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An Overview of Fish Aggregating Devices and Their Uses in the Fishing Industry

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Abstract

Fish aggregating devices, more commonly called FADs, are anchored or drifting objects that are placed in the ocean to attract fish. Drifting FADs are not tethered to the bottom and Moored FADs occupy a fixed location. The most suitable distance between each FAD depends on the abundance and type of species targeted; ranging between several hundred and one thousand meters for pelagic fish in coastal waters; or 5 to 10 nautical miles for deep-water tuna FADs. Fishes are mostly attracted to artificial reef and FADs to avoid predation and will look for hiding places such as FADs and artificial reefs. Hand lines, squid jigging and trolling were recommended to be used around FADs, since they are selective fishing gears. FADs will also cause ghost fishing. Fishes from FADs consists mainly groupers, red snappers, sweet lips, Indian mackerel, Spanish mackerel, barracuda, yellow snapper, nemipterids, trevally, trigger fish, dolphin fish and sharks.

Introduction

Fish aggregating devices, more commonly called FADs, are anchored or drifting objects that are placed in the ocean to attract fish. They may be a permanent or temporary structure or device made from any material and used to lure fish. They have been used for thousands of years in various forms. The earliest surface/ midwater FADs were elements from nature such as driftwood and trees. Now surface and midwater artificial FADs are systematically used in a large number of countries. Traditional FADs, based on long-term fishing experience, are made on-the-spot with local materials and used in shallow coastal waters (depth 50-200 m) by small-scale fishers to catch small pelagic fish and bait, *e.g.*, payaos (Philippines), unjang (Malaysia), rumpon (Indonesia). Modern FADs, the result of imported technology and materials, can be anchored to over 3000 m. Drifting FADs are not tethered to the bottom and can be natural objects such as logs or man-made. Certain models have large surface dimensions. Moored FADs occupy a fixed location and attach to the sea bottom using a weight such as a concrete block. A rope made of floating synthetics such as polypropylene attaches to the mooring and in turn attaches to a buoy. The buoy can float at the surface (lasting 3-4 years) or lie subsurface (mid water FAD) to avoid detection and surface hazards such as weather and ship traffic. The midwater FADs - where the only surface component is a small marker buoy is less subject to stress from wind and waves and the risk of damage by ships. Subsurface FADs last longer (5-6 years) due to less wear and tear, but can be harder to locate. Smart FADs include sonar and GPS capabilities so that the operator can remotely contact it through satellite to determine the population under the FAD.

FADs can be used in either a single or multiple arrangements.

The most suitable distance between each FAD depends on the abundance and type of species targeted; ranging between several hundred and one thousand meters for small pelagic fish in coastal or shallow waters; or 5 to 10 nautical miles for deep-water tuna FADs. Fish also aggregate under drifting logs and even whales, and rules on fishing around FADs often apply to all objects drifting on or near the sea surface. Various types of FADs in different areas, after a short period, attract and aggregate fish around the structure, irrespective of its design. They aggregate in considerable numbers around objects such as drifting flotsam, rafts, jellyfish and floating seaweed. The objects appear to provide a "visual stimulus in an optical void", and offer some protection for juvenile fish from predators. The gathering of juvenile fish, in turn, attracts larger predator fish. The mobile, lighter structures can be moved to attract fish to a particular point. Still others can be removed from the water during certain seasons when the fish are not in the area or when the weather is rough, *e.g.*, monsoon (Chapman *et al.,* 2005; Rohit, 2013).

Simple or advanced FADs are left drifting in deep waters to help offshore, artisanal and industrial fleets catch big pelagic fish, mainly tuna. Hundreds of simple, traditional types of drifting FADs are used by each large, modern tuna purse seiner operating in certain areas. Before FADs, the commercial purse seiners used to target surface-visible aggregations of birds and dolphins, which were a reliable signal of the presence of tuna schools below. The artisanal FADs are smaller and used by subsistence, artisanal and recreational fishers. These are mostly anchored offshore or near-shore and in lagoon and maybe surface or subsurface. The Industrial FADs are huge structures and may be drifting or anchored. The fishers use purse seine, long line or pole & line type of fishing and cater to fishing companies in support of industrial scale vessels. Industrial FADs improve the catch rate of purse seine and pole & line vessels that target large schools of tuna. These are commonly drifting rafts, with an electronic beacon so the fishing boat can find the FAD and sometimes sonar equipment that shows the amount of fish under it. Shoals of juvenile big eye tuna and yellow fin tuna aggregated closest to the devices, 10-50 m. Further out, 50-150 m, was a less dense group of larger yellow fin and albacore tuna. Yet further out, to 500 m, was a dispersed group of various large adult tuna (Figure 1) (Chapman *et al.,* 2005; Rohit, 2013).

Types of FADs are discussed below.

Artisanal FADs

Artisanal FADs are used to improve the catch rate of people who catch fish to feed their families or sell in small amounts at local markets. They are anchored within range of small motor boats and canoes and they are an important tool for food security and domestic fisheries' development. The fishing methods used, such as hand line and trolling, select only the species that the fishermen want, and only a small proportion of the fish around the FAD are caught (Figure 2).

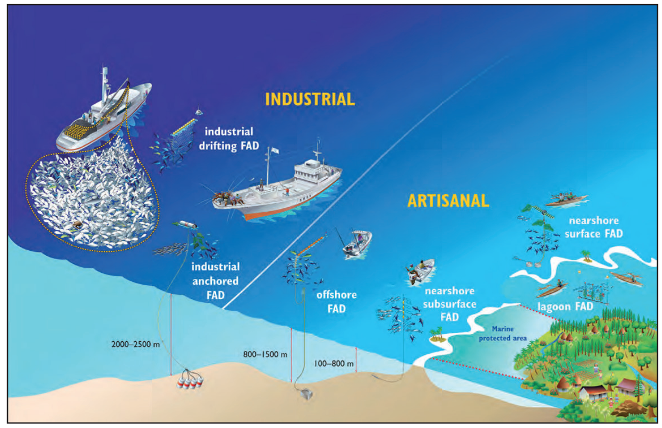

Figure 1: Employing positions of FADs

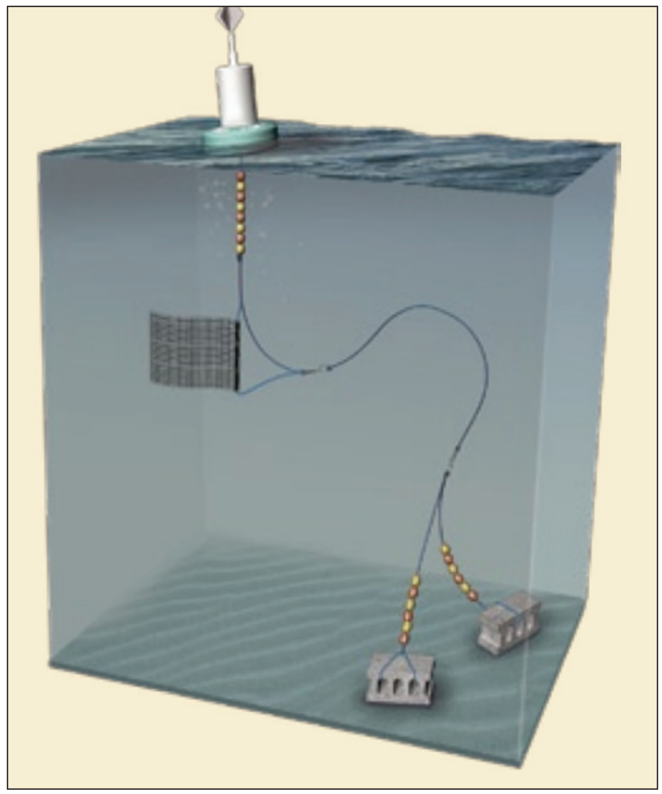

Figure 2: Artisanal Anchored FAD

Advantages

- Increased catch rate and improved access to tuna and other oceanic fish (Food security).
- Increased catch rate and reduced cost of fishing (Vessel efficiency).
- Transfer of fishing effort from the reef to the oceanic waters (Coastal resource management).
- Increased food security and resilience of coral reef ecosystems (Climate change adaptation).
- Sport fishing developed around FADs (Tourism).

• Improved through defined fishing zones around FADs (Safety at sea).

Problems

• All FADs eventually break free and some are lost before the benefits are realized. Others are destroyed by passing ships or are vandalized by people who do not understand their benefits (Short lifespan).

• User conflict will be caused by overcrowding of fishers and not enough FADs in an area.

• Insufficient human and financial resources to maintain and extend FAD programs.

Industrial FADs

Industrial FADs improve the catch rate of purse seine and pole and line vessels that target large schools of tuna. Sometimes sonar equipment shows the amount of fish under the FAD. Most fishing is by purse seine - a non-selective method which catches all the fish around the FAD (Figure 3).

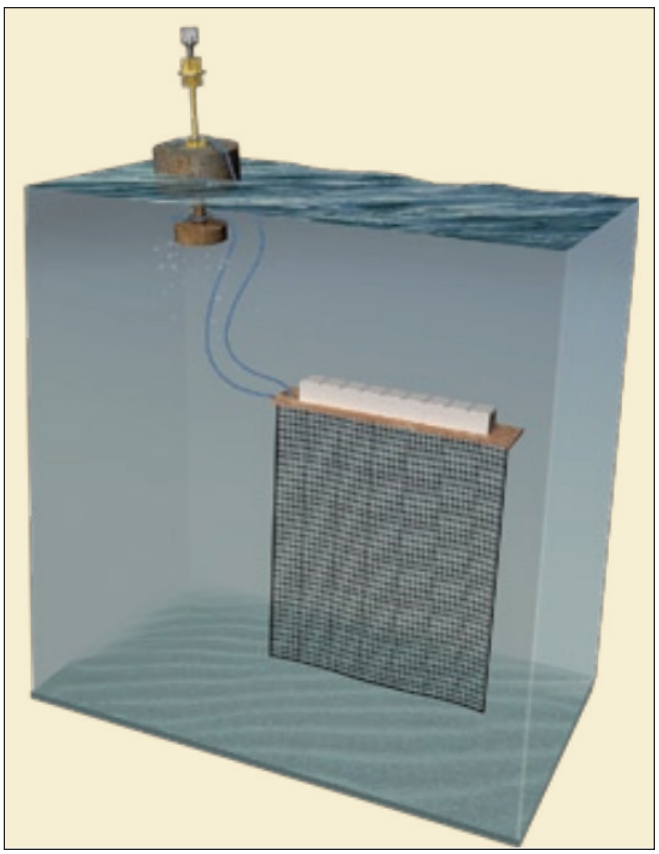

Figure 3: Industrial drifting FAD

Advantages

• Increased catch rate in the biggest tuna fishery in the world (Food security).

• Improved economic viability and fuel efficiency of fishing vessels (Efficiency).

• Small, locally based vessels that supply domestic tuna canneries are dependent on FADs (Domestic development).

Problems

• Contributing to over fishing of any particular species, even though it will not be the target species;

• Purse seine nets set around FADs catch more small tuna. These are worth less and catching them can lead to over fishing;

• Purse seine by-catch is lower than in many other fisheries (*e.g.*, longlining, prawn trawling). However, there is more by-catch in FAD sets than in non-FAD sets. Turtles and silky sharks are of particular concern.

Why Fishes are Gathering around FADs?

Fishes are attracted to artificial reef and FADs to avoid predation, these small preys will look for hiding places such as FADs and artificial reefs. Some fishes approaches the FAD for their breeding purposes like laying the eggs. The fishes do not stay close at the reef and FADs all the time. Some fishes are attracted to artificial reef and FADs throughout its entire life cycle, where others seem to exhibit the behavior only during part of their life cycles (Chapman *et al.,* 2005; Rohit, 2013).

Manufacturing Process

The combination of FADs and artificial reef in one unit is referred to as ARFADs. It is consisted different components like floats, an attractor, and an anchored mooring. The upper part of the structure consists of float, appendages and mooring line. The float is attached to a heavy molded concrete anchor resting on the bottom of the sea by means of a long anchor line made of polyethylene rope, known as mooring line. This anchor acts to hold the FADs in position as well as acting as artificial reef to attract demersal fishes. A very important part of the FADs is the fish attractor. This part is made of plastic strips and attached to an anchor line (Chapman *et al.*, 2005; Rohit, 2013).

Floats

Floats must be strong enough to support the weight of appendages and to make the anchor line into vertical position. The surface floats that are attached to the FADs are primarily used to assist fishers to locate location. These floats can be made of Styrofoam. The submerged floats used for these ARFADS can be made up of hard plastics.

Anchor

An anchor is used to keep the FADs in its proper location. Well-constructed massive anchors made from concrete are essential for holding ARFADs in place over a long term period. These concrete anchors are recommended for durable ARFADs and they are well suited especially for course sand and rocky bottoms.

Appendages

Appendages streaming along anchor line increase FADs effectiveness in attracting and holding schools of pelagic fish. The appendage provides shelter, allowing a build-up of prey species, which provide a strong visual stimulus to the predators. Coconut and nipa fronds, mangrove leaf, rubber tyres, plastic strapping, old rope and netting have widely been used in FADs. Plastic straps that are used to bind cartons were found to be the most effective material for appendages.

Rope

The rope is used to fix appendages, floats as well as concrete anchor. Important factors such as specific gravity whether the material floats or sinks in seawater, breaking strength, strength-to-size ratio, elongation and elasticity, resistance to cyclic and shock loading, abrasion resistance, and durability need to be also considered. The recommended rope material for coastal water ARFADS is polypropylene. Polypropylene has moderate breaking strength, ranging between 4,200 and 8,200 kg for 2.2 cm diameter rope. Polypropylene has good elastic properties and it can stretch up to 9% of its length and still return to its original length. Having the specific gravity of 0.91 and it can easily float and its buoyant property has the tendency to lift weight (Figure 4).

Figure 4: Polypropylene rope

Deploying Process

In order to benefit small scale fishers, the selected site for ARFADs should not be too far away from any fishing village. The criteria for deployment of these ARFADs in selected area are based on the availability of fish for aggregation, oceanographic and meteorological conditions. In evaluating a particular site, consideration should be given to the bottom topography, wind, wave and current actions. The ideal location should be those in shallow calm areas (15-30 m) of low shipping line with bottom type hard enough to prevent the sinking of anchor. The selected areas should also be free from any trawling activities or drift netting.

The Flag/ Buoy

Some fishers use land marking as reference point for the location of their FADs.

Life Span

The life span of each ARFADs is expected to be more than 10 years with the anchors. It is expected that plastic straps will last for more than 10 years in the sea condition. However after 6 months, fishers should put extra floats to support heavy appendages that caused by fouling flora and fauna.

Fishing

Hand lines, squid jigging and trolling were recommended to be used around FADs, since they are selective fishing gears. Other methods such as trap and gillnets are strongly not recommended because they can easily entangle with mooring line. Uncollected trap around FADs will also cause ghost fishing. Fishes from FADs consists mainly groupers, red snappers, sweetlips, Indian mackerel, Spanish mackerel, barracuda, scads, yellow snapper, nemipterids, trevally, trigger fish, dolphin fish and sharks.

Management

Fish aggregating devices are meant to retain migratory fish species to remain temporarily or aggregate in scattered schools and this caused for them to be caught easily. This type of activity can lead to a long-term overfishing of stock and such phenomenon has occurred in a purse seine fishery associated with FADs. In order to avoid this issue the best method is hand lining, jigging and trolling.

Fishing effort should be distributed wisely in order to avoid any conflict among fishers. These closed areas from trawling activities will protect juveniles in shallow nursery grounds and provide fishing sites for artisanal fishers using selective gear to capture big sized fish. The issue is that the regulatory mechanism is not in place to require the purse seine fishery, which makes billions of dollars each year from this type of fishing, to retrieve their gear from the ocean (Morgan, 2011).

Conclusion

Anchored FADs are an important tool for small-scale coastal fishing communities to assure their food security and small-scale fisheries livelihoods. FAD programs have been insufficiently institutionalized within government fisheries departments with respect to priority, funding and human resources dedicated to the FAD program. It is important to monitor catch and effort data, and ideally to involve fishers in the process, so as to determine the levels of exploitation around anchored FADs and the impact of anchored FADs on the overall fishery. Governments should prepare the legal framework governing the construction, deployment, use, ownership, rights and responsibilities, sanctions and fines for noncompliance related to different types of FADs in the waters under their jurisdiction. Training in anchored FAD fishing techniques and in safety at sea should be provided to all anchored FAD users. Scuba divers are often required to perform routine anchored FAD maintenance tasks such as replacing or cleaning aggregators, and changing hardware such as shackles, thimbles, and ropes (Morgan, 2011).

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