

Historical Overview of North Atlantic Right Whale Entanglements and Their Impacts

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Right whale entanglements in fixed fishing gear occur frequently and in recent years, these entanglements have resulted in more severe injuries and complex, high risk gear configurations. These entanglements result in compromised health which is more pronounced in reproductive females and leads to reduced calving. Previous assessments of where entanglements occur have shown that they interact with gear throughout their range and not just in known high use areas. Changes in rope manufacturing in the mid 1990's as well as an expansion of fishing effort and shifting whale distributions may all be factors leading to the increase in these more dangerous entanglements. To fully address the entanglement problem, management must occur throughout their range. Protecting this species from entanglements needs to be a collaborative effort between fishermen, scientists, and managers in both countries to ultimately succeed.

Historical Overview of North Atlantic Right Whale Entanglements and Their Impacts

Amy Knowlton, Marilyn Marx, Philip Hamilton,
Heather Pettis, Roz Rolland and Scott Kraus



Talk overview

- How we monitor entanglement interactions – it all starts with the Catalog
 - Scar coding
 - Injury severity
 - Gear configuration risk
 - Visual health assessment
 - Where they get entangled and in what type of gear
- How are these data are used to inform research and management? What have we learned? Where are there gaps?
 - Annual scarring rates and severity levels
 - Population health
 - Survival studies
 - Gear types/Locations/Rope strength analyses

Scar coding



Minor



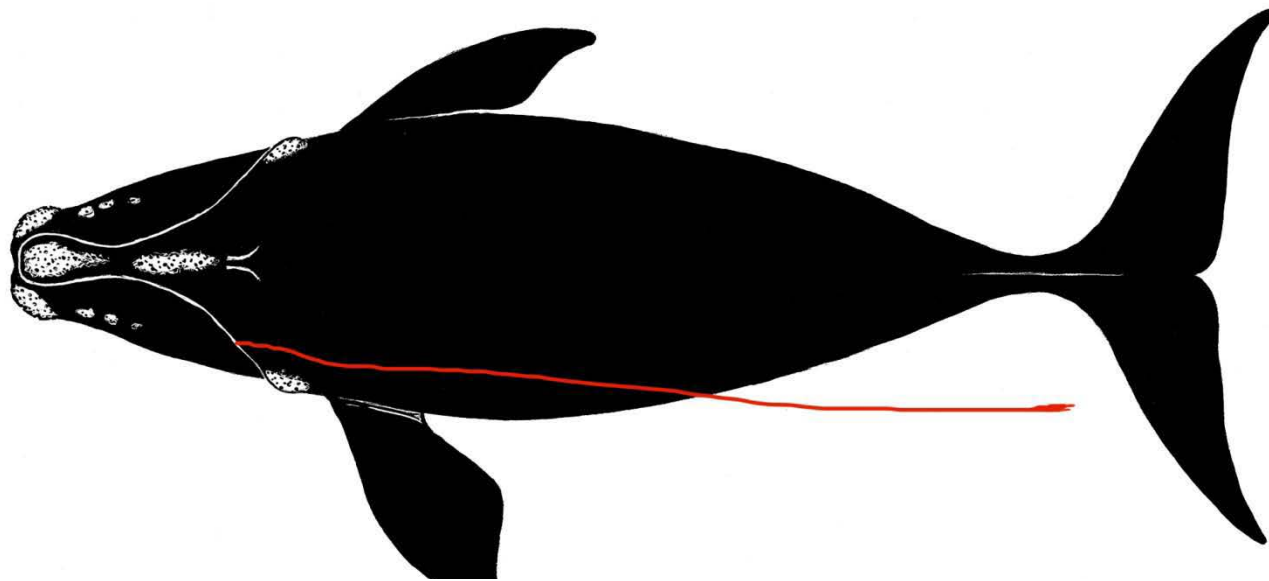
Moderate



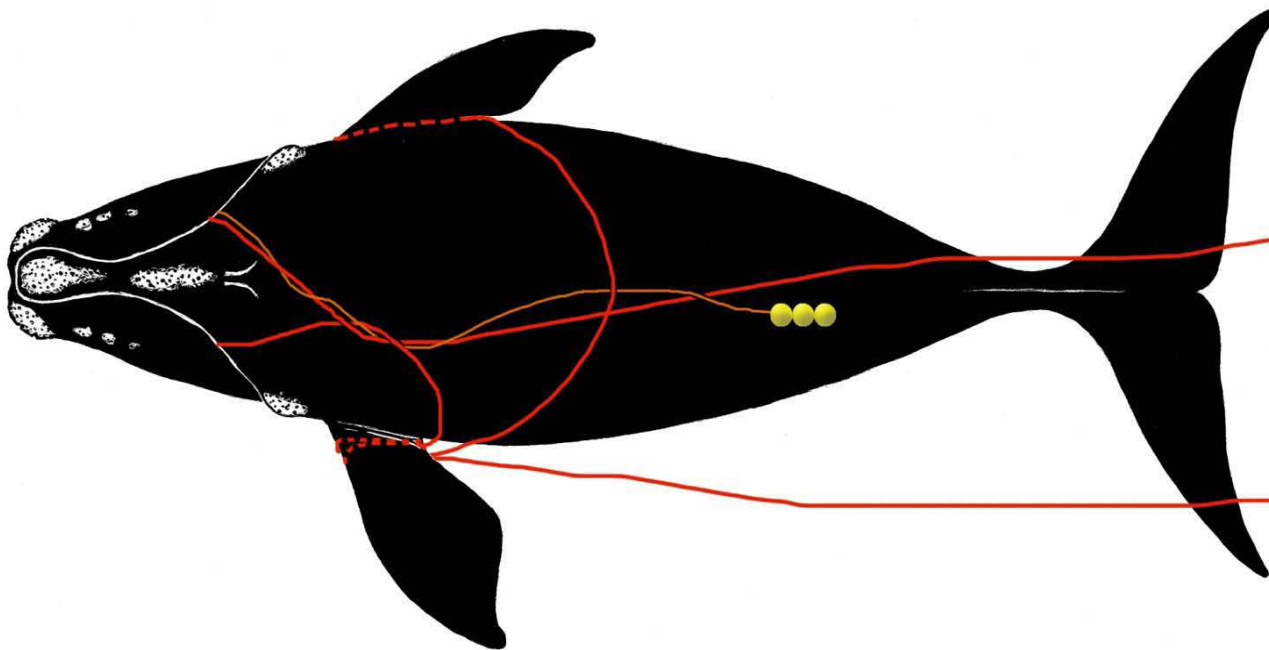
Severe

- Review all photos of each individual to look for evidence of wrapping scars or attached gear
- Categorize according to month/year documented and severity of the scars

Entanglement configuration risk



Low risk



High risk

Low risk

RW #1719



High risk

“Snowball”



Visual health assessment

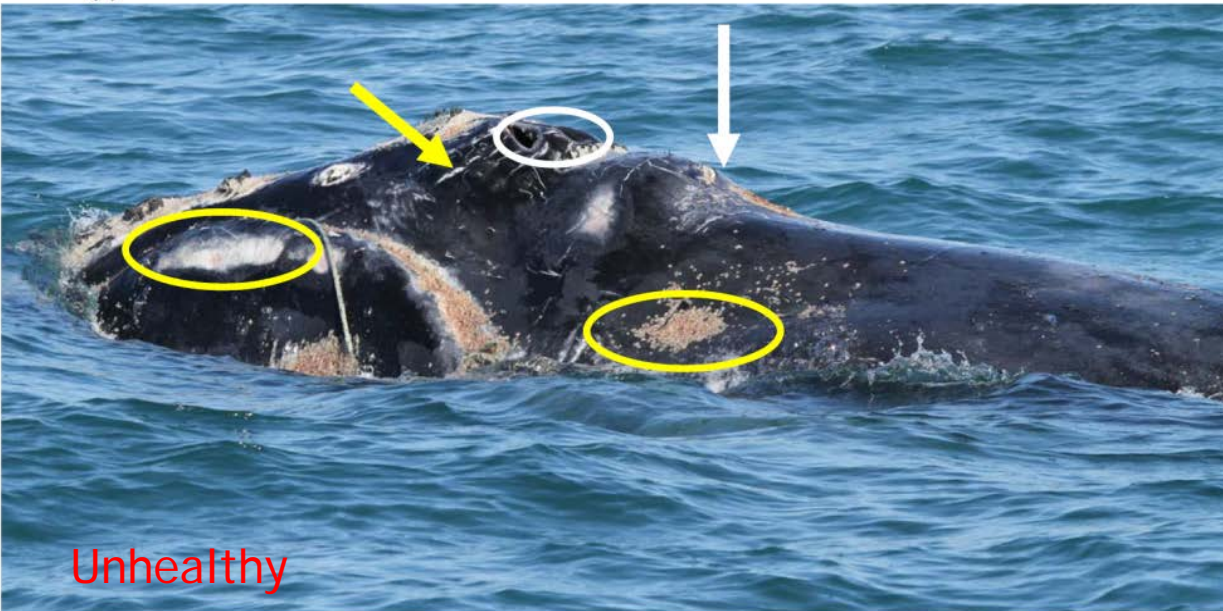
(a)

Same whale in both photos



Healthy

(b)



Unhealthy

Use ordinal scores of:

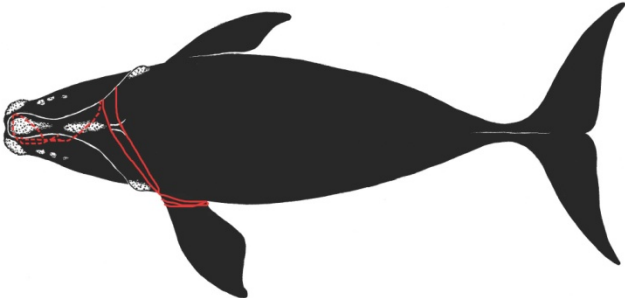
- Body condition
- Skin condition
- Presence/absence of orange cyamids
- Presence/absence of rake marks by blowholes

Pettis et al. 2004. Visual health assessment of endangered North Atlantic right whales (*Eubalaena glacialis*) using photographs. Canadian Journal of Zoology. 82: 8-19.

CASE STUDIES

- Created for all right whales entangled in gear
- Include information on life history, gear type (when known), gear component, rope strength, whale and gear images

Species: Right Whale		Whale ID: Eg #2301			
Date First Observed Entangled?	6 Sept. 2004				
Sex	Female	Birth Year	1993	Age at entanglement	11
Case Study ID	PCCS	NMFS	GEAR ID		
	WR-2001-21	E20-04	J090604 a-c		
Gear Sample Collected?	Yes		Gear Type: Unknown		



Reproductive prior to entanglement detection?	Yes				
Reproductive after entanglement detection?	No				
Wound severity	Mouth	Head/ Rostrum	Flippers	Body	Flukes
	None	High	High	Medium	Medium
Duration of time carrying gear	Minimum 178 days, maximum 531 days				
Disentangled?	No				
Status	Dead 3 Mar 2005				
Number of prior entanglement interactions	3				

Entanglement Configuration	Line wrapping over head from right mouthline to left flipper wraps, line essentially cleated from baleen on right to flipper on left.		
Anchoring Point(s)	Mouthline, flipper		
Gear Configuration Confidence	Moderate		
Remaining Questions	The extent of wrapping at left flipper unknown; bitter ends cannot be accounted for and unclear if any line was trailing.		
Comments	Extensive weaving of line through baleen was documented at necropsy.		
Polymer Type	PP	PP/PET	PP/PET
Gear Component			
Rope Diameter (inches)	3/8 (0.394)	1/2 (0.472)	7/16 (0.425)
Breaking	Tested	486	900
Strength (lbs)	New	2 430	4 500
			3 500

These can be found at www.bycatch.org



06 Sept 2004 - NEA



04 Mar 2005 - WHOI



06 Sept 2004 - NEA



04 Mar 2005 - WHOI



04 Mar 2005 - WHOI



04 Mar 2005 - WHOI



Methods and findings can be found in these three papers and annual reports to NOAA Fisheries and other funders

- Knowlton, A.R., J. Robbins, S. Landry, H. McKenna, S.D. Kraus, and T. B. Werner. 2016. Effects of fishing gear strength on the severity of large whale entanglements. *Conservation Biology* 30: 318-328.
- Knowlton, A.R., Hamilton, P.K., Marx, M.K., Pettis, H.M, and Kraus, S.D. 2012. Monitoring North Atlantic right whale *Eubalaena glacialis* entanglement rates: a 30 year retrospective. *Marine Ecology Progress Series* 466:293-302.
- Pettis, H.M., Rolland, R.M., Hamilton, P.K., Brault, S., Knowlton, A.R., and Kraus, S.D. 2004. Visual health assessment of North Atlantic right whales (*Eubalaena glacialis*) using photographs. *Can. J. Zool.* 82(1): 8–19.

Where they get entangled and in what kind of gear

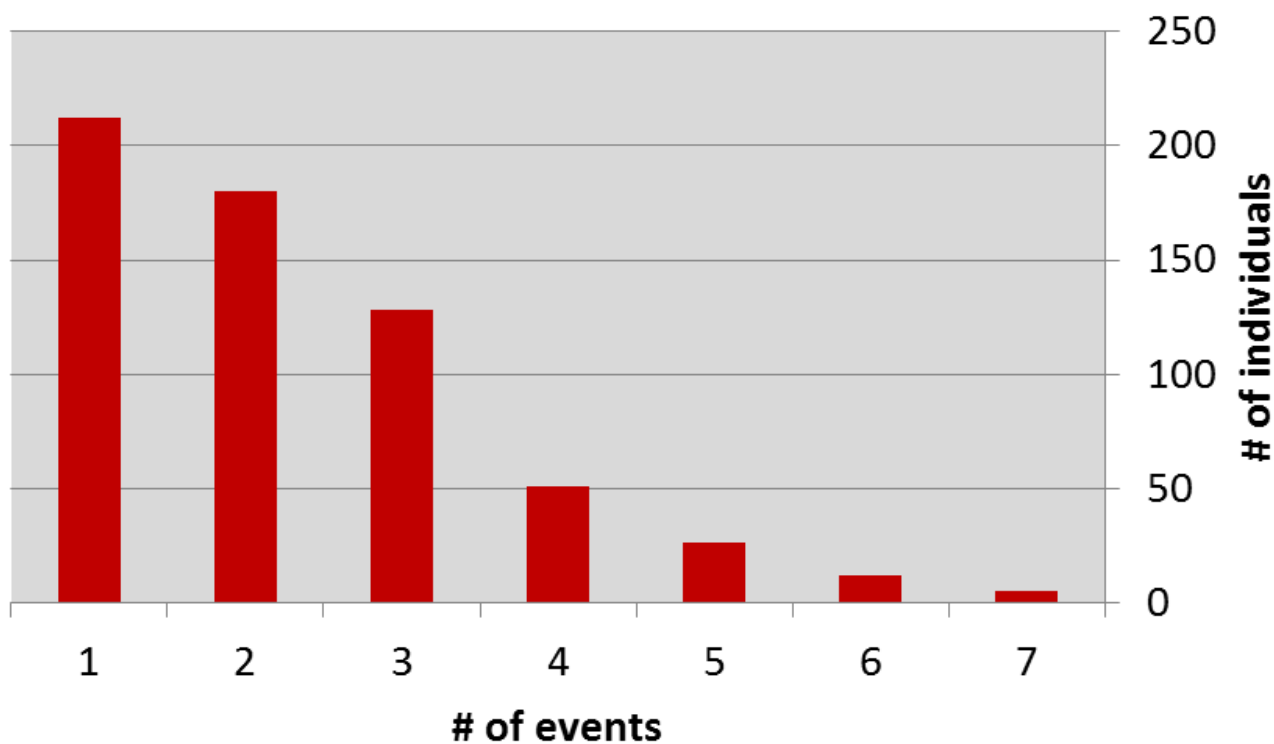
- Case assessments typically done by NOAA Fisheries or DFO using gear collected by disentanglement teams or from carcasses
- Based on gear markings/interviews with fishermen to trace back to where the gear was set
- Collected gear archive is maintained in one location by NOAA Fisheries for gear collected in U.S.; not certain where DFO gear archive lives

How these data are used to inform
research and management

What have we learned? Where are
there gaps?

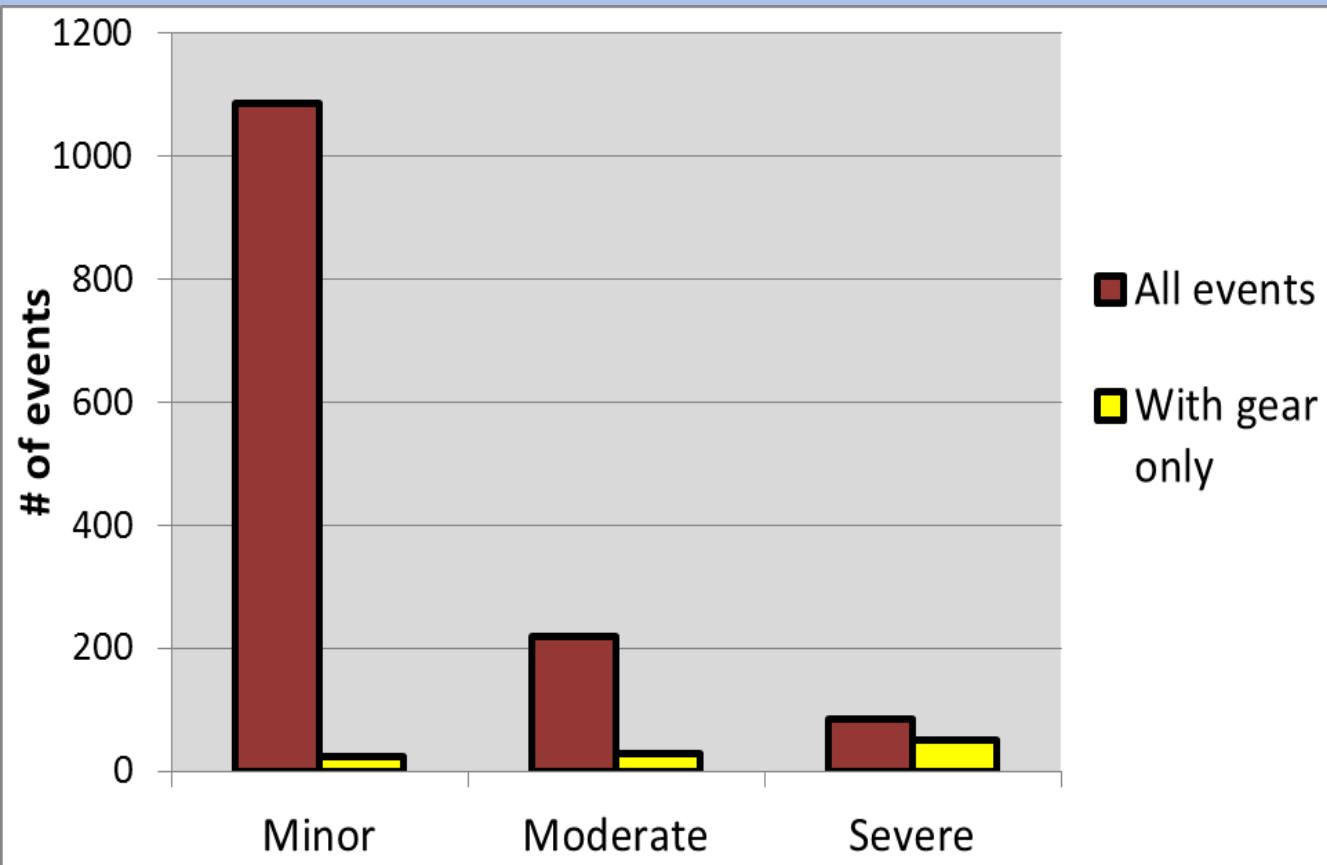
Right whales are entangled frequently

of entanglement events per whale



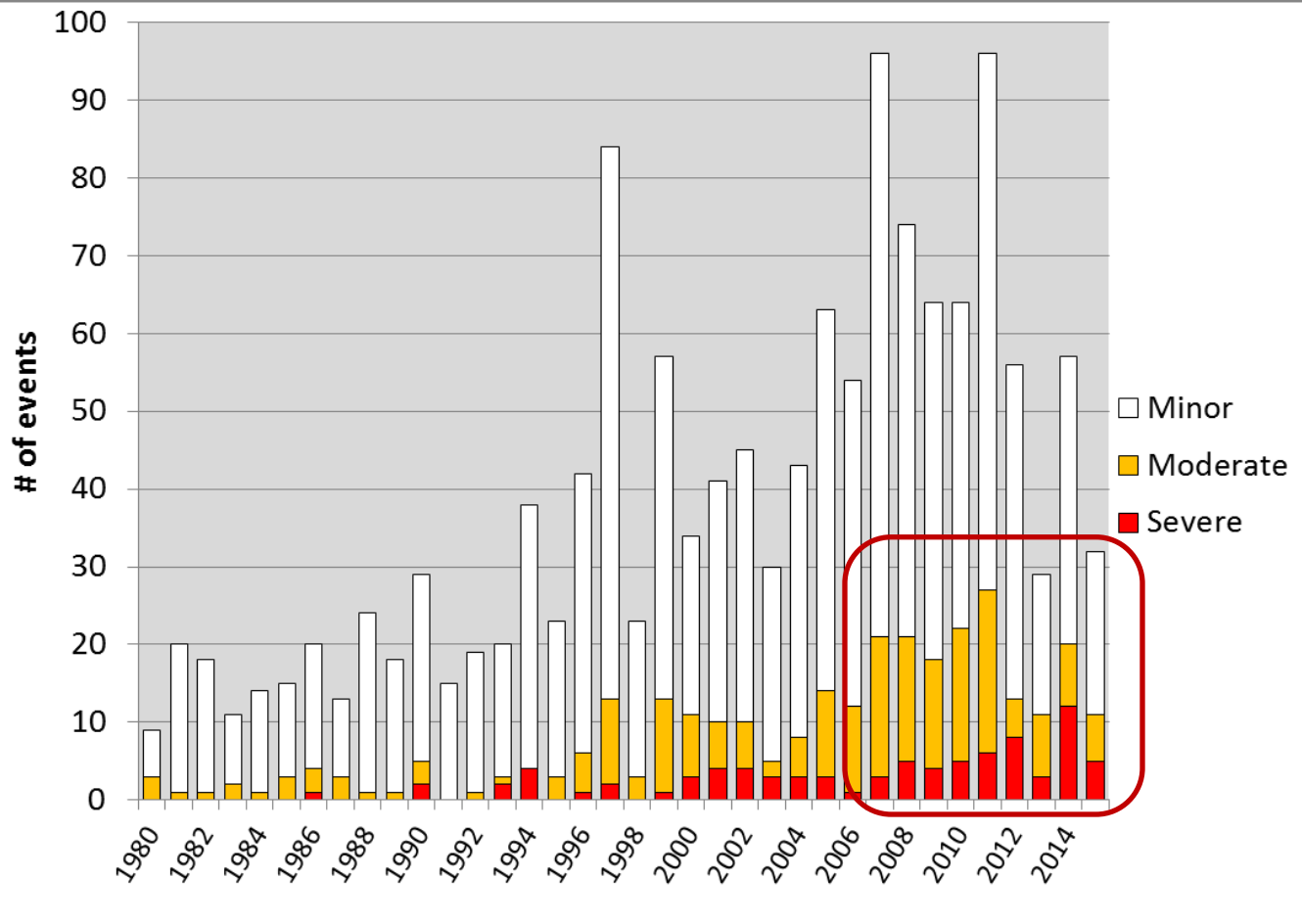
- 1,390 unique entanglement interactions from 1980-2015
- 85% of population with evidence of entanglement involving 614 individuals
- 2/3 of these individuals have been entangled more than once
- 94 individuals have been entangled 4 or more times

Injury severity and presence of gear



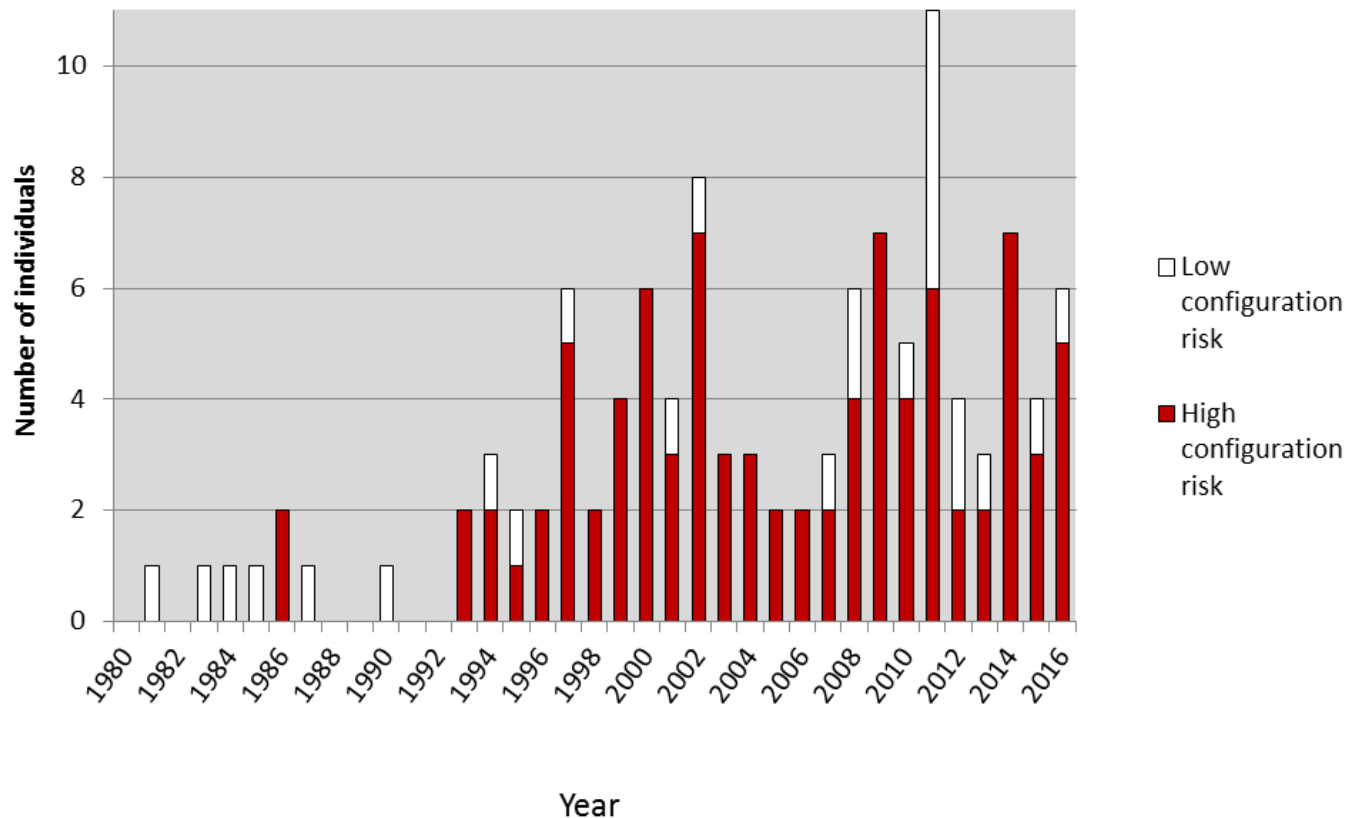
- Majority of entanglements (78%) result in minor injuries
- Most of the whales with severe injuries (n = 85) also have attached gear (n = 51)
- Moderate and severe injuries (n = 305) result in health impacts

Injury Severity by Year



- Moderate and severe injuries have become significantly more prevalent in the past decade

Entanglement configuration risk



113 cases with attached gear


Majority of entanglements are high configuration risk since mid 1990's

Rate of entangled whales has increased significantly over 36 year period when compared to population size

Ways to assess how an entangled or injured whale will fare


Marine Pollution Bulletin 115 (2017) 91–104


Contents lists available at ScienceDirect

 **ELSEVIER**

Marine Pollution Bulletin

journal homepage: www.elsevier.com/locate/marpolbul



Predicting lethal entanglements as a consequence of drag from fishing gear  CrossMark

Julie M. van der Hoop^{a,b,*}, Peter Corkeron^c, Allison G. Henry^c, Amy R. Knowlton^d, Michael J. Moore^b

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^b Biology Department, Woods Hole Oceanographic Institution, Woods Hole, MA 02543, USA
^c NOAA Fisheries, Northeast Fisheries Science Center, Woods Hole, MA 02543, USA
^d New England Aquarium, Central Wharf, Boston, MA 02110, USA

- Measured the amount of drag of different rope lengths
- Calculated the energetic impacts on 10 right whale cases
- Determined how long it will take to reach critical duration which can lead to death
- Tool that could be used for assessing new cases

Health of North Atlantic right whales *Eubalaena glacialis* over three decades: from individual health to demographic and population health trends

Rosalind M. Rolland^{1,*}, Robert S. Schick², Heather M. Pettis¹, Amy R. Knowlton¹, Philip K. Hamilton¹, James S. Clark³, Scott D. Kraus¹

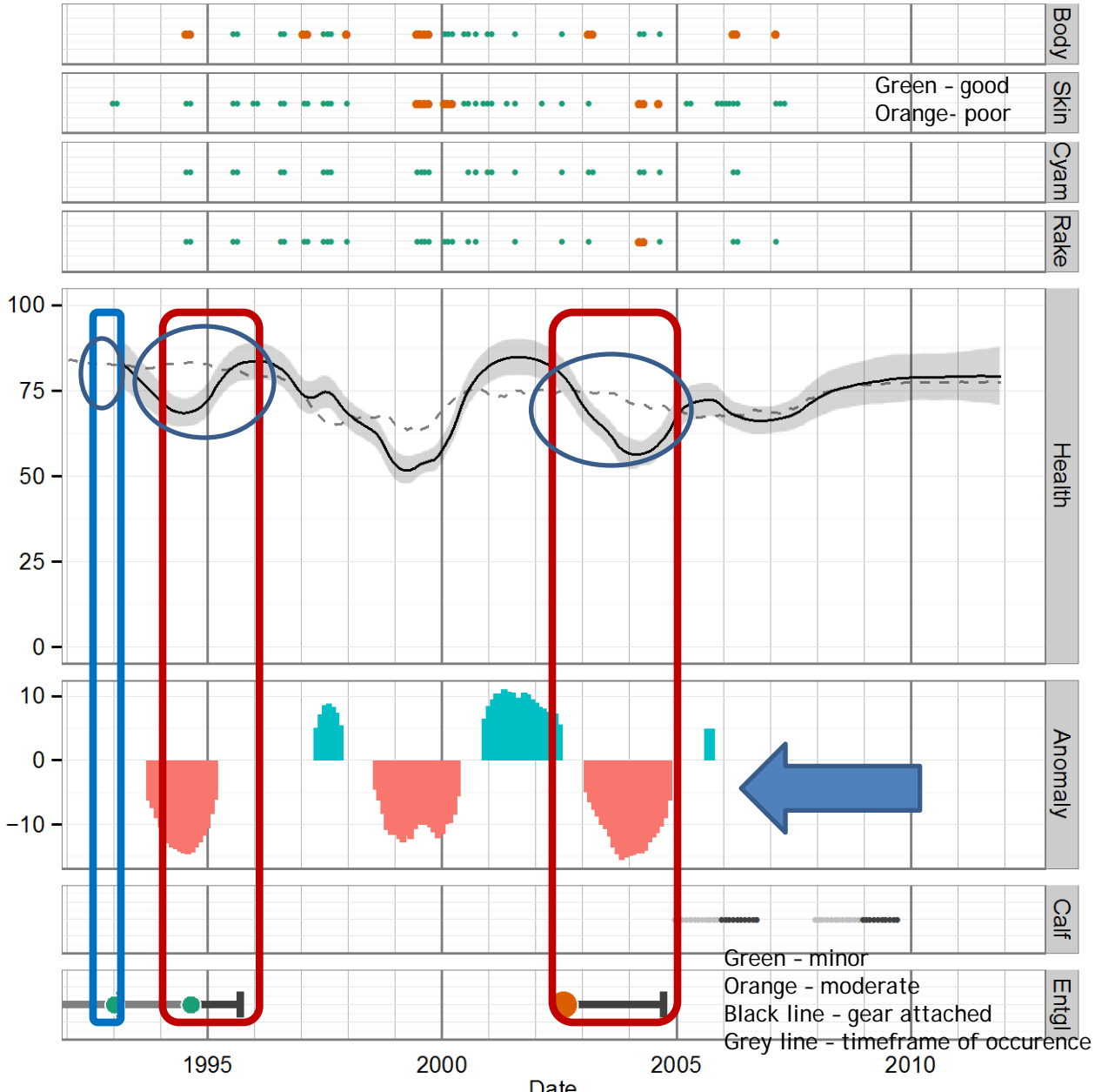
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³Nicholas School of the Environment, Duke University, Durham, NC 27708, USA

- This paper describes a new approach to evaluating health and impacts on reproduction and overall population health
- We are using this approach to evaluate sub-lethal effects of entanglement

EGNo = 2320



Entanglement health windows

With gear (red box):
Up to 3 months prior to first sighting with gear to 3 months after last sighting with gear

Scars only (blue box):
Up to 3 months prior to first detection with scars

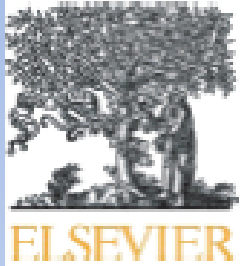
Calculated average health anomaly score of all months in window

Health effects of entanglements (Knowlton et al. In progress)

- Health declines as entanglement severity increases
- The health of reproductively active females is disproportionately affected by entanglements
- Plays a major role in reducing calving rates

How entanglement effects survival

Biological Conservation 191 (2015) 421–427



Contents lists available at ScienceDirect

Biological Conservation

journal homepage: www.elsevier.com/locate/bioc

Apparent survival of North Atlantic right whales after entanglement in fishing gear

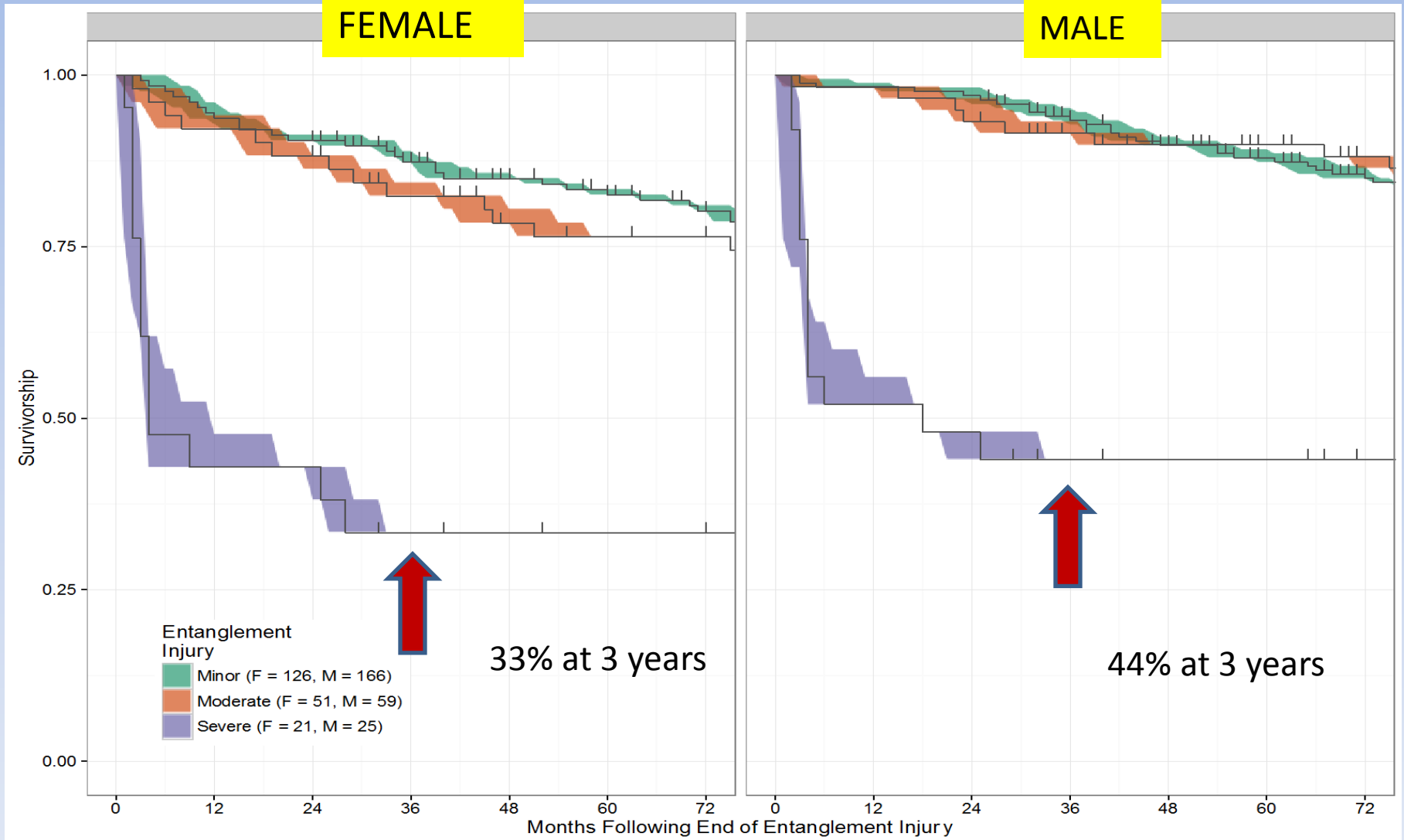
Jooke Robbins^{a,*}, Amy R. Knowlton^b, Scott Landry^a

^a Center for Coastal Studies, 5 Holway Avenue, Provincetown, MA 02657, United States

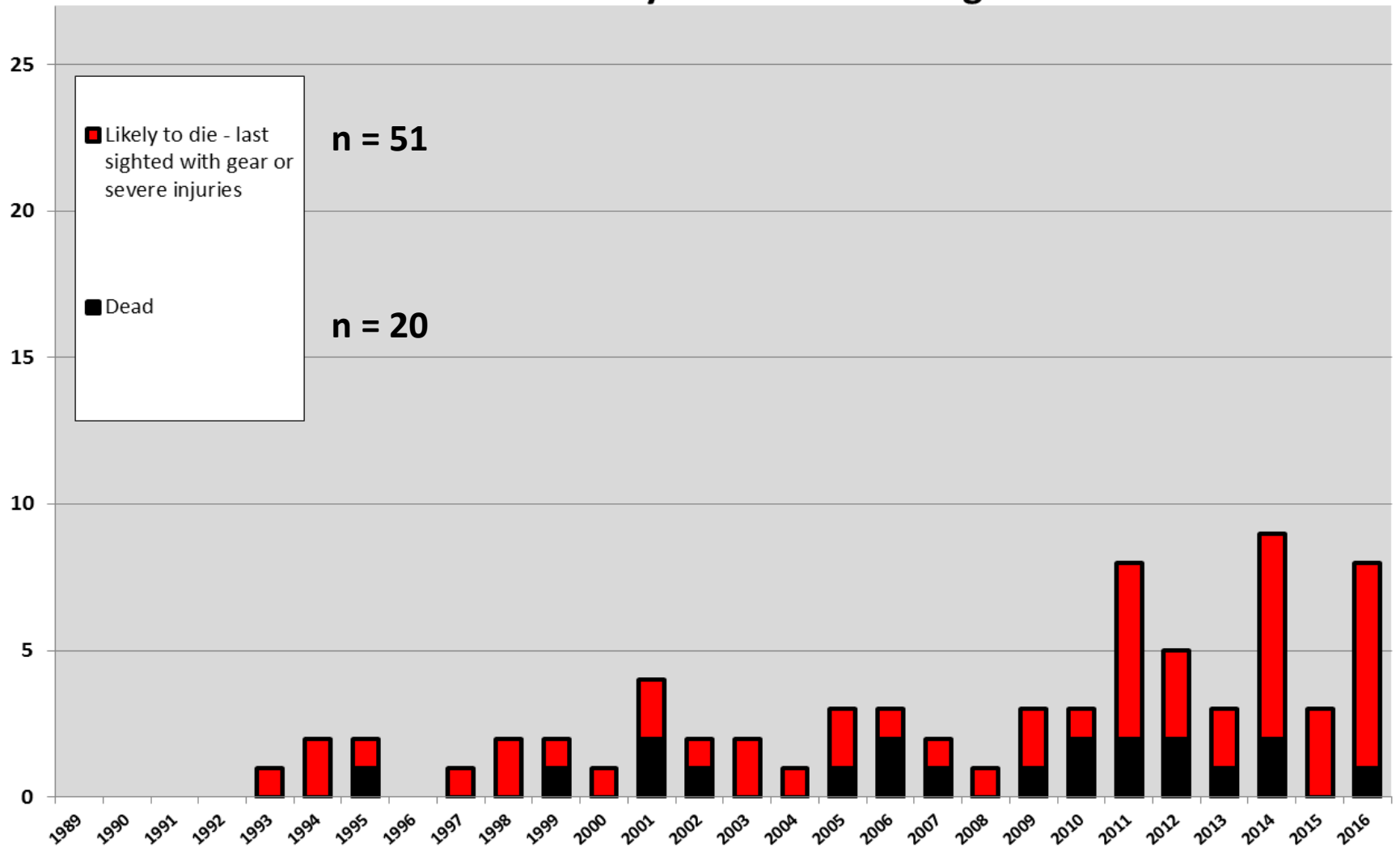
^b New England Aquarium, Central Wharf, Boston, MA 02110, United States

- 50 right whales entangled in gear were evaluated
- Survival dropped to 0.733-0.749 within 1st year of being entangled versus non-affected whale survival of 0.961-0.986
- Health impacts were the most predictive of subsequent survival

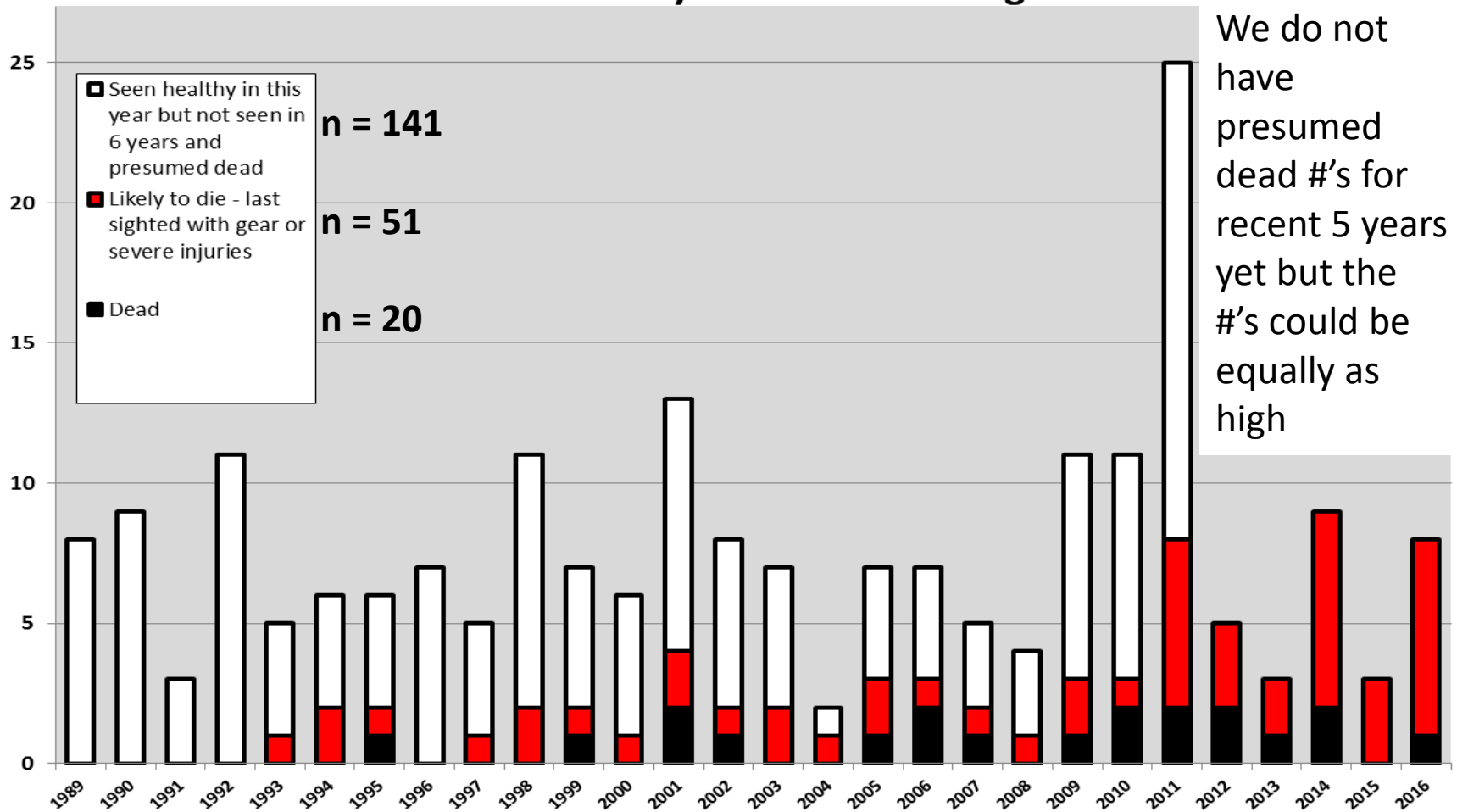
Survival by Gender (Knowlton et al. In progress)



Dead or likely dead from entanglement



Dead or likely dead from entanglement



- May be missing a lot more entanglement cases – assume that some proportion of presumed dead whales died from entanglement

FISHING GEAR INVOLVED IN
ENTANGLEMENTS OF RIGHT
AND HUMPBACK WHALES

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Gear types

- Majority of entanglements with gear involve ropes only that can't be linked to gear type
- Of those that could be identified, majority are pot gear (lobster, other) with a smaller proportion involving gillnet gear
- Crab pot gear is becoming more prevalent
- Study is being updated

Where do entanglements occur?

Everywhere ...

Based on right whale data through 2006

Right whales can carry gear long distances

Red: where RW first sighted with gear

Green: where that gear was traced back to

Blue: RWs found near where gear was set

Reliability of eyewitness reports of large whale entanglement

Jooke Robbins, John Kenney, Scott Landry, Edward Lyman and David Mattila; 2007 report to the International Whaling Commission

What have we learned from the ropes that entangles large whales

Published in April
2016

Open access

Conservation Biology



Contributed Paper

Effects of fishing rope strength on the severity of large whale entanglements

Amy R. Knowlton,^a ¶ Jooke Robbins,† Scott Landry,† Henry A. McKenna,‡ Scott D. Kraus,^a and Timothy B. Werner^a§

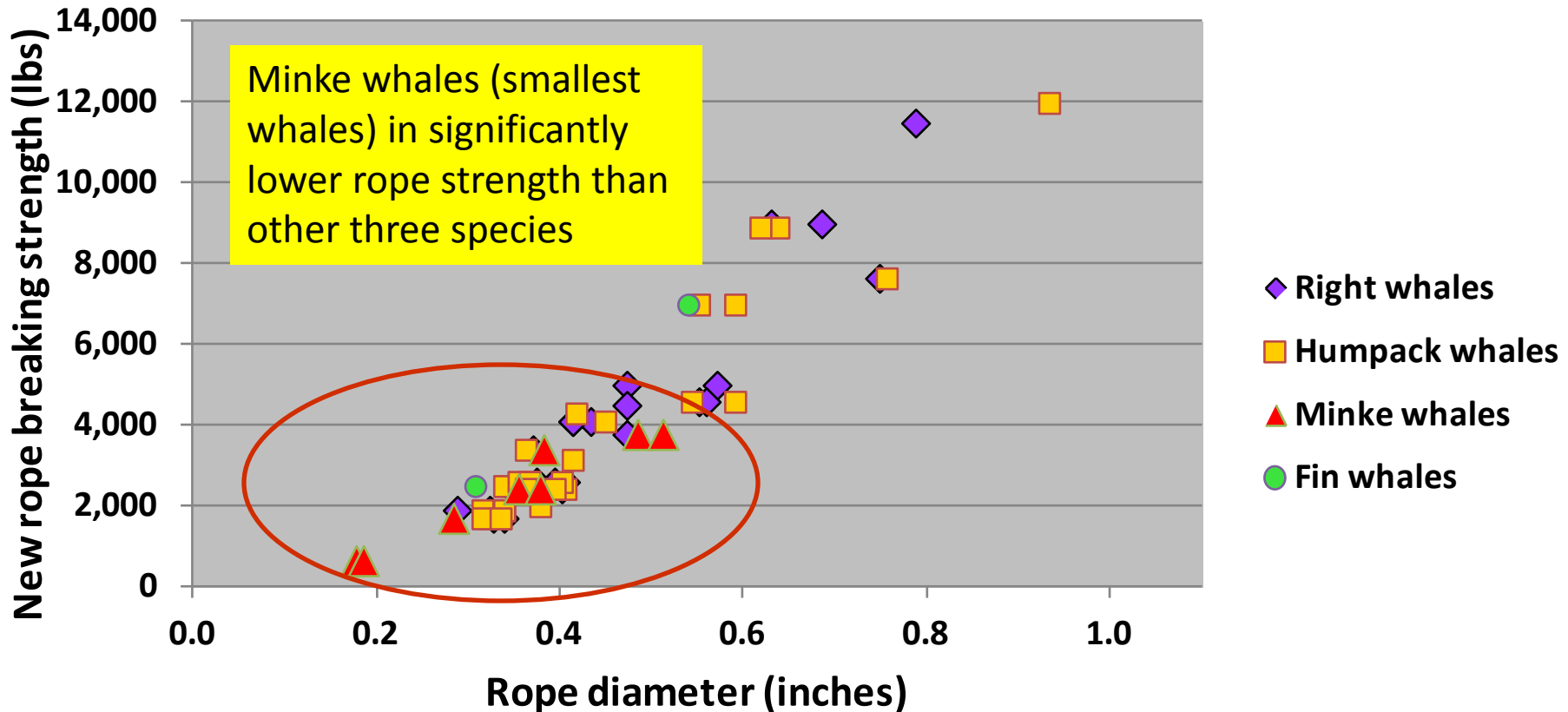
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‡35 Hubbard Road, Weston, MA 02493, U.S.A.

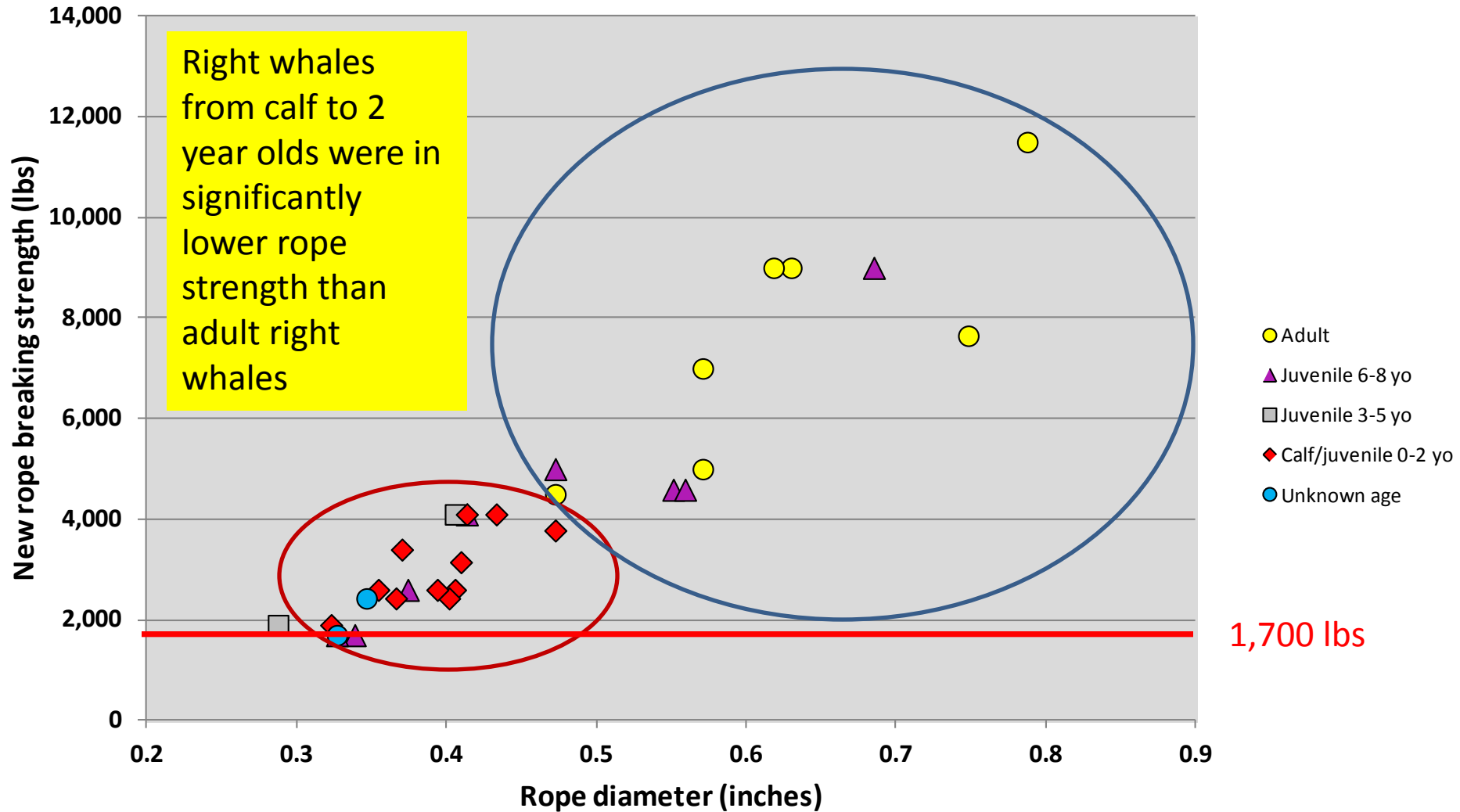
§Department of Biology, Boston University, 5 Cummings Mall, Boston, MA 02215, U.S.A.

Rope retrieved from all species

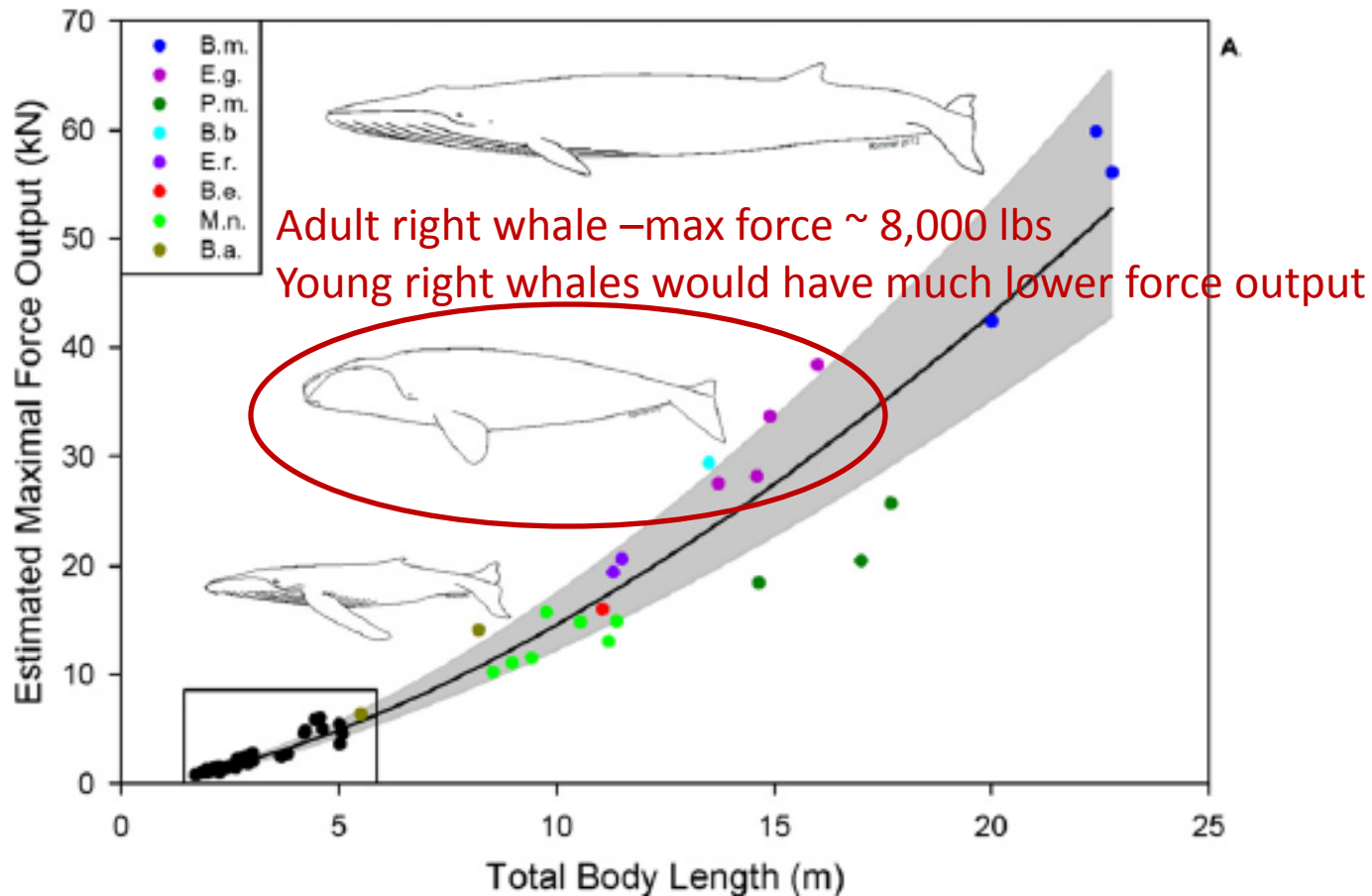


- Evaluated rope strength and polymer type in 70 whale cases with retrieved gear (from disentanglements or from carcasses)
- We plotted the new rope strength for the given polymer and diameter according to species.
- The cases involved 30 right whales, 30 humpback whales, 8 minke whales and 2 fin whales

Right whales by age



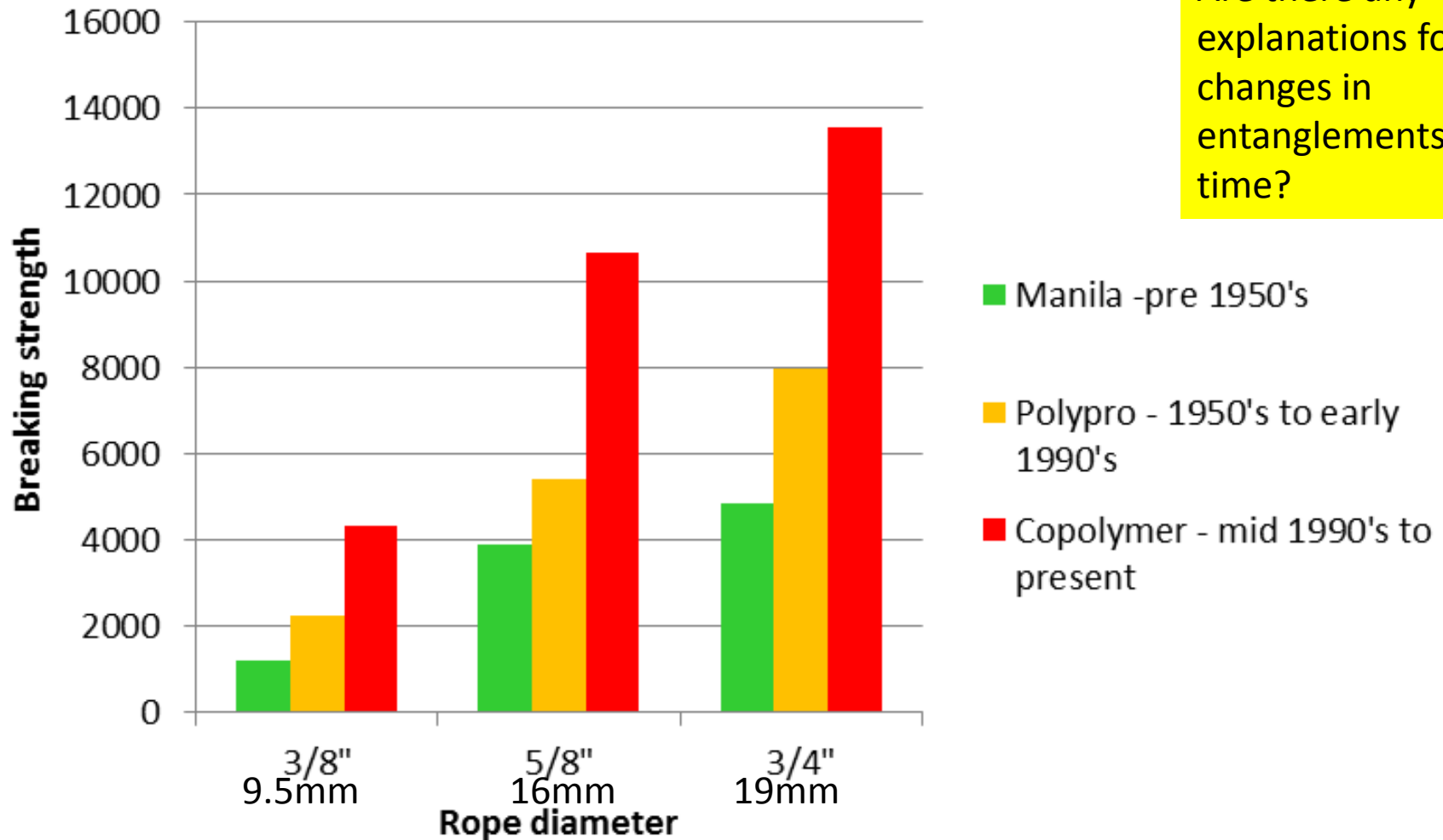
- Severity of injuries was also greater in higher rope strengths
- Concerned that juveniles could be drowning in stronger ropes
- Data indicates that ropes of 1,700 lb strength could reduce lethal entanglements



Our findings meshed with findings of Arthur et al. which show increasing estimated force output based on musculature and total length

Arthur LH, McLellan WA, Piscitelli MA, Rommel SA, Woodward BL, Winn JP, Potter CW, Pabst DA. 2015. Estimating maximal force output of cetaceans using axial locomotor muscle morphology. *Marine Mammal Science* DOI: 10.1111/mms.12230

Rope manufacturing changes



Are there any explanations for the changes in entanglements over time?

- Improvements in rope manufacturing may be one important aspect of this problem
- Efforts underway are to understand the strains placed on ropes during fishing operations
- Presentation on that work on Tuesday at 11:15, Room 200 D

The last 5 years – 2012-2016 (and 2017)

- 7 entangled carcasses (plus 2 in 2017)
- 19 live entangled whales (plus 7 in 2017)
- 24 whales with severe injuries and no gear (2017 assessment in progress)

The entanglement issue has been at a crisis level throughout the right whale's range for many years

Summary

- We understand more about right whale entanglements than any other whale population
- Our monitoring approach is able to detect changes in entanglement rates and severity on a near real-time basis
- The entanglement problem has become more pronounced likely as a result of stronger ropes, increased density of fishing effort, expanded range of fishing and shifting distribution of right whales
- The impacts on health and reproduction are greater than we had previously recognized
- To fully address the entanglement problem, management must occur throughout their range
- Protecting this species from entanglements needs to be a collaborative effort between fishermen, scientists, and managers in both countries to ultimately succeed

Acknowledgements

An aerial photograph of two North Atlantic Right Whales swimming in the deep blue ocean. The whales are dark in color with characteristic white patches on their heads and necks. They are moving from the bottom left towards the top right of the frame, leaving a white wake behind them.

FUNDING SUPPORT

- NOAA Fisheries
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The North Atlantic Right
Whale Consortium

The Right Whales