North Atlantic Right Whale Consortium
2020 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 and Northeast Right Whale Implementation Teams, 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 SPECIES 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 species, 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 species 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 species. 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. Additionally, the Board recognizes the importance that passive acoustic monitoring has played in our understanding of right whale distribution and its potential role in mitigating anthropogenic impacts on the species. The Board strongly supports and encourages efforts to develop a comprehensive Right Whale Acoustic Detection Database that will serve as an additional resource in conservation and management efforts.

Since 2010, 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, amd 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 continue to be a priority. These strategies should include efforts to not only locate, including use of passive acoustic monitoring, 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. The drastic shifts in right whale distribution, both temporally and spatially, and the speed at which they occurred, should be viewed as a harbinger of the inadequacy of static mitigation efforts focused solely on past habitat use.

In 2020, **two** right whale mortalities were detected, a decrease over 10 mortalities in 2019. The causes of death were attributed to a vessel strike for the first and possible injury during birth or dystocia for the second. The confirmed vessel strike was the first vessel strike mortality detected in US waters since 2017. There were three additional vessel strikes detected in 2020, one of which was presumed fatal and also occurred in U.S. waters. The presumed fatal strike occurred in an active Seasonal Management Area with vessel speed restrictions in place and the confirmed mortality in an area not under vessel speed restrictions at the time of detection. The absence of detected mortalities in Canadian waters in 2020 was encouraging and likely driven by several factors, including the reduction in large vessel traffic due to COVID-19 as well as ongoing vessel strike and entanglement mitigation measures in Canadian waters.

There were no confirmed entanglement mortalities detected in 2020, however, **five** right whales were documented carrying gear- four of the entanglements first seen in 2020. Four of the five entanglements are considered to be life-threatening and though all five were detected in U.S. waters, the origin of the gear in all cases is currently unknown.

Ten right whale calves were born in 2020, up from seven in 2019. However, births remain significantly below what is expected and over the last four years (2017-2020) detected mortalities outnumbered births by 3:2. The species continues to be in decline and in July 2020, the International Union for Conservation of Nature (IUCN) red listed the North Atlantic right whale changing its status from endangered to critically endangered. This designation is made when a species is considered at high risk for global extinction. The North Atlantic right whale is the only large whale species on the list.

Discussions about reducing anthropogenic impacts on right whales in both Canadian and U.S. waters are ongoing and encouraging. However, despite the 2020 reduction in overall mortalities and increase in births over 2019, a one year improvement does not a trend make and the species remains in decline. Anthropogenic injuries and mortalities remain a threat to the existence of North Atlantic right whale and immediate, broad-based mitigation strategies that result in significant risk reduction throughout the right whale's range (both realized and potential) 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 1, 2020, the database consists of over a million slides, prints, and digital images collected during the 83,988 sightings of 761 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 2019 were available for these calculations. Here we describe four different estimate methods and present the Consortium's best estimate for 2019. 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 2019 is 458.

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 2019 range from a low of 339 to a high of 723 with a middle estimate of 486.

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 2019 is 347.

Pace Method

The Pace Method was added to the 2016 report card and has 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 accounts for 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 2019 is 366. 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 1, 2020 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 but the MNA did not are all 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 2019 would be 423 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 that 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. There is some evidence this delay may be impacting the Pace model for recent years.

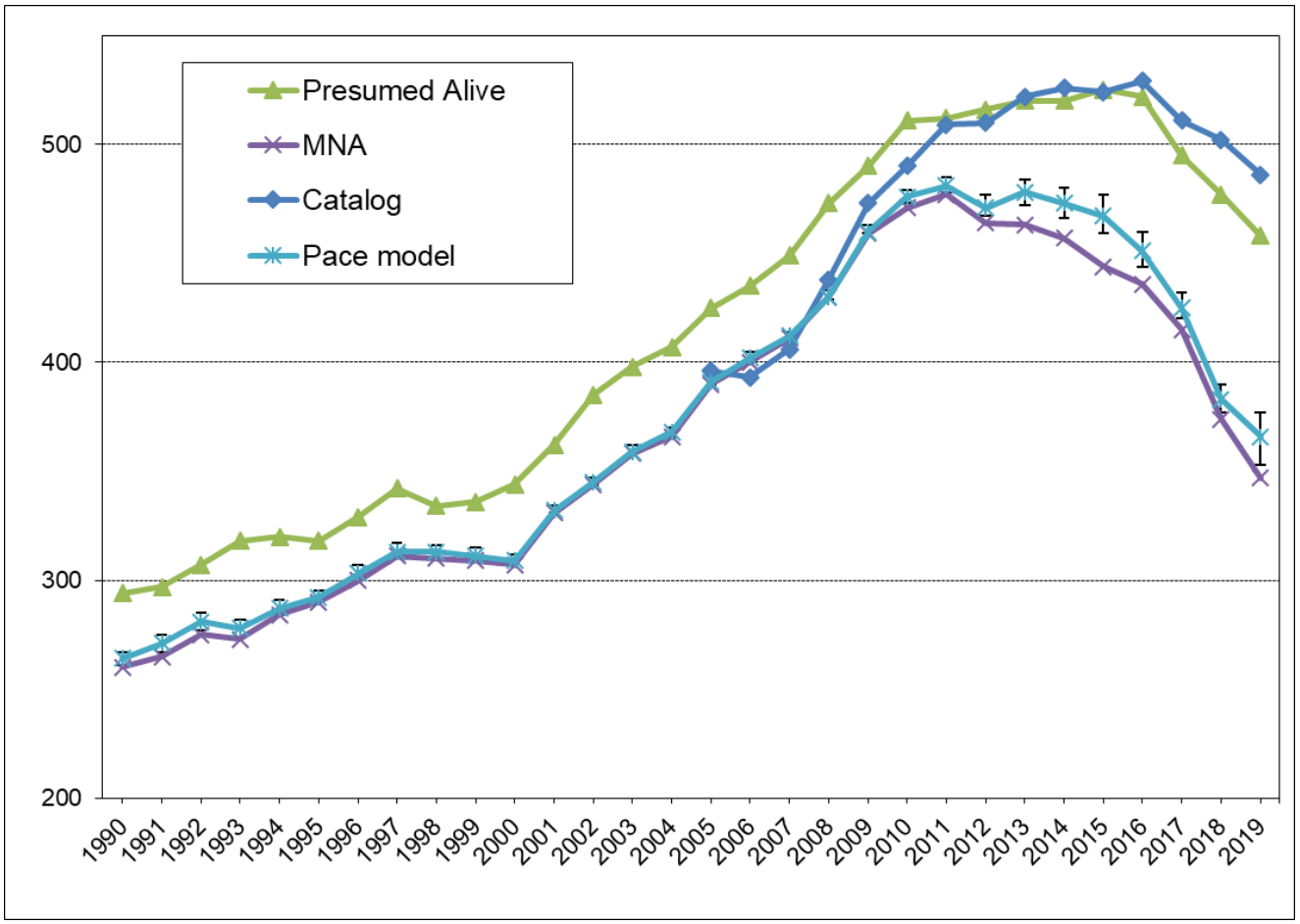

Figure 1. Assessments of the North Atlantic right whale population based on four available assessment methods. The Pace model shows a point "estimate" along with error bars which represent 95% of the posteriori probability. That model estimates the number of whale alive *at the start* of each year plus any new whales estimated to enter during that year. Data through 2019 as of September 1, 2020.

Best Right Whale Population Estimate 2019

We believe the Pace Method provides the best estimate for 2019. To get an estimate of whales alive *at the end* of 2019, we can take the estimate at the start of 2019 (366, Figure 1) and subtract the observed deaths during 2019 (8 cataloged whales and two unidentified). Therefore, **the best estimate for the end of 2019 is 356 whales** (95% confidence range +/- 11 and 13 respectively) using data as of September 1, 2020. This represents a more precipitous drop than previous years. Last year's Pace Method number for 2018 was 85 animals more than the MNA number at that time; this year's number is just 19 more than the MNA number (and that MNA number will increase over time as more whales are identified in 2019 and more "after" years are added). Survivorship is decreasing and that alone may account for the narrowing of the gap between MNA and the Pace Method number. The completion of 2019 data and the processing of additional 2020 data, along with further examination of the model, may help determine whether there is, in fact, a downward bias and if so, how large it is.

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). Data as of September 1, 2020.

Table 1. Annual counts of photo-ID sightings, unique individuals, presumed living whales, survey effort (in Beaufort conditions ≤4), 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 2019 are final as not all of the data for that year have been submitted or analyzed. Data as of September 1, 2020.

Year	Sightings	Unique IDs	Best Population Estimate (Pace model)*	Survey Effort (1,000 km)	% of Presumed Alive Population Seen*
2000	3286	246	309	125	80%
2001	3983	286	332	127	86%
2002	2725	315	345	252	91%
2003	2406	315	359	180	88%
2004	1839	299	368	287	81%
2005	3408	364	391	357	93%
2006	2803	348	402	316	87%
2007	3768	384	412	267	93%
2008	4164	408	430	254	95%
2009	4698	427	460	246	93%
2010	3236	432	476	271	91%
2011	3479	444	481	234	92%
2012	2127	383	471	271	81%
2013	1905	296	478	215	62%
2014	2404	379	473	200	80%
2015	1774	268	467	184	57%
2016	2210	327	451	155	73%
2017	3126	377	425	178	89%
2018	3833	358	383	190	93%
2019	4402	339	366	141	93%

*In previous Report Cards, the population estimate and resulting % presumed alive seen were based on the Middle Catalog number (see Population Status section above and Appendix 1). Given that the Report Card now considers the population estimate based on the Pace Method to be the most accurate estimate, we have modified Table 1 to include the Pace Model estimate as the best population estimate and as the denominator for the calculation of the % presumed alive population seen.

Reproduction
There were 10 documented calves born in 2020 (Table 2).

Table 2. Summary of calving events and associated inter-birth interval times for North Atlantic right whales from 2009-2020. 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
2020	10	77/13%	7.6	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 2020 – 31 December 2020, two right whale mortalities were documented in U.S. waters (Table 3). The necropsy for the first, a calf of the year, was conducted and the cause of death was identified as vessel strike. The second mortality documented was a neonate discovered in November 2020. Initial necropsy results suggest the calf died at, or shortly after, birth. There was no evidence of anthropogenic injury found. 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.

Non-lethal Vessel Strikes, Entanglements, and Entrapments

Vessel Strikes:
There were three non-lethal vessel strike injuries documented between 01 January 2020 – 31 December 2020 (Table 4). One of these cases, the 2020Calfof2360 sighted with strike wounds in January, was considered non-lethal because it was last seen alive. However, the injuries to the whale were severe and the whale is not expected to have survived.

Entanglement and Entrapments
There were five active entanglement/entrapment cases reported between 01 January 2020 – 31 December 2020, of which four were new. Table 5 includes newly reported cases as well as pertinent updates to previously reported cases.

Table 3. Documented right whale mortalities 01 January 2020 – 31 December 2020.

Whale #	Date	Location	Sex	Age	Field #	Necropsied?	Cause	Comments
2020Calfof3560	06/25/2020	NJ - MIDA	M	calf		Yes	Vessel strike	Necropsy results indicate that the calf had evidence of at least two separate vessel collisions, the latter of which occurred shortly before the whale died and was the likely cause of death. The calf was last sighted alive on 04/06/2020 off North Carolina. The whale's mother was resighted on 07/22/2020 in the Gulf of St. Lawrence.
	11/20/2020	NC – MIDA	M	calf	CALO 20-09	Yes	Possible dystocia	Necropsy indicates no evidence of human interactions from entanglement or vessel strike. Initial results suggest the whale died during birth, or shortly thereafter. Multiple genetic samples were collected in order to identify the calf's mother.

Table 4. Right whale vessel strikes (non-lethal) detected between 01 January 2020 – 31 December 2020.

Whale #	Date of First Injury Sighting	First location	Sex	Age (current)	Comments
2020Calfof2360	01/08/2020	Georgia	Unk	calf	At first sighting of the calf of the year, at least two wounds consistent with propeller strike were observed on calf's head. The anterior most wound wraps over front of left rostrum and is deep. Aerial images do not allow for full assessment of the wounds. There is concern that the injury may impede suckling. Resighted 01/10/2020 by aerial team, noted that wounds were still bleeding. A multi-agency effort to deliver antibiotics to the calf on 01/15/2020 was successful. Neither the calf nor its mother #2360 have been sighted since 01/15/2020. Given the nature of the injuries to the calf, it is not expected to have survived the strike.
1017	02/29/2020	Cape Cod Bay	M	40+	Sighted with series of 25+ minor prop cuts down right flank. Orange cyamids are visible in several aft cuts. Overall condition of the whale is good. Last sighted without cuts on 07/11/2019 in the Gulf of St. Lawrence.
4539	04/05/2020	Cape Cod Bay	M	5	Whale observed on 04/05/2020 in Cape Cod Bay with wound to right blowhole and very faint and minor marks on right side that appear to be propeller marks. Whale appeared to be in good condition. Resighted several times in the Gulf of St. Lawrence between June and September 2020.

Table 5. Right whale entanglements and status updates 01 January 2020 – 31 December 2020. 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 (in 2020)	Comments
3466	12/21/2019	~20m south Nantucket USA	M	15	At the initial entanglement sighting, the whale had multiple passes of yellow line through its mouth. The line appeared to be buoyant and trails behind the whale to a jumble and at least one bitter end. There is no evidence of tackle or buoys and the flippers do not appear to be involved. No response was mounted due to the time of day and distance from shore. The large amount of line and the jumble indicate that the whale will have difficulty shedding the gear and the configuration may become more complicated. **Resighted on 01/18/2020, 01/22/2020, and 1/31/2020 southeast of Nantucket. Reporting group indicates no change in entanglement or condition. Response not possible given time of day and distance to shore.**
3180	**02/24/2020**	**~45m SE of Nantucket**	**F**	**19**	**Whale sighted during an aerial survey, no response possible due to time of day and distance from rescue team. The full extent of the entanglement is unclear, however, a white bullet buoy was visibly lodged in the mouth and there may be a tight wrap of line around the bonnet. No trailing or suspended gear was visible. The whale was in extremely poor condition: emaciated, grey, and large cyamid aggregations on head and above both flippers.**
WR-2020-02	**03/16/2020**	**George's Bank**	**Unk**	**Unk**	**A commercial fisher reported an entangled right whale ~130nm east of Cape Cod on Georges Bank via the USCG. No response was mounted due to the time of day and distance. Entanglement described as whale with two orange polyballs trailing ~30ft aft of the flukes. No images were taken.**
4680	**10/11/2020**	**~3m east of Sea Bright , NJ**	**M**	**4**	**At a minimum, the whale has two passes of line around its rostrum, with line embedded in the rostrum. There is a large open lesion above the left shoulder. The whale is in extremely poor condition with significant body condition loss, lesioned and grey skin, and accumulations of orange cyamids on head and body. Survival is questionable.**
3920	**10/19/2020**	**South of Nantucket**	**M**	**11**	**During a search for entangled right whale #4680, the CCS aerial survey team found #3920 entangled south of Nantucket on 10/19/2020. The free-swimming whale had line wrapped tightly around it's hear with line embedded in the forward part of the upper jaw. There was also trailing line. The CCS response team was able to locate the whale, affix a telemetry buoy to the entanglement, and remove ~100 feet of trailing line. Whale location and weather are being monitored for further intervention.**

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 2020, thirteen new injury-of-interest events were documented for twelve whales, including four whales with attached gear, six entanglement injuries but no gear attached (including two new injuries detected for one whale), and three vessel strikes (Tables 6 and 7). Of these twelve whales, four 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 four newly injured whales (Table 7). Twenty whales previously on the monitoring list were removed, including six who became presumed dead (Knowlton et al. 1994). The remaining 14 whales were removed for improved condition and/or length of time since initial injury detections. As of 31 December 2020, the Serious Injury/Human Impact list includes 62 whales with 74 injuries documented from March 2004 through 31 December 2020 (Table 8). The majority of the injuries are entanglement related (63/74, 85.1%) followed by vessel strikes (9/74, 12.2%). There are two whales on the list with injuries of unknown origin.

Table 6. 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 twelve 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	**-**	**72 (9)**
2020	**-**	**62 (13)**

*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 7. Impact of anthropogenic injury on right whale visual health for newly detected injured right whales.

	Entanglement		Vessel Strike	Other	Total
	Gear Present	No Gear Present			
Decline in Condition	3	0	1	0	4
Inconclusive	1	3	0	0	4
No Decline in Condition	0	2	2	0	4
Total	4	5	3	0	12*

*Two new injuries were detected on whales that were already on the monitoring list. One newly injured whale had two injuries detected in 2020.

Table 8. Impact of anthropogenic injury on right whale visual health by injury type based on assessments of photographs pre- and post-injury for all North Atlantic right whales on the Serious Injury/Human Impact list as of 31 December 2020.

	Entanglement		Vessel Strike	Other	Total
	Gear Present	No Gear Present			
Decline in Condition	10	11	1	1	23
Inconclusive	12	14	2	1	29
No Decline in Condition	1	4	3	0	8
Extended Monitor	1	1	0	0	2
Total	24	30	6	2	62*

*This represents the number of whales on the monitoring list. Twelve 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: 2019

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 2019 (analysed 01 September 2020) is summarized below (Table 9) 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

BOS: Blue Ocean Society
CCS: Center for Coastal Studies
CMARI: Clearwater Marine Aquarium Research Institute
CWI: Canadian Whale Institute
DAL: Dalhousie University
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
QLM: Quoddy Link Marine
TC: Transport Canada
UNB: University of New Brunswick
WHOI: Woods Hole Oceanographic Institution

Table 9. Summary of 2019 right whale sightings by habitat region. Analyses for 2019 data are ongoing and therefore the data presented here should not be considered complete.

Region	# Sightings	Sighting Months	Survey types/activities	Organizations
Bay of Fundy	70	May, Jul - Oct	Vessel surveys, biopsy sampling	GMWSR, NEAq, QLM
East (East of Mainland US (Azores, Nova Scotian Shelf, Spain, Bermuda, Canary Islands)	11	Jul, Oct	Aerial surveys	DFO
Gulf of Maine	335	Jan - Mar, May - Sept, Nov	Aerial & Vessel surveys	NEAq, NEFSC
Great South Channel	61	Mar - Sep	Aerial & Vessel surveys	CCS, NEFSC
Jeffreys Ledge	4	Jul, Sep - Oct	Aerial surveys, whale watch	BOS, CCS
Mid-Atlantic (includes south of Cape Cod)	436	Jan - May, Jul - Sep, Nov - Dec	Aerial & Vessel surveys	NEAq, NEFSC
New England (Massachusetts Bay/Cape Cod Bay)	1372	Jan - May	Aerial & Vessel surveys, biopsy & habitat sampling, drone photogrammetry	CCS, NEFSC, WHOI
North (North of 46° incl. Newfoundland, Gulf of St. Lawrence, Iceland)	1827	May - Oct	Aerial & Vessel surveys, biopsy sampling	CWI, DAL, DFO, NEAq, NEFSC, TC, UNB
Southeast United States	146	Jan - Mar, Nov - Dec	Aerial & Vessel surveys, biopsy & drone sampling	CMARI, FWRI, GDNR

MANAGEMENT AND MITIGATION ACTIVITIES

NMFS, United States 2020 Management and Mitigation Activities

- *North Atlantic Right Whale Unusual Mortality Event*
  An Unusual Mortality Event (UME) was declared by the National Marine Fisheries Service (NMFS) for North Atlantic right whales (*Eubalaena glacialis*) starting in 2017 due to elevated strandings along the Northwest Atlantic Ocean coast, especially in the Gulf of St. Lawrence region of Canada. This is a transboundary event and the investigation includes whales stranding in both the United States and Canada. The event is ongoing with the 32 confirmed dead stranded whales (21 in Canada; 11 in the U.S.) to date. The breakdown by year includes 17 confirmed dead stranded whales (12 in Canada; 5 in the U.S.) in 2017, three whales in the U.S in 2018, nine whales in Canada and one in the U.S in 2019, and two dead whales in the U.S. in 2020 (through 08 December). Of the 32 dead right whales, 22 were necropsied and 18 were determined to have died as a direct result of human activities (either confirmed, probable, or suspect), from entanglements (8) or vessel strikes (10). Additionally, since 2017, 13 live free-swimming non-stranded whales have been documented with serious injuries from either entanglements (4 in Canada; 8 in the U.S.) or vessel strikes (1 in the U.S). Therefore, the preliminary cumulative total number of animals currently in the North Atlantic right whale UME is 45 individuals, including 32 confirmed mortalities and 13 seriously injured free-swimming whales. Thus, given there are less than 400 individual North Atlantic right whales remaining, these 45 individuals in the UME represent at minimum 10% of the population, which is a significant impact on such a critically endangered species.
  More information can be found at NMFS UME website: (https://www.fisheries.noaa.gov/national/marine-life-distress/2017-2020-north-atlantic-right-whale-unusual-mortality-event).

- *North Atlantic Right Whale Monitoring Plan*
  NMFS summarized the findings of a 2019 North Atlantic Right Whale expert Working Group that considered right whale monitoring objectives related to: (1) improving our understanding of population status by identifying and tracking essential population metrics, and (2) improving our understanding of distribution and habitat use. A report of the Working Group's recommendations was released in August

2020 and can be found on NMFS' website at: https://www.fisheries.noaa.gov/resource/document/north-atlantic-right-whale-monitoring-and-surveillance-report-and-recommendations.

The report presents the Working Group's recommendations for a comprehensive monitoring strategy to guide future analyses and data collection on (1) North Atlantic right whale demographics and population status, (2) distribution shifts and habitat use range-wide, and (3) the health of individuals and the population. NMFS is currently reviewing the Working Group's recommendations, as well as other information relevant to monitoring right whales, as it considers making any changes to its current right whale monitoring and surveillance program. In doing so, we will work closely with our partners to ensure that all North Atlantic right whale monitoring efforts are effective in helping to recover the species.

- *North Atlantic Right Whale Health Assessment Workshop:*
  NMFS convened a Workshop on North Atlantic Right Whale Health Assessment June 24-26, 2019 in Silver Spring, Maryland, under the auspices of the Working Group on Marine Mammal Unusual Mortality Events (Working Group) in response to the ongoing North Atlantic Right Whale UME 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.

  Over the course of the three days, the workshop participants helped NMFS 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 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.

  A draft report detailing the workshop proceedings and recommendations is now complete. Release of the report was previously delayed but we now anticipate it will be released in early January 2021.

- *Vessel Speed Rule Report*
  NMFS has undertaken an assessment of the right whale vessel speed rule. The assessment will include information on biological effectiveness, mariner compliance, outreach and enforcement efforts, navigational safety, and economic impacts. Additionally, the assessment will assess the voluntary Dynamic Management Area (DMA) program and examine small vessel (<65ft) traffic patterns within Seasonal Management Areas.

  NMFS continues to move forward with a suite of activities designed to 1) further investigate possible changes to the speed rule regulations, 2) assess the efficacy of other vessel strike mitigation efforts, and 3) enhance our outreach and enforcement strategies.

- *DMA and Right Whale Slow Zone info*
  NMFS began the voluntary DMA program at the same time as our mandatory speed reduction regulations. Under this program, NMFS established DMAs when visual sightings documented the presence of three or more right whales within a discrete area. Vessels 65 feet and larger were asked to avoid or slow to 10 knots or less in these areas to protect right whales from vessel strike. Early in this fiscal year, the North Atlantic right whale Northeast U.S. Implementation Team identified the opportunity for NMFS GARFO to enhance vessel strike reduction efforts by also using acoustic information to alert vessels of right whale presence. Based on this idea, NMFS GARFO launched the Right Whale Slow Zones campaign in August of 2020. Under this new name – Right Whale Slow Zones – NMFS GARFO is expanding voluntary speed reduction efforts in the Northeast U.S. Now, NMFS GARFO is asking vessels of all sizes to avoid or slow down to 10 knots or less in areas where right whales have been seen (i.e., DMAs) or heard (i.e., areas where acoustic detections are received).

  Over the last five years NMFS has recorded a noticeable and steady increase in the number of DMAs triggered. During 2016, five DMAs occurred and speed restrictions were requested. However, in the last three years (2018-2020), notifications have increased to 20 or more annually. Historically, DMAs were triggered/and initiated due to right whale visual observations. In August of 2020, since the launch of Right

Whale Slow Zones, acoustic receivers and arrays were added as a new technology used to trigger right whale presence notifications in the Northeast U.S. To date, (12-9-2020) we have had four acoustically triggered SLOW Zone events in two locations (New York Bight, NY and Atlantic City, NJ). Two events in each location, which have led to extensions of the original trigger.

The North Atlantic right whale Northeast Implementation Team identified and outlined some of the positive opportunities for NMFS to begin using acoustic receivers and detections as another alternative trigger for establishing right whale SLOW Zones. These suggestions were researched, discussed and developed by management. Acoustic triggers were accepted and have been established in the Northeast U.S. per the NEIT recommendation related to trigger criteria, duration and size.

- *U.S. North Atlantic Right Whale Implementation Teams*
  In 2020, 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:
  - *Northeast U.S. Implementation Team (NEIT)*
    NMFS GARFO continued to liaison with the NEIT on activities to assist in the implementation of the recovery plan in the Northeast U.S. This included the NEIT's continued discussion and furtherance of identified priorities to support right whale recovery in the Northeast. For example, the NEIT's recommendation to NMFS GARFO to enhance vessel strike reduction efforts using acoustic information informed the acoustic portion of the new "Right Whale Slow Zones." Specifically, the areas triggered by acoustic detections in the Northeast U.S. are established per the NEIT recommendation related to trigger criteria, duration and size.
  - *Population Evaluation Subgroup*
    The U.S. Implementation Team's Population Evaluation Tool Subgroup continued to meet and work towards development of a population viability analysis to characterize North Atlantic right whale extinction risk. This is a coastwide collaboration including Canada.

- *Species in the Spotlight*
  North Atlantic Right Whales became a Species in the Spotlight in 2019. NMFS is working to develop a Species in the Spotlight 5-year action plan which builds upon existing recovery and conservation plans and details the focused efforts needed over the next five years to reduce threats and stabilize the North Atlantic right whale population decline. Considerations include input from the Northeast and Southeast Implementation Teams from their October 2019 joint meeting. NMFS expects the action plan to be publicly available in the spring of 2021.

- *Atlantic Large Whale Take Reduction Plan*
  NMFS is requesting comments on the proposed rule to modify the Atlantic Large Whale Take Reduction Plan (ALWTRP) and associated Draft Environmental Impact Statement (DEIS). The proposed rule and a Notice of Availability of the DEIS were published in the Federal Register on December 31, 2020. Links to both documents as well as supporting information can be found on the ALWTRP website.

  Comments on the Proposed Rule and DEIS are due by March 1, 2020. NMFS is holding informational sessions in January to give the public an opportunity to learn about the proposed rule and DEIS before providing comments. Comments can be submitted in writing or orally:
  - To submit written comments go to the regulations.gov website, search for NOAA-NMFS-2020-0031 and choose "Comment Now".
  - Oral comments can be provided during February public hearing sessions.

  Proposed changes to the Plan would:
  - Modify gear marking to introduce state-specific colors for gear marks and increase the number of gear markings and areas requiring marked lines.
  - Modify gear configurations to reduce the number of vertical lines by requiring more traps between buoy lines and by introducing weak insertions or weak rope into buoy lines.
  - Modify existing seasonal restricted areas to allow ropeless fishing,
  - Add one or two new seasonal restricted areas that are closed to buoy lines but allow ropeless fishing.

  Contact Colleen.Coogan@noaa.gov or Marisa.Trego@noaa.gov with questions.

- *Offshore Wind Energy:*
  Offshore wind energy development along the U.S. East Coast continued to progress rapidly in 2020, including the first two turbines being installed in Federal waters off the coast of Virginia. Currently, there are 16 active leases on the Outer Continental Shelf of the U.S. East Coast between southern New England and North Carolina. Many of the proposed projects are simultaneously conducting site assessment activities, including geotechnical and geophysical surveys, and preparing Construction and Operating Plans. The effects of all these activities on protected species and their habitat are assessed under the ESA and the Marine Mammal Protection Act (MMPA). NMFS continued its engagement in the burgeoning industry in 2020 fulfilling multiple roles, primarily providing input and review throughout the One Federal Decision process as a cooperating agency to the Bureau of Ocean Energy Management , the lead Federal agency for authorizing the construction, operation, and eventual decommissioning of any offshore wind project) and also providing data and analyses on protected species to developers and working on a number of regional coordination projects to advance our scientific understanding of the effects of offshore wind development. Additional activities in 2020 included:
    - Completing the ESA section 7 biological opinion for the Vineyard Wind 1 project, the Opinion can be found at: https://repository.library.noaa.gov/view/noaa/27243
    - Continuing to conduct a programmatic ESA consultation on offshore wind energy survey activities to include actions from Maine-Florida and update analyses of effects to ESA-listed species and their habitats.
    - Processing MMPA Incidental Take Authorizations related to Vineyard Wind 1 and South Fork construction**.**
    - Coordinating with the Northeast Fisheries Science Center (NEFSC) to improve our understanding of the effects of offshore wind development on protected species.

  More information on NOAA's role in offshore wind energy development can be found at: https://www.fisheries.noaa.gov/new-england-mid-atlantic/science-data/offshore-wind-energy-development-new-england-mid-atlantic-waters

- *Aquaculture Interactions Working Group (AIWG):*
  The NOAA Aquaculture Interactions Working Group (AIWG) coalesced in 2019 in partnership between the NMFS Office of Protected Resources and Office of Aquaculture to address the potential risk of protected species interactions with marine aquaculture gear. The objectives of this working group are to: (1) consider ways to assess the risk of adverse impacts to protected species associated with various types of aquaculture gear, (2) evaluate strategies to avoid or minimize risks to protected species and their habitats (e.g., siting, engineering design, monitoring), and (3) develop operational products such as guidance documents and best management practices that will constitute national guidance on assessing and minimizing potential risks to protected species and their habitats from aquaculture operations. Efforts by the AIWG are ongoing, with guidance and information produced by this working group expected throughout 2021.

- *Ropeless Fishing Research:*
  During FY20 the NMFS NEFSC accelerated the research and development of a ropeless fishing pilot program. Many activities have been accomplished or are being planned to aid in both testing and development of ropeless systems. The NEFSC has built relationships with fishermen, manufacturers of ropeless systems, and nongovernmental organizations (NGO) to help facilitate the development of safe and operationally feasible methods to remove the vertical lines from pot/trap and other fishing gears.

  We continue to expand our capacity to work on innovative gear solutions. Activities include:
    - NEFSC acquisition of a total of 10 ropeless fishing systems from six vendors were added to the collaborative Gear Library which now maintains 47+ ropeless fishing systems.
    - Contracting with 16 collaborative fishermen to conduct both inshore and offshore trials of ropeless fishing systems.
    - Completion of 120 active fishing hauls using ropeless fishing systems. Dedicated training/rigging days accomplished prior to each new vessel or ropeless fishing system.
    - Two federal employees have been reprogrammed to work on ropeless testing and four contractors added to the team.
    - Economics staff are estimating anticipated cost reductions of ropeless technology over time.
    - NEFSC/Protected Species Branch is working with the National Aeronautics and Space Administration's Center for Collaborative Excellence and Yet2 to crowdsource market research to

identify vendors with the expertise to develop an inexpensive geolocation system for traps and pots to be used by fishermen, managers, and enforcement.
    - Funding was provided to the National Fish and Wildlife Federation to develop a scoping project to elicit feedback from key stakeholder groups on ropeless fishing conflict issues (matched by $300,000 from private corporations).
    - NMFS staff are actively participating in newly formed ropeless fishing forums including the Ropeless Consortium and Canadian Gear Innovation Summit.
    - Worked with communications staff to develop an infographic and informational videos on ropeless systems.
    - Working with NGOs and engineers to develop a geolocation system to resolve issues of gear conflict, fishermen setting their gear over or fishing through ropeless fishing system systems set on the ocean floor.

- NOAA called for 27 Dynamic Management Area (DMA) voluntary speed reduction zones between 01 January 2020 and 31 December 2020 (Table 10).

Table 10. Dynamic Management Area (DMA) voluntary speed reduction zones posted by NOAA between 01 January 2020 and 31 December 2020.

Trigger Date (date of RW sightings)	**Number of Right Whales**	**Sightings Source**	**General Location**	**Boundaries**
1/22/2020	58	NOAA aerial team	31 nm south of Nantucket	41 11 N 40 22 N 069 32 W 070 37 W
1/31/2020	50	NOAA aerial team	31 nm south of Nantucket	41 11 N 40 22 N 069 32 W 070 37 W
2/9/2020	14	NOAA aerial team	31 nm south of Nantucket	41 11 N 40 22 N 069 32 W 070 37 W
2/20/2020	8	NARW Sighting Survey	31 nm south of Nantucket	41 11 N 40 22 N 069 32 W 070 37 W
3/2/2020	66	NARW Sighting Survey	Extended 31 nm south of Nantucket and 47 nm SE Nantucket, MA	41 11 N 40 22 N 069 32 W 070 37 W 41 02 N 40 15 N 068 58 W 070 01 W
3/12/2020	13	NOAA Aerial team	31 nm south of Nantucket and 47 nm SE Nantucket, MA	41 11 N 40 22 N 069 32 W 070 37 W 41 02 N 40 15 N 068 58 W 070 01 W
3/23/2020	4	NOAA Aerial team	East of Boston	42 45 N 42 04 N 070 11 W 071 10 W
4/9/2020	5	Opportunistic Sighting from Shore	Nahant, MA	42 47 N 42 05 N 070 26 W 071 23 W
4/24/2020	4	Boston Harbor Cruise	NE of Boston	42 47 N 42 05 N 070 26 W 071 23 W
8/31/2020	8	NOAA Aerial Team	South of Nantucket	41 16 N 40 32 N 069 37 W 070 28 W
9/14/2020	7	NOAA Aerial team	South of Nantucket	41 16 N 40 32 N 069 37 W 070 28 W
9/24/2020	4	NEA aerial survey	South of Nantucket	41 16 N 40 32 N 069 37 W 070 28 W
10/4/2020	3	NEA aerial survey	South of Nantucket	41 16 N 40 32 N 069 37 W 070 28 W
10/19/2020	6	CCS aerial survey	South of Nantucket	41 16 N 40 32 N 069 37 W 070 28 W

Table 10 (cont'd). Dynamic Management Area (DMA) voluntary speed reduction zones posted by NOAA between 01 January 2020 and 31 December 2020.

Trigger Date (date of RW sightings)	**Number of Right Whales**	**Sightings Source**	**General Location**	**Boundaries**
10/31/2020	4	NOAA aerial survey	South of Nantucket	41 16 N 40 32 N 069 37 W 070 28 W
11/15/2020	4	NOAA aerial survey	SE of Nantucket	40 59 N 40 23 N 069 05 W 069 52 W
11/17/2020		WHOI Acoustic Buoy	SE of New York City	40 41 N 40 01 N 73 03 W 073 55 W
11/20/2020		WHOI Acoustic Buoy	SE of Atlantic City	39 25 N 38 44 N 073 44 W 074 36 W
11/29/2020	3	NEA aerial survey	SW of Nantucket Isl.	41 01 N 40 22 N 070 07 W 070 59 W
11/30/2020		WHOI acoustic buoy	SE of New York City	40 41 N 40 01 N 73 03 W 73 55 W
12/7/2020		WHOI Acoustic Buoy	SE of Atlantic City	39 25 N 38 44 N 073 44 W 074 36 W
12/9/2020		WHOI Acoustic Buoy	SE of New York City	40 41 N 40 01 N 73 03 W 73 55 W
12/14/2020	4	NEA aerial survey	SE of Nantucket Isl.	41 26 N 40 44 N 069 31W 070 25 W
12/20/2020		WHOI Acoustic Buoy	SE of New York City	40 41 N 40 01 N 73 03 W 73 55 W
12/20/2020		WHOI Acoustic Buoy	SE of Atlantic City	39 25 N 38 44 N 073 44 W 074 36 W
12/30/2020	7	PR Observers aboard survey vessel - VENTUS	S of Martha's Vineyard	41 25 N 40 44 N 069 59 W 070 55 W
12/31/2020		WHOI Acoustic Buoy	W of Martha's Vineyard	41 34 N 40 54 N 070 50 W 071 43 W

Fisheries and Oceans Canada and Transport Canada, Canadian 2020 Management and Mitigation Activities

Input from Fisheries and Oceans Canada

- 2020 is the fourth 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).

- In February 2020, additional management measures to protect North Atlantic right whales were announced for 2020 and beyond. These include the expansion of temporary area closures to fisheries triggered by single whale detections in the Gulf of St. Lawrence, Roseway and Grand Manan Basins, and the entire Bay of Fundy as well as season-long area closures to protect aggregations in the Gulf of St. Lawrence. The new season-long closure protocol, an adaptive management measure, resulted in the largest area closed to fishing to date. As of November 13, 2020, 175 full grids (approximately 36,000 km2) were closed for the season. As of November 13, 2020, 36 full grids were temporarily closed (approximately 6,400 km2) within the Gulf of St. Lawrence, Bay of Fundy and Roseway Basin. In comparison, the static season long closure area to protect right whales in 2019 was 2,200 square km.

- This is also the first year where acoustic technology was used to trigger fishery area closures. This technology successfully detected the presence of whales, in turn, triggering both fishing and shipping measures.

- Canada implemented a requirement for fixed gear fisheries in Atlantic Canada and Quebec to be marked by end of 2020 and to have weak breaking points in their vertical lines as well as other gear modifications

for the end of 2021 and beyond. Additionally, all fishing licence holders are required to report lost gear and any interactions with marine mammals.

- Canada's on the water, in the air and acoustic whale surveillance program covers all of Atlantic Canada and Quebec, with targeted monitoring in the Gulf of St. Lawrence, the Bay of Fundy and other areas. For example, at any given time through peak NARW months in Canada (April to November), upwards of 4-5 planes from DFO and Transport Canada were monitoring different areas for right whales and potential overlap with fishing activity and vessel traffic. As of November 2020, over 2000 hours of flights were designated for NARW.

- Right whales were first sighted in Canadian waters on May 3rd, 2020. As of early December, there have been over 1000 detections in Canadian waters of right whales and 128 different individuals have been identified from visual surveillance in Canadian waters this year, including five new right whale calves. Analysis of photos from 2020 is ongoing.

- With less than 400 remaining, the Government of Canada continues to take action to protect the endangered North Atlantic right whale. To date, there have been no Right whale deaths or new entanglements reported in Canadian waters for 2020.

- The Government of Canada has been working with industry, to identify gear solutions for alleviating injury to right whales and has provided funding for entrepreneurs and the fishing industry for gear development and pilots. Many innovative approaches to addressing gear modification were discussed during the Gear Innovation Summit hosted by the Minister of Fisheries and Oceans from February 11-12, in Halifax, N.S.

- Over the past three years, ropeless gear trials have been conducted in Atlantic Canada. In 2020, the Department supported the first dedicated trials of ropeless gear for crab fishing in an area closed due to the presence of right whales, their catches were sold on the commercial market. Future gear modifications that are being considered include: requirements for maximum rope diameters of 5/8 inches, sinking rope between pots and traps, and reductions in vertical and floating rope.

- Fisheries and Oceans 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. The Department is also delivering $4.5 million over four years to build additional capacity across Canada for safe and effective marine mammal incident response. The funds for 2020-21 will further support necropsies, Indigenous community response capacity, and in particular increased large whale disentanglement response capacity in the Gulf of St. Lawrence. Meetings are held annually with Marine Mammal Response partners to discuss the operational season and needs moving forward.

- Fisheries and Oceans hosted the Gear Innovation Summit in Halifax on February 11-12, 2020. The Summit provided an opportunity for harvesters, technical experts, non-government and government agencies to share information and learn about technologies and programming aimed to the prevention, reduction, and retrieval of ghost gear and industry-led whale safe gear initiatives. Attended by over 250 stakeholders as well as the Minister of Fisheries and Oceans, the event included plenary sessions, expert panel discussions and a trade show to allow for harvesters to further discuss the application of technology in their operations.

- Fisheries and Oceans is committed to addressing the threat of abandoned, lost, or otherwise discarded fishing gear through various initiatives, including the Sustainable Fisheries Solutions and Retrieval Support Contributions program (Ghost Gear Fund). Projects supported by Fisheries and Oceans Canada have been responsible for the removal of almost 69 tons worth of lost or discarded fishing gear from coastal waters in Atlantic Canada this year.

- On November 17-18, 2020, Fisheries and Oceans Canada held the North Atlantic Right Whale Roundtable Meeting with indigenous groups, the fishing industry, provinces, and marine mammal experts. The Roundtable and other discussions with harvesters play an important role in the preparation of Canada's measures to protect right whales and to support sustainable fisheries for 2021 and beyond.

Input from Transport Canada

Essential Population Monitoring and Priorities

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 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. In 2020, Canada further expanded on the measures introduced in July 2019. There were no known right whale mortalities in Canadian waters in 2020.

Management and Mitigation Activities

- In 2020, 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 North Atlantic right whale. These measures, applicable to all vessels longer than 13m, came into force on April 28, 2020 and were in place until November 15, 2020.
- Additionally, Transport Canada instituted Seasonal Management Areas from April 28 to June 30, 2020 to expand the static speed restriction zone for part of the season and a mandatory restricted area in and near the Shediac Valley to protect aggregating North Atlantic right whales from August 2 to October 9, 2020 – the area was closed to all vessels longer than 13m with exceptions for fishing and certain other activities. Vessels permitted to transit in or through the zone were limited to speeds of no more than 8kn
- Transport Canada also conducted a trial voluntary slowdown in Cabot Strait from April 28 to June 15, 2020, and October 1 to November 15, 2020.
- Transport Canada used two new surveillance technologies to detect North Atlantic right whales to inform active management of dynamic vessel speed measures - a Remotely Piloted Aircraft System (RPAS or drone) and an acoustic underwater glider. These two technologies complimented the surveillance flights flown by Transport Canada's National Aerial Surveillance Program (NASP).
- Transport Canada began evaluating the 2020 measures before the conclusion of the season, and continues to engage with the marine transportation industry, fishers, scientists, and other stakeholders to refine and develop measures for 2021.
- 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.

2020 NORTH ATLANTIC RIGHT WHALE PUBLICATIONS/REPORTS

Reports and publications that utilized NARWC databases in 2020 and/or those of general interest to the right whale community are listed and hyperlinked (when available) below.

Publications/Theses

Baumgartner MF., Bonnell J, Corkeron PJ., Van Parijs SM., Hotchkin C, Hodges BA., Bort Thornton J, Mensi BL., Bruner SM. 2020. Slocum Gliders Provide Accurate Near Real-Time Estimates of Baleen Whale Presence From Human-Reviewed Passive Acoustic Detection Information.Frontiers in Marine Science 7:100. DOI=10.3389/fmars.2020.00100

Brown, A.H. and Niedzwecki, J.M., 2020. Assessing the risk of whale entanglement with fishing gear debris. Marine Pollution Bulletin, 161, p.111720.

Christiansen F., Dawson S.M., Durban J.W., Fearnbach H., Miller C.A., Bejder L., Uhart M., Sironi M., Corkeron P., Rayment W., Leunissen E., Haria E., Ward R., Warick H.A., Kerr I., Lynn M.S., Pettis H.M., Moore M.J. 2020. Population comparison of right whale body condition reveals poor state of the North Atlantic right

whale. Mar Ecol Prog Ser 640:1-16. https://doi.org/10.3354/meps13299

Davis, G.E., Baumgartner, M.F., Corkeron, P.J., Bell, J., Berchok, C., Bonnell, J.M., Brault, S., Buchanan, G.A., Cholewiak, D., Clark, C.W. and Delarue, J., 2020. Exploring movement patterns and changing distributions of baleen whales in the western North Atlantic using a decade of passive acoustic data. Global Change Biology.

de Lavigerie, G.D., Bosselaers, M., Goolaerts, S., Park, T., Lambert, O. and Marx, F.G., 2020. New Pliocene right whale from Belgium informs balaenid phylogeny and function. Journal of Systematic Palaeontology, pp.1-26.

Fortune, S.M., Moore, M.J., Perryman, W.L. and Trites, A.W., Body growth of North Atlantic right whales (*Eubalaena glacialis)* revisited. Marine Mammal Science.

Henry A.G., Garron M., Morin D., Reid A., Ledwell W., Cole TVN. 2020. Serious Injury and Mortality Determinations for Baleen Whale Stocks along the Gulf of Mexico, United States East Coast, and Atlantic Canadian Provinces, 2013-2017. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 20-06; 53 p.

Ierardi, J.L., Veloso, A. and Mancia, A., 2020. Transcriptome analysis of cadmium exposure in kidney fibroblast cells of the North Atlantic right whale (*Eubalaena glacialis*). Comparative Biochemistry and Physiology Part C: Toxicology & Pharmacology, p.108946.

Johnson, H.D., Baumgartner, M.F. and Taggart, C.T., Estimating North Atlantic right whale (*Eubalaena glacialis*) location uncertainty following visual or acoustic detection to inform dynamic management. Conservation Science and Practice, p.e267.

Kelley, D.E., Vlasic, J.P., Brillant, S.W. 2020. Assessing the lethality of ship strikes on whales using simple biophysical models. Mar Mam Sci. 2020; 1– 17.

Koubrak, O., VanderZwaag, D.L. and Worm, B., 2020. Saving the North Atlantic Right Whale in a Changing Ocean: Gauging Scientific and Law and Policy Responses.

Martins, M.C.I., Miller, C., Hamilton, P., Robbins, J., Zitterbart, D.P. and Moore, M., Respiration cycle duration and seawater flux through open blowholes of humpback (*Megaptera novaeangliae*) and North Atlantic right (*Eubalaena glacialis*) whales. Mar Mam Sci. 2020; 1-20

Montes, N., Swett, R. and Gowan, T., 2020. Risk of encounters between North Atlantic right whales and recreational vessel traffic in the southeastern United States. Ecology and Society, 25(4).

Moore M.J., Mitchell G.H., Rowles T.K., and Early G. 2020. Dead Cetacean? Beach, Bloat, Float, Sink. Front. Mar. Sci. 7:333. doi: 10.3389/fmars.2020.00333

Myers, H.J. and M.J. Moore. 2020. Reducing effort in the U.S. American lobster (*Homarus americanus*) fishery to prevent North Atlantic right whale (*Eubalaena glacialis*) entanglements may support higher profits and long-term sustainability. Marine Policy 118:104017

Ohnemus, K.P. The (en)tangled web they weave: Stakeholder perceptions of the Large Whale Take Reduction Plan process. 2020. Open Access Master's Theses. Paper 1836. https://digitalcommons.uri.edu/theses/1836

Radvan S. 2019. Effects of inbreeding on fitness in the North Atlantic right whale (*Eubalaena glacialis*). Honours thesis Submitted to Saint Mary's University, Halifax, Nova Scotia. 63 pp.

Rockwood, R.C., Adams, J., Silber, G. and Jahncke, J., 2020. Estimating effectiveness of speed reduction measures for decreasing whale-strike mortality in a high-risk region. Endangered Species Research, 43, pp.145-166.

Simard, Y., Roy, N., Giard, S. and Aulanier, F., 2019. North Atlantic right whale shift to the Gulf of St. Lawrence in 2015, revealed by long-term passive acoustics. Endangered Species Research, 40, pp.271-284.

Reports

Bourque, L., Wimmer, T., Lair, S., Jones, M., Daoust, P.-Y. 2020. Incident Report: North Atlantic Right Whale Mortality Event in Eastern Canada, 2019. Collaborative Report Produced by: Canadian Wildlife Health Cooperative and Marine Animal Response Society. 210 pp.

Fauquier D., Long K., Biederon I., Wilkin S., Rowles T., Patterson, E., Henry A., Garon M., Fougeres E., Famer, N.A., Baker J, Ziccardi M. 2020. Report of the Health Assessment Workshop for North Atlantic Right Whales (*Eubalaena glacialis*), June 24-26, 2019. NOAA Tech. Memo. NMFS-OPR-65, 67 p.

Gavrilchuk, K., Lesage, V., Fortune, S., Trites, A.W., and Plourde, S. 2020. A mechanistic approach to predicting suitable foraging habitat for reproductively mature North Atlantic right whales in the Gulf of St. Lawrence. DFO Can. Sci. Advis. Sec. Res. Doc. 2020/034. iv + 47 p.

Knowlton A.R., Zani M.A., Howe K.R., Hamilton P.K., Burgess L.A., Graham K.M., Pettis H.M., Kraus S.D., Brown M.B. 2019. Research, Monitoring and Conservation of the North Atlantic Right Whale (Eubalaena glacialis) in the southern Gulf of St. Lawrence and the Bay of Fundy – 2019. Report to Irving Oil. 61 pp.

Lehoux, C., Plourde S., and Lesage, V. 2020. Significance of dominant zooplankton species to the North Atlantic Right Whale potential foraging habitats in the Gulf of St. Lawrence: a bioenergetic approach. DFO Can. Sci. Advis. Sec. Res. Doc. 2020/033. iv + 44 p.

Morin, D., Moise, M., Higgins, J., Minton, M. 2020. 2017 Atlantic Large Whale Entanglement Report. Greater Atlantic Region Policy Series 20(2).

O'Brien O, McKenna K, Baumgartner M, Redfern J. 2020. Megafauna Aerial Surveys in the Wind Energy Areas of Massachusetts and Rhode Island with Emphasis on Large Whales. Summary Report Part 1: Sightings and Data – Campaign 5, 2018-2019. Report to Massachusetts Clean Energy Center. 63 pp.

Oleson E.M., Baker J., Barlow J., Moore J.E., Wade P. 2020. North Atlantic Right Whale Monitoring and Surveillance: Report and Recommendations of the National Marine Fisheries Service's Expert Working Group. NOAA Tech. Memo. NMFS-F/OPR-64, 47 pp.

Pettis HM. 2019. Monitoring injured North Atlantic right whales: December 2019 report. A report to the Volgenau Foundation. 10 pp.

Pettis HM, Pace RM, and Hamilton PK. 2019. North Atlantic Right Whale Consortium 2019 annual report card. Report to the North Atlantic Right Whale Consortium, November 2019. 19 pp.

Tetra Tech and LGL. 2020. Final Comprehensive Report for New York Bight Whale Monitoring Aerial Surveys, March 2017 – February 2020. Technical report prepared by Tetra Tech, Inc. and LGL Ecological Research Associates, Inc. 211 pp. + appendices. Prepared for New York State Department of Environmental Conservation, Division of Marine Resources, East Setauket, NY. May 18, 2020

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.

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.

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 2019 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 9/1/20.

Low: 339 individuals	
339	Cataloged whales seen in 2019
Middle: 486 individuals	
458	Cataloged whales presumed alive in 2019
23	Intermatch whales likely to be added to Catalog
5	Calves from 2018 and 2019 likely to be added to Catalog
High: 723 individuals	
690	All Cataloged whales in 2019 minus those known dead
26	All active intermatch codes without 2018 & 2019 calves
7	All uncataloged 2018 and 2019 calves minus dead