Evaluation of Mooring Line Resistance to Shark Bite

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ABSTRACT

Durability of mooring lines is important in the economics of deep water moorings and FAD pelagic fisheries. In our 1986 study in Puerto Rico, five of the seven moorings failed during the study, with several factors pointing to fish bite of the synthetic mooring lines as the cause. Fish bite has been implicated in buoy loss in other areas as well and this is seen as a major obstacle to the endurance of synthetic mooring lines in tropical and sub-tropical seas.

In the present study, four new mooring lines were tested in oceanic conditions off the coast of Culebra, Puerto Rico. This area was chosen for its similarity to the area previously used in 1986 and its accessibility to the study team. The lines were monitored biweekly, by SCUBA divers and a video camera. Attempts were made to encourage shark attack, at first by placing FAD attractors on the bridle above the lines, and later by tying fish directly to the lines. Although sharks were seen and caught in this area, and the tied fish were eaten, the mooring lines themselves had little damage and did not fail. The lines have been retrieved and will be examined further in the laboratory.

INTRODUCTION

Deep water moorings are important for gathering physical data, often in remote places. In recent years they have been used for Fish Aggregating Devices (FADs) as well (Brock, 1985). Because of the depths involved the lines can be expensive, even if used in conjunction with simple mooring designs. Of available materials, chain is the most durable but it is expensive and heavy, requiring large costly buoys for buoyancy. Steel cable unfortunately, has a life expectancy of little more than a year in the marine environment due to corrosion and fatigue

Synthetic lines, such as nylon and polypropylene, can theoretically last five to seven years in the sea, but in reality seldom do. Studies have shown that fish bites, presumably by sharks, are responsible for many of the failures (Prindle and Walden, 1976). Our study of FADs off Puerto Rico in 1986 (Feigenbaum *et al.*, in press) arrived at the same conclusion. Since present materials are unsuitable, new products are needed. They should be compatible with the marine environment, be able to withstand fish attack and resistant to structural failure. The present study tested four new products using them in FADs in a location where they would be exposed to both natural forces and shark attack.

MATERIALS AND METHODS

The island of Culebra, Puerto Rico is located 26 km (16 miles) east of the main island of Puerto Rico. The northern side of this island has a flat shelf about 18 km wide (11 miles) at a depth between 37-55 m (120-200 feet). The study area itself was located on the shelf about 5.6 km (2.5 miles from the island at a depth of 51 m (167 feet) (Fig. 1). This area is fully exposed to the trade winds and other oceanic conditions, and was chosen because of its similarity to the area used by Feigenbaum *et al.* (in press) including being in the pathway of migratory pelagic fish (Wagner and Wolf, 1974; Centaur Assoc., Inc., 1983).

Four experimental lines were tested:

1. A 3/8 inch Spectra® core with a Spectra® cut resistant jacket (Allied Fibers of Petersburg, Virginia).
2. A 3/8 inch Kevlar® core with a Kevlar® braid (Whitehill Manufacturing Co. of Lima, Pennsylvania).
3. A 1/2 inch polyester parallel fiber core with 76 mills Surlyn® extruded jacket (New England Ropes of New Bedford, Massachusetts).
4. A 5/16 inch Kevlar® core with polyofin jacket and an additional stainless steel braid and polyofin jacket (United Rope Works-Phillstran of Montgomery, Pennsylvania).

These lines were incorporated into simple semi-taut moorings (Boy and Smith, 1984; 1985) using standard foam-filled truck tires for flotation, a chain bridle, and a combination Danforth/small concrete block system for anchoring (Fig. 2). Opaque attractors were attached by divers to the chain bridle directly above the test lines to bring small schooling fish away from the buoy and down closer to the lines. The test line segments themselves were 36.5 m (120 feet) in length.

The four units were deployed from an 5.5 m (18 foot) boat, two at a time, in early June, 1988. The buoys were placed on a line 031°T, 91-183 m (300-600 feet) apart. SCUBA divers examined the lines approximately every two weeks. In September and October divers tied fish directly to each of the test lines to increase the probability of shark attack. The moorings were checked the following day. Test lines were removed in late October, 1988, and will be carefully examined at Old Dominion University.

RESULTS

Sharks were observed around the FADs at night throughout the study. Large barracuda and other fish have recently been observed as well. From June through August there was no evidence of attacks on the test lines, and no failures in the mooring systems. The first series of fish tied to the mooring lines,

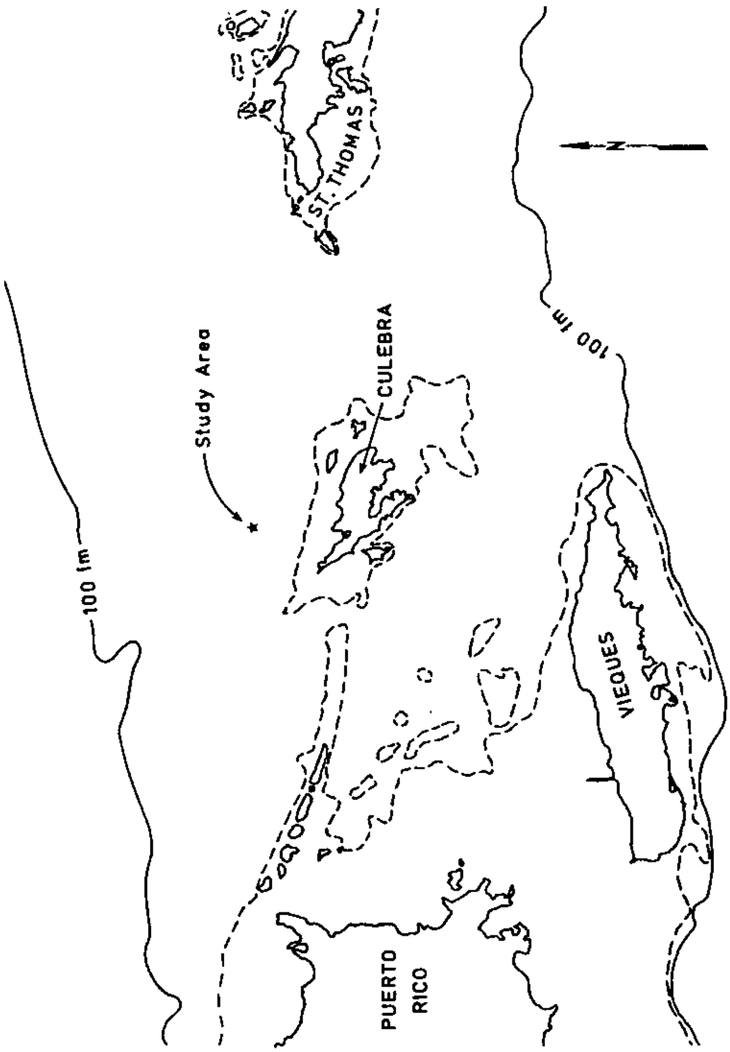

Figure 1. Location of the study area.

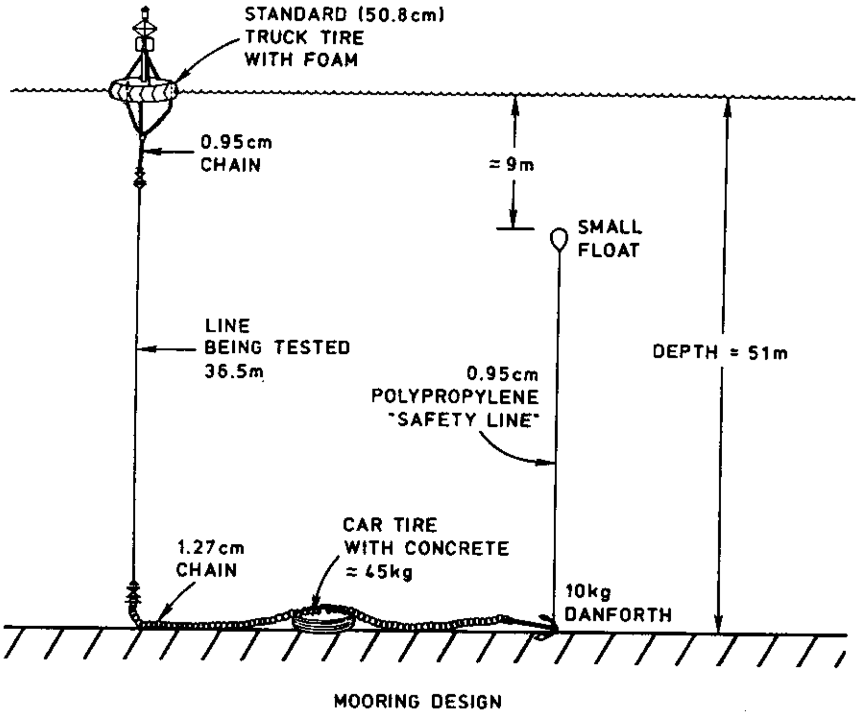

Figure 2. Mooring line design.

in September, resulted in a small nick in line #4. In the other 3 cases fish were cleanly eaten without damage to the lines. The second series of fish tied to the lines, in October, resulted in a bite mark on line #1 and slash marks on line #3. Fouling has covered these lines and we do not yet know if other bites were attempted. The four moorings survived several severe storm systems during the study, including Hurricanes Gilbert and Helena.

DISCUSSION

The four moorings were in the water for almost 5 months. All show promise of durability in the marine environment and are candidates for deep water moorings for data collection and FADs. However, tests of longer duration are necessary. At this time the lines tested are experimental and not currently available. Prices are not yet known, but the lines will undoubtedly be more costly than conventional nylon or polyporpylene. Some may prove too expensive for artisanal fisheries use. Interested parties should contact the manufacturers directly for price and availability information.

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