Evaluating needs for the set up and maintenance of land-based FAD retrieval programs

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Abstract

Lost and abandoned fish aggregating devices (FADs) have potential deleterious environmental impacts on the marine environment, particularly FADs built with long lasting synthetic materials beaching in sensitive ecosystems like coral reefs. To mitigate potential pollution and seabed erosion impacts various land-based FAD retrieval programs (FRPs) have been set up in recent years in specific sensitive areas. These programs collect FADs just before they reach the coast or if they have already stranded, they will extract as much material as possible to dispose of it on land. To implement such programs personnel and infrastructures are required and funds needed to enable maximum recovery of lost and abandoned FAD structures. In this document we try to understand the requirements and costs involved to set up FRPs in coastal locations. Different formulas exist for recuperating FADs arriving (i.e., dedicated retrieval vessels, cooperation with artisanal fisheries). We present the results of a survey on FRP costs and discuss the benefits of different FAD collection approaches.

Introduction

Marine pollution generated by humans is one of the most pressing problems in the world's oceans (Borrelle et al., 2017; Kaandorp et al., 2023). An important component of the synthetic materials littering oceans (e.g., plastics) originate from abandoned, lost or otherwise discarded fishing gear (ALDFG) (Moralles-Caselles et al., 2021; Richardson et al., 2022; Apete et al., 2024). Most of today's fishing gears, such as nets and longlines, are made of long-lasting pretrochemical derived materials (i.e., nylon or polyamide, polyester, polyethylene and poly-propylene) designed to endure under harsh conditions and which may take decades to centuries to decompose (Barnes et al., 2009; Vodopia et al., 2024). Many of these ALDFG can ghost fish for extended periods of time while at sea, especially those having net material (i.e., gillnets, driftnets, trawl nets) (Apete et al., 2024). Even when these lost fishing gears break down, they will eventually generate micro- and nano-plastics that enter the marine food web (Benson et al., 2022).

An example of fishing gear that can become lost or abandoned are fish aggregating devices (FADs). Both drifting FADs (dFADs), mostly employed by purse seiners, and anchored FADs (aFADs), employed by pole and line, can become ALDFG (Imzilen et al., 2022). Because the use of netting in FADs has been prohibited by all tuna RFMOs, these are less likely to ghost fish when lost. However, if the FADs are built with synthetic materials, they will still generate pollution, and their structures can cause damage in sensitive ecosystems (Schiller et al., 2025). For aFADs that break away from their mooring it is more difficult to track their fate as they are usually not equipped with radio o satellite GPS. On the other hand, dFADs can be monitored thanks to their GPS buoys (Lopez et al., 2014), but if these are turned off or the buoy sinks, they will stop emitting the position. Often fishers will deactivate FAD buoys if they move away from the fishing grounds, in which case, their drift is difficult to follow.

Several management options are available at present to mitigate the pollution impacts of lost or abandoned FADs in tropical tuna purse seine fisheries which try to reduce their numbers and synthetic materials. Actions include active FAD limits per vessels, temporal FAD closures, adoption of short-term calendars for the implementation of biodegradable FADs and some RFMOs have even limited the size of the dFAD structure (e.g., tail depth). Another important option to reduce marine pollution by FADs is for fishers to collect them at sea (e.g., to reuse in another fishing area), or FRPs before they get to close to the coast and also when they have beached. The only RFMO resolution that currently calls for the recovery of FADs is Res. C-21-04 which requires large-scale purse seine vessels to recover a number of FADs equal to the number they have set within 15 days before a closure. However, this conservation measure is very limited in time. While some RFMOs support FRPs (e.g., IATTC Res. C-23-03, paragraph 3) and are considering starting trials, most programs in place today have been set up by other type of organizations, whether through FIPs funded by the purse seine industry, NGOs, governments or a combination of them (e.g., Palmyra, Galapagos, Seychelles, French Polynesia).

Having a basic understanding of the costs and benefits of executing different land-based FRPs with significantly different approaches can be of for fishery stakeholders (e.g., RFMOs, governments, NGOs, etc.) wishing to set up floating object recovery projects. Although the costs of each FRP is very context specific and can vary ostensively even using similar approaches (i.e., different costs of equipment and salaries depending on the country), identifying costs associated with the program as a starting reference point can be interesting. Here we present the results gathered from a survey conducted with 3 different FRPs currently operating.

METHOD

To characterize the costs involved in different types of land-based FRDs we prepared a questionnaire that was sent out to different organizations running such programs (Annex I). The questions were centred around fixed and variable costs involving material purchases, annual personnel costs and various other expenses they needed to have an operational program in place. Costs included items from FAD collection to the disposal phase. If some cost had not been included in the survey, responders had the chance to provide more categories and explain them in the comments sections provided.

Most consulted programs operate from a base on land and have a spatial coverage of one to a small number of islands that they monitor for FAD retrieval. However, some programs have a wider spatial range than others, but for the purpose of standardizing the survey we asked participants to calculate the costs for a restricted program operating only in one island.

For the first section of the survey, we asked participants how much they had spent on purchasing a collector vessel including its associated equipment (i.e., a speedboat with its engines, GPS, radio system, echosounder) or in not owned, the rental costs of a vessel per year. Another item required to locate FAD positions and establish communications between team members were cellular phones, computers, etc. In some cases, FAD retrieval teams consist of trained scuba divers who dive during pick up events. Cost ranges were divided into 5 categories (0-2000, 2000-10000, 10000-50000, 50000-100000, 100000-200000, 200000-300000 USD).

The survey also asked what the annual salary of a person was involved full time in the FAD retrieval program (i.e., program coordinator) and number of people involved in the FAD collection process. Also, the travel costs of sending personnel to the designated

FAD retrieval locations (e.g., from their hometown in the continent to the FAD program islands).

Other possible costs associated with FAD retrieval programs that are incurred regularly included buoy satellite data fees and satellite phone fees to pinpoint the position of FADs when searching for them, fuel expended per excursion to retrieve FADs, rent for a recycling or storage area for materials collected, routine vessel maintenance costs, vessel docking fees, costs of shipping buoys back to their owners (if collaborating with particular purse seine fleets), and other various subcontracting services (e.g., production of FAD retrieval manuals for fishers or general public; rental of rooms for meetings, etc.)

RESULTS

Looking at types of FRPs on land, we identified two very different approaches that resulted in dissimilar financial expenses. In FRP1 the project was supervised by a program coordinator, but the actual recovery of FADs was performed by the collaborating artisanal fleet operating in the location of the program. In this program there was no need to own or rent a collector vessel, instead fishers recollecting a FAD were paid per unit depending on the distance they had to travel. The other two programs consulted operated with their own team of collecting personnel from a rented (FRP2) or an owned vessel (FRP3). In both cases this was one of the largest expenditures for them (Table 1). In all programs they required a relatively minor investment in cellular phones and computers to send and process information on FAD locations. Regarding scuba diving materials (e.g., tanks, buoyancy control devices, masks, regulators, etc.) this was a minor cost that only occurred in the programs with researchers trained to perform these tasks, but not in programs with fishers collecting FADs.

Table 1 – Cost associated with infrastructure for FAD retrieval vessels, communications, and diving FAD collection equipment (units in thousands of USD).

Description	0-2	2-10	10-50	50-100	100-200	200-300
Collector vessel purchase (boat, engines, GPS,echosounder)						FRP3

Collector vessel rental per year				FRP2		
Cellular phones/computers	FRP1, FRP2, FRP3					
Scuba diving equipment per person	FRP2, FRP3					

Regarding personnel costs FRP1 had one salary for the program coordinator, with the rest of the onsite tasks being conducted by fishers when paid for the FAD pick up activities. In FRP2 and FRP3 there were several persons with annual salaries such as the vessel captain and some of the other workers. The salaries were probably higher because in the countries of these programs the minimum salary was higher, and the personnel involved were often highly qualified researchers.

Table 2 – Annual salary and travel costs per person in FAD retrieval program (units in thousands of USD).

Description (per person)	**0-2**	**2-10**	**10-50**	**50-100**	**100-200**	**200-300**
Annual salary			FRP1	FRP2 FRP3		
Travel	FRP1 FRP2	FRP3				
Fishers' payment per FAD retrieved	FRP1					

Other running costs of the programs involved satellite buoy data and phone fees incurred while monitoring FADs to know their exact location once in the program's perimeter (Table 3). These were generally below 2000 USD per year but also depend on the number of FADs intercepted and how many times they need to request satellite information until intercepted. Fuel per FAD retrieval trip was estimated below 100 USD, but the overall costs are also dependent on the number of annual trips to search for FADs. In the case of FADRP1 the payment per FAD retrieved by fishers included the fuel costs. In one program (FRP2) they had a cost associated with the rental of on land storage facilities to store FAD retrieved materials. In the other two programs they did not have these costs, either because the local municipalities provided these locations for free or because they already owned space on land to store or dispose of the materials. In the programs which used rented or owned collector vessels there were some costs with their maintenance and occasional repairs and vessel insurance. In one of the programs (FRP2) they also had to pay docking fees to keep the vessel at a port. Another program (FRP1) had a minor annual cost associated with sending recuperated operational echo-sounder buoys back to the continent to the port where the owner purse seine vessels are based.

Table 3 –Variable costs in FAD retrieval programs (units in thousands of USD).

Description	0-2	2-10	10-50
Buoy satellite data fees	FRP1, FRP2	FRP3	
Fuel per FAD retrieved	FRP2, FRP3		
Recycling/storage area rental	FRP1, FRP3	FRP2	
Vessel maintenance	FRP3	FRP2	
Docking fees	FRP2		
Shipping buoys to owner vessels	FRP1		
Subcontracting of services	FRP1		
Vessel insurance	FRP3	FRP2	
Satellite phone fees	FRP1, FRP2, FRP3		

The survey included a section asking for sources of revenue in the FRPs, such as reselling of found buoys or other options. However, none of the responders filled information in this section.

Looking at number of FADs retrieved per year in each program, 10 FADs per year were estimated for FRP1, 200 FADs for FRP2, and 25 FADs for FRP3, although these numbers can change per year. The number of FADs recuperated per year is influenced by many factors, including average number of FADs that pass near the program's area covered each year, reporting rates by the purse seine companies, recovery area covered by each program, oceanographic conditions, time the FRD has been operating (i.e., new programs are more likely to find more stranded FADs that had accumulated over the years before FAD clean ups were in place).

When adding up the different costs for the FRPs, the most economical program was FRP1 (range: 25000-30000 USD/year) in which fishers were paid per FAD recovery event, whereas programs run with their own or rented vessel and a team of members of the organization like FRP2 and FRP3 required more resources (range: 250000 – 400000 USD/year) in which the principal costs were vessel costs and personnel salaries. Note that if FRP1 had collected as many FADs as FRP2 per year, then cost of the fisher associated program would have been over 100000 USD. For the costliest program, FRP3, more 60% of the budget was the new vessel purchase, but after this initial investment, the annual cost average should be lower.

DISCUSSION

Characterizing the needs and benefits afforded by different FRPs is key for planning the set up of new programs to minimize impacts of FADs arriving at sensitive coastal areas. While the number of running FRPs at present is limited, we envisage that more land-based FAD recovery programs will be set up in the future, given that RFMOs and other management bodies have expressed their support for this kind of mitigatory activity. Also, some purse seine companies certified or seeking certification by the Marine Stewardship Council (MSC) have conditions under Principle 2 on marine habitat impacts that they must pass (Schiller et al., 2025). While the cost presented in the document are rough estimates, at least it provides a scale of the financial needs to run different kinds of programs. The FRPs are very dependent on the existing conditions of the location in which they are set up. For example, in more isolated locations with little or no human activity (e.g., remote MPAs), FAD recovery efforts will be more costly.

With the first FRP consulted, the formula employed was to subcontract local artisanal fishers to collect FADs by informing them of their positions when nearing the coast. In this case, the formula resulted the most economical as costs of owning or renting a dedicated vessel was replaced by paying fishers between 300-600 USD per FAD recovered. This approach has several benefits such as the quick interception of the FADs if there are sufficient available fishing vessels operating in the area monitored. In addition, if several FADs happen to be approaching the coast simultaneously, more than one vessel can be employed to pick them up. It also provides local artisanal fishers an extra source of income when FADs are recuperated. However, this formula of collaborating with artisanal fishers might not be available in all FRP locations. For example, in some areas artisanal fishers will not present (e.g., MPAs with no take zones) or might not be willing to cooperate with FAD clean ups originating from industrial fleets. Also, even if present, some very small vessels might not be capable of bringing onboard large FADs. On the other hand, if the artisanal vessels in the FRP area are larger (e.g., semi-industrial > 20 m LOA) they might charge higher rates per FAD retrieved (e.g., more fuel consumption), elevating the costs of the program. Therefore, the right conditions need to be in place to develop a FRP based on artisanal fishers conducting the recovery of FADs.

Having a full team of dedicated researchers to conduct a FRP results in higher costs, particularly because of the collector vessel and salaries of the workers. However, it also ensures that the number one priority of these vessels is to collect FADs, and the team of researchers has plenty of experience on how to recuperate the materials causing the least amount of damage to the seabed. These programs usually have well trained divers who can extract the maximum number of materials, even those submerged, with minimal impact on the substrate. For example, with artisanal fishers, if the submerged tails of the FADs are entangled in the substrate underwater, it will be difficult for them to retrieve it. Pulling the FAD out of the water if the tail is deeply enmeshed can be a serious source of damage to corals and other sensitive seafloors. Another benefit of researcher operated FAD retrievals, is that data collection is more complete. For instance, divers can characterize in detail impacts of the FADs down to the different species of corals affected and spatial extent of the damage (e.g., measure underwater trails caused by FAD rafts dragging on the seafloor). This information is very important to fully understand the impacts of FADs and try to remediate them, for example by modifying FAD designs to prevent such effects.

If a program was covering a large area for retrieval (e.g., a chain of islands or long stretch of an EEZ's continental land) the FRP would need to be scaled up and the costs here shown would increment according to the resources employed (e.g., extra number of vessels, personnel, etc.). Having combined researcher and fisher retrieval approaches within an area should not be discounted as it would be viable to have a dedicated team of researchers in the principal island or area of recovery, and a support infrastructure of artisanal fishers in other more distant zones. Similarly, in this document we have not analysed the costs of running a FRP at sea (i.e., operating vessels that pick up abandoned FADs in open ocean waters). However, such exercise would also be useful to estimate the logistical needs and financial viability of setting up at sea these collection programs. Note that simultaneously running on land and at sea FRPs is compatible given the large number of FADs that are lost every year.

As documented here, all land-based FRPs will have some personnel and logistical running costs, irrespective of the program. To fund these FRPs different sources have been employed, from purse seine industry-based FIPs (FRP1), to EEZ government funding (FRP2), to NGO donors (FRP3). All the consulted FRPs must expend considerable time and effort to annually raise the funds to maintain the retrieval programs operational. Given the high number of FADs lost at sea and reaching sensitive coastal areas, ensuring long-term funded FRPs to assist with the minimisation of FAD impacts is key. Furthermore, exploring formulas to offset the costs of these programs, such as selling back to industry recuperated functional echo-sounder buoys at a reduced sale price, or “pay-to-play” approaches could be explored. It should be noted that it would totally be unfeasible for large-scale purse seiners to collect at sea all the FADs they deactivate, given the large dispersal and different zones were FADs are deployed. The economic costs of a purse seiner travelling days to pick up FADs outside the fishing zones would be prohibitive. However, combining impact mitigation approaches such as biodegradable FADs and FAD recovery programs, both on land and at sea, can solve the problem of marine pollution by lost and abandoned FADs.

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Annex I – Anonymous FAD Retrieval Program Questionnaire.

SURVEY ON FAD RETRIEVAL PROGRAM ASSOCIATED COSTS

This is a survey to enquire about the costs associated with setting up and running a FAD retrieval program in order to better inform other stakeholders or managers thinking about setting up FAD retrieval platforms. As a first scenario we would assume that the operating area for the program is a single site (i.e., an island or limited coastal region) and that all costs are paid by a single entity (i.e., no cofinancing).

If you identify any missing costs not covered in the survey, please annotate their description and cost in the empty spaces in the tables provided in the survey. If some of the costs do not apply to your program just annotate NA (not applicable). If your program operates differently or want to describe in more detail some aspects, please let us know in the comment section at the end of the survey.

The data provided will be treated anonymously and before any report, publication or presentation resulting from the questionnaires participants will be asked for their consent and invited to be coauthors should they wish to participate in such documents.

Many thanks for your help!

1) FAD RETRIEVAL PROGRAM SETTING UP COSTS:

1.1. Materials:

Description	**Cost (USD)**
Collector vessel purchase (engine/s included)	
Collector vessel rental (if not owned) per year	
Radio, sounder & GPS equipment	
Cellular phones/computers	
Scuba diving equipment per person	
Others	

1.2. Personnel:

Description	**Cost (USD/year)**	**Number of persons**
Number of Full time equivalent (FTE)/Year		
Annual salary per person		
Insurance per person		
Travel per person		
Accommodation per person		
Others		

2. RUNNING COSTS:

Description	Number of FADs
FADs retrieved per year (average)	

Description	Cost (USD/ year)
Buoy satellite data fees	
Fuel per FAD retrieved	
Recycling/storage area rental	
Vessel maintenance	
Docking fees	
Shipping buoys to owner vessels	
Subcontracting of different services (describe types in comments)	
Licenses/Fees (describe types in comments)	
Others	

3. REVENUE

Description	Income (USD/ year)
Reselling of recovered echo-sounder buoys	
Fleet donations (describe types in comments)	
Others	

4. COMMENTS: