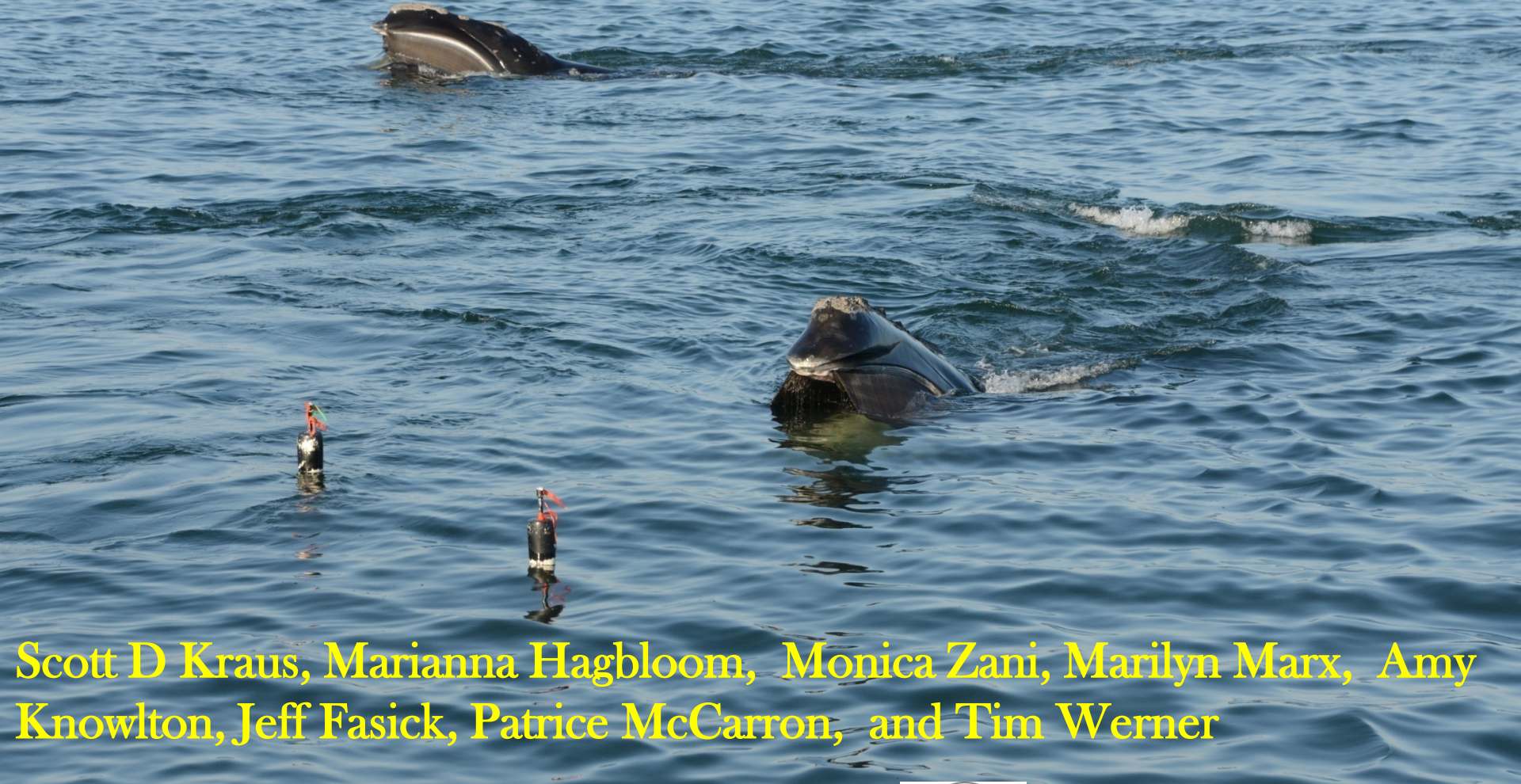
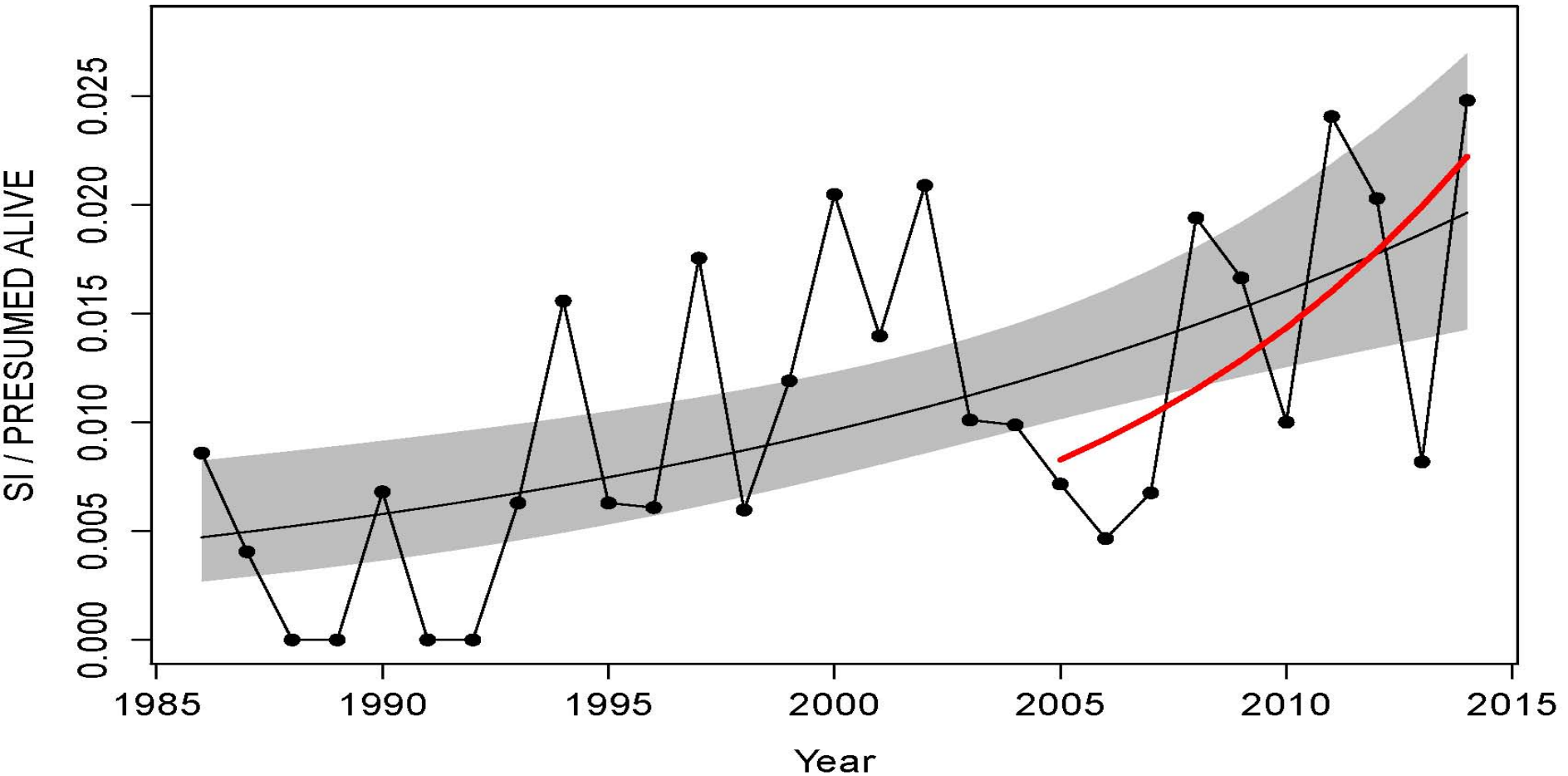


Assessing the Potential of Colored Fishing Ropes To Reduce Right Whale Entanglements



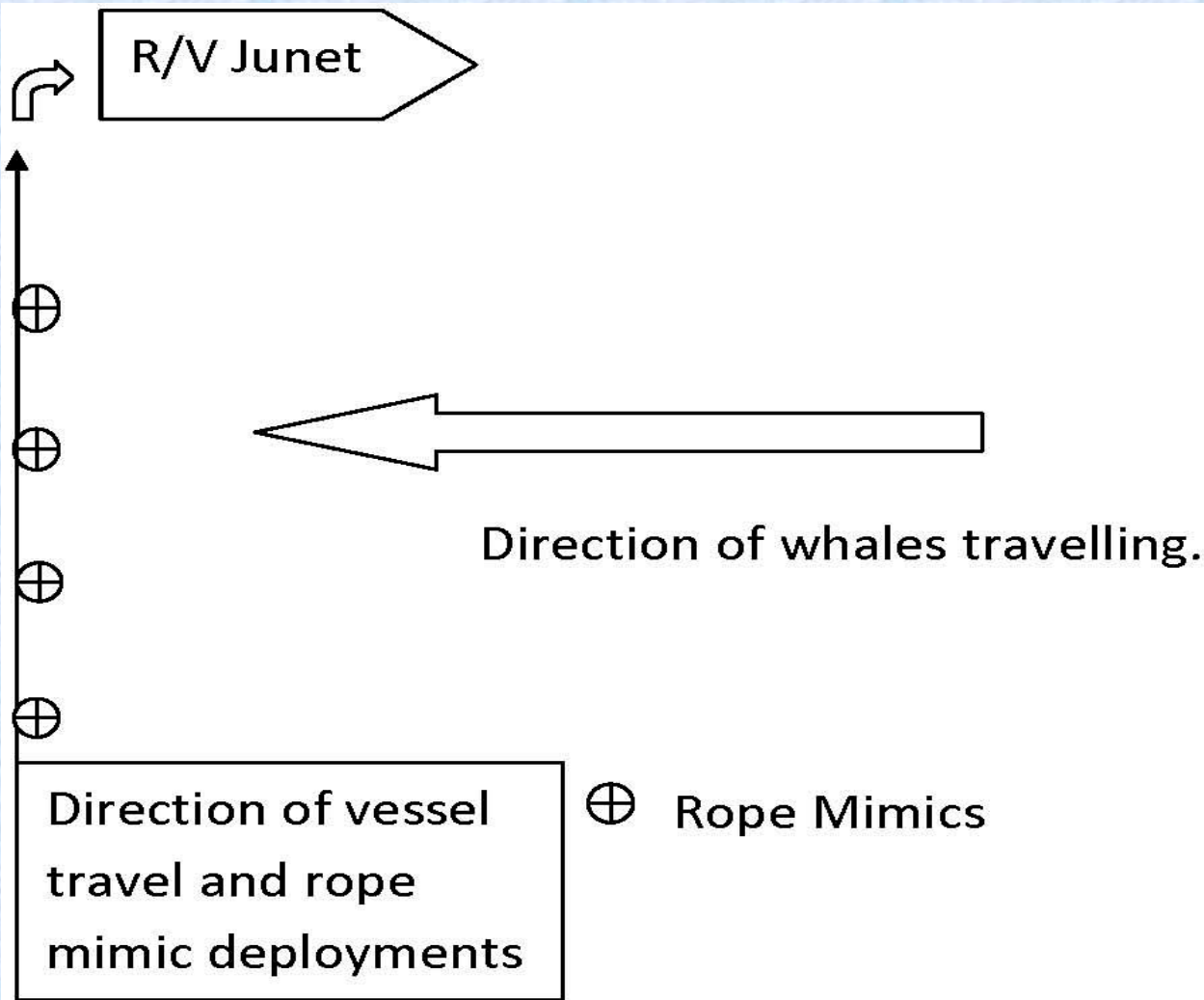
Scott D Kraus, Marianna Hagbloom, Monica Zani, Marilyn Marx, Amy Knowlton, Jeff Fasick, Patrice McCarron, and Tim Werner

Serious injuries from entanglements, corrected for population growth



- **Over 10% of all right whales get entangled in fishing gear every year, and this percentage is increasing.**
- **Why don't right whales see the ropes and avoid them?**

Birds-eye view of experiment



← PVC rope mimic extends 6+ m underwater, is weighted at bottom



TECHNICAL LED'S LED COLOR CH

WAVELENGTH(NM)
940
880
850
660
635
633
620
612
605
595
592
585
4500K
6500K
8000K
574
570
565
560
555
525
505
470
430

Day
↓

* →

* →

* →

3 colors

RELATIVE INTENSITY VS WAV

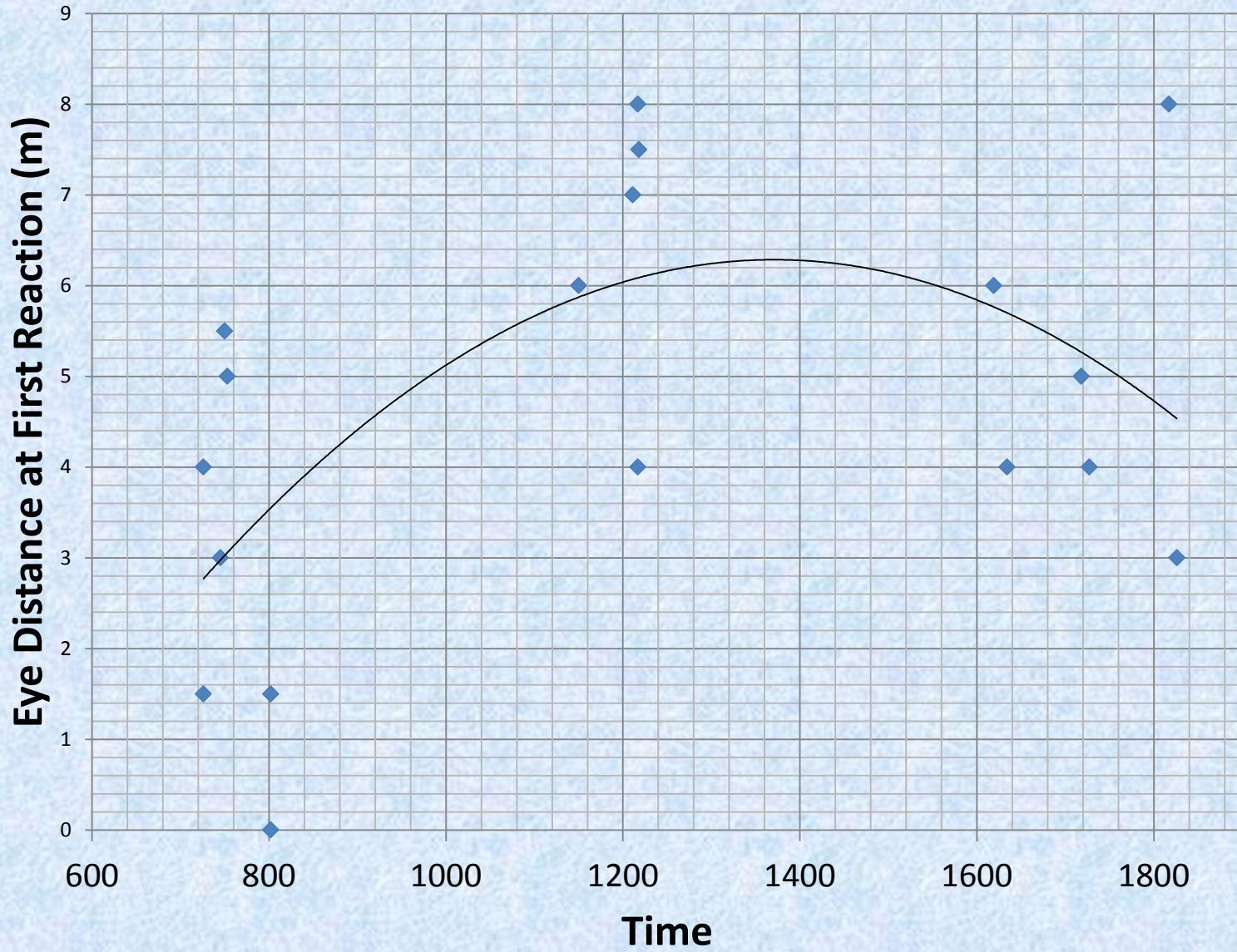
Experimental Results 2011-2013

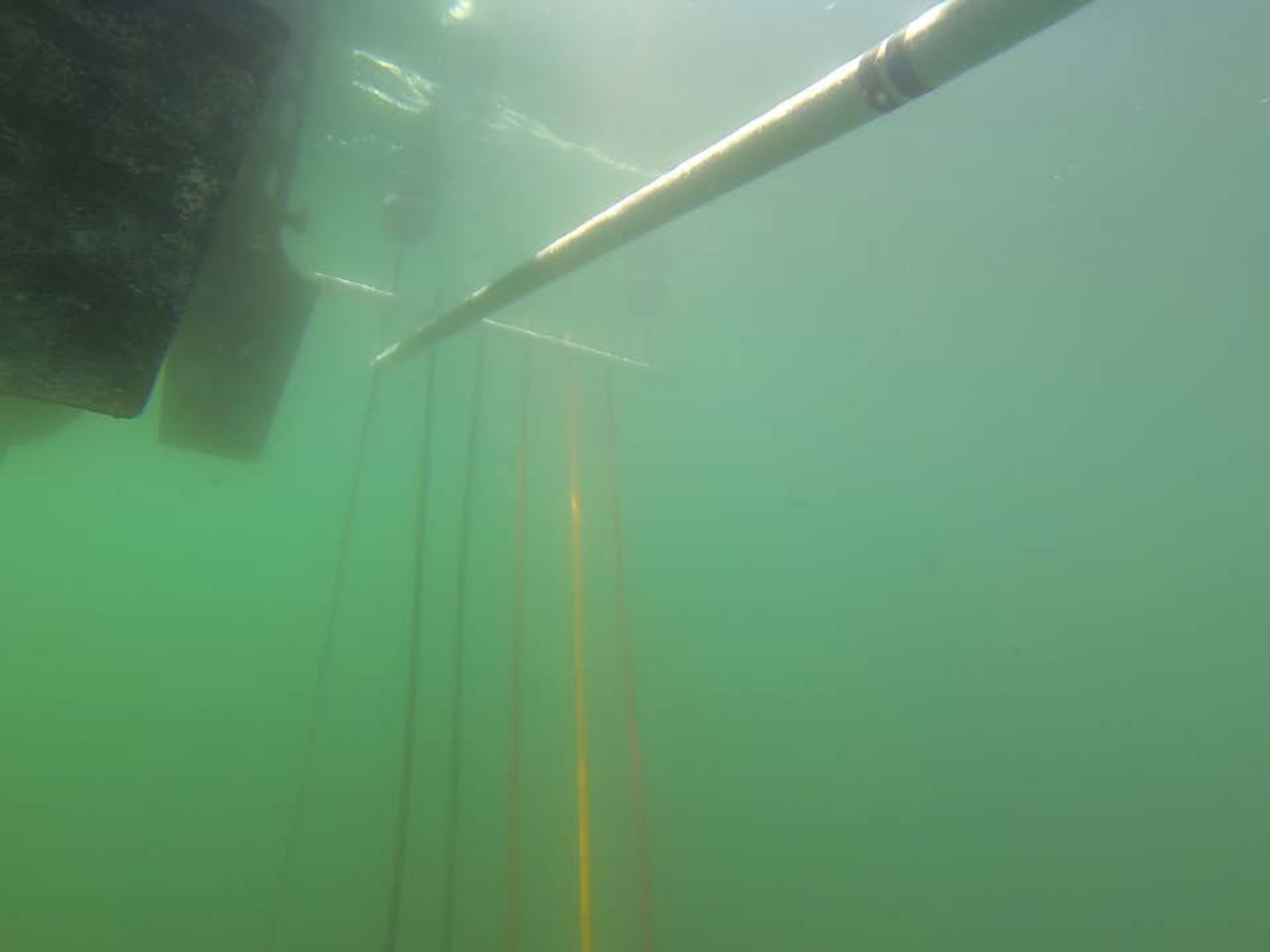
- **154 Events Total**
- **69 eliminated (whale subsurface, > 10 m from rope, interference from another whale, etc.)**
- **70 whales < 10 m w/a detectable reaction**
- **15 whales <10 m w/no detectable reaction**
- **17 records of whales hitting a rope mimic**

Closest eye distance @ change in behavior (m)			Collisions w/Ropes
Color	Mean	Var	
Red	3.85	2.56	2
Orange	4.14	5.13	3
Black	3.00	3.39	4
Green	1.89	2.15	8

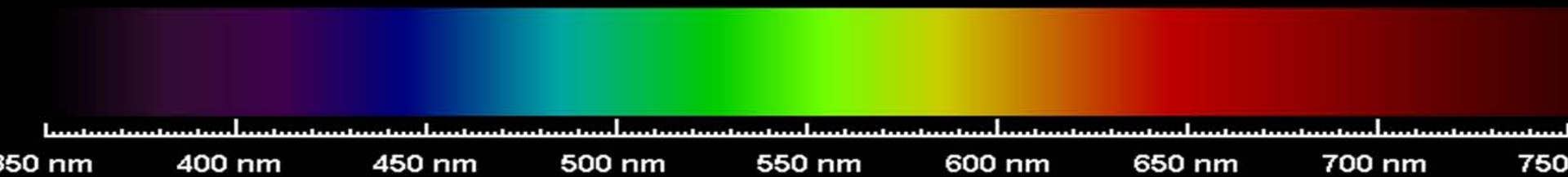
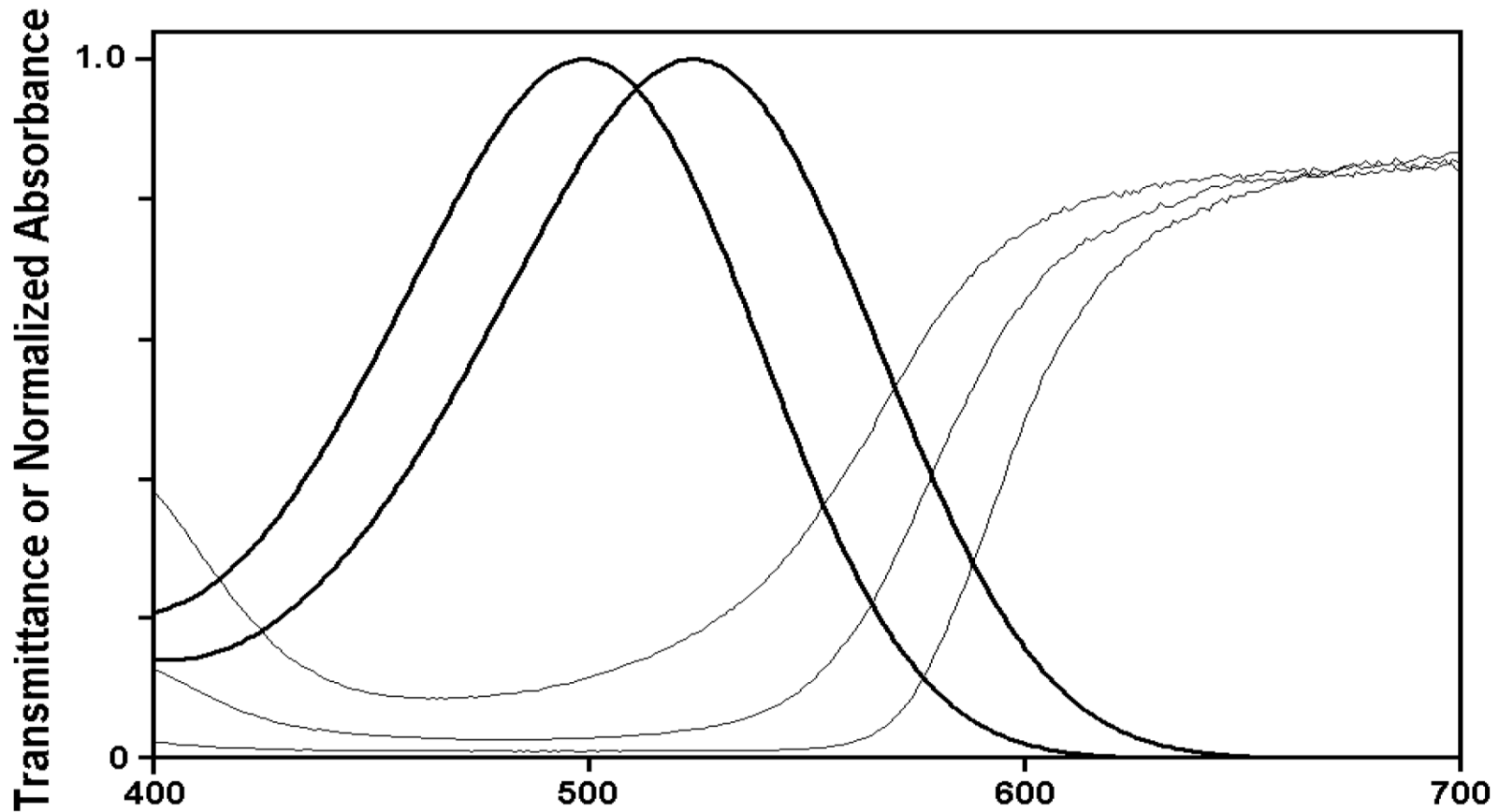
Are the differences significant?			
	red	orange	Black
Red			
Orange	0.7140		
Black	0.2725	0.1779	
Green	0.0050	0.0039	0.1064

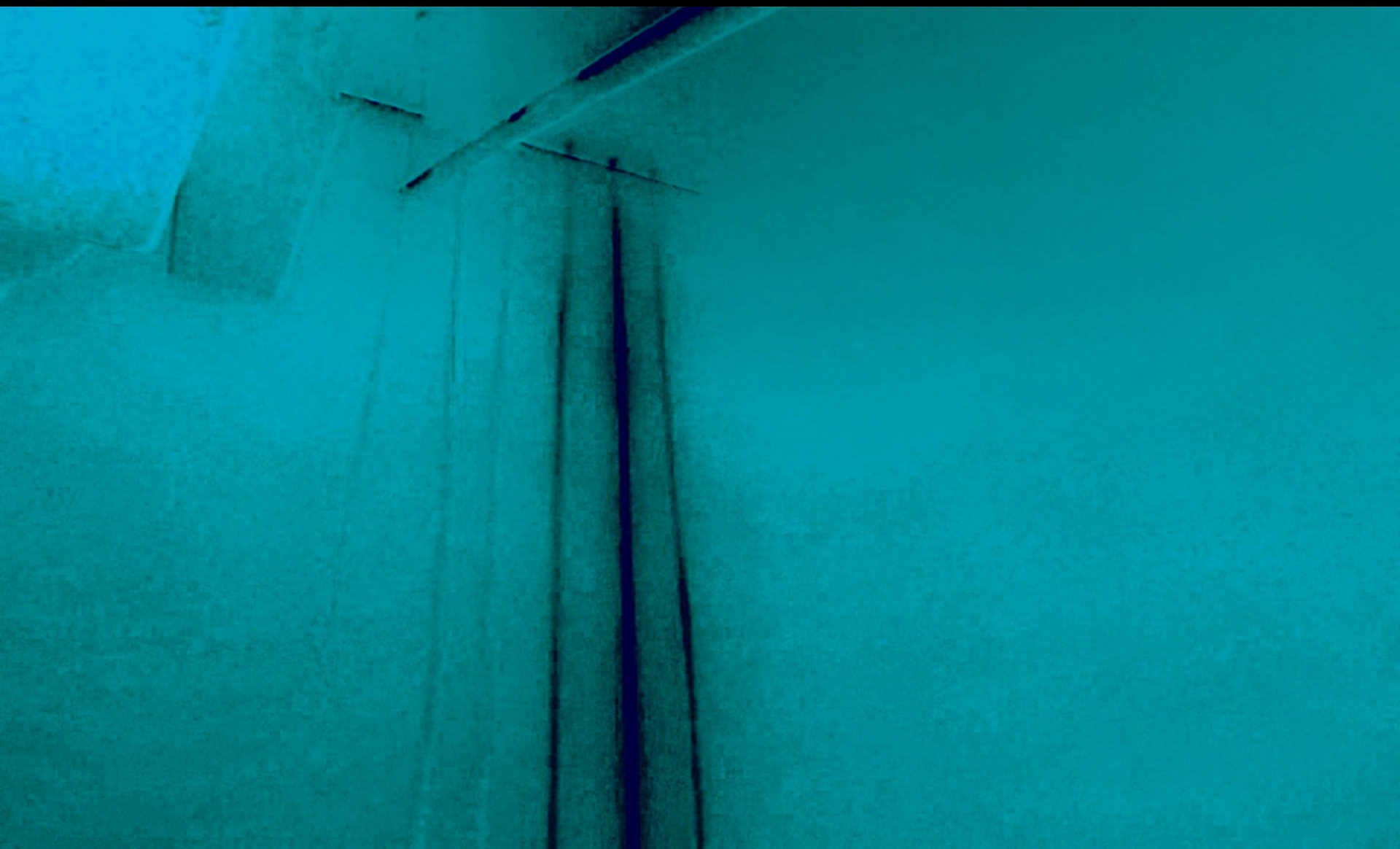
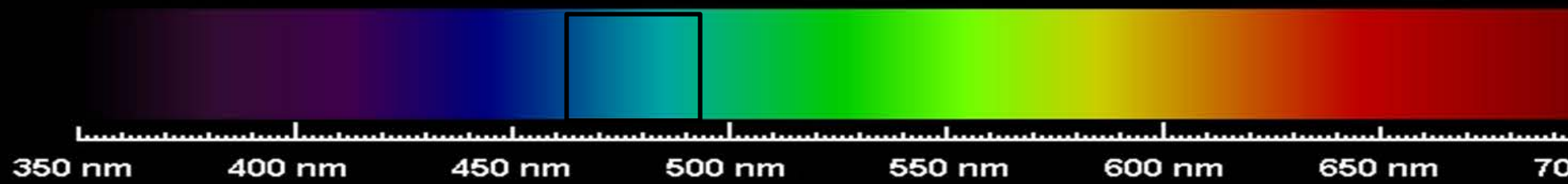
Change of Behavior Distances By Time - Orange Ropes

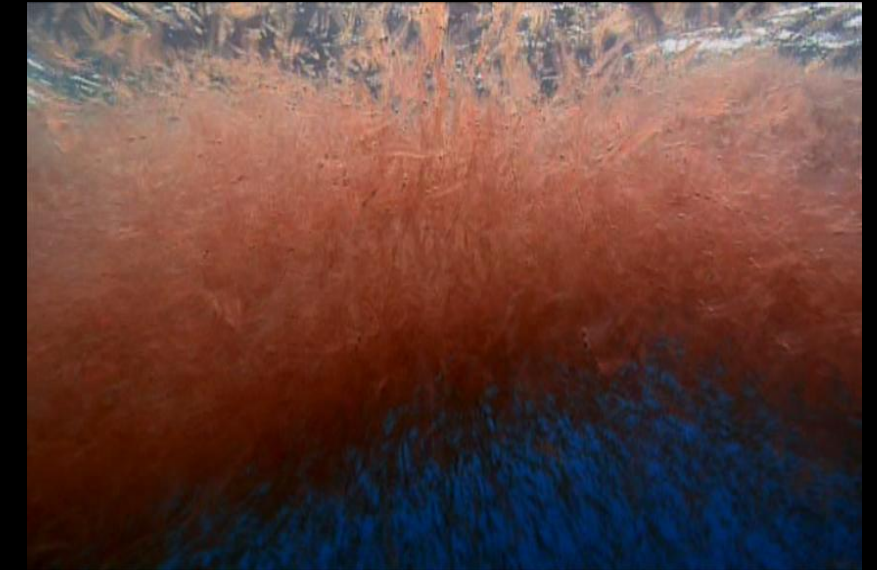
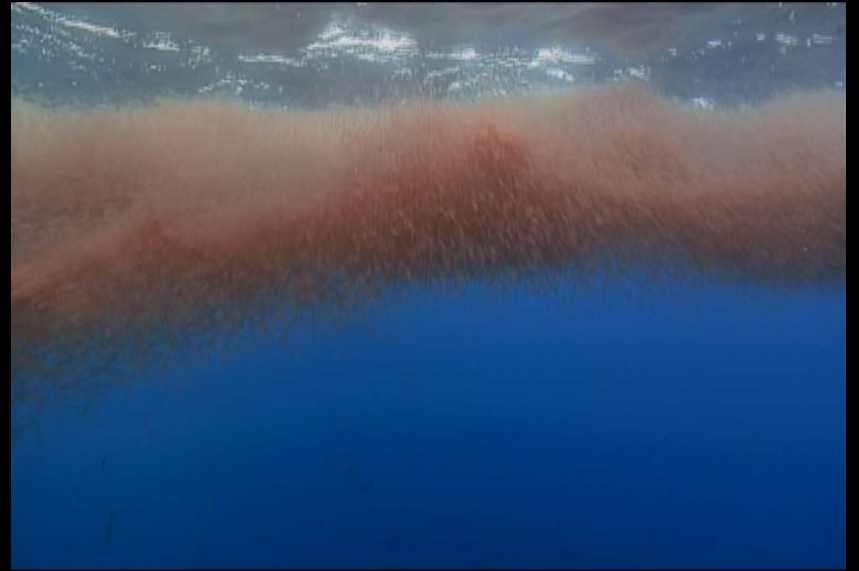




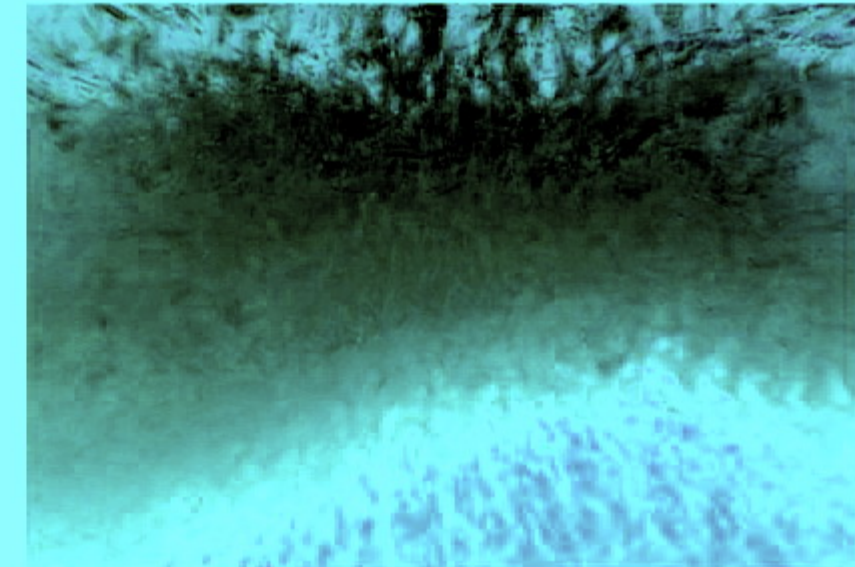
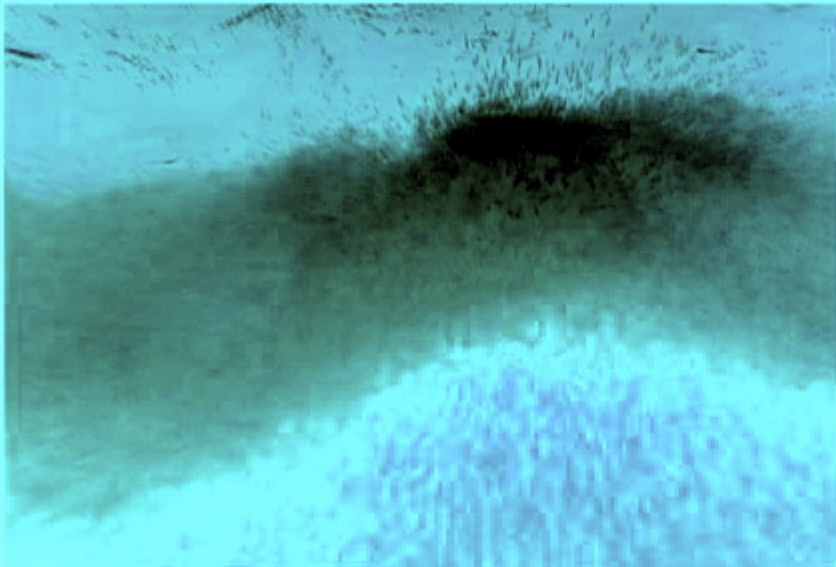
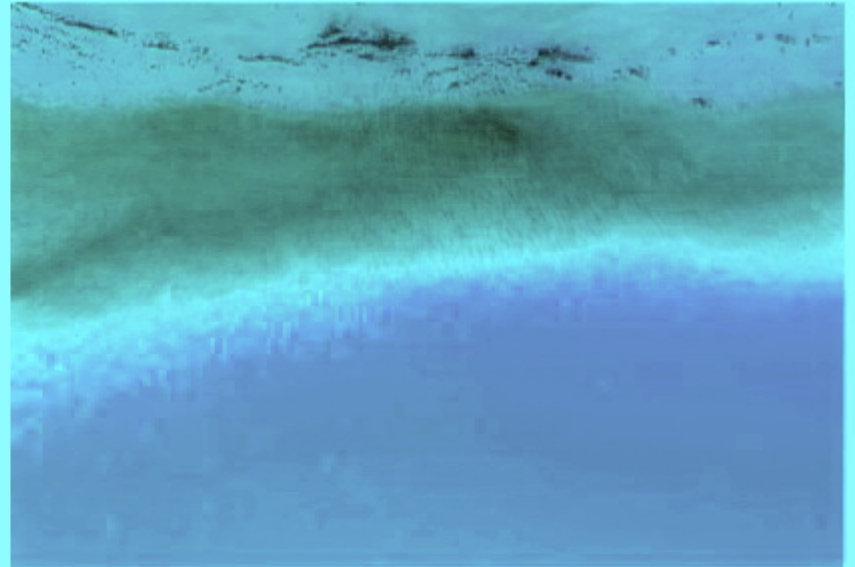
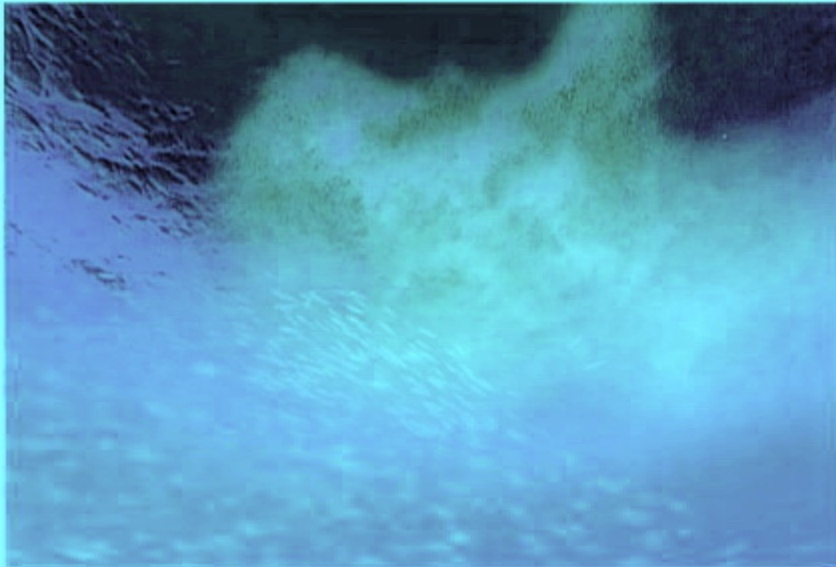
Right Whale Visual Pigment Absorbance Spectra & *C. finmarchicus* Oil Pigment Transmission Spectra







Photographs provided by National Geographic's "Kingdom of the Blue Whale"



Photographs provided by National Geographic's "Kingdom of the Blue Whale"

Conclusions on color

- *Right whales don't see color the way we do, but,*
- *Orange and Red Ropes detectable at furthest distances,*
- *Green Ropes were least detectable by whales*
- *Sometimes, you just run into things...*



Caveat: Effect appears to be underwater visibility dependent

And...MORE Questions!

Resolution in Whale Eyes? Do 1 inch fake ropes = 3/8" real ropes?

What about darkness? How good is a whale's low-light eyesight?

Acknowledgments

This work was supported by the Bycatch Reduction and Engineering Program of NMFS/NOAA, and conducted under NMFS Permit No 15415. Dave Arch, Ken Fosdick, and Bob Wallace supported surveys and rope deployments aboard the R/V Junet.

Thanks to Stormy Mayo and the Provincetown Center for Coastal Studies crew for real-time feeding predictions in Cape Cod Bay.

Thanks to the fishermen who asked why whales couldn't avoid ropes, and sparked this study on whale vision.

Mark Baumgartner, Brian Kot, and Stormy Mayo served as advisors for this research.

