Investment profile for anchored nearshore fish aggregating device

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Anchored artisanal fish aggregating devices (FADs) can be highly effective in increasing fishery yields and reducing production costs; however, there are a number of variables that impact on the efficacy of FADs. These variables have significant implications for the financial yield and economic returns from FADs. This article documents the variables that determine whether a positive or negative return on investment (RoI) is achieved for FAD programmes, and provides recommendation to improve the likelihood of a positive return.

Introduction

The effectiveness of an anchored FAD is often measured in terms of its aggregating efficiency and improved yield to the fishing community. This is a reasonable measurement if we consider FADs as sunk costs; however, administrators of FAD programmes should adopt a long-term investment outlook for FADs and manage the variables that determine whether FADs derive a positive or negative economic return.

FAD programmes are too commonly thought of as short-term, project-driven activities. As in any infrastructure project, FADs should be considered as long-term investments that attract sustained budget with the objective of supporting domestic artisanal fisheries and increasing domestic production.

Return on investment (RoI)

When we discuss return on investment (RoI) of a FAD programme, we are referring to the improved productivity and cost savings that are realised by the fishing sector when fishing near and around FADs, in comparison with the investment expended for deploying and maintaining FADs.

Some of the expenditures that are incurred throughout the life of a FAD include materials for fabrication, deployment expenses, maintenance, replacement and management.

The financial return from FADs depends on a number of variables, which are outlined below. This article only considers the direct benefits of FADs, which are improved productivity and cost savings to the fishing community. Indirect benefits and costs are not considered due to the complexity of measuring these.

Calculating the financial benefits of FADs

In determining an investment profile, the financial returns to the fishing community must be calculated. This section describes each benefit and the method for quantifying these benefits. Equations are provided to assist with the calculations.

Change in catch rate

The effectiveness of a FAD in aggregating fish can be measured in terms of change in catch per unit of effort (CPUE). In other words, what is the CPUE when fishing near FADs ($CPUE_{FAD}$) in comparison to the CPUE when fishing in open water ($CPUE_{OW}$)? The difference between the two (ΔCPUE) (equation 1) multiplied by the price of fish (PF) gives us the change in revenue per unit of effort (ΔRPUE) (equation 2).

Fishing effort

The benefits of FADs can only be realised when the fishing community fish near FADs. Without any effort dedicated to fishing near FADs, productivity benefits cannot be realised.

When multiplying total fishing effort (TE) by the change in revenue per unit of effort from fishing FADs, we can determine the impact that FADs have on the total revenue (TR) of the fishing industry (equation 3)

Change in cost

Direct cost savings, via reduced fuel consumption and/or labour, contribute to determining financial return from a FAD.

Change in fuel consumption (ΔFC) per unit of effort is the difference between the open water fuel consumption (FC_{OW}) and the fuel consumed when fishing near FADs (FC_{FAD}) per unit of effort (equation 4). When multiplying ΔFC with the cost of fuel (C_F) we can estimate the savings of fuel (FS) to the fishing community per unit of effort (equation 5).

Total fuel savings (TFS) to the fishing community is the fuel saving (FS) per unit of effort multiplied with the total fishing effort at FADs (equation 6).

Calculating savings in labour costs is difficult due to the fact that fishers do not usually go home when they reach a given level of production; instead, they continue fishing until time, fuel or space (in the hold) runs out. Labour savings can be measured by calculating the effort required to fill a vessel's hold. That is, the vessel capacity (VC) divided by $CPUE_{OW}$ less the vessel capacity divided by $CPUE_{FAD}$ (equation 7). The result is the change in labour (ΔL), in terms of hours, to fill the hold. Multiplied with the cost of labour (C_L), we derive labour savings (LS) per vessel (equation 8).

To estimate the labour saving benefit to the entire fishing industry, an average vessel capacity (AVC) or fleet profile is required. When multiplying the AVC by labour savings, we can estimate the total labour savings (TLS) (equation 9), in terms of dollars saved in labour to the fishing industry.

Equations

- $\Delta CPUE = CPUE_{OW} - CPUE_{FAD}$ (1)
- $\Delta RPUE = \Delta CPUE \times P_F$ (2)
- $TR = \Delta RPUE \times TE$ (3)
- $\Delta FC = FC_{OW} - FC_{FAD}$ (4)
- $FS = \Delta FC \times C_F$ (5)
- $TFS = FS \times TE$ (6)
- $\Delta L = (VC / CPUE_{OW}) - (VC / CPUE_{FAD})$ (7)
- $LS = \Delta L \times C_L$ (8)
- $TLS = AVC \times LS$ (9)
- $TC = TFS + TLS$ (10)

The change in total cost (TC) from FADs is calculated by the total fuel savings plus the total labour savings (equation 10).

Now that we have determined how to calculate the direct financial change as a result of FADs, we can identify other variables that impact on whether a positive RoI is realised.

Return on investment

Longevity

Longevity (T), in terms of the life of an anchored FAD, significantly affects whether a positive or negative return is achieved.

For example, if the value of the FAD is $10,000 and it takes 100 days of fishing to achieve the equivalent benefit (TR + TC), then at 100 days a neutral return is achieved (i.e. exactly cover costs). In this case, if the FAD's longevity is less than 100 days, then a negative return is realised.

Therefore, the aggregation of total financial benefits of FADs over time must exceed the investment expense to realise positive returns, which is why longevity is important.

Investment, maintenance and management cost of FAD programmes

The cash flow generated from increased revenue (and reduced costs) need to exceed the upfront investment (I) and ongoing maintenance (M) of the FAD. Once this is achieved, then we begin to realise a positive RoI (equation 11).

Indirect impacts of FADs

Only direct benefits are considered in this article. If considering the indirect impacts (X) of FADs, a positive RoI would be achieved over a shorter period of time than when only considering direct benefits. The positive indirect impacts (e.g. reduced pressure on the reef, driving tourism, import substitution, sea safety) and negative indirect impacts (e.g. domestic price decline, resource depletion) of FADs are difficult to measure, so they have been omitted from the investment profiling.

Positive return on investment is achieved when:

$$(TR + TC) > (I + M) \qquad (11)$$

Aggregation of all affects of a FAD

Achieving a positive RoI is dependent on the investment and maintenance costs, the change in total revenue, the change in costs (fuel and labour), and the indirect impacts of FADs. Putting all of these benefits together, a positive RoI is subject to the time that the anchored FAD lasts.

RoI is calculated as:

$$RoI = I_o + \sum_{n=1}^{T}\left(\frac{(TR_n + TC_n + X_n - M_n)}{(1+r)^n}\right)$$

Where: r = the discount rate
n = number of years

Given the variability in investment expense, aggregating efficiency and cost implications — which can change from one FAD to another depending on location, bathymetry and season — there are no averages that can universally be applied for an investment profile. Considering this, a hypothetical example is given to display the investment profile of a FAD over time.

FAD investment profile

To present the investment profile of a FAD, a hypothetical situation if formulated, which only accounts for change in CPUE. That is, all other variables, such as change in costs and indirect impacts, are assumed to remain the same. This assumption is made due to the complexity of adjusting for the wide array of factors in formulating an example.

For the hypothetical investment profile, the following parameters have been applied:

- Investment and deployment cost for a FAD is $5,000;
- Annual maintenance cost for a FAD is $1,000;
- Price (per kg) for fish is $5; and
- Discount rate of 10% per annum is applied.

These figures are realistic; however, there are few data to support the change in CPUE as a result of FADs. Therefore sensitisation of CPUE change is required.

The investment profile considers three scenarios, each with high, medium and low changes in CPUE. Numerically, these changes in CPUE are assumed to be 5 kg hr^{-1}, 3 kg hr^{-1} and 1 kg hr^{-1} for each respective scenario. Additionally, annual effort dedicated to fishing near FADs is sensitised to be low (250 hours), medium (500 hours) and high (750 hours).

Figure 1 displays the affect that effort and catch rate have on whether a positive or negative return is achieved.

Consider scenario 1, which allocates 250 hours of fishing effort per year. Clearly, with a low effort coupled with a low CPUE change of 1 kg hr^{-1}, the FAD cannot achieve a positive return due to the ongoing maintenance costs outweighing the increase in CPUE. However, when effort is increased to 750 hours per year a positive RoI is achieved after two years when CPUE change is low.

Time, or FAD longevity, also has significant implications on whether a positive return is realised. Again, consider scenario 1 and the median CPUE change of 3 kg hr^{-1}. In this scenario, a positive RoI is realised after two years. Consider the implications if the FAD is lost after one year — a negative return would be realised when, if the FAD had lasted for its expected life, a positive return would have occurred. Furthermore, the additional benefits that are derived after year 2 are not realised when the FAD is lost. In all scenarios, excluding scenario 1 with low CPUE change, the longer the FAD lasts, the higher the return on investment.

From this, two essential FAD management policies should be adopted. First, fishers should be encouraged to increase fishing effort at FADs so that any benefits from increased CPUE are realised. Second, regular maintenance to increase the life of a FAD should be practiced, with budget allocated for ongoing maintenance and replacement of worn components.

Discussion

FAD programmes in Pacific Island countries and territories are usually project based with short-term investment outlooks. Benefits of FADs, however, are often only realised over the medium term, as in the case of scenario 1. Therefore, for an economy to realise the full benefit of a FAD, management measures, such as frequent maintenance, need to be sustained.

Assuming that FADs do increase catch rates, the above scenarios show that the longer the life of a FAD, the higher the return on investment.

Recommended management measures for FADs include:

- Sustained long-term budget allocation for deployment, maintenance and replacement of anchored nearshore FADs.
- Implementation of data collection to better quantify the efficacy of FADs.
- Improved promotion of the use and purpose of FADs to increase fishing effort at FADs.
- Development of a FAD fishing code-of-conduct for all users of FADs.
- Development of FADs that have improved longevity (i.e. subsurface FADs).

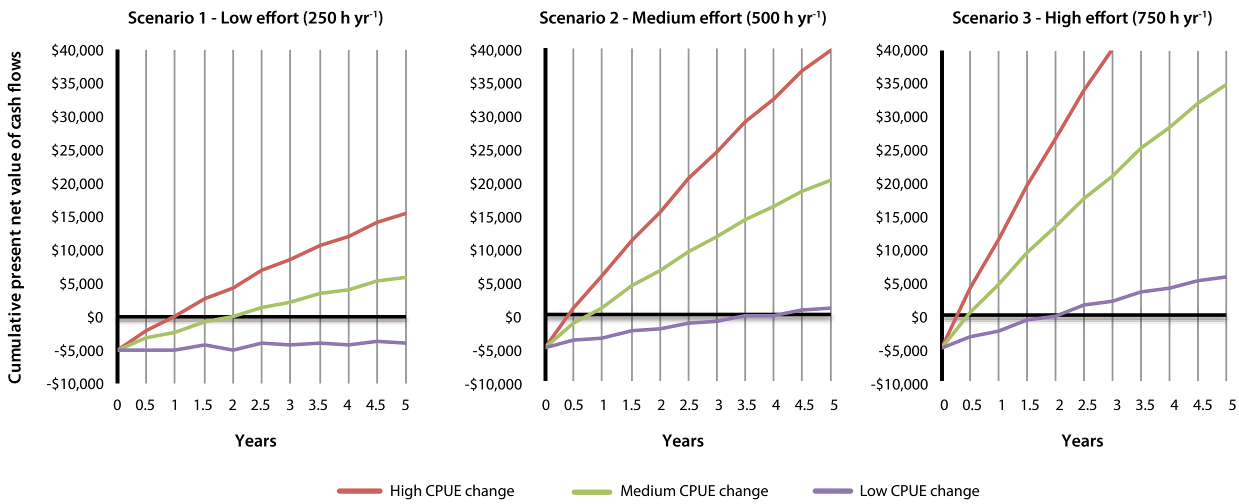

Figure 1. Investment profile for FADs based on low-, medium- and high-effort scenarios