The benefits of fish aggregating devices in the Pacific

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Introduction

Fish aggregating devices (FADs) are widely used in Pacific Island countries and territories (PICTs) as a means to improve fisheries production in oceanic and, more recently, inshore fisheries. Traditional FADs have been used since the early 1900s, when Indonesian and Filipino fishermen used floating rafts of bamboo to aggregate schools of fish. Recent developments in and experimentation with modern FAD design, deployment site, and deployment depth has occurred throughout the Pacific as a means to improve yields of and access to artisanal fish stocks.

Significant government capital and human resources have been allocated to the fabrication, deployment and maintenance of FADs, and training of fishermen in FAD fishing techniques. Most importantly, however, significant effort has been dedicated to fishing around FADs as they are thought to provide an array of benefits to fishing communities, both at the commercial and subsistence level.

The assumed benefits of FADs have driven numerous deployment programmes in PICTs. Sims (1988), however, claims that FAD programmes are viewed by governments as short-term development initiatives. This view can be attributed to the lack of supporting data to quantify the economic benefits of FADs and, therefore, FAD programmes have difficulty in attracting long-term financial support.

Numerous studies identify the direct and indirect benefits of FADs; however, few have quantified the financial and economic benefits of FADs to fishing communities and PICT economies. Due to a rigorous data collection programme carried out by Niue's Department of Agriculture, Forestry and Fisheries, a cost–benefit study was completed to determine the financial and economic returns of FADs in Niue.

This paper identifies the benefits and costs of FADs and presents the results of the Niue cost–benefit study. Additionally, this paper presents the key fields for data collection to effectively monitor the effectiveness of FAD programmes.

The benefits of FADs

FADs provide direct and indirect benefits to fishing communities and PICT economies. Some of these benefits are easier to quantify than others, although it is important to recognise that FADs provide an array of benefits. Anderson and Gates (1996) define the benefits of FADs as follows.

Increased fishery production – Due to the aggregating phenomenon of FADs, they are known to increase catch per unit of effort (CPUE), which allows for increased access to protein or saleable product. Increased production plays an important role in food security at the subsistence level while allowing for increased revenue in the commercial sector. Detolle et al (1998) claim that catches at Reunion Island increased by 143% over a period of eight years subsequent to the deployment of FADs.

Reduced pressure on reef resources – Factors such as modern fishing gear and techniques, increasing population, exports, and tourism — to name a few — are placing pressure on inshore and coastal reef resources. In the Pacific, most species of tuna remain underexploited, and FADs provide a means to sustainably access this stock. Aggregating tuna stocks around FADs allow fishermen, who primarily derive their sustenance and income from inshore and coastal fisheries, to access oceanic resources, thereby reducing their reliance on reef and inshore resources.

Import substitution – Increased production reduces the demand and supply gap for protein, thereby reducing reliance on imports. Hotels and restaurants typically import fish, which can be substituted with FAD-caught fish due to increased and more consistent production.

Export creation – Increased production of high value artisanal species enables producers to target lucrative export markets, thereby increasing the opportunity for fishery commercialisation.

Sports fishing – FADs are known among the sports fishing community to increase the probability of catch. Anderson and Gates (1996) estimate that sports fishers spend USD 40,000 for every marlin caught in international game-fishing tournaments. Sports fishing-driven tourism has many flow-on economic benefits, such as government revenue from licensing, increased demand for the hospitality sector, improved sales of fishing gear, increased demand for alternative tourism activities, and an influx of foreign currency.

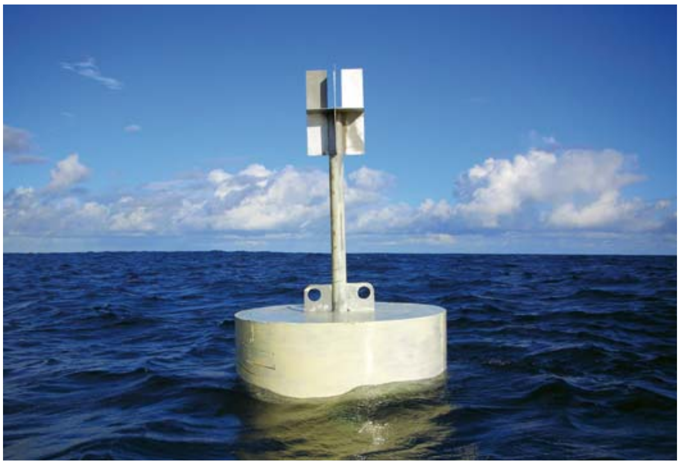
Commercial development – Increased catches resulting from FADs promote market channel development, thereby providing opportunities in the processing sector to add value to the tuna resource. This creates employment and provides economic returns from the tuna resource, which otherwise would only be realised through licensing revenue. A small and inconsistent supply from primary producers often hinders processing industries, and FADs provide a means to fill this supply gap.

Cottage industry development – Increased production provides an opportunity for cottage industry development, such as women's processing groups that produce tuna jerky and fish silage, as well as small catering businesses.

Increased employment – FADs create jobs in fisheries administrations, in terms of planning, fabrication, deployment, monitoring and maintenance of FADs. Additionally, the positive benefits to the primary fishing sector and the processing sector create employment.

Reduced fuel consumption – Defined fishing grounds around FADs theoretically reduce searching time for fish. Reduced searching time, generally leads to increased time spent fishing and reduced fuel consumption, resulting in reduced fishing costs, especially in the case of nearshore FADs. Detolle et al (1998) claim that fuel consumption is reduced three-fold when trolling near FADs compared with open water trolling at Reunion Island.

Safety at sea – Pacific fishing vessels, especially small-scale operators, often overlook basic sea safety practices and there are frequent cases of small vessels being lost at sea. FADs provide a defined fishing ground, which increases vessel activity and improves the probability of stranded vessels gaining assistance from another fishing vessel. This eliminates the need for costly search and rescue operations, which are usually funded by governments.



FADs, which can be moored several miles from the coast, provide a defined fishing ground where small fishing boats venturing offshore have a better chance to be found if in trouble.

FADs maintain fishing interest – Reduced catches from overexploited resources can result in fishers abandoning their profession for more lucrative opportunities. Abandonment of primary production has adverse effects for PICT economies, ranging from a decline in protein availability, increased dependence on imports, increased pressure on land resources to fill the protein gap, decline in cottage and commercial value-adding operations, decreased employment, and diminished export potential. Increased catches from FADs (or reduced effort required to maintain production quantities) allow fishers to remain in the industry.

This section has underscored the theoretical benefits of FADs. It is, however, recognised that FAD programmes can have undesirable impacts, and these are detailed below.

Adverse impacts of FAD programmes

Adverse impacts of FADs can usually be attributed to poor research, planning and preparation, which can result in the resources allocated to FAD programmes being wasted. Anderson and Gates (1996) define the adversity of FAD programmes as follows.

Market saturation – An oversupply of fish can result in a decline in the market price, which can reduce the profitability of commercial fishing operations. It can also discourage fishermen from fishing and motivate them to take up employment in another industry. Detolle et al (1998) claim that tuna prices fell from USD 6.50/kg to USD 4.50/kg over a 10-year period at Reunion Island subsequent to the deployment of FADs.

Introduction of species that are not in demand – Tuna are not traditionally a major species for subsistence use and domestic markets, and in many PICTs, demand for tuna is weak. Pelagic species, which are primarily caught around FADs, may have low demand and would, therefore, be low value.

Vandalism – The cutting of FAD mooring lines has occurred throughout the Pacific for unknown reasons. Some suggest that it is done to discourage new entrants to the industry, keep catches low as a means to sustain the fish resource, and obtain the floats, which are used for other purposes. Unfortunately, vandalism can take place before the desired results are achieved, which results in wasted programme funds.

Natural disasters – Cyclones and tsunamis can break FADs from their anchors. Fortunately, subsurface FADs are less susceptible to this and careful planning of FAD deployment time can ensure greater longevity of FADs. For example, deployment of a FAD after the cyclone season will ensure that the FAD will not be broken until the next season, which might give sufficient time for the positive benefits to be realised.

Overexploitation of a resource – This paper focuses on the benefits of FADs to domestic and subsistence fishers, however it must be noted that fishing techniques, such as purse-seine fishing around FADs, can result in biologically unsustainable yields.

Monitoring FAD programmes in PICTs

To measure the direct benefits of FAD programmes in PICTs, ongoing collection of fishery and socioeconomic data is required. It is acknowledged that countries are constrained by financial and human resources to collect and monitor FAD data; however, data are important for justifying ongoing investment in FAD programmes.

To fully realise the direct benefits of FADs, several types of data should be collected in order to effectively monitor FAD programmes.

Catch and effort data – It is unrealistic to collect catch and effort data for every fishing trip; however, a representative sample should be collected, which can be extrapolated to represent the total fishery. The following information should be frequently collected:

- fishing area or FAD number and/or name;
- fishing method;
- time spent practicing each method; and
- total number and weight of each species caught by the fishing method used.

SPC's Regional Artisanal Logbook is designed to collect the above data and it is recommended that fishers be encouraged and trained to complete a logsheet for every fishing trip. From these data, time series catch estimates can be calculated at different fishing areas under differing fishing methods. CPUE can be calculated from these data, which allows for the determination of change in CPUE at different fishing areas, including FADs.

Financial data – The collection of financial data enables the profitability of fishing vessels to be calculated for different fishing grounds. This allows for quantification of the benefits derived from different fishing grounds, including FADs. The following financial information should be collected:

- time of vessel departure and return (to account for labour);
- cost of fuel, bait, ice and other expendable items used during the fishing trip; and
- price received per kilogram for each species of fish.

These data allow for the estimation of the financial performance of the whole fishery and enables the analyst to determine the change in profitability to the sector from fishing different fishing grounds, including FADs. These data also allow for the determination of change in costs incurred, such as fuel, when fishing at different grounds.

The total value of the fishery to the economy can be calculated by combining financial data with catch and effort data. It can also be used to determine the net economic benefit of FADs when comparing benefits such as improved yield, with the costs of FAD programmes.

Market information – In addition to gathering financial data from fishers, it is important to complete surveys of various wholesale, retail, export, import, and informal (road side or other) markets. Generally, the information that should be collected includes price (sold), cost of goods sold (purchase price) and quantity.

These data enable the analyst to determine: where value is added throughout the marketing channel; what proportion of total catch is marketed and what is consumed; change in price over time; the correlation between FAD programmes and imports (import substitution); and the correlation between FAD programmes and exports.

FAD usage – An estimate of the number of commercial and subsistence fishers using FADs is required in order to determine whether the intended purpose of the FAD is met. For example, if a FAD was deployed to relieve pressure on reef resources and an increasing number of subsistence fishers are recorded to be fishing around FADs, then one can assume that the programme is effective. Conversely, if FADs are not seen to be used, then management must determine why: Are they ineffective in aggregating fish? Is there a need to raise community awareness? Is there a requirement to teach FAD fishing techniques?

FAD usage data also allow managers to make informed decisions when expanding their FAD programme, and to determine deployment site, education and awareness requirements, and the optimal number of FADs to be deployed.

Case study: Cost–benefit of FADs in Niue

Niuean fishermen have been filling out fishing logsheets since 2001, and the data have been collated and recorded by the Data Management Section of SPC's Oceanic Fisheries Programme up until 2008. These data were used to compute the cost–benefits of FADs.

Key data that were used to complete this assessment include:

- fuel consumption per trip;
- hours of each fishing activity per trip;
- fishing activity;
- location; and
- catch, both in terms of the number of fish per species and the weight per species.

Fishing effort

In total, 2,933 fishing trips and 12,140 hours of effort were recorded for the period 2001 to 2008. Figure 1 represents the total fishing trips (left axis), FAD fishing trips (left axis) and total effort (hours of fishing; right axis).

The number of fishing trips peaked in 2003 and declined in subsequent years. For the purpose of this case study, it was assumed that fishing trips per annum remained steady at the peak level in 2003 of 972 trips per annum. This assumption is justified for the following reasons.

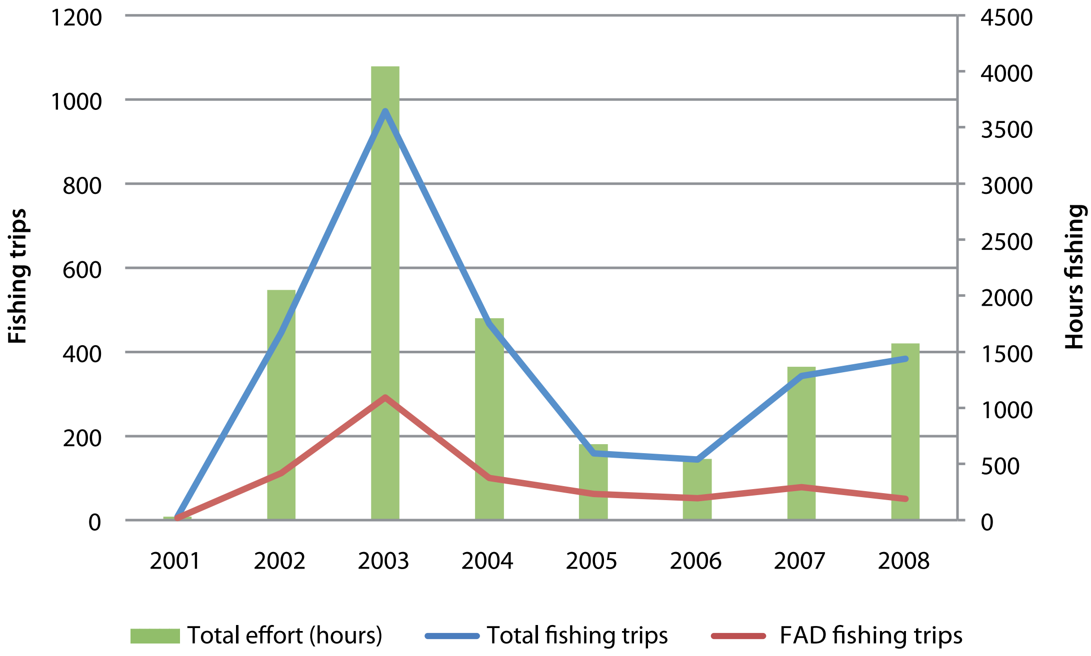


Figure 1. Total fishing trips, FAD fishing and effort (hours).

- Communication with Niue Department of Agriculture, Forestry and Fisheries revealed that similar numbers of boats are registered, with the same number of people on the local fishing license list. Niue Department of Agriculture, Forestry and Fisheries' interpretation of the decline in reported trips can be attributed to the slow distribution of logbooks.
- SPC (2005) states that catch data only represent between 20% and 40% of actual effort, so the assumption of continued effort at the 2003 level is deemed conservative.
- Commercial and subsistence fishing in Niue is entirely dedicated to supplying the domestic market. Therefore, the industry is not subject to shocks in global demands for fish, which might explain a dramatic decline in production. Given that fish is a main source of protein in Niue, it can be assumed that the domestic demand for fresh fish is fairly steady.

Fishing methods

In total, 12 fishing methods were recorded:

- open water trolling;
- offshore FAD trolling;
- inshore FAD trolling;
- bottom fishing;
- vertical longlining;
- drop stone;
- single hook drift line;
- scoop net (for flying fish);
- jigging;
- handlining; and
- palu-ahi.

Of these, the most commonly practiced fishing methods are open water trolling, offshore FAD trolling and inshore FAD trolling. Inshore FADs are classified as FADs located in depths of less than 600 m, while offshore FADs are classified as those located in depths of more than 600 m.

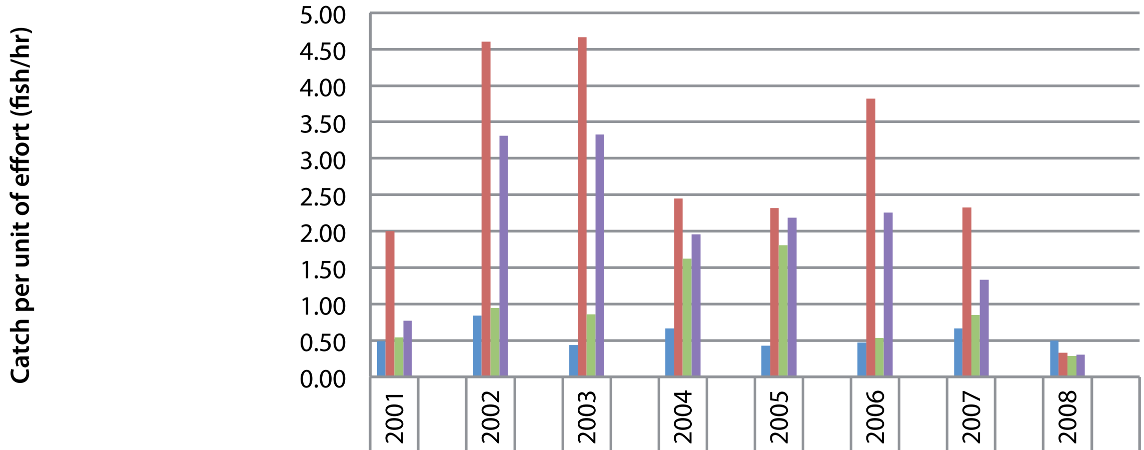
It is widely known that CPUE differs greatly by fishing method. Because of this, the cost–benefit study only compares CPUE of open water trolling and FAD trolling (inshore and offshore) to allow for a "like-for-like" comparison. This ensures consistency in CPUE comparison, although it understates the value of production around FADs because "other" fishing methods are omitted from the cost–benefit analysis.

Catch per unit of effort

For this study, a unit of effort is defined as one hour of fishing per vessel.

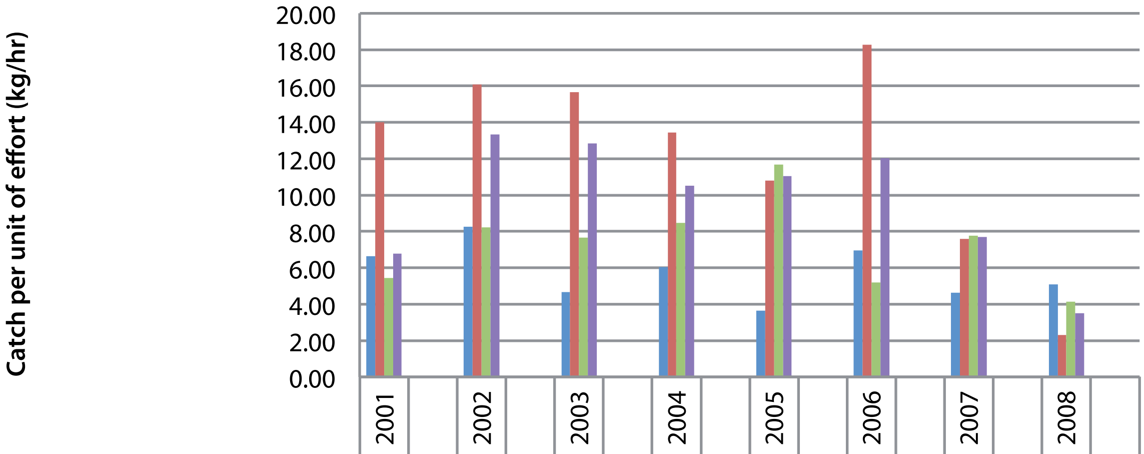
CPUE was calculated to account for the number of individual fish caught per unit of effort and weight of catch per unit of effort. CPUE data are presented as CPUE (fish/hr) and CPUE (kg/hr) for each respective calculation.

Figures 3 and 4 display CPUE in fish and weight respectfully for open water trolling, offshore FAD trolling and inshore FAD trolling. Additionally, a combined CPUE was formulated to present the combined CPUE of FAD trolling in comparison to open water trolling. "Combined CPUE" is simply an aggregation of catch and effort for offshore and inshore FADs, which makes it possible to compare the CPUE of "with FADs" and "without FADs". This gives a baseline comparison of the impact that FADs have on CPUE.



	2001	2002	2003	2004	2005	2006	2007	2008
Open water CPUE (fish/hr)	0.49	0.84	0.44	0.66	0.42	0.47	0.67	0.49
Offshore FAD CPUE (fish/hr)	2.00	4.60	4.67	2.45	2.31	3.82	2.32	0.33
Inshore FAD CPUE (fish/hr)	0.55	0.95	0.86	1.62	1.80	0.53	0.85	0.28
Combined FAD CPUE (fish/hr)	0.77	3.31	3.33	1.96	2.19	2.25	1.33	0.30

Figure 2. CPUE (fish/hr) comparison of different fishing methods, 2001–2008.



	2001	2002	2003	2004	2005	2006	2007	2008
Open water CPUE (kg/hr)	6.65	8.27	4.68	6.05	3.64	6.94	4.64	5.08
Offshore FAD CPUE (kg/hr)	14.0	16.1	15.6	13.4	10.8	18.2	7.58	2.29
Inshore FAD CPUE (kg/hr)	5.45	8.21	7.66	8.47	11.6	5.20	7.78	4.15
Combined FAD CPUE (kg/hr)	6.77	13.3	12.8	10.5	11.0	12.0	7.71	3.49

Figure 3. CPUE (kg/hr) comparison of different fishing methods, 2001–2008.

Figure 2 presents CPUE in terms of number of fish. CPUE (fish/hr) increases both when fishing offshore and when fishing inshore FADs for all years, with the exception of 2008. Offshore FADs have the greatest impact on CPUE (fish/hr), although it is clear that inshore FADs also improve CPUE (fish/hr).

Figure 3 presents CPUE in terms of catch weight. CPUE (kg/hr) increases when fishing at offshore FADs for all years, with the exception of 2008. Inshore FADs show increased CPUE (kg/hr) in 2003, 2004, 2005 and 2007. Although offshore FADs have the greatest impact on CPUE (kg/hr), it is clear that inshore FADs also improve CPUE (kg/hr).

Fish caught by artisanal gear in Niue are sold by weight (NZD/kg), and the financial and economic components of this cost–benefit study also value fish by weight. Therefore, for the remainder of this paper, catch is discussed in terms of weight (kg) and not in terms of pieces. It is, however, recognised (as displayed in Fig. 2) that CPUE (fish/hr) generally increases when fishing around FADs.

Table 1. Average CPUE (kg/hr) for trolling at different fishing grounds, 2001–2008.

	2001	2002	2003	2004	2005	2006	2007	2008	Average
Open water CPUE (kg/hr)	6.65	8.27	4.68	6.05	3.64	6.94	4.64	5.08	6.29
Offshore FAD CPUE (kg/hr)	14.00	16.10	15.65	13.45	10.81	18.27	7.58	2.29	17.83
Inshore FAD CPUE (kg/hr)	5.45	8.21	7.66	8.47	11.67	5.20	7.78	4.15	8.69
Combined FAD CPUE (kg/hr)	6.77	13.32	12.84	10.51	11.03	12.05	7.71	3.49	13.26

Table 1 presents CPUE (kg/hr) for open water, offshore and inshore FADs, and combined FAD trolling. The last column represents the average CPUE per hour of trolling for each of the different fishing areas for the whole period (i.e. 2001–2008). Interestingly, average CPUE (kg/hr) for offshore FAD trolling is approximately three times the average of open water trolling; while the average CPUE (kg/hr) for inshore FAD trolling is approximately one-third greater than the average for open water (non-FAD) trolling. Combined CPUE (kg/hr) for offshore and inshore FADs is double that for open water trolling.

These figures present the incremental increase in CPUE when fishing around FADs. The averages will be used to determine the increased value of production as a result of FADs at 2003 effort levels, and to compute the cost–benefit of FADs.

Fuel consumption

The data presented in Table 2 show that fuel consumption per hour of fishing is approximately 0.5 litres less when fishing around FADs than when open water trolling. Although this figure sounds trivial, when multiplied by the total effort of open water trolling in 2003, this equates to a fuel savings of 979 litres per annum. That is, if fishermen allocated their entire effort of open water trolling to FAD trolling, fuel consumption would be reduced by 979 litres per annum.

Financial analysis

This section determines the net financial gain per annum as a result of the increased CPUE and reduced fuel consumption when fishing around FADs. All prices are in New Zealand dollars (NZD).[1]

The major assumptions adopted for this financial assessment include:

- Annual effort is assumed to remain steady at 2003 levels;
- Average fuel consumption for the period 2001–2008 is applied;
- Average CPUE for the period 2001–2008 is applied;
- Average cost of fuel and 2-stroke oil mix is NZD 2.05 per litre;[2] and
- A price of NZD 7.50 per kilogram is assumed.[3]

To understand the net financial gain from FADs, we adopt a "with FAD and without FAD" scenario, incorporating the above assumptions. First we will determine the effect on production; second we will determine the effect on cost; and finally, we will determine the net combined financial gain from FADs.

Table 2. Litres of fuel consumed per unit of effort (L/hr) at different fishing grounds, 2001–2008.

	2001	2002	2003	2004	2005	2006	2007	2008	Average
Open water trolling (L/hr)	7.35	4.89	6.64	5.81	5.50	5.75	6.19	5.65	5.92
Offshore FAD trolling (L/hr)	8.00	4.54	5.84	4.99	5.23	5.85	7.46	6.92	5.53
Inshore FAD trolling (L/hr)	5.45	4.25	5.31	4.73	5.69	5.28	5.88	6.60	5.26
Combined FAD average (L/hr)	5.85	4.44	5.65	4.84	5.35	5.58	6.39	6.71	5.41

1 NZD 1.00 = AUD 0.78 = USD 0.79 (October 2011)
2 Cost of fuel is calculated at NZD 1.70 per litre of petrol and NZD 0.35 per litre of oil mix.
3 A consultation with Niue Department of Agriculture, Forestry and Fisheries revealed that 2009–2011 prices for wahoo, tuna, mahi mahi and other pelagic species ranges from NZD 8–9 per kilogram. In times when there is an oversupply, prices fall to NZD 6–8 per kilogram. Therefore, a mid-point of NZD 7.50 has been adopted for this study.

Table 3. Annual catch (kg) and revenue (in NZD) with and without FADs.

	CPUE kg/hr	Effort hrs	Catch kg	Price NZD	Revenue NZD
With FADs					
Offshore FAD trolling	17.83	733	13,069	7.50	98,020.42
Inshore FAD trolling	8.69	399	3,463	7.50	25,972.89
TOTAL		1,132	16,532		123,993.31
Without FADs					
Offshore trolling	6.29	733	4,611	7.50	34,579.28
Inshore trolling	6.29	399	2,507	7.50	18,799.71
TOTAL		1,132	7,117		53,378.98
Net gain from offshore FADs			8,459		63,441.15
Net gain from inshore FADs			956		7,173.18
TOTAL NET GAIN			**9,415**		**70,614.33**

Changes in annual production from fishing FADs

Table 3 presents the with FAD catch scenario of trolling around FADs and the without scenario with open water trolling. This calculation accounts for the change in average CPUE as a result of trolling around FADs in comparison to open water trolling, while holding effort levels steady.

Assuming that fishing effort remains steady at the 2003 level, a net annual increase in total catch (9,415 kg) and total revenue (NZD 70,614) is achieved as a result of increased average CPUE from fishing around FADs. Of this total increase, NZD 63,441 is attributed to offshore FADs.

Changes in annual cost of fuel from fishing around FADs

Table 4 presents the cost scenario for fishing with FADs and without FADs. This calculation accounts for changes in fuel consumption per unit of effort as a result of fishing around FADs, or more generally, changes in cost of fishing per hour. Table 4 uses 2003 data for total effort.

Table 4 shows that a net gain (cost saving in fuel) of NZD 1,125 is achieved per annum by fishing around FADs at 2003 effort levels.

Total annual financial gain from FADs

Tables 3 and 4 present the net production gain and the net cost (fuel) saving, respectively.

By combining the net production gain with the fuel cost saving, we derive a net financial gain of NZD 64,027 from offshore FADs and NZD 7,712 from inshore FADs. This results in a total combined gain of NZD 71,739 per annum from FADs in Niue.

Table 4. Annual cost of fuel with and without FADs.

	Fuel consumption L/hr	Total effort (2003) hrs	Total fuel consumption L	Cost per litre NZD	Total cost NZD
With FADs					
Offshore FAD trolling	5.53	733	4,053	2.05	8,309.65
Inshore FAD trolling	5.26	399	2,096	2.05	4,297.13
TOTAL		1,132	6,150		12,606.79
Without FADs					
Offshore trolling	5.92	733	4,339	2.05	8,895.69
Inshore trolling	5.92	399	2,359	2.05	4,836.32
TOTAL		1,132	6,699		13,732.01
Cost saving from offshore FADs					586.03
Cost saving from inshore FADs					539.18
NET COST SAVING FROM FADs					**1,125.22**

Economic analysis

SPC (2005) has calculated the investment expense for fabricating and deploying inshore and offshore FADs in Niue and their ongoing maintenance expense as follows: NZD 4,767 for fabrication and deployment of offshore FADs, NZD 3,405 for inshore FADs, and NZD 700 for their annual maintenance. This section determines whether a positive economic return is achieved when comparing the total gains from FADs with the government investment required to fabricate, deploy and maintain FADs.

It is assumed that FADs need to be replaced every two years and that maintenance of FADs occurs once every two years. This assumption is conservative as experience has shown that FAD longevity in Niue is four to eight years, as stated by the Niue Department of Fisheries.

Table 5 provides a breakdown of the returns (cash inflow) and investments (cash outflow) of FAD programmes.

The Niue FAD programme is financially and economically profitable, at a 5% discount rate (Table 5). The critical point for determining when an investment is economically viable is where the net present value (NPV) equals zero. That is, when NPV is greater than 0, the investment is considered to be economically profitable; if it is less than zero, then the investment is not economically sound at a 5% discount rate.

In this situation, government investment of NZD 39,729 provided an economic return of NZD 95,813 over a two-year period. At the point where NPV equals zero, financial returns from FADs justify a government investment of NZD 134,658 over a two-year period.

Table 5. Cashflow and net present value of FADs in Niue.

	Year 1	Year 2
Financial gain (cash inflow)	NZD	NZD
Offshore FAD	64,027	64,027
Inshore FAD	7,712	7,712
TOTAL GAIN	**71,740**	**71,740**
Cost of FAD (cash outflow)		
5 x offshore FADs	23,839	
3 x inshore FADs	10,215	
TOTAL INVESTMENT	34,054	
Maintenance of FADs (cash outflow)		
5 x Offshore FADs		3,706
3 x Inshore FADs		1,969
TOTAL MAINTENANCE		5,675
Cash flow		
Offshore FAD	40,188	60,321
Inshore FAD	-2,503	5,743
NET CASH FLOW	37,686	66,065
Cumulative cash flow	37,686	103,750
Net present value or NPV (5% discount rate)		
Offshore FADs NPV	92,987.55	
Inshore FADs NPV	2,825.94	
TOTAL NPV	95,813.49	

Results of the financial and economic analysis

The results of this study are positive, although they are considered to be a conservative estimate of the total financial and economic gains from FAD programmes in Niue. Data are not available to determine the full financial and economic benefits associated with FAD programmes; however, the author estimates that these results could be doubled to represent a more realistic figure of benefits. The reasons for this being:

- logsheets that are submitted do not represent the entire fishing effort per annum, even in 2003 when the submission of logsheets peaked;
- trolling was the only fishing method considered in this study, although trolling only represents 87% of catch (kg);
- the benefits of FAD-driven demand for sports fishing tourism was not considered or quantified in this study; and
- other cost savings were omitted, such as the reduced cost of search and rescue for troubled fishing vessels.

The results of this study are that inshore and offshore FADs increase total catch per annum by a value of NZD 70,614 and reduce fuel costs by NZD 1,125, creating a net annual financial gain for the Niuean fishing industry of NZD 71,739.

In terms of the economics of government investment in FAD programmes, a positive NPV is indicative that ongoing investment in FAD programmes should be supported.

Policy implications and conclusion

This paper presents the theoretical benefits of FADs, of which some are supported by the Niue cost–benefit study. From the results, conclusions can be made about the total benefit of FADs and the government investment policy that should be adopted for future deployment, maintenance, monitoring and replacement of FADs.

The case study is indicative that FADs provide benefit in the form of increased catch rates and reduced fuel consumption. Sims (1988) estimates that the average economic return of FADs to Cook Islanders is NZD 0.91 per line per hour (one hook) or a total benefit of NZD 37,000 per annum.

Given the positive financial returns, FADs provide a positive economic return (on investment) over a two-year period.

Policy implications

It is recommended that PICTs adopt the following recommendations.

- The private fishing sector is encouraged to fabricate, deploy and maintain FADs.
- Government should continue to invest in FAD replacement, fabrication, deployment and maintenance. However, assuming diminishing returns to scale, governments should not adopt a policy to deploy more FADs than are needed. That is, policy should be adopted to replace all FADs that are lost, and continued support should be given to the deployment of new FADs up until a point where diminishing returns to scale are identified.
- There should be continued promotion and support for data collection as defined in this paper.
- Fishermen should be trained in FAD fabrication and deployment, and in FAD fishing techniques.
- The benefits of FADs to the private sector should be promoted.

FAD maintenance may require diving operations. Their cost must be accounted for. Image: Richard Story.

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