**The Financial Implications of Trap Rope Replacement: A Preliminary Assessment**

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**Introduction**

This report is based on a Biological Opinion the National Marine Fisheries Service (NMFS) is utilizing toward seeking a regulatory rule mandating a specific color scheme for rope currently used in the commercial spiny lobster trap fishery.

The purpose of this analysis is to provide a preliminary assessment of the financial implications of replacing the rope currently used for commercial trap lines with a rope of an alternative color scheme. The industry of particular interest is the spiny lobster trap fishery (vertical and “trawl” sectors). However, prior to discussing the financial implications, the motivation behind the rope replacement is discussed, as well as the physical properties of the currently used and proposed rope.

**Management Motivation for Rope Replacement**

On rare occasion, sea turtles become entangled in trap lines. Reportedly 10 sea turtles were found entangled in trap lines on the S. Atlantic side of the Upper-Lower Keys region during the 2004-2007 period, resulting in 2 sea turtle deaths (NOAA, 2009, pages 96-97). Although the associated mortality was deemed to not have a “measurable impact on the reproduction, numbers, or distribution” of sea turtles in the region, management is considering proposing trap fishery gear changes … requiring trap lines with a color scheme unique to the commercial trap industry … that would provide for better determination of the source of a line found on an entangled sea turtle (NOAA, 2009, page 152). In particular, management would like to be able to determine if the entangling line is associated with the commercial trap fishery. Presumably such an industry-specific, line color scheme would be useful in cases where BOTH the unique harvester number on the float and the unique certificate information on the trap are missing on a rope found associated with an entangled sea turtle, or associated with other environmental interactions.

The industry predominantly uses solid black, polyethylene rope for trap lines (Florida Keys Commercial Fisherman’s Association, personal communication, 2011). The length of the lines can be no more than 15’ longer than the water depth in which the trap is currently being deployed. However, the use of black polyethylene line is not necessarily unique to the commercial trap fishery. Other industrial and recreational uses occur. Using a rope with a marker/flag woven into the rope strands or a single, different colored strand woven into the rope may help identify the source. What is proposed by management is that the rope currently used by the industry be replaced, or phased out, with a rope having a unique distinguishing characteristic that can be readily identified as being a commercial trap line … if found associated with an entangled sea turtle. The following discussion addresses some of the financial issues associated with such a transition away from the solid black polyethylene rope currently utilized by the industry.

**Properties of Currently Utilized Rope and Alternative Rope**

The commercial trap fishery in the Florida Keys and other regions of the state primarily use black polyethylene rope. This is due to historical use showing that such rope has a longer life than other types and colors of ropes, particularly when used in a manner in which the rope is subjected to high levels of abrasion, tension, and ultra-violet light (UV) exposure, the latter being of particular concern for rope near the water surface. UV is particularly damaging to synthetic fibers [1, 2]. However, polyethylene rope (various forms of polyesters) is recognized as being much more durable to such factors than ropes made from other synthetic polymers (e.g., polypropylene, polybutylene, nylon) or natural materials (e.g., cotton, jute, sisal, manila) [3]. Along with other polymer fibers, polyethylene subjected to UV degradation can have dramatically reduced load limits [4, 5]. To make the polymer fibers more resistant to UV degradation, carbon black is often added [4, 6], which helps the polymer fiber to retain the useful tensile properties [1 te refps the polymer fiber to retain the useful tensile properties (on black if often added, which helps the polymer fib er]. The carbon black stops the UV from penetrating deeply within the polymer fiber, resulting in only surface degradation, rather than degradation deep within the fiber [4]. As a result, black polyethylene is often recognized as the “color” most resistant to UV, resulting in a longer life. Other “colors”, including white, do not have the UV resistance that black fibers do, resulting in a shorter serviceable life in similar conditions [3]. Useful life of some polyfiber products due to UV degradation can be as low as 2-3 years [7], although this reference was for non-marine use.

Literature would suggest that a solid black, polyethylene rope would have the greatest resistance to UV degradation. This would be a relevant issue when considering replacing one of the black strands of a 3-strand, polyethylene rope with a strand that would be white or some other color. As noted earlier, “colors” other than black will likely not have the UV resistance as the black polyethylene. Thus, the length of rope nearest the water surface, with the non-black strand, may lose tensile strength quicker than an all black rope, as the non-black strand degrades quicker due to UV exposure. A degraded strand would result in a rope that may fail sooner under load. This would then result in the need to replace the entire rope on a more frequent basis. However, a recent conversation with a senior faculty member of the University of Florida’s Department of Materials Science and Engineering suggests yet another potential flaw in a rope with a different colored strand (A. Brennan, personal communication, 2011). Polyethylene is noted as being the strongest synthetic fiber … and black will be the stiffest fiber. A rope consisting entirely of black strands will likely stretch uniformly. Placing an inherently weaker or less stiff, different colored strand within a collection of all black strands will result in non-uniform stretching, contributing to an increased chance of failure under load. Thus, an all black polyethylene rope would be preferred (on the basis of UV resistance and tensile strength) to a black rope with one or more colored strands … or a rope consisting of either all white strands or strands of another color (or mix of colors).

**Preliminary Financial Analysis on a Rope Replacement Scenario**

Replacement of the existing commonly utilized, black polyethylene rope with a polyethylene rope of a differing color scheme may result in additional cost to the industry. That additional cost may be comprised of capital outlay (if the alternative rope has a greater unit cost than black polyethylene), replacement cost (if the alternative rope has a shorter serviceable life), labor cost (associated with the time required to actually retrofit all fishable traps), and disposal costs. This analysis addresses the first two potential costs. Thus, the total estimated costs associated with rope replacement (if positive) in this analysis will be lower bound estimates, without consideration given to potential labor and disposal costs. The cost estimates apply to the entire industry, as opposed to a “typical” harvester. In addition, all cost estimates are *nominal*, without inflation or discounting being factored into the future values in a multi-year planning horizon. Finally, the analysis considers *only* the spiny lobster trap fisheries … the costs associated with rope replacement in the stone crab and blue crab trap fisheries are not included.

**Assumptions**

The following set of assumptions applies for the cost analysis:

*Rope size (diameter) currently used by industry (and number of traps)* – based on anecdotal industry information and records maintained by NMFS and FFWCC.

* Spiny Lobster Vertical fishery – 11/32”, 3-strand black polyethylene (436,500 traps)
* Spiny Lobster “Trawl” fishery – 3/8”, 3-strand black polyethylene (48,500 traps)

*Average length of line per trap* – 90’ (same for each fishery, based on anecdotal industry observations)

*Alternative rope* – same diameter, black polyethylene rope for each fishery … but the alternative rope has a single colored (blue) strand woven in.

*Serviceable life of rope* – (based on anecdotal industry observations)

* Solid black polyethylene rope: 7 years
* Colored (blue) strand polyethylene rope: 3 years (the minimum life also suggested by [7]).

*Per unit (ft) Price of rope* – (based on communications with Lee Fisher International, Inc. and Atlantic & Gulf Fishing Supply Co.) Includes state sales tax, and shipping / handling cost (**Table 1**).

**Table 1. Per Unit Cost for Rope, by Size and Type.**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Line Size** | **Color** | **Weight (lbs) /**  **1200’ coil** | **Price per**  **1200’ coil** | **Shipping Cost / 1200’ coil** | **Tax** | **Total Cost /**  **1200’ coil** | **Cost / ft of line** |
| 11/32” | Solid black | 32 | $64.50 | $21.74 | $6.04 | $92.28 | $0.077 |
|  | Blue strand | 32 | $74.50 | $21.74 | $6.74 | $102.98 | $0.086 |
| 3/8” | Solid black | 46 | $75.00 | $24.02 | $6.93 | $105.95 | $0.088 |
|  | Blue strand | 46 | $75.00 | $24.02 | $6.93 | $105.95 | $0.088 |

**Cost Estimates for a Single Replacement Event**

Given the assumptions maintained with regard to the number of traps, length of rope per trap (ft), and the per foot cost of the two types of rope, the following costs were estimated for a single rope replacement across all traps within each fishery (**Table 2**). These estimates serve to provide a comparison of the cost to replace the currently utilized solid black polyethylene rope with rope containing a colored strand.

**Table 2. Costs for Each Rope Type, by Fishery Sector.**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Fishery** | **# of Traps** | **Rope (ft) per trap** | **Cost / ft (black)** | **Cost / ft (colored)** | **Total Cost**  **(black)** | **Total Cost**  **(colored)** | **Rope Cost Difference** |
| S. L. V. | 436,000 | 90 | $0.077 | $0.086 | $3,021,480 | $3,374,640 | $353,160 |
| S. L. T. | 48,500 | 90 | $0.088 | $0.088 | $384,120 | $384,120 | $0 |
| Total | 484,500 |  |  |  | $3,405,600 | $3,758,760 | $353,160 |
| S.L.V. – spiny lobster vertical; S. L. T. – spiny lobster trawl. | | | | | | | |

**Replacement Schedule: 7 years (black rope), 3 years (colored strand rope)**

As mentioned in the assumption discussion, the black rope is assumed to have a serviceable life of 7 years, while the colored-strand rope has a serviceable life of 3 years. This assumption applies across both trap fishery sectors. These serviceable life estimates represent anecdotal information provided by the industry. Readily available estimates of rope life were not available from any of the vendors contacted. The serviceable life of rope will vary across use conditions, such as frequency of trap pulls, weight of trap being pulled, depth and clarity of water, amount of UV exposure, degree of fouling, and other factors. Reference [7] suggested a minimum life of 2-3 years. Given the assumed difference in serviceable life for each type of rope, the black rope will need to be replaced less frequently over time, while the colored-strand rope will need to be replaced more frequently. The following table shows the replacement schedule and annual replacement cost (not including labor or disposal costs) for each type of rope over a 15-year planning horizon … across both fisheries. The analysis below also assumes that a total replacement of all rope occurs in Year 1, and then every 7 years for black rope and every 3 years for rope with a colored strand (**Table 3**). Purchases are incurred at the beginning of the respective year.

**Table 3. Rope Replacement Schedule.**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Rope Type** | | **Years 1-8 of 15-year Planning Horizon** | | | | | | | | | | | | | |
| **1** | | **2** | | **3** | **4** | | **5** | **6** | | | **7** | | **8** |
| Black | | $3,405,600 | |  | |  |  | |  |  | | |  | | $3,405,600 |
| Colored | | $3,758,760 | |  | |  | $3,758,760 | |  |  | | | $3,758,760 | |  |
|  | **Years 9-15 of 15-year Planning Horizon** | | | | | | | | | | | | | | |
| **9** | | **10** | | **11** | | **12** | **13** | | | **14** | **15** | | **Total** | |
| Black |  | |  | |  | |  |  | | |  | $3,405,600 | | $10,216,800 | |
| Colored |  | | $3,758,760 | |  | |  | $3,758,760 | | |  |  | | $18,793,800 | |
| **TOTAL difference in rope replacement cost across the 15-year planning horizon 🡪** | | | | | | | | | | | | | | $8,577,000 | |

**Discussion**

Given the assumptions held for the analysis (e.g., number of traps fished by sector, unit cost of rope by type, length of feet or rope per trap, unit price of rope by type, serviceable life of rope by type, etc.), the replacement cost for black rope across the entire industry, if done within a given year, would be $3,405,600. The initial investment cost across the industry for a rope with a blue strand would be $3,758,760. Assuming that black rope is used and replaced after every 7 years of use by the industry, the total cost of replacement across a 15-year planning horizon would be $10,216,800. Assuming that the black rope is replaced in Year 1 with colored-strand rope … and then again after every 3 years of use by the industry, the total cost of replacement across a 15-year planning horizon would be $18,793,800. Thus, given the assumptions utilized in the analysis, the total difference in replacement costs across the entire industry and across a 15-year planning horizon would be $8,577,000.

An alternative to using rope with a colored strand might be that of simply placing a marker or flag in the rope at regular intervals. This marker could be woven into the existing strands of the currently utilized black polyethylene rope. Anecdotal observations by industry representatives suggest that such a marker would not hold up well to the abrasion of retrieval gear during repeated retrievals … for even a “short” period of time. Thus, the cost associated with such a rope was not included in the analysis. However, if such markers are found to be resilient to the abrasion of repeated retrievals, addressing that option would have merit.

**Conclusions**

The trap fisheries in the Florida Keys region, as well as elsewhere in the Gulf and South Atlantic region, typically utilize black polyethylene rope for their trap lines. This is true across all sectors of the trap fishing industry, although the diameter of the rope diameter may vary by sector. On rare occasion, sea turtles become entangled in trap lines. During the 2004-2007 period, 10 turtle entanglements were reported, resulting in 2 turtle deaths. In response, management is considering requiring the industry to utilize rope with a built-in characteristic that would allow an accurate identification of the user group associated with ropes found in any future sea turtle strandings and/or other environmental interactions.

Utilizing a polyethylene rope other than solid black may create some inherent concerns. Other “colors”, such as white or others, may be associated with less tensile strength and/or a shorter serviceable life. Given the current market prices for such rope, and adhering to a range of assumptions, the total *additional cost* of requiring the industry to utilize a colored-strand rope across a 15-year planning horizon would be $8,577,000. This estimate is in nominal “out of pocket” dollars, without accounting for inflation or the discounted value of future dollars. This cost estimate also does not include labor costs or the costs associated with line disposal. The serviceable life assumption is key to this analysis.

This information will hopefully be useful to industry and management as a decision is sought regarding such a rope requirement. Obviously, changes in key assumptions will change the final cost estimates. Regardless, the benefits associated with any reduced sea turtle mortality associated with trap line entanglement will need to be carefully considered with respect to the estimated industry costs of adopting an alternative to the trap lines currently utilized by industry.

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