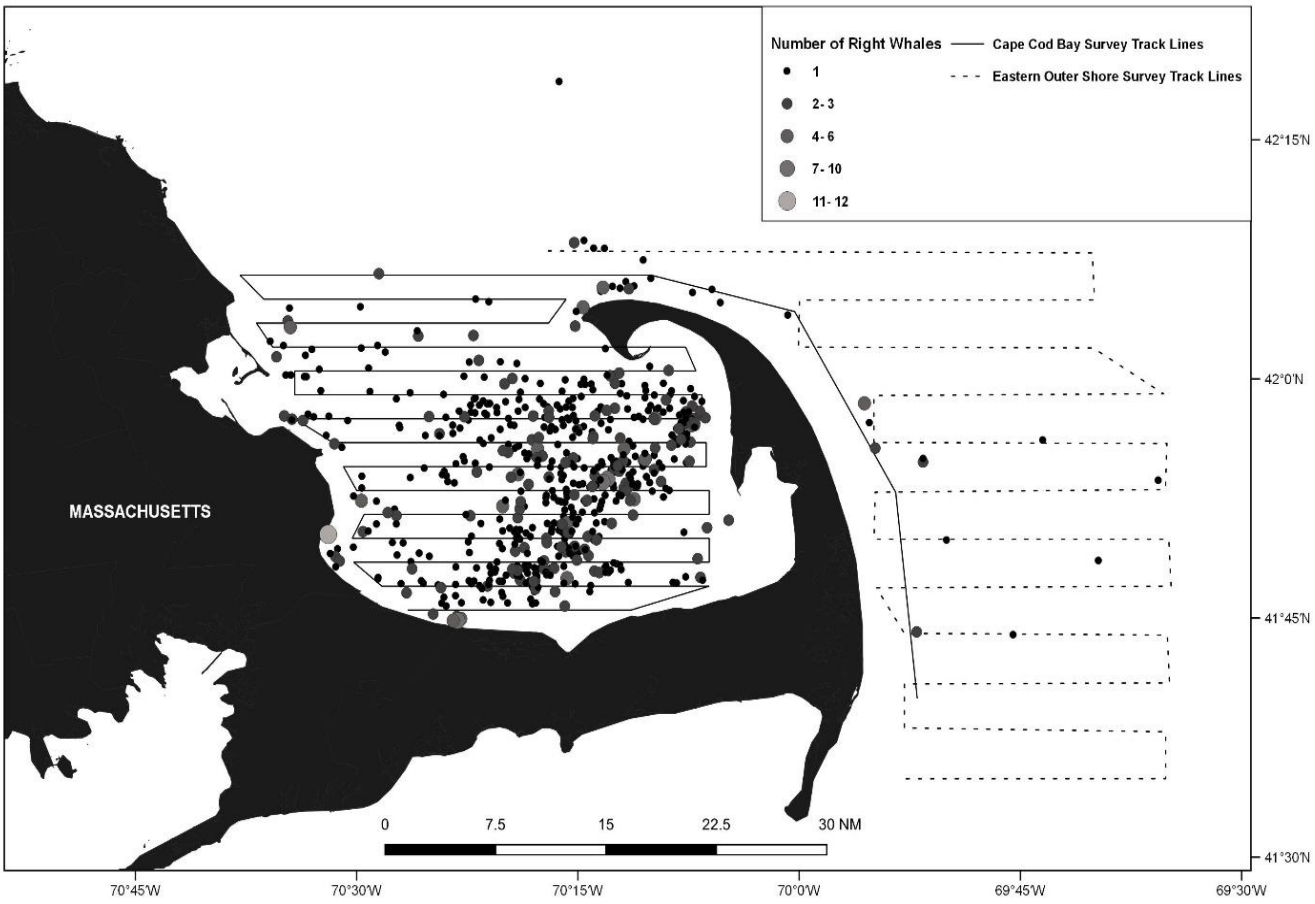




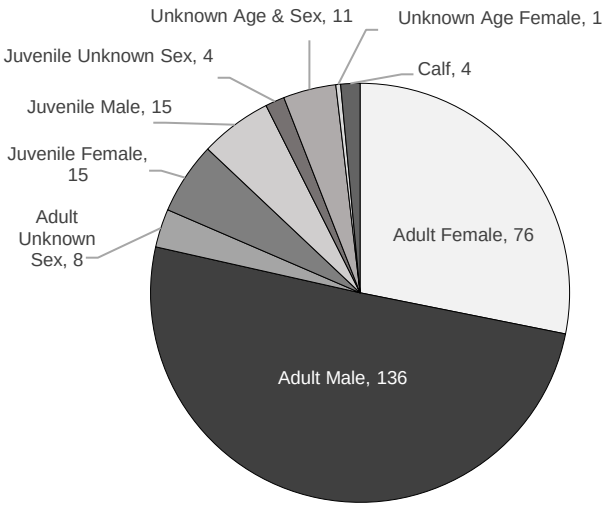
Verified right whale sightings by the Volunteer Sighting Network (VSN) during the 2018-19 southeastern U.S. (SEUS) season. Sightings resulted from a collaborative effort between the Marineland Right Whale Project and the Marine Resources Council, and included collaboration by the Florida Fish and Wildlife Team. All sightings were of mother-calf pairs. Total n = 20. New MC reports for the season were Catalog #4180 on 5 February and #3370 on 12 February.

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

November 2018 to May 2019



- Conducted 38 aerial surveys from 12 November 2018 to 16 May 2019, aboard Cessna Skymaster and O2-Skymaster
- Areas surveyed: Cape Cod Bay (29), Eastern shore of Cape Cod (5), Jeffreys Ledge (3), Massachusetts Bay/ Stellwagen Bank (1)
- Observed right whales on 33 of the 38 surveys
- Surveyed 12,682 nautical miles in Cape Cod Bay and adjacent waters
- Peak of the 2019 season was on 07 April flight with 129 individuals documented
- Documented at least 270 individual right whales throughout the season across all CCS platforms. Vessel/ opportunistic recorded 5 of the 270 not observed by aerial effort



RWEP team: Stormy Mayo, Amy James, Brigid McKenna, Alison Ogilvie, Christy Hudak, Keith Hankowsky, Pippa Low, Kate McPherson

Research conducted under NMFS Permit #19315-01

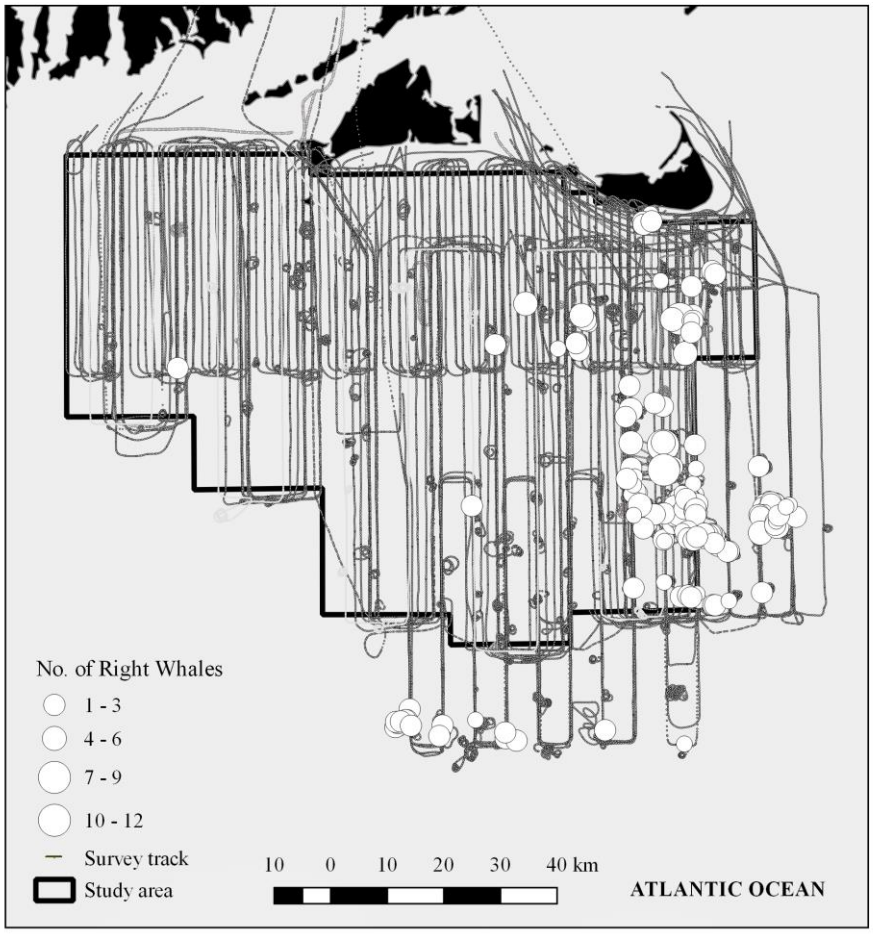
New England Aquarium
Protecting the blue planet

Anderson Cabot Center for Ocean Life at the New England Aquarium

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

November 2018 to August 2019

Survey effort and results: 284 right whales were observed.
Research team: Ester Quintana and Orla O'Brien
Funding sources: Massachusetts Clean Energy Center/Bureau of Ocean Energy Management



Month	General surveys			Condensed/ Supplementary surveys		
	Total	HOBBS hours	Km	Total	HOBBS hours	Km
November	1	7.8	1,147.68	-	-	-
December	2	13.3	1821.44	-	-	-
January	1	6.4	975.08	2	11.6	1279.36
February	1	5.8	924.52	3	15.0	2097.75
March	1	4.5	685.43	3	10.7	1558.09
April	1	7.0	1035.45	5	17.1	2653.17
May	1	5.8	923.59	5	23.7	3408.60
June	1	7.5	1036.93	3	12.1	1835.14
July	1	6.2	971.93	5	17.4	2644.29
August	-	-	-	3	8.8	1552.75
Total	10	64.3	9522.05	29	116.4	17029.15

NEFSC MAY 2019 NARW CRUISE

These summaries include catalog and intermatch individuals photographed on the spring Right Whale Cruise during May 2019, aboard RV Connecticut. Adults are ≥9y.o. Juveniles < 9y.o., and calves are calves of the year.

All identified individuals (photo-ID ongoing)
Total individuals: 44

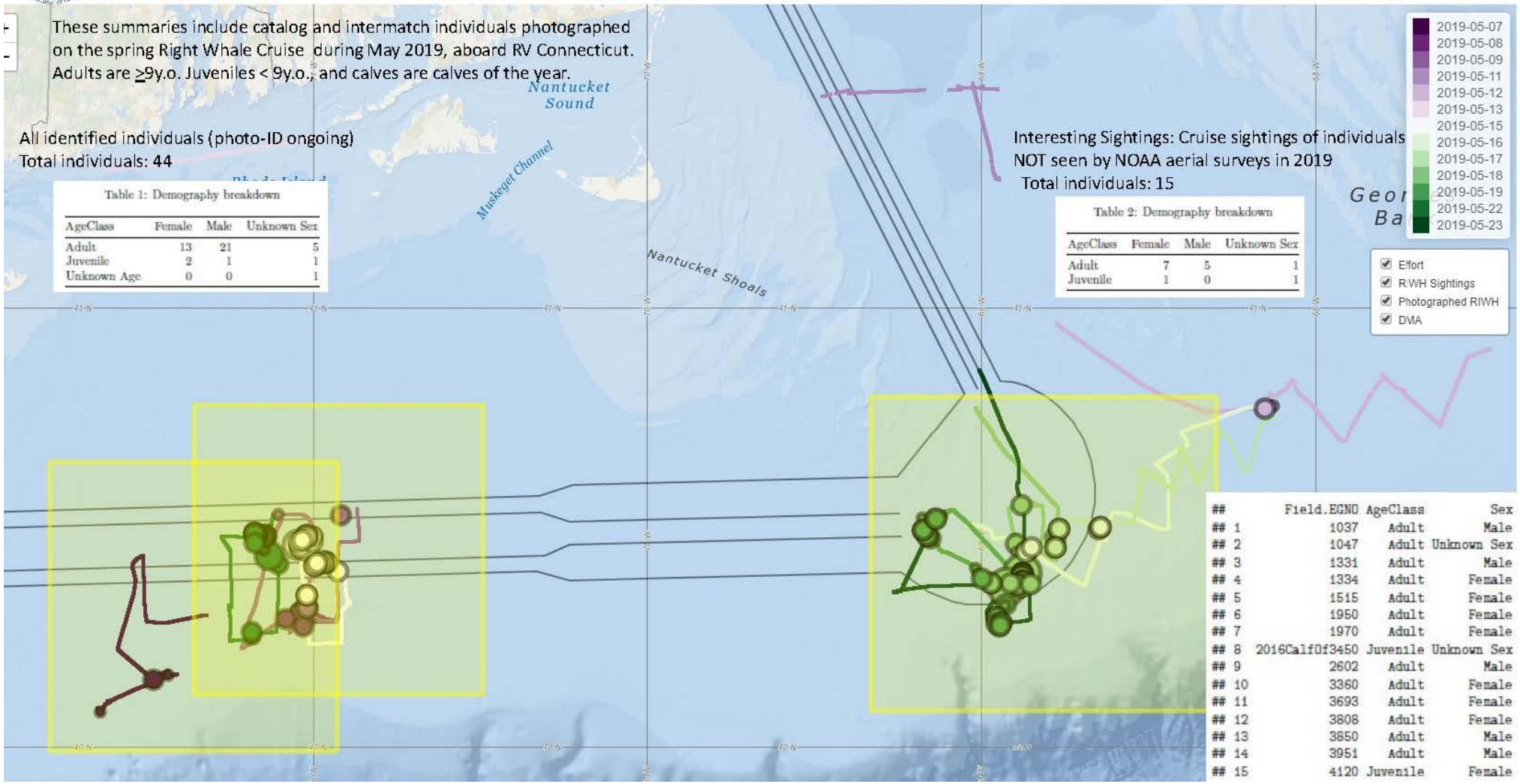
Table 1: Demography breakdown

AgeClass	Female	Male	Unknown Sex
Adult	13	21	5
Juvenile	2	1	1
Unknown Age	0	0	1

Interesting Sightings: Cruise sightings of individuals NOT seen by NOAA aerial surveys in 2019
Total individuals: 15

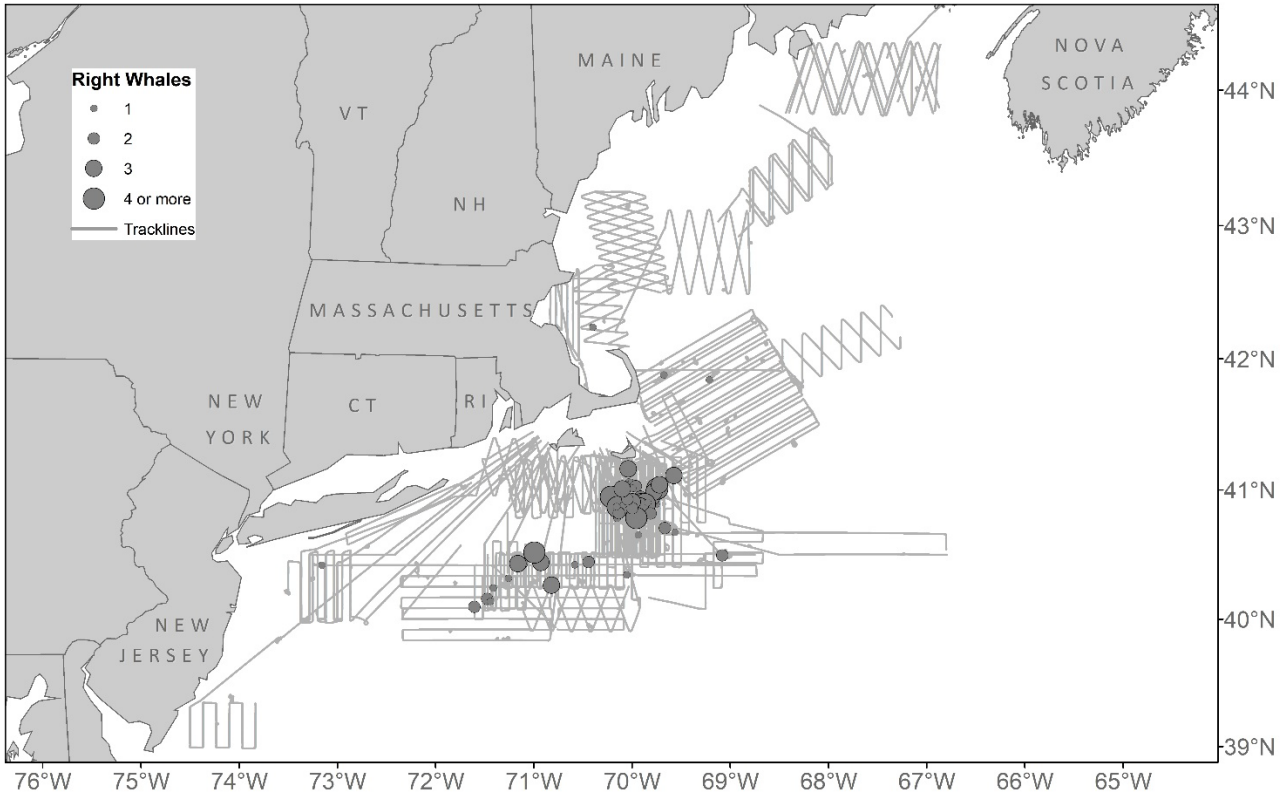
Table 2: Demography breakdown

AgeClass	Female	Male	Unknown Sex
Adult	7	5	1
Juvenile	1	0	1




```
##         Field.EGNO AgeClass         Sex
## 1             1037    Adult        Male
## 2             1047    Adult Unknown Sex
## 3             1331    Adult        Male
## 4             1334    Adult      Female
## 5             1515    Adult      Female
## 6             1950    Adult      Female
## 7             1970    Adult      Female
## 8  2016CalfOf3450 Juvenile Unknown Sex
## 9             2602    Adult        Male
## 10            3360    Adult      Female
## 11            3693    Adult      Female
## 12            3808    Adult      Female
## 13            3850    Adult        Male
## 14            3951    Adult        Male
## 15            4120 Juvenile      Female
```

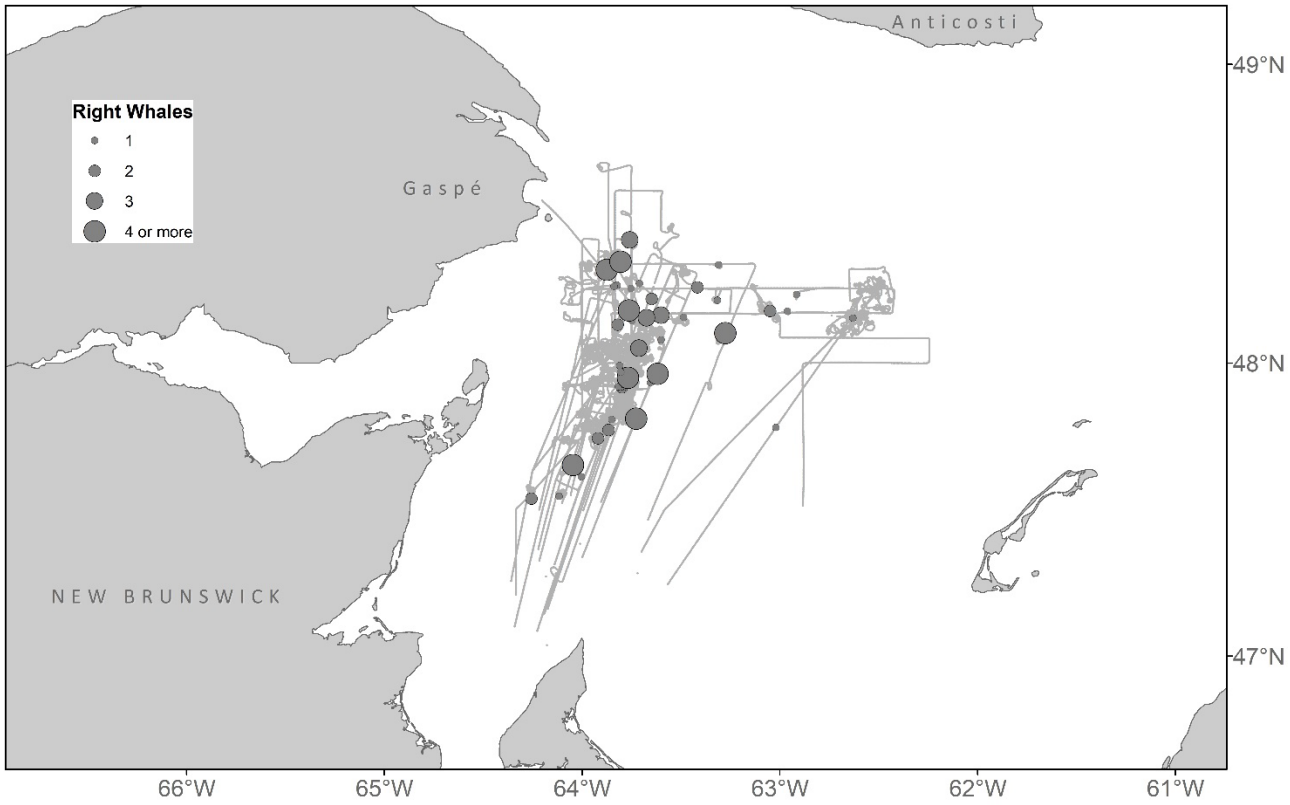
NMFS Northeast Right Whale Aerial Surveys
October 2018 – October 2019
United States



- NOAA Twin Otter conducted surveys in the US from November 18, 2018 - September 9, 2019
- Total flight time (including transits) was 312.6 hours
- Observed right whales on 34 of the 59 survey days
- Sighted 670 right whales (including repeats of individuals) with maximum aggregation size of 80
- Matched 231 unique individuals including:

AgeClass	Female	Male	Unknown Sex
Adult	60	125	6
Juvenile	12	9	7
Unknown Age	0	0	12

NMFS Northeast Right Whale Aerial Surveys
October 2018 – October 2019
Canada



- NOAA Twin Otter conducted surveys in Canada from June 4, 2019 – August 26, 2019
- Total flight time (including transits) was 110.1 hours
- Observed right whales on all 19 of the 19 survey days
- Sighted 799 right whales (including repeats of individuals) with maximum aggregation size of 65
- Matched 128 unique individuals including:

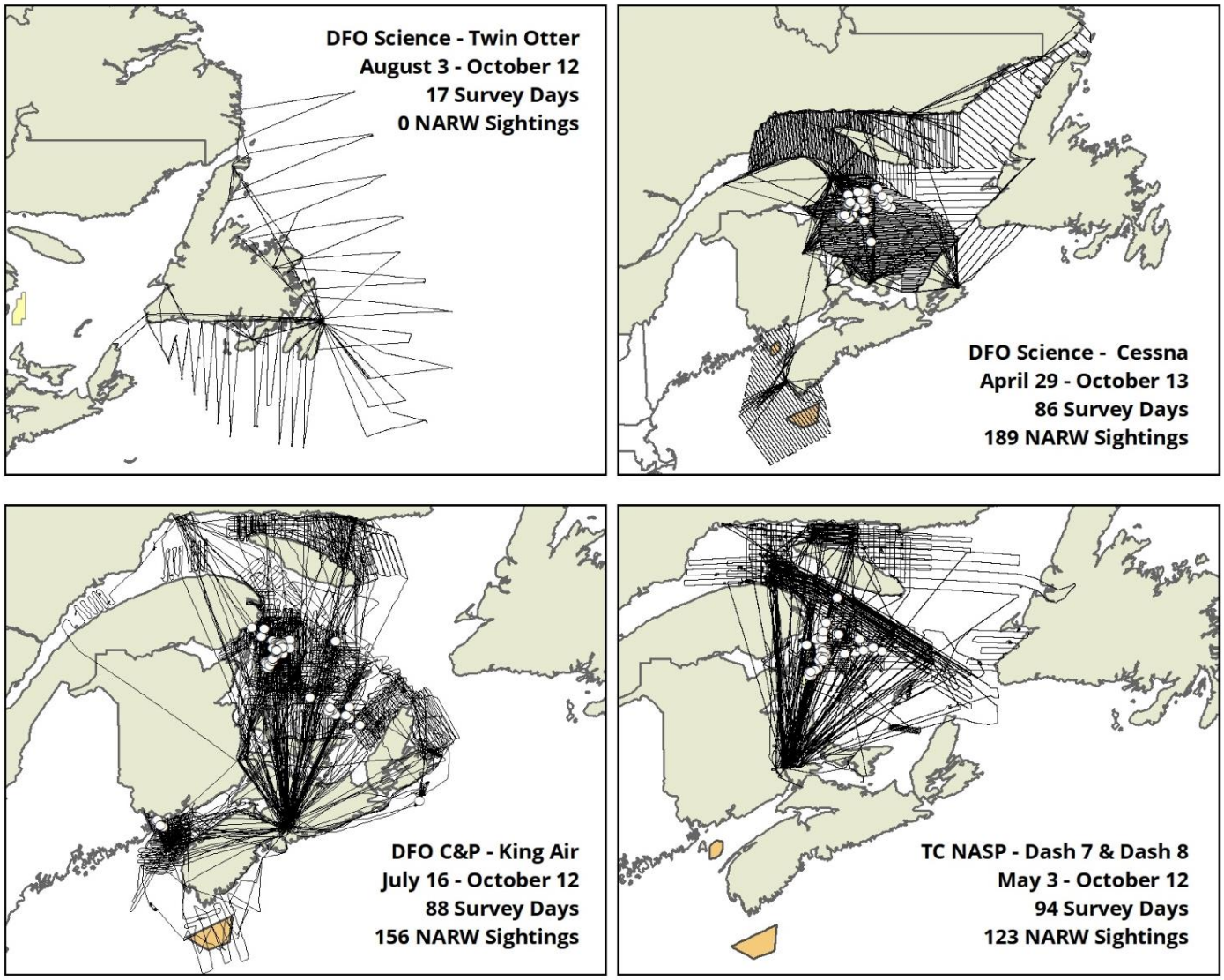
AgeClass	Female	Male	Unknown Sex
Adult	36	65	2
Juvenile	7	11	2
Unknown Age	0	0	3
Calf	0	0	4

Marine mammal aerial surveys in Canadian waters

conducted by

Fisheries and Oceans Canada and Transport Canada

April to October 2019

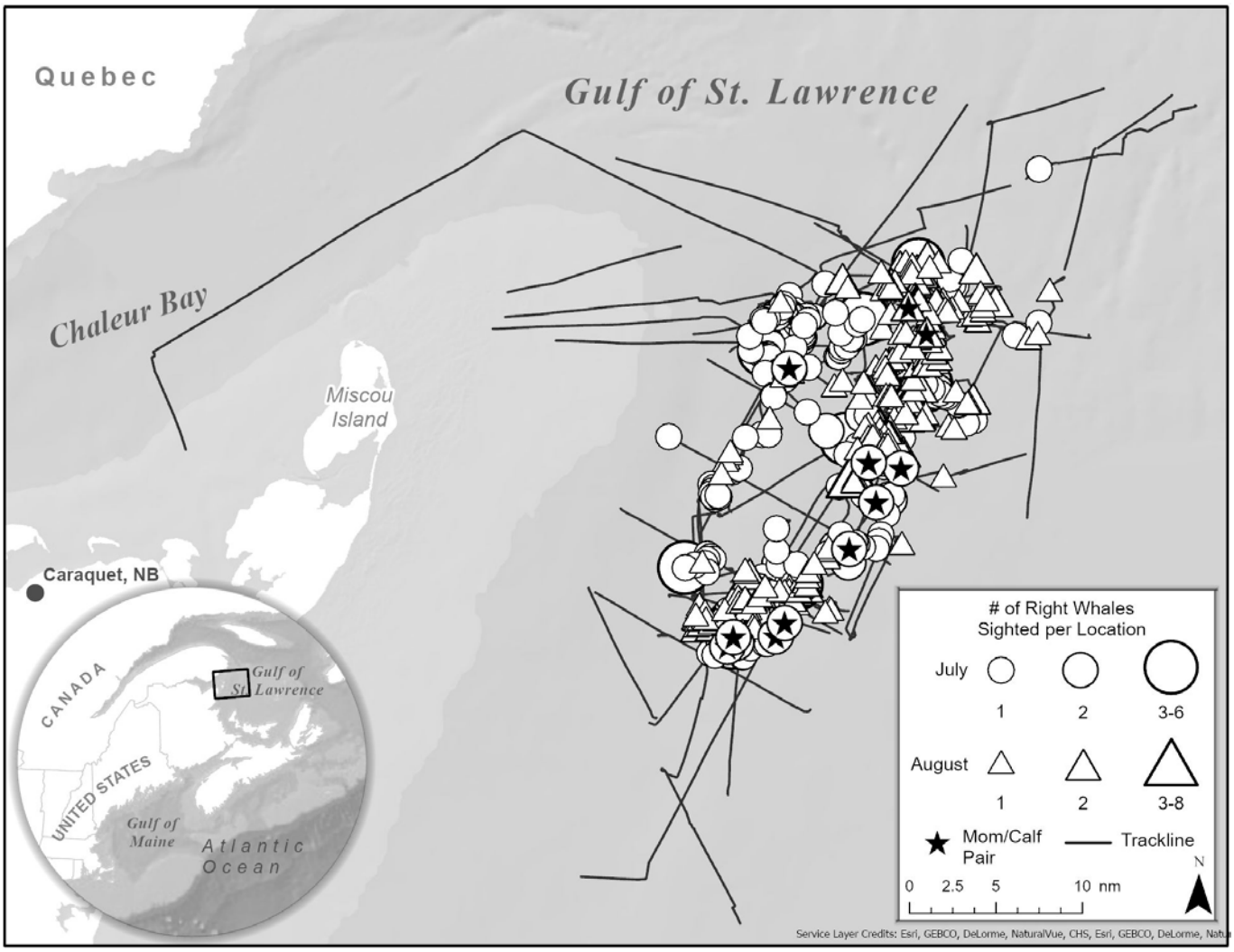


DFO C&P- Fisheries and Oceans Canada- Conservation and Protection

TC NASP- Transport Canada National Aerial Surveillance Program (Atlantic [Dash 8] and Central [Dash 7])

- All surveys except for the DFO Science- Twin Otter extended beyond October 12.
- Sightings in map (White circles) represent either single or multiple individuals.
- Imagery is collected and submitted to the Right Whale Consortium. Photo-identification have not been completed.

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



	Cruise 1	Cruise 2	Total
Cruise Dates	05 July – 22 July	07 August – 25 August	
No. of survey days	15	14	**29**
Track line Miles (NM)	500	639	**1139**
No. of photo-documented sightings	202	341	**543**
No. of Unique Individuals	85	92	**110**
No. of Mom/calf pairs	4	1	**4**

Survey Team:

New England Aquarium: Amy Knowlton, Philip Hamilton, Marianna Hagbloom, Kelsey Howe, Megan McOsker and Monica Zani

Dalhousie University: Hansen Johnson, Meg Carr, Delphine Durette-Morin, Kimberly Franklin and Marcia Pearson

University of New Brunswick: Kim Davies

Funding by: Fisheries and Oceans Canada, Habitat Stewardship Program of Environment and Climate Change Canada, Irving Oil, Island Foundation, NSERC, the Marine Environmental Observation Prediction and Response Network of Centres of Excellence and World Wildlife Fund.

Research conducted under section 73 SARA permit issued by Department of Fisheries and Oceans Gulf Region (permit no. DFO-GLF-2017-01) and Quebec Region (permit no. QUE-LEP-001-2019). Map by Brooke Hodge.

Research effort Mingan Island Cetacean Study – Jacques Cartier Passage 2019

- 44 days on the water (average 50) between June 10 and September 28
- 12,341km covered (13,000km annual average), 611 hours of survey effort

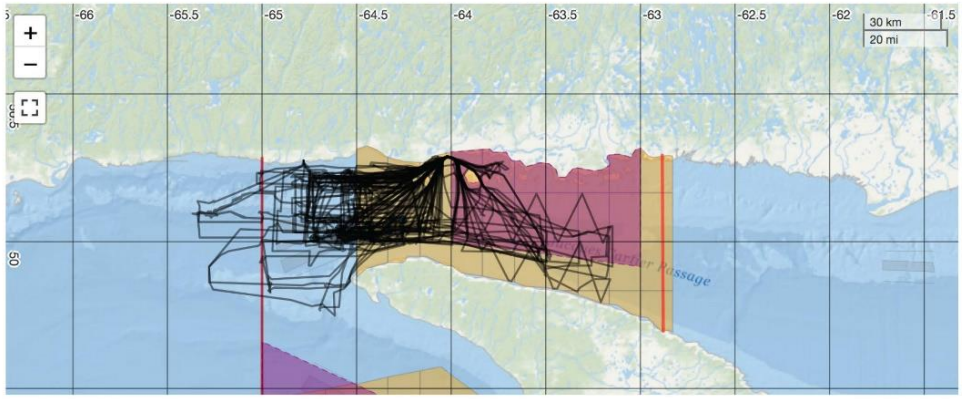


Figure1: Boat tracks (spatial effort) 2019

- NARW were observed on 12 days
- July 11 through September 22
- 18 sightings including 4 individuals
- individuals present for 2+ months
- #1701, #3710, #3890, #4042

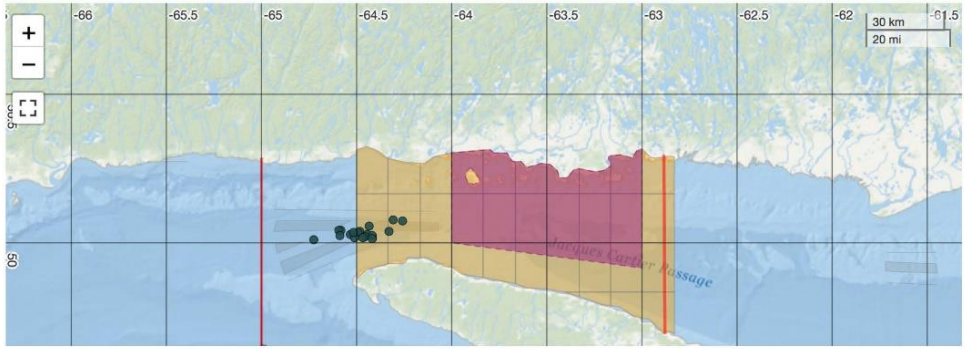
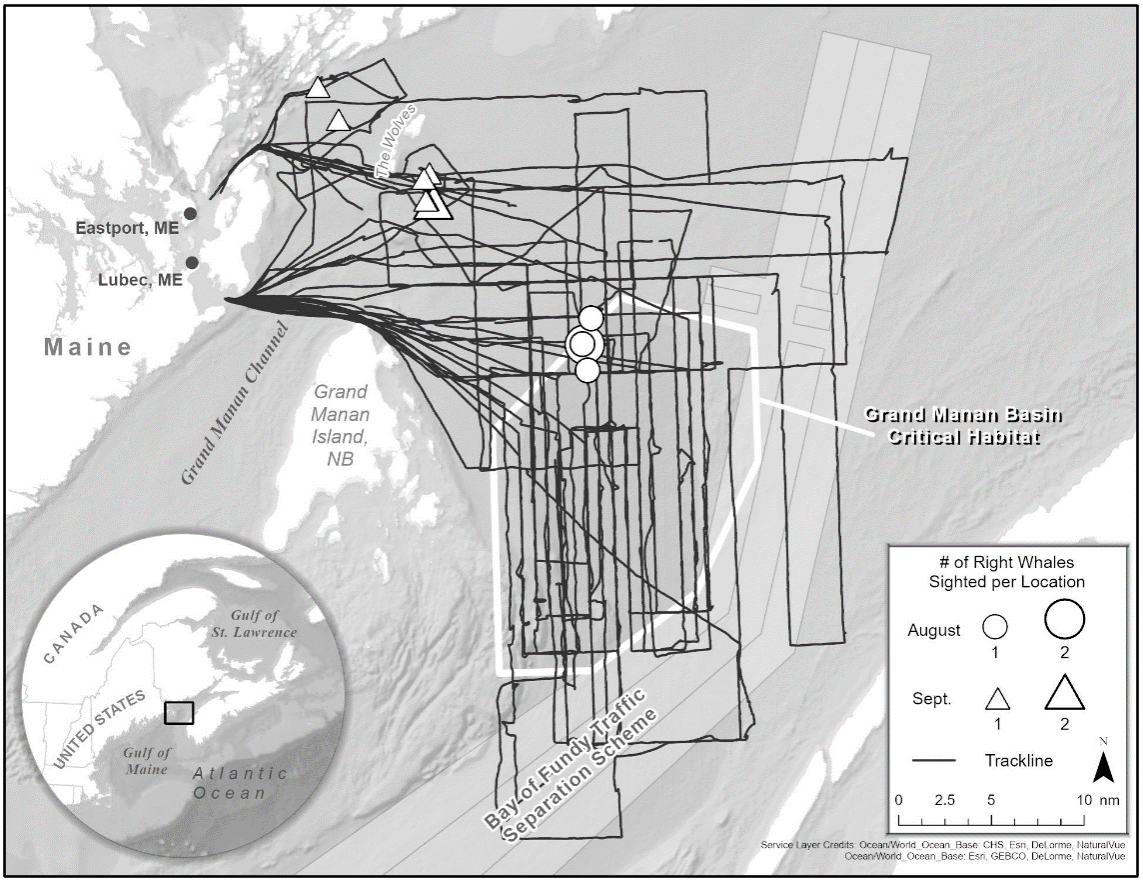


Figure 2: Right whale sightings 2019 (Maps by http://whalemap.ocean.dal.ca/)

New England Aquarium

Anderson Cabot Center for Ocean Life at the New England Aquarium

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



Month	No. of survey days	Track line miles (NM)	No. of right whale sighting events	No. of right whales	No of unique individuals
June	2	230	0	0	0
July	5	541	0	0	0
August	5	472	4	5	5
September	6	515	7	8	7
Total	**18**	**1758**	**11**	**13**	**9**

Right Whale Catalog No.	Sex	Age
#2201	M	27
#3150	M	18
#3392	M	A*
#3650	F	13
#3790	F	12
#3830	M	11
#3908	F	10
#3991	F	10
#4041	F	9

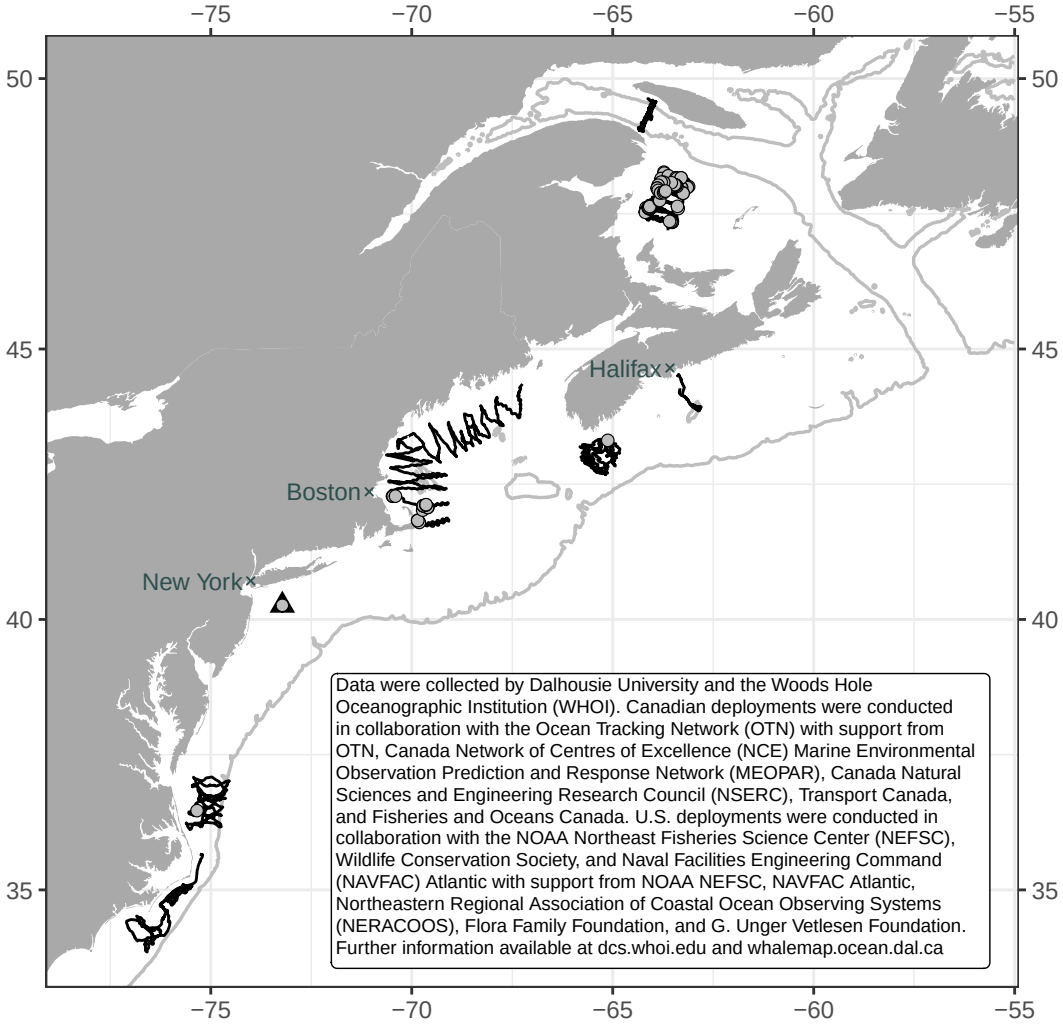
*Adult of unknown age

Survey team: Johanna Anderson, Marianna Hagbloom, Philip Hamilton, Kelsey Howe, Celia Jellison, Amy Knowlton, Marilyn Marx, Anne McGhie, Brigid McKenna, Bill McWeeny, Heather Pettis and Monica Zani.

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

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

Near real-time passive acoustic monitoring for right whales



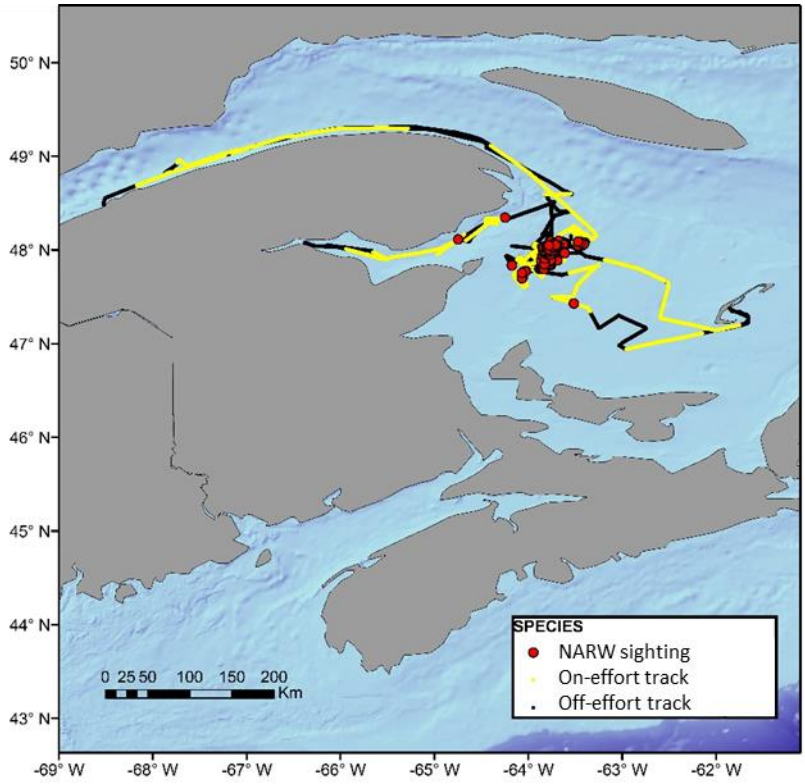
Slocum glider tracks and moored buoy positions are shown as black lines and triangles, respectively, with grey circles indicating locations of definite right whale detections.

Platform	Name	Region	Start Date	End Date	Days	Track Distance [km]	Detections
slocum	fundy	Gulf of St Lawrence	Jun-04	Jun-25	21	428	9
slocum	bond	Gulf of St Lawrence	Jul-24	Aug-14	21	291	26
slocum	dal556	Gulf of St Lawrence	Aug-14	Oct-01	48	671	25
slocum	scotia	Gulf of St Lawrence	Jun-05	Aug-28	84	1329	29
slocum	capx638	Gulf of St Lawrence	Sep-04	Ongoing	47	1061	0
slocum	bond	Roseway Basin	Aug-28	Sep-25	28	925	0
slocum	scotia	Roseway Basin	Sep-25	Ongoing	26	865	1
slocum	scotia	Scotian Shelf	Mar-13	Mar-27	14	224	0
slocum	we14	Mid-Atlantic Bight	Jan-22	Mar-18	55	1009	0
slocum	we15	Mid-Atlantic Bight	Jan-23	Mar-18	54	1226	1
slocum	we03	Gulf of Maine	Dec-01*	Apr-22	142	2592	19
buoy	nybight	New York Bight	Feb-20	Ongoing	242	NA	10

* deployment started in 2018

TOTAL: 12 deployments, 782 days, 10621 kilometers, 120 detections

Gulf of St. Lawrence Cruise by Fisheries and Oceans Canada, Maritimes & Quebec: North Atlantic right whale monitoring, prey distribution & potential effects of ship-based oil spill



Primarily in August, 158.85 on-effort MMO hours were completed during the cruise, with around 300 hours total MMO effort, as there were usually 2 observers on-effort at any given time. During this time we had 141 confirmed NARW sightings, comprising of a minimum of 442 animals (including resightings and thus not a minimum count for the survey). We identified 39 animals, plus a calf associated with it's mother, for a total of 37 individuals, which represents the minimum number of individual animals observed during the cruise. These were: 1042; 1209 (El); 1249 (Lacrosse); 1271 (Dropcloth); 1403 (Meridian); 1419; 1429 (Scarf); 1507 (Manta); 1820 (Cello); 1934 (Sagamore); 1971 (Nantucket); 2209; 2303; 2681 (Hyphen); 2705 (Silver); 2753 (Arpeggio); 2760; 2791 (and calf); 2920; 2930 (Specs); 3191; 3232 (Lobster); 3333; 3442 (Armada); 3520 (Millipede); 3530 (Ruffian); 3550; 3617 (Salem); 3651; 3660 (Sirius); 3701 (Eros); 3904 (Champagne); 3981; 3992; 4123 (possibly); 4140 (Casper); 4190; 4423; and 4440.

Beyond sightings 30 photogrammetry flights over whales (not all successful, some over multiple whales). Additionally, 18 blow samples from individual NARWs were collected, 3 DTAGs were deployed for up to 6 hours each, and 9 satellite tags were deployed (in collaboration with Dr. Russ Andrews, University of Alaska, Fairbanks) on the first leg between 22nd July and 19th August.

Science crew (DFO unless otherwise noted): Alice Ortmann, Andrew Wright, Pam Emery, Hilary Moors-Murphy, Clair Evers, Gabrielle Macklin, Yves Morin, Marc Ringuette, Kevin MacIsaac, Susan Cobanli, Sophie Comtois, Catherine Johnson, Caroline Leherbauer, Jennifer Mason, Geneviève Perrin, Camilla Ryther, Brian Robinson, Gary Wohlgeschaffen, Liam Olders (Liam Olders Aerial), Melanie White (Clearwater Aquarium), Michael Williamson (King's College London), and Russ Andrews (University of Alaska, Fairbanks). Ground support: Simon Higginson and Veronique Lesage

Research was conducted under SARA and FA permits issued by Department of Fisheries and Oceans Canada on the Coriolis II and Quebequois. Map provided by Pam Emery.

THIS IS A DRAFT DOCUMENT AND SHOULD NOT BE SIGHTED. DATA PRESENTED HERE IS NOT YET COMPLETE FOR 2019 AND WILL BE UPDATED WITH YEAR-END INFORMATION ON 31 DECEMBER 2019. ONCE THE REPORT IS FINAL, IT WILL BE POSTED TO THE NARWC WEBSITE AND DISTRIBUTED.

North Atlantic Right Whale Consortium
2019 Annual Report Card

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NORTH ATLANTIC RIGHT WHALE CONSORTIUM BACKGROUND

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

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

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

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

ESSENTIAL POPULATION MONITORING AND PRIORITIES

In the 2009 Report Card to the International Whaling Commission (IWC), the Consortium Board identified key monitoring efforts that must be continued and maintained in order to identify trends in the population, as well as assess the factors behind any changes in these trends (Pettis, 2009). The key efforts are: (1) Photographic identification and cataloging of right whales in historically and emerging high-use habitats and migratory corridors, including, but not limited to, the southeast United States, Cape Cod Bay, Gulf of St. Lawrence, Great South Channel, Bay of Fundy, Scotian Shelf, and Jeffreys Ledge, (2) Monitoring of scarring and visual health assessment

from photographic data, (3) Examination of all mortalities, and (4) Continue using photo-ID and genetic profiling to monitor population structure and how this changes over time.

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

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

In 2019, **ten** right whale mortalities were detected, bringing the total detected mortalities for the last three years to **30**. Over the same time period, a total of **12** right whale calves were born. Given that detected mortalities likely under-represent actual mortalities by a significant amount (Kraus et al. 2005, unpub. data), the state of this population is dire. Anthropogenic factors, including entanglement in fixed fishing gear and vessel strikes, have been implicated in 13 of the 30 most recent mortalities (the remaining 17 have undetermined cause of death, though two of these are suspected as human impact – one entanglement and one vessel strike). Additionally, for all mortalities detected between 2003 and 2018 for which a cause of death could be determined, all juvenile and adult deaths were due to either entanglement or vessel strike (Sharp et al. 2019). Anthropogenic related deaths, which management measures have clearly not reduced (Pace et al. 2014; Sharp et al. 2019), are increasing the threat to the survival of this species.

In the spring of 2018, Canada announced new measures to mitigate both entanglements and vessel strikes in areas in which right whales frequent, including vessel speed reductions, temporary and fixed fisheries management areas and closures, and increased reporting requirements for fishing activity, lost gear, and interactions with marine mammals. There were no detected right whale mortalities in Canadian waters in 2018, though there were three entangled whales detected that year. In 2019, similar mitigation measures, though reduced in scope compared to 2018, were put into place in Canadian waters. Between 04 and 27 June 2019, seven right whale mortalities were detected in Canadian waters, three of which were attributed to vessel strikes. In response, vessel strike mitigation measures in the Gulf of St. Lawrence were expanded on 08 July 2019. Two additional right whale mortalities were detected in Canadian waters in July 2019 (causes of death undetermined) and a third whale who became severely entangled in the Gulf of St. Lawrence in August 2019, well after the snow crab fishery season was over, was discovered dead in waters off New York, U.S. in September 2019.

While there were no right whale mortalities detected in Canadian waters in 2018, three were detected in U.S. waters, all of which were entanglement related. One of these three entanglements was attributed to snow crab gear. Additionally, live entangled whales were detected in U.S. waters in both 2018 (1) and 2019 (1).

Ongoing discussions about reducing anthropogenic impacts on right whales in both Canadian and U.S. waters are encouraging. However, immediate, broad-based mitigation strategies that result in significant risk reduction throughout the right whale's range in light of changing distributions and habitat use must be a priority if this species is to survive.

POPULATION STATUS

The ability to monitor North Atlantic right whale vital rates is entirely dependent on the North Atlantic Right Whale Identification Database (Catalog), curated by the Anderson Cabot Center for Ocean Life at the New England Aquarium. As of September 4, 2019, the database consisted of over a million slides, prints, and digital images collected during the 78,399 sightings of 746 individual right whales photographed since 1935. Each year,

2,000 to 5,000 sightings consisting of 20-30,000 images are added to the identification database. Using Catalog data, a number of methods have been employed to estimate the number of North Atlantic right whales alive annually. Due to lag times in Catalog data submissions and data processing, only data through 2018 were available for these calculations. Here we describe four different estimate methods and present the Consortium's best estimate for 2018. The first two methods use the calendar year; the last two methods use the "whale" year which runs from December 1 to November 30. This latter definition was created to avoid "double counting" whales seen in the southeast US in December and January

Presumed Alive Method

The presumed alive method (PA) counts whales that have been seen at least once in the last six years (Knowlton et al. 1994). It is a consistently measureable and easily available value, but it assumes that whales remain alive for six years after their last sighting (which is often not the case) and the estimates for recent years may be artificially low due to delays in data processing. The PA number for 2018 is 462.

Catalog Method

The Catalog method (formerly referred to as the "Report Card" method) includes a low, middle and high estimate. A table with all of these estimates as well as a full description of the methodology is provided in Appendix 1 of this report card. The values are based upon the number of photographed whales only; they exclude potential unphotographed whales and therefore should not be considered a "population estimate". This method has the weakness of utilizing the PA methodology with its assumptions, but it does incorporate whales that have been photographed but not yet added to the Catalog. The Catalog estimates for 2018 range from a low of 343 to a high of 727 with a middle estimate of 502.

Minimum Number Alive Method

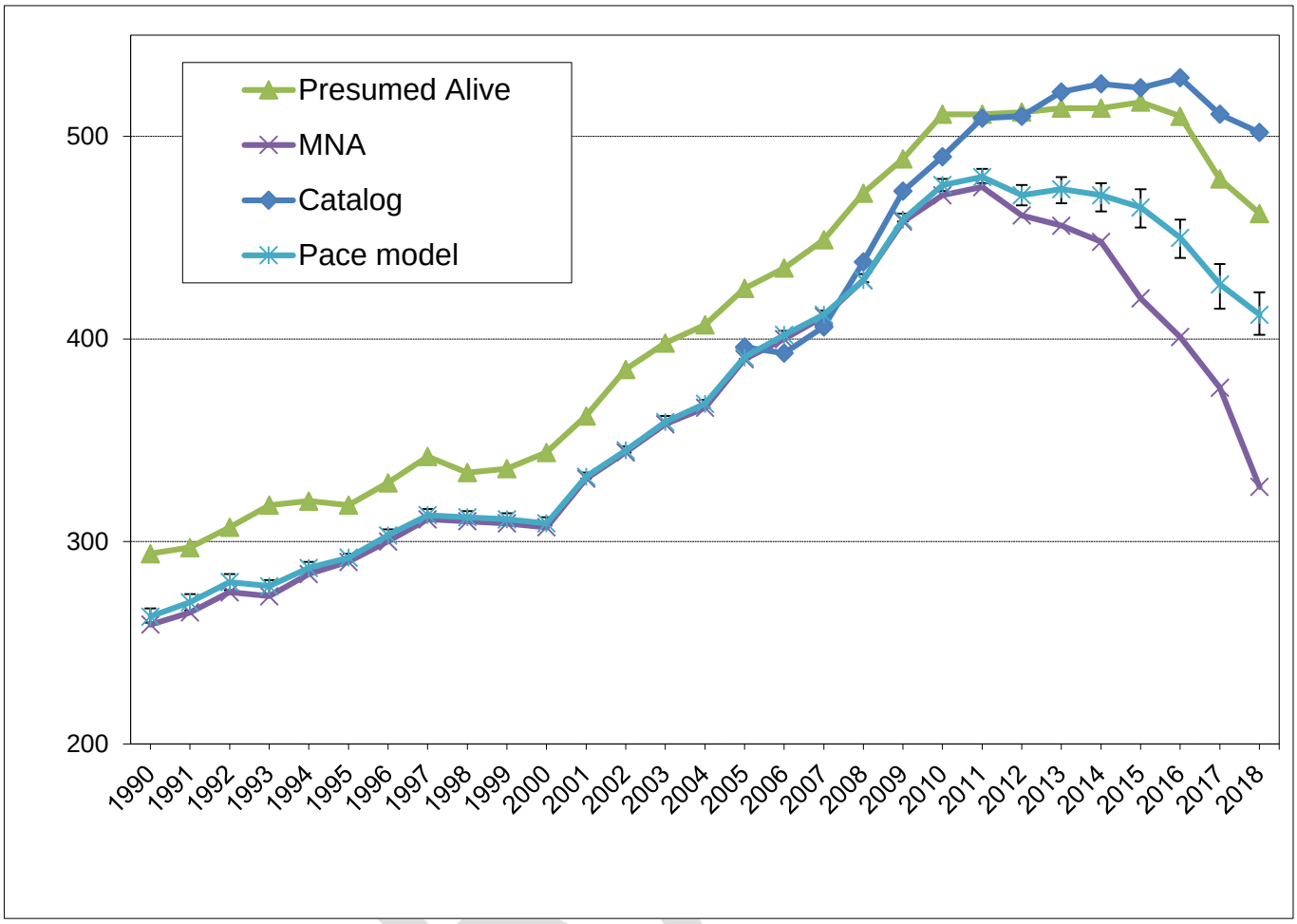
The Minimum Number Alive (MNA) is the number that was historically used in National Marine Fisheries Service stock assessment reports and counts whales seen in a given year, plus any whale not seen that year- but seen both before *and* after (see Hayes et al. 2017). The MNA number is more accurate than PA for older years, but is also not accurate for recent years for the same reason as the PA method, plus the fact that there have been fewer "after" years to detect a whale. The MNA number for 2018 is 327.

Pace Method

The Pace Method was added to the 2016 report card been included ever since. This analysis comes from the Pace et al. 2017 model which "adapted a state-space formulation with Jolly-Seber assumptions about population entry (birth and immigration) to individual resighting histories and fit it using empirical Bayes methodology." This model estimate includes whales that have not been photographed. The full methodology is available in the paper. It is important to note that the estimates provided by the Pace et al. 2017 methodology represent the estimated abundance at the *start* of the sample period plus all new entries into the population. That number for 2018 is 412. If one wanted an estimate at the end of the interval, one could subtract the number of known dead (or estimated number of dead if a detection rate for carcasses was available).

The full results for all four methods are presented in Figure 1**.** All numbers except the past Catalog method estimates were recalculated using data as of September 4, 2019 and therefore the numbers in this figure will differ from those in past report cards. The PA number is always artificially high as a comparison to the past year's MNA numbers attest. The difference is largely due to whales that have not been seen since before the year in question. For example, the 30+ animals that the PA number included in 1990 and the MNA did not are whales that have not been seen since 1990 and are thus very likely dead. From 1990 to 2010, the average difference between the PA number and the MNA number was 35 animals. If that difference remained consistent into this decade, the adjusted presumed alive number in 2018 would be 427 whales. The Pace method removes assumptions of when a whale is alive and is likely more accurate. The Catalog estimates are always higher than the other two methods for the most recent years. However, the fact that the old Catalog estimates for 2005 to 2009 were close to the eventual MNA numbers suggests that the methodology worked reasonably well through 2009. However, starting in 2010, the two numbers started to diverge. This is partially because fewer whales were seen so the MNA number may be artificially low. But it also appears that the six-year assumption for PA whales is increasingly erroneous; whales die sooner than six years after their last sighting. The Catalog estimate does however capture recent increase in calves that have not yet been cataloged. This delay in cataloging is largely due to the right whale distribution shift which has resulted in fewer calves being seen on the feeding grounds with their mothers, and fewer sightings of them as juveniles anywhere- both of which make cataloging recent calves challenging.

Figure 1. Assessments of the North Atlantic right whale population based on four available assessment methods. The Pace model shows a point "estimate" along with error bars which represent 95% of the posteriori probability. That model estimates the number of whale alive *at the start* of each year plus any new whales estimated to enter during that year. Data through 2018 as of September 4, 2019.



Best Right Whale Population Estimate 2018

We believe the Pace Method provides the best estimate for 2018. To get an estimate of whales alive *at the end* of 2018 using this methodology, we take the estimate at the start of 2018 (412, Figure 1) and subtract the observed deaths during 2018 (2 cataloged whales and one unidentified). Therefore, the best estimate for the end of 2018 is **409** right whales (95% confidence range +/- 11 and 10 respectively) using data as of September 4, 2019.

How Well Are We Monitoring?

Below is an annual count of sightings, unique individuals, whales presumed alive, kilometers of effort that have been submitted to the sightings database at the University of Rhode Island, and percent of the population that is identified each year from 2000 onward (Table 1). The shift in whale distribution has reduced both the number of sightings contributed to the Catalog and the percent of the population seen annually since 2011. Data as of September 4, 2019.

Table 1. Annual counts of sightings, unique individuals, presumed living whales, survey effort, and the percentage of the population seen. Survey effort from dedicated surveys only; opportunistic sightings do not record or report effort. None of the numbers for 2018 are final as not all of the data for that year have been submitted or analyzed. Data as of September 4, 2019.

Year	Sightings	Unique IDs	Presumed Living Population	Survey Effort (1,000 km)	% of population seen
2000	3087	236	344	125	69%
2001	3849	282	362	127	78%
2002	2718	303	385	252	79%
2003	2405	314	398	180	79%
2004	1811	286	407	287	70%
2005	3399	353	425	357	84%
2006	2801	347	436	316	80%
2007	3739	379	450	267	84%
2008	4147	390	473	254	83%
2009	4635	422	491	246	86%
2010	3224	421	512	271	82%
2011	3464	437	513	234	85%
2012	2127	375	512	271	73%
2013	1905	296	514	215	58%
2014	2399	369	513	200	72%
2015	1771	262	510	184	51%
2016	2199	319	499	155	64%
2017	3014	343	465	178	74%
2018	3453	343	462	135	74%

Reproduction

There were 7 documented calves born in 2019 (Table 2).

Table 2. Summary of calving events and associated inter-birth interval times for North Atlantic right whales from 2009-2019. The number of available cows, defined as females who have given birth to at least one previous calf, were presumed to be alive, and have not given birth in the last two years, are followed by the percentage of available cows to successfully calve. First time mothers are now included in the available to calve count.

Year	Calf Count	Available Cows/ % to calve	Average Interval	Median Interval	First time Moms
2009	39	66/59.1%	4.0	4	8
2010	19	49/38.8%	3.3	3	4
2011	22	51/43.1%	3.7	3	3
2012	7	66/10.7%	5.4	4	2
2013	20	90/22.2%	4.6	4	7
2014	11	86/12.8%	4.4	4.5	1
2015	17	84/20.2%	5.5	6	4
2016	14*	85/16.5%	6.6	7	4
2017	5	71/7.0%	10.2	8	0
2018	0	76/0	-	-	-
2019	7	87/8.0%	7	7	1

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

Mortalities
Between 01 January 2019 – 31 December 2019, ten right whale mortalities were documented. Nine were detected in Canadian waters and one in U.S. waters (Table 3). Cause of death was identified in four cases (three vessel strike and one entanglement). The Consortium Board recognizes necropsies as significant data collection events that provide valuable information on which management and conservation measures can be (and have been) based. The Board views consistent necropsy response and support (both financial and personnel) as critical to monitor both right whale recovery and the efficacy of management actions.

Live Vessel Strikes, Entanglements, and Entrapments
Vessel Strikes:
There were no non-lethal vessel strike injuries documented between 01 January 2019 – 31 December 2019.

Entanglement and Entrapments
There were seven active entanglement/entrapment cases reported between 01 January 2019 – 31 December 2019, of which four were new. Table 4 includes newly reported cases as well as pertinent updates to previously reported cases.

Table 3. Documented right whale mortalities 01 January 2019 – 31 December 2019.

Whale #	Date	Location	Sex	Age	Field #	Necropsied?	Cause	Comments
4023	06/04/2019	GSL	M	9		Yes	undetermined	
1281	06/20/2019	GSL	F	38+		Yes	vessel strike	Last sighted alive on 05 and 06 June 2019 in the Gulf of St Lawrence
Unk	06/24/2019	Cabot Straight	Unk	Unk		No	undetermined	Carcass not recovered. Reported with images on 07/18/2019
1514	06/25/2019	GSL	M	34+		Yes	vessel strike	Last sighted alive 05 and 07 June 2019 in the Gulf of St. Lawrence
3815	06/25/2019	GSL	F	11		No	undetermined	Resighted floating in the GSL 07/18/2019
3329	06/26/2019	GSL	F	16		Yes	undetermined	Last sighted alive on 04/25/2019 in Cape Cod Bay
3450	06/27/2019	GSL	F	15+		Yes	vessel strike	Last sighted alive on 05 and 10 June 2019 in the Gulf of St. Lawrence
3421	07/18/2019	GSL	M	15		Yes	undetermined	Last sighted alive on 10 June 2019 in the Gulf of St. Lawrence
Unk	07/21/2019	Cape Breton	Unk	Unk		No	undetermined	Carcass not recovered. No conclusive evidence that this is the same carcass as was first seen on 06/24/2019.
1226	9/16/2019	NY	M	40+		Yes	entanglement	Was seen entangled and possibly anchored in the Gulf of St. Lawrence on 08/06/2019. Was not resighted prior to its death.

Table 4. Right whale entanglements and status updates 01 January 2019 – 31 December 2019. Newly reported entanglements (carrying gear) and updates to previously reported entanglements are in **bold**. Dead whales first sighted entangled at death are not included here. However, whales sighted alive as entangled and later dead are included.

Whale #	Date of First Entanglement Sighting	First location	Sex	Age (current)	Comments
4091	05/12/2018	60 miles ESE of Chatham, USA	F	8	The whale has line wrapped around its right flipper, at minimum, with about 50ft green line trailing. What appears to be a red, yellow and green buoy is near the right flipper. Due to weather forecast and distance, the CCS response team could not mount a response. **Resighted 12/31/2018 and 01/13/2019 south of Nantucket. Although the view of right flipper was not ideal, neither line nor the buoy were visible.**
3960	08/20/2018	Gulf of St. Lawrence	M	9	Whale observed with multiple wraps of the rostrum, damaged baleen, and no line trailing, although the sighting team felt that there was likely weight attached. Throughout the sighting the whale was thrashing at the surface and the configuration of the entanglement changed often. This behavior, the condition of the whale and changing entanglement configuration, led the team to believe that it was likely a new entanglement. As the team on scene was consulting and documenting the whale, its entanglement configuration continued to change and the whale picked up speed swimming at ~8kts. After more observations, the team felt that the whale might have shed the entanglement. No additional sightings of this whale have been reported. While observers noted that no gear was visible at the end of the sighting, they could not see all body areas and the whale was relatively distant and therefore the whale is considered still entangled. **Resighted in Cape Cod Bay on 03/20/2019 and confirmed to be gear free.**
2310	12/20/2018	Southeast of Nantucket	M	Adult, >24	The whale appears to have a short bitter end at the area of its left pectoral flipper that enters its left mouth. The line passes through the mouth and exits out the right side, trailing roughly 1-2 body lengths, at minimum, aft of the flukes. It appears as though the trialing line sinks into the water column due to the nature of the line, no bitter end was observed. There were no significant injuries associated with the entanglement documented. The whale was slightly thin. A response was not mounted. The whale may shed the line on its own. **Resighted on 02/3/2019 south of Nantucket and again on 4/25/2019 in Cape Cod Bay. Disentanglement attempt was unsuccessful and entanglement remains.**
4423	**04/25/2019**	**Great South Channel**	**M**	**5**	**Entanglement consists of thick line coming from depth approximately one whale length behind flukes that leads to a mass of rope and possibly submerged buoy. Whale is thin and grey. Resighted in July 2019 in the Gulf of St. Lawrence still entangled. A disentanglement attempt on 07/16/2019 appears to have cut part of the line on the right side of the whale and altered the tautness of the line configuration. Multiple resights in July and August show that the whale remains entangled with a bridle of heavy rope through its mouth and is trailing a ball of gear aft of the flukes. The condition of the whale remains poor. Resighted 10/28/2019 in the Gulf of St Lawrence and confirmed to be gear free. Condition is still poor with large lesions on both sides of the head and behind the blowholes. Whale does present as thin based on aerial images.**

Table 4 (cont'd). Right whale entanglements and status updates 01 January 2019 – 31 December 2019. Newly reported entanglements (carrying gear) and updates to previously reported entanglements are in **bold**. Dead whales first sighted entangled at death are not included here. However, whales sighted alive as entangled and later dead are included.

Whale #	Date of First Entanglement Sighting	First location	Sex	Age (current)	Comments
4440	**06/29/2019**	**Gulf of St. Lawrence**	**M**	**5**	**The whale was essentially hogtied with line from the mouth to the peduncle. Line exiting the left mouthline trails to peduncle and line exiting from the right mouthline and/or the right flipper leads there as well. At the peduncle there are at least two passes of line forming a tight wrap. Beneath the flukes is a heavily damaged Norwegian float and on top of the flukes there is a light knot and short bitter end. Wounds around the peduncle are extensive. A disentanglement effort on 07/16/2019 was successful in making a cut in the line exiting the left side of the mouth. The whale was resighted on 07/19/2019, at which time a survey team observed that the line in the mouth had been shed. At that time, there remained a line wrap and buoy at the peduncle and trailing line of approximately one length aft of the flukes. On 08/14/2019, the whale was sighted gear free in the Gulf of St. Lawrence.**
3125	**07/04/2019**	**Gulf of St. Lawrence**	**M**	**18**	**Last sighted gear free 03/20/2019 in Cape Cod Bay. Extensive entanglement through the mouth with multiple trailing lines. Rope may involve both flippers as well. A research team in the Gulf was able to attach a telemetry buoy to the entangling gear on 07/19/2019. The whale was tracked to the Scotian Shelf and intercepted by a disentanglement team from Newfoundland on 07/23/209 and 07/25/2019. The team believes they were able to cut one line of rope at the head and may have damaged others. Another disentanglement attempt was made on 08/2/2019 ~60miles east of Cape Cod. Multiple cuts to the entangling lines were made and the whale can now open its mouth. Remaining line on the whale includes embedded mid-rostrum wrap and wrap over the blowholes as well as line that is likely extensively woven in the baleen. The whale's condition is poor.**
1226	**08/06/2019**	**Gulf of St. Lawrence**	**M**	**Adult, >40**	**Last sighted gear free in the Gulf of St. Lawrence on 07/16/2016. Whale has at least two wraps around rostrum and a trailing bitter end. There appears to be extensive damage to the peduncle and the whale may be anchored. Whale was found floating dead off the coast of New York on 09/16/2019. See Table 3 above for details.**

Monitoring Health of Injured Right Whales

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

Between 01 January and 31 December 2019, eight new injury of interest events were documented, all of which were entanglement related (three with attached gear and five with injuries but no gear attached). Of these eight, three exhibited declining condition coinciding with injury. The impact of injury on the health of four whales was inconclusive. There were no visual indicators of injury impact on health condition for the remaining newly injured whale. Seven whales previously on the monitoring list were removed, including one who was discovered dead on 6/4/2019 in the Gulf of St. Lawrence. The remaining seven whales exhibited stable health condition and wound healing. As of 31 December 2019, the Serious Injury/Human Impact list includes 71 whales with 79 injuries documented from March 2004 through 31 December 2019 (Table 5). The majority of the injuries are entanglement related (68/79, 86.1%) followed by vessel strikes (9/79, 11.4%). There are two whales on the list with injuries of unknown origin (Table 6).

Table 5. Since the inception of the injured right whale monitoring protocol, the number of injured whales and newly reported injuries has varied by year. The number of whales included on the injured whale list is given for each report and is followed parenthetically by how many of those were newly detected injuries. There are currently eight whales on the injured list with multiple injuries.

Year	June	December
2013	**33***	**32 (2)**
2014	**45 (16)**	**50 (6)**
2015	**51 (4)**	**59 (9)**
2016	**60 (4)**	**63(8)**
2017	**61 (4)**	**70 (10)**
2018	**74 (9)**	**70 (8)**
2019		**71 (8)**

*The first injured whale monitoring report was distributed in June 2013 and therefore does not include a comparative number of newly reported injuries. In 2019, reporting moved from a biannual to an annual basis.

Table 6. Impact of anthropogenic injury on right whale visual health by injury type based on assessments of photographs pre- and post-injury for all North Atlantic right whales on the Serious Injury/Human Impact list as of 31 December 2019.

	Entanglement		Vessel Strike	Other	Total
	Gear Present	No Gear Present			
Decline in Condition	9	14	2	1	26
Inconclusive	11	13	1	1	26
No Decline in Condition	5	9	3	0	17
Extended Monitor	1	1		0	2
Total	26	37	6	2	71*

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

Aerial and Vessel-based Sighting Summary: 2018

Prior to the 2017 Report Card, sighting information was reported for the time period following the previous NARWC Annual Meeting. However, that reporting included the current year for which not all data has necessarily been received and/or processed. Therefore, beginning with the 2017 Report Card, sighting summaries will be presented for the previous calendar year. Cataloged sighting information for the year 2018 (analysed 04 September 2019) is summarized below (Table 7) and includes survey, research, and opportunistic sightings. Months with sightings, survey types, and major contributing organizations (>10% total sightings for region) are listed.

Major Contributing Organizations

BHC: Boston Harbor Cruises
CCS: Center for Coastal Studies
CMARI: Clearwater Marine Aquarium Research Institute
CWI: Canadian Whale Institute
CWR: Campobello Whale Rescue
DFO: Fisheries and Oceans Canada
FWRI: Florida Fish and Wildlife Research Institute
GDNR: Georgia Department of Natural Resources
GMWSR: Grand Manan Whale and Seabird Research Station
NEAq: New England Aquarium
NEFSC: Northeast Fisheries Science Center
NWW; Newburyport Whale Watch
QLM: Quoddy Link Marine
TC: Transport Canada
WHOI: Woods Hole Oceanographic Institution

Table 7. Summary of 2018 right whale sightings by habitat region. Analyses for 2018 data are ongoing and therefore the data presented here should not be considered complete.

	# Sightings	Sighting Months	Survey types/activities	Contributing Organizations
Bay of Fundy	19	Jul-Sep	Vessel surveys, biopsy sampling	CWI, CWR, GMWSR, NEAq, QLM
East (Nova Scotian Shelf)	8	May	Aerial surveys	DFO/TC
Gulf of Maine	164	May, Oct, Dec	Aerial and Vessel surveys	NEAq, NEFSC
Great South Channel	150	Jan, Mar-Apr, May, Aug-Sep	Aerial and Vessel surveys	NEFSC
Jeffreys Ledge	9	Apr-May, Dec	Aerial surveys, whale watch	BHC, CCS, NWW
Mid-Atlantic (includes south of Cape Cod)	283	Jan-Apr, Jun-Sep, Nov-Dec	Aerial surveys	NEAq, NEFSC
New England (Massachusetts Bay/Cape Cod Bay)	1617	Jan-May, Nov-Dec	Aerial and Vessel surveys, biopsy and habitat sampling, drone photogrammetry	CCS, NEFSC, WHOI
North (Gulf of St. Lawrence)	1287	May-Sep	Aerial and Vessel surveys, biopsy sampling	NEAq, NEFSC
Southeast United States	46	Jan-Feb, Dec	Aerial and Vessel surveys, biopsy sampling	CMARI, FWRI, GDNR

Management and Mitigation Activities

United States

- NOAA called for 25 Dynamic Management Area (DMA) voluntary speed reduction zones between 01 January 2019 and 31 December 2019 (Table 8).

Table 8. Dynamic Management Area (DMA) voluntary speed reduction zones posted by NOAA between 01 January 2019 and 31 December 2019.

Event ID	**Trigger Date** (date of RW sightings)	**Number of Right Whales**	**Sightings Source**	**General Location**	**Boundaries**
163	1/2/2019	53	Aerial survey	South of Nantucket	41 12 N 070 36 W 40 28 N 069 31 W
164	1/15/2019	100	Aerial survey	South of Nantucket	41 12 N 070 36 W 40 28 N 069 31 W
165	1/27/2019	20	NEA aerial survey	South of Nantucket	41 12 N 070 36 W 40 28 N 069 31 W
166	2/4/2019	11	NEA aerial survey	South of Nantucket	41 12 N 070 36 W 40 28 N 069 31 W
167	2/17/2019	19	NEA aerial survey	South of Nantucket	41 12 N 070 36 W 40 28 N 069 31 W
168	3/1/2019	10	NEA/USCG Survey	South of Nantucket	41 12 N 070 36 W 40 28 N 069 31 W
169	3/13/2019	15	Research Vessel	South of Nantucket	41 12 N 070 36 W 40 28 N 069 31 W
170	3/28/2019	6	Aerial Survey	South of Nantucket	41 12 N 070 36 W 40 28 N 069 31 W
171	4/7/2019	15	NEA aerial survey	South of Nantucket	41 12 N 070 36 W 40 28 N 069 31 W
172	4/19/2019	11	Boston Harbor Cruises	East of Boston	42 40 N 070 20 W 42 02 N 071 15 W
173	4/23/2019	3	NEFSC aerial	Southwest Martha's Vineyard	40 39 N 070 56 W 39 59 N 071 47 W
174	4/29/2019	3	NEFSC survey	South of Martha's Vineyard	40 47 N 070 29 W 40 07 N 071 22 W
175	5/7/2019	4	NEFSC survey	SW Martha's Vineyard	40 39 N 070 56 W 39 59 N 071 47 W
176	5/14/2019	4	NEFSC aerial survey	South of Martha's Vineyard	40 47 N 070 29 W 40 07 N 071 22 W
177	5/16/2019	5	NEFSC ship survey	SE of Nantucket	40 48 N 068 24 W 40 05 N 069 20 W
178	5/15/2019,	4	NEA aerial survey	South of Nantucket	40 44 N 070 01 W 40 04 N 070 51 W
179	5/22/2019	15	NEFSC Ship survey	SW Martha's Vineyard	40 39 N 070 56 W 39 59 N 071 47 W
180	5/22/2019	15	NEFSC Ship survey	South Martha's Vineyard	40 47 N 070 29 W 40 07 N 071 22 W
181	5/25/2019	9	NEA aerial survey	South of Nantucket	40 44 N 070 01 W 40 04 N 070 51 W
182	7/15/2019	3	NEA aerial survey	South of Nantucket	41 34 N 070 32 W 40 54 N 069 39 W
183	7/25/2019	7	NEA aerial survey	South of Nantucket	41 14 N 069 32 W 40 29 N 070 32 W
184	8/3/2019	10	NEFSC aerial survey	South of Nantucket	41 14 N 069 32 W 40 29 N 070 32 W
185	8/12/2019	9	NEFSC aerial survey	South of Nantucket	41 14 N 069 32 W 40 29 N 070 32 W
186	8/30/2019	19	NEFSC aerial survey	SE of Nantucket	41 23 N 068 14 W 40 43 N 070 10 W
187	9/9/2019	7	NEFSC aerial survey	SE of Nantucket	41 23 N 068 14 W 40 43 N 070 10 W

- In 2019, NMFS conducted a number of management activities under the Endangered Species Act (ESA) related to recovery plan implementation specific to Section 4(f). This included:
    - Convened U.S. North Atlantic Right Whale Implementation Team (RWIT; composed of the Northeast U.S. Implementation Team (NEIT) and Southeast U.S. Implementation Team (SEIT)) to coordinate on coast wide issues. Regional teams also continued to meet and work independently on regional issues. The RWIT's Population Evaluation Tool Subgroup continued to meet and work towards development of a population viability analysis.
    - Announced the availability of the latest comprehensive report on Recovering Threatened and Endangered Species FY 2017-2018 and added the North Atlantic Right whale to the Species in the Spotlight. As part of the Species in the Spotlight campaign, NMFS will develop a five-year action plan. The 5-year action plan will build upon existing recovery and conservation plans and will detail the focused efforts needed over the next 5 years to reduce threats and stabilize the North Atlantic right whale population decline. NMFS sought input on the plan from the U.S. RWIT. With North Atlantic Right Whales now being added to the list, NMFS hopes that more focused attention will help stabilize the declining population. NMFS recognized the Right Whale Consortium as a *Species in the Spotlight Partner* which recognizes the efforts of over 200 partners dedicated to conserving and recovering the species.
- The Atlantic Large Whale Take Reduction Team continued their efforts to meet the requirements of the Marine Mammal Take Reduction Act, to develop recommendations to modify the Atlantic Large Whale Take Reduction Plan to reduce entanglement related serious injuries and mortalities to below the Potential Biological Removal Level of less than one per year. During a full Team meeting in April 2019, attendees came to near-consensus on recommendations to achieve risk reduction targets by jurisdictional/lobster management area to respect the diversity of the trap/pot fisheries. Two primary risk reduction measures were proposed:
    - Rope breaking at 1700 lbs or less via engineered weak rope or by introducing weaknesses regularly in rope, and
        - Less rope - reduce the number of buoy lines

    And the recommendation included strong support for:
    - Gear marking
    - Safety exemption
    - Monitoring post implementation: including whale numbers and distribution, endline numbers, outcomes on socioeconomics
    - Support for regulating in a way that allows regional gear innovations

    NMFS is working with the states and offshore lobster fishermen to develop take reduction measures for the Gulf of Maine and southern New England waters. Alternatives being developed are consistent with an agreement to achieve risk reduction across lobster and state management areas through a combination of line reductions and weak rope/weak insertions into rope. Scoping was conducted in August, 2019, with eight meetings held from Maine through Rhode Island. Alternatives and analyses that will be included in the Draft Environmental Impact Statement will reflect scoping comments received from over 800 people that attended scoping meetings, and nearly 27,000 pieces of correspondence received during scoping. The Draft Environmental Impact Statement and Proposed Rule are anticipated to be published for public comments in early 2020.
- NMFS convened two workshops related to NARW recovery and conservation:
    - NARW Health Assessment workshop from June 24-26, 2019 in Silver Spring, Maryland, held under the auspices of the Working Group on Marine Mammal Unusual Mortality Events. Workshop participants assessed current health information data, including associated data gaps, and identified appropriate available and needed tools and techniques for collecting standardized health data that can be used to understand health effects of environmental and human impacts (e.g. entanglement) and inform fecundity and survivorship models to ultimately guide NARW recovery.
    - NARW Monitoring and Surveillance workshop from October 22-24, 2019 in La Jolla, CA. NMFS working group members developed recommendations for prioritizing and integrating NARW monitoring and surveillance efforts range-wide across platforms (aerial, vessels, passive acoustic monitoring). NMFS will evaluate the recommendations and develop a comprehensive strategy to inform NARW conservation efforts and maximize NMFS' efficiency and ability to leverage resources to answer outstanding questions related to population and health status, as well as distribution and habitat use.
- In 2019, the NMFS Greater Atlantic Regional Fisheries Office had an increase in activity under the ESA related to the burgeoning offshore wind energy industry. With 15 active leases on the Outer Continental Shelf (OCS) of the East Coast, much of this work was providing technical assistance about protected species to developers and the Bureau of Ocean Energy Management (BOEM, the lead Federal agency for authorizing the construction, operation, and eventual decommissioning of any offshore wind project). Many of the proposed projects are currently in the site assessment phase; effects of site assessment activities, including geotechnical and geophysical surveys, are assessed under the ESA and permits may also be necessary under the Marine Mammal Protection Act (MMPA). Effects of some survey activities are considered in a 2013 programmatic biological opinion (Data Collection and Site Survey Activities for Renewable Energy on the Atlantic Outer Continental Shelf). This Opinion is in the process of being updated. Additional activities in 2019 included:
    - Initiating an ESA section 7 consultation for the construction, operation, and decommissioning of Vineyard Wind 1, the first commercial scale offshore wind energy project in the United States in the northern portion of lease area

OCS-501. Consultation is expected to be completed following the issuance of a Supplemental Environmental Impact Statement by BOEM.
    - Re-initiating the 2013 programmatic biological opinion on offshore wind energy survey activities to expand the geographic range to include actions south of North Carolina and to update relevant background information and complete updated analyses of effects to ESA listed species including NARWs.
- Following receipt of letters in the fall of 2018 from researchers both for and against invasive tagging of NARW, NMFS agency scientists and managers re-evaluated the risks and benefits of invasive tagging for this species. Following this review, in May 2019, NMFS instituted a temporary suspension of dart tagging of reproductive-age female NARW while tag improvements are being implemented and tagging reports are more closely reviewed. NMFS' current position on invasive tagging of NARW includes:
    - Prohibiting deep-implant tags designed to anchor in the fascia between muscle and blubber layers;
    - Allowing use of dart-style tags designed to anchor into the blubber layer, except on lactating females with neonates, and calves less than approximately 6 months old; and, temporarily suspending dart tagging of reproductive-age females; and
    - Requiring enhanced mitigation specific to dart tagging (including requiring the use sterile tags, prohibiting tagging of compromised individuals, requiring notification of tagging, and follow-up monitoring).

  As part of an adaptive management plan, NMFS will annually re-evaluate use of dart tags on NARW, or earlier as needed, based on review of the following:
    - Monitoring reports submitted by researchers including information on efficacy of the tags (e.g., tag transmission duration) and effects of the tags (e.g., wound reaction and healing, animal health and behavior) for NARW and other cetacean species;
    - Tagging protocols and best practices developed by the International Whaling Commission, the International Union for the Conservation of Nature, and the Office of Naval Research;
    - The current status of and threats to the NARW population; and
    - Management needs to support conservation and recovery.

Canada

- 2019 is the third year that the Government of Canada has implemented targeted management measures to help protect and recover NARW by addressing primary threats to the population: vessel strikes (Transport Canada lead) and entanglement in fishing gear (Fisheries and Oceans lead).
- The 2019 measures are focused on the prevention of entanglement and vessel strike by managing snow crab and lobster fisheries and all other non-tended fixed-gear fishing in Quebec and Atlantic Canada. Fisheries management measures include:
    - A season-long area closure (static zone) in the Gulf of St. Lawrence, covering 2,400km2;
    - If one or more right whales are detected anywhere in known foraging areas in the Gulf of St. Lawrence or the 2 critical habitats in the Roseway and Grand Manan Basins, 15 day closures (dynamic zone) of up to 2,100 km2 are implemented for snow crab and lobster fisheries (and all other non-tended fixed-gear fisheries); and
    - Outside these areas, in Quebec and Atlantic Canada sightings are reviewed on a case-by-case with special consideration given to sightings of 3 or more whales or a mother and calf pair.
- In response to the NARW mortalities in 2019, on July 9, DFO expanded the dynamic zone to the entire Gulf of St. Lawrence covering 227,940 km^2, stretching from the St. Lawrence Seaway, to the Cabot Strait and Strait of Belle-Isle. As a result, any sighting of a single NARW observed in the entire Gulf of St. Lawrence triggers a dynamic closure to all non-tended fixed gear fisheries. The number of flights by DFO were also doubled, from 5 to 10 per week.
- DFO has also implemented a range of fisheries measures to reduce the amount of rope in the water to lower the risk of NARW entanglement. Since 2017 they have adjusted opening and closing times in key fisheries, including in the Gulf of St. Lawrence. This minimizes the number of vertical lines and limits the number of traps, such as in the Gulf crab fishery.
- DFO also implemented requirements to identify and sequentially mark buoys, and are phasing in mandatory fishery-specific gear marking for all fixed-gear fisheries by 2020. Finally, they require all fishing licence holders to report lost gear and any interactions with marine mammals.
- Extensive surveillance of Quebec and Atlantic Canadian waters for NARW was achieved using multiple aircraft, vessels, and passive acoustic technology including hydrophones and gliders. Fisheries and Oceans, Transport Canada and partners are preparing plans for survey and surveillance efforts in 2020.
- As in 2019, DFO's Conservation and Protection branch continued to conduct extensive air and vessel patrols to verify compliance and enforce management measures related to NARW, including opening/closing of fishing areas and the removal of lost, abandoned, illegal or otherwise discarded fishing gear (i.e. "ghost gear"). Enforcement actions taken by fishery officers can lead to charges for violations under the *Fisheries Act*, *Species at Risk Act,* and other applicable laws and regulations.

- DFO has continued annual investment of over $1 million for marine mammal response organizations and investments in science to better understand threats to right whales, and to inform future management measures. They meet annually with our Marine Mammal Response partners to discuss the operational season and needs moving forward.
- DFO has implemented mandatory lost gear reporting for licence holders in all fixed-gear fisheries, as well as, mandatory reporting of any accidental contact between marine mammal and a vessel or fishing gear.
- From July 18-20, 2019, DFO also participated in a coordinated blitz with Canadian Coast Guard to retrieve ghost gear from five key areas in the Gulf of St. Lawrence. The five areas were identified based on the lost gear reports as well as areas of heaviest fishing in 2019. Over the course of the operation, 101 crab pots were recovered, over 10,000 lbs of crab were returned to the water, and 9.1 km of rope was removed from the water.
- DFO is supporting a number of industry trials of "whale safe" gear technologies that minimize or eliminate the risk of entanglement to whales and evaluating pilot projects using scientific expertise. The Department is hosting a Gear Innovation Summit in February 2020, which will include a stream focused on technological solutions to mitigate ghost gear.
- In 2019, Transport Canada once again implemented a large mandatory static speed restriction zone covering much of the Gulf of St. Lawrence, and dynamic speed restriction zones in the shipping lanes north and south of Anticosti Island to reduce the risk of vessel collisions with the NARW. These measures came into force on April 28, 2019 (see map HERE).
- On July 8, 2019, following the NARW mortalities, enhanced measures were announced, including expanding the speed restriction zones further east, increasing the number of vessels that speed restrictions apply to (all vessels over 13 m instead of just vessels 20m+), increasing the buffer zones around the dynamic speed zones, and increasing aerial surveillance (see map HERE).
- Transport Canada tested additional surveillance technologies to evaluate their effectiveness for possible integration into vessel traffic management in the Gulf of St. Lawrence, including a trial for a second year of Remotely Piloted Aircraft Systems (RPAS) and, in collaboration with the University of New Brunswick, a trial of acoustic monitoring to detect NARW in the dynamic speed zones using an underwater glider.
- Transport Canada began evaluating the 2019 measures before the conclusion of the season, and continues to engage with the marine transportation industry, scientists, and other stakeholders to refine and develop measures for 2020.
- Canada's National Marine Mammal Peer Review Committee met in October 2019 to review data and address question related to right whale distribution, habitat use, and risk of interactions with fishing gear and collision with vessels in Canadian waters.
- The Government of Canada consults with fishing and shipping industry representatives, Indigenous groups and other partners, for feedback on measures and to support the development of future measures. The NARW Roundtable meeting held on November 7th, 2019.

2019 North Atlantic Right Whale Publications/Reports

Reports and publications that utilized NARWC databases in 2019 and/or those of general interest to the right whale community are listed and hyperlinked below.

Publications

Accardo, C.M., Ganley, L.C., Brown, M.W., Duley, P.A., George, J.C., Reeves, R.R., Heide-Jørgensen, M.P., Tynan, C.T. and Mayo, C.A. 2018. Sightings of a bowhead whale (*Balaena mysticetus*) in the Gulf of Maine and its interactions with other baleen whales. *J. Cetacean Res. Manage.* 19: 23-30.

Baumgartner, M.F., Bonnell, J., Van Parijs, S.M., Corkeron, P.J., Hotchkin, C., Ball, K., Pelletier, L.P., Partan, J., Peters, D., Kemp, J. & Pietro, J. 2019. Persistent near real-time passive acoustic monitoring for baleen whales from a moored buoy: system description and evaluation. *Methods in Ecology and Evolution*.

Christiansen, F., Sironi, M., Moore, M.J., Di Martino, M., Ricciardi, M., Warick, H.A. & Uhart, M.M. 2019. Estimating body mass of free-living whales using aerial photogrammetry and 3D volumetrics. Methods in Ecology and Evolution: 1-11. DOI: /10.1111/2041-210X.13298

Crance, J.L., Berchok, C.L., Wright, D.L., Brewer, A.M., Woodrich, D.F. 2019. Song production by the North Pacific right whale, *Eubalaena japonica*. J. Acoust. Soc. Amer. 145 (6). https://asa.scitation.org/doi/10.1121/1.5111338

Crum, N., Gowan, T., Krzystan, A., & Martin, J. 2019. Quantifying risk of whale–vessel collisions across space, time, and management policies. *Ecosphere*, *10*(4), e02713.

Davies, K.T., & Brillant, S.W. 2019. Mass human-caused mortality spurs federal action to protect endangered North Atlantic right whales in Canada. *Marine Policy*, *104*, 157-162.

Davies, K.T., Brown, M.W., Hamilton, P.K., Knowlton, A.R., Taggart, C.T., & Vanderlaan, A.S. 2019. Variation in North Atlantic right whale *Eubalaena glacialis* occurrence in the Bay of Fundy, Canada, over three decades. *Endangered Species Research*, *39*, 159-171.

Durette-Morin, D., Davies, K.T., Johnson, H.D., Brown, M.W., Moors-Murphy, H., Martin, B., & Taggart, C.T. 2019. Passive acoustic monitoring predicts daily variation in North Atlantic right whale presence and relative abundance in Roseway Basin, Canada. *Marine Mammal Science*, 35(4), 1280-1303.

Ganley, L. C., Brault, S., & Mayo, C. A. 2019. What we see is not what there is: estimating North Atlantic right whale *Eubalaena glacialis* local abundance. *Endangered Species Research*, *38*, 101-113.

Gowan, T.A., Ortega-Ortiz, J.G., Hostetler, J.A., Hamilton, P.K., Knowlton, A.R., Jackson, K.A., George, R.C., Taylor, C.R., & Naessig, P.J. 2019. Temporal and demographic variation in partial migration of the North Atlantic right whale. Scientific Reports 9: 353. https://doi.org/10.1038/s41598-018-36723-3

Hamilton P.K. & Kraus S.D. 2019. Frequent encounters with the seafloor increase right whales' risk of entanglement in fishing groundlines. Endang Species Res 39:235-246. https://doi.org/10.3354/esr00963

Harcourt, R., van der Hoop, J., Kraus, S., & Carroll, E.L. 2019. Future directions in Eubalaena spp.: comparative research to inform conservation. *Frontiers in Marine Science*.

Myers, H.J., Moore, M.J., Baumgartner, M.F., Brillant, S.W., Katona, S.K., Knowlton, A.R., Morissette, L., Pettis, H.M., Shester, G., & Werner, T.B. 2019. Ropeless fishing to prevent large whale entanglements: Ropeless Consortium report. *Marine Policy*, *107*, 103587.

Parks, S.E., Cusano, D.A., Van Parijs, S.M., & Nowacek, D.P. 2019. Acoustic crypsis in communication by North Atlantic right whale mother–calf pairs on the calving grounds. *Biology Letters*, *15*(10), 20190485.

Plourde, S., Lehoux, C., Johnson, C. L., Perrin, G., & Lesage, V. 2019. North Atlantic right whale (*Eubalaena glacialis*) and its food:(I) a spatial climatology of Calanus biomass and potential foraging habitats in Canadian waters. *Journal of Plankton Research*.

Record, N., Runge, J., Pendleton, D., Balch, W., Davies, K., Pershing, A., Johnson, C., Stamieszkin, K., Ji, R., Feng, Z. & Kraus, S., 2019. Rapid Climate-Driven Circulation Changes Threaten Conservation of Endangered North Atlantic Right Whales. *Oceanography*, *32*(2).

Rolland, R. M., Graham, K. M., Stimmelmayr, R., Suydam, R. S., & George, J. C. 2019. Chronic stress from fishing gear entanglement is recorded in baleen from a bowhead whale (*Balaena mysticetus*). *Marine Mammal Science*.

Sharp, S.M., McLellan, W.A., Rotstein, D.S., Costidis, A.M., Barco, S.G., Durham, K., Pitchford, T.D., Jackson, K.A., Daoust, P.Y., Wimmer, T., Couture, L., Bourque, T., Frasier, T., Frasier, B., Fauquier, D., Rowles, T.K., Hamilton, P.K., Pettis, H.M., & Moore, M.J. 2019. Gross and histopathologic diagnoses from North Atlantic right whale *Eubalaena glacialis* mortalities between 2003 and 2018. *Diseases of Aquatic Organisms*, *135*(1), 1-31.

Sorochan, K. A., Plourde, S., Morse, R., Pepin, P., Runge, J., Thompson, C., & Johnson, C. L. 2019. North Atlantic right whale (Eubalaena glacialis) and its food:(II) interannual variations in biomass of Calanus spp. on western North Atlantic shelves. *Journal of Plankton Research*.

van der Hoop, J.M., Nousek-McGregor, A.E., Nowacek, D.P., Parks, S.E., Tyack, P., & Madsen, P.T. 2019. Foraging rates of ram-filtering North Atlantic right whales. *Funct Ecol*. 2019. 33: 1290– 1306.

Reports

Hamilton PK, Knowlton AR, Hagbloom MN, Howe KR, Pettis HM, Marx MK, Zani MA, and Kraus SD. 2019. Maintenance of the North Atlantic Right Whale Catalog, Whale Scarring and Visual Health Databases, Anthropogenic Injury Case Studies, and Near Real-Time Matching for Biopsy Efforts, Entangled, Injured, Sick, or Dead Right Whales. Report to National Marine Fisheries Service, Wood Hole, MA Contract No. 1305M2-18-P-NFFM-0108. 105 pp.

Hayes SA, Josephson E, Maze-Foley K, Rosel PE. 2019. US Atlantic and Gulf of Mexico Marine Mammal Stock Assessments - 2018. NOAA Tech Memo NMFS-NE 258; 291 p.

Morin, D., Salvador, G., Higgins, J., Minton, M. 2019. 2016 Atlantic Large Whale Entanglement Report. Greater Atlantic Region Policy Series 19-04. NOAA Fisheries Greater Atlantic Regional Fisheries Office - www.greateratlantic.fisheries.noaa.gov/policyseries/. 115 p.

REFERENCES

Hayes S.A., Josephson E., Maze-Foley K., Rosel, P.E., editors. (2017). US Atlantic and Gulf of Mexico Marine Mammal Stock Assessments -- 2016. NOAA Tech Memo NMFS NE 241; 274 p. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026, or online at /publications/doi:10.7289/V5/TM-NEFSC-241

Knowlton, A.R., Kraus, S.D., Kenney, R.D. (1994). Reproduction in North Atlantic right whales *(Eubalaena glacialis)*. *Can J Zool* Vol. 72:1297-1305.

Knowlton, A.R., Robbins, J., Landry, S., McKenna, H., Kraus, S.D., Werner, T.B. (2016). Effects of fishing gear strength on the severity of large whale entanglements. *Conserv Bio.* 30: 318-328.

Kraus, S.D., Brown, M.W., Caswell, H., Clark, C.W., Fujiwara, M., Hamilton, P.K., Kenney, R.D., Knowlton, A.R., Landry, S., Mayo, C.A., McLellan, W.A. (2005). North Atlantic right whales in crisis. *Science*, *309*(5734), pp.561-562.

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

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

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

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

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

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

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

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

Sharp, S.M., McLellan, W.A., Rotstein, D.S., Costidis, A.M., Barco, S.G., Durham, K., Pitchford, T.D., Jackson, K.A., Daoust, P.Y., Wimmer, T., Couture, L., Bourque, T., Frasier, T., Frasier, B., Fauquier, D., Rowles, T.K.,

Hamilton, P.K., Pettis, H.M., & Moore, M.J. 2019. Gross and histopathologic diagnoses from North Atlantic right whale *Eubalaena glacialis* mortalities between 2003 and 2018. *Diseases of Aquatic Organisms, 135*(1), 1-31.

Appendix 1

Catalog Assessment Method

We have developed standardized criteria that can be applied each year to get a low, middle (best estimate) and upper number of whales in the population as determined from Catalog data. One term needs to be explained to understand these numbers. Whales are given temporary intermatch codes if 1) two or more sightings match each other, and 2) neither have been matched to a catalog whale. Some of these whales will eventually be matched to existing cataloged whales and others will be determined to be "new" to the Catalog and assigned a number. Once an intermatch whale is given a Catalog number, or matched to another intermatch code whale, the intermatch code is made inactive. The results for 2018 are provided below in Table 1.

LOWER

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

MIDDLE

The middle bound is determined by summing three categories:

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

UPPER

The upper bound is also the sum of three categories:

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

Table 1. The Catalog method of estimating the population represents an assessment of the number of photographed whales in the North Atlantic Right Whale Identification Database. Analysis completed 9/4/19.

Low: 343 individuals	
343	Cataloged whales seen in 2018
Middle: 502 individuals	
462	Cataloged whales presumed alive in 2018
37	Intermatch whales likely to be added to Catalog
3	Calves from 2017 and 2018 likely to be added to Catalog
High: 727 individuals	
684	All Cataloged whales in 2018 minus those known dead
39	All active intermatch codes without 2016 & 2017 calves
4	All uncataloged 2017 and 2018 calves minus dead

Report from NARWC Education Committee
November 2019
Robert Rocha – Chair

Regional (submitted by Anne DiMonti, Monica Pepe, Robert Rocha)
ASRI, NBWM, WDC and hosted the first ever *Whales on the Lawn* event at the Audubon Society of RI Nature Center and Aquarium in Bristol, RI on Saturday, June 8, as part of the World Ocean Day celebration. All three partners set up their inflatable whales on the ASRI front lawn and set up display tables with activities. Nearly 200 people attended.

The Education Committee's Facebook page, *Face-ing Extinction: The North Atlantic Right Whale*, has 2,477 followers, an increase of 63% since the 2018 NARWC meeting. This page is managed by WDC.

Bob, Monica and Anne continued to meet monthly throughout the year. We continued to work on outreach based on the *Sharing the Seas: Safe Boating for Sailors and Whales* program, initiated in 2015. Monica and Anne participated in the National Sailing Programs Symposium in Jacksonville, FL. Monica and WDC participated in the Vineyard Cup race on Martha's Vineyard, and published an article in *WindCheck* magazine (distributed to sailors throughout the Northeast).

Florida (submitted by Cheryl Munday)
The 10th Annual Right Whale Festival held on November 2, 2018 in Jacksonville Beach was a huge success with 9000 attendees. This year the Festival is "moving on up" to Amelia Island, FL on Nov. 2 & 3. It is now a two-day event that includes over 60 educational exhibitors & 20 ocean themed art & gift vendors, a lecture tent that includes a land based right whale sighting and reporting training. Seven vessels that are involved with marine mammal related law enforcement and rescue will be on hand for attendees to experience, and various group athletic events including a guided kayak tour, beach yoga and a beach bike-ride. Additional kids' activities include the right whale obstacle course, an "aerial survey" themed airplane carnival ride for kids, and a new kid's migration map program that requires school-aged children to navigate the festival grounds to answer questions about right whales to win a prize. The festival is complete with live music, great food, and family fun while learning about right whales. rightwhalefestival@gmail.com for info.

Maine
Bar Harbor (submitted by Zack Klyer)
Jeff Dobbs and Zack are still producing the film project called "Saving Giants: Survival of the NARW." Zack presented a talk titled, *Educating marine audiences about ropeless fishing*, at the National Marine Educators Association Conference at UNH this summer.

Castine (submitted by Bill McWeeny)
This year the Calvineers continued on their mission to help "right whales recover through education." They first educated themselves about what scientists were doing to study right whales and to advocate for rule changes that could prevent right whale accidental deaths by humans. They updated their PowerPoint Presentation and took it to many organizations and schools.

The accomplishments are:

- Presentation to the Sippican Middle School, Marion, MA.
- Production of six infomercials about scientists work with right whales.
- Received the "From the Bow Seat Gold Award" for the Infomercials, a $500 award.
- Presented to the Staff at Gulf of Maine Research Institute, Portland, ME.
- Co-sponsored and ran the annual New England Right Whale Festival at the NEAq
- Presented to the staff at Coastal Fisheries, Deer Island, ME.
- Calvineer Charlotte Griffith, published her work on white-bellied right whale genetics. The name of her article is "White Belly Dominance Investigation" published in the peer reviewed student journal, "Findings from the Field", Volume 2, June 2019, produced by the Gulf of Maine Education Department, pages 9-14.
- Six Calvineers submitted an abstract to the 2nd World Conference on Marine Mammal Science. The abstract was accepted as a Poster Presentation.
- Presented to Lubec Middle School students, Lubec, ME

- Went on a Whale Watch with Mackie Green and saw a right whale (#3991)! First time in 8 years a Calvineer has seen a live right whale.
- Currently they are making a PSA about why Maine Lobstermen should use 1700-lb breaking strength ropes & consider lowering the number of endlines they currently fish in Maine waters.

Eleven Calvineers will attend the 2nd World Conference on Marine Mammal Science from December 8th to December 12th, in Barcelona, Spain. They will present their Poster and attend many talks. The Calvineers have been working for 18 months fundraising for the trip that is now totally funded.

Massachusetts
Boston (submitted by Kara Mahoney Robinson)
NEAq Right Whale related activities:

- 7 Whale Day programs were booked at school across New England, reaching 748 students and 132 adults, for a total of 880 people.
- Right Whale Festival - NEAq hosted the Calvineers, Bow Seat Awareness Program, Conservation Law Foundation, Boston Harbor Cruises, Mass Environmental Trust, Ghost Whale Art, Year of the Right Whale, Women Working for the Oceans, Earth Detectives and the Aquarium's staff. The event featured presentations from the Calvineers and Aquarium teens as well as a panel discussion moderated by Brian Skerry. This was a smaller event than in previous years, but spurred a lot of great conversation!
- 3 events, including the Cambridge Science Festival, and the Aquarium's 50th anniversary celebration events where we had a table engaging participants in Right whale advocacy around entanglements and shifts in Right whale migration
- Our 42-foot inflatable Right whale "Calvin" was invited to the State House for the first time! Kelly Kryc, the Aquarium's Director of Policy and Leadership spoke at this event that promoted recognition of the SAVE (Scientific Assistance for Very Endangered) Right Whales Act. https://www.neaq.org/blog/state-house-right-whales/ It was a great event to bring Right Whales forward in people's minds and of course to take selfies with our beloved Calvin.

Quote from a colleague:
"AZA approached NEAQ to see if we would be interested in leading a SAFE (saving animals from extinction) program on the right whale. Other orgs have said they will only come on board if we lead, based on our role in the right whale community. NEAQ is/was wary of whether the SAFE framework provides a needed tool or if it's more work than results will bear.

In response, NEAq convened a meeting at AZA with about 40 people from orgs from Canada to Florida. We learned what SAFE was, heard from Heather Pettis about the state of right whales, heard from Kelly Kryc about the policy solutions and opportunities of combining east coast zoo/aquarium voices/power and wrapped the discussion with a productive brainstorm session about what a collaborative conservation agenda could look like.

Gloucester (submitted by Allison Rosner, from the full report to the NEIT)

- Ship Strike Coordinator provided outreach information at 30 meetings and/or events. Focus was state port authorities, with additional audiences being USCG trainings and general audience.
- NOAA is managing 33 Dynamic Management Areas.
- GARFO hosted 8 scoping meetings: 4 in ME, 1 in NH, 2 in MA and 1 in RI. Attendance was > 825; received > 27,180 emails, 150 mailed letters.
- Online and Social Media included 33 DMA web postings and 5 other NARW related web stories, 25 NARW-themed and 22 general whale Facebook posts to their 2.9 K followers.
- Fishery gear & enforcement liaisons hosting 16 trainings related to ALWTRP regulatory updates. Twelve were led for enforcement agencies and four for industry. Two tours of the gear warehouse in Narragensett were let for TRT members and the OLA.
- Whale SENSE training was held for 218 whale watch staff.
- NOAA Fisheries awarded a $5K contract to On the Water to create the PSA "Safe Boating Around Whales". Video has received 1540 YouTube views, 10,000 FB views with >15,000 people reached, 822 website views, and landed in the inbox of 78,359 e-newsletter subscribers.

- NMFS sent 12,500 "See a Spout Watch Out" brochures to USCG Auxiliary.

New Bedford (submitted by Robert Rocha)
The New Bedford Whaling Museum unveiled phase two of our *Whales Today* exhibit in February 2019. One of the featured displays is a custom-made life-sized head of a NARWC with its mouth open, as if it were feeding at the surface. Detailed input from Michael Moore, Marilyn Marx and Bill McLellan was critical in our efforts to have an accurate model sculpted. Several informational panels and pieces of art related to NARWs, taken from the NBWM collection, were erected on the wall next to the model.

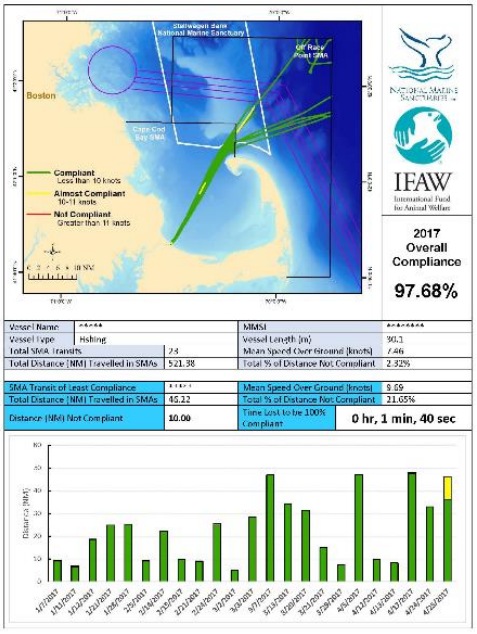
Hosted our 10th annual Right Whale Day, in partnership with the Museum's High School Apprentices, NECWA, NOAA, WDC, and AIS Scientific and Environmental Services. More than 300 visitors did whale activities on our plaza, made crafts with NECWA, posed with Rocky the whale, tried some of AIS's observing tools, and went into the Museum's inflatable humpback whale and WDC's inflatable NARW.

Plymouth (submitted by Monica Pepe)
In March, Whale and Dolphin Conservation secured our new and improved life-size inflatable, Delilah. Since then, nearly 4,000 people have toured the whale and learned about WDC's conservation efforts. This number is a combination of in-school sessions and outreach events geared towards boaters and families. At the beginning of November, she even travelled to the Southeast region's 11th Annual Right Whale Festival and made stops at schools in New Jersey and Connecticut along the way! Among the outreach events this year was the 2nd annual New England Whale Festival in Quincy, MA, a WDC-hosted event where we educate attendees about right whales and other local species using a number of interactive displays and activities.

Additional accomplishments include:
- Co-hosted two public education sessions with Rep. Matthew Murratore (MA) where right whales and local conservation implications were discussed.
- Interviewed for the Boston Sunday Review radio show
- WDC's Facebook content included 67 right whale specific posts from January-September 2019, which began incorporating new conservation marketing techniques.

Scituate (submitted by David Wiley)
Stellwagen Bank NMS and IFAW completed the 2018 Right Whale Corporate Responsibility and Report Card project, detailing the compliance and commitment of vessels traversing NOAA's Cape Cod Bay and Off Race Point Seasonal Management Areas (SAMs) for right whales. The project uses the USCG AIS system to track ship speeds. For each ship, a report card was generated with a map displaying each transit the ship made through the SMA, a bar chart showing the speeds of each transit, and an overall grade for the ship (Figure 1). Data were used to grade ships based on the percent SMA distance traveled at compliant speeds as follows: A+: 99 – 100% compliance and mean speed =<10 kts; A: 90 – 98.9% or mean speed =<10 kts. and mean speed least compliant transit =< 10kts; B: 80 – 89.9% or mean speed =<10 kts. and mean speed least compliant transit <10.5 kts; C: 70 – 79.9% or mean speed 10 – 10.5 kts. and mean speed least compliant transit 10.5 – 11 kts; D: 60 – 69.9% or mean speed >10.5 kts. and mean speed least compliant transit >11 kts; F: <60% or mean speed >11 kts. and mean speed least compliant transit >11.5 kts

Report Cards for 228 ships and 115 companies were completed and mailed. The timing of the mailing was designed to have companies receive the information at the onset of the 2019 SMA season. A sample report card is below:



A **Corporate Responsibility Certificate** highlighting the grade received by a ship or company was provided to all ships and companies receiving A+ or A grade.

Summary results were calculated for each shipping category. Of the commercial ships, the "Tug" category received the most favorable grades (86% A & A+; 0% F), followed by "Cargo" (77% A & A+; 6% F) and "Tanker" (61% A & A+; 11% F). This indicates that increased outreach to the Tanker community is particularly important. Passenger vessels were also identified as a community in need on increased outreach and education (61% A & A+, 5% B, 19% C and 1% D). Overall, 77% of vessels received grades of A or A+ and only 5% receive a grade of F.

More information is available from David Wiley (NOAA, SBNMS and Patrick Ramage, IFAW)

New Hampshire (submitted by Jennifer Kennedy)
Year of the Right Whale
Blue Ocean Society for Marine Conservation and The Whalemobile have partnered on an initiative called Year of the Right Whale, which is an update of the project formerly called Right Whale World Year. The YoRW is an initiative that strives to celebrate, educate and fundraise for right whales to ensure the species receives adequate protection by 2020.

Project components include:

- Inspiring people to learn about right whales and take action by viewing our 'Booth in a Box' at fairs, festivals, schools and events across the U.S., especially along the East Coast
- Working with whale watch companies to provide talking points & activities for their passengers
- Collating and distributing right whale curricula
- Outreach through social media and at in-person events
- Raising funds to support research that helps right whales

STUDENT/RESEARCHER ROUNDTABLE HOSTS
NARWC Annual Meeting
15 November 2019

Table 1: Colleen Coogan & Nick Sisson (NOAA GARFO)

Colleen Coogan is a biologist/policy analyst currently coordinating marine mammal Take Reduction Teams for the NMFS Greater Atlantic Region. Her efforts over the past two years have been directed at collaborating with the Atlantic Large Whale Take Reduction Team, a 61person stakeholder team, to develop measures to reduce the risk of right whale serious injuries and mortalities in US commercial fisheries. Her two years in this position were preceded by over 23 years working for NMFS in 3 regions and headquarters, primarily on policy and regulations related to conservation and recovery of endangered marine mammals, sea turtles, and anadromous fish.

Nick Sisson is a contractor working in the Protected Resources Division at NOAA's Greater Atlantic Regional Fisheries Office (GARFO) primarily on offshore wind energy and protected species issues. His work focuses on implementing the Endangered Species Act and working with other NOAA divisions and federal agencies to mitigate the effects of the wind energy industry on protected species, fisheries, and habitat. Prior to joining GARFO in 2019, Nick was a 2018 Knauss fellow in the Office of Protected Resources at NOAA Headquarters working on North Atlantic right whale conservation and management, and national bycatch reduction initiatives. Previously Nick has lived and worked along both coasts of the U.S. (and Alaska), studying marine mammals, seabirds, fish, crustaceans, and octopus.

Table 2: Sean Hayes & Allison Henry (NOAA NEFSC), and **Matt Hardy (DFO)**

Sean Hayes received undergraduate degrees from SUNY Cobleskill and Cornell, and his PhD from UC Santa Cruz, where he studied marine mammal physiology and behavior. After years in academia, Sean found his true passion lies in civil service when he joined the National Marine Fisheries Service (NMFS) in 2001. He has since worked on a broad range of challenges and species from pinnipeds to salmon to seabirds and cetaceans. His science experiences have taken him across the country from NMFS offices in Hawaii, California and Oregon, to serving under the NOAA Chief Scientist in Washington DC. In 2016, Sean became the Protected Species Branch Chief at NOAA's Northeast Fisheries Science Center in Woods Hole, Massachusetts, where he works with teams leading the center's ESA and MMPA research portfolio which includes salmon, marine mammals and sea-turtles. He is currently enjoying a 'sweet spot' in his career, where he remains engaged with the science but is able to affect change at higher levels. In this capacity, he is working to focus scientific effort on the ecological challenges of our marine resources in order to remove the ambiguity around stakeholder concerns, thus enabling managers and stakeholders to make scientifically informed decisions to ensure sustainability of our marine resources. He is also enjoying being much closer to his family farm in NY and exploring life in his new home on beautiful Cape Cod with his pups, wife, and new daughter.

Allison Henry is a biologist at NOAA Fisheries Northeast Science Center in Woods Hole, MA. As part of the large whale team she focuses on right whale recovery, individual photo-identification, and human-induced injury and mortality of large whales. When not sitting at a land-based desk, she's sitting at a desk in one of NOAA's Twin Otters - the Cadillac of the aerial survey world. Allison has participated in surveys conducted along the Canadian & US east coast and in Alaska for over 20 years and s till can't tell you if she likes seeing whales from the air or from a boat better. She has a B.A. in Biology from St. Mary's College of MD proving you don't have to have a graduate degree to have a successful marine mammal career.

Matthew Hardy is a Research Manager for the Fisheries and Ecosystem Sciences group with Fisheries and Oceans Canada. He leads a team of scientists, biologists and technicians to deliver fresh water and coastal field programs, offshore vessel-based research, and aerial-surveillance in the Gulf of Saint Lawrence. He's responsible for research, stock assessment, and monitoring for various commercially and recreationally fished species as well as for species at risk; this includes Atlantic salmon, lobster, herring, snow crab, groundfish, and marine mammals. Matthew's group provides science advice and works extensively with fishermen, stakeholders and indigenous groups to understand the implications of scientific research on fisheries and environmental issues.

Table 3: Michael Moore (WHOI)

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

Table 4: Peter Corkeron & Dan Pendleton (New England Aquarium)

Peter Corkeron recently started work with the whale research team at the New England Aquarium. Prior to this move, he spent 8 years with the large whale research group at NOAA's Northeast Fisheries Science Center in Woods Hole. Peter's PhD, awarded by the University of Queensland, was on the behavior and ecology of inshore dolphins in southeast Queensland, Australia. Since then, he's studied whales, dolphins, dugongs and seals at various places around the world. The aim of his work has always been to use science for marine conservation. He has been involved in research on North Atlantic right whales for over a decade, and on right whales since 1991.

Dan Pendleton, specializes in using data from earth-orbiting satellites and ocean models to answer contemporary questions in marine mammal ecology and conservation. He began doing marine mammal surveys with the New England Aquarium in 2006. After finishing his Ph.D. and working as a postdoctoral associate at the National Oceanic and Atmospheric Administration, he rejoined the Aquarium team in 2012 to pursue the development of habitat models for baleen whales and other marine mammals. His research is focused on hindcasting and predicting the timing and extent of habitat use, and estimating the influence of climate change on marine mammal populations.

Table 5: Christy Hudak (Center for Coastal Studies) and **Mason Weinrich (research NGOs)**

Christy Hudak is an associate scientist with the Center for Coastal Studies in Provincetown, MA. Christy manages the research vessel operations and habitat database for the Right Whale Ecology Program. Her expertise focuses on the zooplankton resource in Cape Cod Bay and surrounding waters. She also is the back-up aerial observer for the Right Whale aerial team. In addition, Christy is also working on microplastic research in seal scat, Great Shearwater stomach contents, and zooplankton samples and expanding the eDNA collection program at the Center for Coastal Studies.

Maison Weinrich developed a whale research initiative in Gloucester, MA in the form of the Whale Center of New England which had research, education and conservation as its mission over the course of 39 years. As part of that initiative, research and education was simultaneously conducted as part of whale watch and research activities. This served to increase public awareness of marine mammals, their environment, those factors that serve to enhance their preservation and to threaten their existence. Mason served as an educator to the public and a consultant to various groups that served the purpose of marine mammal research and education, nationally and internationally. His research focus includes right whale feeding, mating, and zooplankton studies on Jeffery's Ledge.

Table 6: Dennis Heinemann & Peter Thomas (Marine Mammal Commission)

Dennis Heinemann is a marine ecologist. He earned an MS in zoology at Oregon State University in 1978, an MA in Applied Statistics at the University of New Mexico in 1983, and a PhD in ecology at the University of New Mexico in 1985. He began his research career as an academic (grad school, post doc) and research consultant, working on 1) the community dynamics and predator-prey relationships of high latitude (Alaska and Antarctica) marine birds and mammals, 2) impacts of oil spills on marine birds and mammals, and 3) predator-prey relationships in endangered terns (roseate and least) in Massachusetts and California. Following that period, Dennis spend eight years with the CSIRO in Australia, working on 1) the impacts of human activities on coastal ecosystems, 2) monitoring bycatch of seabirds in longline fisheries, and 3) design criteria of marine protected areas used as fisheries management tools. Upon returning to the U.S., he worked for a short period for the National Marine Fisheries Service as a fisheries stock assessment scientist at the Southwest Fisheries Science Center. Dennis then spent several years as senior scientist with the Ocean Conservancy in Washington DC, where he focused on 1) science-based advocacy for the conservation and sustainable management of commercial and recreational fish stocks in the U.S., and 2) the establishment of MPAs in the U.S. and the Caribbean. In addition, he started up a climate-change program shortly before leaving in 2011 to join the Marine Mammal Commission. At the Commission, he was the Commission's Science Director for several years, and more recently has been leading its efforts in the areas of fisheries interactions and ecosystem ecology, as well as representing the Commission in a variety of science, management and policy fora, such as NMFS's take reduction teams. In his fisheries advisor role, Dennis is focused on finding science-based policy and management solutions to critical marine mammal bycatch issues, such as those facing North Atlantic right whales.

Peter Thomas is Executive Director of the Marine Mammal Commission, the only U.S. government agency that provides comprehensive oversight of all science, policy, and management actions affecting marine mammals. He earned his Ph.D. in Animal Behavior from the University of California, Davis, with behavioral research on southern right whales at Peninsula Valdés, Argentina. In the early 1980s, he was part of a team studying bowhead whale behavior in response to seismic testing in the Canadian Beaufort Sea. As Assistant to the Director of the Minnesota Zoological Gardens he led a review of the zoo's marine mammal program. He joined the U.S. State Department in 1991 as a AAAS Science and Diplomacy Fellow. In ten years at State, he managed U.S. policy and international negotiations on the Convention on Biological Diversity and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and served as an advisor to the Organization for Economic Cooperation and Development in Paris. He was instrumental in the creation of the International Coral Reef Initiative and the U.S. Coral Reef Task Force. He joined the U.S. Fish and Wildlife Service in 2001 as Chief of the Division of Management

Authority overseeing permitting and policy for U.S. wildlife imports and exports under the CITES Convention. Dr. Thomas started at the Marine Mammal Commission in 2008 as International and Policy Program Director, overseeing regulatory reviews and leading the Commission's work on acute marine mammal conservation issues such as the endangered vaquita porpoise, freshwater cetaceans, and the effects of climate change. He is lead author of the 2015 assessment of the Status of the World's Baleen Whales and a 2019 paper on the impact of electro-fishing on freshwater cetaceans.

Table 7: Kim Tilas (Massachusetts Environmental Trust) and **Sharon Young (The Humane Society)**

Kim Marshall-Tilas moved to the US from Canada in 1992 to work with Dr. Roger Payne at Ocean Alliance where she implemented education programs and worked as a scientific associate for OA's Southern Right Whale Program in Argentina and for the Voyage of the Odyssey international expedition. During her more than two decades with OA she also worked to help develop marine mammal conservation programs in Alaska, Papua New Guinea, and the Galapagos Islands. Currently, Kim is the Director of The Massachusetts Environment Trust. The Trust's grantmaking program provides funding to projects that support the advancement of marine animal conservation efforts and restoration and enhancement of aquatic ecosystems within Massachusetts. Revenues for the program are generated from the sale of the Trust's three environmentally-themed license plates issued by the Registry of Motor Vehicles – the Right Whale Tail/Roseate Tern, Leaping Brook Trout, and Blackstone Valley Mill. Kim's proudest career moment was swimming with a southern right whale and calf in the Imax film called "Whales". She remains very committed to helping people and organizations that are helping whales!

Sharon Young is the Senior Strategist for Marine Issues with The Humane Society of the US. She is appointed to serve on a number of federal task forces regarding marine mammal conservation and recovery including the SE Right Whale Recovery Plan Implementation Team and a number of congressionally mandated task forces focused on fishery impacts on marine mammals including the Large Whale Take Reduction Team, the Hawaii false Killer Whale Take Reduction Team, the Bottlenose Dolphin Take Reduction Team and the Longline multi-species Take Reduction Team. She has also served on the task force reviewing state applications for lethal management of pinnipeds on the US west coast. Sharon has taught or guest-lectured at several NE universities regarding marine mammal conservation and has co-authored publications on marine mammal conservation.

Table 8: Lyne Morissette and **fisherman (TBD)**

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

Table 9: Hansen Johnson (Dalhousie University) and **Andrew Wright (DFO)**

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

Andrew Wright has just begun a postdoc in Halifax, NS, Canada, leading the Maritimes Region Fisheries and Oceans Canada assessment of impacts of shipping noise on North Atlantic right whales as part of Canada's Oceans Protection Plan. This includes work to better establish baselines for noise in eastern Canada, examine potential overlap with NARW occurrence, and increase understanding of noise impacts on NARW. Specific lines of research will focus on sleeping behaviour, acoustic masking, stress responses and body condition. He also continues to work with sleeping in wild bottlenose dolphins with Dolphin Watch Alliance

in Egypt and killer whale acoustics in the Ross Sea through Gateway Antarctica at the University of Canterbury in Christchurch, New Zealand.

Table 10: Stephanie Milne (U.S Offshore Renewables) and **Jessica Mucci Heath (Smultea Sciences)**

Stephanie Milne is a marine biologist with 20 years' experience in scientific consultancy. She began her career working on fishing vessels in Alaska for National Marine Fisheries Service, collecting data to help regulate and ensure the sustainability of the resource. In 2006 she switched her focus from fisheries to marine mammals, accepting a position with RPS, a leading scientific consultancy. She spent many years working offshore as a Protected Species Biologist, where the focus of the work is to monitor and mitigate impacts to marine species from sources of man-made noise. Seven years ago she retired her coveralls and hard hat and moved to Houston to support offshore projects as a Marine Environmental Project Manager, where she now manages RPS Americas Protected Species division. She has also accepted the role of Team Leader of U.S Offshore Renewables and is very excited to be supporting the development of alternate energy sources.

Jessica Mucci Heath, Project and Protected Species Observer (PSO) Director for Smultea Sciences, started her wildlife career working as a zoo keeper in her home state of Ohio from 2001-2006. In mid-2006 she learned of an incredible opportunity working offshore aboard research vessels protecting marine mammals and sea turtles from anthropogenic noise in the marine environment. Following her passion of protecting marine life, she made the professional leap to try something new and it paid off in a big way! Jessica has since worked around the world in the offshore marine wildlife field and hasn't looked back. She has become an expert in visually and acoustically monitoring for marine mammals, traveled the world, observed countless marine species, and made lasting friendships around the globe. To date, one of her true passions is teaching and exciting people to journey into the industry she loves.

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