Whale Release Ropes

Amy Knowlton, Tim Werner and Scott Kraus

Anderson Cabot Center for Ocean Life
at the New England Aquarium

Consortium for Wildlife Bycatch Reduction

Florida FWC
Taken under NOAA permit #594-1759

Talk overview

- Evidence that whale release ropes could benefit large whales
- Where and how could whale release ropes be effectively used based on strains placed on ropes during fishing
- Status of whale release rope manufacturing and testing

Conservation Biology

Contributed Paper

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

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

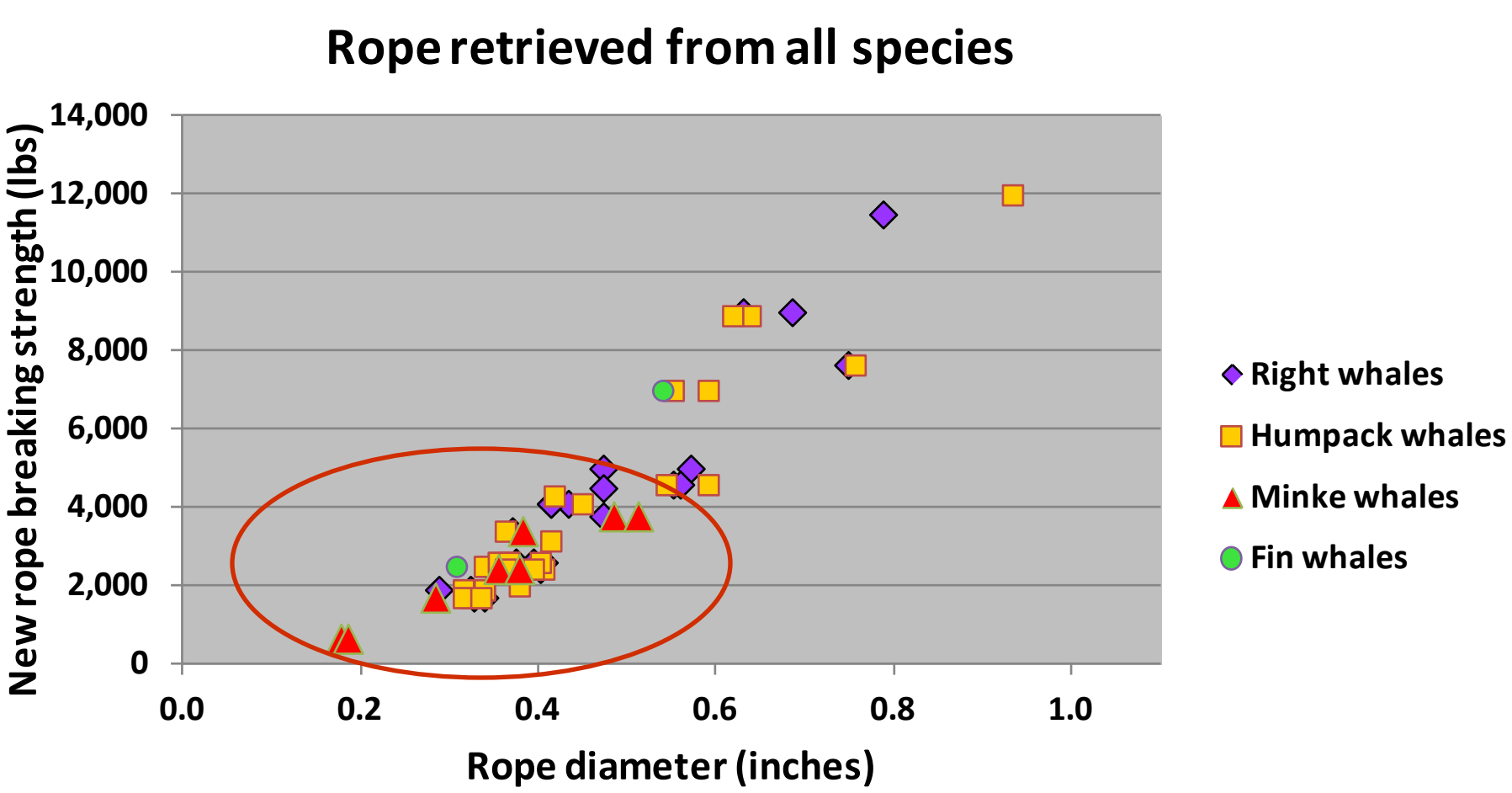
*New England Aquarium, Central Wharf, Boston, MA 02110, U.S.A.
†Center for Coastal Studies, 5 Holway Avenue, Provincetown, MA 02657, U.S.A.
‡35 Hubbard Road, Weston, MA 02493, U.S.A.
§Department of Biology, Boston University, 5 Cummington Mall, Boston, MA 02215, U.S.A.

Abstract: *Entanglement in fixed fishing gear affects whales worldwide. In the United States, deaths of North Atlantic right (Eubalaena glacialis) and humpback whales (Megaptera novaeangliae) have exceeded management limits for decades. We examined live and dead whales entangled in fishing gear along the U.S. East Coast and the Canadian Maritimes from 1994 to 2010. We recorded whale species, age, and injury severity and determined rope polymer type, breaking strength, and diameter of the fishing gear. For the 132 retrieved ropes from 70 cases, tested breaking strength range was 0.80–39.63 kN (kiloNewtons) and the mean was 11.64 kN (SD 8.29), which is 26% lower than strength at manufacture (range 2.89–53.38 kN, mean = 15.70 kN [9.89]). Median rope diameter was 9.5 mm. Right and humpback whales were found in ropes with significantly stronger breaking strengths at time of manufacture than minke whales (Balaenoptera acutorostrata) (19.30, 17.13, and 10.47 mean kN, respectively). Adult right whales were found in stronger ropes (mean 34.09 kN) than juvenile right whales (mean 15.33 kN) and than all humpback whale age classes (mean 17.37 kN). For right whales, severity of injuries increased since the mid 1980s, possibly due to changes in rope manufacturing in the mid 1990s that resulted in production of stronger ropes at the same diameter. Our results suggest that broad adoption of ropes with breaking strengths of ≤7.56 kN (≤1700 lbsf) could reduce the number of life-threatening entanglements for large whales by at least 72%, and yet could provide sufficient strength to withstand the routine forces involved in many fishing operations. A reduction of this magnitude would achieve nearly all the mitigation legally required for U.S. stocks of North Atlantic right and humpback whales. Ropes with reduced breaking strength should be developed and tested to determine the feasibility of their use in a variety of fisheries.*

Keywords: bycatch, humpback whales, injury severity, North Atlantic right whales, rope diameter, rope manufacturing

Published in journal in April 2016

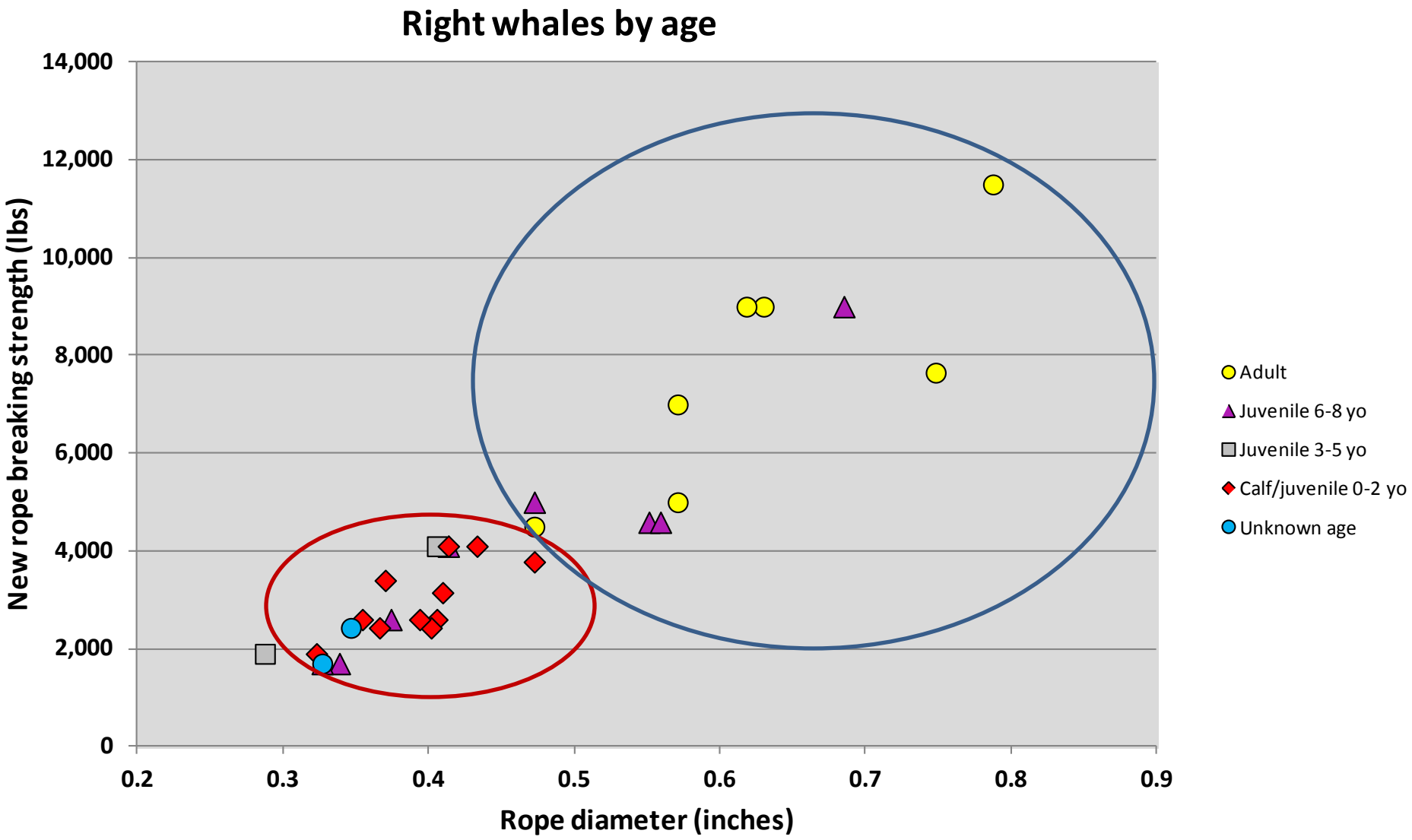
Open access

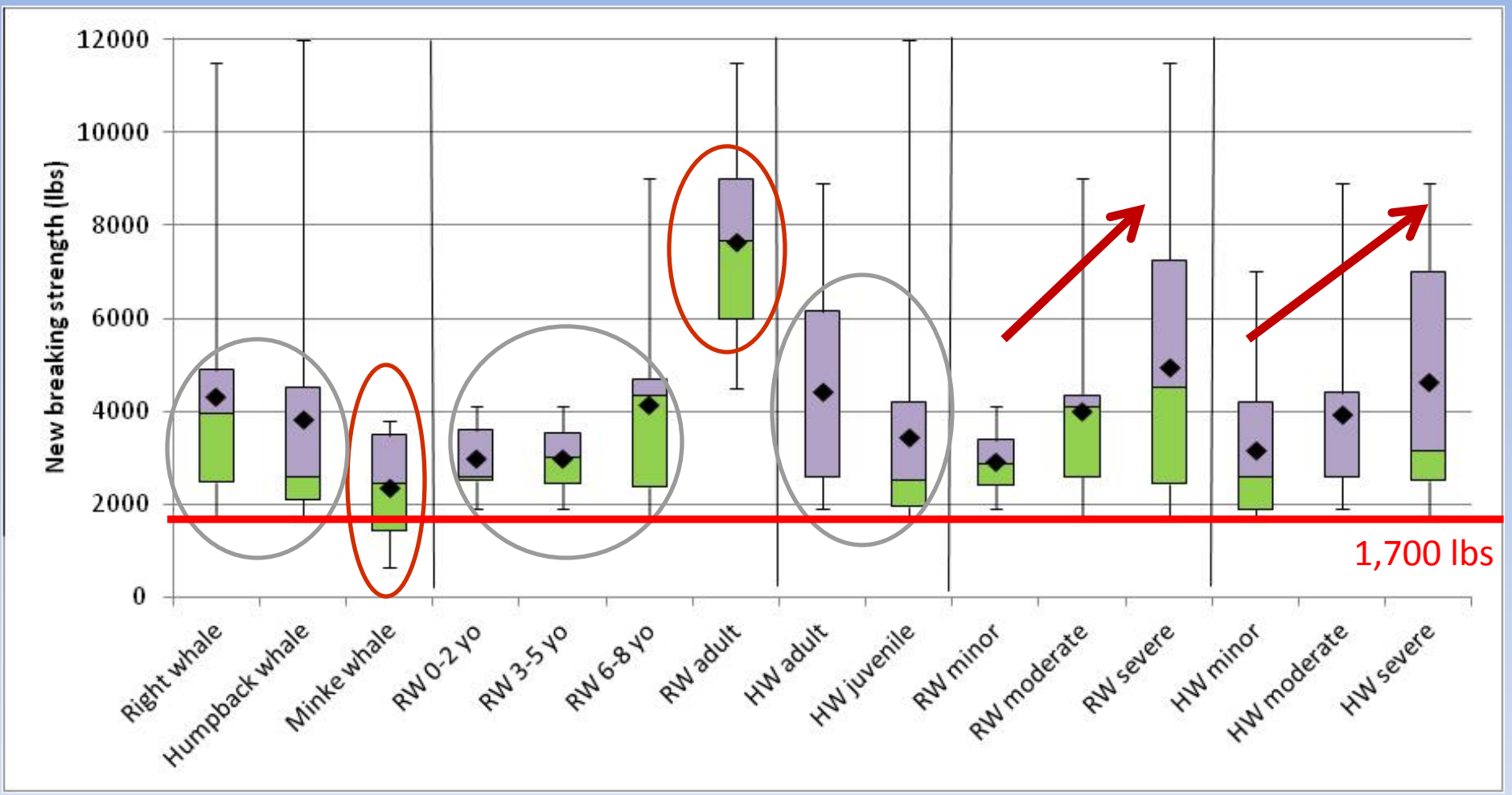


70 large whales with 132 retrieved ropes

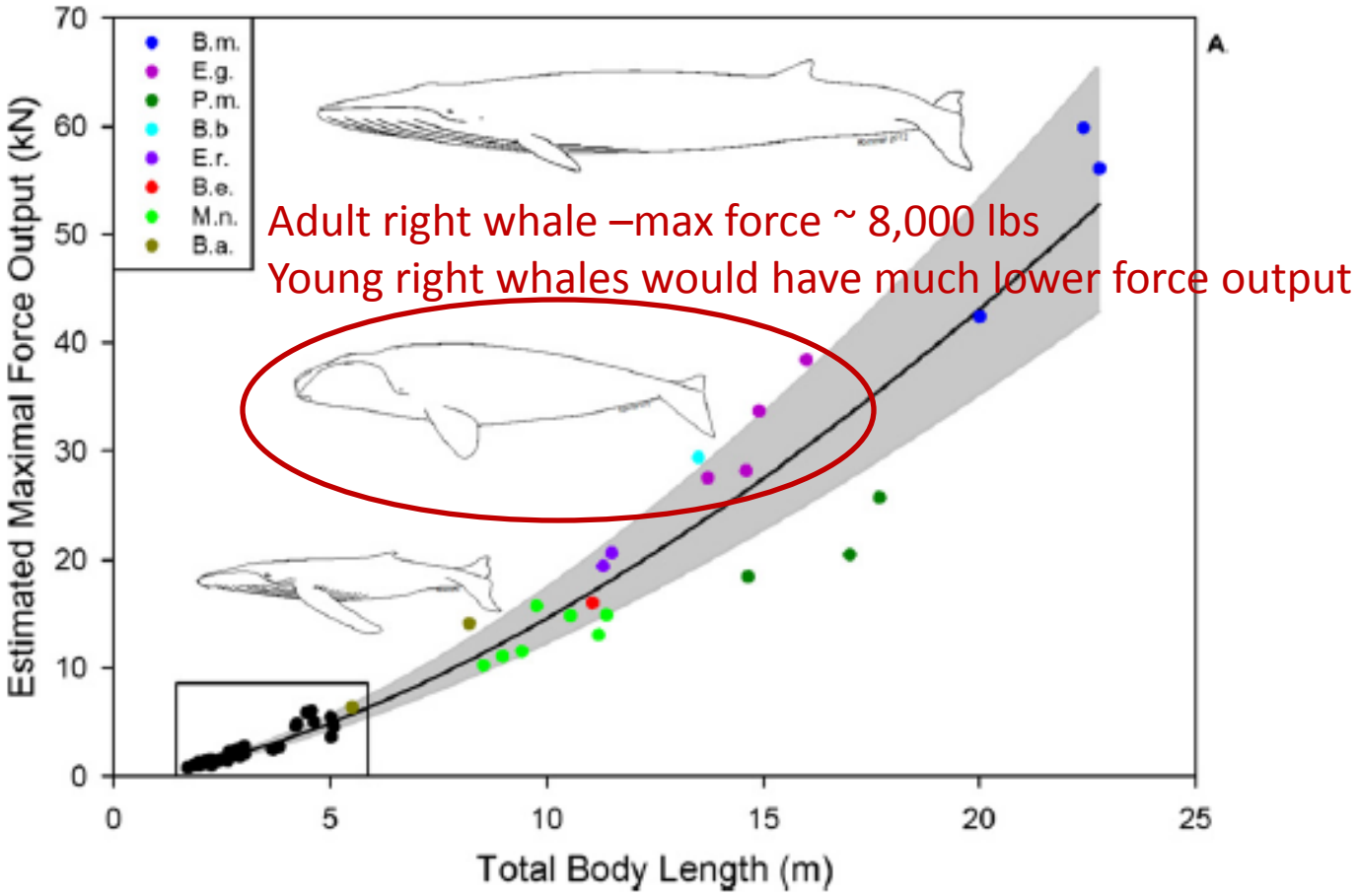
Used strongest rope for each case

30 RW, 30 HW, 8 MW, 2 FW


Right whales by age
New rope breaking strength (lbs)
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
Rope diameter (inches)
Adult
Juvenile 6-8 yo
Juvenile 3-5 yo
Calf/juvenile 0-2 yo
Unknown age

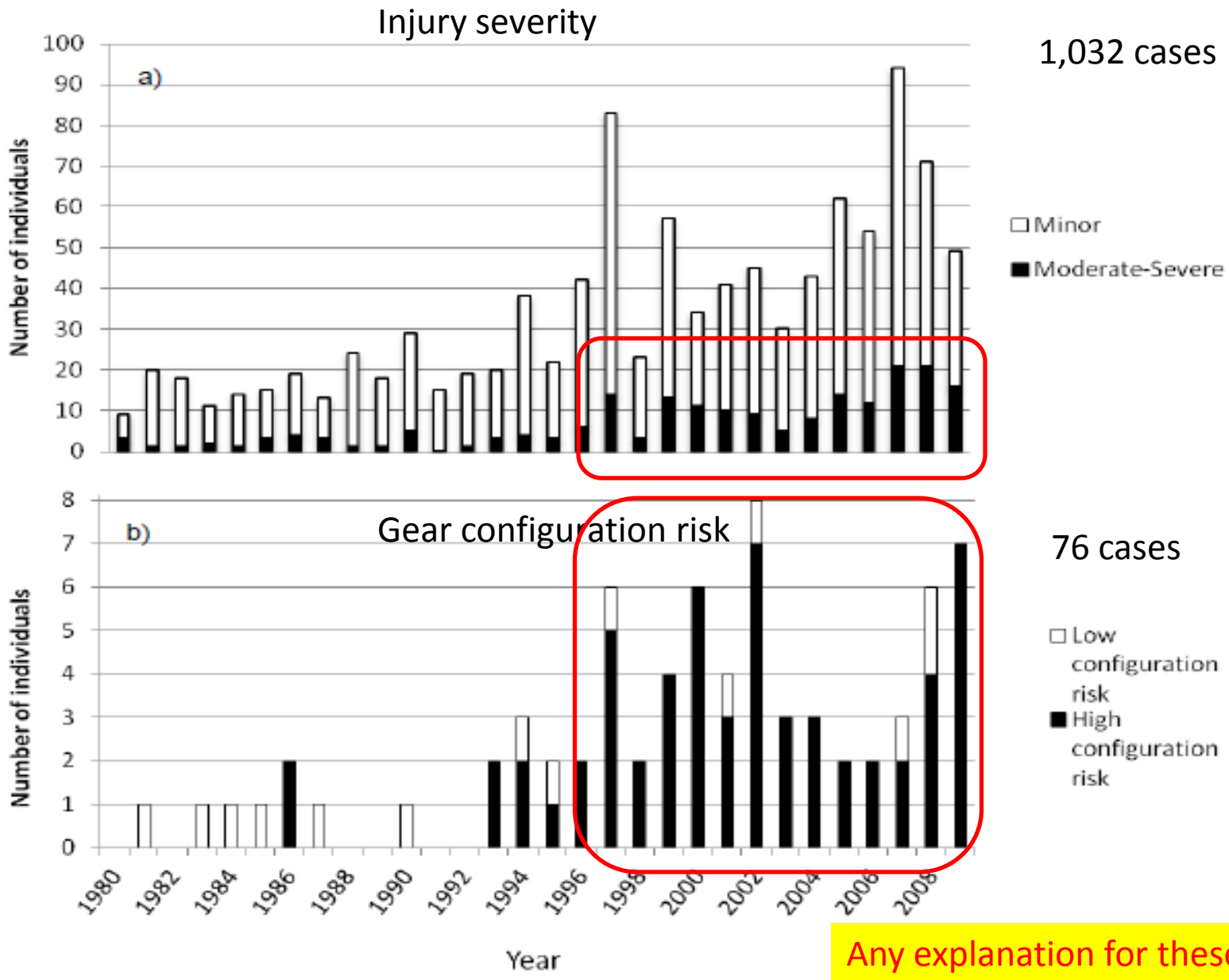


- Minke's in significantly lower breaking strength than right and humpback whales
- Adult right whales in significantly stronger ropes than juvenile RW and all humpbacks
- Breaking strength trended upward with injury severity

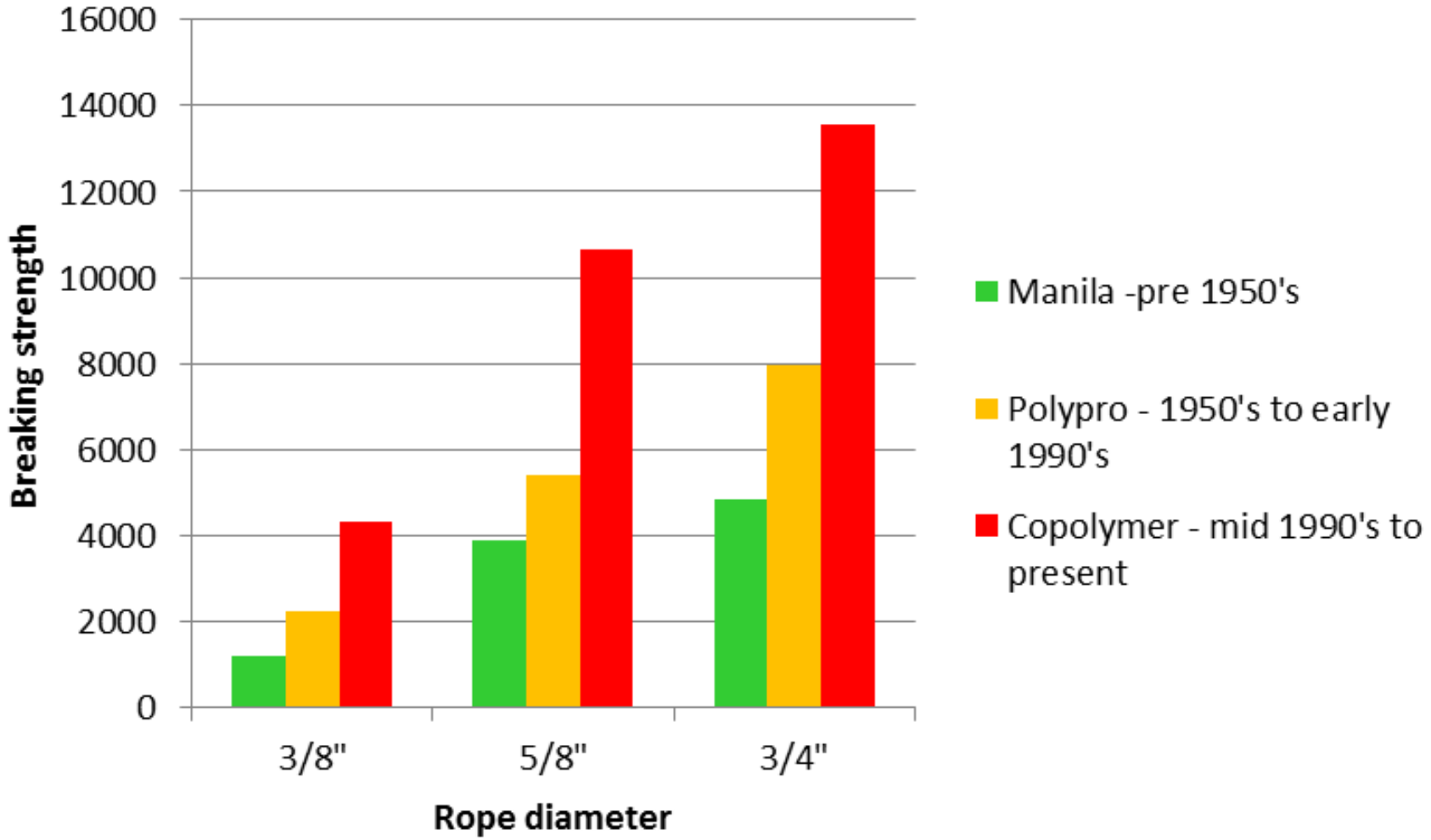


Our findings meshed with findings of Arthur et al. which show increasing estimated force output based on musculature and total length

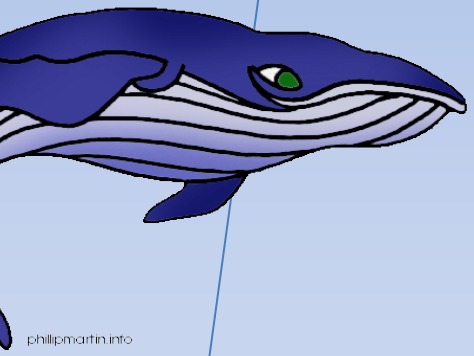
Arthur LH, McLellan WA, Piscitelli MA, Rommel SA, Woodward BL, Winn JP, Potter CW, Pabst DA. 2015. Estimating maximal force output of cetaceans using axial locomotor muscle morphology. Marine Mammal Science DOI: 10.1111/mms.12230.


Injury severity
a)
Number of individuals
100
90
80
70
60
50
40
30
20
10
0
Minor
Moderate-Severe
1,032 cases
b)
Gear configuration risk
Number of individuals
8
7
6
5
4
3
2
1
0
Low configuration risk
High configuration risk
76 cases
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
Year
Any explanation for these temporal changes?

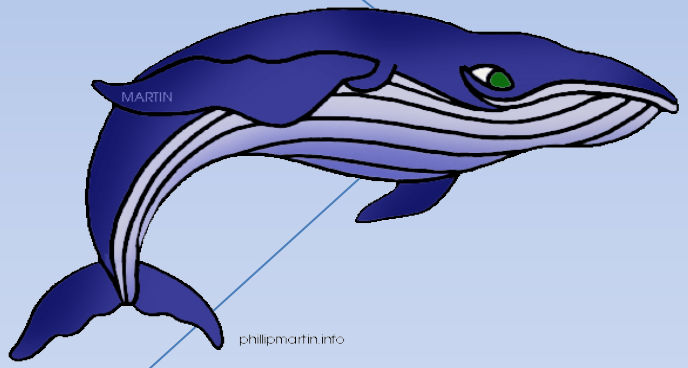
Rope manufacturing changes



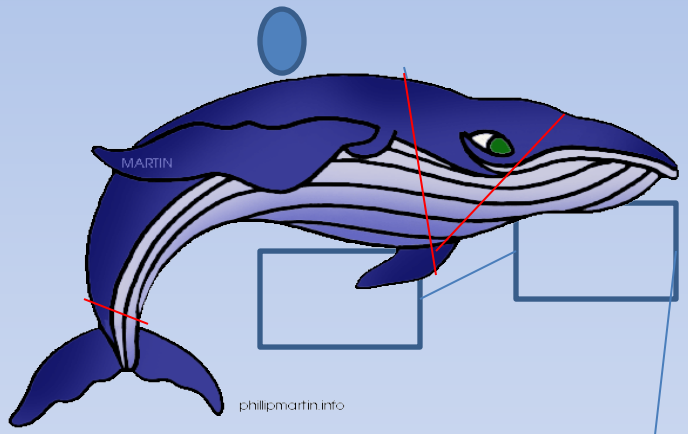
STRONG ROPE



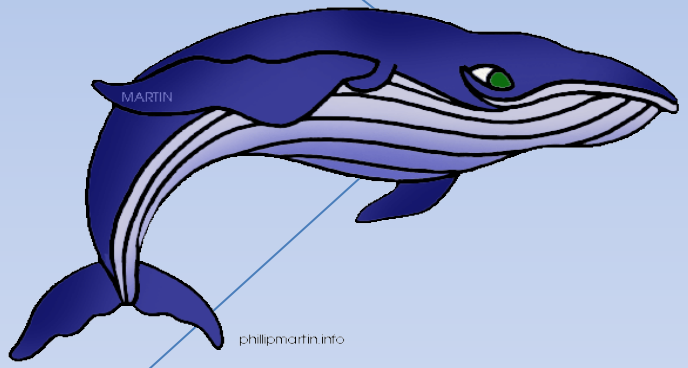
STRONG ROPE



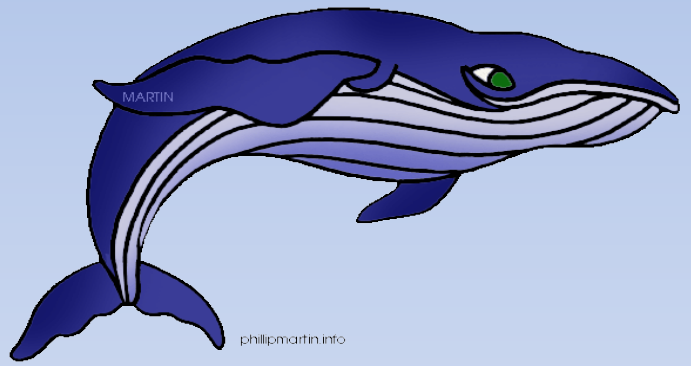
STRONG ROPE



WHALE RELEASE ROPE



WHALE RELEASE ROPE

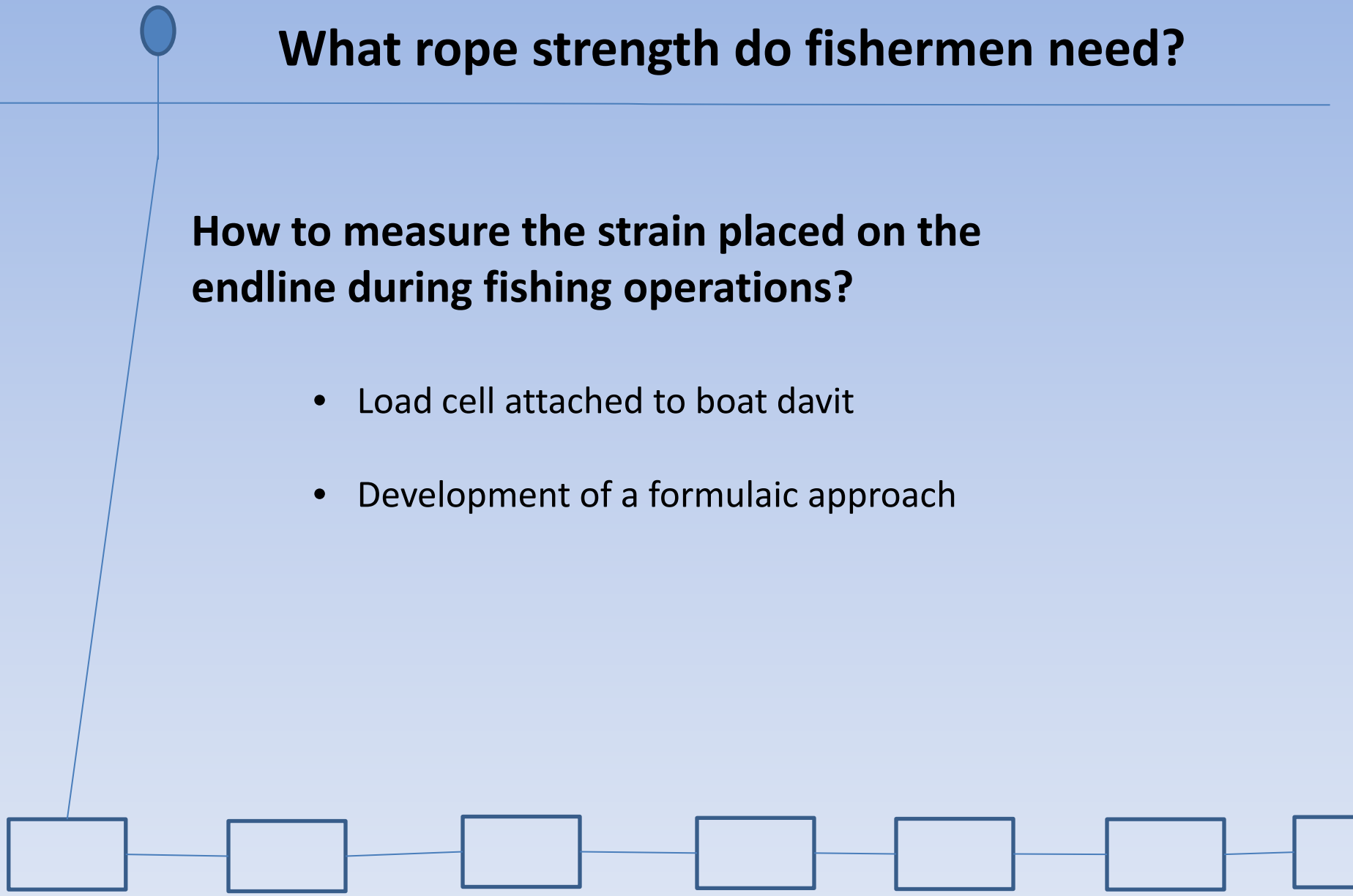


This could also benefit fishermen as it would be less likely that their gear would be shifted from where it was set and they could grapple for it

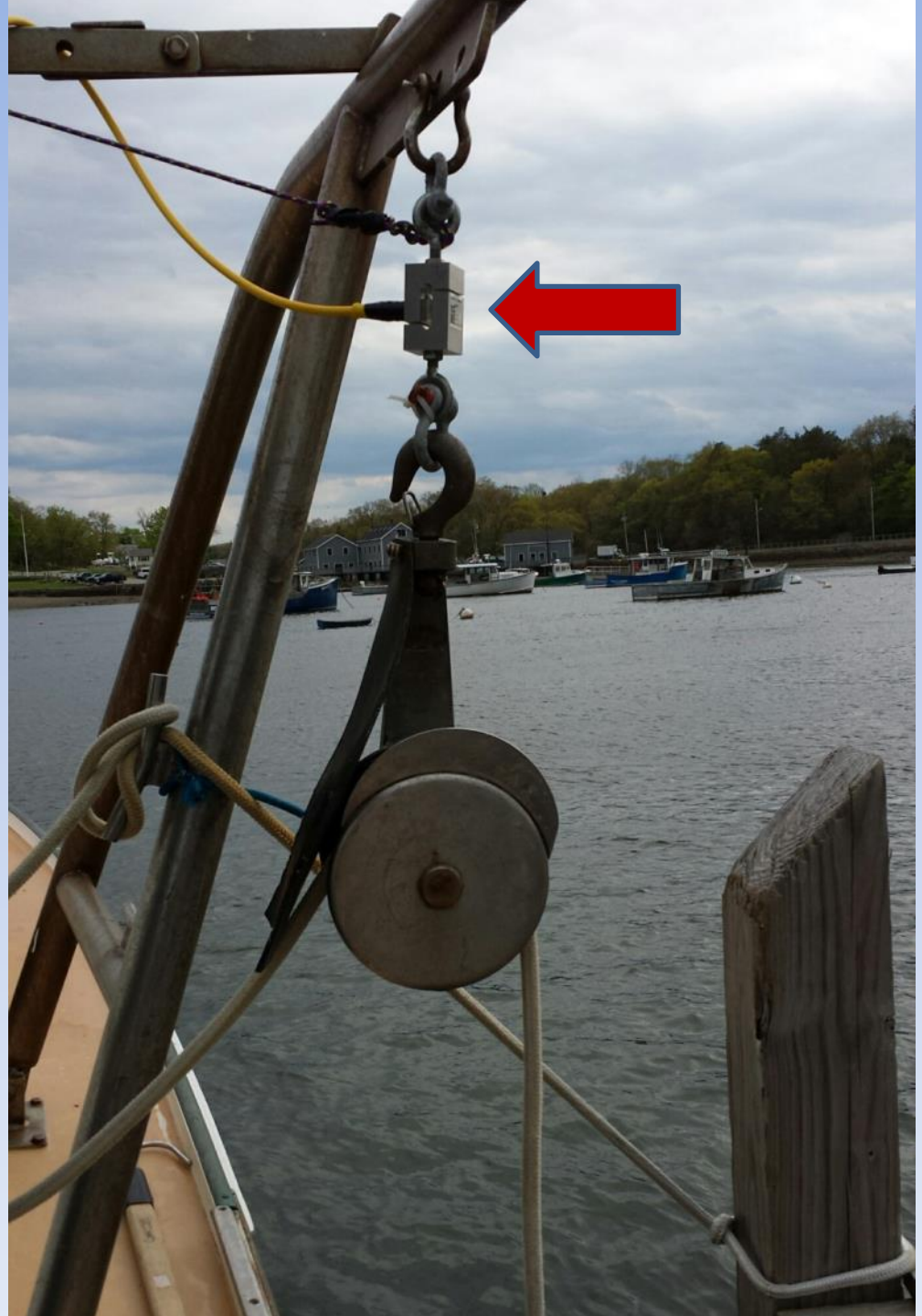
What rope strength do fishermen need?

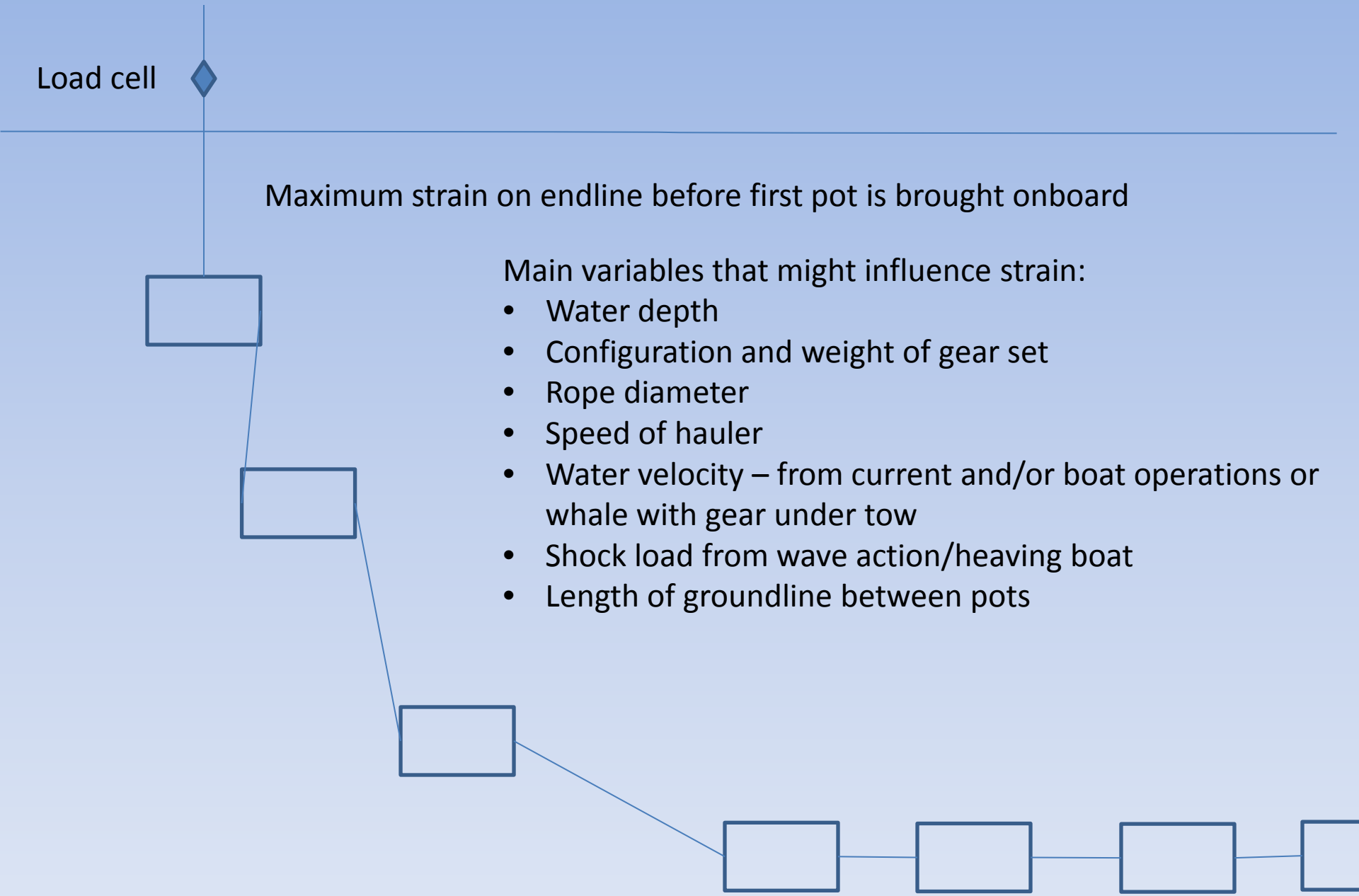
How to measure the strain placed on the endline during fishing operations?

- Load cell attached to boat davit
- Development of a formulaic approach




MISS ATTITUDE



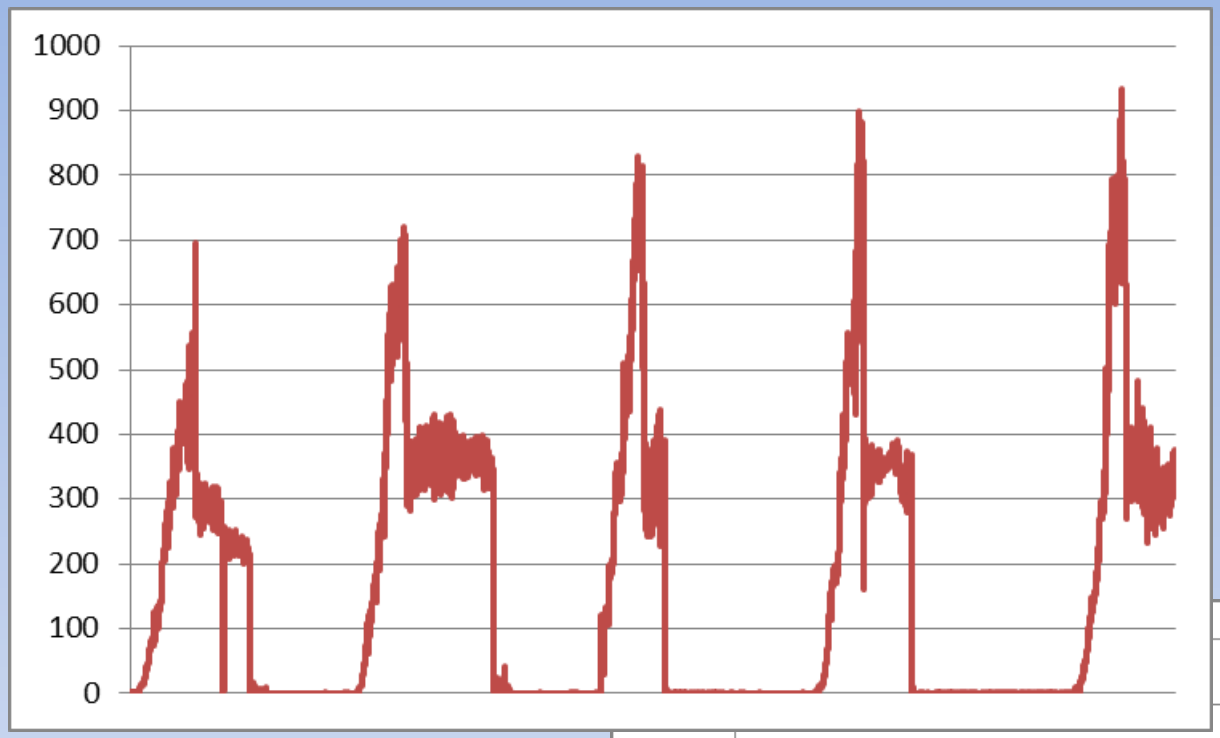


Maximum strain on endline before first pot is brought onboard

Main variables that might influence strain:

- Water depth
- Configuration and weight of gear set
- Rope diameter
- Speed of hauler
- Water velocity – from current and/or boat operations or whale with gear under tow
- Shock load from wave action/heaving boat
- Length of groundline between pots

AT SEA TESTING

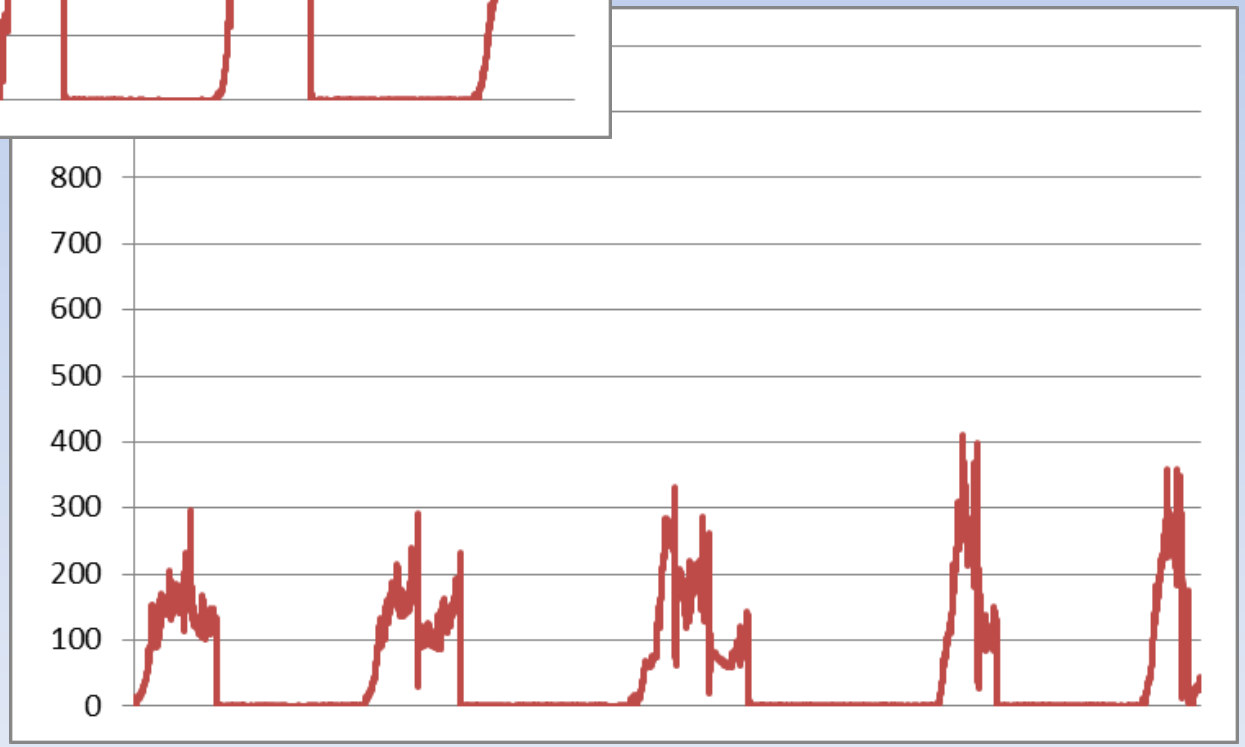


Hauling 5 pot trawl in 200 ft water depth

With ~90 ft of groundline between first and second pot

With ~210 ft of groundline between first and second pot – “groundline extension”

= notable reduction in strain



TOWING A SINGLE POT AT VARIOUS SPEEDS

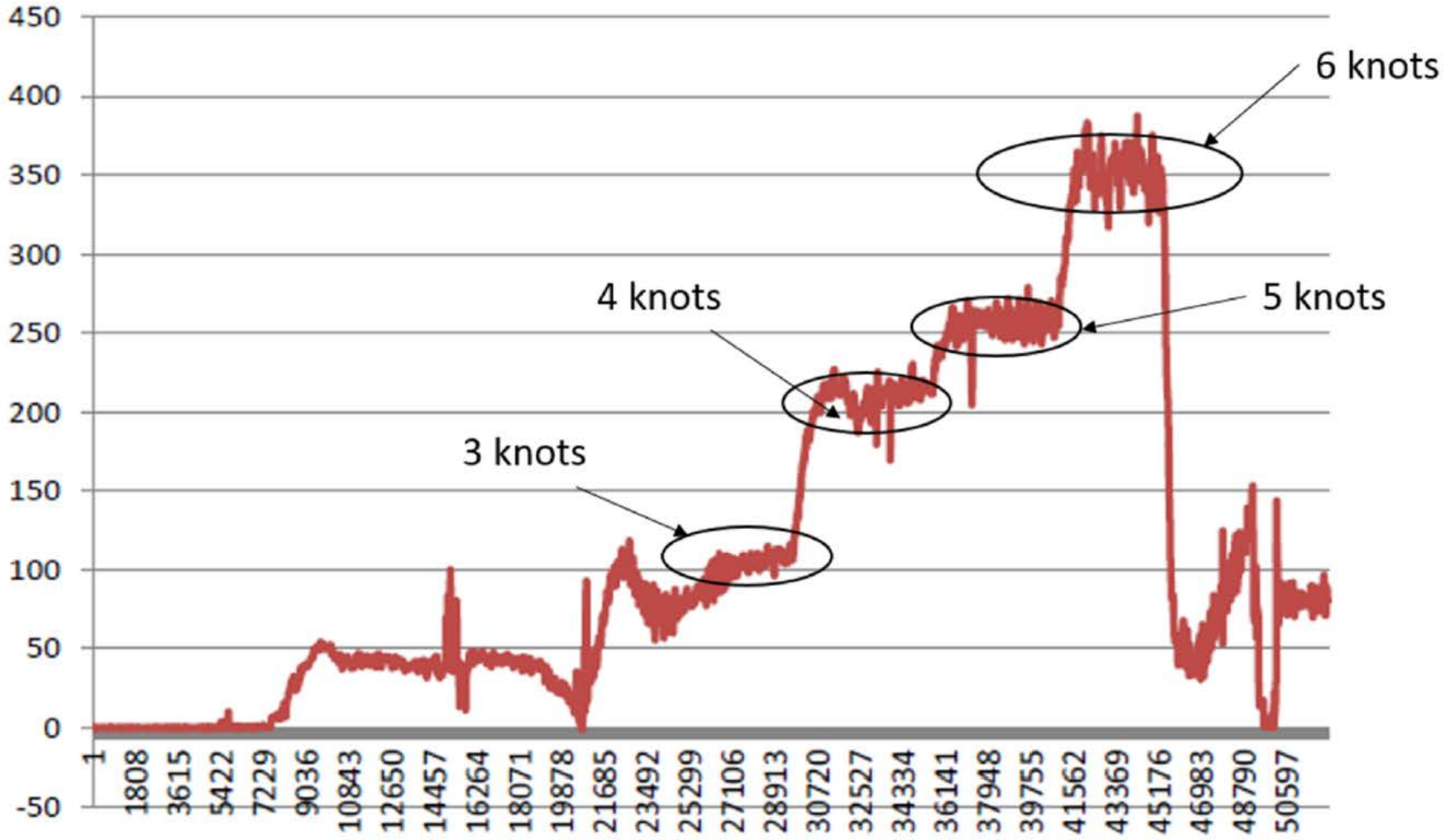


Figure B1: The single lobster pot system line tensions as measured by NEAq personnel

Formulaic approach

- Consulting with engineer Dr. Jud DeCew
- Using OrcaFlex software – used in oil and gas industry to understand strains placed on ropes
- Can plug in a variety of changeable parameters to build a model
- Can evaluate different water depths, gear configurations, and water velocities
- Preliminary results are available and under review
- Will continue to ground truth the model with some at-sea testing

Component	Parameter	Value
Line	Diameter	0.375”
	Material	Polypropylene
	Mass (dry)	0.028 lb/ft
	Mass (wet)	-0.004 lb/ft
	M.B.L.	2161 lbf
Lobster Pot	Dimensions	48” x 22.5” x 15”
	Mass (dry)	65 lb
	Mass (wet)	57 lb
	Drag coefficient	1.395

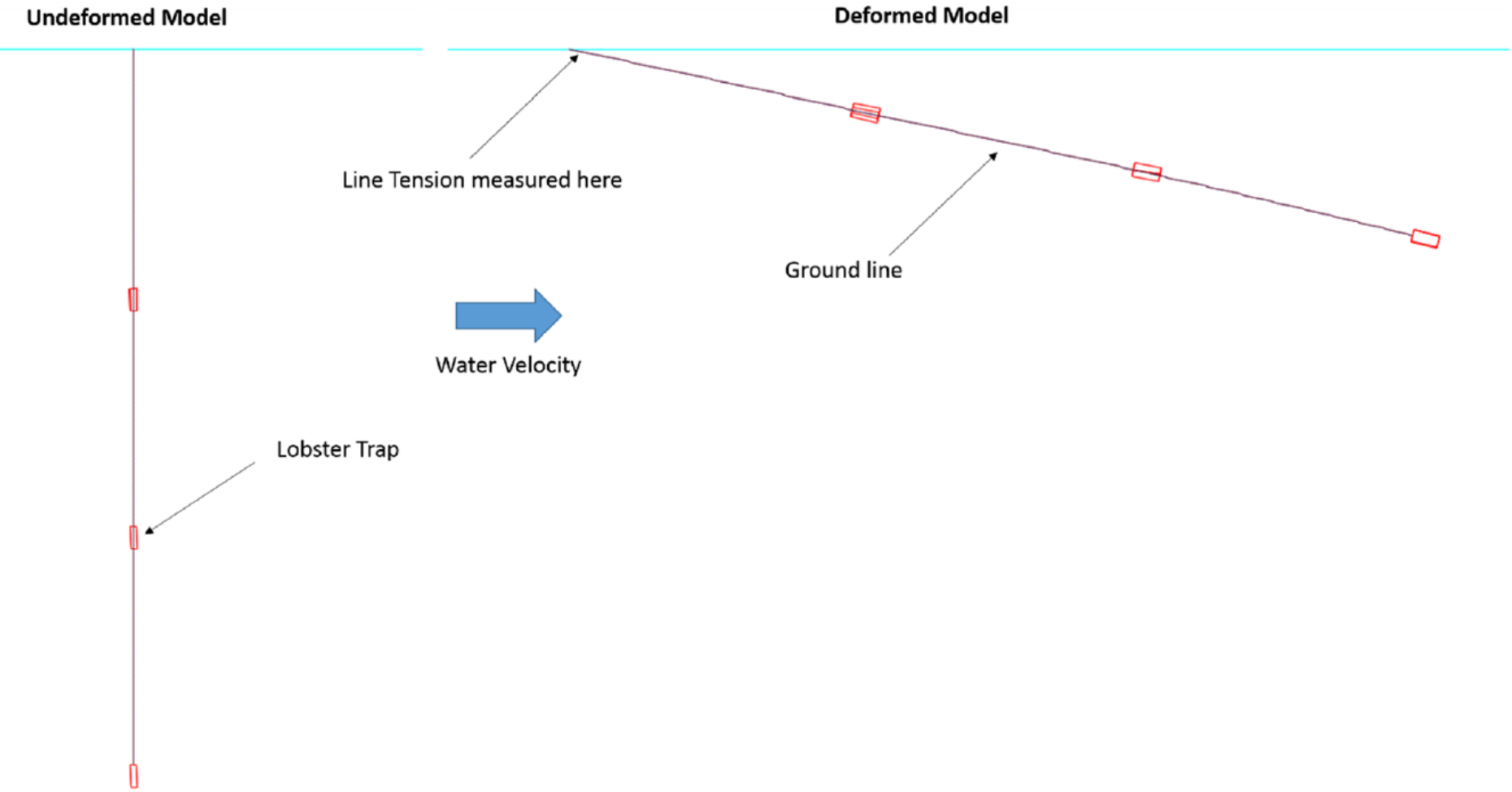


Figure 9: The baseline system subjected to a 2.9 knot (1.5 m/s) water velocity.

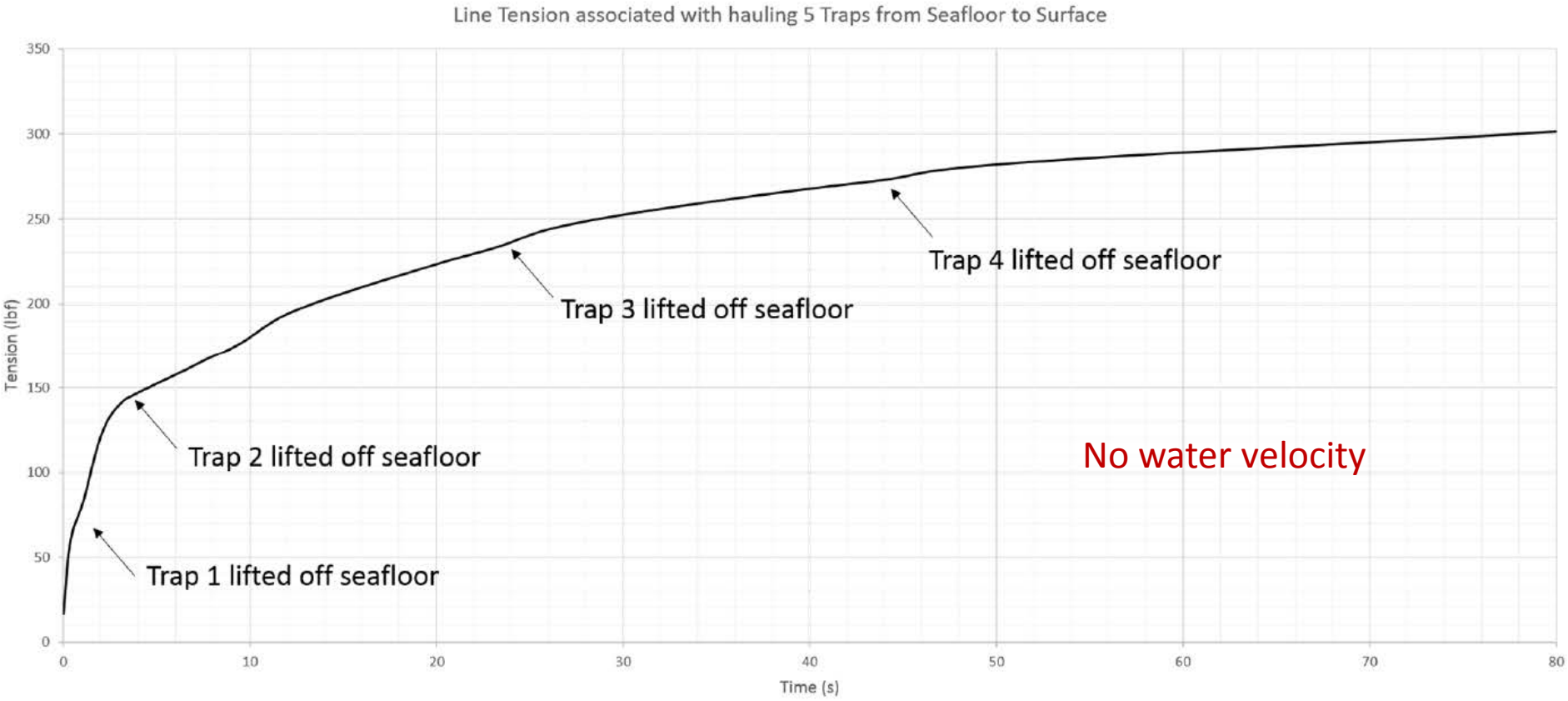
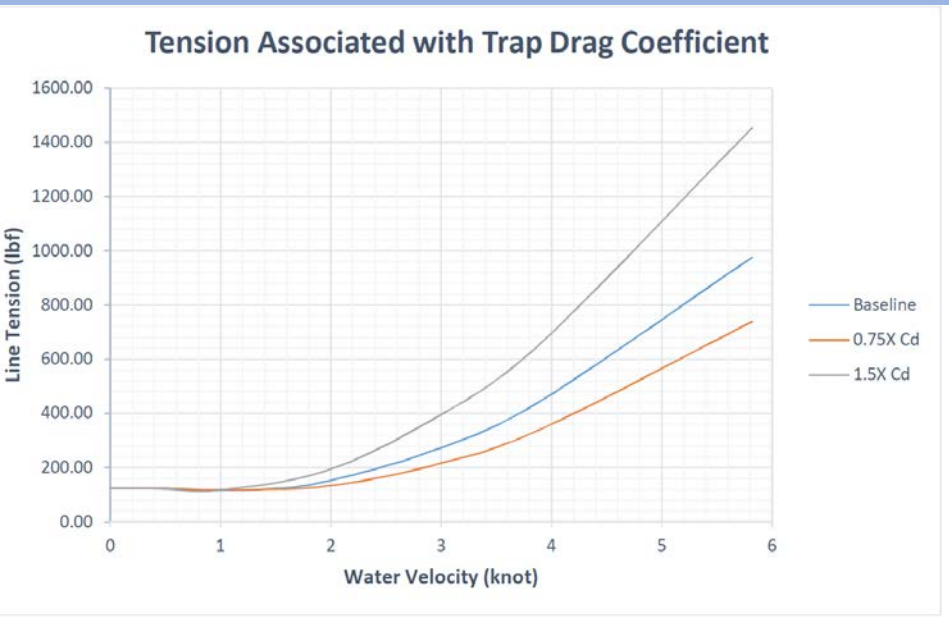


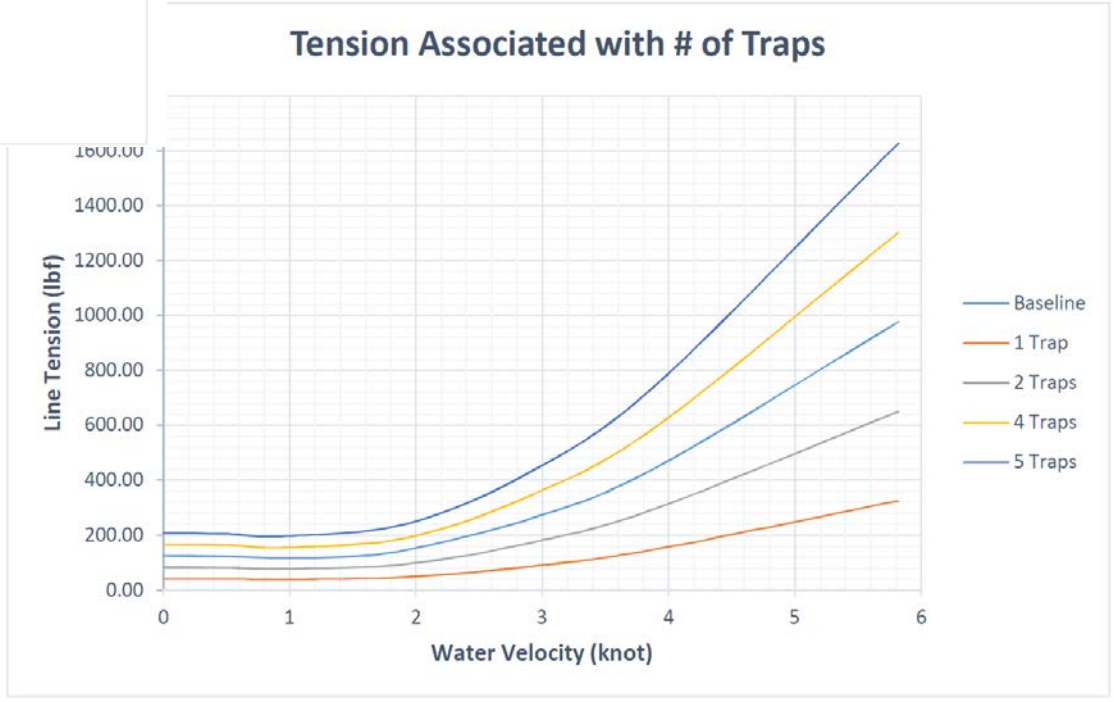
Figure 30: The line tension associated with a simulated recovery of a 5-lobster trap system, which initiated from the seafloor.

Simulated hauling of a 5 pot trawl with no water velocity – maximum strain 314 lbs

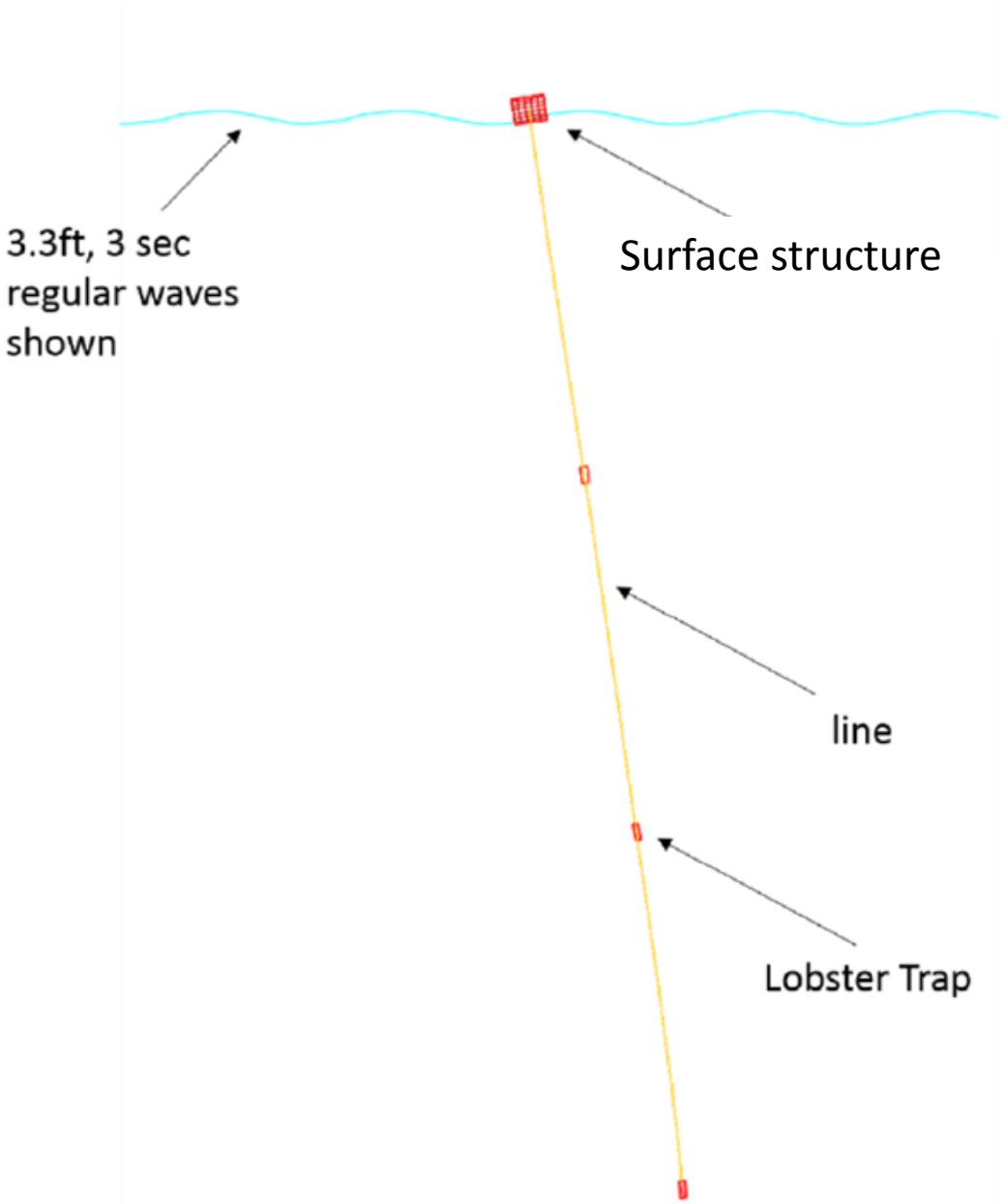
Sensitivity analyses of static parameters



Trap drag coefficient and # of traps on the water column had the most sensitivity as water velocity increases

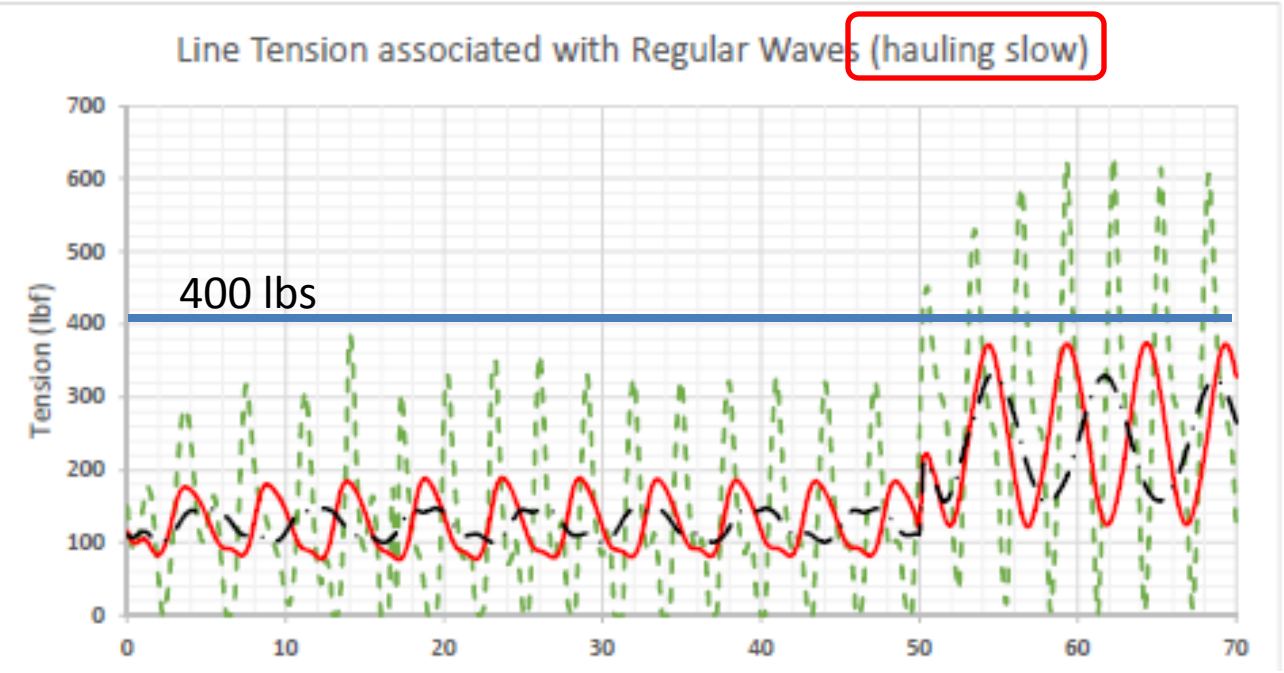


Influence of wave action and hauler speed



3 pots in the water column

3.3 ft (1 meter) wave height



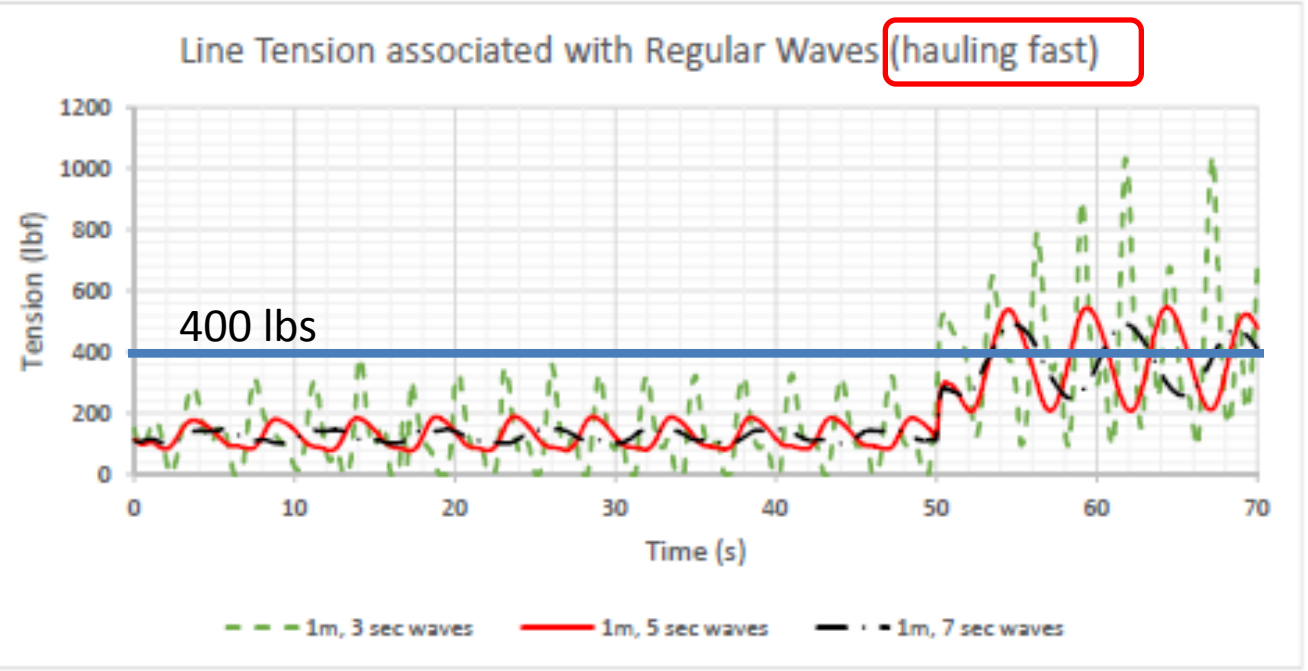


Figure 26: The line tension of the baseline system in regular waves, with fast (1.463 m/s) line hauling

Different wave periods

Hauling initiated at 50 sec mark

Hauling speed can dramatically influence rope strain especially as waves are closer together

Peak at slow hauling is ~ 600 lbs

Peak at fast hauling is ~1,000 lbs

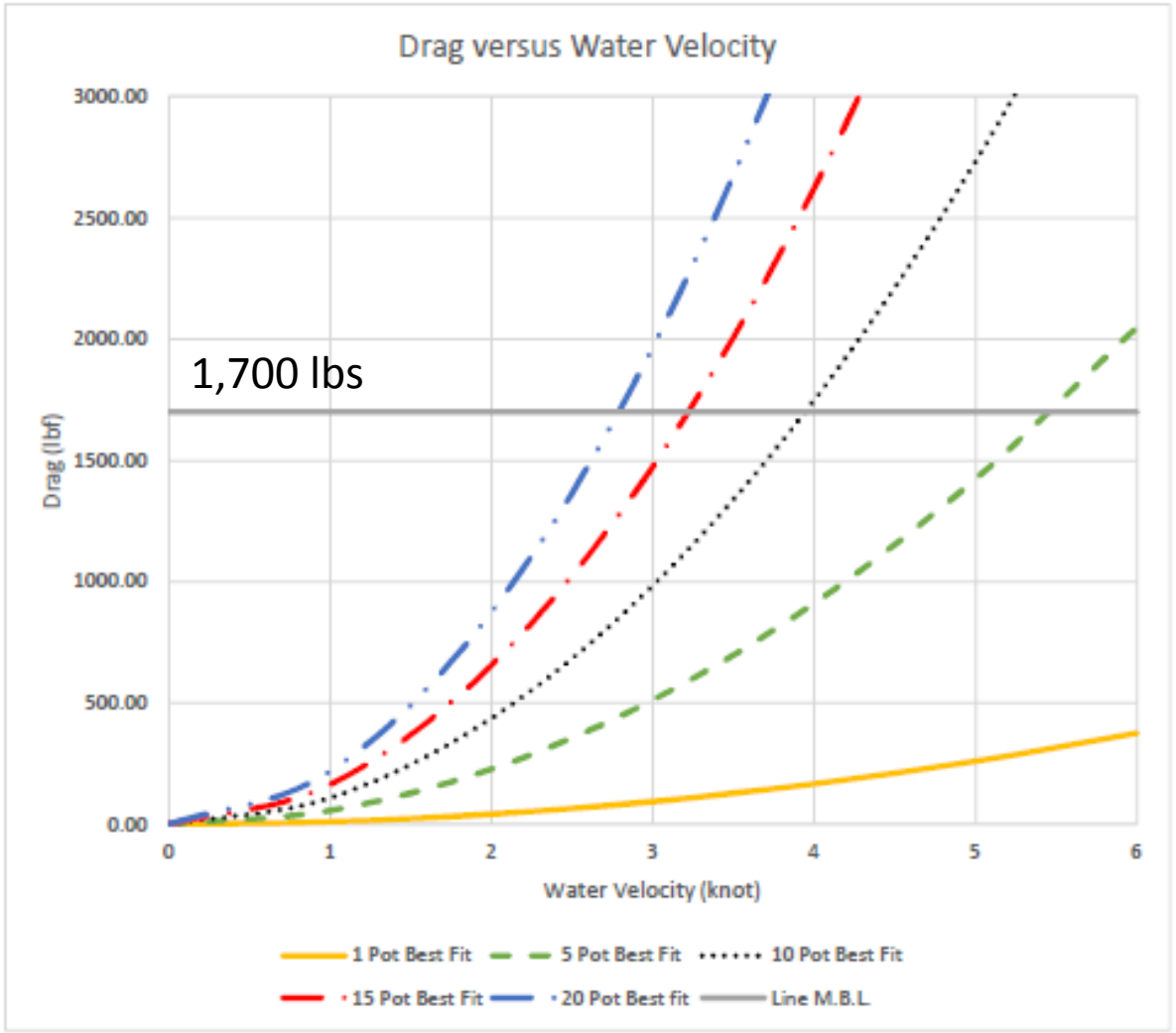


Figure 6: The velocity square best fit curves for a variety of lobster pot systems based on field data for a 1, 2 and 5 trap system. Each curve is governed by the equation shown in Table 4.

If a whale reacts by increasing its velocity when entangled, the greater the # of pots attached, the more quickly the whale will reach the 1700 lb breaking strength.

Trawling up may be a benefit AS LONG AS the end line is of reduced breaking strength

Reducing the # of pots in the water column at any one time will reduce the hauling strain

With reduced breaking strength endlines, if sinking groundlines are stronger, may help with gear retrieval

Main findings

Operational measures can be taken to reduce the strain while fishing:

– reduce hauler speed especially in high seas
– reduce # of pots in water column (until reach stronger sinking groundline) – groundline extension
– try to keep vessel over the top of gear when hauling

Main findings

Main parameters effecting rope strain

- Drag coefficient and # of pots in the water column
- Water velocity
- Wave height and period
- Hauler speed

Parameters that will be further tested: line stiffness/stretchiness, influence of groundline extension, bigger wave heights

Status of whale release rope manufacturing and testing

Weak Rope Trials: 2006-2008

Three separate batches

Rope types: 5/16" and 3/8" diameter; 600 and 1200lb breaking strength

Rope was fished as endline and usually spliced with float rope on lower third

"Fishable" in many parts of Maine

Where rocky bottoms and with stronger tides and currents, they reported concerns about an increased likelihood that ropes would break over what they typically use

Prior studies to assess whether weak ropes are "fishable" have been done

Goal is to create and test a variety of whale release ropes that are not costly

Status of whale release rope manufacturing and testing

3 different whale release rope types

- Hollow braided sleeve to create weak links in rope
- Cut strand rope – cut a specific # of strands in regular rope to create weak links in rope
- Reformulated rope to be 1700 lb breaking strength along entire length

Status of whale release rope manufacturing and testing

- At sea testing – late spring/summer 2017
  - Will compare whale release prototypes with control ropes to evaluate gear loss, degradation, and handling concerns
- Lab testing will be done before and after at sea testing

Paradigm shift in fishing is essential

- Make **all** gear ideally "safe" or at least "safer" for whales
- Ropeless fishing techniques would eliminate entanglements
- Red/orange colored ropes may prevent many entanglements from occurring (according to studies by Kraus and others)
- Whale release rope (<1,700 lb breaking strength) would reduce severity of entanglements
- Other measures such as sinking groundlines, end line reduction and closures would reduce the frequency of entanglements by lowering the amount of rope in the water column
- Measures would need to be implemented throughout the right whale's range in the U.S. and Canada

Acknowledgements

Grant support to the Bycatch Consortium and the Anderson Cabot Center from:

- NOAA Fisheries
- Massachusetts Executive Office of Energy and Environmental Affairs
- Island Foundation
- Volgenau Foundation
- Cross Foundation

At sea load cell testing:
- Monica Zani
- Mike Lane

Formulaic testing
- Jud DeCew

Fishing industry feedback and at-sea testing
- Mass Lobstermen's Association
- Maine Lobstermen's Association
- South Shore Lobster Fishermen's Association