Final report on 2009 right whale entanglement scar coding efforts

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Overview

This report summarizes right whale entanglement scarring analyses for 2009 using sightings from the North Atlantic Right Whale Consortium (NARWC). We also will soon be resubmitting a paper on this work (all years 1980-2009) to Marine Ecology Progress Series. We had submitted the paper on the data through 2006 last spring and received feedback that they would like to publish the work but revisions were needed. After incorporating the revisions and updating some of the analyses, we decided it would be more prudent and valuable for management efforts to incorporate data through 2009 into the paper. This final report compares the 2009 scarring data to the entanglement trends summarized in the draft paper. The details of the methodology used for scar coding and analyses are detailed in the paper and thus are only summarized briefly below.

Similar to last year's report on the 2007 and 2008 data, we have included a segment in this report that summarizes wound severity levels for the 2009 events. We have also provided a brief case study for all animals considered to have high severity wounds. Although we intend to evaluate the severity of all entanglement events to look for trends over time, this is being carried out under separate funding and is not presented here. Because wound severity may serve as a proxy for the level of struggle an animal endures during the entanglement interaction and/or the impacts of a long duration entanglement, we believe this is important information to provide to managers.

Explanation of analyses described in report

Scar coding was carried out for all animals sighted in 2009 and any new pre-2009 sightings added to the catalog since the 2011 report. Scar coding was also carried out for any new whales added to the catalog with sightings up to and including 2009. In addition to calculations of annual population entanglement rates and detection of new entanglement interactions, explanations about several analyses that are described in the paper and presented in this report for the 2009 data are provided below:

Annual entanglement detections

This analysis presents the number of new entanglement detections by year as a proportion of the number of animals identified in each year independent of how well the animal was photographed. The year a scar was detected may not represent the year the entanglement occurred (i.e. if the whale had not been seen for many years) so this analysis is only useful for documenting that entanglements have occurred, but does not provide precise annual entanglement rates.

Annual rate of entanglement

To obtain an assessment of the annual rate of entanglement, subsets of animals seen and adequately photographed in both years of sequential two-year combinations (i.e., 1980/1981, 1981/1982…) from 1980 through 2009 were analyzed. For an animal to be considered adequately photographed, clear images showing the entire area of the dorsal peduncle or one of the fluke insertion areas were required in both years to allow

for inter-year comparisons. For calves and one year olds, the peduncle area had to be well photographed in only the second year to be included.

Age at Entanglement Detection

To determine whether or not there are differential entanglement rates between age classes, the percentage of annual entanglement events by age group was examined

Time Frames of Entanglements

To estimate the timeframe of entanglement interaction (i.e. the period within which the whale must have encountered the fishing gear) the last sighting without the scarring and the first sighting with the scarring were identified. Entanglement time frames were classified as follows: 1) within six months, 2) within one year, 3) within two years, 4) within three or more years and 5) unknown time frame.

Animals carrying gear and with severe entanglement wounds

Entanglement events at which whales were seen carrying fishing gear and/or with deep wounds from entanglement were categorized as a serious entanglement according to NEAq criteria. The criteria used here to define serious injury from entanglement included: 1) any animal seen bearing gear, or; 2) any animal with a cut deeper than 8 cm caused by an entanglement (Knowlton and Kraus 2001).

Scar coding results

In our 2011 report, scarring results were provided through 2008 (updated from 2006). A comparison of entanglement events from 1980-2009 and those previously reported are summarized below and in Table 1.

Summary of NARWC scarring data 1980-2009 with changes since last analysis in 2011(1980-2008)

Data points for all animals seen from 1980 through 2009

- Total # of animals reviewed in all years: **626** (increase of 25 animals)
    - # of batches (sightings of an individual within season/year) analyzed – all years: **12,894**
    - 2009 batches: **1,145**
    - Batches prior to 2009 added: **122**
- # of separate entanglement interactions all years 1980-2009: **1,032** (increase of 72 events)
    - 2009 interactions: **49**
    - Events prior to 2009 added: **23**
- % of population entangled at least once: 519/626 **82.9%** (increase of 0.9%)**
- # of animals without entanglement scarring: **107** (decrease of 1 animal)
    - # of these above animals where tail region was not seen: **47** (decrease of 2 animals)
- # of females in the population prior to 2010: **239** (increase of 8)
- % of females entangled at least once: 198/239 **82.8 %** (decrease of 2.9%)
- # of males in the population prior to 2010: **272** (increase of 10)
- % of males entangled at least once: 247/272 **90.8%** (increase of 1.5%)
- # of unknown sex in the population prior to 2010**: 115** (increase of 7)
- % of unknown sex entangled at least once: 74/115 **64.3%** (increase of 7.8%)

** The calculation for % of the population entangled at least once for this report includes only animals sighted from 1980-2009. In prior years, we had included all animals sighted prior to 1980, but these pre-1980 data were not useful for comparative purposes due to lack of survey effort, so we have excluded these data points for this report. If we had used the old method in this report, the resulting percentage would be 81.9% vs. 82.9% presented here. Only seven entanglement interactions had been documented prior to 1980.

Table 1. Changes in the number of new entanglement events added by year since the 2011 report

Year	2012 report	2011 report	Change from 2011 to 2012
1980	9	9	0
1981	20	20	0
1982	18	16	2
1983	11	11	0
1984	14	14	0
1985	15	16	-1
1986	19	19	0
1987	13	13	0
1988	24	24	0
1989	18	18	0
1990	29	29	0
1991	15	15	0
1992	19	19	0
1993	20	20	0
1994	38	38	0
1995	22	22	0
1996	42	41	1
1997	83	83	0
1998	23	23	0
1999	57	57	0
2000	34	35	-1
2001	41	41	0
2002	45	44	1
2003	30	28	2
2004	43	43	0
2005	62	62	0
2006	54	52	2
2007	94	90	4
2008	71	58	13
2009	49		49
Total	1,032	960	72

Of the 72 new entanglement event recorded in this updated analysis, forty-nine entanglement events were added in 2009. The remaining 23 events were added in previous years. Reasons for the addition of new events in previous years include: 1) the

addition of new animals to the catalog with sighting histories that began prior to 2009; 2) recent identifications of older sighting, and; 3) better quality recent images of animals that provided evidence that a certain scar visible prior to 2009 was from entanglement – these events were back coded to the appropriate year. Two events were shifted back in time because of better photographic evidence from previous years resulted in subtracting that animal from the year for which the entanglement was initially coded.

Annual entanglement detections

The annual detection of new entanglement scars between 1980 and 2009 ranged from 8.6% (in 1987) to 33.6% (in 1999) with an average of 15.5%, SD +/- 5.5%. For 2009, 11.9% of all right whales sighted had newly detected entanglement scars including one animal that had two detections in 2009 (Table 2). This percentage is below the annual average but within the standard deviation.

Table 2. Number of newly detected entanglements in 2009 for all animals sighted.

Year	# of individuals sighted	# of newly detected entanglements	Percentage
2009	413	49	11.9%

Annual rate of entanglement

For each two year period from 1980/1981 through 2008/2009, the percentage of adequately photographed individuals with evidence of a new entanglement interaction by year two of the given time period ranged from 13.4% to 46.7% with an annual average of 24.8%, SD =+/- 9.4%.

The percentage of adequately photographed individuals with evidence of a new entanglement interaction in 2009 was 18.7%, below the average of 24.7% but within the standard deviation (Table 3).

Table 3. Number and rate of adequately photographed animals entangled by year 2 for the 2008-2009 time period.

Year	Adequately photographed	Entangled by year 2	Entanglement rate
2008/2009	225	42	18.7%

Timeframes of entanglement

The timeframe of entanglement detection (i.e. the maximum timeframe within which the interaction must have occurred based on time between sightings without and then with entanglement scars) has improved over the decades with nearly half of all events detected within a one year timeframe since 1990, and 66% of the events detected within a two year timeframe.

For 2009, 80% of the entanglement detections were determined within a one-year timeframe. This high percentage is valuable for annual monitoring of entanglement rates and the impacts of management changes to fishing activity.

Table 4. Number and percentage of detections within given timeframes.

Detection timeframe	# of detections in 2009 (n = 49)	Percent of total detections
< 6 months	24	49%
< 1 year	15	31%
< 2years	2	4%
< 3 years	2	4%
>3 years	1	2%
Unknown timeframe	5	10%

Age at entanglement detection

Data from historical analyses have shown that calves and juveniles get entangled at a higher rate than adults. In 2009, this pattern continued with 69% of all the entanglement detections involving calves and juveniles, yet, calves and juveniles only represented 34.8% of all 413 animals sighted in 2009.

Table 5. 2009 entanglement events by age group.

# (%) of events	Calf	Juvenile (1-8 years old)	Adult (>8 years old)	Unknown age
2009 (n = 49)	10 (20.4%)	24 (49.0%)	11 (22.4%)	4 (8.2%)

Animals carrying gear and with severe entanglement wounds

The number of animals carrying gear (independent of outcome) plus the number of animals with severe entanglement wounds were combined and divided by the total number of animals seen in a given year to determine the percentage of 'serious entanglements' for all years resulting in an annual average of 1.2%, SD +/- 0.8%.

In 2009 a total of seven animals were sighted carrying gear. This compares with two carrying gear in 2007 and seven in 2008. According to an assessment of these seven animals by the Provincetown Center for Coastal Studies (PCCS), six had entanglements considered to be life threatening and one had a non-life-threatening, simple-entanglement configuration. Of the six with life threatening entanglements, five were successfully disentangled (#1151, #3311, #3420, #3714, and #3821) and one remained entangled at its last sighting (#1019). The whale with the non life-threatening entanglement (#3850) shed its gear. Of these seven animals carrying gear, two (#1019 and #3311) acquired severe wounds and are described in Appendix 1.

In addition to the seven animals carrying gear, one animal (#3930) had severe wounds in 2009 from an entanglement but no gear remained attached. This animal is also described in Appendix 1 and the severity levels are described further below and in Appendix 2.

For 2009, this rate is 1.9% which is higher than the 1.2% annual average but within the standard deviation (0.8%)

Entanglement severity

Entanglement severity was divided into three categories (minor, moderate, severe) based on the degree of wound severity found on the body (low, medium, high). Each animal's wound severity levels were reviewed by body region and the overall entanglement severity (minor, moderate, severe categories) was coded as the highest wound severity detected. The effort to categorize all entanglement events according to severity is being carried out under a different grant in collaboration with Jooke Robbins

from PCCS, who is conducting similar analyses for humpback whales. The criteria developed for this other study are provided in Appendix 2.

In 2009, three of the 49 animals (6%) with new entanglement wounds were observed with severe wounds. One of the animals had been entangled for months, one was seen with gear attached and severe tail wounds and not subsequently sighted, and one had severe tail wounds and no gear attached. A more detailed review of those three animals along with images is provided as Appendix 1. In addition, 13 (27%) of the 2009 entanglement detections were considered moderate and 33 (67%) were considered minor. We cannot yet describe how these figures compare with the historical findings regarding annual entanglement severity as this work is still underway.

Discussion

The 2009 scarring data indicate a continued high level of interaction between fishing gear and right whales with 11.9% of all animals sighted exhibiting new entanglement scars in this year. This rate is below the annual average of 15.5% but within the standard deviation of 5.5%. The percentage of adequately photographed animals with new entanglement scars is 18.7%, which is also below the average of 24.8% but within the standard deviation of 9.4%. These 2009 figures represent a reduction from the rates provided in last year's report on 2007 and 2008 data. The percentage of all sighted whales observed with new entanglement scars was 22% in 2007 and 14% in 2008 (compared to ~12% in 2009). The percentage of adequately photographed whales with new entanglement scars was 41% for 2006/2007 and 24% for 2007/2008 (compared to 19% in 2009). The reduction in these rates is encouraging although more years of

evaluation are necessary to determine whether this reduction in rates is significant, or is a reflection of random variation in the data.

The percentage of animals whose entanglements were detected within a one year timeframe was high (80%, 39 of 49). This high rate of short-timeframe detection is valuable for monitoring the frequency of interaction with gear in relation to changes that have been put in place to reduce entanglements. For example, the sinking groundline rule was implemented in April 2009. Whether this important change to U.S. fishing gear has resulted in an overall reduction in observed entanglement interaction can be evaluated using all of these above metrics.

As documented in prior reports, calves and juveniles remain more vulnerable to entanglements than adults with 69% of the 2009 events involving this age group even though they only represented 35% of the animals sighted in 2009.

The number of animals seen carrying gear or with severe wounds from entanglements remains a concern for the population. The seven animals seen with gear attached, plus one animal with severe wounds and no gear, represent 1.9% of the sighted animals in 2009. This rate is higher than the average of 1.2% for 1980-2009 although within the standard deviation of 0.8%. Considering that five of the seven animals carrying gear were disentangled and likely saved from a long-term entanglement that might have led to their death, the continued high number of animals in this category through 2009, as well as the preliminary count of severe entanglement events from 2010 (at least 4) and 2011 (at least 11), suggests that the entanglement problem has not yet been resolved.

The monitoring approach provided by the analyses summarized here, and detailed in the paper soon to be resubmitted to the Marine Ecology Progress Series, represents the only method currently available for assessing the frequency, severity, and potential consequences of recent entanglement interactions. To maintain the degree of precision that these metrics can provide, it will be essential to continue survey efforts and to ideally expand vessel-based monitoring where feasible, as entanglement scars are more easily detected from vessel-based images. Also, with the recent NMFS implementation of new methods for serious injury and mortality determinations, this scar coding effort is invaluable for assessing the impacts of entanglements to this population and providing NMFS the data necessary for their stock assessment reports. Monitoring entanglement levels going forward is essential as the difficult work of managing and mitigating these interactions continues.

Appendix 1 – Severely injured animals: 2009

Catalog #	Sex	Birth year	Date of entanglement detection (date seen prior wound/gear free)	Age at entanglement detection	Location when detected/Observer
1019	Male	Unk	18 Jul 2009 (15 Mar 2009)	29+ years old	Georges Bank/ Carol Carson

Description:
This animal was observed on only one day bearing gear with a large yellow polyball attached. It is not known were the gear was attached to the body but around 70-100 feet of gear was trailing behind the flukes. Significant, relatively-fresh entanglement wounds were evident on the tail (note that propeller cut wounds just forward of peduncle on the left side were from a previous incident). The animal appears to be in good health although the observer noticed he did not fluke up high during the sighting. The wounds on the tail seem to be fairly deep although it is difficult to assess whether they penetrate muscle or bone and/or are greater than 8 cm in depth. However, to err on the side of caution considering that it is not clear how the gear is attached, we have coded this event as severe. There have been no subsequent sightings of this animal and its fate remains uncertain.

Right side of fluke and peduncle

Old propeller cuts on left flank

Yellow poly-ball pulled subsurface

Catalog #	Sex	Birth year	Date of entanglement detection (date seen prior)	Age at entanglement detection	Location when detected/Observer
3311	Unk	2003	14 Jan 2009 (21 Apr 2008)	6 years old	Southeast US/Sea to Shore Alliance

Description:
This animal was observed entangled over a nearly two month period with multiple lengths of rope through the mouth and trailing several body lengths behind the animal. One rope was bound over the rostrum and cutting in. Rope was also cutting deeply into the lower left lip. It remains uncertain how or if the flippers were tightly wrapped with gear. The tail had extensive entanglement wounds. The animal was the subject of intensive disentanglement and sedation efforts with most gear removed by March 6, 2009 but the animal was in very poor condition at that time with deep cuts on rostrum and lower lip. There have been no subsequent sightings of this animal and it is likely dead.

Jan 14, 2009 sighting

March 6, 2009 – line cutting deep into rostrum

Entanglement wounds on flukes

Catalog #	Sex	Birth year	Date of entanglement detection (date seen prior)	Age at entanglement detection	Location when detected/Observer
3930	Male	2009	9 Aug 2009 (12 Feb 2009)	Calf	Bay of Fundy/New England Aquarium

Description:
This calf was observed with its mother and had deep entanglement wounds around the tail stock but no gear was attached. The wounds were deepest at the leading edges just adjacent to the insertion with the deepest part of the injury on the ventral aspect of the fluke. There were moderate entanglement wounds at the mouth and flippers as well. There was evidence of compromised health (poor skin condition) at the first sighting with these wounds in August 2009. The animal was resighted in January 2010 in the southeast U.S. with continued evidence of poor skin condition but a seemingly healthy fat layer. The flukes were beginning to show evidence of angling upwards. The animal was last sighted in April 2011 in Cape Cod Bay skimfeeding. He now had patches of red cyamids present on the body just aft of the blowholes and the flukes had become further deformed with the two fluke tips practically touching dorsally as a result of the deep wounds. There have been no subsequent sightings and the fate of this animal remains uncertain due to its declining health.


Dorsal flukes – January 2010


Ventral flukes – January 2010


April 2011 – red cyamids on body, flukes deformed

Appendix 2. Criteria for designation of entanglement related wounds.

These wound categories have been applied to different body regions for each entanglement event for a different study and are used to determine the overall severity of each entanglement event.

LOW

- Small, linear wrapping scars or depressions in the skin that do not penetrate into the blubber and are less than ~ 2 cm in width, less than 2 cm in depth (approximate depth of epidermis).

  Note: Extent of depression/scar coverage in any given body area is low; these types of scars may fade altogether over time especially when found on calves or young juveniles.

MEDIUM

- Wrapping wounds or depressions that are bright white when healed and are greater than ~ 2 cm in width, and/or between 2 and 8 cm in depth, and/or penetrate the skin extending into the blubber (hypodermis layer) but not into muscle or bone.
- Broad areas of abrasion on a given body area that have removed a layer of skin but may not penetrate into the blubber.
- Wounds or bright white scars on the head, flipper or tail that extend beyond the skin but do not extend beyond blubber (actual depth of wound not measured at these areas as blubber layer is shallow).

  Note: The wounds may be raw (red) looking when fresh but typically heal within weeks leaving no raw areas.

HIGH

- Wrapping wounds on the body more than 8 cm in depth and/or extending into bone or muscle.
- Tail, flipper, or head wounds extending into the bone or muscle.
- Broad areas where skin and blubber tissue has been removed and muscle or bone is exposed (note: these wounds may also extend to 8 cm but not easy to be certain – often these wounds will heal but sometimes raw areas may still be evident months or years after the initial event).
- Significant deformity or discoloration of fluke or flipper, for example a twisted fluke caused by torquing by rope/gear, or evidence of a white flipper (indication of circulation impairment) that occurs in conjunction with a known entanglement event even if gear or wounds are not seen on the flipper (this latter criteria applies to right whales only).

Note: In cases of an animal carrying rope around the rostrum or taught over the blowhole where feeding or breathing is considered to be impeded, these injuries will be coded as high; and if a juvenile has constricting wraps anywhere on its body and is still growing, these injuries will also be coded as high.