Anderson Cabot Center for Ocean Life at the New England Aquarium

Whale-release Rope: An Overview

What is whale-release rope? Whale-release rope is a pot or gillnet vertical line that has a ***virgin breaking strength* of 1700lbf (7562N) or less**, which is weaker relative to what is currently used in the northeastern U.S.

Why use weaker rope? **Scientific evidence indicates that whale-release rope would contribute to reducing North Atlantic right whale (NARW) entanglements***.* Historical records show that the incidence and severity of NARW entanglements correlates with an increase in the breaking strength of ropes used in northwest Atlantic pot fishing, specifically linked to the adoption of co-polymer ropes which replaced ones manufactured with weaker synthetic fibers--such as polypropylene--and before that natural fibers that were even weaker at similar diameters. An analysis of specific whale entanglement cases showed that NARWs were more likely to be found entangled in ropes of higher breaking strengths, and that **reducing the breaking strength to 1700lbf or less would lead to fewer and less severe whale entanglements** (Knowlton et al., 2016).

Is switching to 1/4" diameter rope an option for achieving ropes that meet the objective of fishing with weak rope? Ropes of this diameter often have the reduced breaking strength that would qualify them as weak rope; however, several research studies have consistently shown that these ropes could lead to more severe lacerations more quickly, and therefore **the health risk might negate any possible benefits of using these lower breaking strength ropes**.

What is the "South Shore Sleeve"?
The braided sleeve design, a design from the South Shore Lobster Fishermen's Association and developed by rope manufacturer NovaBraid, is a 3- to 6-foot hollow braided sleeve that can be integrated into typical three-strand fishing ropes. This is achieved by cutting the three-strand rope and inserting the bitter ends into each end of the sleeve at a side-cut until they meet in the middle. A small length of the sleeve is tucked in to the rope at both ends to help ensure the rope will not pull out of the sleeve. In lab tests, the sleeves break on average at 1600lbf (Figure 1).

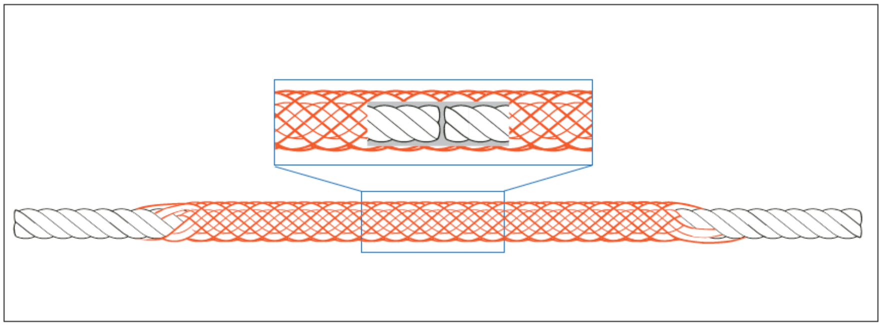

Figure 1. The "South Shore Sleeve" tested by lobster pot fishermen off of the eastern U.S. The diagram shows the sleeve (colored orange) integrated into a typical vertical line that has been cut so that it can be inserted into the sleeve. (M. Riley, NEAq).

What is the difference between a rope of reduced breaking strength throughout its entire length versus one that has weak points located at particular locations? As long as there are places along the rope that have a breaking strength of 1700lbf or less, the benefit of the rope to whales should be realized unless that weak point is somehow nullified. This might occur if too few weak points are incorporated into the rope. For example, a single weak point could become lashed securely on the body of a whale or placed above the point where the whale hits the rope and not allowing the rope to part from the heavy bottom gear. To improve the likelihood of weak ropes functioning as intended, a rule of thumb when using the braided sleeve rope (*see above*) is to insert a "weak link" every 40ft. That length was derived from the average length of a NARW. By spacing the placement of weak inserts at a distance of one NARW body length, the rope likely would part below the whale as it swims or thrashes, reducing the chance of it trailing heavy gear and above the whale as the surface buoys are pulled subsurface creating another counterforce. The amount of drag would be lower once the rope parts in these multiple points compared with longer trailing lines often seen in entanglements (van der Hoop et al., 2017). Trailing line and gear can create drag on a swimming whale that reduces its available energy (van der Hoop et al, 2016), which can lead to ropes becoming more embedded in the tissue and also result in other adverse health effects to the individual whale and the population.

There is insufficient information about the range of behaviors exhibited by whales when they encounter ropes to suggest an optimal location of only a single weak point. Furthermore, **it is likely that entanglements in vertical lines occur throughout the water column, from the surface to the bottom, where whales and their prey are both known to occur**. Whales occur in both surface waters and deep on the seafloor even when transiting as shown from satellite-tagged individuals (Mate et al., 1997) and photographic evidence (Hamilton and Kraus, 2019). A recent study that used a computer model to simulate whale entanglements in rope used in lobster pot gear demonstrated that those occurring closer to the sea floor increased the risk that the entanglement would be complex and life-threatening (Howle et al., 2019). It is therefore important to design weak ropes so that they can produce the desired effect at all depths where entanglements can occur by locating weak spots at multiple locations (</= 40') or have the entire length of the rope consist of this reduced breaking strength. It is possible to make the entire rope with a breaking strength of 1700lbf at 3/8" diameter. Some

manufacturers have produced such rope in the past; however, at least one of these prototypes costs more than using braided sleeves. If such ropes could be produced at target diameters and be demonstrated as practical for fishing, they could serve as alternatives.

As presently required under U.S. regulations, don't weak links placed at the upper end of the vertical line where they attach to the buoy produce the same effect? The purpose of the NMFS-regulated weak link was to facilitate parting of the surface buoy from the endline to help ensure the whale could fully shed the gear. Hypothetically, that would only occur if the rope slides through the mouth or across the body to that weak link before the whale becomes entangled (NMFS, 2000). Presumably, the drag or counterforce required to trigger this particular weak link is not always effective, if at all, as many cases of entangled whales have gear retrieved in which this weak link remains intact. Furthermore, it is clear from the high frequency of baleen whale entanglements that ropes do not slip easily through the baleen before becoming wedged. **The objective of weak rope is to have the break occur as soon as possible once contact is made with the rope, and to reduce the amount of entangling and trailing line that can occur.** Unlike weak links positioned at the base of the surface buoy, a precautionary approach is to have multiple weak links placed at 40ft intervals along the endline or to construct the entire rope at the target strength.

If putting a knot in a rope reduces its breaking strength, would this be a simpler way to reduce its breaking strength? Tying a knot into a rope creates a weak point in the rope that reduces its breaking strength by approximately one-half. It can therefore serve the purpose of inserting a weak point in the rope that might break at 1700lbf or less; however, NOAA Fisheries recommends that knots not be used because of the increased possibility **that the knot can lead to ropes causing damage to baleen or becoming lodged within it, and lower the probability of ropes sliding through the mouth or off the flippers or fluke** (NMFS 1997). The presence of knots may also be more likely to increase the probability of catching in other parts of the rope that could hinder shedding of the entangling gear.

Are whale-release ropes practical for pot fisheries in the northwest Atlantic? The principal considerations for fishermen have to do with the potential for ropes to break at a higher rate,

and the safety hazards these breaks may pose. **Loads measured on lobster pot vertical lines both in the field with lobster fishermen and using computer engineering models have shown that they generally fall well below 1700lb during typical fishing operations (including hauling), and can be reduced further through basic changes to fishing practices. For example, avoiding excessively fast hauling speed especially in high seas, increasing the length of groundline between the first and second traps in multi-trap trawls and hauling as directly as possible over the buoy line so that it is as perpendicular as possible to the surface of the water are operational changes that can reduce tension** (Knowlton et al, 2018). Vertical lines are certainly prone to breaking under high strain, such as when hang-downs occur, and undesired parting occurs even when stronger ropes are used. It may be that in instances when ropes break either from passing vessels snagging them or from whale entanglements, that the shorter time between an encounter with a rope and when it breaks might reduce the distance in which the gear could be dragged and therefore fishermen may be more successful in relocating their gear for retrieval.

How can we evaluate if whale-release ropes are appropriate for particular fishing circumstances? NEAq research scientists have worked with an engineer to tailor a computer model that accurately calculates loads on lobster pot gear (DeCew 2017). **By inputting the weight, drag coefficient, configuration of the pots, the length of the rope, and other basic variables, this program can produce reliable estimates of gear loads on a vertical line under different water current and hauling speed scenarios**.

Have whale-release ropes been evaluated by fishermen? Yes. The Maine Lobstermen's Association tested early prototypes and found them to be relatively reliable along much of their coastline (Bycatch Consortium, *unpublished data*). A controlled longer-term study was carried out with lobster, crab, and whelk fishermen from Massachusetts and New Hampshire, with the results reported in Knowlton et al. (2018). Lab and field tests of vertical lines with braided sleeves showed that they broke at just below 1700lbf and are feasible during normal fishing activity as only 11.8% of experimental endlines were reported broken or missing in comparison to 8.5% of control endlines. After 35 hauls, there was almost no reduction in breaking strength of the sleeves, while control lines lost approximately 9% of their virgin breaking strength after fewer than 15 hauls. Furthermore, several fishermen in Massachusetts report using the sleeves through three seasons and continue to fish with them integrated into their buoy lines. Ropes with braided sleeves integrated or ropes manufactured entirely with a reduced breaking strength also pass easily through current deck haulers.

Are braided sleeves expensive or do they involve challenging rigging requirements?
It takes approximately 2-3 minutes to splice in a single sleeve, although with practice and the use of a splicing fid tool this time can be reduced. Each 6-foot sleeve costs just over $2 to acquire at present but can be cut in half and be just as effective at a 3-foot length, and requires no other modification in rigging in order to haul it onto the gunwale or perform any other fishing operation using existing equipment or operational practices.

What is the influence of gear configurations on increasing rope breaks before whales become entangled? Computer models suggest that the higher the counter force of bottom gear weight and surface flotation, in combination with other drag forces generated by ropes and water current, the higher the probability that the 1700lbf tension will be attained when a whale becomes entangled (DeCew, 2017). **The extent to which a thrashing or swimming force of an entangled whale contributes to the load on the rope in which it is moving against or in which it is entangled remains to be determined.** Nevertheless, these forces, at least in some cases, exceed those from the typical load created when fishing pots are hauled, and thrashing behavior has been observed in whales encountering ropes. Entanglement scenarios run to date show that the breaking strength threshold is attained by a constant swimming speed even when not introducing the high forces generated by thrashing.

What are the next steps? The dynamics of how whale-release ropes function to reduce entanglement incidence and severity is part of on-going research using different computer models, including one that simulates whale entanglement scenarios (Howle et al., 2019). Although how ropes will function when a whale encounters and interacts with the gear is still under investigation, historical trends and analysis of gear removed from entangled whales both provide evidence showing that reduced breaking strength ropes will contribute to short- and long-term reduction in NARW entanglements and impacts.

References

DeCew, J. 2017. Numerical analysis of a lobster pot system. Contract report to the New England Aquarium, Boston, MA, 61 pp.

Hamilton, P. K., & Kraus, S. D. 2019. Frequent encounters with the seafloor increase right whales' risk of entanglement in fishing groundlines. *Endangered Species Research*, 39, 235-246.

van der Hoop, J. M.,Corkeron, P., Kenney, J., Landry, S., Morin, D., Smith, J., Moore, M.J. 2016. Drag from fishing gear entangling North Atlantic right whales. *Marine Mammal Science* 32(2): 619-642.

van der Hoop, J. M. , Corkeron, P., 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.

Howle, L.E., Nowacek, D., Kraus, S.D. and Werner, T.B. 2019. Simulation of the Entanglement of a North Atlantic Right Whale (*Eubalaena glacialis*) with Lobster Trap Gear. *Marine Mammal Science* 35(3):760-778.

Knowlton, A.R., Robbins, J., Landry, S., McKenna, H.A., Kraus, S.D., and Werner, T.B. 2016. Effects of fishing rope strength on the severity of large whale entanglements. *Conservation Biology, 30*(2): 318-328.

Knowlton, A.R., Malloy, R., Jr., Kraus, S.D., *and Werner, T.B. 2018. Development and evaluation of reduced breaking strength rope to reduce large whale entanglement severity. Report* to the State of Massachusetts Executive Office of Energy and Environmental Affairs under Grant # CT EVN 0607160000 000 000 3938. 63 pp.

Mate, B. R., Nieukirk, S. L., & Kraus, S. D. 1997. Satellite-monitored movements of the Northern right whale. *Journal of Wildlife Management 61*(4):1393-1405.

NMFS. 2000. Taking of Marine Mammals Incidental to Commercial Fishing Operations; Atlantic Large Whale Take Reduction Plan Regulations. Interim Final Rule. Federal Register 65(246):80368-80381.

NMFS. 1997. Environmental assessment and regulatory impact review of the Atlantic Large Whale Take Reduction Plan and implementing regulations. NMFS Department of Commerce, National Oceanographic and Atmospheric Administration. Gloucester, MA, NMFS. 97 pp.

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