

# Positive results of a FAD monitoring programme in Yap

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## Introduction

A nearshore fish aggregating device (FAD) is an anchored or drifting object that is placed in the ocean to attract fish.<sup>1</sup> Tuna and other pelagic fish gather around a FAD, making it easier to find and catch them. Nearshore FADs are deployed to improve the efficiency of small-scale fishers, but are also thought to provide other benefits, such as reducing fishing pressure on reefs, and providing a means to adapt to the predicted effects of climate change.

Six nearshore FADs were deployed in Yap State, Federated States of Micronesia in early 2013. The FADs were deployed as a component of the “Community-based Ecosystem Approach to Fisheries Management (CEAFM) and Climate Change Adaptation” project under the Secretariat of the Pacific Community (SPC) and the German Agency for International Cooperation’s “Coping with Climate Change in the Pacific Islands Region” (CCCPIR) project.<sup>2</sup>

In addition to the six FADs supplied under the CCCPIR project, SPC provided Yap State with sufficient materials to fabricate an additional six FADs in case some of the primary FADs were lost.

Through consultations with various communities in Yap, FADs were deployed because of<sup>3</sup>:

- human population growth leading to overfishing in coastal zones;
- declines in reef fish catch rates;
- the unhealthy state of some reefs in Yap and their predicted further decline as a result of climate change;
- a loss of mangrove habitats;
- blue holes<sup>4</sup> getting smaller and shallower; and
- the increasing local demand for fresh fish.

Four municipalities with access to the six FADs were selected to help implement a newly designed FAD monitoring programme<sup>5</sup> to collect data over a five-month period with the primary objective of gaining an understanding of their effectiveness. The preliminary results of the monitoring programme are presented below.

## Results

The monitoring programme consisted of interview-based, fisheries-dependent surveys, including fishing vessel counts and catch and effort interviews, and a household calendar survey that collected information on a household’s daily fishing activities, fish consumption and sales.

In total, 660 fishing trips were reported over the sampling period, and assuming that 100% of fishing trip coverage is reported, this amounts to an estimate of 1,496 fishing trips per year across all sampling sites (Table 1). This is likely to be an underestimate, but these are nonetheless used in the extrapolation of total effort estimates in the economic analysis presented thereafter.

*Table 1. Matrix of vessel-based fishing effort (fishing trips).*

	Paddle	Motor	Total
Total reported trips (8 April–8 September 2013)	185	475	660
Average trips reported per week	8	21	29
Estimated number of trips per year	419	1,077	1,496

About 63% of fishing events<sup>6</sup> by location occurred on the reef over the sampling period (80% of total reported

<sup>1</sup> Refer: [http://www.spc.int/DigitalLibrary/Doc/FAME/Brochures/Anon\\_12\\_PolicyBrief19\\_FADs.pdf](http://www.spc.int/DigitalLibrary/Doc/FAME/Brochures/Anon_12_PolicyBrief19_FADs.pdf)

<sup>2</sup> Refer: [http://www.spc.int/DigitalLibrary/Doc/FAME/InfoBull/FishNews/142/FishNews142\\_18\\_Brunken.pdf](http://www.spc.int/DigitalLibrary/Doc/FAME/InfoBull/FishNews/142/FishNews142_18_Brunken.pdf)

<sup>3</sup> Source: GIZ/SPC (2012), Community Fisheries Management Plans for the CCCPIR Project selected sites, Yap State

<sup>4</sup> Blue holes are holes in the reef that are productive fishing zones.

<sup>5</sup> See: [http://www.spc.int/DigitalLibrary/Doc/FAME/InfoBull/FishNews/140/FishNews140\\_08\\_Sharp.pdf](http://www.spc.int/DigitalLibrary/Doc/FAME/InfoBull/FishNews/140/FishNews140_08_Sharp.pdf)

<sup>6</sup> A fishing event is defined as a period when a single fishing method is practiced in a single location. When a new fishing method is practiced or the fishing location is changed, this constitutes a new fishing event. We report by fishing event so that fishing variables, such as catch rates at and away from FADs, can be delineated.

effort – hours), with FADs making up 22% of fishing events by location (10% of total reported effort – hours) and open water, mangrove and lagoon fishing making up the remainder (Fig. 1).

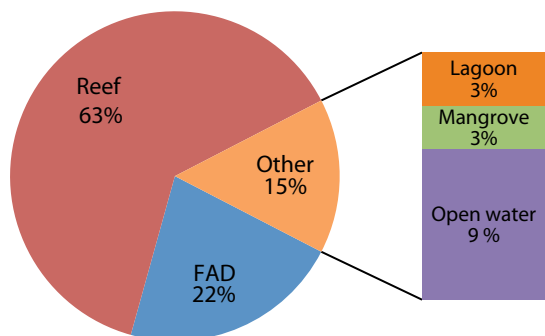


Figure 1. Proportion of fishing events by location.

Figure 2 presents the weekly frequency of fishing events (n = 336) by fishing location, simply disaggregated as FAD fishing and non-FAD fishing<sup>7</sup> (660 trips were recorded through the vessel count, but only 245 catch-and-effort interviews were conducted, related to 336 fishing events).

Although there is no clear trend, there is a notable increase in FAD fishing effort in August and September (weeks 19–22 in Fig. 2). Catch and catch rates<sup>8</sup> are analysed below, but the time series is too short to provide an indication of whether this effort increase is seasonal, a lagged effect of the FAD fishing training, an indication that the FADs had reached “maturity”, or other dependent or independent factors. Additional data will improve the understanding of fishing behaviour and trends.

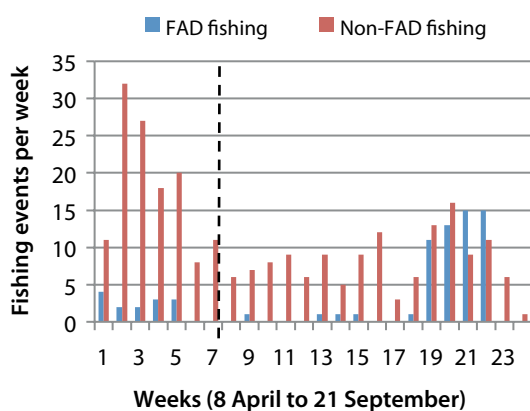


Figure 2. Weekly frequency of fishing events by location. The vertical dotted line is the time when a FAD fishing skills workshop was delivered in Yap.

There is a strong correlation between fishing effort (location) and catch category, hence total reported catch is dominated by reef fish (Fig. 3). However, FAD catch represents 20% of the total reported catch of 13,900 kg, when fishing effort at FADs only represents 10% of the total effort of 1,127 hours recorded over the sampling period.

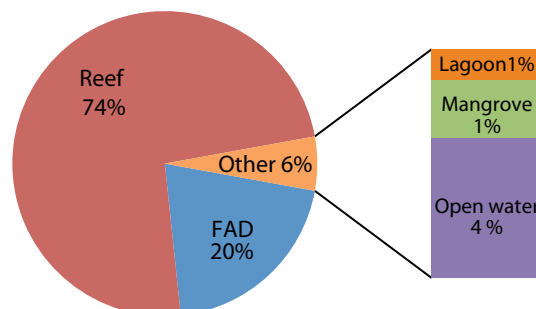


Figure 3. Fish catch (% of total catch) at different fishing locations.

This is due to the high catch rates obtained at FADs (~25 kg h<sup>-1</sup> boat<sup>-1</sup>) (Fig. 4), followed by open water and reef locations (each with ~12 kg h<sup>-1</sup> boat<sup>-1</sup>). Catch per unit of effort (CPUE) is averaged over the whole sampling period and average non-FAD CPUE was ~12 kg h<sup>-1</sup> boat<sup>-1</sup>, which is used in the with-and-without analysis below.

Given that fish are typically priced and sold by weight, CPUE (kg h<sup>-1</sup> boat<sup>-1</sup>) is the logical proxy applied in the economic analysis.

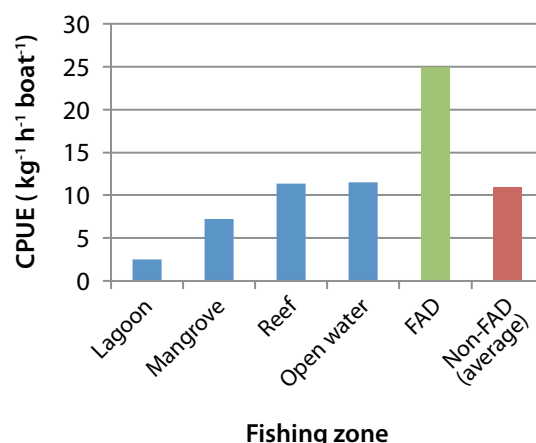


Figure 4. Mean catch rates (CPUE: kg h<sup>-1</sup> boat<sup>-1</sup>) by fishing location.

<sup>7</sup> Non-FAD fishing includes fishing on the reef, inside the lagoon, near mangroves and open water locations.

<sup>8</sup> Catch rates, or catch per unit of effort (CPUE), is given in kg per hour per boat. In Yap, coastal fishing boats usually carry one or two fishers.

### Results of the household socioeconomic survey

In total, 131 household completed the calendar-based questionnaires over three periods of four weeks each. Collectively, the calendar data amounted to 3,668 days, with 13 data units produced per household per day.

Figure 5 presents the results of the household fishing activity for calendar periods 1 to 3 (CP1 to CP3). The data indicate that households across all three sites go fishing ~40% of days, or 2.8 days per week. In CP1 and CP2, fishing occurs on the reef 86–88% of the time, while FAD and open water fishing (non-FAD) occurred between 6% and 8% of the time. In CP3, the proportion of fishing trips occurring on the reef declined to 61% while FAD fishing markedly increased to 29%; these results correspond to those presented in Figure 1, confirming the robust nature of the monitoring programme and similarly, the time series is too short to make inference about fishing trends.

Corresponding to the change in fishing location, analysis of the household calendar data revealed that there was a change in fish consumption (reef fish being consumed 84% of the time in CP1 and CP2, declining to 70% in CP3) and sales (reef fish being sold 85% of the time in CP1 and CP2, declining to 55% in CP3).

### Economic analysis

The fisheries-dependent and household socioeconomic data were collated to inform a mid-term economic analysis (consisting of “with-and-without”, “cost–benefit” and “what-if” analysis) of the FAD project in Yap.

#### With-and-without analysis

The change in the value of catch resulting from increased catch rates at FADs is estimated in order to determine the financial benefit of FADs in increasing small-scale fisher efficiency. This is done by taking the hours fished at FADs and applying an average non-FAD catch rate (Fig. 4) to compare the value of production with and without FADs. Assuming that, in the absence of FADs, fishing effort (hours) dedicated to FADs is applied to non-FAD locations, the difference between the value of the catch with and without FADs amounts to the financial benefit of the increased fisher efficiency resulting from FADs.

This is modeled under three scenarios using the FAD and non-FAD (average) CPUEs ( $\text{kg hr}^{-1} \text{boat}^{-1}$ ) presented in Figure 4. The scenarios are: actual reported fishing effort at FADs over the five-month monitoring period, and extrapolated<sup>9</sup> fishing effort for five-month and one-year periods (Table 2).

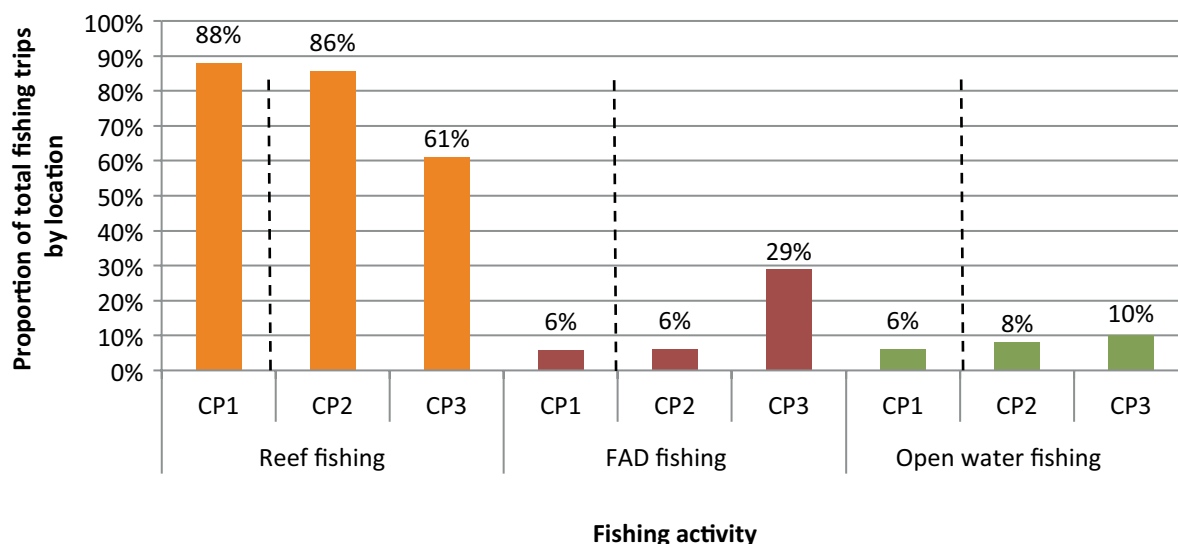


Figure 5. Household fishing activity by location from the calendar survey at all sample sites, CP1 to CP3. The vertical dotted line is the time when a FAD fishing skills workshop was delivered in Yap.

<sup>9</sup> Fishing effort is extrapolated by multiplying the estimated 1,496 fishing trips (Table 1) per annum by 22% (FAD fishing events), equating to 329.12 FAD fishing events per annum. Dividing this by 12 and multiplying by 5, we estimate 137.13 fishing events at FADs over the five-month sampling period. The average fishing effort at FADs of 1.56 hours is multiplied with the estimated fishing trips (137.13) to estimate our total FAD fishing effort of 213.93 hours over five months.

Table 2 demonstrates that the actual change in revenue to the fishing community resulting from increased catch rates at FADs after five months was ~USD 5,285, and when extrapolating, this amounts to ~USD 9,908 over the five-month sampling period. Over a year, this is estimated to increase catch value by ~USD 23,780 to the fishing community in the sample sites.

### Mid-term cost–benefit analysis

In calculating the economic return from the project, the project cost was approximately USD 20,000, with capacity building and monitoring costs treated as sunk<sup>10</sup>.

Accounting for the project cost and the benefits (cash inflow) presented in the with-and-without analysis (Table 2), and applying a 10% discount rate, the project generated a positive economic return (NPV) within a year; over a two-year period, it is estimated to have generated a net economic benefit of ~USD 21,272 (Table 3). That is, after investment costs for FAD materials and deployment are stripped out, the economic benefit amounts to USD 22,272, or an internal rate of return (IRR) of 84%.

This financial benefit omits other direct and indirect benefit of FADs, such as reduced fishing pressure on

Table 2. With and without analysis of the FAD project.

#### Scenario 1: Five-month period benefit of FAD (actual reported, no extrapolation)

	CPUE (kg hr <sup>-1</sup> boat <sup>-1</sup> )	Effort (h)	Total catch (kg)	Price (USD kg <sup>-1</sup> )	Revenue (USD)
With FADs	24.94	114.10	2,846	3.30	9,392
Without FADs	10.91	114.10	1,245	3.30	4,107
<b>Change in revenue resulting from FADs</b>					<b>5,285</b>

#### Scenario 2: Five-month period benefit of FAD (extrapolated)

	CPUE (kg hr <sup>-1</sup> boat <sup>-1</sup> )	Effort (h)	Total catch (kg)	Price (USD kg <sup>-1</sup> )	Revenue (USD)
With FADs	24.94	213.93	5,336	3.30	17,609
Without FADs	10.91	213.93	2,333	3.30	7,700
<b>Change in revenue resulting from FADs</b>					<b>9,908</b>

#### Scenario 3: Annual estimated benefit of FAD (extrapolated)

	CPUE (kg hr <sup>-1</sup> boat <sup>-1</sup> )	Effort (h)	Total catch (kg)	Price (USD kg <sup>-1</sup> )	Revenue (USD)
With FADs	24.94	513.43	12,806	\$3.30	42,261
Without FADs	10.91	513.43	5,600	\$3.30	18,481
<b>Change in revenue resulting from FADs</b>					<b>23,780</b>

Table 3. Mid-term cost–benefit analysis of the Yap FAD project.

	Year 0 (USD) (actual)	Five months (USD) (extrapolated)	Year 1 (USD) (projected)	Year 2 (USD) (projected)
Cash inflow (benefit)		9,908	23,780	23,780
Cash outflow <sup>11</sup> (project cost)	20,000			
Net cashflow	-20,000	9,908	23,780	23,780
Net present value (NPV)	-20,000	9,523	21,618	19,653
<b>Cumulative NPV</b>	<b>-20,000</b>	<b>-10,477</b>	<b>1,618</b>	<b>21,272</b>

<sup>10</sup> Sunk costs are non-recoverable costs that are omitted from investment appraisal (e.g., project-associated costs such as training, monitoring).

<sup>11</sup> Purchase of sufficient materials for 12 FADs, 1 container and shipping plus USD 3,762 for anchors, deployment and miscellaneous costs.

reefs, which leads to improved ecosystem services and climate change adaptation, which should be considered in a comprehensive cost-benefit analysis.

### What-if analysis

Figures 2 and 5 demonstrate that FAD fishing effort increased in the latter months of the monitoring period and from this, it can be inferred that fishing effort transfer occurred from non-FAD to FAD fishing locations<sup>11</sup>. Considering this, we conduct a what-if analysis to predict the financial benefit derived from increased fishing effort and catch rates at FADs should this trend of effort transfer continue. This is done by modelling three effort transfer scenarios where it is hypothesised that fishing effort at non-FAD locations is transferred to FAD locations with FAD catch rates applied. For the three scenarios 25%, 50% and 75% of total non-FAD effort transfer are modelled.

Under these scenarios and assuming that catch rates and fish price remain steady, 25%, 50% and 75% effort transfer from non-FAD to FAD fishing locations would increase revenue to the fishing community by USD 50,065 (24% increase in revenue), USD 100,130 (47% increase) and USD 150,195 (71% increase) over a one-year period, respectively.

Considering the trends presented in Figures 2 and 5, it is reasonable to assume that scenario 2 (50% effort transfer) is a likely scenario when hypothesising fishing effort transfer. Therefore, over the life of the FAD project (two years), it is estimated that effort transfer and increased catch rates at FADs may increase revenue to the fishing community by approximately USD 200,260 (47%).

### Conclusion

The interim results of the fisheries-dependent monitoring programme and household survey are indicative that both boat-based fishers and Yapese households utilise coastal areas (reefs, lagoons and mangroves) as their primary fishing grounds and source of food and income. This, in itself, demonstrates the importance for improved coastal fisheries management to build resilient coastal ecosystems under a scenario of climate change. It also demonstrates the need to provide alternative opportunities for Yapese fishing communities to continue their traditional fishing ways in anticipation of declining coastal fisheries productivity.

A FAD is identified as an infrastructure that facilitates the capture of pelagic fish, providing access to fish stocks, such as tunas, that are resilient to high levels of fishing pressure by small-scale fleets and are less susceptible to the projected effects of climate change. The analysis of the data derived from the FAD monitoring programme in Yap enables the following conclusions:

- FADs improve fisher efficiency, in terms of increasing catch rates.
- FADs may encourage household behavioural changes, in terms of diverting fishing activity away from the coast, and in changing fish consumption and sales from reef fish to pelagic fish that are typically associated with FADs.
- The financial cost incurred from procuring and installing FADs is significantly outweighed by the additional catch values generated.
- If fishing effort continues to be transferred from the reefs, lagoons, mangroves to open water area, catches and associated revenue to fishing communities will increase.

The above conclusions are not definitive due to the short time series and it is, therefore, recommended that the monitoring activity be extended for a longer period.

### Acknowledgements

Numerous stakeholders have been involved in the Coping with Climate Change in the Pacific Islands Region project and their contribution is gratefully acknowledged; however for the FAD monitoring component of the project, the contributions of the following individuals are greatly acknowledged and appreciated: the five data collectors Joseph Waayan, John Gamou, Joe Lukangaw, Paul Gorong, and John Yangruw; the fishers and households in the municipalities of Rumung, Maap, Gagill and West Fanif who provided their valuable data; Yap Community Action Programmeme (YapCAP), especially Julian Tewasilpiy, who administered the data collection programme; Yap's Marine Resources Management Division of the Department of Resources and Development, especially Mr James Pong, who oversaw the data collection programme; the New Zealand Aid Agency (NZAID) who funded the data collection; the German Agency for International Cooperation (GIZ), especially Fenno Brunken; and the Secretariat of the Pacific Community (SPC), especially Etuati Ropeti, Michel Blanc, William Sokimi and the Data Management Team.

<sup>12</sup> Figure 2 demonstrates that FAD fishing in the last two months of monitoring accounted for almost 50% of boat-based fishing activity, while Figure 5 demonstrates household FAD fishing activity (including non-boat based) was approximately 30% of total fishing activity in CP 3.