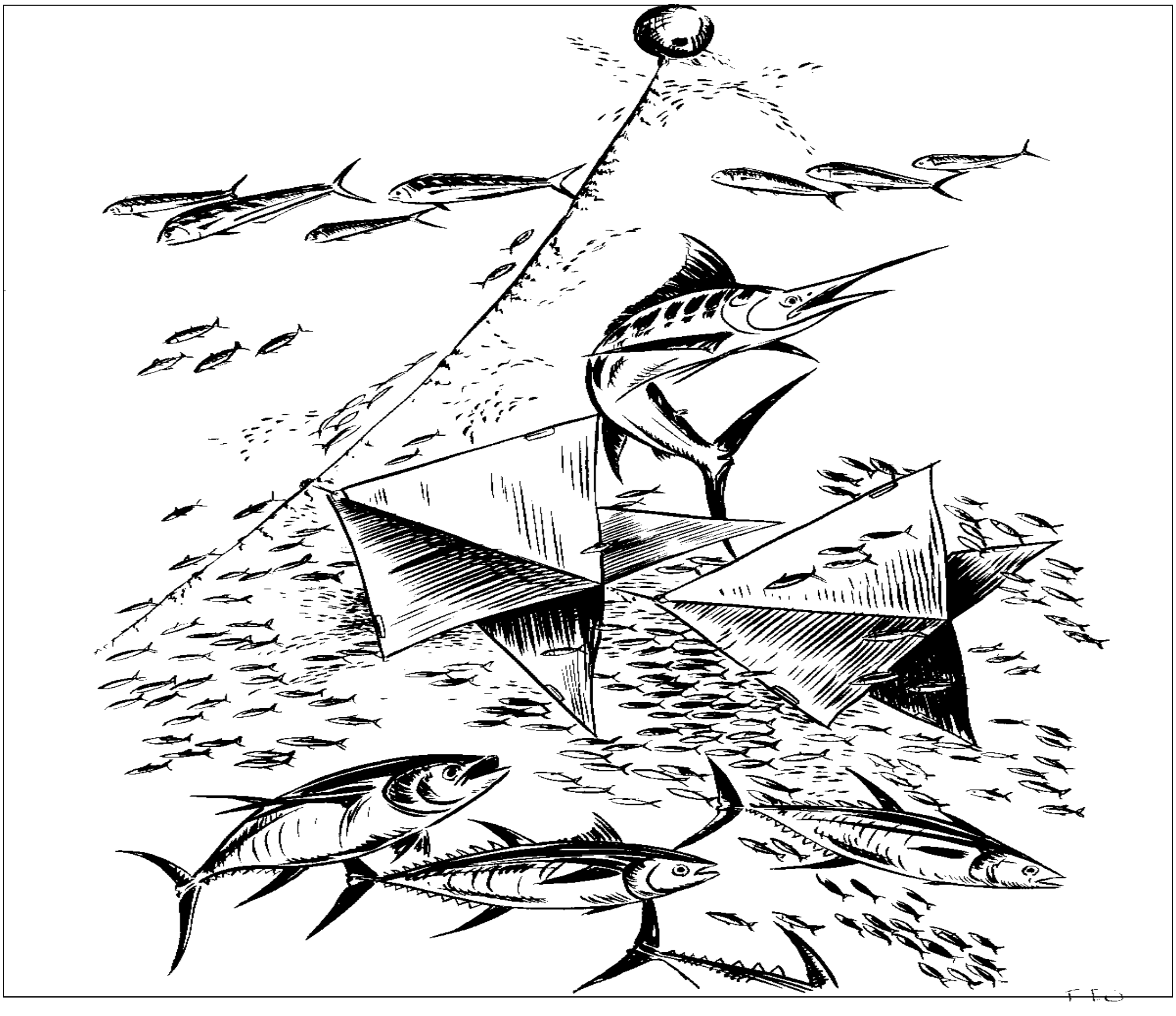
FAD FISHING SKILLS WORKSHOP

Module 1

OVERALL DESCRIPTION OF FADS



SECRETARIAT OF THE PACIFIC COMMUNITY

INTRODUCTION

Fish Aggregating Devices, commonly referred to as FADs, are man-made structures. FADs came about from fishermen's observations of fish behaviour. While searching for pelagic fish offshore, fishermen routinely observed schools of fish that were associated with floating logs, seaweed, or other drifting objects. Fishermen got the idea to construct their own floating structures and anchor them offshore to the seabed, hoping that if fish aggregated around the structures they would not have to search for free-floating objects to catch fish.

1. THE BASIC PRINCIPLES OF FADS

1.1 Beginning of FADs

AV 1-1.1

Fishermen found that man-made structures created the same aggregating behaviour that fish exhibited around drifting objects. Since the early 1900s, fishermen in Indonesia and the Philippines have used FADs. The early FADs were constructed from available local materials. Rafts were constructed from lengths of either **bamboo** or **coconut logs**. Moorings consisted of hemp or coconut fibre rope, and anchors were fashioned from stones.

Fishermen believed that additional underwater surface area made FADs more attractive to fish, so palm fronds were often attached to the underside of the raft or strung along a length of rope that was attached to the raft.

These FADs were principally fabricated and used by artisanal fishermen throughout the Philippines and Indonesia until the early 1970s. The development of the purse seine and pole-and-line fishery led to FAD use on a larger commercial scale. FAD use by the large commercial fisheries created a widespread awareness of FADs and their potential benefits.

1.2 How FADs work

FADs exploit the natural tendency of pelagic fish to associate with drifting objects. Without FADS, fish are either widely dispersed throughout an area or occur in far-ranging free swimming schools. Exactly why FADs aggregate fish the way they do is uncertain. There are two basic theories as to why pelagic fish are attracted to FADs.

N°1 Many fishermen and scientists believe a relationship exists between the amount of marine growth on drifting objects and the presence of pelagic fish. Lots of marine growth means lots of fish, or a greater chance of fish aggregating. Little growth means fewer fish, or less chance of aggregation. The same sort of relationship is believed to exist with the size or the amount of **shelter** provided by the flotation device. The larger the flotation device the more attractive it is to fish. Small objects provide little shelter and are less attractive. This is the prime reason for attaching palm fronds or other appendages to FADs.

AV 1-1.2a

N°2 The aggregation phenomenon of FADs may also arise from pelagic species desiring to establish occasional **points of reference**. A good way of describing the theory is that pelagic fishes live in an environment that is essentially void or empty. In this limitless dark space a FAD represents a small light to which fish are attracted because it provides some sort of spacial orientation. Fish remain around the light for a time, making daily excursions away from it after dusk and returning to the FAD before dawn. After some time the fish leave the FAD, driven by other urges which have become stronger. Another way of describing the theory is by using the analogy of a lost traveller walking towards a lone tree in the middle of a desert as it provides his only point of orientation.

AV 1-1.2b

Both theories have their strong and weak points. It is likely that components of each theory act together in some way.

1.3 Aggregation phenomena

AV 1-1.3

FADs aggregate fish **on the surface** and **at depth**. Tuna that aggregate near the surface generally occur in large schools and usually range in weight between two and eight kilos. Fish that aggregate in deeper water between 50 and 400 metres occur in smaller groups and usually range between 15 and 75 kilos. Fish attracted to FADs may associate with the FAD for several days or even several weeks. The departure and replacement of schools of fish often produces a steady state, where the FAD is productive constantly over an extended period of time. The aggregation area around a FAD can range from one to five miles depending on the FAD location. Generally yellowfin tuna, mahi mahi, and wahoo aggregate close to the FAD while schools of skipjack roam within a one to three mile radius of the FAD.

FADs do not attract fish to an area where fish do not already occur. The likelihood for a FAD to work well depends largely on the abundance and seasonality of pelagic fish that naturally occur in the surrounding waters. If tunas and other pelagic species are abundant in an area year round, or have a long season of peak abundance, a FAD is likely to work well.

1.4 FAD location and spacing

AV 1-1.4

FAD location and spacing between FADs are important factors to consider. Fish associate more strongly with a FAD if there are no other FADs or reefs nearby. FADs are generally more effective when located at least **four to five miles from the seaward reefs** and **spaced 10 to 12 miles apart**. Closer spacing interferes with the FADs ability to attract and hold fish.

2. THE FAD-ASSOCIATED FISH SPECIES

AV 1-2a
AV 1-2b

FADs attract pelagic (open ocean) fish. The principle species associated with FADs include **tunas**, **mahi mahi**, **wahoo**, **rainbow runner**, **oceanic barracuda**, **marlin** and **sharks**. Tuna species commonly found around FADs are skipjack, yellow fin, big-eye and albacore. Skipjack, as well as small yellowfin and big-eye, occur near the surface, while large yellowfin, big-eye and albacore are commonly found in deeper water. Also bait fish such as big-eye scad (**atule**) and **opelu** aggregate under the flotation device.

Sharks frequently take up residence around FADs and can frustrate fishermen who target fish in deeper water. If FADs are fished regularly, it is generally possible to quickly fish sharks down to a level where they do not pose much of a problem. Often fishermen drop baited buoy lines while trolling to catch sharks, and retrieve them when the surface fish have stopped biting.

3. THE BENEFITS OF FADS

The potential benefits most often associated with FADs are:

- ***Increased availability of pelagic species***

  FADs bring the fish to the fishermen—fish that would otherwise be dispersed over a wide area gather around the FAD. The fish are more available to the fishermen, therefore individual fishermen catch more fish.

- ***Reduced search time and reduced fuel consumption***

  When FADs are not present, troll fishermen must search for feeding schools of surface fish; seabirds indicate the presence of schools and drifting objects. Searching for schools of fish takes time and consumes a lot of fuel. Fishermen may travel from 20 to 30 miles a day searching for fish. FADs focus the fishing effort. Fishermen can travel directly to the FAD to fish, no search time is required and less fuel is consumed. Fishermen can spend more time fishing, therefore more fish are caught, and with less fuel consumed, profits are higher.

- ***Reduced fishing pressure on inshore and offshore bottom-fish resources***

  If fishermen are catching more fish and earning better incomes due to FADs, other fishermen who target inshore and offshore bottom-fish will be inclined to enter the FAD-based fishery. If significant numbers of fishermen shift to the FAD-based offshore fishery, it will reduce the pressure on the bottom-fish resources.

- ***Increased safety for fishermen***

  Small-scale commercial fishermen routinely do not equip their vessels with adequate safety gear; many do not have VHF or HF radios. If a vessel becomes distressed, there is no way to signal for help. Without FADs, fishermen become distressed over a wide area while searching for fish. The likelihood of a distressed vessel encountering other fishermen to assist is low. FADs increase fishermen's safety because they not only aggregate fish but also aggregate fishermen. With FADs, if a vessel is in distress it can signal other vessels fishing around the FAD for assistance.

4. THE MAIN COMPONENTS OF A FAD

FADs first gained widespread popularity throughout the Pacific Island region in the late 1970s, following their use by commercial fisheries in the Philippines and a FAD programme conducted in Hawaii by the National Marine Fisheries Service. The programme in Hawaii focused on adapting the relatively fragile Philippine FADs to withstand deep-water, harsh marine environments around the Pacific Islands. These first generation FADs consisted of a wide array of raft designs: bamboo rafts, foam-filled tractor tires or steel drums, and aluminum catamarans. Moorings consisted of polypropylene rope with a mid-warp counter weight that prevented slack rope from floating to the surface where it could be cut by propellers from fishing vessels. Anchors consisted of concrete blocks, surplus steel or scrap metal chained together.

FAD loss rates were high and FAD lifespans low. The average lifespan was nine months. FADs became immensely popular with fishermen during the four-year period that followed the initial trials, but the high unit costs and the short lifespans prompted the South Pacific Commission to undertake a region-wide project to advance FAD technology to a level that would increase the average lifespan for FADs to two years. The project's primary focus was FAD moorings, as the main reason that FADs failed in many countries was due to deterioration of mooring components or improper mooring design. The outcome of the project was the publication of a FAD handbook that introduced the **catenary curve mooring**, a design based on sound engineering principles and intended for deepwater moorings, as well as a list of specific recommendations for all mooring components.

4.1 Principle of the catenary curve mooring

AV 1-4.1

The catenary curve mooring is a **composite sinking-buoyant rope** mooring design. Lengths of sinking rope (**nylon**) and buoyant rope (**polypropylene**) are spliced end to end to form the mooring. Sinking rope is used for the upper section of the mooring and buoyant rope for the lower end.

TEACHING HINT !

Show AV 1-4.1 and distribute the hand-out of the recommended components for a catenary curve mooring system.

The combination of sinking and buoyant rope creates a catenary curve which forms around the point where the ropes are spliced together. The catenary curve makes it possible to build slack into the mooring so it can withstand strong currents and rough seas. The length of the sinking rope in the upper mooring is calculated so that in a calm sea the buoyant polypropylene rope remains below the surface preventing boats from damaging the rope. The length of the buoyant polypropylene rope is also calculated to provide enough buoyancy to lift the bottom steel hardware and chain off the seabed. This prevents the rope from being chafed on the seabed.

4.2 Recommended hardware

The breaking strength of all hardware should be equal to or in excess of the breaking strength of the chain. To prevent galvanic corrosion, hot-dip galvanised hardware components made from the same grade of steel should be used. **Galvanic corrosion** is a type of corrosion that occurs when two dissimilar metals are placed in sea water. The two metals plus the seawater form a small chemical battery. The metal that is more susceptible to corrosion will dissolve at an accelerated rate. The simplest way to prevent galvanic corrosion is to use metallic mooring hardware components made from the same material. If this is not possible, sacrificial zinc anodes can be placed in contact with another metal. As zinc is very susceptible to corrosion, it will dissolve before corrosion starts to dissolve the other metal. Basically, **do not use components made from different metals if possible.** To offset wear and general corrosion, oversized hardware components should be used at all attachment points in the upper and lower moorings.

5. DIFFERENT TYPES OF FLOTATION DEVICES

5.1 Steel spar buoy design

AV 1-5.1

The South Pacific Commission FAD handbook recommended a **steel spar buoy** as a flotation device for the catenary curve mooring. The steel spar buoy design is a non-directional, wave-riding buoy. In other words, as the buoy is cylindrically shaped it spins in the water and rides on top of the waves. The buoy hull provides enough buoyancy to support the weight of the buoy, 30 metres of upper mooring chain and the nylon rope. Also, there is ample reserve buoyancy to support increased tension on the mooring during pe-riods of strong currents, high winds and rough seas.

Anti-flooding and anti-capsizing features are incorporated into the buoy design. The hull is divided into three separate compartments, each of which can be tested for leaks before the buoy is put into service. If a leak does occur only one compartment will flood. A single 4" Schedule 40 galvanised pipe that passes through the hull forms the buoy mast and a rigid mooring attachment. The rigid mooring attachment which extends below the buoy, the mooring attachment pad-eye and the weight of the upper chain collectively function to stabilise the buoy and prevent it from capsizing. The buoy design also has a radar reflector and a battery-powered flashing light that fits snugly into the pipe mast. The buoy is simple to construct from readily-available materials. Fabrication only requires basic welding skills. Steel buoys are durable and require little maintenance. The average fabrication cost for one unit was US$1,000 in 1993.

5.2 Alternative inexpensive FAD designs

Although the steel spar buoy in combination with a catenary curve mooring proved to have the longest life span of any FAD design tested in the region, the cost for the basic components was very high. The average cost for one unit deployed in a depth of 1,000 metres was US$6,000. For many countries intending to initiate FAD projects the cost of deploying the recommended FAD design was prohibitive. In recent times some countries have expressed the need for the Commission to design alternative FAD systems that are effective and relatively long lived, but less costly.

A number of inexpensive alternative FADs were designed and deployed in the region over the last couple of years. Each design had advantages and disadvantages compared to the steel spar buoy/catenary curve design. Although the alternative FAD designs were less expensive to fabricate, they generally required regular maintenance.

5.2.1 The Filipino 'payao'

AV 1-5.2a

One alternative design was the **Filipino 'payao'** developed for the purse-seine industry. Filipino fishing companies have deployed hundreds of these FADs throughout the Pacific region. The cost for one unit is approximately US$1,800 for a 2,500 to 3,000 metre FAD site. The average lifespan is claimed to be 18 months, with some units surviving for as long as five years.

TEACHING HINT !

Discuss the various components of the payao: float, raft, appendages, upper, main and lower mooring; counterweight and anchor.

It is believed that **regular inspection** and **maintenance** are the key factors to a successful and cost-effective 'payao' FAD device. The top 100 metres of polypropylene rope must be routinely replaced after 4 to 5 months as the rope deteriorates due to the effect of ultra-violet light. Also, the upper mooring cable deteriorates rapidly due to corrosion and must be inspected on a regular basis.

5.2.2 The Indian Ocean design

During a workshop on FADs, members from the French delegation gave an account of an inovative FAD raft design in use in the Indian Ocean. The Indian Ocean design originally consisted of 30 to 50 plastic pressure-resistant floats strung on a variety of materials including nylon rope, combination wire rope or stainless steel cable, in each case with a sheathing of plastic pipe to prevent chafing. The advantage of this design over other surface flotation devices was that it reduced the amount of strain on the mooring system, as it rode with the waves on the ocean surface and would submerge without damage under the effect of strong currents or storm conditions. The main drawback of the design was that the cost was approximately US$1,500 due to the expense of the pressure-resistant floats.

AV 1-5.2b

After experimenting with various materials in the Pacific region and desiring to lower the costs, second-hand purse seine floats were used to replace the pressure-resistant floats. These floats were obtained from fishing vessel suppliers when they were discarded by purse seiners—they were damaged by passing repeatedly through the power block that hauls the purse seine nets. Although no longer suitable for seining, many of the floats were suitable for FADs. The floats can be purchased for as little as US$1.00 each. The material for stringing the floats was replaced with a PVC - coated wire cable. The cable consisted of 16 millimetre, 7 strand wire rope covered with an eight millimetre coating of PVC, giving a final diameter of 32 millimetres. The PVC was bonded to the wire rope, and was watertight and protected the floats from abrasion. The total cost for the entire flotation device was **US$180**, compared to US$1,500 for the pressure-resistant float device.

TEACHING HINT !

Discuss the various components of the Indian Ocean design

The mooring ropes for the Indian Ocean design can be reduced to a diameter of **16 mm**, as there is considerably less drag and virtually no slamming or jerking to strain the upper mooring section. The reduced diameter represents a considerable saving.

6. THE BASICS OF FAD DEPLOYMENT

Deploying FADs is a complicated procedure. Getting a FAD on station in its intended location requires **careful planning and coordination**. There are a number of steps to follow before putting a FAD to sea. Safety of the crew and vessel and operational efficiency are the primary concerns during deployments. Many things can go wrong!

Improper deployment techniques contribute significantly to the premature loss of FADs. Taking the time to check and double check, then carefully carrying out each step ensures a successful deployment. The recommended procedure for FAD deployments is the following:

- discuss with local fishermen the areas where pelagic species tend to be abundant;
- conduct intensive FAD site surveys;
- arrange the FAD on the vessel deck for efficiency and safety;
- follow recommended procedures for deploying the FAD;
- mark the latitude, longitude and depth of the FAD after deployment;
- check the upper mooring to ensure that it is not tangled.

TEACHING HINT !

Show the video *Deployment of FADs in Tokelau*, then discuss with the trainees the main points presented in the video.

7. FAD INSPECTION AND MAINTENANCE

Routine inspection and maintenance can prevent premature FAD loss through detection and replacement of badly worn components. Fishermen are a valuable source for gathering information about the condition of FADs. They can report to fisheries officers if FAD buoys are leaking or upper mooring connections are wearing. Such reports have often allowed fisheries officers sufficient time to replace a leaking buoy and save the FAD.

Inspection of FADs should include the following measures:

- check the position of the waterline on the buoy to determine whether there are any leaks;
- examine the buoy for potential problem areas where signs of excessive corrosion have developed;
- check buoy lights for cracks in the lenses and water leaks, replace dead batteries or bulbs if necessary;
- examine the general condition of the shackles, chain and swivels of the upper mooring for wear.

Maintenance of FADs is carried out by hauling up a portion of the upper mooring, and securing the mooring to the maintenance vessel at some point below the damaged component. The maintenance vessel must be sufficiently large so that there is no risk of capsizing. It is preferable to conduct maintenance procedures in calm seas, when there is no risk of the vessel dragging the anchor.

There are **two methods** that can be used to haul the upper mooring. The simplest method is to use on-board **hydraulic winches**. If the vessel does not have any lifting gear, skilled divers can rig **lifting bags** to raise the upper mooring to the surface.

AV 1-7

Regardless of the lifting method, divers must first rig the mooring for hauling. They must dive to the point below the damaged component and tie a rope. The divers can then direct the crew on-board to begin hauling the rope. After the mooring has been lifted and secured to the vessel, the damaged or worn components can be replaced. Once the repairs have been completed the mooring can be put over the side of the vessel and released.