SOUTH PACIFIC COMMISSION
FISH AGGREGATING DEVICE (FAD) MANUAL

VOLUME I
PLANNING FAD PROGRAMMES

BY JAMES ANDERSON AND PAUL D. GATES

COASTAL FISHERIES PROGRAMME
CAPTURE SECTION

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SOUTH PACIFIC COMMISSION
NOUMEA, NEW CALEDONIA

Original edition: English

South Pacific Commission Cataloguing-in-publication data

South Pacific Commission fish aggregating device (FAD) manual/
by James Anderson and Paul D. Gates
Contents: v.i. Planning FAD programmes —v.ii. Rigging deep-
water FAD moorings—v.iii. Deploying and maintaining FAD
systems

1. Fish aggregating device—Handbooks, manuals, etc.
2. Fisheries—Equipment and supplies. I. South Pacific
Commission Coastal Fisheries Programme Capture Section.

639.2028 AACR2
ISBN 982-203-482-2 (set)
ISBN 982-203-485-7 (v.i)

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Prepared for publication with the assistance of the Fisheries Information Section,
and printed at South Pacific Commission headquarters, Noumea, New Caledonia.
Cover printed by Stredder Print Limited, Auckland, New Zealand,
1996

Dedication

The SPC Fish Aggregating Device (FAD) Manual
is dedicated to the memory of Paul Gates,
former SPC Fisheries Development Officer and later consultant to the Commission,
who devoted a large part of his professional career to this work.
His original research, writings and artwork
have been drawn on heavily in its production.

ACKNOWLEDGEMENTS

This handbook was prepared by James Anderson, of the Marine Resources Assesment Group (MRAG) Limited, London. Much of the content is original, but Jim was also able to draw extensively on materials prepared by South Pacific Commission consultant Paul Gates for a planned series of SPC documents relating to the application of fish aggregating devices in Pacific Island fisheries. Paul was tragically killed in a diving accident before his work was completed or published. This handbook is dedicated to his memory.

Preparation of the handbook took place as a collaborative effort between the South Pacific Commission (SPC) and the British Overseas Development Administration (ODA), which seconded Jim Anderson to SPC in Noumea for the time needed to complete the initial write-up. After completion of the final draft, a substantial process of review and editing took place that involved several staff of the SPC Fisheries Programme. Garry Preston, Peter Cusack, Aymeric Desurmont, Satalaka Petaia and Julian Dashwood all contributed to finalising the document.

Publication was made possible by funding from the Australian Government through AusAID and the United Nations Development Programme.

PUBLISHER'S NOTE

The handbook constitutes one of the results of a programme of research called The Interaction between Fish Aggregation Devices and Artisanal Fishermen, which was undertaken by the ODA Fisheries Management Science Programme in cooperation with SPC FAD deployment programmes in Vanuatu and Fiji. It also comprises the first of a series of handbooks on FAD programme planning, deployment and engineering by the South Pacific Commission.

The ODA undertakes a number of programmes in several areas of natural resources research including management science, aquaculture. genetics and post-harvest fisheries. These are guided by its Renewable Natural Resources Research Strategy (RNRRS). More information on this strategy and on specific ODA fisheries research programmes can be obtained from:

Natural Resources Department
Overseas Development Administration
94 Victoria Street
LONDON SW1E 5JL
United Kingdom
Tel: (44) 71 917 7000 Fax: (44) 71 917 0679

More information on the Fisheries Management Science Programme can be obtained from:

Marine Resources Assessment Group Limited
27, Campden Street
LONDON W8 7EP
United Kingdom
Tel: (44) 71 225 3666 Fax: (44) 71 823 79 16

Further information on the South Pacific Commission's Fisheries Programme can be obtained from:

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CONTENTS

INTRODUCTION

In recent years, fish aggregating devices (FADs) have become widely adopted as a means of improving fisheries production. However, most FAD deployments have taken place without careful consideration of the social and economic effects their presence will have on the fisheries sector and those involved in it. The result has been that, while the FADs have usually aggregated fish as intended, FAD deployment programmes have frequently not produced the social and economic benefits expected.

In most cases FAD deployments are financed through government budgets. Given the nature of FADs —they have limited life-spans—it is important for fisheries managers to be confident that FAD deployments and renewals will benefit fisheries development objectives. These might include increased fish production, efficient employment of capital and human resources, and positive contributions to local and national economies. It is thus important that data on the impacts of FADs be gathered, so that the benefits they bring can be demonstrated and quantified.

In most cases, the effects of FADs—both positive and negative—are not monitored, and there is no real information on the true impacts of sometimes very costly FADs on local fisheries. This handbook is intended to lead the reader through the significant areas of planning and monitoring that should be addressed if FADs are to fulfil their potential and if unforeseen negative effects are to be avoided. It describes the use of simple assessment methods that will assist programme managers to develop rational, sustainable FAD programmes.

CHAPTER 1

FAD PROGRAMME BASICS

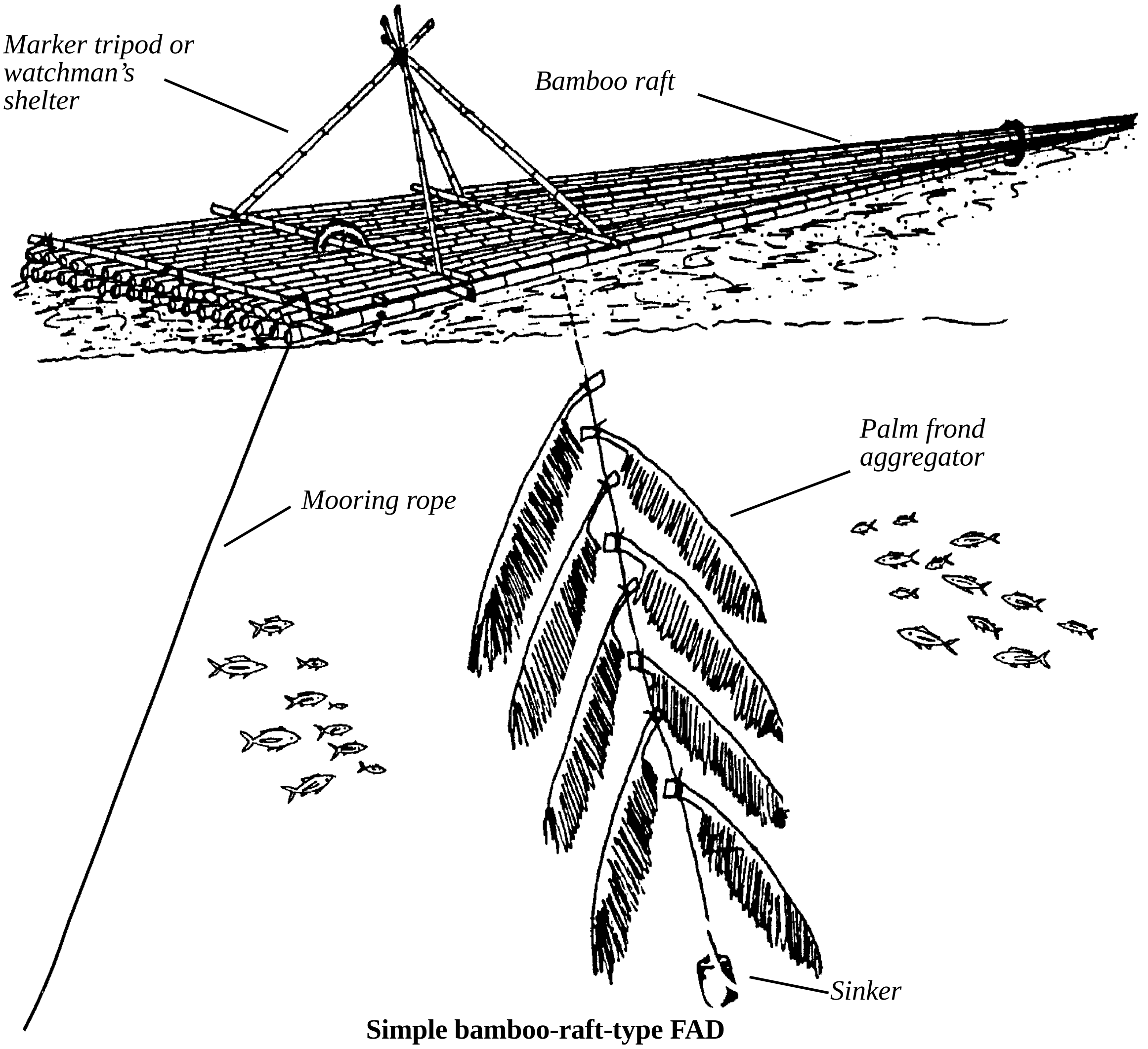
This chapter gives an introduction to FADs and describes some of the ways in which they can benefit fisheries. It also shows that FAD programmes can cause unexpected problems.

Oceanic fishes such as tunas are often found gathered around floating logs and other drifting objects, sometimes in very large numbers. Having observed this behaviour, fishermen learned that they often had higher catches when they found floating objects and fished near them than when they fished in the open ocean.

Some industrial fishing techniques rely on this tendency for tuna to gather near natural floating objects to improve their catch; many tonnes of tuna have sometimes been taken around even small bodies of floating debris.

TRADITIONAL FADS

In the early 1900s, fishermen in Indonesia and the Philippines began building floating rafts of bamboo and other materials to attract schools of fish. They moored these rafts to the sea-floor with natural fibre ropes secured to baskets of stones that served as anchors. These man-made structures were the first fish aggregating devices, or FADs.

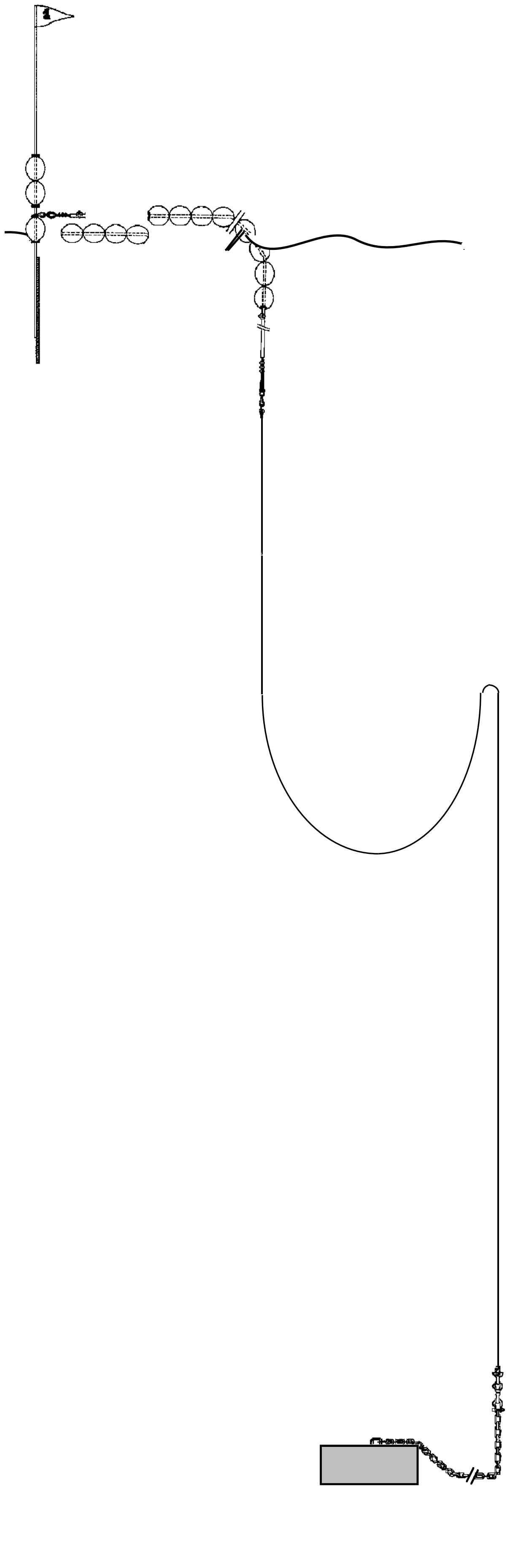


Simple bamboo-raft-type FAD

The use of FADs by both small-scale fishermen and industrial fishing fleets is now very widespread. In the Philippines over 3,000 FADs are in use, and most yellowfin tuna production comes from them.

Much research and effort has been put into improving FAD technology over the last 15 years. Most of these efforts have concentrated on successfully keeping FADs in place in the often harsh environment of the open ocean.

MODERN FADS



Modern FADs may be anchored in waters up to 2,000 m deep and be equipped with radar reflectors and solar-powered lights. FAD rafts that were once built from natural materials are now commonly made from steel, aluminium and fibreglass. Some modern FAD designs use rafts that will submerge without damage under the effect of strong currents or storm conditions. Carefully calculated combinations of synthetic ropes are now used to produce mooring lines designed to withstand the harsh conditions of the marine environment. Some of these FADs have life-spans of up to five years in the ocean. However, the basic idea of fixing a floating structure in the sea, in a way that will gather fish, remains the same as 100 years ago.

WHY FADS ATTRACT FISH

Although fishermen have been using FADs for nearly a century, and much is now known about the behaviour and biology of tunas and other pelagic fishes, the reasons why FADs attract fish still remain largely unexplained. Research into this question, mostly through observing fish behaviour in association with FADs, has suggested several possibilities, of which the most important are the 'shelter and protection' and the 'orientation' theories.

Shelter and protection

This theory suggests that both the FAD raft and the mooring line offer protection to fish from predators. Schooling fish may remain close to or 'hide' behind mooring lines and the underwater parts of FAD rafts, or may school together even more closely when under threat from predators. Observations on shallow-water FADs have suggested that predators may be confused by this behaviour and unable to complete their attacks.

Orientation

This theory argues that fish use the FAD as a physical reference point in an ocean generally devoid of such signals. Some tuna species have been observed to leave the FAD at night to feed, and return during the day, while others appear to remain close to the FAD at night and forage during the day.

In either case it is apparent that the fish are able to find their way to and from the FAD when they wish. Although fish may spend days or weeks associated with a FAD in this way, other urges eventually cause them to move on and be replaced by new arrivals.

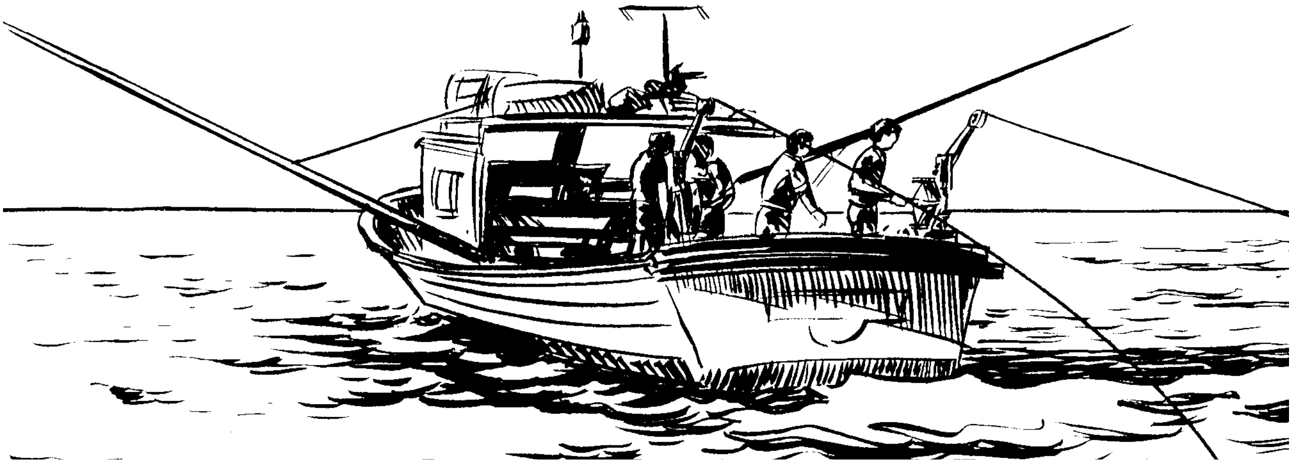
AGGREGATION

There is no evidence to suggest that FADs increase the overall number of tuna in a given area of ocean. Rather, they gather fish from a large area to a smaller one and so make them easier to find and catch. FADs allow fishermen to concentrate their fishing effort in an area where the fish are themselves concentrated. As a result, overall catches and catch rates around FADs tend to be higher than in open-water fishing.

FADs aggregate different fish at different depths. Small tunas are usually found schooling near the surface. Larger yellowfin, bigeye and albacore tunas generally gather near FADs at depths between 50 m and 300 m, although they can also be found closer to the surface at times, especially at night. Other fish species, including rainbow runner, mahi-mahi, sharks and billfish are also commonly attracted to FADs.

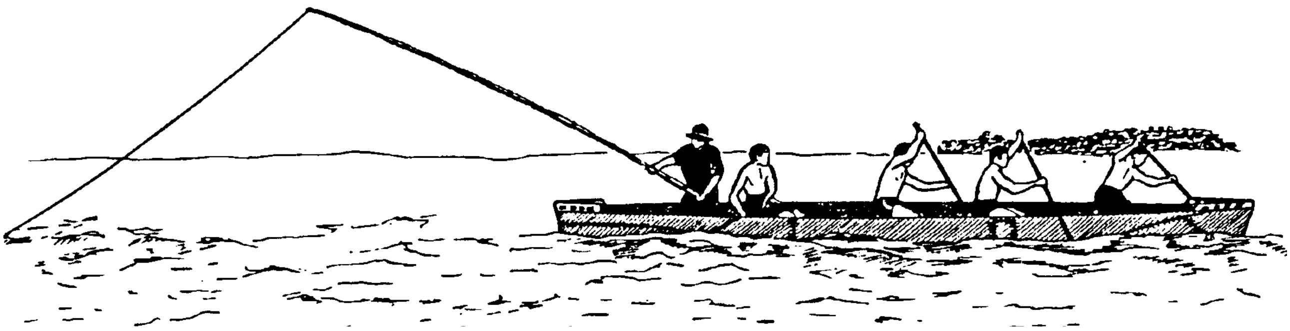
FAD FISHING METHODS

There are several fishing methods that are particularly suited to use around FADs.



Trolling

Surface and sub-surface trolling with feathers, plastic lures or natural bait is a common and simple method for FAD fishing. The gear is inexpensive and can be fished from a small boat.

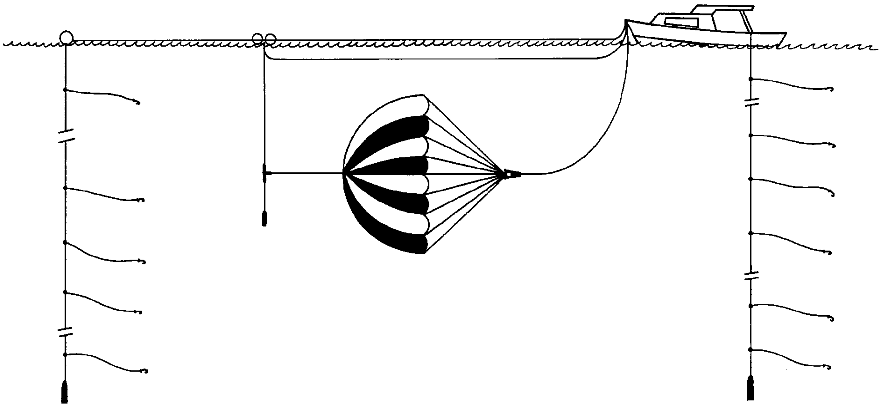


Pole-and-line fishing

Pole-and-line fishing is a surface fishing method used by both artisanal and industrial-scale fishing vessels. Unbaited, barbless hooks tied on a fixed length of line attached to a fishing pole are jigged in an actively feeding surface school of yellowfin or skipjack tuna. In the industrial version of this method, as well as in certain small-scale pole-and-line fisheries, the fish are encouraged to bite by bringing them into a feeding frenzy using live bait cast into the water from the fishing boat.

Trapping

Fish traps are a traditional fishing gear that can sometimes be used effectively near FADs, especially shallow-water FADs, to capture small pelagic fish. In some cases, live fish in the traps may attract other fish to the FAD. As well as a means of capturing small fish for food, fish traps are a good way to catch bait for other fishing methods, such as vertical longlining.

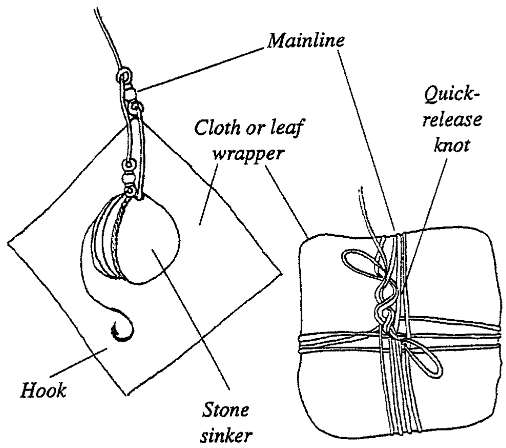


Vertical longlining

Vertical longlining (in this case, using a sea anchor or parachute) is another mid-water FAD fishing technique which enables a small-boat fisherman to simultaneously fish a range of depths. A weighted mainline is rigged every few metres with short branch lines carrying baited hooks. The mainline can be fished from a boat or set to drift near a FAD, supported by surface floats.

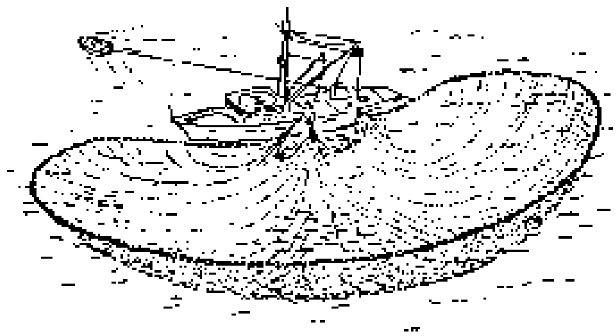
Drop-stone handlining

This is a fishing method that targets the larger, deep-swimming tunas. The drop-stone technique has long been used in the Pacific region to fish known areas of tuna aggregations, often called `tuna holes', and has proved to be an effective FAD fishing technique. Chopped bait is wrapped in a leaf or cloth, along with the baited hook, and a stone for weight. A slip knot is then tied around the package with the mainline. When the package of bait and the baited hook reach the target depth, the mainline is jerked to release the knot, the stone falls free and a cloud of bait and the hook drift free in the current at a depth where they are likely to be taken by large yellowfin or other tuna.



Ring-netting and purse-seining

Ring-netting is a FAD fishing method commonly used in the Philippines. Schools of bait-fish or smaller pelagic species aggregated around a FAD are drawn to the fishing-boat by the use of lights. A ring-net is set around the school and drawn in under the fish. The same technique is carried out on a larger scale by purse-seiners, which may take many tons of tuna in a single set.



Others

Many other fishing methods can also be productively used around FADs. These include a range of commercial and sport-fishing techniques, including deep-trolling, ika shibi fishing, jigging, spin-casting and even spear-fishing.

WHY DEPLOY FADS?

FADs have been deployed by fisheries managers, industrial fishing companies, fishermen's associations, coastal communities and even by individual fishermen throughout the Pacific and elsewhere in the belief that they will benefit fisheries. The types of benefits that might be expected would include some or all of the following.

Increasing fisheries production

Ensuring the sustainability of subsistence fisheries and maintaining an adequate supply of affordable dietary protein are primary objectives for most Pacific Island countries and territories and for other developing nations. FADs can play an important part in achieving these objectives by significantly increasing sustainable fish production.

In most Pacific Island countries and territories there are few opportunities for income generation apart from agriculture and fisheries. In areas where there is a lack of arable land and the population is increasing, fisheries may present the only avenue for development. FADs can be effective fisheries enhancement tools because they can improve catch rates, improve the stability of landings of much-needed protein and increase the incomes of artisanal fishermen.

FAD programmes may also be implemented in order to increase the production and efficiency of an existing commercial pelagic fishery. FADs can make it possible for fishermen to produce good catches more consistently, an important factor in developing markets.

FADs can create economic opportunities for people without access to arable land. In many developing countries rural residents are migrating to urban areas. It is often difficult for these people to find employment and they have no land to work. New fishing opportunities can provide them with a source of subsistence food and income (see 'Displaced peoples', below).

Reducing pressure on reef resources

In many coastal areas, growing populations and the need to increase fisheries production have led to overfishing of inshore and reef resources. At the same time, tuna resources generally remain under-exploited and provide an opportunity to increase fisheries production. If fishermen who normally fish inshore are able to catch more fish and earn better incomes by changing to FAD-based tuna fishing, the fishing pressure on inshore resources will be reduced.

Imports and exports

Hotels, resorts and local wholesalers often import fish that could be replaced by fresh local catches if regular supplies were available. FADs should improve the reliability of the local fresh fish supply and could lead to a reduction in imports.

In addition, one of the most lucrative additional benefits from FAD deployment programmes can be the export of high-quality fish to other countries where higher prices can be obtained.

Sports fishing

The amount of money sport-fishermen are prepared to spend to catch 'the big one' is not to be underestimated. In Hawaii it has been estimated that sport-fishermen spend a total of about US$40,000 for every marlin caught in international game-fishing tournaments. FADs are known to attract marlin and other sport fish such as tunas, wahoo, mahi mahi and sharks.

Displaced peoples

Daugo Island off Port Moresby in Papua New Guinea (PNG) is home to a migrant community from Hula in the Central Province. The community has no access to land on the mainland and Daugo Island itself is not well-suited to agricultural production. The major economic activity is fishing, but some local reef stocks appear to be overfished and nearby reefs have suffered through destructive fishing practices. At the same time, the proximity of Port Moresby's large urban population provides a strong market for fresh fish.

In response to a request from the PNG Department of Fisheries and Marine Resources, SPC undertook a trial FAD deployment for the island's fishermen.Within the first three months of deployment, partial monitoring of catches at the FAD showed that 3.6 tonnes of tuna had been caught by a handful of Daugo Island fishermen. This fish was sold in Port Moresby for US$6,600. The fishermen's catch rate around the FAD was double that previously recorded for open-water fishing.

Tourists who are avid sport-fishermen may spend US$500 or more per day on a boat charter. The probability of catching a fish will be improved by the presence of FADs. It may therefore be possible to persuade fishing clubs or resorts to deploy FADs, or contribute to their costs, depending on how much use they make of them.

Commercial development

Increased fish catches resulting from the deployment of FADs can lead to the development of small-scale secondary enterprises which produce value-added products, such as smoked or dried tuna for local consumption or export. Such activities create employment opportunities for people other than those directly involved in catching fish, particularly women. This may be an option for communities which can produce an oversupply of fresh fish but are unable to access other markets (see 'Value-added products', below).

Value-added products

Products such as tuna jerky offer new marketing opportunities for countries that may be able to land greater quantities of fish but that do not have good on-shore facilities for fresh or frozen fish storage and marketing. If large quantities of fish are flooding the local market—as may happen when a FAD programme gets up and running—drying to produce jerky or other products is a good option.

Both yellowfin and skipjack tuna can be used to produce tuna jerky, which is made from strips or pieces of tuna steeped in a salty marinade for several hours, and then dried in the sun or in a dryer. It takes about 5 kg of fresh fish to produce 1 kg of tuna jerky, which, once dried, can be safely stored for months. By using more sophisticated drying techniques and packaging equipment, high-quality, attractively-packaged tuna jerky can be produced for export.

SPC has been providing technical advice and assistance to tuna jerky procesing operations now under way in at least three Pacific Island countries and territories, and has assisted with the deployment of FADs in Tokelau to supply the jerky processing plant with consistent catches.

Fuel consumption

Without FADs, tuna fishermen must search offshore for schools of surface fish or for the seabirds that indicate the presence of fish schools. Searching for fish generally takes up a lot of time and consumes large amounts of fuel. FADs focus fishing effort. Fishermen can proceed directly to and from the FAD to fish. No search time is required, much less fuel is consumed and more time is spent fishing. Reduced fuel consumption means lower expenses for the fishermen.

FADs do not guarantee fuel savings, however. Depending on FAD placement and the fishing strategy in use, FADs can actually lead to increases in fuel consumption. For example, in Hawaii, where a large number of FADs have been deployed, sport-fishermen usually head directly to a FAD to troll. If they do not catch fish at the first FAD, they will go at full throttle to another. If this FAD is no good, they will go on to another, until they have visited several FADs. They may or may not eventually make the catch they want, but will certainly have used up a lot of fuel in the process.

Safety at sea

FADs attract fish, and therefore attract fishermen. One aspect of FAD deployments which is generally overlooked is that they increase the safety of fishermen operating perhaps 10 or 15 miles offshore. Despite public education campaigns and frequent cases of small boats being lost at sea, many small-scale fishermen in the Pacific Islands do not have back-up engines or carry even basic safety equipment such as life-jackets or flares extra fresh water and food. If problems develop at a FAD, there is more chance that other fishermen operating in the area can assist the vessel in distress. Failing this, a small-boat search-and-rescue operation will have a head start if it is known that the lost boat was fishing at the location of the FAD.

Problems

This section has described some of the benefits that FADs can bring. These benefits are not always assured, however. Unexpected results, arising mostly from poor research and planning, can see the resources devoted to a FAD programme wasted. The next section introduces the idea of FAD programme planning.

WHY PLAN?

The effects that FAD deployments have on a fishery will vary from place to place, and perhaps, over time in the same place. Some surprises can result, including unpleasant ones. The potential for FADs to provide the benefits expected of them may be reduced unless a careful assessment of their possible impact is made.

'How FADs can go wrong' (below) gives an account of a FAD programme that did not deliver the benefits expected, even though the FADs worked. This example shows the need to plan FAD use carefully and illustrates some of the classic problems encountered by FAD managers.

How FADs can go wrong

Several FADs were deployed in a Pacific nation in the hope of increasing fisheries production and efficiency. The FADs proved to be very effective and extremely popular with fishermen.

As more fishermen came to use the FADs, the Fisheries Department introduced the fishermen to the technique of vertical longline fishing for tuna. This also proved very successful, with many fishermen re-fitting their boats, building small hand-operated longline drums and buying other equipment. Many people who had not previously been fishermen realised they could now make good catches quite easily, and entered the fishery by investing in boats and gear.

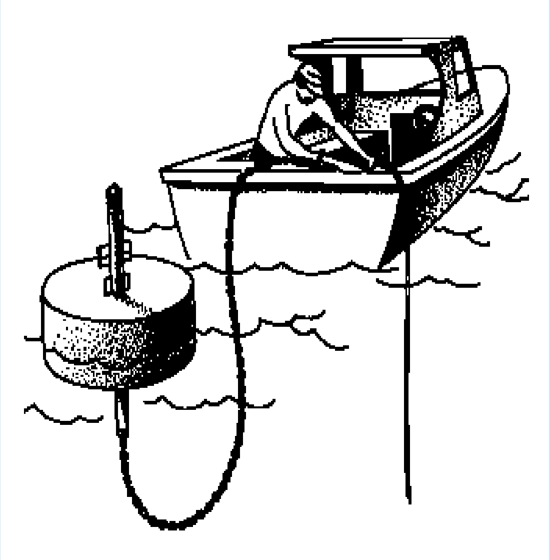
Before long, however, the increase in landings of fish led to a drop in fish prices at the market. This caused a good deal of discontent among those older fishermen who had been successful before the FADS were deployed. However, the fishermen making significantly increased catches—the majority—were happy enough with their overall boost in income.

A local fish-buyer soon stepped in and started to export the larger FAD-caught tuna, because he had heard that they were worth a good deal more on the overseas auction market than they were locally. He offered the fishermen better prices for their fish than they could get on the local market.

However, the fishermen's fish-handling practices, which were acceptable to the local market, were not good enough to produce the high quality needed for the export market. As a result, the fish-buyer found that a lot of his export fish was only getting low prices and he was unable to obtain a regular supply of high-quality fish.

Because the local buyer could not get the good export prices he had expected , he could no longer pay better prices to fishermen. Some angry fishermen refused to sell their fish to him and sold their catch at the local market, even though prices there were lower.

Some of the older fishermen wanted to reduce the quantity of fish being supplied to the market, thinking that this would drive the market price back to pre-FAD levels. These fishermen, who had been operating successfully before



the FAD programme began, were confident that they would be able to take good catches without FADS, and cut away 6 of them, leaving only two FADs in operation.

Many of the other fishermen, however, were now dependent on the FADs for maintaining their catch levels,and incomes, and wanted more FADs deployed as soon as possible. Unfortunately, the Fisheries Department had spent all the FAD budget on the initial deployments, and needed to find additional funds for replacements.

This time, however, they were unable to obtain the funds because of the problems created as a result of the first round of FAD deployments. There was virtually no documented evidence to show that the FADs had provided benefits for most fishermen—even though they had—and these fishermen's incomes then began to suffer when the Fisheries Department was unable to deploy new FADs.

Many of the problems described in `How FADs can go wrong' could have been avoided with proper planning. In particular, the programme planners should have:

• looked at trends in supply and demand, and anticipated that increased supply might mean decreased prices. They could then have considered the balance of benefits, weighing up the availability of more fish at lower prices to the general population, and the increasing numbers of successful fishermen, against the decline in income for existing successful fishermen;

• looked at quality requirements in export markets before encouraging the local fish buyer to try export shipments. They should have planned to provide training in export fish handling for fishermen;

• held some stand-by FAD units in reserve to cover losses;

• gathered information on the productivity of the FADs to use in support of their application for more FAD funds.

WHAT IS A FAD PROGRAMME?

The term **FAD programme** implies an organised approach to deciding what the deployment of one or several FADs should achieve. Implementing a FAD programme means setting realistic, achievable goals, and then taking the steps necessary to see that these objectives are met.

As we have seen, FADs can have a dramatic impact on a fishery. Increased fisheries production is the most obvious and usual desired outcome and is almost always the reason for considering the deployment of FADs in the first place. However, the flow-on effects—both positive and negative—that result from the deployments will be the real measure of a FAD programme's success.

Success in realising the benefits that FADs can offer, and in dealing with problems that might arise, will largely depend on a close understanding of local fisheries by FAD programme planners, a clear idea of what the FAD deployments are intended to achieve, and careful planning. In this way some control of the effects of FAD deployment can be exercised.

This collection of factors constitutes a **FAD programme.**

INFORMATION NEEDS

In order to plan, FAD programme planners need various kinds of information including:

• basic statistics relating to the make-up of the local fishing fleet, including vessel types, numbers, capabilities, and areas of operation;

• knowledge of the fishing techniques and gear in use, and the costs and returns involved in existing local fishing efforts;

• an understanding of local market systems and opportunities, including the level of demand for fresh fish in urban and rural areas, existing distribution systems, and levels of imports and exports;

• data on whether inshore marine resources are locally over-exploited or depleted, and, if so, to what degree and in what areas;

• information on local pelagic fish resources, including abundance and seasonality;

• an assessment of the risks to safety that fishermen are currently facing.

Familiarity with at least some of this basic information is the first step in successful FAD programme planning.

RESOURCE NEEDS

As well as the presence of sites that are physically suitable for FAD deployment, certain basic resources are needed to implement a successful FAD programme. These include:

• sufficiently skilled manpower;

• suitable survey and deployment vessels and equipment;

• funds for seabed survey, FAD materials and deployment;

• funds for maintenance and monitoring.

With the information and resources described above, it should be possible to develop and put in place a properly planned and executed FAD programme that will bring maximum benefits to the maximum number of people while avoiding costly mistakes.

CHAPTER 2

PLANNING FAD PROGRAMMES

This chapter will look at some of the things it is important to consider in order to decide whether FADs should be deployed at all, and, if so, how many should be set, and where. The chapter begins with ideas about collecting information concerning local fisheries and assessing the need for FADs. It goes on to discuss marketing considerations and FAD site selection, and concludes with a site selection checklist.

EFFECTS OF FADS ON LOCAL FISHERIES

FADs may be deployed for a variety of reasons. Irrespective of what these might be, however, the FADs will affect already-existing fisheries. The effects will vary from place to place, but the things that might be expected to change include:

- fishing gears, methods, strategies and patterns;
- the volume and composition of fish landings;
- fishing pressure on already existing resources;
- the performance of different fishermen relative to each other (a likely source of conflict);
- demand for ice, bait and fishing gear.

To understand these changes, whether they are positive or negative, and how they should be dealt with or accounted for, it is essential to have a good understanding of the nature and status of the existing fisheries in the area. This means gathering information from all available sources—local fishery statistics, import-export data, trade statistics, the national census, rural agricultural surveys, dietary surveys and, of course, anecdotal information. There are numerous types of data available that are useful in FAD programme planning, and some can be obtained at little cost in terms of money or effort.

The following paragraphs give some examples of changes or trends in existing fisheries that should be considered, since they may influence the final form of a FAD programme.

LOCAL FISHERY CHARACTERISTICS

Catch rates

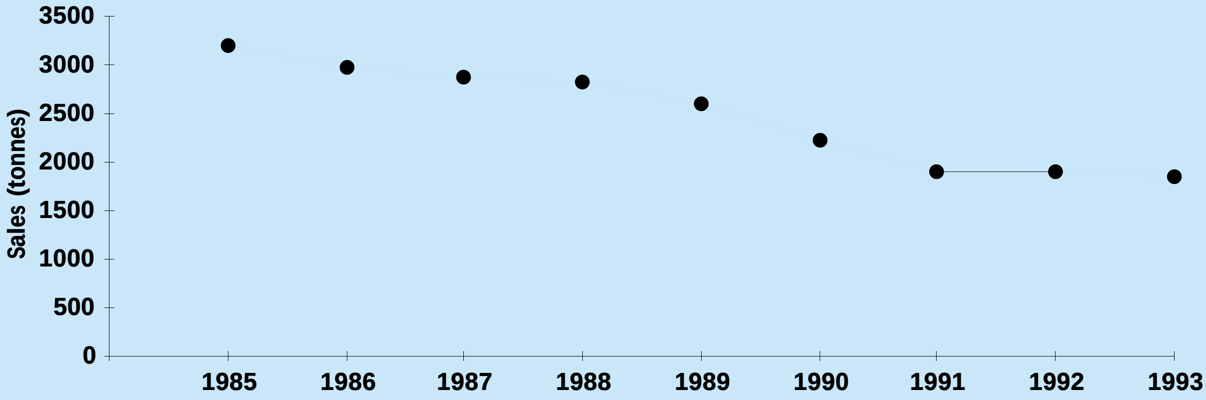
Increases in human populations or the need to fish for cash income as well as for food will increase fishing pressure on marine resources. When inshore areas start to become more heavily exploited, fishermen have to spend longer periods of time at sea to catch the same quantity of fish.

Sometimes, although total catches are similar to what they were in the past, there may be more boats operating. Each fisherman may be catching less, and earning less, than previously. FAD deployment may be a way of maintaining or increasing individual fishermen's earnings.

Production

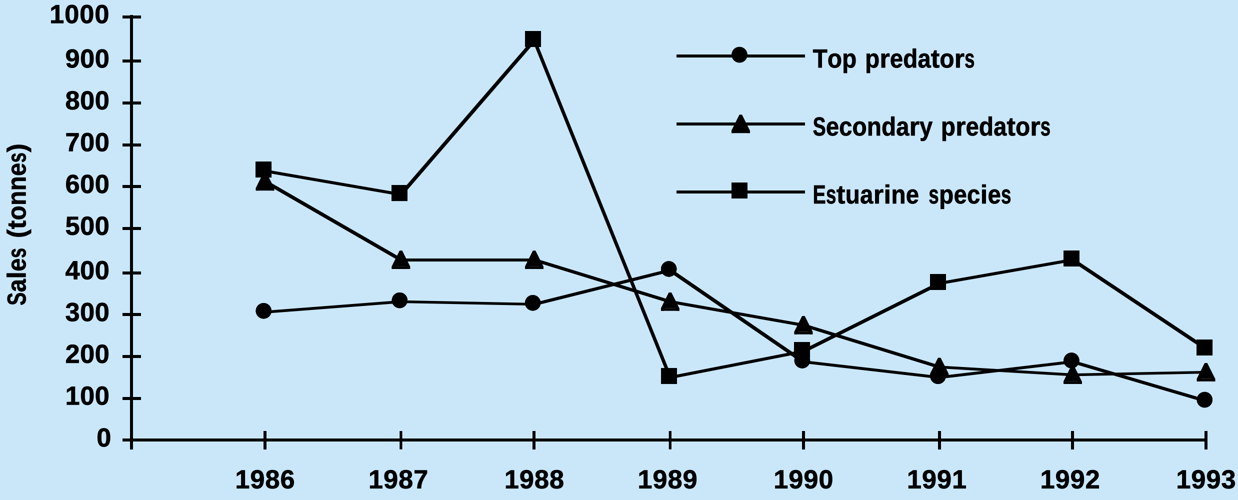
Declining inshore fisheries production is one of the reasons why FAD deployments might be thought useful. Before using this as a justification for a FAD programme, it is important to try to verify whether, in fact, production really is declining, and if so, to what extent (see 'Fiji fish sales' below).

Fiji fish sales



This graph shows total fish sales (mostly inshore species) in Fiji's Central Division, where the capital of Suva is located, from 1985 to 1993. The data show that fish sales have fallen by at least one third over the last eight years. Although in this particular case the decline is probably attributable to a real fall in landings, other factors that may affect fish sales figures include changing consumer preferences or altered fish distribution and marketing systems.

Species composition



The figure above shows sales of three categories of fish from 1986 to 1993 in Fiji's Central Division. The sales of top-level reef predators (snappers and groupers) and second-level reef predators (emperors) have declined by almost 60 per cent. The gill-net fishery for estuarine fish also shows a decline in sales.

Incomes

If FADs are to prove effective, they must offer reasonable returns compared with reef fishing. While it is reasonable to expect that FADs will increase the productivity of troll fisheries, it is necessary to estimate how much the FADs will have to produce to give a revenue per hour as good as, or better than, the revenue that can be earned from reef fishing.

Changes in gears

If catches of the preferred (and more valuable) fish species decline, fishermen may change their fishing gear and tactics to target different types of fish. For example, gill-netting may be replacing handlining, and this should be reflected by increased proportions of gill-net caught species in the landings statistics.

Small fish

An important indication of increasing exploitation within any fishery is a reduction in the size of the fish landed. If a high proportion of the catch is made up of sexually immature fish, this may mean that the fish are being caught before they can reproduce, and may be an indication of future problems.

Changes in species composition

The way a reef fishery changes in response to fishing pressure often depends on the types of fishing gear used. When reefs are heavily fished with handlines, the first fish to disappear are generally the large and aggressive predators, such as the snappers and groupers. There are fewer of these large fish in a given area of reef than of herbivores such as parrotfish. With consistent fishing pressure, the local fish population can be substantially reduced.

If the fishermen mainly use gill-nets or spears, the proportions of other types of fish may decrease. For example, parrotfish are vulnerable to spear fishing at night and may decline in the face of an active spear-fishery (see 'Species composition', above).

Travelling further

More fishing effort may mean more money spent on fuel. An examination of patterns of local fishing activity may show that fishermen are now having to fish further from home than previously. This will increase their fuel costs; their incomes will be further reduced and they will need to catch more fish to pay for the extra expenses.

Changing lifestyles

A decline in fresh fish sales does not always indicate a decline in fish stocks. People's diets are changing, particularly with increasing urbanisation, and products such as tinned fish may be less expensive and more convenient than fresh fish. Market information may indicate what the consumers want and what they are buying.

TALKING TO FISHERMEN

One of the first steps in planning any FAD programme is to seek the views and ideas of the people who are supposed to benefit from it. By using basic extension and communication techniques, it should be possible to establish a two-way flow of information that helps the fishing community or industry as well as the FAD programme planners.

Pre-deployment survey

Information from fishermen is critical for assessing whether FADs are wanted and needed. A good deal of information on existing fisheries may also be available from this source. If fishery statistics are sparse, talking with fishermen and fish-dealers may be the only option for information-gathering.

Fishermen's views can be surveyed through the use of simple questionnaires (see 'Sample survey questions' opposite) that can be used as a basis for interviews with fishermen. Questionnaires should be designed to provide basic information about the current organisation and status of fisheries, and to indicate any problems faced by fishermen. A survey can also help detect the likelihood of conflicts between fishermen from different communities, fisheries or areas.

Will the FADs be used?

Before initiating a FAD programme, it is critical to understand the fishermen's attitudes and make sure the FADs are likely to be used. Although inshore fishery landings and catch rates may be declining, this may be offset by increasing prices. Fishermen may not need to fish offshore around FADs to make a good income, or they may not be used to fishing outside the reef. Furthermore, they may be reluctant to invest in different fishing gear or to change the way they are used to fishing.

Customary fishing rights

Are there any traditional management systems that should be considered? What are the traditional laws or practices concerning customary ownership of fishing grounds? Does customary ownership extend past the reef edge and into open water? Are there restrictions on access to fishing grounds? If customary boundaries exist, consideration might be given to deploying FADs far enough out to sea to be outside customary boundaries.

Sample survey questions

- ***Date/ place/ time***
- ***Name of interviewer/ fisherman/ boat***
- ***How many years have you been a fisherman?***
- ***How many days do you go fishing each week?***
- ***What work do you do when you are not fishing?***
- ***Do you own your own boat?***
- ***Boat type/ length/ power/ fuel consumption***
- ***How many crew usually fish on your boat?***
- ***What are the main areas you fish?***
- ***Are any of these areas under customary ownership?***
- ***What fishing gear do you use?***
- ***What types of fish do you catch?***
- ***How much fish do you usually catch (by numbers or by weight)?***
- ***Do you sell or trade part of your catch? How much? Where?***
- ***Do you have any problems selling your fish?***
- ***Have you noticed any change in your catch since you started fishing? In the last five years?***
- ***Have you changed your fishing grounds for any reason?***
- ***What is the best fishing season? Are there some times of the year you don't fish? Why?***

Incomes and earnings

Obtaining information on the average catch per year or average earnings from fishing per year is important, but fishermen may be reluctant to give this information for fear of it being used for tax purposes. Obtaining these data will thus depend on the relationship between extension agents and fishermen, as well as on the fishermen's being convinced that the data will be used for their benefit.

The collection of catch-and-effort information from fishermen can allow the fishermen's average incomes to be calculated. It is useful to compare the incomes of fishermen using different gear types or fishing in different areas (inshore versus offshore, for example). Comparing fishermen's incomes with other types of employment allows the significance of fishing to a community's well-being to be assessed. If fishing is a minor activity in comparison to agriculture, then, although fishermen may ask for FADs, they may not make much use of them when they are deployed.

FISHERMEN'S PARTICIPATION IN FAD PROGRAMMES

It is important to consider the effect a FAD will have on the communities in the area where it will be deployed. Conflict between user groups, as well as vandalism, have accounted for the loss of many FADs.

FADs as community property

Fishermen may become quite possessive about FADs, even when they have not contributed to the cost of the FADs or even helped look after them. In some countries, though, fishermen or fishing associations have been encouraged by the Government to contribute towards the cost of FADs.The fishermen thus have a financial stake in the programme, and a greater sense of responsibility for the welfare of the FADs (see 'FAD cost-sharing', below).

FAD programme planners should try to involve the fishing community at all stages of the FAD programme, to create a sense of FAD guardianship. Consultation at the planning stages in regard to siting is important. Some fishermen might be invited to help construct the FAD and be taken out during deployment. This is also a good way of making the FAD's position known to a fishing community.

After the FAD has been deployed, the fishermen should be encouraged to participate in its maintenance. They can be provided with old ropes or nets to replace the aggregators, and asked to inspect the FAD raft each time they are out and to report any damage or wear. The importance of recovering FAD rafts that may break loose should be pointed out to fishermen, not only for the value of the raft, but because retrieving the broken mooring line may give valuable information about the cause of loss.

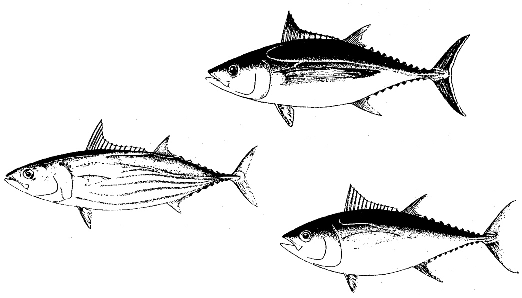
Conflicts

Conflict between different types of users of a FAD is common and almost unavoidable. Full-time fishermen can be possessive about 'their' FADs, and resent part-time and recreational fishermen, especially those who illicitly sell their catch, using them. Conflict also arises between fishermen using different gear types, between artisanal and industrial fishermen, or because of overcrowding around the FAD, especially at weekends in areas where there is a large recreational fishery.

Conflicts can, however, be minimised by siting FADs where different users are unlikely to interfere with each other's fishing, or through awareness and education programmes. Banning some fishermen or fishing methods from a FAD is not usually a realistic option, but through communication fishermen can be encouraged to reach agreements on (for instance) when certain methods can be used at the FADs or what restrictions (such as a ban on tying boats to the FAD raft) should apply.

Vandalism

FADs have been cut away or damaged for reasons based on conflict (for example, fishermen stealing or smashing FAD marker lights so that other fishermen cannot find the FAD before daylight), or simply because fishermen or passing vessels steal floats, chain or mooring line for their own use. Deliberate damage to FADs can be avoided by the use of strong materials such as chains and cables, rather than rope, for the upper mooring. This increases costs substantially, and in any case will not deter a really determined vandal. Making communities aware of the benefits that FADs can offer and establishing a sense of community stewardship over FADs is probably a more useful approach.



FAD cost-sharing

In the Maldive Islands, in the Indian Ocean, fishermen pay for 50 per cent of the cost of FADs. The Government also contributes 50 per cent, to give the poorer fishermen access. Most fishing effort at these FADs involves small-scale pole-and-line vessels and there are no reports of conflict between fishermen.

In the Philippines, FADs (or Payaos) are built using local materials and deployed by local fishermen, fishing companies, or both. In some cases pole-and-line fishing companies and local artisanal fishermen have worked together to deploy and maintain the FADs. The fishermen guard the FADs from poaching and report back to the company when there are large schools of tuna around them. They monitor the FAD to give the company early warning of the need for maintenance.

One of the most important considerations when implementing a FAD programme is whether or not fishermen will be able to sell or dispose of their fish.

If the objective of the FAD programme is to increase the availability of fresh fish for subsistence consumption in rural areas, most of the fish will be distributed on a non-commercial basis, through communal sharing or barter.

If, however, the FADs are principally intended to increase economic opportunities for local residents, an understanding of the marketing possibilities is more important. The existence of fish marketing opportunities is one of the key factors to be taken into account when deciding whether FADs are worth deploying, or when selecting FAD sites.

There are three levels of marketing to consider: local, national and export.

LOCAL MARKETING

In most situations, this is the preferred market for fish caught around FADs, and the easiest to access. Fishermen will not have to organise the transport of their fish to distant market sites.

It may be difficult to assess the potential of markets, whether they be rural or urban, to absorb additional quantities of fish. To help understand the likely demand, as much sales information as possible should be gathered from fishermen and fish-dealers. Do they have any problems selling their fish or does the price drop when there is an excess of fish? Are there some seasons or days of the week when they get better, or worse, prices for their fish?

There are usually local preferences for certain species of fish. In some nations where tuna catches are small, people are not familiar with them and they fetch lower prices than inshore or reef fish species, while in other countries the opposite is the case. If reef fish are the favoured types, it may be that an influx of lower-priced tunas will open up a new market, catering for those who cannot afford to buy reef fish on a regular basis. Depending on catch rates, the high volume of tunas caught around a FAD may offset the lower price for the fishermen.

Reef fishermen may spend one or more nights at sea before landing their catch. Some may hold their fish at home and bring the fish to market at the weekend so that they can sell it at a higher price.

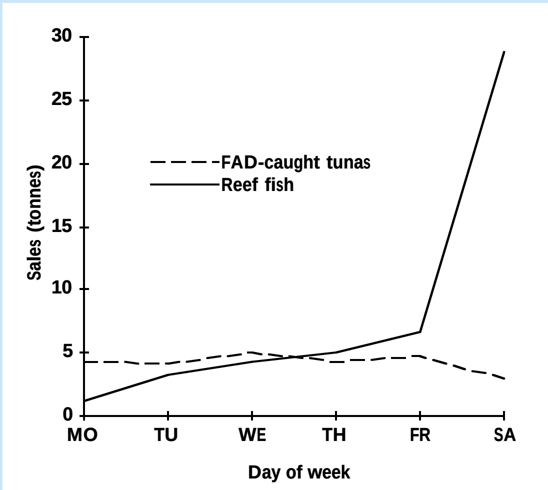
In the case of a FAD-based fishery, however, fish are usually landed once or twice a day. The fact that fish are available every day from FADs may create new markets (see ‘Meeting local demand’, below).

Helping to develop fish-market sites and marketing opportunities is a practical way in which a Fisheries Department can promote fish sales. Sometimes the provision of only very basic facilities, for example a concrete slab, some shade, water supply and perhaps some concrete benches, will get things moving.

Meeting local demand

The primary fish market in Suva, the capital of Fiji, is at Nubukalau Creek. The market attracts fishermen from many surrounding areas as well as fish-dealers who import fish from outlying islands. Sales information from local markets indicated that Saturday is by far the most important day in terms of quantity of fish sold.

The development of a FAD fishery off Suva led to larger quantities of fish being available throughout the week. The following figure shows the pattern of landings of the two fisheries at Nubukalau Creek.



The data show that, for at least three days of the week, the FAD fishery contributes a significant quantity of fish to the overall total. It is only on Fridays and Saturdays that reef-fish dominate the market.

The FAD fishermen do not generally have a problem selling their fish, except perhaps on Saturdays. This suggests that there was an unfulfilled demand for fresh fish during the week, and that it has been met by the FAD fishermen.

Fisheries Departments are also in a good position to make fishermen aware of marketing options; they can assist fishermen to make contact with the markets and deal with them in a businesslike way. Access to institutional markets, such as schools and hospitals, and commercial markets, such as hotels and restaurants, could be made easier with the help of fisheries authorities. However, government agents should take care not to become too involved in day-to-day business operations. Attempts to influence markets too much on the fishermen's behalf can easily lead to dissatisfaction on all sides.

NATIONAL MARKETING

In some situations it may not be possible to market increased production from FADs locally and catches will need to be transported to other markets. It is important to look at the costs and practicalities of reaching such markets, to assess whether they can absorb increased catches from FADs.

How difficult will it be to transport fish from landing sites to markets? Is it possible to transport the fish and maintain the quality demanded by the buyers? The availability of reliable transport systems, whether by road, sea, or air, is crucial. What is the likelihood that transport links may be disrupted by bad weather, for example?

Are there any ice-machines or freezers in the area? Are there any fishermen or fish-dealers who are transporting fish to other markets at the moment? Where existing transport and marketing networks have been developed, the experience of those involved should be used. They may well be able to expand their current operations to include FAD-caught fish.

A particular attraction of establishing markets in urban centres, rather than attempting to increase local sales, is the higher prices generally available for fresh fish. The demand is also likely to be greater, because of the concentration of population. However it is also important to consider any negative effects of increased competition from FAD-caught fish on these markets.

EXPORT MARKETING

FADs may open up a fishery for large tunas. There may be export marketing possibilities for these potentially valuable fish if handling facilities and transport to overseas markets are adequate to get the fish (see 'Export markets', opposite).

It should, however, be understood that export markets always demand very high standards of catch handling, to ensure that the fish comply with the often strict hygiene requirements of the importing country, and that the quality satisfies the demands of sophisticated customers. It is therefore essential for the handling standards needed for export fish to be clearly understood by the fishermen. Fisheries Departments can help ensure that this is the case by organising fish handling and quality workshops for fishermen and fish traders.

Successful export marketing also depends on a regular supply of fish to overseas buyers. If fish exports are already taking place, adding FAD-caught fish to the existing operation is a simple step. However, if there is no existing export operation, problems of supply from the FADs are likely during periods of bad weather or outside the main tuna season. Reliable transportation from the landing site to the export packing site and then overseas may also be difficult to organise in isolated areas with limited infrastructure.

It should therefore be accepted that, in some areas where FADs are deployed, export marketing of fish will never be feasible without very costly infrastructure development.

Export markets

Two FADs placed off Suva in Fiji are very successful at aggregating large, deep-swimming tunas. Five fishing crews use the FADs regularly, fishing out of Yamaha fibreglass skiffs. The fishermen became skilled at catching and landing tunas weighing more than 80 kg.

Although local restaurants purchased some of these fish, in general they were too large for the local market. The fishermen approached a local company which exported large tunas for the sashimi market in Japan. The company demanded high standards of fish quality, so the fishermen began to take ice out to sea with them, something they had not done up to that point.

The returns were well worth the effort. In the local market, yellowfin tuna sell for about US$2.00 per kg. The export company buys the large yellowfin for US$5.00 per kg, and in three months bought over US$20,000 worth of fish from the local fishermen. In addition, the quality of fish on the local market began to improve as the fishermen began to use ice as a matter of routine.

An integral part of a well-designed FAD programme is the right choice of location for the FADs. There are a number of important characteristics that need to be taken into account if a site is to function well.

PHYSICAL FACTORS

Sea floor

Is the bottom flat or gently sloping, or is it so steep that the anchor may drag into deeper water when the wind or current is strong? Is the bottom free of trenches and pinnacles on which the mooring rope might abrade? The best FAD site is a flat sea-floor area at least one kilometre square. Sites should be thoroughly surveyed in advance to ensure the suitability of the bottom.

Depth

Mooring ropes are the most expensive part of a FAD, so the deeper the FAD is set, the more it will cost. Pacific Island countries are surrounded by deep ocean with steep bottom contours and little or no continental shelf. As a result, most FADs in the Pacific region are set in deep water, at depths between 750 m and 1500 m.

Because of the cost factor, there is little point in deploying in greater depths unless there are some special reasons for doing so. Savings can sometimes be made by setting close inshore, but as a rule FADs deployed less than two miles from the coast or the barrier reef tend to be less effective than those moored further offshore.

Currents

If currents often exceed two knots, the FAD raft may be submerged by the drag of the current, the anchor may shift, or the continued strain on the mooring line may cause something to break.

Strong currents will also make fishing more difficult for the fishermen. Information on currents should be sought from marine charts, ports and marine authorities, and the fishermen themselves.

Winds and storms

Winds above 15 knots may prevent fishermen from using FADs, so a FAD in an exposed site may not yield good landings even if fish are abundant around it. Where possible, FADs should be set off lee shores to provide sheltered fishing conditions. If there are seasonal wind shifts, FADs should be deployed in such a way that fishermen can access at least one FAD throughout the year.

There are no 'cyclone-proof' FADs, but knowledge of the frequency and severity of storms may help in estimating FAD longevity and annual replacement costs. FADs are best deployed at the end of the storm season so that they will give a full calm-season's fishing before the risk of destruction by another cyclone arises.

FAD spacing

Research indicates that FADs have a range of influence of several miles. Tuna can travel for a distance of at least four miles from a FAD and then return directly to it. This suggests that spacing two FADs within about ten miles of each other is likely to result in fish moving from one FAD to the other, thus reducing the aggregating effect of each. It is therefore usual practice to try to set FADs at least ten miles apart, although there are many situations where this is not possible—for instance when the physical characteristics of the target area, such as nearby shipping lanes or a lack of shelf area, limit the available space. In some cases, however, even closely-spaced FADs have been highly effective, and the fact that there are more FADs in a given fishing area may minimise conflicts by creating more 'elbow room' for fishermen where there are many vessels operating.

OPERATIONAL FACTORS

Tuna abundance

Clearly an area where tuna is known to be abundant will be more promising as a FAD site than one where there is no known history of tuna concentration. As part of the FAD programme planning process, local fishermen, industrial fishing vessel operators and mariners in general should be consulted on tuna abundance and seasonality, and their answers taken into account.

Suitable boats

Under most circumstances, FADs will need to be accessible to small boats, so they will have to be deployed within a reasonable range of one or more suitable landing sites. If fishermen have to travel too far to reach the FAD, the benefits of increased catches may be eaten up by greater fuel expenses and time lost in traveling.

The local boats need to be checked to ensure that they are suitable for FAD fishing. Fishermen may have to spend large sums of money to equip their boats properly. If the cost of doing this is excessive, or if fishermen have no access to credit, the site may not be suitable for a FAD deployment.

Infrastructure

To be able to fish a FAD, fishermen will need a certain amount of infrastructure support. Basic fishing gear needs to be available in the area. In addition depending on the circumstances, on-shore fish handling facilities such as ice machines, cold stores, and product marketing outlets or transport facilities may be needed. It is important to assess the importance of these to the overall FAD programme, and to avoid sites where FADS will be useless because of lack of infrastructure support.

HOW MANY FADS?

Apart from budgetary considerations and the physical characteristics of the area, the level of FAD usage expected should also be considered when deciding how many FADs should be deployed. A large number of FADs deployed for just a few fishermen may result in the overall FAD programme being uneconomic. On the other hand, too few FADs deployed in an area with large numbers of fishermen will inevitably lead to FAD overcrowding and competition for space. As well as the potential for direct conflict, the result may be that catch rates fall and the benefits of the FADs are reduced.

The number of fishermen likely to use a FAD should be estimated at the start. Understanding the numbers of potential users and subsequently the number of FADs to be deployed is essential when developing a FAD programme budget.

The following are some typical FAD usage levels:

• two FADs off Viti Levu in Fiji were regularly fished by 4 or 5 fishermen. The maximum number recorded in one week was 18;

• in the Maldive Islands FADs were generally fished by 8–10 artisanal pole-and-line boats;

• The average number of fishing trips made to FADs in the Comoros Islands was 10 vessels per day.

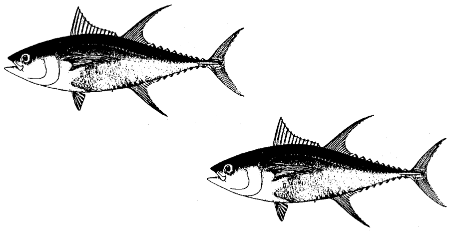
If FADs are being set in an area for the first time, it may be worth beginning with a trial deployment of a single FAD. The FAD's performance and level of use by fishermen can be monitored, while most of the FAD programme funds are kept in reserve for additional deployments or replacements. Since fishermen involved in a new FAD fishery may have spent money re-fitting their boats or buying new fishing gear, it is vital for funds to be set aside so that lost FADs are quickly replaced and programme continuity maintained.

USING A SITE SELECTION CHECKLIST

It is a useful exercise to collate all the available information on each site into a common, logical format so that sites can be compared with each other and those that look most promising assessed. The sample checklist opposite shows most of the important characteristics to be considered, and can be used to refine the site selection process.

Using a checklist enables those sites that are least suitable for FAD deployments to be detected. Prioritisation of the various criteria listed here will largely depend upon local circumstances and the objectives of the FAD programme.

Chapter 4 describes in more detail a simple economic analysis that can be used to assess how the costs and benefits of FAD programmes might be affected by factors such as distance from ports, local market prices or weather conditions. Such an analysis permits an assessment of the likely economic performance of each site, which is an important component of site selection in most cases.



Site selection checklist

- ***Is the seafloor slope gentle and free of trenches and pinnacles?***
- ***Is the current less than two knots for most of the time?***
- ***Are there enough days per year when the wind is less than 15 knots to make the FAD worthwhile?***
- ***Can fish from the FAD be sold, transported to remote markets, processed locally or otherwise disposed of easily?***
- ***Is the FAD close enough to be accessible to the users?***
- ***Are there enough boats in the area capable of fishing on the FAD?***
- ***Are local fishermen familiar with FAD-fishing techniques?***
- ***Will the fishermen use the FADs?***
- ***Will the FAD be overcrowded with fishermen?***
- ***Is there a risk of conflict between different user groups or communities?***
- ***Are there any limitations on who can have access to the fishing area?***
- ***Will users contribute financially to FAD costs?***
- ***Will users help maintain and look after FADs?***

CHAPTER 3

FAD PROGRAMME MONITORING

Expenditure on survey, construction and deployment of FADs can be considerable. It is therefore essential to make sure that the investment is worthwhile, and that any problems or conflicts that may develop are detected and dealt with.

The majority of FAD deployments carried out to date have not been adequately monitored, nor has their economic performance been properly assessed. The various problems that have developed may be minimised or avoided in the future if information is collected on the effects of FAD deployment. Monitoring should therefore be an integral part of any FAD programme and the costs of monitoring should be included in the budget.

Monitoring should not consist only of the collection of fisheries data such as catch-and-effort statistics and biological observations. It should also include socio-economic studies of the community or fishery where the FAD programme is expected to have some impact. This chapter discusses some aspects of the monitoring process.

The purpose of gathering information on a FAD programme is to enable the effects of the programme to be assessed and its benefits measured. To allow this, a range of fishery and socio-economic data is needed. Although the extent to which information can be obtained will be limited by the financial and human resources available for data collection, ideally these should include:

• catch-and-effort data, broken down as far as possible by time, fishing area, fishing gear, fish species and fishing vessel or fleet;

• economic data and information on fishing vessel operations;

• market data: fish price and sales volumes, and information on market trends;

• social information, including observations on FAD programme effects, FAD use, and the incidence of conflicts —or cooperation—among users.

CATCH-AND-EFFORT DATA

It will never be possible to collect data on every fish caught by every boat, but the information collection programme should be designed to obtain representative samples so that information for the entire fishery can be calculated or extrapolated by multiplying up the data gathered. A representative number of fishing vessels should be sampled from time to time and the following data recorded for each fishing trip:

• fishing area or FAD number;

• fishing methods used;

• time spent using each method;

• total number and weight of each species (and, if possible, size class) of fish caught by each fishing method.

Gathering this data will allow calculation of the total daily, weekly, monthly or yearly catch, and seasonal or other variations in this, by any combination of species, fishing area and/or fishing vessel or fleet. It will also provide information on catch per unit of effort, which is in itself a good indicator of fishing effectiveness, of changes in the resource itself, and of economic performance in the fishery.

In addition, if funds and manpower permit, it is valuable to measure the individual lengths and weights of representative samples of the fish caught. This will allow investigation of changes in the nature of the fish resource itself over time, and will be especially valuable in the distant future when questions of resource over-exploitation may arise.

ECONOMIC DATA

In addition to the catch-and-effort data noted above, sampling of fishing vessels should also include gathering of at least the following minimum set of economic data:

• time of vessel departure and return (so that the length of the fishing trip can be calculated);

• costs of fuel, bait, ice and other expendable items used during the trip;

• price received per pound or kg for each different species or grade of fish.

These data will make it possible to monitor the expenditure and income of individual fishing units (fishermen or fishing vessel) of the economic performance of the fishery as a whole, and of the way this varies between areas, among different components of the fleet, and over time. Comparison of these data with information obtained before the FADs were deployed makes it possible to assess of the real economic impact of the FADs.

If resources permit, additional data can be gathered on the level of expenditure by fishermen on new or improved fishing gear or vessels, and on the extent to which loans are being used (and successfully repaid) in the fishery.

MARKET INFORMATION

As well as gathering economic data from fishermen, it is important to obtain similar information from as wide a variety of retail and wholesale market outlets as possible. In addition to local fresh fish retail stores, municipal markets and roadside outlets, data should be gathered from exporters, processing companies, and fish traders who may be transporting substantial volumes of fish from area to area within the country.

Again, financial and manpower resources will limit the extent to which these can be sampled, but the minimum data collection should consist of periodic sales volumes and prices for FAD-caught fish and fish products from a representative sample of outlets. These data can then be multiplied up to provide estimates of economic measures applicable to the area, the fishery, or the country as a whole.

This type of information will permit monitoring of price trends and seasonal or periodic changes that may affect the economics of fishing around FADs. It will also allow assessment of the degree to which value is being added to FAD-caught fish by processors and exporters. Processing to produce high-value products, such as tuna jerky or sashimi-grade, export-quality tuna, can flow on from the deployment of FADs. Depending on local circumstances, this value-added component can be one of the most important benefits of a FAD programme.

Another potential benefit that can arise from increased fish production from FADs is import substitution. An indication as to whether this is happening can be obtained by gathering fish import data from customs or government statistics departments, or by surveying wholesalers to find out if they have reduced their orders for imported fish in response to the increase in local supply.

SOCIAL INFORMATION

Social information is not as amenable to quantitative sampling than catch-and-effort and market data. However, it should be possible to obtain qualitative information on the social impacts of a FAD programme through communication with FAD users.

FADs may change the way fishermen organise their time. There is evidence from some fisheries to suggest that the pattern of a fisherman's day can be changed for the better by the use of FADs. Fishermen can target particular fishing areas and therefore organise their days around one or two fishing trips to the FAD, rather than searching open water for fish and having less chance of making good catches. This may allow them to spend more time on other economic or subsistence activities (such as agriculture) or simply to have more leisure or family time.

One important potential impact is the creation of new jobs in the capture or marketing of FAD-associated fish. In particular, fishermen are likely to use family members to help catch or sell the fish, thus providing employment for relatives or friends.

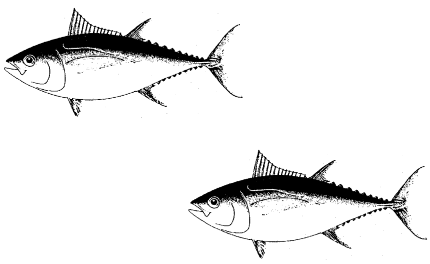
Develop in your survey work a way of obtaining an idea of the nature and extent of any effects on the family. How is the improved income being used? Are additional school-fees being found or is the extra income going towards better nutrition? Alternatively, are there negative effects (such as increased alcohol consumption) that may run counter to the aims of the programme?

FAD USAGE

If the FADs were deployed to create a new pelagic fishery or enhance an existing one, an estimate of the numbers of commercial fishermen using the FADs should be made. If the intention of deploying FADs was to reduce pressure on the reef or lagoon fishery, it is important to find out whether inshore fishermen have switched to using the FADs. How many recreational fishermen are making use of them? Information on the numbers and types of fishermen using the FADs, and the reasons why they enter and leave the fishery, will allow planning for new FAD deployments, and the avoidance of conflicts between users if overcrowding appears to be a problem.

Alternatively, if fishermen are not using a FAD as much as expected, it is important to discover why. The FAD may not be aggregating good quantities of tunas, in which case the only real solution is to look for more productive sites. However, the fishermen's unfamiliarity with the fishing techniques used, fear of venturing offshore, or insufficient navigation skills to enable them to locate the FAD can all contribute to under-use. These factors should be investigated through interviews and discussion, since they may dictate a need for greater extension efforts, an improved public awareness programme, or training in basic fishing and navigational skills.

Finally, it is important to be aware of the 'main players' in the FAD fishery. There are always one or two fishermen who tend to be outspoken. They are often the ones who initiate conflicts when problems arise. However, they are also the people who may be able to organise or motivate fishermen in a positive way, and turn potential conflicts into cooperation by putting in place arrangements for FAD sharing or maintenance.



The previous section described some of the main types of information that are needed if a realistic assessment of a FAD programme's effects is to be made. However, data-gathering is in itself a costly and time-consuming process, and the extent to which this information can be obtained will be limited by the financial and human resources available for data collection. Funds and manpower will also be key factors when deciding how much effort to put into the data collection process.

The purpose of this section is not to provide detailed information on the establishment of data collection systems, but to underline some of the key factors that should be considered when data collection is planned, as it should be, within the framework of a FAD programme. SPC Handbook No. 26, *Fisheries statistics training course*, provides much more detailed information on the establishment and use of fishery statistics systems than can be given here.

ACTIVE AND PASSIVE DATA COLLECTION

There are two main methods of collecting data, which are referred to here as active and passive.

The active collection of information involves visits to landing sites and marketing outlets to carry out interviews, weigh and count fish and gather anecdotal information from the fishermen. It is thus a labour-intensive operation requiring a significant commitment of manpower and funds.

Passive data collection, on the other hand, relies on fishermen themselves providing the requested data in a standardised format, usually through filling in logbooks or pre-printed data forms. This method of obtaining information can be cheaper and less labour-intensive. However, data collectors still need to make regular visits to landing sites, or to the fishermen involved in the project to talk to and encourage them, as well as to collect completed data forms and issue new ones.

Passive systems may be more difficult to develop, and are probably more appropriate for commercial or industrial fisheries. Fishermen in these situations have a higher level of organisation (perhaps cooperatives, associations or unions) and will be more used to dealing with fishery officials and completing forms.

Even in artisanal fisheries, however, there may be ways of encouraging fishermen to participate in passive data collection systems. For instance, fuel and ice subsidies may be available, and can be linked to declarations or submissions by fishermen that are themselves a valuable source of data. Alternatively, fishermen can actually be paid a fee for filling in data forms. This has been done in one Pacific Island country, and provided information much more cheaply than employing data collectors would have done.

In addition, fishermen may have something to gain in terms of bank loans if they participate in a data collection system. Most fishermen use bank loans to purchase new boats, engines and perhaps fishing equipment, and bank managers want evidence that fishermen are capable of repaying their loans (default rates for fishery-related loans in rural development programmes often exceed 75 per cent). If fishermen can be encouraged and helped to collect data on their own performance within the fishery, this can assist them in getting financial assistance from banks.

No matter how much of the actual data recording can be passed over to the fishermen themselves, passive data collection will nevertheless require data collectors to identify and meet regularly with those fishermen providing the data. Fishermen may need periodic encouragement, and a regular review of how well the forms are being completed will maximise the value of the monitoring process.

In many Pacific Island situations passive data collection will not be a realistic option, or will only be possible in a limited way. Active data collection is probably a more realistic approach for artisanal or occasional fishermen who may have lower literacy levels and less experience with paperwork and form-filling.

In this case, the schedule for data collection should be based on the availability of manpower and in such a way that sampling sites are visited either according to a random pattern, or on a systematic basis. Market outlets can normally be visited less frequently or sampled less intensively than landing points, where there tends to be more short-term variation in the data. Social information can be gathered when opportunity permits, for example during occasional extension visits or meetings with fishermen and fishing communities. The most intense sampling should be for catch-and-effort data. Sampling of the different days of the week should take place randomly so that the data being gathered are not biased by the weekly landings cycle.

INTEGRATING WITH CURRENT SURVEY WORK

If regular fisheries surveys are already being conducted at the landing sites that FAD fishermen will use, incorporating the FAD programme's survey needs into this on-going work should be straightforward. An additional budgetary allocation from within the FAD programme may be to cover any additional workload or manpower requirements, but the basic data collection framework will already be in place and should be used to gather FAD-related information.

If no on-going data collection system is already in place, the full cost of the system will need to be included in the FAD programme budget. In this case it should be remembered that the relationship between the existing reef and lagoon fisheries and the FAD programme can be extremely important. Information on these fisheries may be needed to determine the success of the FAD programme, so it may be necessary to include some surveying of the reef or lagoon fishery as part of the FAD monitoring programme. This will provide a better assessment of the impacts of FADs, as well as generating useful information on reef and lagoon fisheries that can be used for other purposes.

OTHER DATA SOURCES

Pre-deployment survey

In Chapter 2 (B) the question of undertaking a pre-deployment survey was discussed. This is a survey to ensure that FADs are in fact needed and to find out what fishermen felt are the major fishery development problems they are facing. Information gathered during the pre-deployment survey provides a vital benchmark against which to measure the impact of the FAD programme, and to assess the real financial and production benefits of the FADs.

Fishing competitions

It is well worth collecting information on the use of FADs by recreational and sport fishermen and game-fishing boat owners. Sport fishermen, especially members of the International Game Fishing Association, or those fishing competitively, often keep very accurate records of their catches and this can be a cheap and valuable source of detailed information.

In some cases it may actually be worthwhile for data collectors or FAD programme managers to organise fishing competitions themselves as a source of data. A competition with one or two attractive prizes (outboard motors or fishing gear, for example) can mobilise a massive fishing effort and, since fishermen have to present their catch for measurement in order to win prizes, full details of the catch and effort can be gathered. The cost of competition prizes can be a small fraction of the cost of operating a more conventional data collection system, and the returns in information far greater.

Educational projects

Involving local schools and colleges in biological or economic studies of FAD and other fisheries can make it possible to collect more data. This can also provide learning opportunities to students and enable them to become familiar at an early stage with career prospects in fisheries science and management.

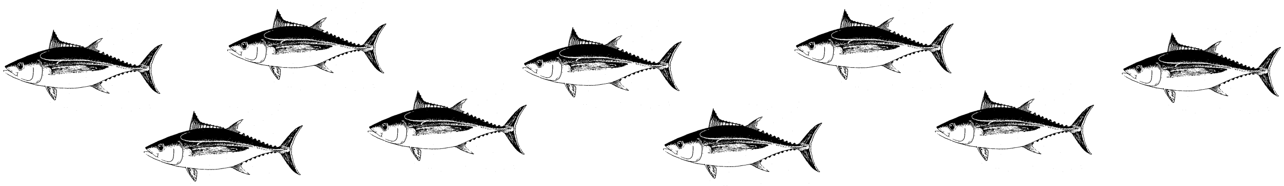
LAW ENFORCEMENT AND TAX

Data collection should never be combined with law enforcement or be seen by the data providers to be connected to it in any way. Cooperation will break down very quickly if data collection staff are also involved in apprehending or prosecuting offenders for contravening fishery or other regulations. The individuals responsible for law enforcement should be different from those involved in fisheries extension. Extension staff may have to turn a blind eye to more trivial breaches of fisheries regulations in order to obtain full cooperation from the fishermen.

Similar considerations apply in the case of tax. Fishermen and others are unlikely to cooperate in providing data, especially economic data, if they think it will used against them by the tax man.

DATA ANALYSIS

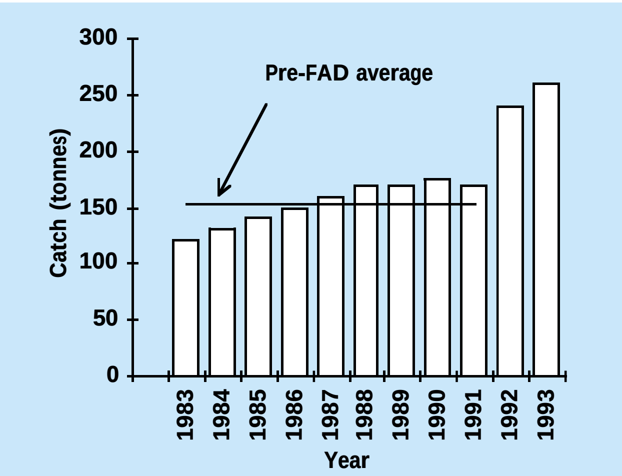
In most cases data will be entered into a computerised database or spreadsheet so that data summaries can be produced and and analyses carried out rapidly and easily. It is therefore essential to ensure from the start that data are collected in a format that is amenable to computerisation, using well-designed survey forms that ask unambiguous questions and that produce numerical data which can be easily entered into the computer. Data analysis considerations are discussed in more detail in the next section.



This section presents some examples of the types of data that might be obtained through a FAD monitoring exercise in which data are entered into a computer database and a spreadsheet package is then used to produce summaries and graphs that help to make the data's significance clear.

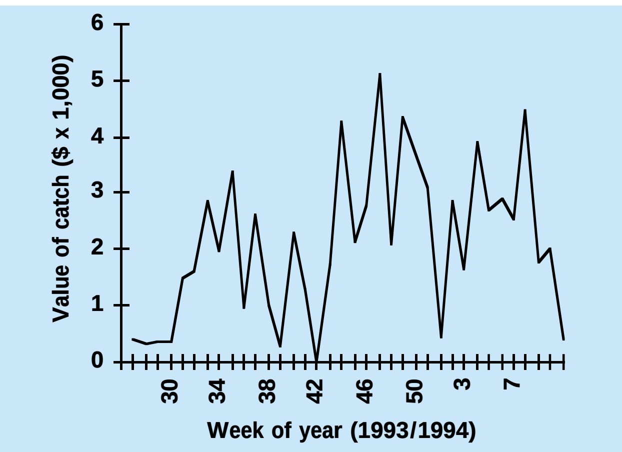
FISHERIES PRODUCTION

The figure below shows annual tuna production estimates for an area around Suva, Fiji, summarised from landings information. The horizontal line represents the average tuna catch (154 tonnes) between 1983 and the deployment of FADs at the end of 1991.



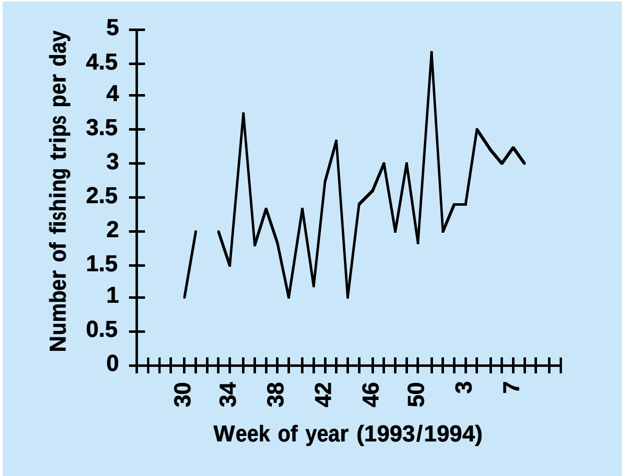
The data show a sharp increase in tuna production following the deployment of the FADs. While it is not possible to conclude for certain that the increase is exclusively due to the FADs, knowledge of the way the fishery operates strongly supports the indication by the data that this is so.

The next figure shows the total value of fishing around the FADs each week. Income from FADs is sometimes over $4,000 per week, at which rate the total costs of the three FADs deployed (one was lost and subsequently replaced) would be covered in less than one month.



FAD USAGE

Are the FADs attracting fishermen? The next figure shows the average number of fishing trips per day to the FADs, again from the Suva fishery. In this case there appears to be an increasing trend to use the FADs.

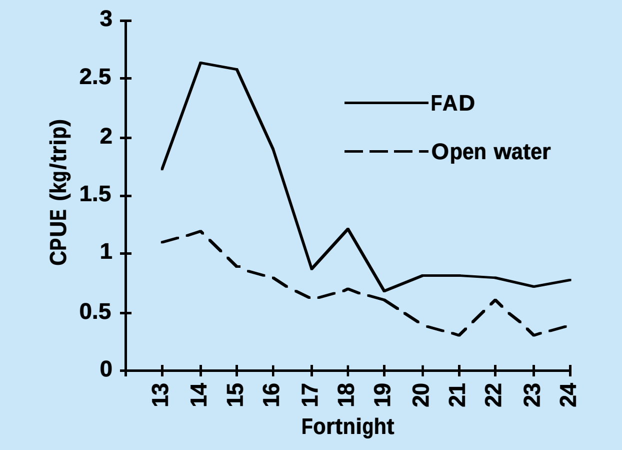


CATCH PER UNIT OF EFFORT

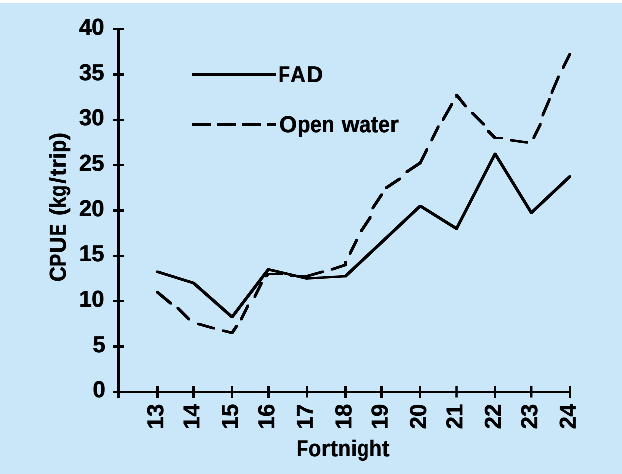
Catch rates, expressed as catch per unit of effort or CPUE, measure the amount of catch a fisherman makes for every unit of effort he expends. A common unit of effort for troll or handline fisheries is the line-hour, which is the product of the number of fishing lines deployed and the time actually spent fishing. CPUE is typically expressed as kilogrammes or pounds of fish caught per line-hour or per trip.

Changes in catch rates over time indicate changes in fishing performance of individual fishermen or of the fleet, or changes in the productivity of the resource. Catch rates can be calculated for different species or fisheries (such as FAD and non-FAD trolling) to allow comparison between them. By multiplying average CPUE figures by estimates of the total effort, catch rates can be used to estimate total landings or increases in catch from the FADs.

FADs may not increase the catch rates for all components of a fishery or fleet. The next figure shows skipjack catch rates (in kg/trip) for paddling (non-motorised) canoes in the Comoros Islands. The average skipjack catch rate on the FADs during this survey (July to December 1989) was almost double that for open-water fishing.



The next figure shows skipjack CPUE for motorised canoes. It indicates that, while the less efficient paddle canoes did better at the FADs, skipjack catch rates for motorised canoes were lower on the FADs than in open water.



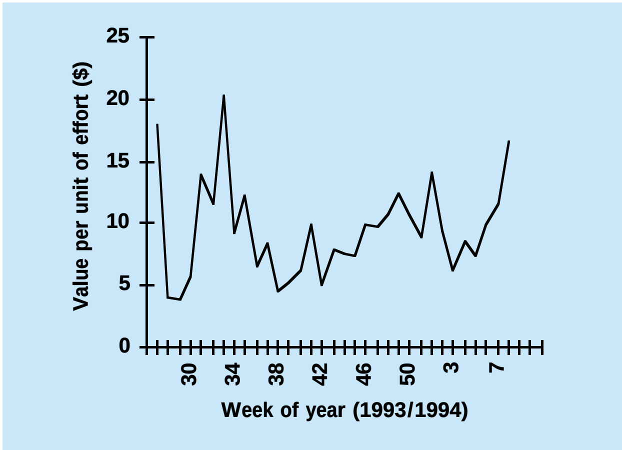
The motorised canoes nevertheless continued fishing on the FADs, producing approximately 30 per cent of the total catch. This was probably because, while the FAD catch rate for skipjack was lower, the catch rate for yellowfin tuna was higher. This shows the importance of collecting detailed catch data by species. In addition, the FADs were closer to port than the normal fishing grounds. Fishermen may have gained in fuel savings, or may have preferred the shorter FAD trips which allowed them to spend more time on shore.

VALUE PER UNIT OF EFFORT

The value per unit of effort, or VPUE (expressed in dollars per line-hour) will depend on the species caught. VPUE is useful as a measure of the returns from fishing, and can allow comparison of the 'wages' earned from different types of fishing.

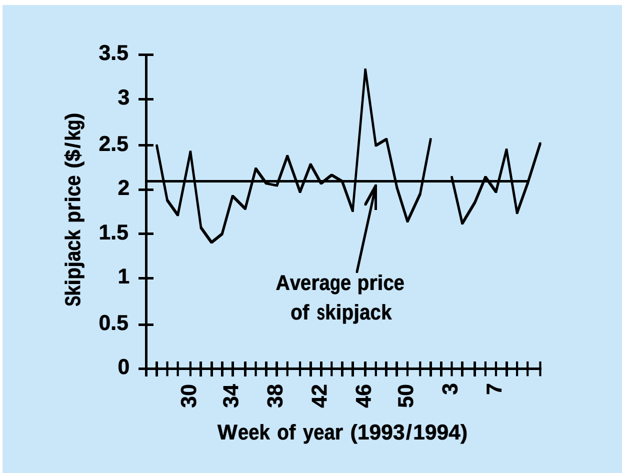
The following figure shows the average VPUE for the Suva troll fishery. There is no obvious trend in the data: VPUE declines during during August and September, but this is probably due to lower winter tuna production and the persistent trade winds during this season. In October a second FAD was deployed nearby, increasing the chances of fishermen finding schools of tuna and reducing the number of no-catch trips.

VPUE from FAD-fishing can be compared with that from other fisheries in the area. If FADs are to be attractive to fishermen, they must be able to offer them equivalent (or greater) rates of return. If FADs are not proving popular, a lower VPUE may be the reason.



FISH PRICES

The figure below shows the mean weekly price for skipjack (F$/kg) in Suva. Although there is variation in price through the year, the price has generally maintained itself and in this case, concern over falling prices resulting from increasing supply proved to be unfounded.



CHAPTER 4

FAD PROGRAMME ANALYSIS

A. POTENTIAL FISH YIELDS

B. FAD PROGRAMME COSTS

C. COST PROFILE OF A FAD FISHING OPERATION

D. FAD PROGRAMME RETURNS

E. FAD PROGRAMME COST-BENEFITS ANALYSIS

F. SOCIAL BENEFITS AND COSTS OF FAD PROGRAMMES

G. FAD PROGRAMME CHECKLIST AND LOGFRAME

Many of the factors that need to be considered in developing a FAD programme have now been discussed, including the criteria for FAD site selection and considerations determining the numbers of FADs likely to be required. The importance of monitoring the progress of each deployment, and of the programme as a whole, has also been emphasised.

This final chapter will concentrate on quantifying the potential benefits and costs of a FAD programme. The simple economic analysis included in this chapter is based on the example of a FAD programme being developed in an area where there is no pre-existing pelagic fishery. The programme is considered as a national investment in the fisheries sector, rather than a Fisheries Department project. The costs of the programme, therefore, include not only those incurred by the Government (through the Fisheries Department, for example), but also the investment by, and production costs to, the FAD users—the fishermen—themselves.

A computer diskette containing the spreadsheets described in this chapter (in Microsoft Excel® format) is included with the handbook. The diskette can be loaded into the computer prior to reading this chapter and used in conjunction with it.

In order to assess the potential economic performance of a FAD programme, it is necessary to estimate the changes in overall production that should result from the FAD deployments. Unless there is a way of estimating production directly—which is not usually the case—making these estimates will require information on fishing effort and catch rates.

FISHING EFFORT

Estimating the fishing effort that will be directed at the FADs is important because the effort (expressed in numbers of vessels, or trips, or line-hours) multiplied by the catch-rate (expressed in catch per vessel, or per trip, or per line-hour) provides an estimate of the total catch and, by extrapolation, of the gross value of the FAD programme to the economy.

In addition, the number of boats expecting to fish each FAD is an important operational consideration. If a large number of vessels attempt to fish around a particular FAD, catch rates may be reduced due to competition between the vessels for a limited amount of operating space (or a finite number of fish). Too much effort at a FAD may also lead to conflict between fishermen.

If there is already some information available on the use rate of FADs from previous FAD deployments in the area, or in comparable areas, this will clearly be a useful basis on which to estimate fishing effort. Alternatively, if there is already an existing commercial pelagic fishery, such as a fleet of small trolling boats, it might reasonably be expected that all the troll boats from the nearest port would use the FADs to varying degrees.

If, however, FADs and pelagic fishing are both new to the area, estimating the level of fishing effort will be more difficult. In this case, a pre-deployment survey of fishermen, as described earlier, is essential in order to get an idea of the potential number of vessels or fishermen likely to use each FAD.

An additional factor will be the question of whether a substantial investment in new fishing boats and gear is expected once the FADs are deployed, or is being promoted as part of the FAD programme. New entrants into the fishery, encouraged by soft loans from local development banks, fuel subsidies, or simply by better fishing prospects, can account for significant additional effort over and above that which may already exist, or that may enter the FAD fishery from other fisheries or areas.

CATCH RATES

Estimates of likely catch rates from around the FADs can be combined with the estimates of effort in order to gauge overall levels of production. Unfortunately, without some form of prior experience in the area, reliable catch rate estimates may be difficult to make. If there is an already-established pelagic fishery, data from open-water fishing activities may provide a useful guide until real data become available.

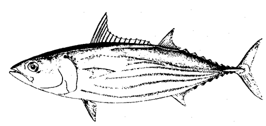
Alternatively, it may be possible to draw on experience from other areas with similar fisheries. The table opposite shows catch rates and related information from a selection of FAD and open-water pelagic fisheries around the world. These data, which are all taken from small-scale fisheries, are summaries only, and are not broken down by species. However, they do give an idea of the possible range of catches in FAD and non-FAD fisheries by different gears in various geographical areas.

In the long run, the analysis of data from the FAD monitoring programme will provide a more realistic estimate of catch rates by species, and the relative contribution of each species to the total catch. This will allow earlier estimates of returns from the FAD programme to be corrected in the light of better information.

PRODUCTION

The increase in production of tuna associated with FAD deployment will depend on the overall catch rate around the FAD, multiplied by the fishing effort. Allowance must also be made for any reduction in catches from non-FAD sites that may result from effort being re-directed toward the FADs.

If no accurate information is available before the FADs are deployed, it may be sensible to develop a range of possible fishing-effort and catch-rate scenarios. These can be used in conjunction with the cost-benefit analysis described later in this chapter. After the first year of FAD use it will be possible to correct the estimates and refine the analysis for the remaining period of the programme.



Comparison of FAD and open-water fisheries in various tropical countries

Location	Site	Depth (m)	Miles from shore	Gear	% of total effort	CPUE range	Mean CPUE
PACIFIC OCEAN							
Fiji	Open water			Troll	12	1.00–30.00	9.60
	FAD	1,200	7.6	Troll	47	0.00–30.00	5.90
	FAD	1,100	9.5	Troll	41	0.00–30.00	7.60
Papua New Guinea	FAD	900	5.5	Toll		0.60–14.50	4.90
Cook Islands	Open water			Troll	57	0.90–2.60	1.50
	FAD	1,100	2.0	Troll	25		1.60
	FAD	1,100	2.0	Handline			4.30
Palau	Open water			Troll		3.70–12.60	8.20
Tuvalu	Open water			Troll		5.50–7.00	2.70
Northern Mariana Islands	Open water			Troll		0.03–10.90	2.25
	Open water			Pole-and-line	90		125.00*
French Polynesia	FAD	631–1,797	1.6–6.6	Pole-and-line	10		150.00*
Philippines	FAD			Handline			55.00*
INDIAN OCEAN							
Maldives	Open water			Pole-and-line		0.00–7.50	0.93
	FAD						200.00*
Comoros Islands	Open water			Handline	73	0.26–0.72	0.42
	FAD	1000	5–12	Handline	27	0.48–1.30	0.78
	Open water			Troll	58	2.40–9.10	5.50
	FAD	1000	5–12	Troll	42	3.20–6.60	5.32
Sri Lanka	Open water			Pole-and-line			
				Handline	25		
	FAD		6–8	Pole-and-line			
				Handline	75	21.00–58.00	

CPUE expressed as kg/line-hour except: * = kg/boat-day

GOVERNMENT COSTS

FAD programmes generally involve an investment. The investment is usually made by the Government, but sometimes by a fishing company, cooperative, club, or other private organisation (which will provide benefits to the private sector). To judge whether it will be worthwhile, the organisation in charge of the programme must assess the potential costs and benefits of the investment. An integral aspect of FAD programme planning, therefore, is the estimation of costs over the duration of the programme.

The costs incurred by a government or company implementing a FAD programme have two basic components:

- Capital costs, including costs of FAD construction, site survey and FAD deployment;

- Recurrent costs, including costs of FAD maintenance each year, as well as the costs of monitoring the programme for feedback on its success.

The table below shows a list of some of the costs likely to be involved in a 'typical' FAD programme. A Microsoft Excel® spreadsheet called FAD_COST.XLS, which corresponds to the table, is included on the diskette accompanying this handbook. The spreadsheet can be used as a basis for recording and summarising costs, and can be expanded or adapted as required.

	A	B	C	D	E	F
1		**Item**	**Unit**	**Unit Cost**	**Quantity**	**Total Cost**
2	**Construction costs**					
3		Safety shackle (19 mm)	item	$2.75	40	$110
4		Chain (16 mm)	metre	$1.95	210	$410
5		Safety shackle (16 mm)	item	$1.75	22	$39
6		Forged swivel (16 mm)	item	$7.50	18	$135
7		Rope connector (19 mm)	item	$2.10	32	$67
8		Sinking rope (19 mm)	metre	$0.95	1,200	$1,140
9		Buoyant rope (22 mm)	metre	$1.10	1,850	$2,035
10		Rope connector (22 mm)	item	$2.30	12	$28
11		Forged swivel (19 mm)	item	$10.25	6	$62
12		Chain (19 mm)	metre	$3.45	55	$190
13		Anchor (1 mt)	item	$500.00	3	$1,500
14		FAD raft	item	$1,200.00	3	$3,600
15		Supervisor's time	hour	$3.75	160	$600
16		Construction team time	hour	$2.10	800	$1,680
17		***Sub-total — construction costs***				***$11,594***
18	**Site survey**					
19		Vesel time	hour	$150.00	40	$6,000
20		Vessel crew	hour	$2.50	400	$1,000
21		Fisheries staff	hour	$3.50	80	$280
22		***Sub-total — site survey***				***$7,280***
23	**Deployment**					
24		Vessel time	hour	$150.00	10	$1,500
25		Vessel crew	hour	$2.50	100	$250
26		Fisheries staff	hour	$3.50	10	$35
27		Additional materials	misc	$1,000.00	1	$1,000
28		***Sub-total — deployment costs***				***$2,785***
29	**Monitoring and maintenance**					
30		Travel costs	misc	$200.00	10	$2,000
31		Fisheries staff time	hour	$3.50	240	$840
32		Additional materials	misc	$350.00	1	$350
33		FAD maintenance	misc	$500.00	3	$1,500
34		***Sub-total — monitoring costs***				***$4,690***
35		**TOTAL COSTS**				**$26,349**

A second spreadsheet, called PRO_COST.XLS, provides a simple table, shown below, that can be used for maintaining a cumulative summary of the annual costs of the FAD programme.

lost fishing gear, cost of vessel and engine wear and tear, etc. Variable costs are related to the length of each fishing trip, since the longer the trip the more is usually spent on fuel, ice, wages and the like.

	A	B	C	D	E	F	G	H
1	**Total programme costs ($)**							
2		**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**TOTAL**
3	Number of FADs deployed	3	1	1	2	1	1	*9*
4	Construction	11,594	4,109	3,922	9,343	4,228	4,104	*37,300*
5	Site survey	7,280	2,747	0	2,985	0	2,336	*15,348*
6	Deployment	2,785	1,109	1,231	1,925	1,151	1,320	*9,521*
7	Monitoring and maintenance	4,690	4,811	5,031	5,396	5,992	6,341	*32,261*
8	**TOTAL COST**	**26,349**	**12,776**	**10,184**	**19,649**	**11,371**	**14,101**	***94,430***

FISHERMEN’S COSTS

The costs of a FAD programme are not borne exclusively by the ‘investor’ who deploys the FADs and operates the programme. Fishermen must also invest time and money in catching fish around FADs. In fact, although most people do not realise this, the majority of fish production costs involved in a FAD programme are of an operational nature and are met by fishermen—hopefully out of the profits they make from fishing. Accounting for fishermen’s costs during the planning process will help in the formulation of advice that may assist them to structure their investments and fishing activities efficiently.

In order to fish the FADs, fishermen may have to borrow money to buy a boat and/or fishing equipment, as well as paying for fuel and for vessel and engine maintenance. These are direct costs to the fisherman, and they fall into two categories: fixed and variable costs.

Fixed costs

Fixed costs are the costs fishermen must pay even if they never go fishing. These include repayment of bank loans obtained to purchase a vessel and engine, as well as such items as routine maintenance costs. For a larger operation, they would also include insurance and port and harbour dues. The total fixed costs for a year’s operations will not vary, whether the fisherman goes fishing a hundred times, or not at all.

Variable costs

Variable costs only arise when fishermen actually go fishing. They include the costs of fuel, rations, ice, wages or a share of the catch for the crew, the replacement of

OPPORTUNITY COSTS

A third, often overlooked, type of cost is the opportunity cost of fishing. This is an indirect cost, but must still be considered.

In the case of a small fishing operation, the opportunity cost is simply the wage the fisherman would have earned if, instead of going fishing, he had taken another job. For example, he could perhaps have chosen to stay ashore, earning $2.00 an hour by cutting copra or working for somebody else. The fact that he chose to go fishing instead means that he did not earn this $2.00 per hour—in other words, he effectively lost the income, which is thus a real cost to him. When an individual decides to go fishing, his costs should include the revenue that he could have earned if, instead of going fishing, he had chosen to carry out some other kind of paid work.

The idea of opportunity cost also applies at the level of the FAD programme itself. A government or company planning to invest in a FAD fishing operation should consider the opportunity cost as being the expected return from the next best alternative investment. By investing in a FAD programme, the government is choosing not to invest in something else. The opportunity cost of this action should be considered as part of the decision-making process.

In rural development programmes the idea of opportunity cost may not be so important. Many rural development programmes are established precisely because there are no other income-earning opportunities in the area.

As noted in the preceding section, the majority of fish production costs involved in a FAD programme are of an operational nature and are met by fishermen. Estimates of the cost of FAD programmes include these. This means that economic profiles must be developed of the operations of the fishermen or fishing vessels that are expected to use the FADs. If there are several categories of vessels in a fishery, it may be necessary to develop cost profiles for each category.

DEVELOPING THE COST PROFILE

To illustrate the process of developing a cost profile, a Microsoft Excel® spreadsheet, shown below, was set up. It includes the various costs the fisherman would incur in buying his equipment and running his fishing operation. A copy of the spreadsheet, which contains all the necessary formulae for calculating the costs based on the parameters shown, can be found as FISH-COST.XLS on the diskette enclosed with this handbook.

been calculated. For a larger vessel, or under different circumstances, it may also be necessary to factor in the costs of bait, ice, crew rations, engine lubricants and other consumables. Since variable costs are calculated on a per trip basis, the more trips carried out, the more important the variable costs will be as a proportion of the total.

Opportunity cost has been included in the profile as one of the variable costs. Opportunity cost was discussed in the preceding section and is here estimated at $2/ hour, which is the assumed salary the fisherman could earn if he chose to do a shore-based job instead of going fishing.

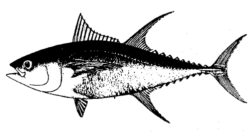
To work out the total costs per fishing trip it has been assumed that the fisherman will make an average of 100 trips per year. Based on this assumption, the fisherman would have to cover $26.38 of fixed costs and $85.50 in variable costs each trip, meaning that he would have to catch $111.88 worth of fish per trip to cover his costs.

Parameters	**Value**	**Costs**	**$**
Cost of boat	$4,500	Annual loan repayments	2,637.97
Cost of engine	$4,250		
Cost of safety equipment	$500	***Sub-total: fixed costs per year***	***2,637.97***
Cost of fishing gear	$750	***Sub-total: fixed costs per trip***	***26.38***
Initial loan	$10,000		
Loan repayment period	5 years	Fishing gear replacement	7.50
Annual interest rate	10%	Opportunity cost of fishing	12.00
Fishing gear replacement ($/ trip)	7.50	Fuel cost	60.00
Opportunity cost of fishing ($/ hour)	2.00	Crew wages	6.00
Fuel consumption (litres/ hour)	12.50		
Fuel cost ($/ litre)	0.80	***Sub-total: variable costs per year***	***8,550.00***
Number of crew	1	***Sub-total: variable costs per trip***	***85.50***
Crew wage ($/ hour)	1.00		
Fishing trip duration (hours)	6.00	**Total costs per year**	**11,187.97**
Number of trips/year	100	**Total costs per trip**	**111.88**

A very simple example is used here of an artisanal fishermen investing in an 8-metre fibreglass skiff, a 40 hp outboard engine and appropriate fishing and safety gear. The various costs involved are shown in the table. It is assumed the fisherman had to take out a $10,000 loan over 5 years, at an annual interest rate of 10 per cent in order to cover his capital expenditure. The annual loan repayment of $2,638 (which is automatically calculated by the spreadsheet) forms the basis of the fisherman's fixed costs. With a larger vessel, additional fixed costs might include insurance, costs of compulsory surveys, and annual maintenance schedules.

To estimate variable costs, an average trip length of six hours has been assumed. On this basis, the costs per trip of fuel, crew wages and expendable fishing gear have

Developing a cost profile using a spreadsheet allows the effects of changes in the assumptions to be easily studied. For instance, by altering the number of trips from 100 to 200 in the table above, the spreadsheet recalculates the figures and shows that total costs per trip would fall from $111.88 to $98.69. By experimenting with the spreadsheet in this way, the major financial risks to a fishing operation can be identified and hopefully accounted for in the planning process.

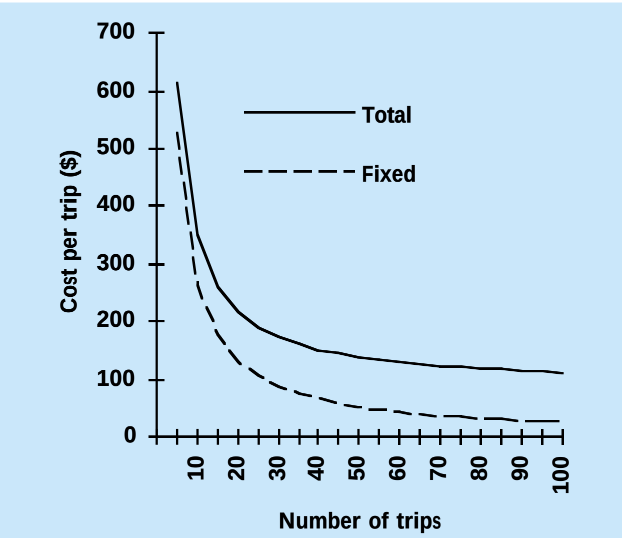


COST PER TRIP

Fixed cost per trip is calculated by dividing the total (annual) investment costs by the number of fishing trips per year. Since fixed costs by definition do not vary, the fixed cost per trip is lower if a greater number of fishing trips are made.

On an annual basis, variable costs vary in relation to the amount of fishing actually carried out. The more trips a fisherman does, the more his variable costs will add up to at the end of the year. On a per trip basis, however, variable costs are essentially constant—an average of $85.50 per trip in the present example.

The figure below shows the relationship between cost per trip and the number of trips carried out.



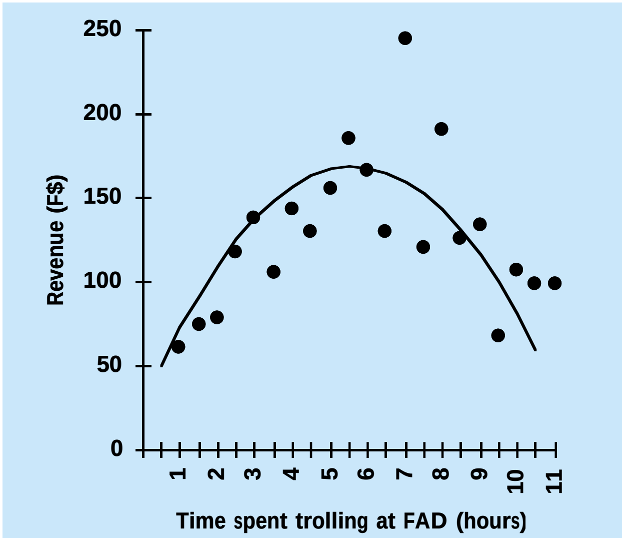
As can be seen, the fixed cost per trip, and therefore total cost per trip, falls rapidly as the number of trips increases. In the case of a new entrant to the fishery who has had to purchase a vessel and gear, fixed costs will be high. In the case of a fisherman who has transferred from another fishery, and who already owns his boat, fixed costs will be lower, and the operating economics of his enterprise more favourable.

TRIP LENGTH

Like the number of trips a year, the length of the fishing trip has an impact on overall fishing economics. If it takes one hour to travel each way to and from a FAD, a three-hour trip will allow for only one hour's worth of fishing. A six-hour trip, on the other hand, will allow four hours, or four times as much fishing time, even though the total trip length is only twice as long.

On the other hand, a fisherman might time his trip so that he arrives at the FAD at the best fishing time, often just before dawn. As the day wears on, the fish go off the bite and catch rates fall, perhaps to a point at which the fisherman is catching nothing. By staying out longer he is using more fuel and paying his crew for nothing, while the fish that he has already caught may be deteriorating in quality. In this case, prolonging the trip reduces the economic returns from his fishing operation.

The figure below, which is based on data from the 1993/1994 Suva FAD fishery, shows how these factors combine to affect fishing economics. The points shown are actual net revenues that fishermen received after fishing for between one and eleven hours around the FAD. A curve has been fitted to the points. This shows that, at first, net revenue increases as trip length increases. Once trip length exceeds six hours, however, net revenue actually falls as the trips become longer.



The graph indicates that, on average, the ideal trip length for this particular fishery would be about six hours. In other fisheries the figure may vary, but in most cases there is an ideal trip length which can be determined by using this approach.

COMPARING COST PROFILES

Once the annual costs and average costs per trip incurred by a fishermen investing in the FAD fishery have been investigated, they can now be compared with production costs for other fisheries. This will make it possible to assess the likely attractiveness of FAD fishing to existing and new fishermen, and the level of investment that would be required for these two types of operators to enter the fishery.

After developing estimates of the potential catch rates, fishing effort and fish yields that will be involved in the FAD programme, as well as cost profiles of the vessels that will be operating in the fishery, it is now possible to gauge the economic benefits the programme should produce. This section and Section 4E describe the steps involved in performing a simple cost-benefit analysis, again using a Microsoft Excel® spreadsheet, called FAD_CBA.XLS, which is included on the diskette enclosed with this handbook.

The first step in the analysis is to set out the various parameters—the constants, variables, and assumptions—that will be used. These include the duration of the programme; number of FADs to be deployed; expected costs of construction of deployment, maintenance and monitoring, expected numbers of vessels, and the costs and returns of fishing. The table below is taken from the FAD_CBA.XLS spreadsheet and shows the parameters used in the present analysis.

things simple, are assumed not to change over the course of the programme.

Fishing costs are also detailed, based on the cost profile developed in Section 4C. Only one thing is changed: instead of making 100 trips a year, it is assumed that the fishing vessels will start off by making only 90 trips a year, but by the end of the programme will have become more efficient, and have more FADs to target, and so can make 110 trips a year. This assumption affects the fixed cost per trip, which falls a little each year, as explained in Section 4C. Estimates of catch rates, number of lines fished per vessel, and fish price are also included in the table and, again to keep things simple, have been kept constant over the 6-year programme period.

Based on the above parameters, the spreadsheet calculates the costs and returns for the sample FAD programme.

	A	B	C	D	E	F	G
1	**FAD programme parameters**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**
2	Number of deployments	2	0	3	0	4	0
3	Number of FADs still on site	2	2	3	3	4	4
4	Construction cost/ FAD	$3,000	$3,000	$3,000	$3,000	$3,000	3,000
5	Deployment cost/ FAD	$250	$250	$250	$250	$250	250
6	Maintenance cost/ FAD/ year	$150	$150	$150	$150	$150	150
7	Monitoring cost/ FAD/ year	$1,000	$1,000	$1,000	$1,000	$1,000	1,000
8	Interest rate	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%
9	**Fishing operation/ production parameters**						
10	Number of fishing vessels	5	7	10	15	18	18
11	Trips per boat per year	90	95	100	105	110	110
12	Average fishing trip length (hrs)	6	6	6	6	6	6
13	Number of fishing lines / boat	2	2	2	2	2	2
14	CPUE (Kg/ line-hour)	7.5	7.5	7.5	7.5	7.5	7.5
15	Fish price / kg	$2.00	$2.00	$2.00	$2.00	$2.00	$2.00
16	Variable costs/ vessel/ trip	$85.50	$85.50	$85.50	$85.50	$85.50	$85.50
17	Fixed costs/ vessel/ trip	$29.31	$27.77	$26.38	$25.12	$23.98	$23.98

As can be seen, a six-year FAD programme is being planned, with a total of nine deployments to be made. The FADs are assumed to stay on site for two years, then be replaced. Only two FADs are to be deployed at the start, with the number increasing to four by the end of the programme as more and more vessels enter the fishery. The costs of constructing, deploying, maintaining and monitoring the FADs are laid out, and, to keep

Users of the spreadsheet can modify the data as they wish and the results will be recalculated automatically. The formulae used in the spreadsheet are summarised in the table below. They are provided as reference for those users who wish to modify the spreadsheet to incorporate additional parameters; otherwise they can be ignored.

Cost and return calculation formulae used in FAD_CBA.XLS spreadsheet	
FAD programme costs	(Number of deployments x [Construction + Deployment cost per FAD]) + (Number of FADs still on site x [Maintenance + Monitoring cost per FAD])
Fishing costs	Number of vessels x Number of trips/ year x (Fixed + Variable costs)
Fishing revenues	Number of vessels x Number of trips/ year x number of hours/ trip x Number of fishing lines per vessel x CPUE x Fish price
Total benefits	Fishing revenues – (FAD programme costs + Fishing costs)

Rows 19-23 of the spreadsheet calculate the costs, returns and benefits (revenues less costs) of the sample FAD programme, as follows.

	A	B	C	D	E	F	G	H
19	**Costs and returns ($)**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Total**
20	FAD programme costs	8,800	2,300	13,200	3,450	17,600	4,600	49,950
21	Fishing costs	51,665	75,324	111,880	174,233	216,774	216,774	846,649
22	Fishing revenues	81,000	119,700	180,000	283,500	356,400	356,400	1,377,000
23	Total benefits	20,535	42,077	54,920	105,818	122,026	135,026	480,401

In order to correctly assess the benefits and costs that a programme generates over its lifetime, it is necessary to account for the effects of time on the value of these benefits and costs. This process is known as discounting. Discounting provides a measure of the present value of a sum of money that may be paid or received some time in the future (see 'The concept of present value', below). In the case of the sample FAD programme, discounting is necessary because many of the costs and revenues are located several years in the future, when prices will have changed substantially due to inflation and other causes.

Because the interest rates that will apply in three, four or five years' time cannot be accurately predicted, a single interest rate is estimated for the length of the programme. This is called the discount rate. The higher the discount rate, the bigger will be the difference between the value of revenues (or costs) in the future and the present value. Investors (including the Government) generally decide on a discount rate at least as high as current interest rates, in order to avoid overestimating future returns on their investments. In the sample FAD programme being considered here, a discount rate of 10 per cent, or 0.1, has been assumed.

The present value of revenues (or costs) for each year of the programme is calculated using the formula:

$$\frac{\text{Revenues (or costs)}}{(1+\text{DR})^{\text{Yr}}}$$

where 'Revenues' is the future value of the programme revenues, 'DR' is the discount rate and 'yr' is the number of years since the programme started.

For example, in year 3 of the sample FAD programme, the revenues from fishing are calculated by the spreadsheet (cell D22) to be $180,000. The present value of these revenues would be calculated as:

$$\frac{180.000}{(1+0.1)^3} = \frac{180.000}{1.331} = 135,237$$

Rows 25–28 of the spreadsheet automatically calculate the present value of costs, revenues, and net benefits of the sample FAD programme based on the costs and revenues already determined, as shown below.

The concept of present value

Present value is one of the most common methods for measuring the attractiveness of an investment. To see why present value is such a useful concept, consider this example.

We will assume that this year is 1996. If someone asked you to give them $1,000 this year, and said that they would give you back $1,000 next year, would you accept? Probably not, because if you took your $1,000 and put it in an interest-earning account in the bank, it would probably earn at least 5 per cent interest in a year. So by the beginning of 1997, you would have $1,050. Would you rather have $1,050 or $1,000 in 1997? Presumably you would rather have $1,050.

The $1,000 that you have in 1996 will have a value of $1,050 in 1997 (assuming an interest rate of 5 per cent). Turn the whole statement around, and we could also say that the value of $1,050 in 1997, is the same as the value of $1,000 in 1996. Remember, we are at present in 1996. So the present value of $1,050 in 1997, is $1,000.

Another way of looking at this situation is to say that something that will have a value of $1,000 in 1997 (one year from now) has a present value of less than $1,000.

To calculate the present value of those $1,000, you must use an appropriate interest rate to bring the 1997 (future) value of $1,000 back to 1996. This is done using the formula.

$$\frac{1,000}{(1+0.05)}$$

(where 0.05 represents the 5% interest rate).

The result will show that the $1,000 that you will have in 1997 are only worth $952.38 today. In other words, their present value is $952.38.

	A	B	C	D	E	F	G	H
25	**Cost-benefit analysis**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Total**
26	Present value of costs (C)	54,968	64,152	93,974	121,360	145,528	124,960	604,941
27	Present value of revenues (R)	73,636	98,926	135,237	193,634	221,296	201,179	923,908
28	Present value of benefits (R-C)	18,668	34,774	41,262	72,275	75,769	76,219	318,966

The total present value of each of the programme components is shown in column H of the spreadsheet. The next section will describe how these totals are used to determine the revenue/cost ratio of the programme.

In the preceding section, the present values of the costs, revenues, and benefits involved in the sample FAD programme were calculated using the spreadsheet FAD_CBA.XLS. For ease of reference, the output from this part of the spreadsheet is shown again below.

	A	B	C	D	E	F	G	H
25	**Cost-benefit analysis**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Total**
26	Present value of costs (C)	54,968	64,152	93,974	121,360	145,528	124,960	604,941
27	Present value of revenues (R)	73,636	98,926	135,237	193,634	221,296	201,179	923,908
28	Present value of benefits (R-C)	18,668	34,774	41,262	72,275	75,769	76,219	318,966

It is important to be able to present a FAD programme proposal in a way that convinces the financial decision-makers to include the programme budget in the appropriate capital and recurrent funding allocations. A number of economic statistics are commonly used by financial planners to assess the benefits of investments in public projects. One such statistic is the revenue-cost ratio of the programme.

REVENUE-COST RATIO

The revenue-cost (RC) ratio is a standard measure of the value derived from the money invested in a project such as a FAD programme. It is calculated as the total present value of project revenues divided by the total present value of costs. In the sample FAD programme the total present values are shown in column H of the spreadsheet. The total present value of revenues is $923,908 over the entire programme length of 6 years, while the total present value of costs is $624,311. The programme thus has a RC ratio of 923,908/ 624,311, which is equal to 1.53. This is calculated in row 29 of the spreadsheet, as shown below.

	A	B	C	D	E	F	G	H
29	Revenue-cost ratio (R/C)	1.34	1.54	1.44	1.60	1.52	1.61	1.53

Although it is generally accepted that the ratio should be more than 1.0 if a project is to be considered viable, in fact projects with a RC ratio of less than 1.5 would not normally be considered for financing unless they could be shown to include other, less-quantifiable benefits such as improved nutrition or safety at sea.

ALTERNATIVE PROGRAMME SCENARIOS

If the FADs fail to attract fish (or fishermen) or are lost the day after deployment, there will be no returns whatsoever from the FAD programme and the investment will have been wasted. It is therefore important to assess how sensitive the economic performance of the programme is to variations in the assumptions, such as catch rates, FAD life, etc., that have been made. These variations can easily be tested by varying the appropriate parameters in the spreadsheet, as shown in the examples below.

Scenario 1: What happens to the expected returns of the programme if the area in which the FADs are deployed has a severe cyclone every year, and the FADs only last one year instead of the two years assumed? The capital costs of the programme (FAD construction and deployment) will double, since FADs will have to be set annually (instead of every two years), to maintain the same number on station throughout the duration of the programme. The table below shows the results of the modification.

	A	B	C	D	E	F	G	H
25	**Cost-benefit analysis**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Total**
26	Present value of total costs (C)	54,968	69,524	93,974	128,019	145,528	132,298	624,311
27	Present value of revenues (R)	73,636	98,926	135,237	193,634	221,296	201,179	923,908
28	Present value of benefits (R-C)	18,668	29,402	41,262	65,615	75,769	68,880	299,597
29	Revenue-cost ratio (R/C)	1.34	1.42	1.44	1.51	1.52	1.52	1.48

In fact this change has a relatively small impact on the programme as a whole. The present value of the programme benefits shows a small decline, falling to $299,597, or 94 per cent of the original value, while the RC ratio declines by about 3 per cent from 1.53 to 1.48. In terms of return on investment, there is little difference between the original programme scenario and this one.

Scenario 2: An alternative scenario could be that each FAD lasts only for 6 months, but is not replaced until the following year. As a result, the fishermen can now only make half the number of FAD fishing trips per year and must spend the other half fishing in open water, where catch rates are 50 per cent less than those around the FAD. The following table shows the results of this changed assumption.

	A	B	C	D	E	F	G	H
25	**Cost-benefit analysis**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Total**
26	Present value of total costs (C)	54,968	69,524	93,974	128,019	145,528	132,298	624,311
27	Present value of revenues (R)	55,227	74,194	101,427	145,226	165,972	150,884	692,931
28	Present value of benefits (R-C)	259	4,671	7,453	17,207	20,444	18,586	68,620
29	Revenue-cost ratio (R/C)	1.00	1.07	1.08	1.13	1.14	1.14	1.11

In this case the present value of project benefits is reduced to $68,620, just 22 per cent of the value in the preceding scenarios when the FADs were promptly replaced. The RC ratio has fallen to 1.11, only slightly better than breaking even. This is a far less attractive scenario than the previous one. While the costs of the programme have remained the same, the revenues have declined significantly, due to less productive fishing by the FAD users. This scenario emphasises the importance of replacing lost FADs quickly in order to minimise fishermen's loss of earnings.

Scenario 3: So far only the number of fishing trips and the life of the FADs have been adjusted to see what effect they have on estimated returns. What happens if the nature of the fishing operation changes, for example by troll fishermen increasing the number of trolling lines used from 2 to 3? In this scenario, the other FAD programme factors remain as in the original example on page 39, and the following table shows the results. In this scenario the present value of project benefits increases significantly to $780,920, while the RC ratio increases to 2.29.

	A	B	C	D	E	F	G	H
25	**Cost-benefit analysis**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Total**
26	Present value of total costs (C)	54,968	64,152	93,974	121,360	145,528	124,960	604,941
27	Present value of revenues (R)	110,455	148,388	202,855	290,451	331,945	301,768	1,385,862
28	Present value of benefits (R-C)	55,486	84,237	108,881	169,092	186,417	176,808	780,920
29	Revenue-cost ratio (R/C)	2.01	2.31	2.16	2.39	2.28	2.41	2.29

Scenario 4: Although the price might be expected to fall as fish supply increases, this may not necessarily be the case. Where FAD-caught species such as tuna are new to the local population, the initial price may be below that of other, better-known species of fish. However, as the population becomes more familiar with tuna, the price may rise. What would happen if the price of tuna increased over the length of the programme by 25¢/year, from $2.00 in Year 1 to $3.25 in Year 6, while at the same time fishermen continued to fish with 3 trolling lines per vessel as in the preceding scenario? The table below shows the results of this assumption. The results for this scenario indicate a significant increase in the present value of project benefits, to $1,313,679 while the RC ratio increases further to 3.17.

	A	B	C	D	E	F	G	H
25	**Cost-benefit analysis**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Total**
26	Present value of total costs (C)	54,968	64,152	93,974	121,360	145,528	124,960	604,941
27	Present value of revenues (R)	110,455	166,937	253,569	399,371	497,917	490,373	1,918,620
28	Present value of benefits (R-C)	55,486	102,785	159,594	278,011	352,389	365,413	1,313,679
29	Revenue-cost ratio (R/C)	2.01	2.60	2.70	3.29	3.42	3.92	3.17

SUMMARY

Investment in FADs, like any investment, contains an element of risk. This simple cost/benefit analysis is useful because, provided that realistic estimates are made of the parameters involved, the risk can be assessed and, to some degree, quantified. An effective monitoring schedule built into the overall FAD programme is essential in order to update and enhance the accuracy of the various parameters as the programme proceeds.

The various scenarios demonstrate that, even if the returns expected from a FAD programme are significant, large losses of revenue can occur when the programme is neglected, and particularly when fishing operations are affected because lost FADs are not quickly replaced.

Cost-benefit analysis is designed to facilitate the allocation of scarce resources, in this case funding from national Government. It provides a decision-making tool, in the form of a set of rules, allowing some projects to be accepted and some to be rejected. Since not all projects will be accepted and funded by the financial decision-makers, it is of great importance to properly evaluate ALL the benefits (and costs) which will flow from the programme.

TANGIBLE BENEFITS

The first chapter of this handbook outlined the major reasons why a FAD-based fisheries development project might be considered. Many of the costs and benefits can be allocated a money value. For example, the cost of a pre-deployment survey can easily be determined by adding up the cost of the necessary labour, transport, materials and so forth. Similarly, benefits from increased fish landings can be priced as the value of the FAD-caught fish sold at market.

NON-TANGIBLE BENEFITS

Unfortunately, not all of the expected benefits (or costs) of a FAD programme can be priced so easily in terms of money. This does not, however, mean that they do not have a financial worth (or price) to the economy, and to society as a whole.

A good example is the cost to the economy of failure to protect environmental or human resources. If inshore and reef fisheries are over-exploited, and the productivity of these fisheries declines as a result, fishermen will lose their jobs. This is a tangible economic loss. Similarly, poor nutrition may lead to ill health in the population and a labour force which is less productive because people take more days off work due to illness. This is again a tangible economic loss.

The fact that some of the benefits of a FAD programme, or any other kind of development project, are not in the form of income, tradeable goods or other easily-valued economic assets does not mean that they should be ignored in a cost-benefit analysis of FADs.

The table opposite outlines the main outputs expected from a typical FAD programme, and indicates how these outputs might interact with the national economy. Not all are as easy to value in money terms as increased harvests from a FAD. However, all play an important role in the economy and the general well-being of a country or region. To evaluate FAD programmes without in some way taking these factors into account would be misleading.

WEIGHTING THE COST-BENEFIT ANALYSIS

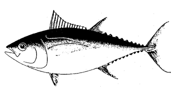
Economists use techniques that can allow the various outputs listed opposite to be incorporated into a cost-benefit analysis such as that described in the two preceding sections of this chapter. These techniques are more complex than the analyses presented so far, and are beyond the scope of the present manual. However, this is not to suggest that these benefits should be totally overlooked. A simple but useful way of accounting for non-tangible benefits (such as improved nutrition, for example) would be to allow for them by incorporating a favourable weighting in the cost-benefit ratio.

For example: it is difficult to quantify damage to coral reefs and to know how such damage will affect the value of reef fisheries and of their future production. Nevertheless, it can be stated with a fair degree of certainty that if reef fisheries are exhausted, a substantial economic loss will be incurred. Therefore, if introducing a FAD programme would reduce the rate of depletion of reef resources, the programme should receive a favourable weighting from financing authorities, in acknowledgement of this actual, if non-quantifiable, benefit.

If this is done, the value of sustaining the reef fishery is not explicitly incorporated into the cost-benefit analysis in money terms. However, the economic value of the fishery is nevertheless acknowledged and accounted for in the decision-making process. The same principle should be applied to health, safety, and other social benefits likely to arise from the programme.

Inclusion in a funding or project proposal (in addition to the basic cost-benefit analysis) of a table such as the one opposite, which defines the non-tangible benefits of the programme proposal, will increase the chance that the funding submission will be favourably received and the FAD programme financed for implementation.

The analyses shown in this and the preceding two sections indicate that FAD programmes can indeed function as economically viable entities within the fisheries sector as a whole. The analyses also suggest that investment in FAD programmes by fishermen's cooperatives or private companies should be an economically productive activity, as long as the critical issue of property rights to the fishing can be addressed.



Economic and social benefits and costs of a FAD programme

BENEFITS Programme outputs	Benefits to the economy
Increased sustainable yields	More comprehensive exploitation of the nation's stock of natural resources
Improved catch rates	More efficient use of fishing industry capital (vessels, etc.)
Improved revenue and stability of revenue from fishery	Improved income for fishermen; greater national wealth
Reduced fuel consumption	Greater efficiency in the fishery; reduced operating costs for fishermen; environmental benefits (less pollution)
Improved stability of catches from fishery	More secure income for fishermen
Market development (local and non-local) through improved reliability of catches	Reduction of imports; development of export industry
Employment through secondary fishing developments based on reliability of catches	Decreased unemployment because of marketing and fish processing activities
Reduced search time	More efficient use of capital; reduced opportunity cost for fishermen
Diversification of marine resource consumption	Lessens dependence on one particular resource and vulnerability to fluctuations
Reduced pressure on inshore fisheries	Allows more sustainable use of current fisheries; improved prospect of introducing management measures to return stocks to optimal level
Reduced pressure on reefs	Preservation of valuable habitat and reef fisheries; reduction in physical destruction
Increased supply of affordable dietary protein	Improved health in population; reduced health costs; increased labour productivity
Safety at sea	Reduced mortality; reduced search and rescue costs
COSTS Programme outputs	**Costs to the economy**
Increasing number of industry participants	Crowding; conflict; sabotage; excess capacity in the fishing fleet
Increased catches	Decreasing prices due to local glut (Price dynamics will be contingent on individual market circumstances. Decreasing prices will benefit consumers—one of the main objectives of FAD programmes—but may harm fishermen who have invested in the industry.)

This last section concludes the handbook by bringing together some of the points discussed in earlier sections, and by establishing a framework for FAD programme planning and implementation.

FAD PROGRAMME PLANNING/ IMPLEMENTATION CHECKLIST

As has been seen, proper planning and monitoring are essential to maximise the benefits derived from a FAD programme. The use of a programme checklist, such as the one below, can help in the planning process by ensuring that all the necessary stages of the programme are carried out and none are overlooked.

As well as listing the tasks to be undertaken, the checklist contains boxes where the completion date of each stage of the programme can be noted. A ‘reference’ box is also included, so that the file number or other location of notes and records on the results of each stage of the programme can be written in to make retrieval easier. Proper record-keeping will not only prevent information being lost during the implementation of the programme, but will also enable others to learn from the successes and failures of the programme and, we hope, improve future FAD-based development exercises.

It is important to realise that good record-keeping also assists in securing funding for ongoing FAD deployments. Since FADs are expendable, they need to be regularly replaced if the economic development they promote is to be maintained. Unfortunately, many valuable FAD programmes have been abandoned in the past simply because those responsible for the programme did not keep records to justify to the financial decision-makers the need for ongoing funding allocations in the face of continued—and entirely predictable—FAD losses.

Needs assessment:	**Date**	**Reference**
Investigate extent of reef and demersal over-exploitation.		
Investigate market demand and supply.		
Assess need to alleviate conflict on fishing grounds.		
Site identification:		
Take into account presence and motivation of local fishermen and investigate customary ownership, etc.;		
Take into account availability of fishing boats and gear; and identify communal fishing practices and fishermen’s organisations.		
Assess physical characteristics of possible sites (depth, currents, etc.).		
Assess distance from markets and state of transport systems.		
Financing requirements:		
Investigate and encourage availability of fishery loans and grants from development and commercial banks and Government for boats, engines and gear.		
Seek budget guidance from Government.		
Programme planning:		
Obtain necessary data to undertake cost-benefit analysis (costs of FADs, boats, gear, fuel, wages, measures of likely catch rates, fishing trip times, measures of interest and discount rates, opportunity cost of labour).		
Undertake cost-benefit analysis and prepare programme proposal in time for Government or donor budget cycle (Note: Governments have their own formats; most donor agencies require proposals in the Logical Framework format shown opposite).		
Programme implementation:		
Undertake detailed site surveys, particularly for depth and current; and take into account fishermen’s views.		
Design appropriate FAD and mooring; buy materials and construct initial number of FADs. Encourage fishermen to participate.		
Deploy FADs and revisit early to ensure no immediate problems, and at regular intervals to ensure appropriate maintenance.		
Replace FADs lost as early as possible.		
Programme monitoring and evaluation:		
Undertake FAD catch, fishermen and market monitoring in addition to or in conjunction with Government statistical programmes. Use results to reassess cost-benefit analyses.		
Review relative operating efficiencies and security of deployed FADs with a view to new placements (as replacements or in subsequent phases).		
Improve FAD designs as appropriate to circumstances (wind, waves, location, fishermen’s advice).		

LOGICAL FRAMEWORK

More and more agencies responsible for funding development projects are adopting the logical framework (or 'logframe') as a project planning and monitoring tool. The logframe provides a clear statement of the goals of the project; the activities to be carried out and their results (as well as how the results are to be measured); and the assumptions and risks that may threaten the project.

A partial FAD programme logframe is illustrated below. The full version would also include the programme budget and perhaps some administrative data, but the sample provides an indication of the type and format of information that many funding agencies require. By adding in some specific details, the sample below could be adapted to the needs of almost any FAD programme, and is provided for this purpose.

NARRATIVE SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS [Indicators of performance]	MEANS OF VERIFICATION [Activities to assess indicators]	ASSUMPTIONS [Necessary conditions and risks]
GOAL			
Provide a development programme to improve the productivity and efficiency of the artisanal fisheries sector through FAD construction and deployment	Increases in artisanal fisheries production and availability of fish supplies to market at improved levels of economic performance.	The analysis of fisheries statistics, including catches, fishing effort, costs of production, prices for both FAD-caught fish and fish from other sources.	Increased fish production can be absorbed into the market at values which support economic efficiency.
PURPOSE			
To develop a means to improve fish production at lower cost by introduction of FADs at appropriate sites. To change the distribution of fishing patterns away from inshore reef areas or other areas of over-exploitation as necessary.	FADs are designed, constructed and deployed and fishermen operate on them. Fishermen fish on them and reduce fishing pressure at other sites.	Monitoring of the programme of FAD construction and deployment; maintenance and replacement. Collection and analysis of data on changes in fishing distribution and recovery of overexploited stocks.	Availability of materials and designs to meet specifications suitable for the area of deployment. Availability of personnel to undertake the monitoring of fishing and fish marketing.
OUTPUTS			
1. FAD DEPLOYMENTS	FADs constructed, deployed, replaced and maintained according to schedule.	Monitoring by Fisheries Department staff.	Low risk of insufficient monitoring.
2. FISH PRODUCTION	Increased fish production and supplies to markets.	Monitoring by Fisheries Department staff.	Development funding/bank loans are available for fishermen to acquire necessary means of production (capital and recurrent).
3. ECONOMIC ACTIVITY	Increased economic activity of artisanal fishermen.	Monitoring by Fisheries Department staff.	Markets for increased production are available; factors of production are available.
ACTIVITIES			
1. FAD DEPLOYMENTS Obtain materials for site-specific designs; construct FADs and deploy at identified appropriate sites.	FADs constructed and deployed according to schedule.	Reports of individual FAD placement operations.	Materials, construction labour a nd vessels for deployment are made available.
2. FISH PRODUCTION Assist fishermen in obtaining loans for the purchase of vessels and equipment.	Fishermen divert fishing activities to FAD fishing and/or obtain credit for investment in vessel, engines and gear to do so.	Statistical and other investigations of fishing activity. Reports of fishery loans from Development Banks or other credit agencies.	Fishermen are willing to operate on FADs. Credit (loans and grants) is available. Assessment of FAD programme results undertaken in addition to or in conjunction with other statistical work.
3. ECONOMIC ACTIVITY Undertake physical and economic evaluation of site-and situation-specific FAD programme.	Cost-benefit analyses undertaken and FAD operation efficiencies evaluated.		All necessary information is obtained to undertake the analyses.

SUMMARY

When FAD deployments have considered as an *ad hoc* fisheries development tool, with little consideration being given to the wider socio-economic context, conflicts and wasted resources have often been the final outcome. FAD programmes in the Pacific and in other regions of the world have failed to live up to expectations, not because they failed to aggregate fish, but because insufficient consideration was given to the social and economic conditions prevailing in the recipient fishing community, or to other operational factors such as the subsequent marketing of the FAD-caught fish.

In this manual the FAD deployments themselves are considered as only one aspect of a wider FAD-based fisheries development programme. The benefits of the programme can be maximised, the costs minimised and the risks of failure reduced by thinking ahead about how fishing communities and local economies will actually react to the new fishing opportunity.

This manual has been designed for use as a FAD programme development tool, but it is not intended to be the last word on the subject. It should guide the reader down a pathway that brings him/her into contact with most of the significant aspects that need to be considered when developing a FAD programme—or, for that matter, many other kinds of fisheries development projects. Any additional, locally specific information or considerations that can be taken into account in the context of a specific FAD programme should only enhance the likelihood of the programme's success.