INDIAN OCEAN COMMISSION

TRAINING HANDBOOK

A PRACTICAL WORKSHOP

IN TECHNOLOGY AND MAINTENANCE OF FISH AGGREGATING DEVICES

(FAD)

IOC

INDIAN OCEAN COMMISSION

FPAOI

FEDERATION OF ARTISANAL FISHERMEN OF THE INDIAN OCEAN

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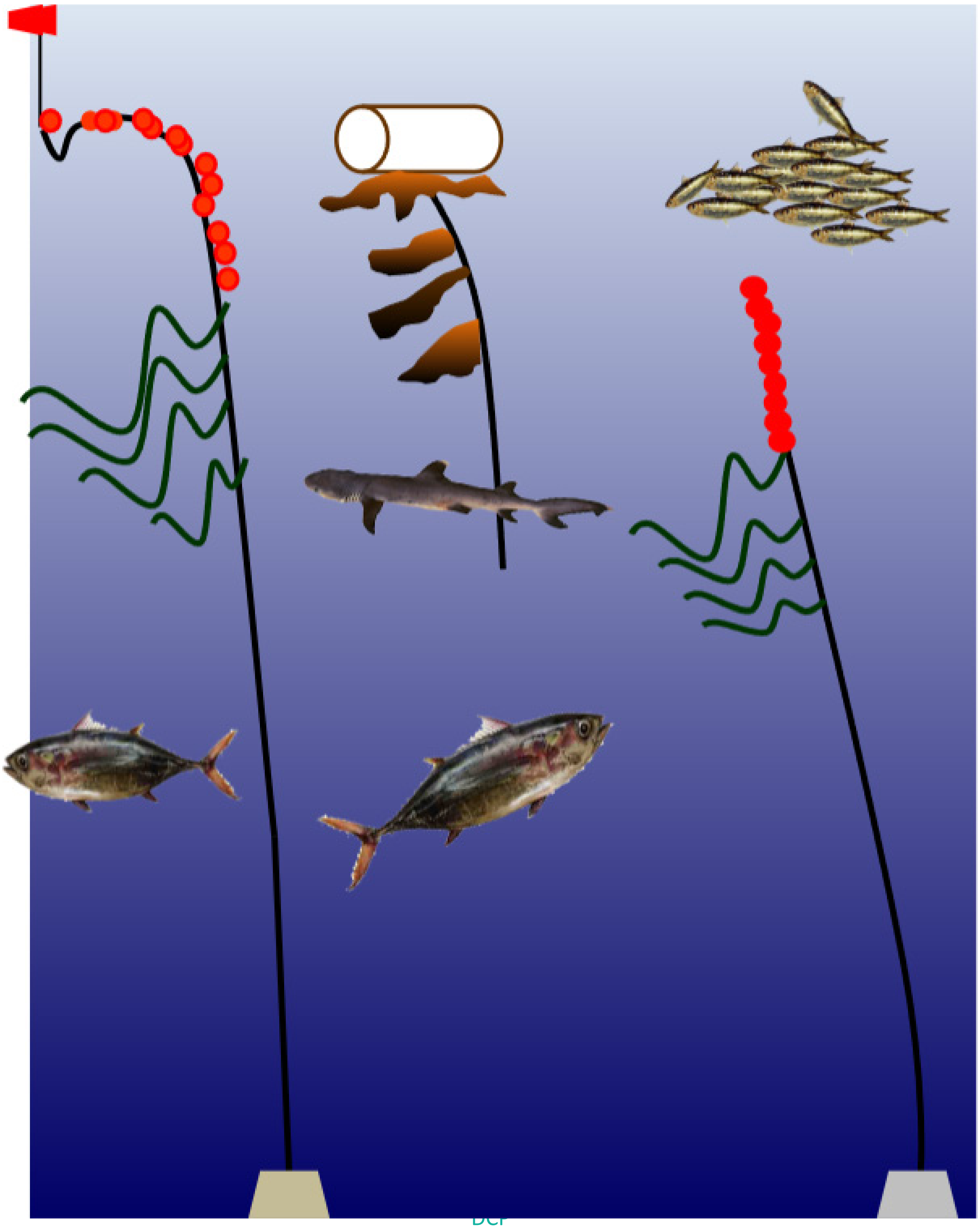
SWIOFISH 2

WORLD BANK GROUP

FPAOI FÉDÉRATION DES PÊCHEURS-ARTISANS DE L'OCÉAN INDIEN
'Unis pour durer'

FADs (Fish Aggregating Devices)



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01 Introduction

(Overview)

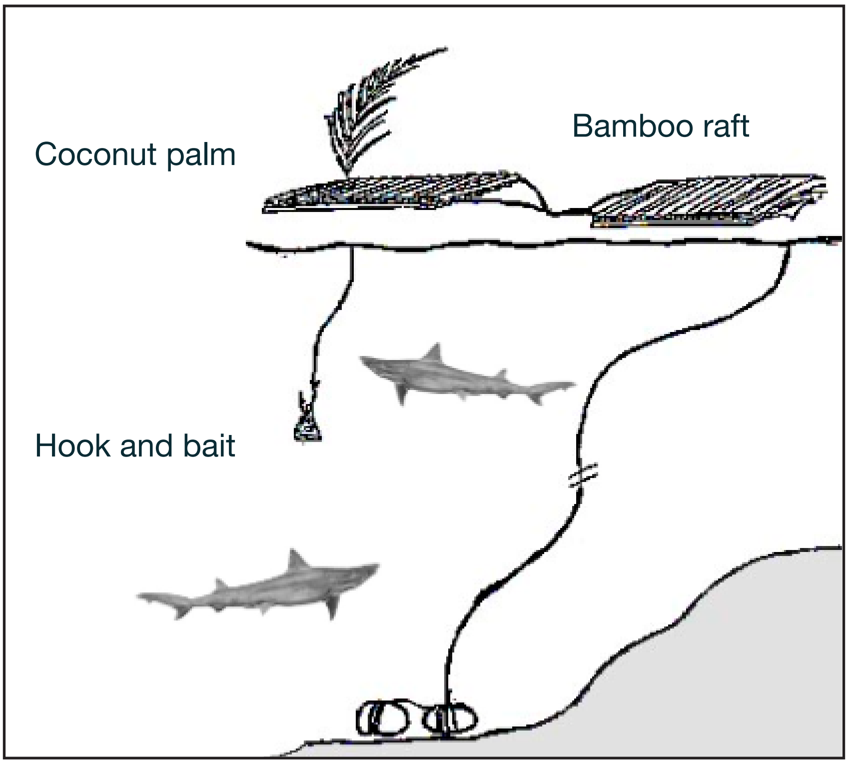
A FAD is a mechanism that intends to recreate the fish food chain at precise, carefully marked locations. Designed with a dead bait, a buoy, a rope and small nets or tarpaulins, this system is used to attract fish. The build-up of algae and food of all kinds on the mesh of the nets and rope leads to the presence of fish, first the small ones, then the medium-sized ones, and then the large ones.

Fishermen often invest a lot of time in finding their catch. Fish aggregating devices, commonly known as FADs, are real time savers – they help fishermen in their search while reducing operational costs (fuel, oil, etc.). Indeed, fish tend to come close to the FADs, regroup and stay nearby the FADs.

Despite the importance of these structures in the local context - i.e. the increase in catches and the large number of fishermen - there have been no notable conflicts between fishermen from other regions over the exploitation of the resource in the vicinity of the FADs. As these structures play a considerable role in the safety of fishermen at sea, the benefits of implementing FADs in relation to the topographical characteristics of the Comoros Islands, in particular Grande-Comores and Anjouan, should not be ruled out.

02 Historical background:
traditional FAD in the Comoros (CHAMPA fishing)

The concept of FADs (Fish Aggregating Devices) is not new to the Comoros. There used to be a shark fishing system called CHAMPA, especially in Anjouan. This mechanism also concentrated a variety of fish. Traditionally, the Champa consists of two interlocking rafts made from banana trunks. The first raft is used as a buoy for the mooring line made of braided coconut fibre rope, ballasted with pebbles at a depth of around 60m. The second raft, moored to the first by the short coconut rope, supports a coconut palm, set up vertically to serve as a marker, and a line ending in a strong hook baited with a sheep's head or a large piece of fish.



In 1961 and 1962, the system was upgraded by the management of the agricultural sector. The banana trunks were replaced by bamboo rafts tied in two perpendicular layers (increasing strength and buoyancy) and the coconut rope by a sisal rope (which is more durable). These new CHAMPAS were also anchored at greater depths (around 100m), and in addition to sharks, many other species were fished around them using hand lines. Other Champas, this time made from steel drums, were set up in Moheli in 1967-1968.

It wasn't until 1984 that systems specifically designed for large pelagics were developed. These experiments were carried out in collaboration with the Fisheries Directorate and the FAO "OISO" project. The floating system was made up of tyres filled with polyurethane foam, and the line was made of 14 mm polypropylene. Two FADs were anchored:

1. at Iconi at a depth of 600 m.
2. near Ouani at a depth of around 1200m.

The monitoring of these FADs was conducted using artisanal fishermen's pirogues, but they disappeared after approximately ten days – almost certainly due to their clearly insufficient buoyancy when facing the currents in the region.

However, the idea of setting up FADs in the Comoros was not abandoned. Since then, several projects have been worked out in order to resume and develop this activity. It was not until 1987-88 that 2 projects financed by the European Development Fund were launched almost simultaneously. The first project, specific to the Comoros, is based in Moroni (Grande-Comore). Its main task was to build and sell motorised fibreglass canoes, and it also planned to set up FADs. The second is regional, but has national support centres in the countries of the Indian Ocean, one of which is based in Mutsamudu (Anjouan). While setting up FADs is its main task, it also aims to train fishermen as part of the National Fishing School.

03 FAD

attracts fish

A fish aggregating device (FAD) generally floats on the surface of the sea and is usually anchored underwater.

Just as bees are attracted to honey, vultures and crows to dead animals and seabirds to schools of fish, fish are attracted to FADs.

Fishermen have been aware that fish are frequently caught in the vicinity of floating objects such as leaves, branches or tree trunks, life jackets, buoys, rafts, wrecks or drifting barrels.

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This phenomenon gave rise to the idea of fixing concentrations of large pelagics around rafts anchored at specific points. We don't know exactly why the fish approach the FADs, but it is generally accepted that the small fish come first, before the large fish feed on them. However, it is possible that large fish approach the FADs because they are of the few objects that they can actually recognise in the open sea.

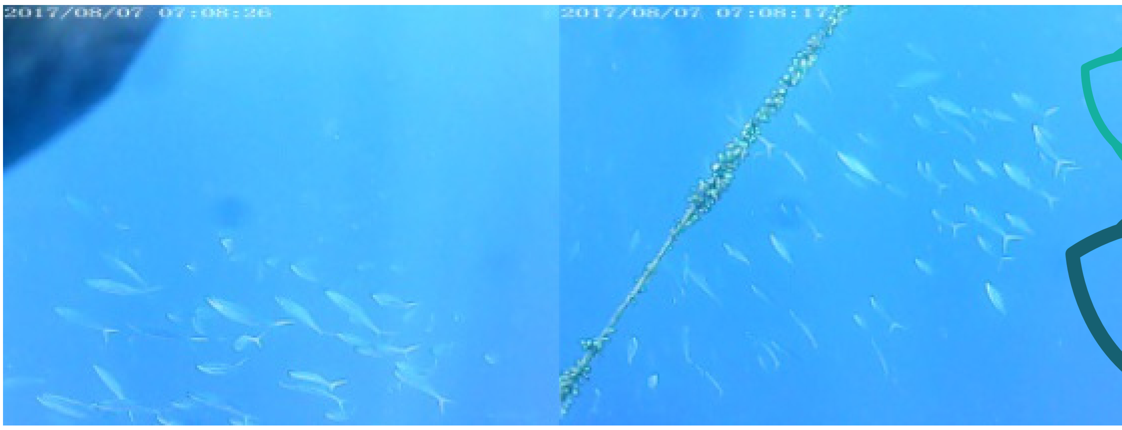
It is possible that the small fish go near the FADs to find shelter from the big fish and to feed on the algae and small animals that live and grow on the structures. These fish will not always stay close to the FADs. Instead, they swim quite a distance from them, then return at different times of the day. They usually swim close to the FADs at sunrise and sunset.

After a while, some fish will practically stay around the FAD all the time. As a result, FADs effectively create fishing areas where fishermen can almost always find fish.

You should be aware that when installing a new FAD, it will take some time before the fish start coming. It may take a week or even longer for a FAD to start working and attracting fish.

Other estimated explanations for the concentration of fish around FADs:

- The scent of buoyant objects attracts fish
- Floating objects and mooring ropes produce sounds through the currents and waves, attracting certain species to come closer to the FADs.
- During the breeding season, some fish lay their eggs on the floating structures, attracting other species to feed on them
- Some fish gather around these devices to form schools and consider them to be their own.

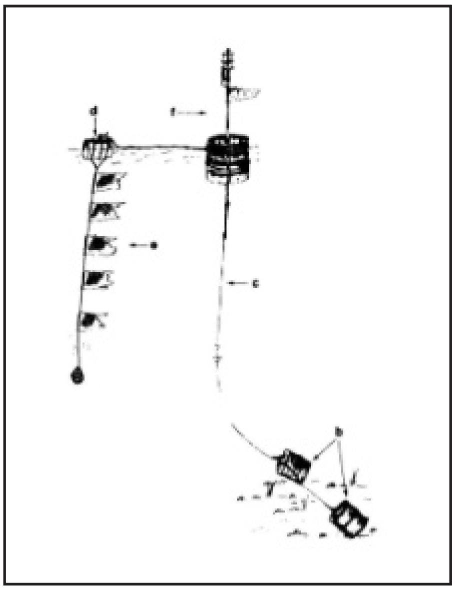


Concentration of associated species around FADs (rainbow, bigeye scad, dolphinfish, skipjack, tuna).

04 FAD technologies:

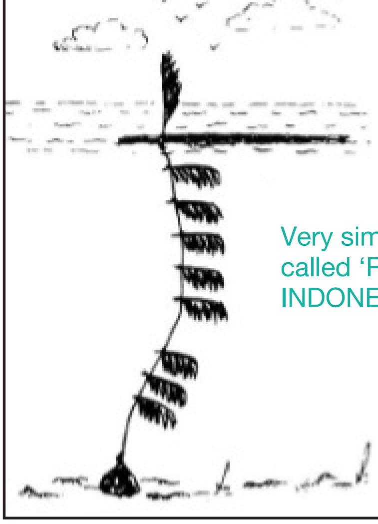
4.1 From the ‘Payao’ to the single sphere

Nowadays, FADs are found throughout almost the entire inter-tropical area of the Indian and Pacific Oceans. The ‘Payao’ from the Philippines, a raft originally made of bamboo and then increasingly of steel, is certainly one of the most widely used FADs worldwide.

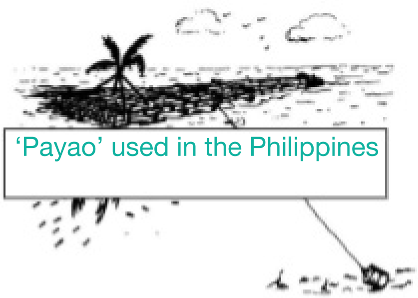


FADs generally float on the surface of the sea and are anchored to the bottom. This FAD has a floating body, two anchors, a mooring line, a buoy, an attracting element for fish, and a pole with a marker, a flag and a radar reflector.

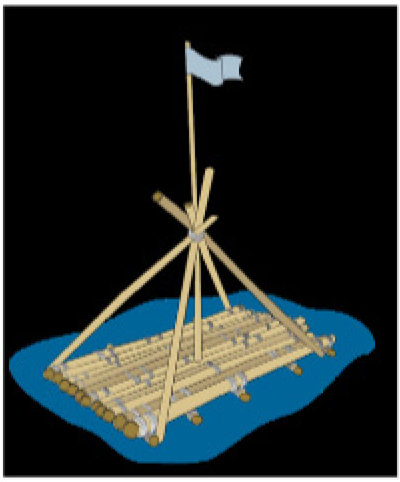
FAD models for shallow depths:

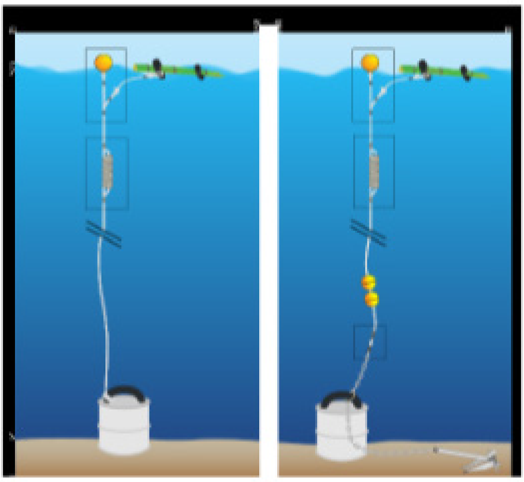


Very simple FAD called ‘Rampon’ INDONESIA



‘Payao’ used in the Philippines



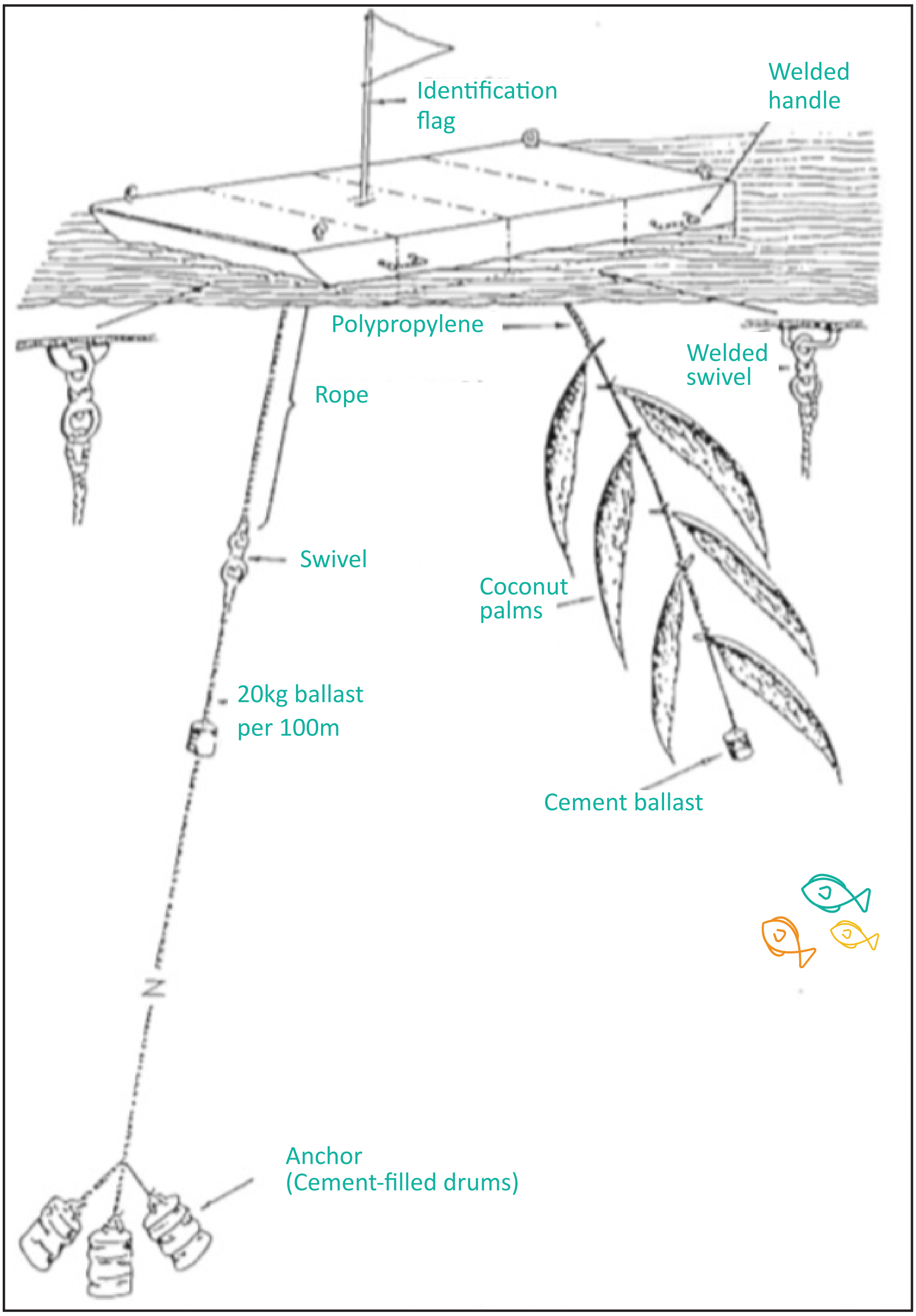


Light FAD made of bamboo (Oceania/Pacific Ocean)

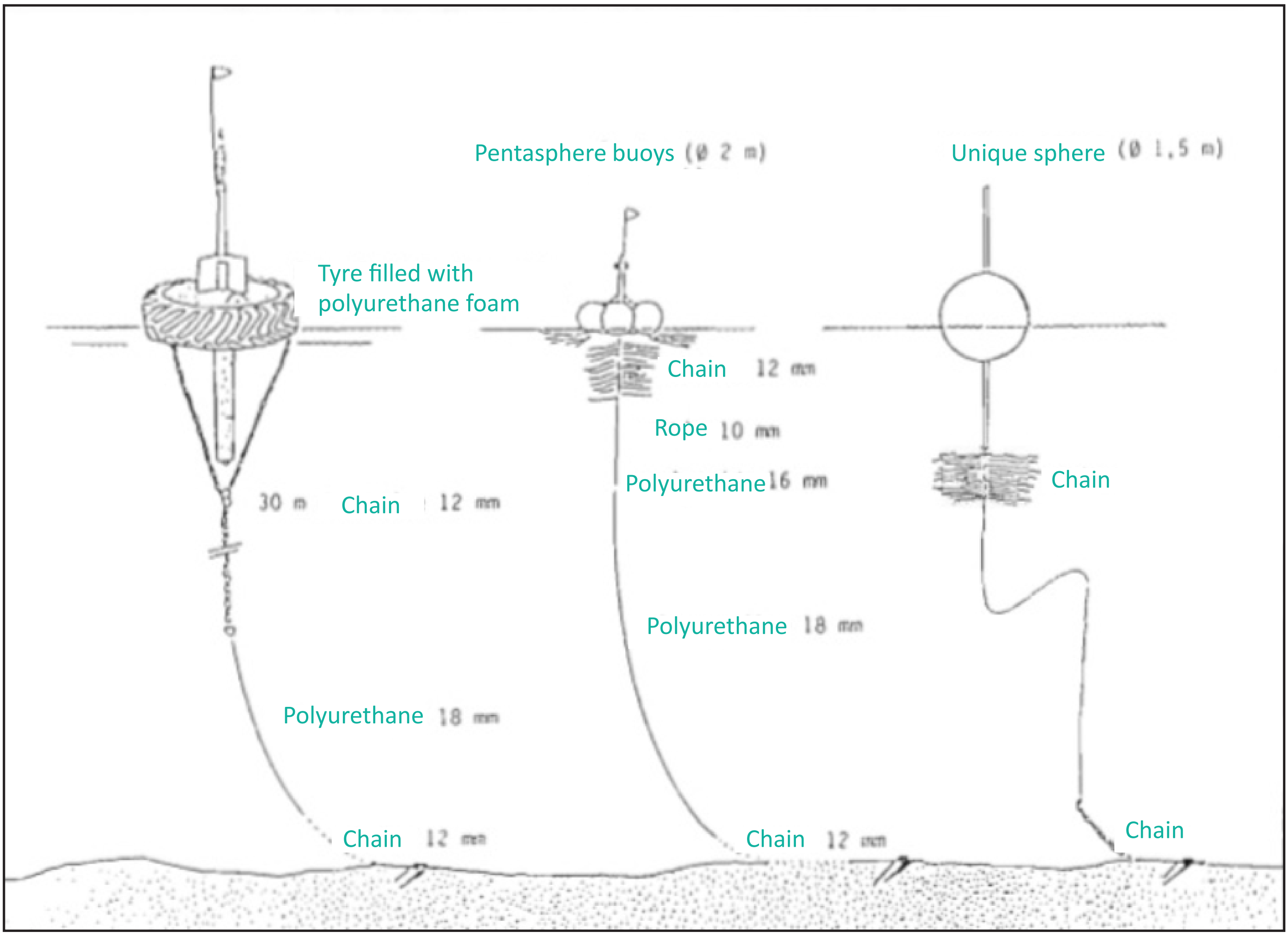
The most widespread ‘PAYAO’ is more or less modified (Fiji, Thailand). In most places, the rudimentary raft has evolved towards more expensive but longer-lasting structures, whether steel pontoons in Japan, wooden catamarans in Vanuatu or aluminium in the Western Samoa and Cook Islands (BERGSTROM, 1983; BOY and SMITH, 1984; MARSAC and STEQUER, 1987).

Another major source of FAD spreading appears to be Hawaï, where numerous FAD attempts have been made (MATSUMOTO et AL, 1981; BOY and SMITH, 1984), the first type of FAD set up consisted of a foam-filled tyre on the surface, similar FADs have been set up in the Maldives, Fiji, the American Samoa Islands. There are also a number of FADs set up in Hawaï (MATSUMOTO et AL, 1981; BOY and SMITH, 1984).

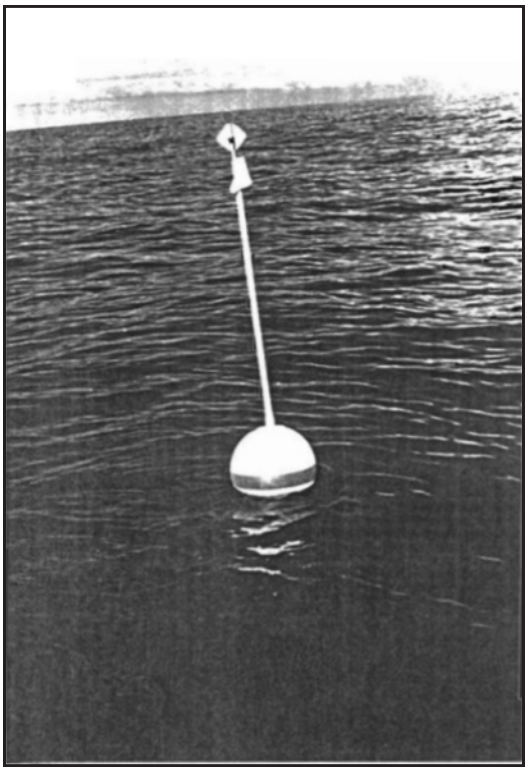
It gradually evolved into a single steel sphere 1.5 m in diameter. The FAD developed in French Polynesia is similar, consisting of a biconvex steel lens 1.5m in diameter (UGOLINI and ROBERT, 1982; DEPOUTOT, 1987; CHABANE, 1990).


Identification
flag
Welded
handle
Polypropylene
Rope
Welded
swivel
Swivel
Coconut
palms
20kg ballast
per 100m
Cement ballast
Anchor
(Cement-filled drums)

Steel Payao



Evolution of the Hawaiian FAD



FAD with unique sphere

4.2 Why use FADs?

In many places, it is not uncommon to find scattered or schools of fish which are hard to catch. One day they may be here and the next they may be elsewhere, much further away. They sometimes stay around for a few days, then move away and come back later. When this is the case, it is advisable to build a FAD and set it up.

As previously mentioned, fish and schools of fish are attracted to FADs. Once a school of fish has located a FAD, it can stay there and circle around for days, weeks and even months before leaving. This means that by using a FAD it is possible to exploit more of the same school of fish.

However, it would be unwise to deploy FADs in areas where there are little or no fish but lots of fishermen. In such cases, FADs are bound to catch the last fish, leaving nothing behind.

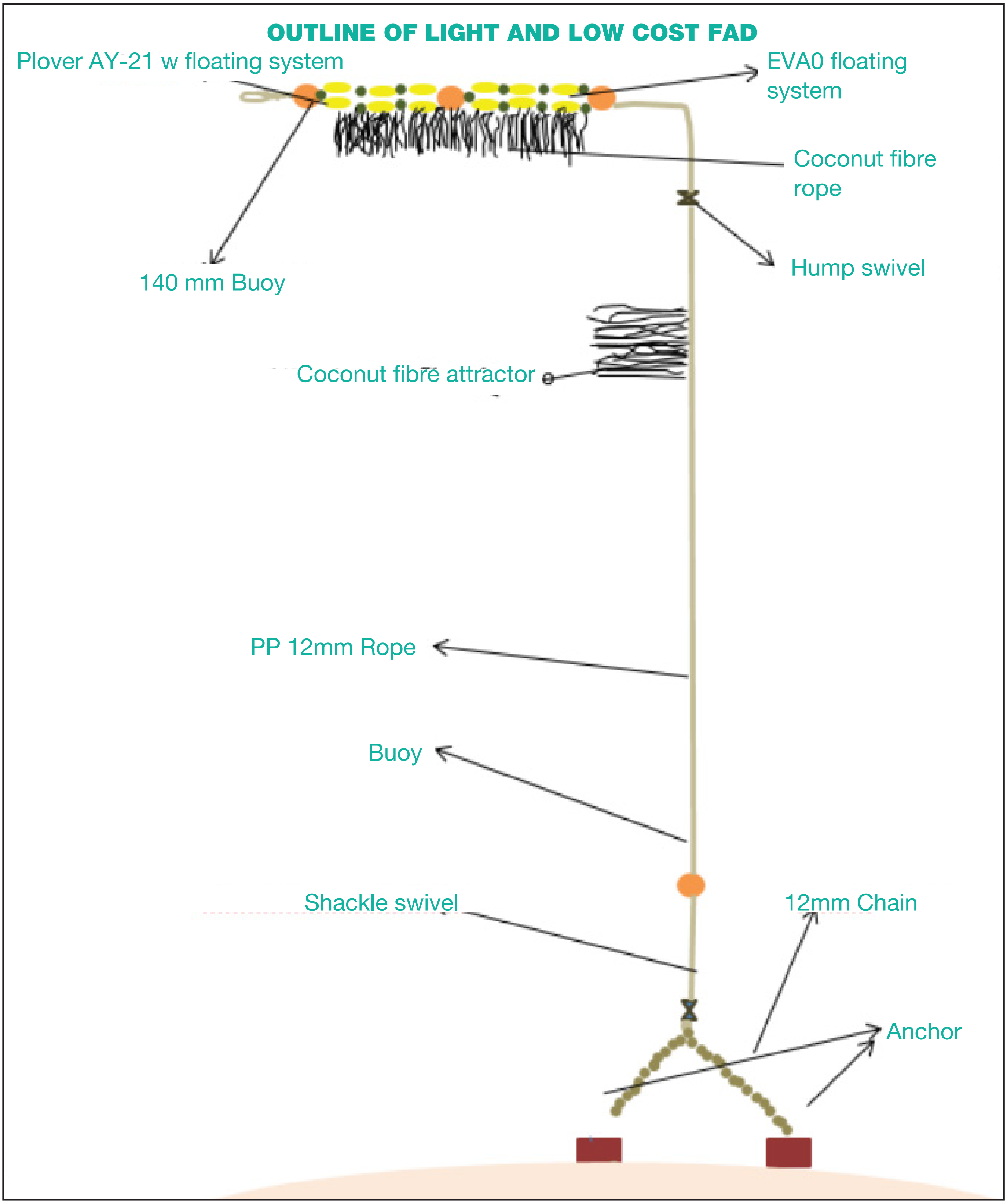
Low-cost FAD for shallow depths

Indopacific FAD (600 m)

4.3 Surface FADs

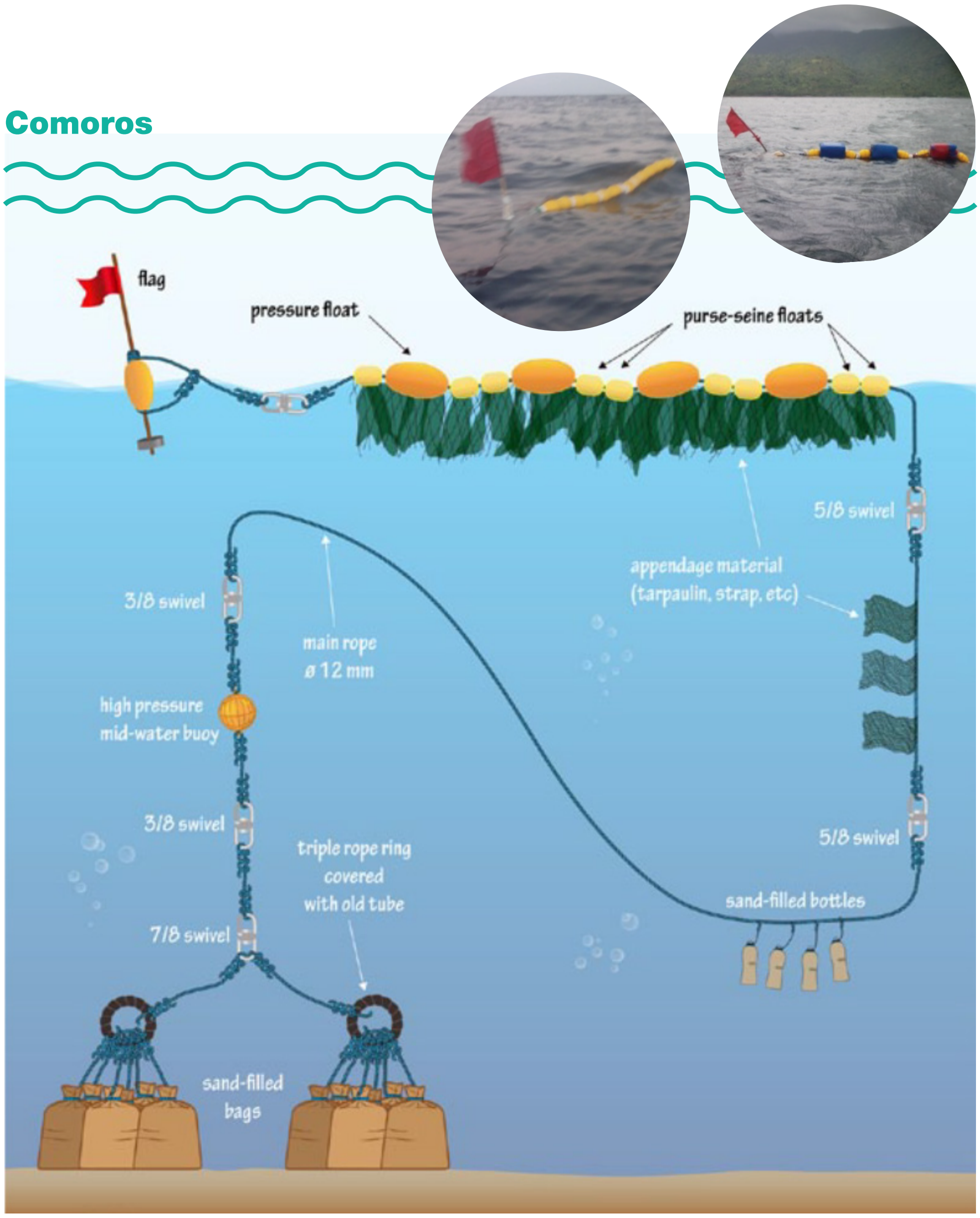
The mooring line used for FADs is generally made of polypropylene of 16 to 20 mm in diameter. There are few examples of lightweight FADs fitted with fine 6 to 8mm rope. The use of a thin mooring line is in fact not incompatible with a long life for the DCP if the assembly is calculated accordingly.

Additionally, a thin line does not require the use of high-resistance floats that can be submerged in strong currents. This is because the frictional force of the water on the rope causing immersion is proportional to the diameter.



Using locally available materials, the low-cost floating FAD structure is made up of 140mm orange buoys and white or yellow EVA buoys. It can be seen from a distance of over 200m and has a coconut fibre attractor. It is attached by swivels to a 12mm PP mooring line, 10mm chain and ballasted with very well cleaned engine blocks (anchoring).

Comoros



LOW-COST LIGHT FAD (PACIFIC ISLANDS)

A light coastal FAD, anchored in shallow waters 50 to 60m and even up to 350m… This is an elaborate version of champas. Composed of an EVA senne floating system, along with a recovery container filled with polyurethane foam or plastic spheres. under which attractive materials such as coconut leaves and sheets of used netting are moored, these FADs provide shelter for schools of small pelagic fish (mackerel, horse mackerel, etc.) resulting from a concentration of fish.

They are very efficient. It is not unlikely to see up to 30 pirogues with hand lines trying to catch these fish. When caught, these are most often used as bait to catch other species. A bait that is generally kept alive in small pots moored alongside the pirogues.

4.4 All-water FADs (1200m to 2800m)

Their main characteristic is that the floating system consists of a coil of plastic spheres. These floats were originally designed to relieve the strain on the rope at the back of the net. They are extremely resistant to compression and have been tested at depths in excess of 660m.

In the event of a strong current at the site where the FAD is installed, excessive forces are exerted on the mooring line. This causes the normally emerged part of the float to sink, absorbing most of the traction. As soon as the weather returns to normal, the whole floating system returns to the surface.

This high-performance system, which is far superior to all those developed to date, guarantees that FADs can last for several years, provided that the surface elements are regularly maintained.

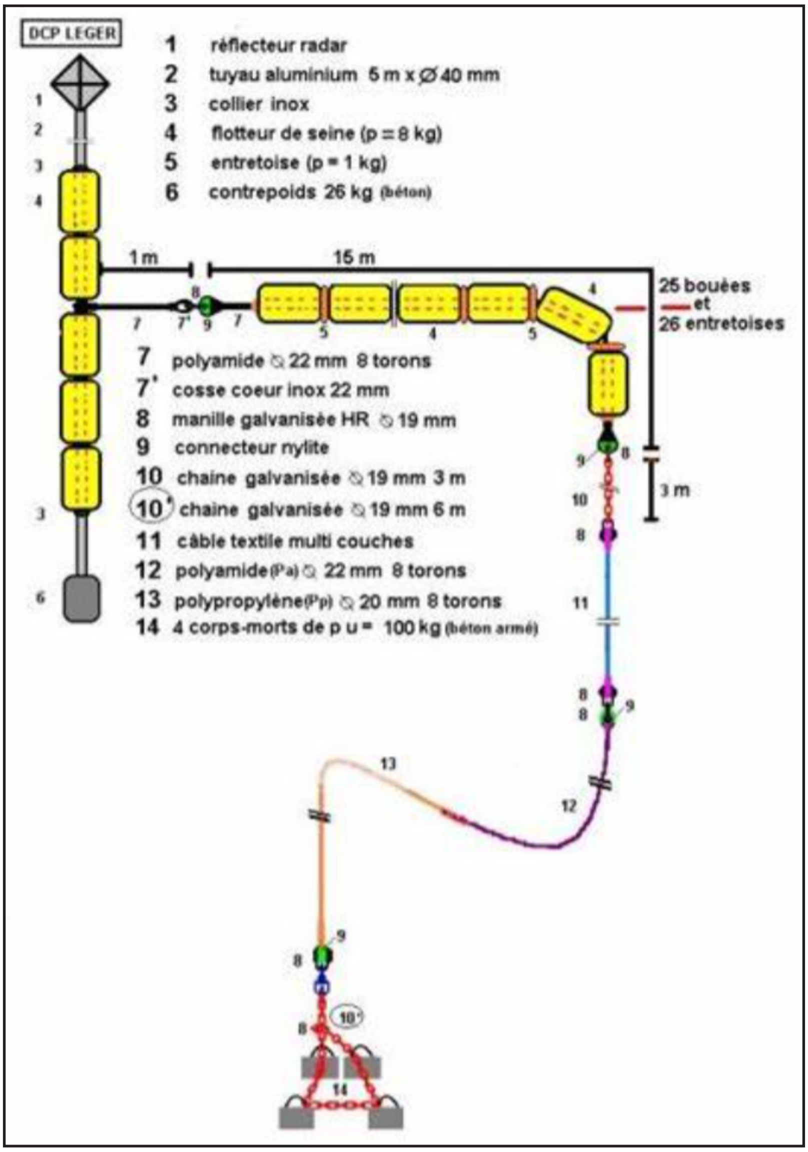
As a general rule, a deepwater FAD is often paired with an inshore FAD, where bait fishing is carried out before heading offshore in search of larger pelagics.

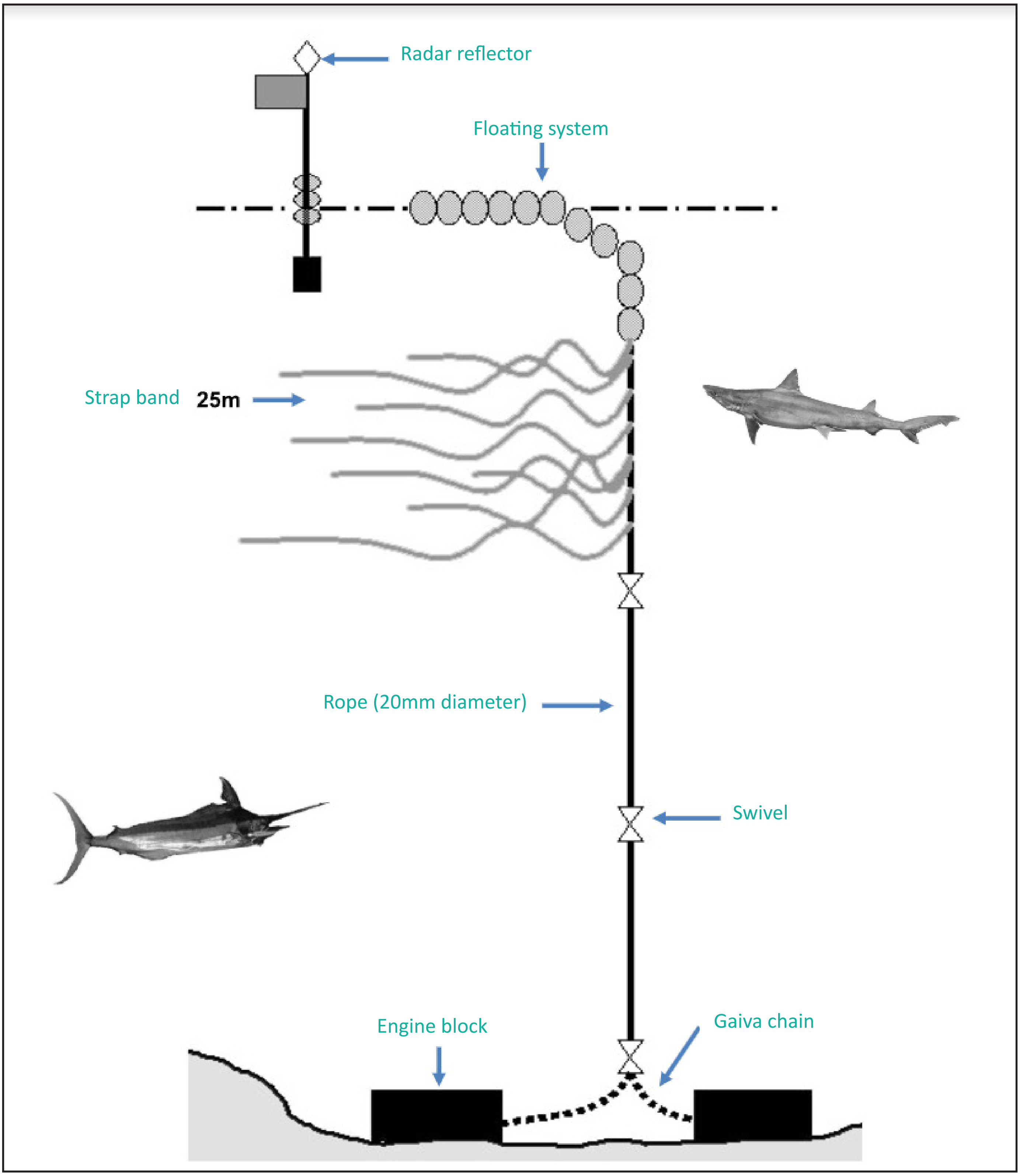
Lightweight FAD with EVA senne floats

Lightweight DCP with polyurethane foam-filled storage containers

Fishing around light FADs: Sélar coulsou, raggedback skipjack, rainbow and tuna.

Installed in-depth FADs (Comoros)





Components of a FAD in the Comoros

4.5 Subsurface FADs

In 2012, while mooring a FAD at Haouhouni in the Nyoumakélé region, a gear designed for a depth of less than 600 m inadvertently slipped on the 700 m isobath and ended up between two waters. Despite this technical error, the area has become a highly productive tuna fishing zone.

- It is a permanent or semi-permanent structure made from any floating material and anchored between two waters to attract fish.

The effectiveness of a mid-water FAD can be summarised as follows:

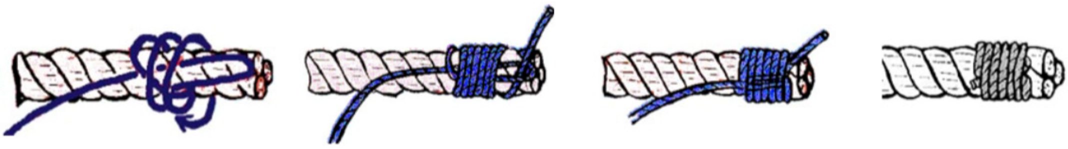
- Reducing fishing effort in comparison with floating FADs: The mid-water FAD is not within the reach of fishermen in transit in the area, as it is submerged. This reduces the concentration of fishing effort, as the position of the FAD is only known by local fishermen.
- Reduce the risk of losing the FAD float:
- The mid-water FAD is not exposed to winds, waves or the risk of damage from ships, as the device is submerged at a depth of some thirty metres or more.. In addition, its immersion protects it from the influence of the sun's rays, so it is protected from the damaging effects of sun and sea water (electrolysis phenomena), the structures have a longer lifespan and the gear is not subject to the pressure of the various marine currents.
- It makes FAD self-management effective: In the Comoros, fishermen often find it difficult to maintain and manage floating FADs, not only because of the costs involved but also because of the shortage of FAD supplies (polyamide rope, swivels, thimbles, etc.).
- Today, the mid-water FAD is becoming increasingly popular in the fishing world thanks to its efficiency, its environmental contributions and its contribution to the sustainable management of fisheries resources.

FAD between two bodies of water

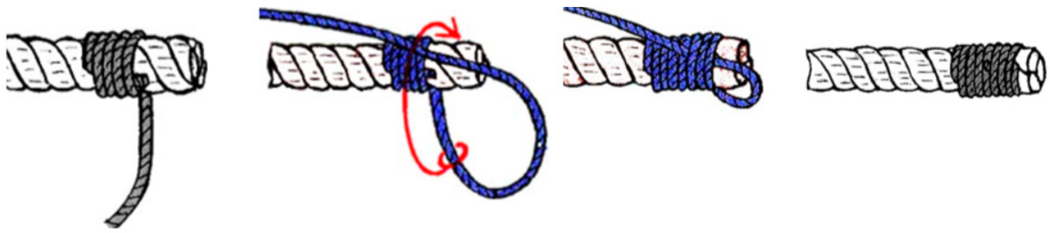
05 CONSTRUCTING a FAD

5.1 Common knots used for the construction of a FAD

a) Dead turn whippings

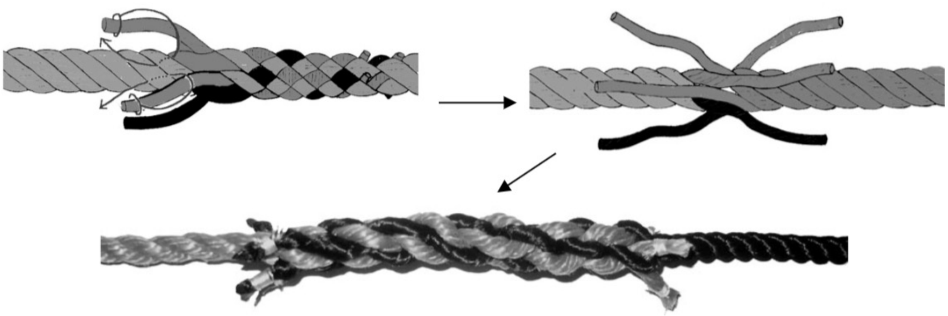


b) Sailboat Whipping



c) Knot of eight

d) Short splice



Eye splice

5.2 The different parts of a FAD

FADs can be built from any floating material: bamboo, pieces of wood, old empty oil drums, barrels, old tyres, inner tubes or any other object that can float.

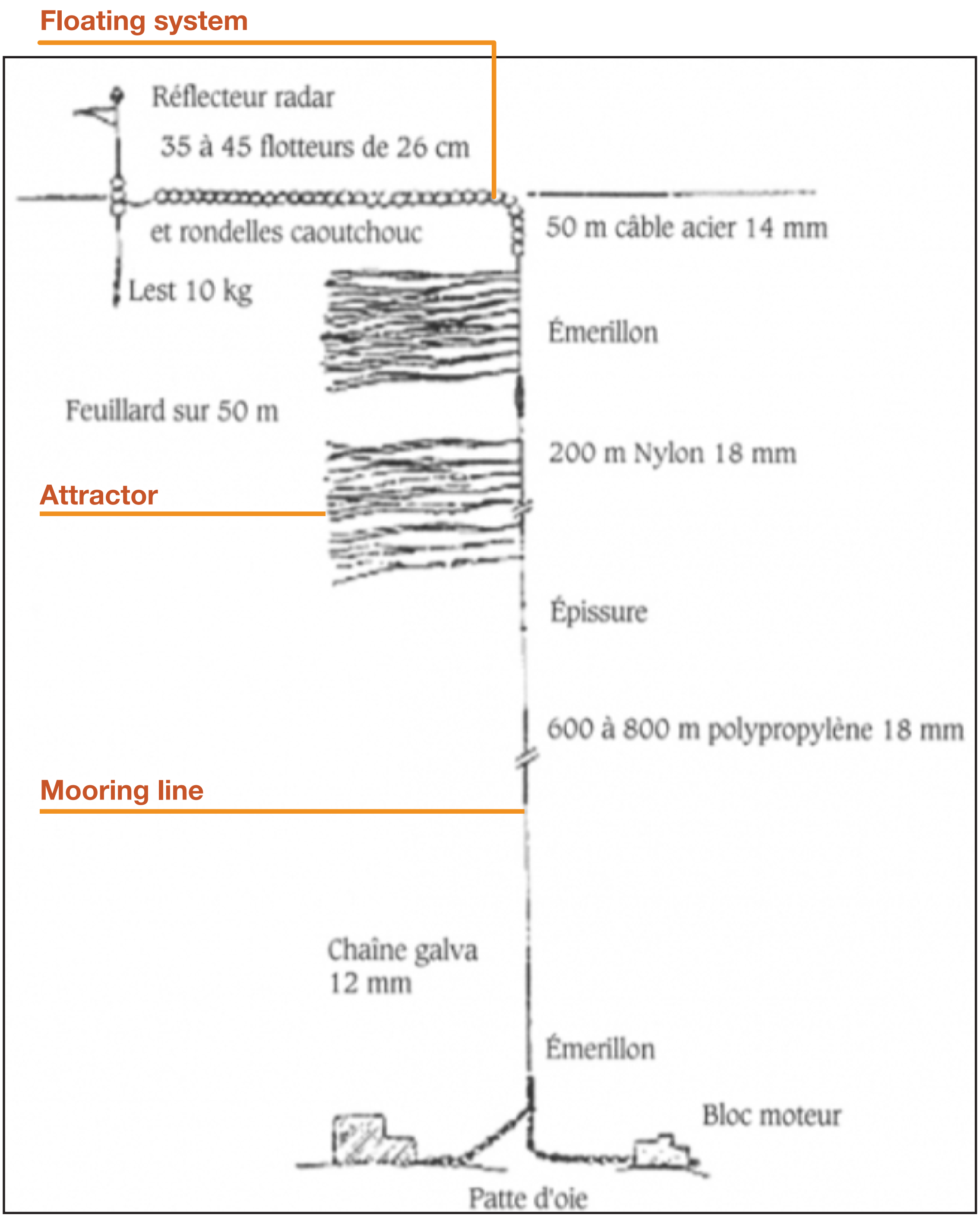
The floating system of the FAD is called a float. Most FAD floats are moored to a heavy anchor on the seabed. The mooring can be made of a wide variety of materials: stone or large concrete blocks, old scrap metal or any heavy object that will hold the raft in place.

The floating system is tied to the anchor by a long mooring line. Pieces of a chain can be used, particularly near the bottom and near the float, or large hawsers made by hand from synthetic fibres (nylon, polypropylene, polyethylene) or natural fibres (coconut or palm fibre, hemp, sisal).

A very important part of the FAD is the fish attractor. The attractor can be made of coconut or banana leaves, tree branches, pieces of used netting or rope. It is moored under the float. Fishermen believe that the attractors draw the fish towards the FAD (some fishermen do not anchor their FAD, but let it drift on the surface). These FADs are generally equipped with a mast, a flag, a light and a radar reflector that enable fishermen to find them.

However, as FADs are made up of a large number of interconnected components, the risk of wear and tear is high, requiring monitoring and maintenance.

The different parts of a FAD



5.3 The floating system

Floating capacity does not need to exceed 200 to 300 litres to ensure a good visibility of the buoys.

There exist a wide range of floating systems – namely the 20cm buoy or the 90cm diameter spherical buoy – filled with polyurethane foam. This sphere, fitted with a pole, is also made of reinforced polyester resin, and comprises a radar reflector and a compartment for a light.

The floating system can be made from 280-litre polypropylene drums, filled with polyurethane foam and strapped to the mooring line.

THE **FLOATING SYSTEM** OF THE **FAD** IS CALLED **THE**

'FLOAT'

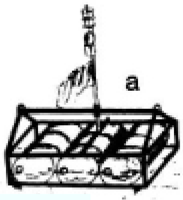
It can be made of any type of buoyant material. Bamboo, pieces of wood, old empty oil drums, barrels, old tyres filled with polyurethane foam, inner tubes, etc.

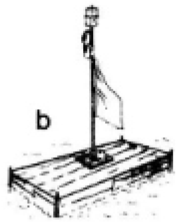




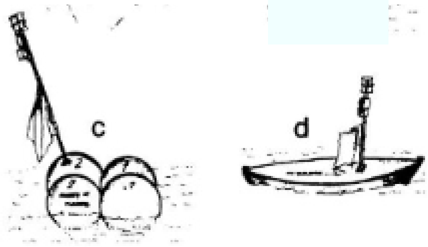


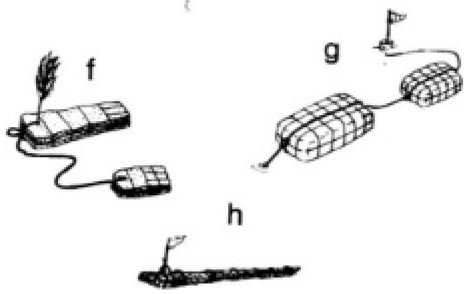

A WIDE RANGE OF FLOATING SYSTEMS

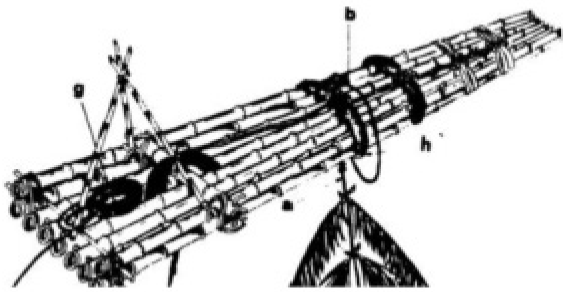




FROM THE SINGLE SPH TO THE SEINE FLOATS







DCP float at lower cost

Indo-Pacific DCP Float

5.4 Material for attraction - 'the attractor'

When the FADs were first installed, they consisted of a layer of netting under the signalling pole in addition to pieces of plastic strap bands fixed over a distance of around twenty metres at the start of the mooring line.

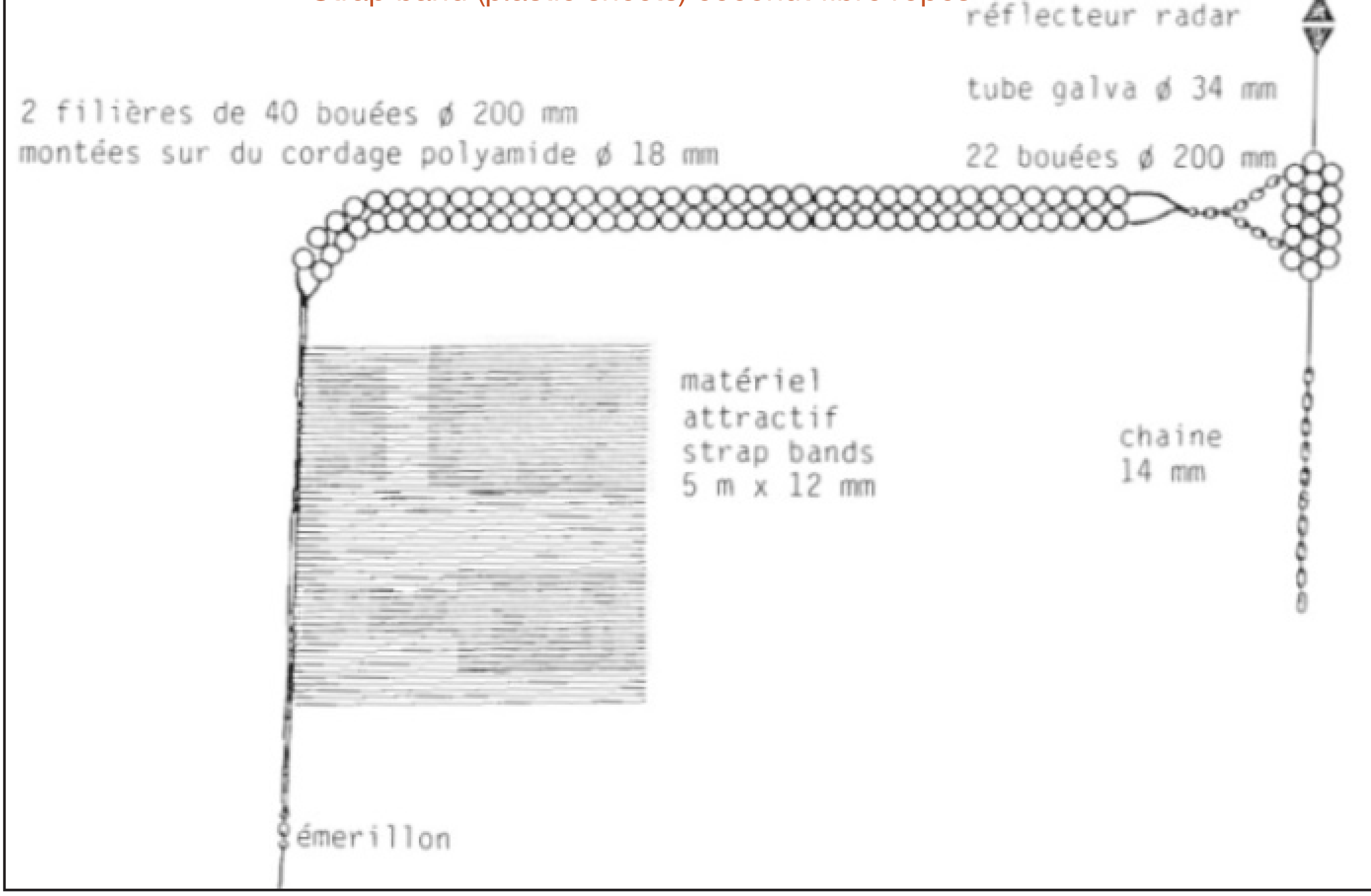
After a few trials, the net was removed to improve the stability of the perch (spotting bell) without any noticeable change in the effectiveness of the FADs.

The curtain of plastic strap bands not only seems sufficient, but is also inexpensive and offers little resistance to currents.

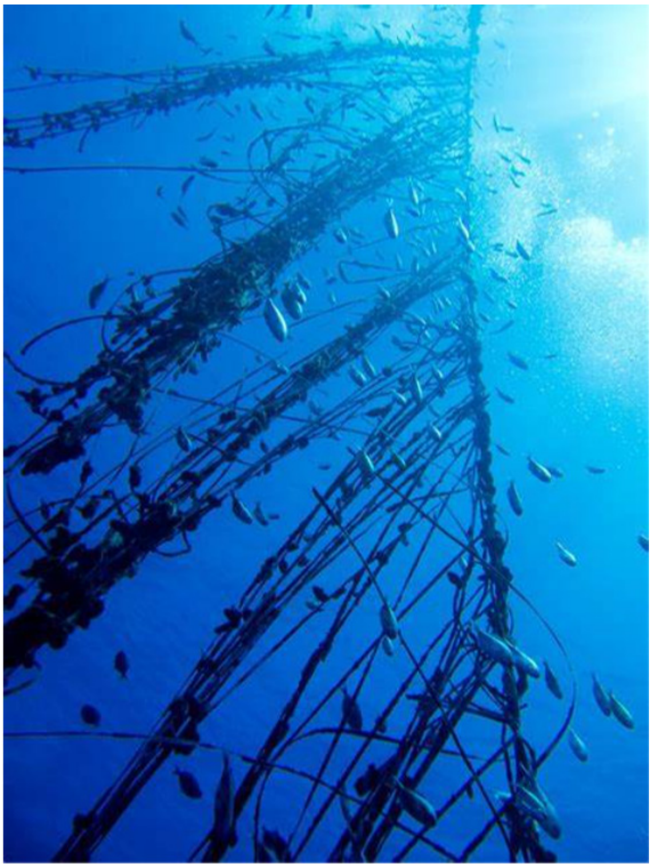
A very important component of the FAD is the fish attractor. It can be made of palm leaves, banana trees, tree branches, pieces of net or used ropes. Fishermen believe that the attractors draw the fish towards the FADs.

Different types of attractors:

Strap band (plastic sheets) coconut fibre ropes



Strap band :



Strap band mixed with coconut fibre rope.

Strap band

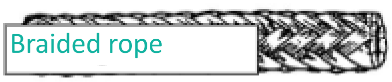
5.5 The mooring line

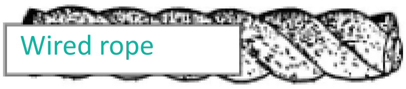
The greater the length of the mooring, the greater the speed of the current above which the float sinks. However, given that a mooring length equal to 1.2 times the depth gives a turning radius of the order of half the depth, it seems difficult to increase this ratio.

The length of the mooring line depends, of course, on the depth of the mooring area. If there are strong currents, a good extra length is needed to prevent the float from being submerged occasionally when the current pulls on the line.

For example, if the depth is 1,000m, you need to add 25 percent more line length: multiply the depth by 1.25 to get the length you need (1,000 × 1.25 = 1,250). The extra length of line is 250m for greater depths, of the order of 2,000m; this extra 250m added to the depth value should be sufficient.

It's best to use synthetic fibre ropes made of nylon, kuralon, dacron, polyethylene or propylene. These two are the most inexpensive, floating ropes. Braided ropes are more resistant but more expensive than cabled ropes.





5.6 Ballast

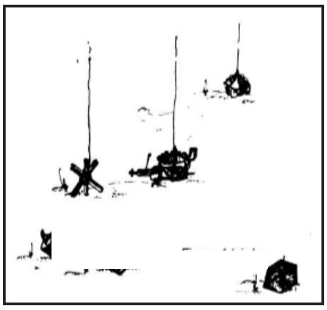
To attach the line to the anchor, always opt for a chain rather than a rope. This prevents the line from breaking when it rubs against a hard bottom, rocks or coral.

Two or more deadweight lines linked together provide a safer anchorage than a single block. The connection between the line and the chain should be secured by a strong swivel. Ensure solid connections between ropes, chains, dead weight and FADs by fitting shackles with wire or welding them together to prevent the shackle from unscrewing and causing the loss of the anchor and the FAD.

The weight of the anchor must be calculated so the float can neither lift it nor cause it to slide along the bottom under the effect of the current-generated forces on the anchor line. If the weight of the block is greater than the buoyancy of the FAD float, the latter will not be able to lift it. This minimum weight is used as the basis for calculating the weight of the anchor.

Anchoring

Engine blocks as anchors

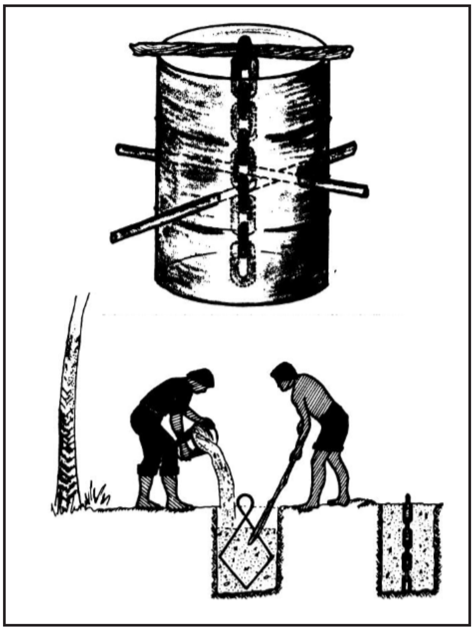


Various anchors

Metal drums to be carefully cleaned as for engine blocks as anchors

Filled with concrete and reinforced with iron scrap to make it heavier

Create hollows in the ground with concrete blocks, which can be used as mooring posts



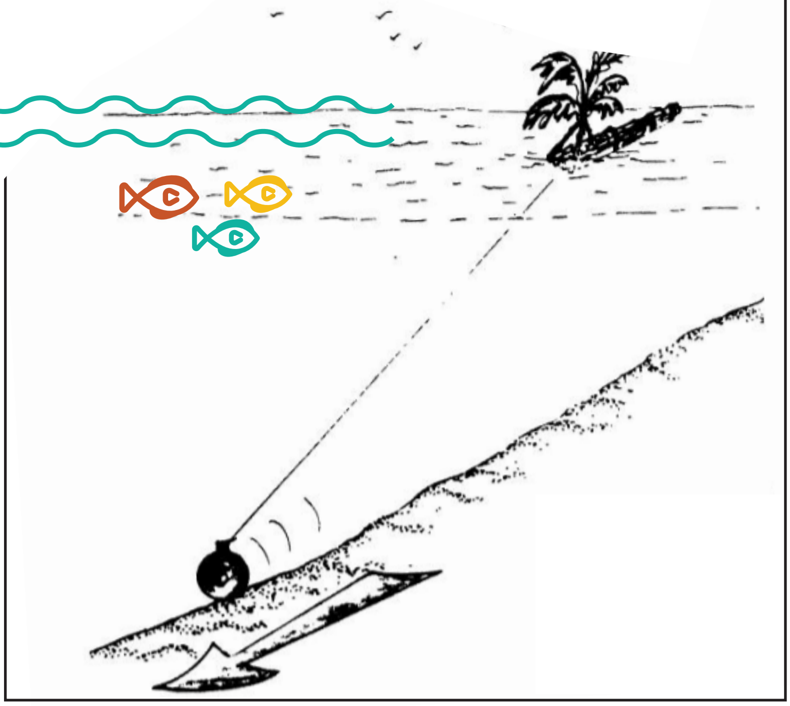
06 FAD set-up
& deployment

6.1 Where to set-up a FAD

Selecting the FAD implementation location

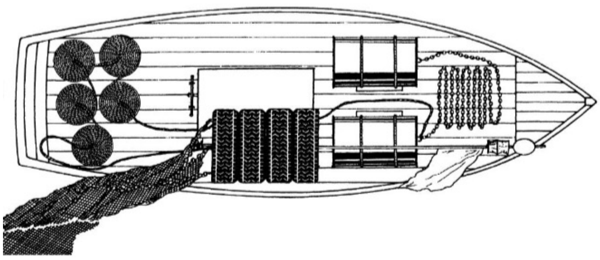
- Historic fishing area
  (fish passage and concentration area)
- Avoid maritime corridors
- Avoid steep slopes
- Knowing the approximate depths
- Areas with diverging and
- converging currents are ideal for nutrient enrichment and make excellent fishing grounds
- Area with slow and moderate currents are generally suitable for FADs
- Muddy and sandy bottom topography are perfect for FAD installation

Prior to launching a FAD, the GPS coordinates, water depth, topographical conditions and distance from the shore and other FADs must be checked. Then only can the fishconcentration device be installed.



6.2 Setting up and deploying the FAD

It is important to have a boat large enough for the installation. The boat must have sufficient capacity to carry the entire FAD in complete safety: float, attractor, chains, complete mooring and the personnel needed to launch it.

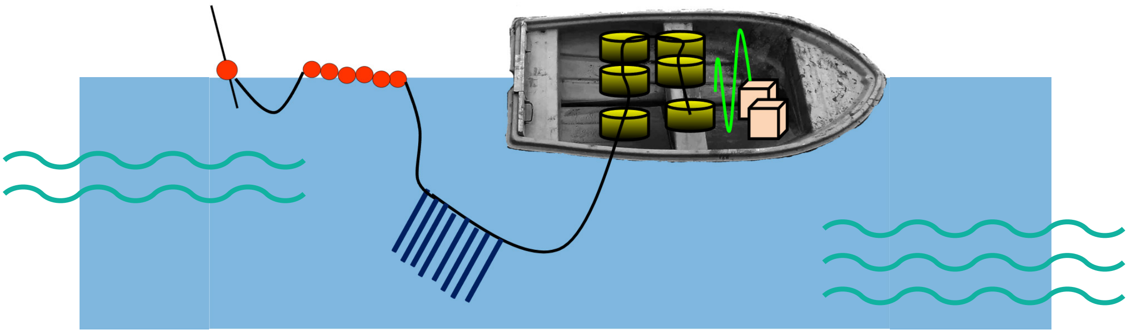


The boat must be stable, have good sailing ability, be at least ten metres long and fairly wide.

First you need to measure the length of the mooring line. Once you've done that, make all the necessary connections between the various parts of the FAD. Everything must be laid out in an orderly fashion on deck, so that there are no unpleasant surprises when you are at sea.

Remember that you should always place the float in the water first, and the dead weight last. The chain should be positioned in a way that the section which is launched first is easy to grip on, i.e. the top.

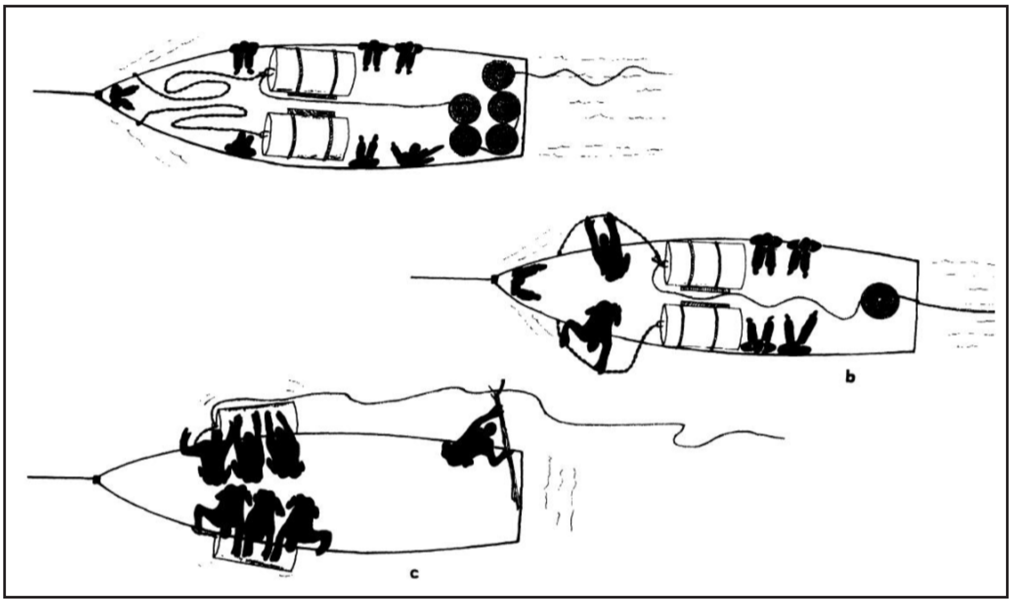
Similarly, the mooring line should be lifted so that the halyard that needs to be spun first is located on top. The whole mooring line should be carefully arranged in stacked halyards in the order in which they are launched. It should preferably be done at the stern of the boat, behind the deadweights, so that the line can be spun quickly and freely, without the risk of getting entangled with the sailors' feet.

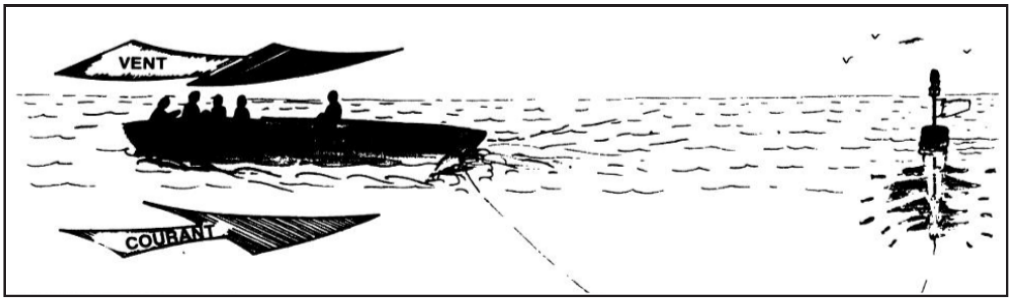


The floating system should be positioned on the bow of the boat. You can place a deadweight anchor on each side of the boat for a better balance and to make it easier to launch. Tie the moorings they cannot move when under way. The moorings should be linked together by a chain of approximately 10 m long.

Carefully lay the chain so that it can gently be launched from the bow, without any risk while the dead weight is still on board. The chain must hang forward while the blocks are being launched and passed over the side at the same time.

Before leaving the docks, it’s crucial that the operational procedures are clear so that everyone knows exactly what they have to do.



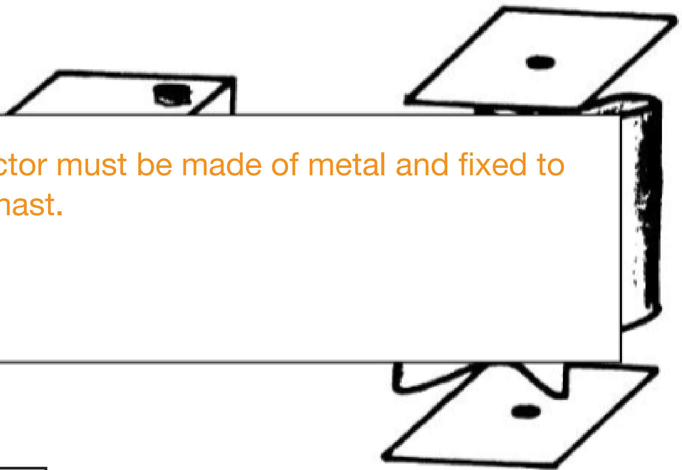


Between port and anchorage, make sure you have all the equipment you need to fit the FAD: buoyancy tube, attractor, mooring line, shackles, swivels, splices, etc.

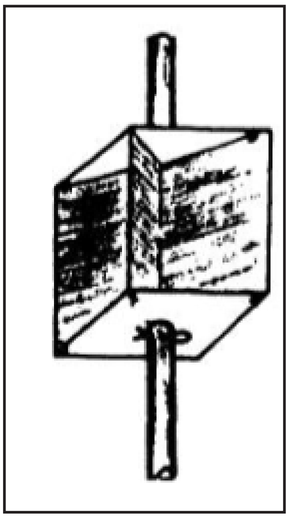
6.3 The radar reflector

The radar reflector is useful for two reasons. Firstly, large boats passing in the vicinity of the FAD will be able to detect the float and avoid it.

The second is that, if you have radar aboard your boat, the radar reflector will enable you to locate your FAD faster.



The radar reflector must be made of metal and fixed to the top of the mast.



07 FAD MAINTENANCE
& serviving

Should a float break or become detached from its anchorage, you have little chance of finding it again. For this reason, you need to be very careful when building and setting up FADs. Every time you fish near them, check that the knots, splices and shackles are secure.

If you find there is something not right, for example a rope or link worn by repeated friction, don't hesitate to replace it.

From the moment they are anchored, the FADs must be inspected at least every 15 days to check the technical condition of the equipment on the surface. These inspections make it possible to detect and control electrolysis between the interconnected components, and the risk of wear and breakage is high, so careful monitoring and maintenance of the FADs is essential.

To avoid losing part or all of a FAD, it is essential to report any anomalies observed on a fish aggregating device.

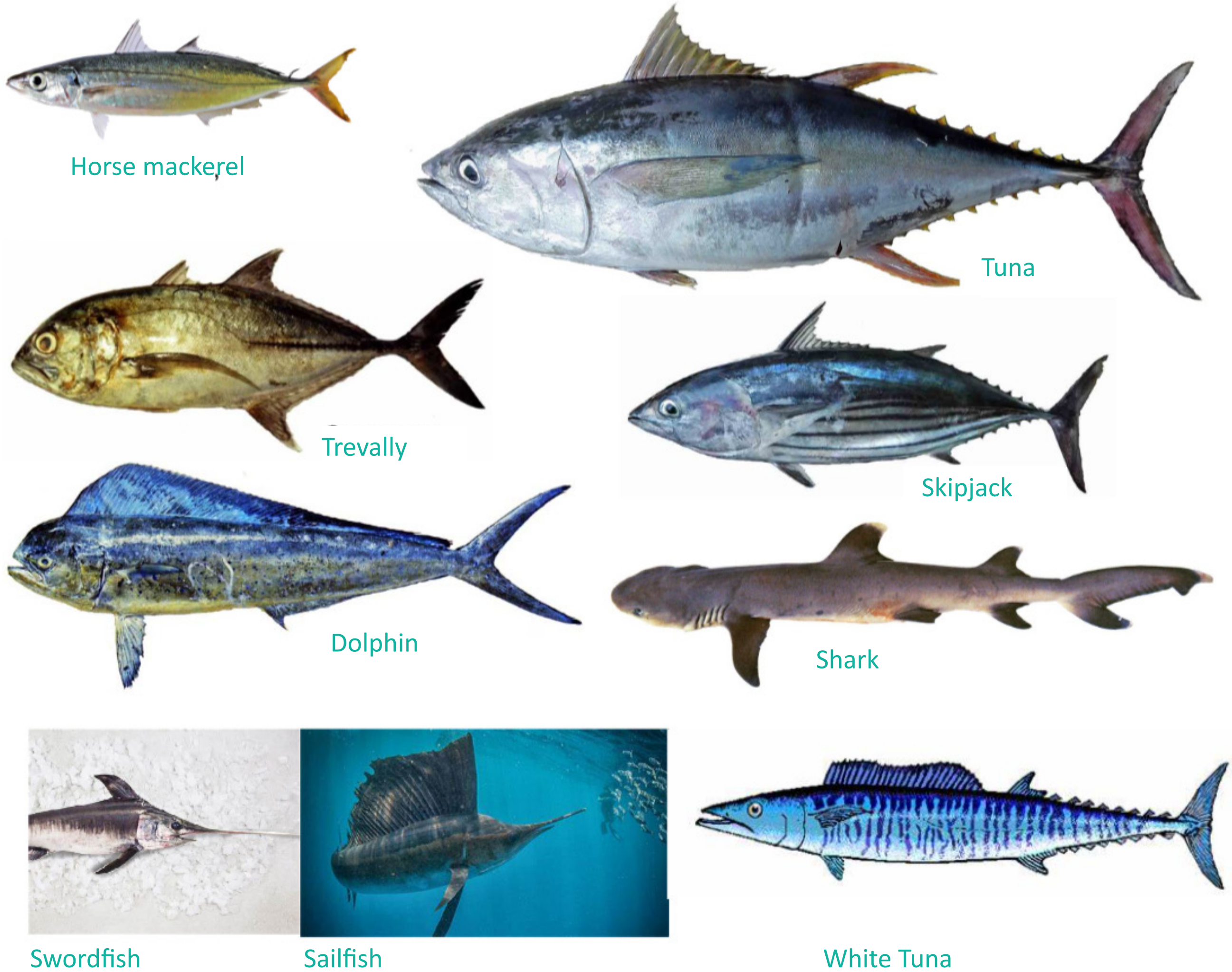
08 A few RECOMMENDATIONS

- Respect fish aggregating devices
- Do not moor yourself to them
- Do not attempt to raise them or attach gear to them
- Replace the float every 7 (seven) months

09 The CATCH

Most of the fish that gather around FADs are schooling ones that live in open water or on the surface, referred to as “pelagic fish”. In contrast, bottom-dwelling fish, known as “demersal fish”, rarely group around FADs.

Notable fish species include all tuna species, all species of skipjack, some species of mackerel, horse mackerel, some species of trevally, dolphinfish, sharks and more.



Bibliography

ENPMM (national fishing and merchant navy school) textbook 2013

Comment construire et placer des dispositifs de concentration de poissons (DCP) - Compiled by Ben-Yami from manuscripts prepared by A.S. de Jesus, C. Peters and B. Bjarnason

Illustrations by Pichovich, Barcali and Carlesi 1990

IFREMER Technologie Des Dispositifs de Concentration de Poissons 1989/90 Gérard Billais, Marc Taquet