MOVING AWAY FROM SYNTHETIC MATERIALS USED AT FADS: EVALUATING BIODEGRADABLE ROPES´ DEGRADATION

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SUMMARY

The present study summarizes the results of a project to test biodegradable ropes, to be used at FADs, in a controlled environment. Three types of biodegradable ropes were tested following their evolution for one year at sea: (i) twisted 100 % cotton rope; (ii) twisted 50% cotton and 50% sisal rope; and (iii) cotton, sisal and linen rope with loops. Samples were deployed in June 2016 in 2 different sites simultaneously, in offshore waters attached to a mooring rope, simulating a FAD in oceanic waters and in a shallow lagoon close to the reef in Maniyafushi island, simulating the arrival of a FAD to the coast. Results show different robustness of the ropes, being the strongest the one made of sisal and cotton. Other considerations for the successful use of biodegradable ropes at FADs are discussed.

KEYWORDS: *biodegradable ropes, FAD, Indian ocean, purse seine fleet, tropical tuna, beaching event*

1. Introduction

Nowadays FADs are made using as main components petroleum products as plastic, PVC, nylon nets, etc., that degrade slowly, causing a growing accumulation of these products in coastal areas year on year. The impacts associated to FAD beaching events are damages in coral reefs, marine pollution as well as ghost fishing (Maufroy et al 2015).

Scientists working on FAD research as well as fishing industry, well aware of the impacts that FAD beaching events can cause in reefs and coastal ecosystems, have been working since 2007 to develop FAD structures that minimize this impact (Franco et al. 2019; Goujon et al 2012; Lopez et al 2016; Moreno et al 2017). Among other experiments, trials with FADs made of diverse materials from natural origin were conducted in real fishing conditions. One of the main difficulties detected during the trials at sea was the lack of sufficient observations during the life of experimental biodegradable FADs. Due to the complex fishing strategy with drifting FADs, a high percentage of FADs deployed by a given vessel is usually fished and retrieved by other vessels, which makes difficult to revisit and get information on how the biodegradable structure evolves as well as on its lifetime.

Due to the lack of data on the behavior of biodegradable materials while testing experimental FADs in real fishing conditions this project aimed at evaluating the time evolution of 3 different biodegradable ropes, under controlled conditions. Specific objectives were (i) to select the most appropriate biodegradable materials and ropes among those with potential to be used at FADs and (ii) to test them in controlled conditions.

2. Material and methods

2.1. Selected ropes for the tests

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Many different materials from natural origin exist, as linen, cotton, hemp, sisal, coconut fiber, jute, etc. however, in order to be useful at FADs the following criteria was taken into account for the selection:

- Accesible & Available in great quantities
- Cost
- They could be processed to make ropes
- 100% natural origin
- Rope diameter easy to handle onboard
- Available as close as possible to fishing grounds

Based on these criteria the following ropes were selected as the most suitable to be used at FADs (Fig 1):

1. Twisted 100 % cotton rope: 20 mm diameter, 4 strands in torsion Z
2. Twisted 50% cotton and 50% sisal rope: 20 mm diameter 4 strands in torsion Z
3. Cotton, Sisal and linen rope with loops (similar to those used in mussel farming but made of natural origin): 16 mm diameter core with loops

2.2. Study site and data collection

Maldivian waters were selected to monitor the evolution of biodegradable ropes in controlled conditions, on one hand because light and water characteristics were similar to those of tropical tuna fishing grounds and on the other, the facilities of Maldivian Marine Research Center allowed a close monitoring of the ropes.

Samples were deployed in June 2016 in 2 different sites simultaneously (Fig 2), in offshore waters attached to a mooring rope, simulating a FAD in oceanic waters and in a shallow lagoon close to the reef in Maniyafushi island, simulating the arrival of a FAD to the coast. These 2 different environments allowed monitoring the behavior of the ropes simulating a FAD while in oceanic waters as well as when a beaching event occurs, monitoring the time that the rope remains in the reef.

Samples of the 3 twines were deployed at sea for one year to measure degradation with time. Once every 2 months, samples were retrieved from the 2 sites and the breaking strength in kg (defined as the weight at which the strings break) for the 3 different ropes was measured using a dynamometer. Breaking strength (Kg) of the strands was measured from month 6 to month 12. The amount of biofouling adhered was also assessed and the weight of the ropes with time at sea measured.

3. Results

Results on the breaking strength of the strings clearly showed that the most resistant rope in terms of breaking strength was the cotton and sisal twisted rope, followed by the 100% cotton rope that had similar performance with time at sea (Fig 3). The weaker rope appeared to be the looped rope, as it suffered a step drop with time, presenting after 6 months at sea a poor performance.

Once the strings were too weak to test the breaking strength, measurements were conducted using strands (months 6 to 12) (Fig 4). Measurements with the strands for cotton rope and mixed, cotton and sisal ropes, showed clearly the robustness of the sisal and cotton rope compared to the one made of 100% cotton. Type 3 rope was too weak after 6 moths to test its breaking strength.

The breaking strength measurements for both, samples in the lagoon as well as for samples anchored offshore showed similar results (Fig 3 and 4).

4. Discussion

Breaking strength measurements showed that mixed, cotton and sisal rope was the strongest rope after one year at sea. However, taking into account that the idea of using biodegradable components at FADs is having a successful FAD for fishing during a given time and that biodegrades as fast as possible after this time, not only robustness but also other important features should be taken into account. For instance, being and easy to handle, ductile rope. Some fishers also suggested the importance of having a rope that easily develops bio-fouling to aggregate non-tuna and tuna species and also a rope that biodegrades as fast as possible after the useful lifetime of the FAD.

Taking into account the results of this project on breaking strength as well as the features mentioned above, the 100% cotton rope seems to better fulfil needed characteristics to be used at FADs. Its breaking strength is not as strong as the mixed sisal and cotton rope however, is ductile and its useful lifetime matches that suggested by fishers for FADs i.e. around 1 year. While it appears from our results that the mixed, sisal and cotton rope would remain strong after 1 year.

The rope with the loops would allow bio-fouling (as used in mussel farming) however it seems that won´t be strong enough to last a year. The fact that bio-fouling has the capacity of aggregating non-tuna and then tuna species has not been scientifically proven and while some fishers support this hypothesis others don´t believe on it and think that bio-fouling makes the FAD weaker due to gaining weight, eventually making the FAD sink or the ropes break.

A good compromise could be using the 100% cotton rope to support the main structure of the FAD, so that bio-fouling would not affect the weight and the FAD would last longer (as shown in the breaking strength results) and using the rope with the loops just to provide some volume to the FAD close to the surface, hanging them from the raft in small pieces.

Other projects working with biodegradable twines have shown that variations in manufacturing processes, or possibly variations in cotton blends, appear to have a significant effect on degradation rate (Winger et al. 2015). So that, not all cotton ropes with the same specifications (diameter, number of strings and strands etc) are expected to behave the same but it appears dependent on the manufacturing process and the quality of the cotton. So that the results of this project on the degradation of cotton ropes could change for ropes made by other manufacturers.

Finally, it should be noted that the ropes in this project were not used in real drifting FADs, thus breaking strength and lifetime of the ropes could be different in real fishing conditions, however our results provide a reference comparing the robustness of the 3 types of ropes and could be used to select the best ropes to be tested in drifting FADs during fishing.

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Figures

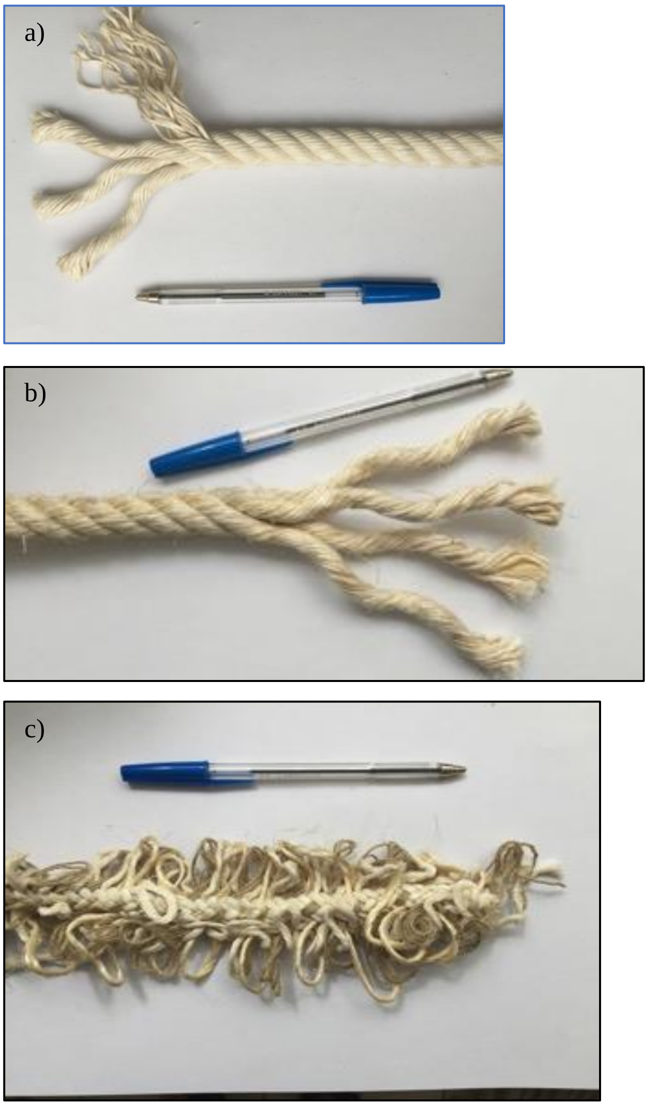

Figure 1. Biodegradable ropes selected for the tests (a) 100 % Cotton rope b) 50% cotton and 50% sisal rope c) Cotton, sisal and linen rope with loops

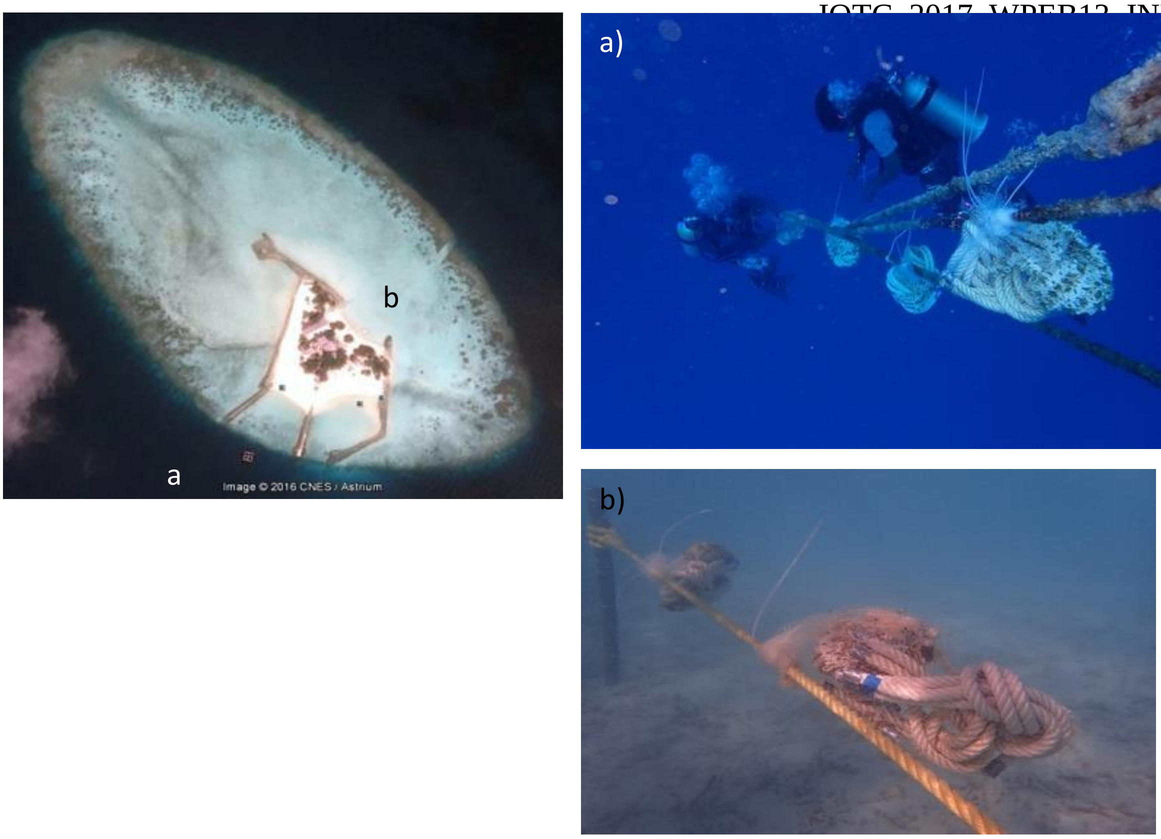

Figure 2. Biodegradable ropes deployment sites. a) anchored in offshore waters b) within the lagoon

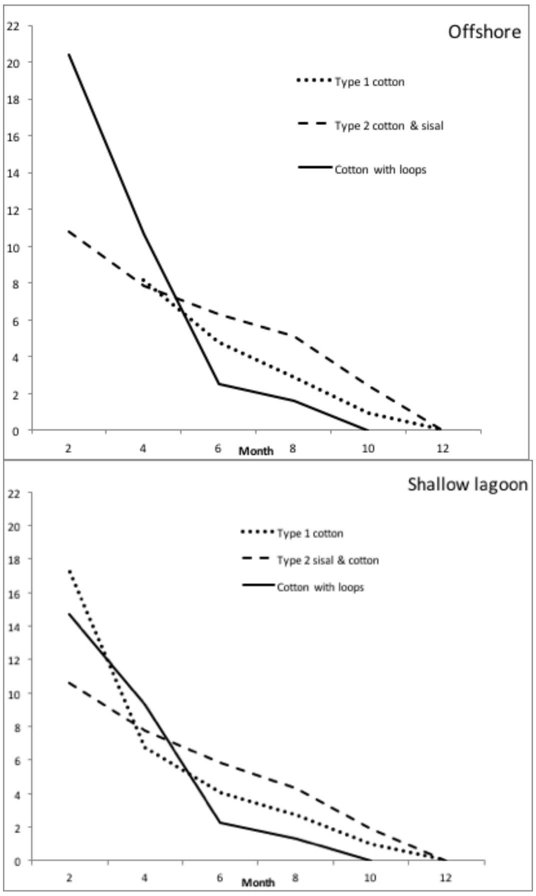

Figure 3. Biodegradable ropes' strings degradation with time. For those anchored in offshore waters (top) and within the lagoon (botton)

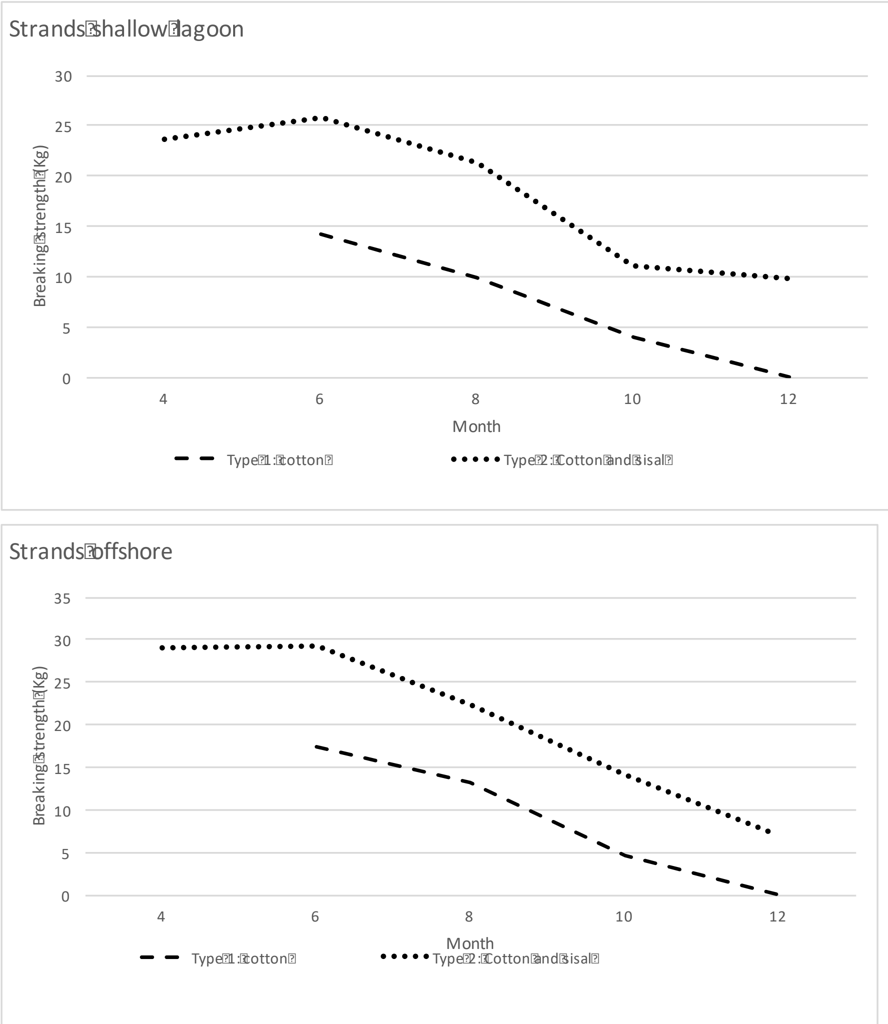

Figure 4. Biodegradable ropes´strands degradation with time. For those anchored in offshore waters (botton) and within the lagoon (top)