North Atlantic Right Whale Consortium
2017 Annual Report Card

AMENDED 8/18/2018

Pertinent information obtained following the distribution of the 2017 report card has been highlighted within the report card. Specifically, two additional mortality cases were added and several cases were updated/corrected with identification information.

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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.

2017 ANNUAL NORTH ATLANTIC RIGHT WHALE REPORT CARD

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

Essential Population Monitoring and Priorities

In the 2009 Report Card to the International Whaling Commission (IWC), the Consortium Board identified key monitoring efforts that must be continued and maintained in order to identify trends in the population, as well as assess the factors behind any changes in these trends (Pettis, 2009). The key efforts are: (1) Photographic identification and cataloging of right whales in high-use habitats and migratory corridors, including, but not limited to, the southeast United States, Cape Cod Bay, Great South Channel, Bay of Fundy, Scotian Shelf, and Jeffreys Ledge, (2) Monitoring of scarring and visual health assessment from photographic data, (3) Examination of all mortalities, and (4) Continue using photo-ID and genetic profiling to monitor population structure and how this changes over time.

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

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

An unprecedented fifteen North Atlantic right whale mortalities were documented in 2017, representing nearly 3% of the population. This, coupled with the decline in reproductive output by 40% since 2010 (Kraus et al. 2016), threatens the very survival of this species. To date, anthropogenic factors, including entanglement in fixed fishing gear and vessel strikes, have been implicated in seven of the fifteen recent mortalities. It is clear that current management regulations have not been effective at reducing serious entanglement injuries (Pace et al. 2014) and since 2010, entanglement related deaths accounted for 85% of diagnosed mortalities (Kraus et al. 2016). Additionally, entanglements reduce survival probability over time for right whales and moderate and severe injuries from entanglement are increasing (Robbins et al. 2015; Knowlton et al. 2016). Although several large scale management efforts to mitigate vessel strikes, including shifts in traffic separation schemes in the Bay of Fundy (2003) and Boston (2007), the designation of the Roseway Basin (2007) and Great South Channel Areas to be Avoided (2009), and the ship speed restriction rule implemented in 2008, have previously been shown to be successful (Laist et al. 2014), vessel strikes have been implicated in two mortalities in and around Cape Cod Bay, U.S., and at least four mortalities in the Gulf of St. Lawrence, Canada, since May 2016. These mortalities call into question the effectiveness of existing spatial and temporal seasonal management areas in the U.S. and suggest the immediate need for vessel strike mitigation implementation in Canada.

Timely and effective efforts to reduce both entanglement and vessel strike mortalities must be a priority for both the U.S. and Canada if this species is to survive.

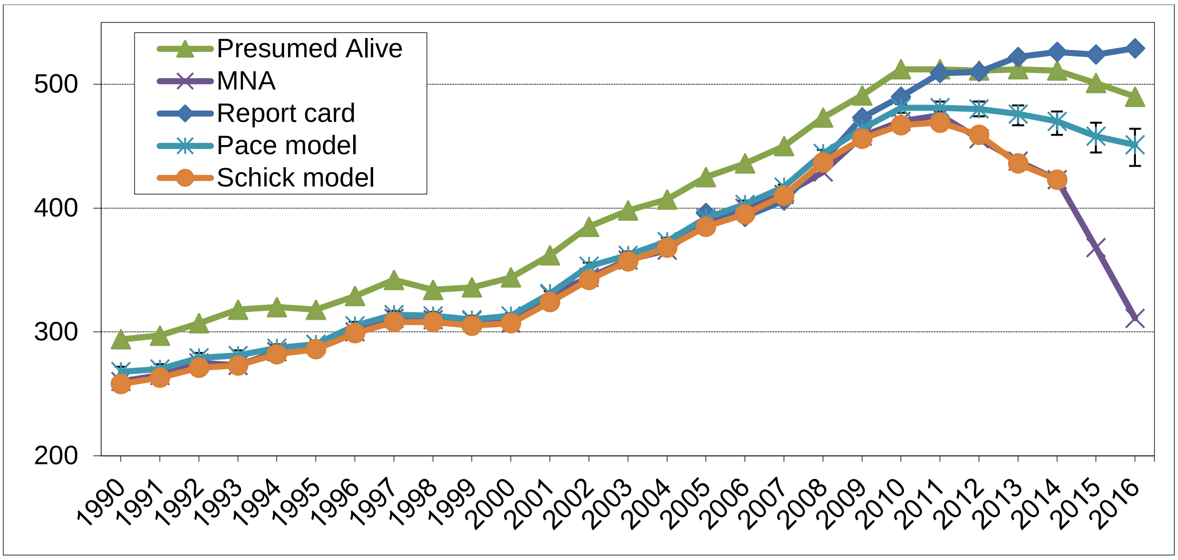
<u>Population Status</u>

Population over Time

Below are assessments of the number of photo-identified right whales within the population over time based on five available methods. The presumed alive (PA) counts whales that have been seen at least once in the last six years. It is a consistently measureable and easily available value, but it assumes that whales remain alive for six years after their last sighting (which is often not the case) and the estimates for recent years may be artificially low due to delays in data processing. The Minimum Number Alive (MNA) is the number used in the NMFS stock assessment reports and counts whales seen in a given year, plus any whale not seen that year-but seen both before *and* after. The MNA number is more accurate than PA for older years, but is also not accurate for recent years for the same reason as the PA method, plus the fact that there have been fewer “after” years to detect a whale. Recently, two additional assessment methods have been developed to better assess abundance and the results of both are included in this report card for the first time. The Pace *et al.* 2017 model “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.” The model allows for animals to be included in the annual abundance estimates that were never seen or cataloged. The full methodology is available in the paper. Schick *et al.* 2013 also developed a model using Bayesian methodology, but unlike the Pace model, it includes health assessment data (see also Schick *et al.* 2016 and Rolland *et al.* 2016). Here we present *preliminary* results from this model through 2014. The model was run through 2015 (the last year for which Health Assessment data were complete) but showed such a precipitous drop in 2015 (over 100 animals) that we suspect it is an artefact of the end of the time series and so that year’s data point was not included. The model has not been used to enumerate the living population before; further testing of it is needed. A brief methodology is provided at the end of the report card. Finally, the report card number has the weakness of utilizing the PA methodology with its assumptions, but does incorporate animals that have been photographed but not yet cataloged. The methodology for the report card numbers is also provided at the end of the report card.

For the graph below, all numbers except the past report card numbers were recalculated using data through 2016, as of September 1, 2017. The PA number is always artificially high as 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. The Pace and Schick models remove assumptions of when a whale is alive and are likely more accurate. The report card numbers are always higher than the other two methods for the most recent years. However, the fact that the old report card numbers for 2005 to 2009 were close to the eventual MNA numbers suggests that the methodology worked reasonably well through 2009. However, starting in 2010, the two numbers started to diverge. This is partially because fewer whales were seen so the MNA number may be artificially low. But it also appears that the six year assumption for PA whales is increasingly erroneous, whales die sooner than six years after their last sighting. The report card does however capture the 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 juveniles anywhere, both of which make cataloging recent calves challenging.

Figure 1. Assessments of the North Atlantic right whale population based on five available assessment methods. The Schick model matches the MNA value closely and thus obscures the MNA line. The Pace model shows a point "estimate" along with error bars which represent 95% of the posteriori probability. The most reliable population number for 2016 is 451 right whales from the Pace model. Data through 2016 as of September 1, 2017.



2016 Assessment of Photographed North Atlantic Right Whales

The ability to monitor North Atlantic right whale vital rates is entirely dependent on the right whale Identification Database, curated by the Anderson Cabot Center for Ocean Life at the New England Aquarium. As of September 1, 2017, the database consists of over 900,000 slides, prints, and digital images collected during the 73,360 sightings of 723 individual right whales photographed since 1935. Each year, 2,000 to 5,000 sightings consisting of 20-30,000 images are added to the identification database. Due to the lag time in processing data, an estimate of the catalogued population is available through 2016.

Table 1 shows an assessment of photographed whales using the Catalog and the presumed alive method. The values are based upon the number of photographed whales only; they exclude potential unphotographed whales and therefore should **not** be considered a "population estimate". The best photo-identification assessment ("Middle") includes 490 cataloged whales that were presumed to be alive in 2016 because they were seen in that year, or any time in the prior five years (Knowlton et al. 1994). The assessment also includes 14 calves from 2015 or 2016 that were considered suitable for eventual inclusion in the catalog and 25 other whales that did not match the catalog, but were re-identified in at least one subsequent year (excluding sightings in field seasons that spanned the calendar year). A detailed explanation of these calculations is included at the end of this report.

Table 1. The report card assessment represents an assessment of the number of photographed whales in the North Atlantic Right Whale Identification Database. A detailed explanation of calculations can be found at the end of this report. Analysis completed 9/1/17.

Low: 304 individuals	
304	Cataloged whales seen in 2016
Middle: 529 individuals	
490	Cataloged whales presumed alive in 2016
25	Intermatch whales likely to be added to Catalog
14	Calves from 2015 and 2016 likely to be added to Catalog
High: 736 individuals	
679	All Cataloged whales in 2016 minus those known dead
31	All active intermatch codes without 2015 & 2016 calves
26	All uncataloged 2015 and 2016 calves minus dead

Analysis 9/1/17

The report card assessment resulted in a best value of 529 photographed North Atlantic right whales, but this year we believe the best estimate of the living population is 451 based on the Pace methodology (data through 2016 as of September 1, 2017).

How Well Are We Monitoring?

Below is an annual count of sightings, unique individuals, whales presumed alive, kilometers of effort that have been submitted to the sightings database at the University of Rhode Island, and percent of the population that is identified each year from 2000 onward (Table 2). The shift in whale distribution has reduced both the number of sightings contributed to the Catalog and the percent of the population seen annually since 2011. Data as of September 1, 2017.

Table 2. Annual counts of sightings, unique individuals, presumed living whales, survey effort, and the percentage of the population seen. Survey effort from dedicated surveys only; opportunistic sightings do not record or report effort. Data as of September 1, 2017.

Year	Sightings	Unique IDs	Presumed Living Population	Survey Effort (1,000 km)	% of population seen
2000	3084	236	342	125	69%
2001	3848	281	360	127	78%
2002	2709	303	383	217	79%
2003	2401	314	396	180	79%
2004	1804	286	405	259	71%
2005	3397	352	420	340	84%
2006	2799	344	431	316	80%
2007	3736	379	445	267	85%
2008	4147	388	467	254	83%
2009	4634	421	483	246	87%
2010	3221	418	501	271	83%
2011	3462	435	501	234	87%
2012	2126	370	502	271	74%
2013	1905	293	504	215	58%
2014	2389	361	501	200	72%
2015	1766	250	490	184	51%
2016	2142	304	490	153	62%

Reproduction

There were five documented calves born in 2017 (Table 3). The average calving interval of 2017 moms was 10.2 years and there were no first-time moms.

Table 3. Summary of calving events and associated interval times for North Atlantic right whales from 2008-2017. The number of available cows, defined as females who have given birth to at least one previous calf and were presumed to be alive, are followed by the percentage of available cows to successfully calve.

Year	Calf Count	Available Cows/ % to calve	Average Interval	Median Interval	First time Moms
2008	23	59/39.0%	3.2	3	7
2009	39	58/67.2%	4.0	4	8
2010	19	45/42.2%	3.3	3	4
2011	22	48/45.8%	3.7	3	3
2012	7	64/10.9%	5.4	4	2
2013	20	83/24.1%	4.6	4	7
2014	11	85/12.9%	4.4	4.5	1
2015	17	80/21.3%	5.5	6	4
2016	14*	81/17.3%	6.6	7	4
2017	5	71/7.04%	10.2	8	0

*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 November 2016 - 31 December 2017, an unprecedented seventeen right whale mortalities were documented (Table 4). Twelve mortalities were detected in Canada and five were detected in the U.S. Causes of death were determined as blunt force trauma for five animals, chronic entanglement for one, and probable entanglement for one. Ten causes of death could not be determined. The Consortium Board recognizes necropsies as significant data collection events that provide valuable information on which management and conservation measures can be (and have been) based. The Board views consistent necropsy response and support (both financial and personnel) as critical to monitor both right whale recovery and the efficacy of management actions.

Live Entanglements, Entrapments, and Vessel Strikes

Entanglement and Entrapments

There were ten active entanglement/entrapment cases reported between 01 November 2016 – 31 December 2017, of which eight were new. Table 5 includes newly reported cases as well as pertinent updates to previously reported cases.

Vessel Strikes:

There were no non-lethal vessel strike injuries documented between 01 November 2016 – 31 December 2017.

Table 4. Documented right whale mortalities 01 November 2016 - 31 December 2017.

Whale #	Date	Location	Sex	Age	Field #	Necropsied?	Cause	Comments
4694	04/13/2017	4nm north Barnstable Harbor, Cape Cod Bay	F	1	IFAW17-182Eg	Yes	Blunt force trauma (confirmed)	25', fresh carcass
3746	06/06/2017	Gulf of St. Lawrence	M	10	MARS2017-136	No	Undetermined	Carcass not recovered
3190	06/18/2017	Gulf of St. Lawrence	M	>17	MARS2017-144	Yes	Undetermined	Cause of death undetermined, some observations suggest blunt force trauma
1402	06/19/2017	Gulf of St. Lawrence	M	33	MARS2017-141	Yes	Blunt force trauma (suspected)	Acute internal hemorrhage
3603	6/21/2017	Gulf of St. Lawrence	F	11	MARS2017-143	Yes	Chronic entanglement (confirmed)	Whale was entangled in snow crab gear between 12 June and 16 June 2017. Whale travelled ~8.8nm miles where it was entangled in a second gear set between 16 June and 21 June 20-17. Mortality occurred between 17 June and 21 June 2017.
3512	6/22/2017	Gulf of St. Lawrence	F	12	MARS2017-155	At sea sampling on 6/22/2017 and again on 7/29/2017	Undetermined	Carcass resighted on 7/24/2017 at Cedar Cove, Newfoundland. Carcass sampled on 7/29/2017.
1207	6/23/2017	Gulf of St. Lawrence	M	>37	MARS2017-142	Yes	Blunt force trauma (probable)	Acute internal hemorrhage
Unk	7/6/2017	Gulf of St. Lawrence	M	Unk	MARS2017-145	Yes	Blunt force trauma (probable)	Skull (maxilla, premaxilla) fracture
2140	7/19/2017	Gulf of St. Lawrence	M	>26	MARS2017-146	Yes	Blunt force trauma (suspected)	Acute internal haemorrhage
2630	7/21/2017	Church Point, Newfoundland	M	>21	M20170095	Limited shore sampling	Undetermined	This whale was genetically identified to Eg #2630
Unk	7/27/2017	Cape Ray, Newfoundland	M	Unk	M20170094	Limited shore sampling	Undetermined	

Table 4 (*cont'd*). Documented right whale mortalities 01 November 2016 - 31 December 2017.

Whale #	Date	Location	Sex	Age	Field #	Necropsied?	Cause	Comments
1911	7/30/2017	River of Ponds, Newfoundland	F	28	F20170093	Limited shore sampling	Undetermined	This whale was initially identified genetically as Eg #4111. However, during final scoring confirmation it was identified to Eg #1911, the mother of Eg #4111.
Unk	8/6/2017	Martha's Vineyard	M	Unk		Yes	Undetermined	
2123	8/9/2017	George's Bank	F	26		No	Undetermined	Carcass not recovered
2015 Calf of 1604	9/15/2017	Gulf of St. Lawrence	F	2	MARS2017-312	Yes	Necropsy results pending	Carcass was entangled
Unk	10/23/2017	Nashawena Island, MA USA	Unk	Unk	IFAW17-375Eg	Yes	Undetermined, necropsy pending	Advanced decomposition, skin and flukes missing. Length extrapolated to 9m. Samples obtained for histology and genetics.
2611	11/7/2017	Madaket Harbor/ Eel Point, Nantucket, MA USA	F	21	IFAW17-401Eg	Yes	Undetermined, necropsy pending	Advanced decomposition. Length of 13-14m extrapolated from length, fluke width, and snout to blowhole and measured total length of blubber coat. Samples obtained for genetics.

Table 5. Right whale entanglements and status updates 01 November 2016 – 31 December 2017. Newly reported entanglements (carrying gear) are bolded.

Whale#	Date of First Entanglement Sighting	First location	Sex	Age (current)	Comments
3821	01/07/2012	Cape Cod Bay	Unk	9	Previously entangled in 2009. Resighted Jan-Feb 2012 (CCB), May 2012 (GSC), April 2013 (CCB) and Apr 2014 (CCB). There was no evidence of significant change in entanglement configuration at last sighting. Resighted Feb 2017 (SNE). Unclear whether gear remains. Sighting on 05/17/2017 indicates that whale is likely gear free.
3823	09/22/2016	Stellwagen Bank	F	9	Whale carried line (including rostrum wrap), buoys and weighted gear. Partial disentanglement that likely cut the rostrum wrap. Telemetry buoy attached, found drifting not attached to whale on 9/26/2016. Confirmed gear free on 3/6/2017.
3405	**12/04/2016**	**New York**	**F**	**13**	**Whale has line and monofilament webbing around rostrum and across right blowhole over the back. Other segments of line may be held in place by webbing. The amount of trailing line is unknown. Not yet resighted.**
3530	**01/05/2017**	**17nm east of Little Cumberland Island, GA**	**M**	**13**	**Line at the head trailing at least one whale's length aft of the animal. Two lines emerged from the right side of the mouth and two twisted lines exited the left side, effectively forming a bridle at the area of the blowholes). The team also felt as though there was likely heavy gear attached to one or more of the trailing lines. Disentanglement effort successfully removed 450 feet of heavy line and a large crab pot. Aerial documentation confirmed the whale to be gear-free.**
4146	**04/23/2017**	**Cape Cod Bay**	**F**	**6**	**Length of yellowish line caught in the left side of the mouth. The line is doubled on itself and trails aft of the flukes by about a body length. There appears to be a jumble of line and/or netting near the end of the trailing gear. Disentanglement response unable to work whale. Not yet resighted.**
BK01BOF15	**7/5/2017**	**East of Miscou Island, New Brunswick**	**Unk**	**>2**	**Snow crab gear on whale appeared to consist of a buoy and line exiting the left side of the mouth (~3 body lengths long) that was fouled on line exiting the right side of the mouth that went down to weighted gear. The animal was surging out of the water, thrashing with its tail, rolling and bringing its head out of the water. There was extensive rope burn all over the animal (suggesting a constantly changing configuration) with some bleeding at the peduncle region. These factors suggest that the whale had recently become entangled. Disentanglement effort on 7/5/2017 successful and whale confirmed gear free on 7/29/2017.**
1317	**7/8/2017**	**East of Miscou Island, New Brunswick**	**M**	**34**	**Aerial survey team observed whale caught in snow crab buoy line, with rope through the mouth and over the rostrum. Response team not able to relocate whale, however line was found floating at the surface with a bitter end. Some of the line was hauled and discovered it was still attached to a trap/trawl. Whale was resighted on 7/25/2017, 8/18/2017, and 8/25/2017 and no gear was visible.**

Table 5 (*cont'd*). Right whale entanglements and status updates 01 November 2016 – 31 December 2017. Newly reported entanglements (carrying gear) are bolded.

Whale#	**Date of First Entanglement Sighting**	**First location**	**Sex**	**Age (current)**	**Comments**
4123	**7/9/2017**	**East of Miscou Island, New Brunswick**	**M**	**6**	**Whale caught in a snow crab gear buoy line at minimum, with multiple body wraps and weighted gear heading to the seafloor. The origin of those wraps appeared to be the mouthline and/or the flipper(s). Disentangled on 7/10/2017. Whale resighted on 7/29/2017 in the Bay of Fundy gear free.**
4094	**7/19/2017**	**East of Miscou Island, New Brunswick**	**F**	**7**	**Entanglement in snow crab gear consists of a buoy line lodged in the right mouthline and trailing aft to a set of buoys with some line sinking, suggesting some weighted gear. It is possible that the buoy line could exit the left side of the mouth, near the gape, and travel under the throat, it seems perhaps more likely that the buoy line is twisted back on itself and lodged within a few plates of baleen on the right side of the mouth. No disentanglement response permitted. Not yet resighted.**
3245	**8/28/2017**	**~20miles east of Perce, Gaspe Peninsula**	**M**	**15**	**Whale entangled in what appears to be heavy line. Type unknown. The whale was essentially hogtied, with line through its mouth, leading to wraps of the peduncle. The whereabouts of any bitter ends are unknown but based on behavior and line impressed into the right flank, it appears the line leads to heavy weight. No disentanglement response permitted. Not yet resighted.**

Monitoring Health of Injured Right Whales

Efforts to better track and monitor the health of anthropogenic injury of North Atlantic right whales were initiated in January 2013. These efforts aim to support annually mandated human induced serious injury and mortality determinations, to reduce the likelihood of undetected and unreported events, and to better assess both short and long term impacts of injury on right whale health. Previously and newly injured right whales with vessel strikes, attached fixed gear, or with moderate to severe entanglement injuries in the absence of attached gear (see Knowlton et al. 2016 for review of injury types) are flagged for monitoring biannually. Each whale's pre- and post-injury health conditions are evaluated using the visual health assessment technique (Pettis et al. 2004) and a determination of the impact of injury on health is made. Based on the available sighting and health information, whales are assigned to one of four categories: 1) Evidence of declining health coinciding with injury; 2) Inconclusive (this determination was assigned to animals when a: evidence of declining health exists but it was unclear whether or not it was linked to injury and/or b: images/information were inadequate to fully assess health condition visually); 3) No indication of declining health caused by injury based on available images/information; 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 June 2016 and 31 May 2017, twelve new severe injury events were documented for right whales, all of which were entanglement related. Of these twelve, seven exhibited declining condition coinciding with injury. The impact of injury on the health of the remaining five whales was inconclusive. Nine whales previously on the monitoring list were removed: seven became presumed dead and two were removed due to sustained improvement in health condition following injury. As of June 2017, the Serious Injury/Human Impact list includes 61 whales with 68 injuries documented from March 2004 through 31 May 2017 (Table 6). The majority of the injuries are entanglement related (51/61, 83.6%) followed by vessel strikes (9/61, 14.8%). There is one whale on the list with an injury of unknown origin (Table 7).

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 biannual report and is followed parenthetically by how many of those were newly detected injuries. There are currently seven 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)**	

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

Table 7. 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 June 2017.

	Entanglement		**Vessel Strike**	**Other**	**Total**
	Gear Present	No Gear Present			
Decline in Condition	8	11	2	1	22
Inconclusive	10	15	5	0	30
No Decline in Condition	1	4	1	0	6
Extended Monitor	1	1	1	0	3
Total	20	31	9	1	61*

*This represents the number of whales on the monitoring list. Seven 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.

<u>Aerial and Vessel-based Sighting Summary: 2016</u>

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 2016 (analyzed 01 September 2017) is summarized below and includes survey, research, and opportunistic sightings. Months with sightings and major contributing organizations (>10% total sightings for region) are listed after total number of sightings. Summaries of survey types (if available) are listed below each region.

Major Contributing Organizations

CCS: Center for Coastal Studies
CWI: Canadian Whale Institute
DFO: Fisheries and Oceans Canada
DN: Doug Nowacek
FWRI: Florida Fish and Wildlife Research Institute
GDNR: Georgia Department of Natural Resources
MICS: Mingan Island Cetacean Studies
NEAq: New England Aquarium
NEFSC: Northeast Fisheries Science Center
PCAN: Parks Canada
QLM: Quoddy Links Marine
ROSE: Rob Seeburger
S2S: Sea to Shore Alliance
UNCW: University of North Carolina, Wilmington
VAQF: Virginia Aquarium and Marine Science Center Foundation
WHOI: Woods Hole Oceanographic Institution

Southeast United States (sightings: 344, January – March, November; FWRI, GDNR, S2S, DN)

- Aerial and vessel surveys, biopsy darting, tagging

Mid-Atlantic (includes south of Cape Cod) (sightings: 12, January - February; NEFSC, ROSE, VAQF/UNCW)

- Aerial surveys

Great South Channel (sightings: 171, April – June, November; NEFSC, CCS)

- Aerial and vessel surveys

New England (Massachusetts Bay/Cape Cod Bay) (sightings: 854, January – May, September, December; CCS, WHOI)

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

Gulf of Maine (sightings: 111, April – June, August – September, November; CCS, NEFSC)

- Aerial and vessel surveys

Bay of Fundy (sightings: 509, July - October; NEAq, QLM)

- Vessel surveys

Roseway Basin (sightings: 2, June, August; NEFSC, DFO)

- Vessel and aerial surveys

North (sightings: 136, July - October; CWI, MICS)

- Vessel surveys

East (sightings: 3, September; PCAN)

- Opportunistic

Right Whale Project Requests for NARWC Data Use in 2017

- Assessment of right whale seasonal distribution along the western shore of Mass Bay in order to assess the feasibility of using weak ropes during certain parts of the winter and spring
- Marine mammal mapping for assessment of offshore drilling site
- Biophysical and Ecological Overview of the Cape Breton Trough Area of Interest
- Development and application of novel statistical models to cope with different survival and movement probabilities when NARW subpopulations subscribe to different migratory strategies
- Analytic support for development and implementation of the Atlantic Large Whale Take Reduction Plan
- Examine the impacts of offshore drilling and seismic testing within and around the critical habitat and migratory corridor of the North Atlantic right whale population
- Combining genetic and photo-identification data to improve abundance estimates for the North Atlantic right whale

Management and Mitigation Activities

Canada

- In November 2016, the Government of Canada announced the Oceans Protection Plan (OPP), which includes a commitment to address the threats to three marine mammal populations: Southern Resident Killer Whale (SRKW), St. Lawrence Estuary Beluga, and North Atlantic Right Whale (NARW).

- In response to the deaths of 12 right whales in the Gulf of St. Lawrence (GSL) between early June and mid-September, DFO and partners conducted seven full necropsies and sampled another five carcasses. Information from these necropsies and sampling contributed to an understanding of the causes of death of six of the right whales.

- Additional activities undertaken in response to the GSL mortality event:

    - Issued notice to the commercial fishing industry in the GSL asking fishermen to watch for whales and to report any sightings.
    - Broadcast notices on the marine radio system to request shipping and fishing industries be on alert for whales.
    - In addition to the toll-free number and the Whale Alert website, individuals can use the established VHF channel 16 to report on observations of dead or injured whales and the Coast Guard will relay the information to the appropriate authorities.
    - Worked with partners to patrol the coast to monitor and assess any reports of dead or distressed whale sightings.
    - Surveillance flights to confirm positions of live right whales in the GSL.
    - The Government of Canada implemented a temporary mandatory slow-down of vessels 20 meters or more to a maximum of 10 knots when travelling in the western Gulf of St. Lawrence from the Quebec north shore to just north of Prince Edward Island. This represents a reduction of speed of approximately one third, assuming average vessel speeds of 15 knots.

- Closed Snow Crab Fishing Area 12 in the southern Gulf of St. Lawrence early (all fishing gear was removed from the water).
- Other fixed gear fisheries restricted to shallow water (less than 20 fathoms), resulting in some fisheries not opening or having delayed openings.
- New requirement for the halibut long-line fishery in the Gulf of St. Lawrence to tend gear.
- Provided $56,000 towards the Whales Habitat and Listening Experiment (WHaLE) to support the development of a real-time whale alert system for mariners, which can inform measures to help reduce whale and ship collisions in Canadian waters.

United States

- NMFS received five requests for authorization to take marine mammals incidental to conducting geophysical survey activity in the Atlantic Ocean. Pursuant to the Marine Mammal Protection Act (MMPA), NMFS requested comments on its proposal to issue incidental harassment authorizations (IHA) to incidentally take marine mammals during the specified activities. Comments and information were due no later than July 6, 2017.

- On 25 August 2017, NOAA Fisheries declared an Unusual Mortality Event (UME) for North Atlantic right whales throughout their range, based on elevated strandings along the Atlantic coast, predominantly in the Gulf of St. Lawrence region in Canada.

- NOAA called for 12 Dynamic Management Area (DMA) voluntary speed reduction zones between 01 November 2016 and 01 October 2017:

2/21/2017	16nm S of Martha's Vineyard	5/19/2017	80nm E of New York
3/6/2017	16nm S of Martha's Vineyard	6/15/2017	13nm S of Nantucket
3/21/2017	22nm SW of Nantucket	7/3/2017	2nm S of Nantucket
3/25/2017	12nm ENE of Boston	7/16/2017	2nm S of Nantucket
4/9/2017	19nm SSE of Nantucket	7/29/2017	S of Nantucket to Nantucket Sound, W to Vineyard Sound
4/19/2017	15nm SSW of Nantucket		
5/4/2017	15nm SSW of Block Island		

2017 North Atlantic Right Whale Publications/Reports

Reports and publications that utilized NARWC databases in 2017 and/or those of general interest to the right whale community are listed and hyperlinked below.

Brillant, S. W., Wimmer, T., Rangeley, R. W., Taggart, C. T. (2017). A timely opportunity to protect North Atlantic right whales in Canada. *Mar Policy*, *81*, 160-166.

Browning, C. L., Wise, C. F., Wise, J. P. (2017). Prolonged particulate chromate exposure does not inhibit homologous recombination repair in North Atlantic right whale (*Eubalaena glacialis*) lung cells. *Toxicol Appl Pharm*.

Burgess, E. A., Hunt, K. E., Kraus, S. D., Rolland, R. M. (2017). Adrenal responses of large whales: integrating fecal aldosterone as a complementary biomarker to glucocorticoids. *Gen Comp Endocr 252*, 103-110.

Convertino, M., Valverde, L. (2017). Probabilistic Analysis of the Impact of Vessel Speed Restrictions on Navigational Safety: Accounting for the Right Whale Rule. *J Nav* 1-18. doi:10.1017/S0373463317000480

Corkeron, P., Rolland, R. M., Hunt, K. E., Kraus, S. D. (2017). A right whale pootree: classification trees of faecal hormones identify reproductive states in North Atlantic right whales (*Eubalaena glacialis). Conserv Phys 5*(1).

Cronin, T. W., Fasick, J. I., Schweikert, L. E., Johnsen, S., Kezmoh, L. J., Baumgartner, M. F. (2017).

Coping with copepods: do right whales (*Eubalaena glacialis*) forage visually in dark waters? *Phil Trans R So. B*, *372*(1717), 20160067.

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Fasick, J. I., Baumgartner, M. F., Cronin, T. W., Nickle, B., Kezmoh, L. J. (2017), Visual predation during springtime foraging of the North Atlantic right whale (*Eubalaena glacialis*). *Mar Mam Sci* doi:10.1111/mms.12417

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. *Eco Evol* 1-12.

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van der Hoop, J.M., Corkeron, P.J., Henry, A.G., Knowlton, A.R., Moore, M.J. (2017). Predicting lethal entanglements as a consequence of drag from fishing gear. Marine Pollution Bulletin 115: 91–104.

van der Hoop, J.M., Nowacek, D.P., Moore, M.J., Triantafyllou, M.S. (2017). Swimming kinematics and efficiency of entangled North Atlantic right whales. *Endang Spec Res* 32:1-17.

Reports

Daoust, P.-Y., Couture, E.L., Wimmer, T., Bourque, L. (2017). Incident Report: North Atlantic Right Whale Mortality Event in the Gulf of St. Lawrence, 2017. Collaborative Report Produced by: Canadian Wildlife Health Cooperative, Marine Animal Response Society, and Fisheries and Oceans Canada. 224 pp.

Books

Laist, D. W. (2017). *North Atlantic Right Whales: From Hunted Leviathan to Conservation Icon*. JHU Press.

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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., 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

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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.*

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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.

Rolland R.M., Schick R.S., Pettis H.M., Knowlton A.R., Hamilton P.K., Clark J.S., Kraus S.D. (2016) Health of North Atlantic right whales (*Eubalaena glacialis)* over three decades: from individual health to demographic and population health trends. *Mar Ecol Prog Ser* 542:265-282

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Schick, R.S., Kraus, S.D., Rolland, R.M., Knowlton, A.R., Hamilton, P.K., Pettis, H.M., Thomas L., Harwood J., Clark J.S. (2016). Effects of model formulation on estimates of health in individual right whales (*Eubalaena glacialis*). Pages 977-985 *in* A. N. Popper and A. Hawkins, editors. Effects of Noise on Aquatic Life II. Springer Press.

Methods for assessing the number of photo-identified right whales within the population over time

Schick Model Population Estimate

In Schick et al. 2013, we built a hierarchical Bayesian model that estimates latent, or true, health of individual right whales using observed data of their visual health status. Specifically, health is estimated as a function of the animal's observed body condition, observed skin condition, observed rake mark status, observed cyamid load, and the animal's age (in years). In addition to estimating health and movement status, in the model we estimate individual survival from one month to the next using a Bernoulli model:

$$\Pr\left(S_{ik,t} = 1\right) = Bernoulli\left(\theta_{ik,t}\right)$$

$$logit\left(\theta_{ik,t}\right) = x_{ik,t}\beta$$

where the design vector ($X\beta$) contains latent health status and a fixed effect for sighting region. Note that in our model iterations to date, we have not been able to differentiate the parameters for zone—so these are all fixed. Essentially, survival is a function of health, which in turn is a function of age and observed health.

The output from this is a monthly survival probability for each animal. In these estimates, we have three fates: 1) observed dead; 2) estimated month of death; and 3) assumed alive. Because the second fate is stochastic, there is a distribution around the most likely month of death. Here we simply depict the most likely month of death for each animal, i.e. the median posterior probability. By extracting these probabilities, we assemble a vector of the month denoting each of the three states: observed dead, estimated died, and assumed alive. Using that vector, we can tally the population size in each month or year combination.

We ran the model using new data. Specifically, we ran the model using data as of September 1, 2017 including photo-identification data complete through 2016 and Visual Health data complete through December 2015. We also included new effort data – extracting from the right whale database, maintained at the University of Rhode Island, all the effort up through December 2016.

Since the year of death is an estimated parameter in a Bayesian framework, we can initialize this for each animal in a variety of ways. For example, we could start the model run with the assumption that all animals are alive up through the end of the data (save of course for the known-dead animals whose time of death is not estimated but rather known). Alternatively, we could assume that the animals are dead after they have not been seen for 6 years. Finally, the approach we have taken here is to initialize the month of death vector using the longest observed sighting gap for that animal. For example, if an animal's longest sighting gap was 4 months, then the starting value for the estimated month of death would be 4 months after their last sighting. If in contrast, and animal's longest sighting gap was 18 months, then the starting value would be 18 months following their last sighting. We feel this approach accounts for the sighting heterogeneity present in the sightings database; however, we stress that this is simply a way to initialize the imputed time of death. Through the runs of the Gibbs sampler, the chain should converge on the posterior probability, regardless of initial value. We are currently investigating the impacts of these alternate model formulations on the final tally of imputed deaths each year. In addition, here we have only presented the median posterior probability for estimated time of death. A fuller analysis will include integrating across the posterior to show the median and 95% Bayesian Credible Interval for animals alive.

Report Card Population Assessment Calculation

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

LOWER

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

MIDDLE

The middle bound is determined by summing three categories:

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

UPPER

The upper bound is also the sum of three categories:

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