

Promoting livelihood benefits from Fish Aggregation Devices

FINAL TECHNICAL REPORT

Project FMSP R8331



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FAD Trials in East Africa

FMSP R8331

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FINAL TECHNICAL REPORT

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2 EXECUTIVE SUMMARY

The project goal was to create an improved understanding of marine and freshwater capture and enhancement fisheries and their contribution to the livelihoods of the poor developed and promoted. The purpose of the project was to test the mechanisms for implementing successful FAD Programmes in East Africa and for communicating that success to relevant stakeholders.

The project started in September 2003 and can be divided in five main phases:

- Site surveys;
- Importation of FAD equipment (twice);
- FAD construction and deployment (twice);
- FAD monitoring; and,
- Offshore fisheries training.

Following delayed but successful importation of all the necessary equipment from Korea, the third phase suffered a set-back due to problems with the original FAD design. The effective delay of one year for a second deployment and project end in October 2005 meant that in the bulk of the outputs and activities were restricted to a period of seven months.

The design failure, requirements and preparations for a second deployment forced a number of adjustments to the project for its continuation. The second importation of equipment and a no-cost extension of the project was needed. As a result, investigations into socio-economic and marketing issues were largely irrelevant since these components rely on the successful use of the FAD and associated gears for a considerable time period, at least a few months, for comparison with existing gears and practices. All efforts were then focused on re-design, importation of equipment for three new FADs and re-deployment. Immediately following deployment, monitoring of FAD performance as the wind and sea conditions increased into the SE Monsoon season became an important activity.

Within this much reduced project life numerous outputs of the project were nevertheless achieved. These included bathymetric data gathered from three sites at two locations, fisheries data gathered from Nungwi on Zanzibar and from bottom catches at Mafia, FAD design and deployment procedures, and practical training knowledge of fishing gear and a series of diverse communication outputs.

In terms of the project's contribution towards DfID's development goals, progress has been made on a number of fronts. Firstly, poor fishers on Mafia Island and Zanzibar have been shown and encouraged to venture further offshore, between 4-6 miles from the fringing coral reefs, to fish around six FADs, the latter representing new technology. At these two offshore locations fish were caught despite the adverse weather conditions during fishing training. Secondly, poor fishers have been instructed and have proven their ability in the use of new technology in the way of braid-line for hand-ling fishing in deepwater and, more significantly the use of circle hooks. Thirdly, fisheries officers from the participating institutions of Mbegani Fisheries Development Centre, the Zanzibar Government Fisheries Department, and staff the Mafia Islands Marine Park have been actively involved in the main phases of the project and are now in a position to independently develop FAD Programmes. Two local vessels were used for FAD deployment (from a Government training institution and the private sector) thus further widening the promotion uptake options for local stakeholders.

Conclusions

Despite delays caused by FAD design alterations and adverse weather conditions, experiences gained from the two deployments and limited fishing and FAD monitoring at the two sites nevertheless provided valuable lessons and insights into the offshore fishery for large pelagic species and deep-water benthic species. Skills within the national fisheries institutions (Mbegani Fisheries Development Centre (MFDC) and Department of Fisheries and Marine Resources (DFMR) (Zanzibar)) were also diversified and improved through experience gained from involvement with the project, firstly through direct involvement with FAD construction and

deployment and secondly from sourcing of bait, testing fishing gears, obtaining fuel, arrangements with fishers and numerous other aspects of the trials.

In terms of wider national and international promotion of FAD fisheries, the project contributed a section to the SADC-EU MCS Programme's (Tanzania Office) Fisheries Observer Handbook (SADC-EU MCS, 2005) and also to a FADs Theme sheet to IUCN's Managing Marine Protected Areas – A Toolkit for the Western Indian Ocean (IUCN, 2004).

Without conclusive results on FAD performance and increase fish yields, adoption cannot be expected. Nevertheless, the project has introduced a wide variety of stakeholders to the concept and potential of deep-sea FAD fisheries, previously tried (unsuccessfully) in Tanzania in 1984. These include poor people (fishers) but also institutions supplying services to the poor (national and district government; national research institutions and NGOs), employers of the poor (fishing and processing companies) and policy-makers (national governments). The project has been able to demonstrate some of the technical requirements for fishing around FADs and this has encouraged at least two NGOs and a successful commercial company to further investigate the potential of investing in FADs beyond the life of R8331.

The potential for uptake can only follow successful trials with yields greater than that of other fisheries. Only when trials (either externally-supported or independently and locally-driven) show the improved catchability and yield of pelagic species associated with FADs, can there be a measurable uptake.

3 BACKGROUND

The project goal was to create an improved understanding of marine and freshwater capture and enhancement fisheries and their contribution to the livelihoods of the poor developed and promoted. For Tanzania and large parts of Kenya, data on the status of the inshore fishery is scarce and there are many problems interpreting what historical and current data does exist. There is a common theme to the majority of investigations into the status of this fishery indicating that it is under stress. There have been a number of investigations undertaken and reports produced on the status of Zanzibar's inshore fisheries over the last three decades (e.g. Tarbit, 1984; Iverson *et al.*, 1984; Jiddawi & Muhando, 1990; Jiddawi 1997). The majority of these reports have concluded that the inshore resources are threatened by destructive fishing methods and over-fishing. For example, almost two decades ago, Tarbit (1984) concluded that 'the artisanal fishermen of Tanzania are approaching the upper limit of exploitation on their traditional fishing grounds'. Jiddawi (1997) observed that 'the fishery now shows signs of being over-exploited as the fishing pressure on the reef increases and destructive fishing techniques proliferate'. Benno (1992, cited in Wagner, 1997) examined beach seine landings in southern Zanzibar and reported that '51.3% of the catch was immature, 37.8% possessed developing gonads and only 7.8% were in a spawning state'. Msuya (1997) presented results from interviews with fishers; these data indicated that 73% of fishers believed that there had been a decrease in catches of coral-reef species and 71% a decline in species diversity.

In terms of the socio-economic context and whilst baseline data is limited, it is estimated that almost 50% of the population of Tanzania are poor (URT, 2000a). Poverty in the Tanzania context is characterised by low incomes and expenditure, high mortality and morbidity, poor nutritional status, low educational attainment, vulnerability to external shocks, and exclusion from economic, social and political processes. Within this there are localised perceptions of poverty (see Narayan, 1997) and regional variations (URT, 2000a). The majority of the poor are in rural areas and the most vulnerable groups are the young (where there is very high unemployment), the very old, women, those in large households and those involved in subsistence agriculture, livestock production and small-scale fisheries (Anon, 2001; URT/UN, 2001). Poverty in mainland Tanzania is most pronounced in Mtwara in terms of life expectancy, infant mortality and under-five mortality; in Lindi in terms of infant mortality, under-five mortality and severe malnutrition; and in Coast and Tanga in terms of food security (cereal equivalent). In Zanzibar, where poverty (as well as political uncertainty) is also an important problem, fish is the principal source of animal protein for the low-income families. However, although landings seems to have remained steady over the last 10-years, there has been a 35% increase in numbers of fishing vessels and a 235%

increase in the number of fishers resulting in a decline in catch-rate (and therefore income) for individual fishers. About 25% of the population is employed either directly or indirectly in fisheries.

In summary, poverty reduction and community empowerment are principle development aims within a relatively hard budget constraint (URT, 2000a). This will be achieved through improved market efficiency, increased productivity and pro-poor policy support, with particular emphasis on promoting export-oriented expansion and diversification of the pro-poor sectors (RFIS, 2002).

Tanzania Coastal Management Partnership (TCMP) – ‘there is a need to identify actions to increase the productivity of current economic activities in rural areas [and to] promote alternative, environmentally-sustainable livelihood opportunities’ (TCMP, 2000).

Zanzibar MALNR (1998) ‘Objective 2.4.2.11: ‘To improve the economic conditions of fishers’

‘Policy Strategies: 1. Provide training and extension services in the use of different fishing techniques for offshore fishing grounds; 2. Establish fish aggregating devices (FADs) and artificial reefs’.

During 2002-2003, the FMSP Project R 8249 (Richmond *et al.*, 2003), on assets associated with a FADs programme, established support from numerous local institutions for the trial of FADS (see letters of support, Annex 12).

4 PROJECT PURPOSE

The purpose of the project was to diversify and improve livelihood opportunities (including access to potentially high-value fishery resources), available to the coastal fishers in East Africa through the deployment of FADs, with associated skill transfer. In doing this, the project will test the mechanisms for implementing successful FAD programmes in east Africa, and to communicate that success to relevant stakeholders. The project aimed to explore and develop offshore fisheries resources using local vessels with expert training, while establishing and testing six FADs at two locations over a 12 month period. The focus was on the pelagic fisheries resources (e.g. tuna) that are known to be attracted to FADs.

The Project will provide direct technical support to poor fishers to expand their sphere of operation away from over-fished near-shore grounds. The project will accept much of the financial risk that can constrain fisheries development in developing countries through provision of FADs, and by undertaking fishing trials to identify the optimum gear configurations, post-harvest treatment and by identifying suitable marketing chains.

On the “A-H steps”, the project is promoting technology or behavioural change among end users by target institutions. The verification that this development step has been taken is manifest by fishers adopting FAD technologies, and that FAD technologies are promoted further by national and donor-led development programmes in Tanzania and Kenya.

5 OUTPUTS

The most important discovery after the deployment in April 2004, was that the SPC Indian Ocean FAD design (see Gates *et al.* 1996), was unsuitable for the conditions off Tanzania. The compressible, purse-seine floats failed to withstand the 4-5 knot seasonal ocean current along the coasts of Mafia and Unguja Islands and consequently, when submerged, the floats collapsed with a loss of surface buoyancy causing the FAD to sink. In the Pacific Ocean, where this FAD design was extensively deployed, a similar problem has led SPC to re-design their FADs (see Chapman *et al.*, 2005).

Following agreement by all project partners at the time, including DFID, MRAG, the consultants and local implementing partners, the project continued under a no-cost extension from DFID (see Project Time-line, overleaf). All efforts were focused on re-design, importation of equipment for

three new FADs and re-deployment. Six FADs were then deployed in March 2005, with four on Zanzibar and two off Mafia. A further set-back was that the project end date, end of October 2005, could not be extended further, eliminating options to conduct fishing trials and continue monitoring catches between November and March, which would have allowed a reasonable period of time to assess the effectiveness of the FADs. The main season for large pelagic species is after October, during the calm period of the NE Monsoon to March (see Richmond, 1999).

The initial design problem and preparations for a second deployment forced a number of adjustments to project activities. Investigations into access, marketing, export and cooperative issues were largely irrelevant since these components rely on the successful use of the FADs and associated gears for a considerable time period, at least a few months, for comparison with existing gears and practices. Policy briefs based on the experiences of these activities have therefore not been produced. Two Technical briefing papers (on FAD Materials and Importation and Logistics) are included in Annex 3. The fishing trials component was also affected by the delayed deployment. Following the accepted three month 'maturation' period for FADs, fishing trials were restricted to July through October 2005, as set by the project end date. The project attempted to maximise training by focusing on the month of October but even then, strong S and E winds restricted access to FADs, hindering both FAD use by local fishers and fishing trials.

Experiences gained from the two deployments and limited fishing and FAD monitoring at the two sites nevertheless provided valuable lessons and insights into the offshore fishery for large pelagic species and for deep-water benthic species. A conventional, scientific report on the entire programme is also presented in Annex 1 and accompanied by a selection of reference photos depicting important and interesting aspects of the project (see Plates 1-6, Annex 2). Annexes 3-12 include a diverse range of information and data associated with the trials and are frequently referred to in the FTR.

Calendar Year	2003				2004												2005										
Calendar Month	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	
Project duration	ORIGINAL PROJECT																NO-COST EXTENSION										
Project Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	
Activities/Sub-activities	----- Six functioning FADs -----																										
Logistics and Preparation																											
• Site Surveys	x			x	X											x											
• FAD Ordering/Construction	x			X	X	X	X	X ¹								X		X	X								
• FAD Deployments					x	-	-									-				X ²							
• Policy brief on FAD Logistics					x	-	-									-				-	-	-	-	-	-	-	X
1. Natural Assets Monitoring																											
• Design and Establish			x		x	x	x	x	x	x	x	x	x	x	x					X	X		X	X	-	-	X
• Initiate Monitoring																			X	X		-	-	-	-	-	X
• Analysis and Reporting																x	x			-	-		-	-	-	-	X
2. Evaluation of Physical Assets																											
• Gear Performance				x	x	x	x	x	x	x	x	x	x	x						-	-	X	X	X	-	-	X
• Post-harvest / Transport				x	x	x	x	x	x	x	x	x	x	x						-	-	-	-	-	-	-	X
• Policy brief on Gears										x						x				-	-	-	-	-	-	-	X
• Analysis and Reporting															x	x				-	-	-	-	-	-	-	X
3. Financial Assets Performance																											
• Monitor fishers' assets						x	x	x	x	x	x	x	x	x						-	-	-	X	-	-	-	X
• Monitor Project assets						x	x	x	x	x	x	x	x	x						-	-	-	X	-	-	-	X
• Preliminary Evaluation						x														-	-	-	X	-	-	-	X
• Facilitate Credit Access							x													-	-	-	-	-	-	-	-
• Final Evaluation															x	x											-
4. Response of Social Assets																											
• Final agreements on FAD locations				X	X															-	-	-	-	-	-	-	-
• Monitor economic cooperation						x	x	x	x	x	x	x	x	x					X	-	-	X	-	-	-	-	X
• Monitor institutional response						x	x	x	x	x	x	x	x	x					-	X	-	X	X	X	X	X	X
• Facilitate cooperation as required						x	x	x	x	x	x	x	x	x					-	X	-	-	X	X	X	X	X
• Final Reporting															x	x				-	-	-	-	-	-	-	X
5. Promote development of Human Assets																											
• Training in fishing techniques					x															-	-	-	X	X	-	-	X
• Monitor application of new skills						x	x	x	x	x	x	x	x	x						-	-	-	X	X	-	-	X
• Develop FAD Training Materials											x	x								-	-	X	X	X	-	-	X
• Disseminate market intelligence																				-	-	X	X	X	-	-	X
• Marketing Policy Brief								x						x						-	-	-	-	-	-	-	X
• Final Reporting															x	x											X

Notes: x - Proposed activity; X Actual activity; 1. First FAD deployment (2 FADs Mafia; 2 FAD Unguja); 2. Second FAD deployment (4 Unguja, 2 Mafia).

R8331 Project Time-line (Sep 2003 - Nov 2005)

5.1 Output 1: Natural assets

Objective: Obtain information on presence and accessibility of large pelagic resources in trial sites, including data on catch-rates, species composition and product size.

5.1.1 Bathymetry data of FAD areas

Bathymetric data was generated from the January 2004 surveys around northern Unguja Island and off eastern Mafia Island (see Fig. 1). Results revealed a gently sloping seabed between depths of 300-700 m in both areas (see Fig. 2 and Guideline 2, Annex 3). The absence of canyons and steep gullies is ideal for FADs, reducing the risk of slippage or loss from deployment over ground with un-expected depths greater than the length of the FAD, which would result in the float section never reaching the surface.

5.1.2 Accessibility to FAD areas

The FAD sites are shown in Figs. 3 and 4, with geographical data shown in Table 1. The position of the FADs was communicated to the Tanzania Harbour Authority (THA) and the necessary "Notice to Mariners" issued (see Annex 4).

Regular monitoring of the weather, especially wind speed and direction, was initiated soon after deployment. Contact with the Tanzania National Meteorological Agency and web-based facilities (e.g. www.weather.com) allowed for close monitoring (see Annex 5).

Access through April and May 2005 was acceptable using local vessels and conditions were favourable for fishing, although this was before the FADs have "matured". By June, increasing southerly winds prevented access on many days and on two attempts at monitoring FADs at Matemwe worsening sea condition forced a trip to be abandoned. Unfavorable conditions continued through the entire SE Monsoon period, until late October. Winds were predominantly southerly, between 10-12 knots, reaching 17 knots, in July and August. The large swells associated with these easterly winds considerably interfered with access especially in Mafia. By end of October the wind was mainly easterly, 8-15 knots, and finally in mid-November the wind has shifted set to northeast. The plot of wind speed shown in Fig. 5 show that southern Tanzania experiences stronger winds and that the months of June through August witnessed the strongest winds.



Fig. 1 The coast of Tanzania and southern Kenya showing FAD survey areas (stars).

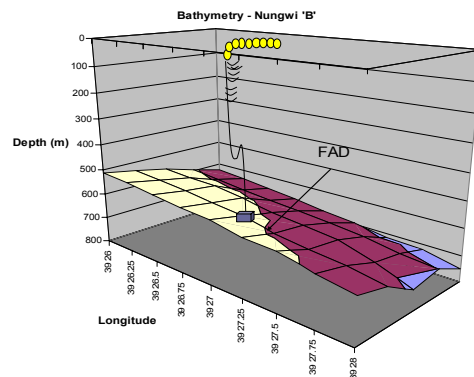


Fig. 2 One of six three-dimensional bathymetric charts for the areas survey area off northern Zanzibar and Mafia with artists impression of FAD inserted (not to scale).

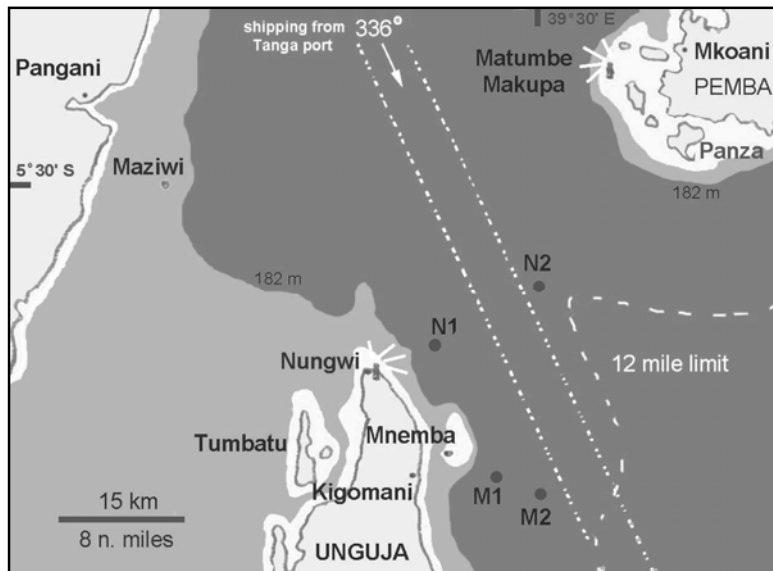


Fig. 3 Northern Unguja and southern Pemba Is., showing FAD sites.

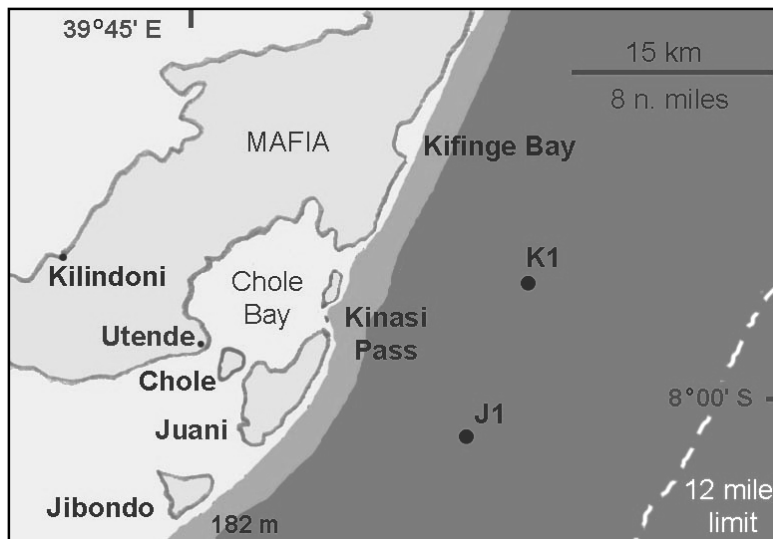


Fig. 4 Eastern Mafia Is., showing FAD sites.

FAD Name	ID	Lat. new	Long. New	Depth (m)
Nungwi 1	N1	5° 41.011'	39° 23.791'	300
Nungwi 2	N2	5° 37.079'	39° 30.055'	650
Matemwe 1	M1	5° 50.716'	39° 27.570'	400
Matemwe 2	M2	5° 52.135'	39° 30.794'	650
Kinasi	K1	7° 56.330'	39° 55.078'	500
Juani	J1	8° 02.300'	39° 52.570'	530

Table 1 Names, positions and water depths of Tanzania FADs deployed in March, 2005.

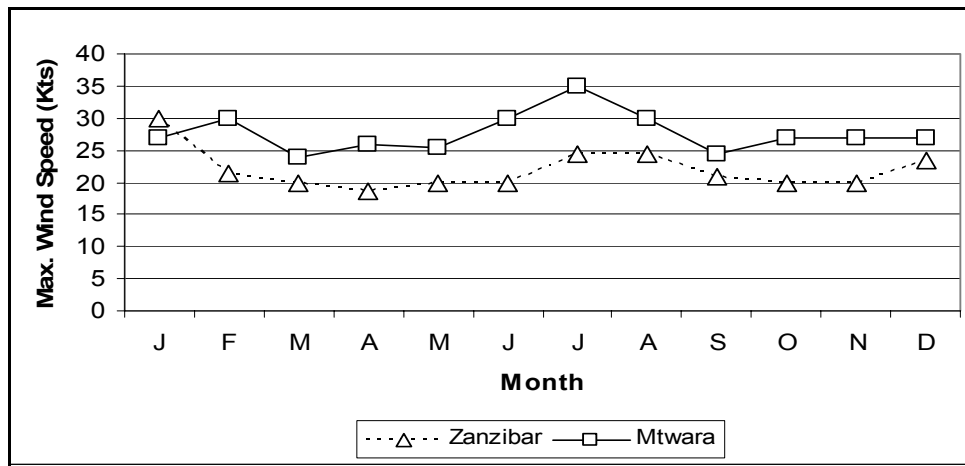


Fig. 5 Maximum monthly wind speeds (1972-96); modified from Dubi (2001).

Five of the six FADs were visited between July and October, 2005, with fishers and using local vessels. The time from Nungwi beach to the nearest FAD, N1 (see Fig. 3) is about one hour (in calm conditions). From Matemwe village, there is an increase in the distance to the FAD depending on the need to first travel up the lagoon and exit the northern pass, or on high tide simply cross the reef. These alternatives depend on the tide and the sea conditions. From the pass, the distance to the nearest FAD M1 requires about one hour. At Utende village in Mafia, about half an hour is required to reach the Kinasi pass at the eastern side of the Chole bay (see Fig. 4). From the Pass, time taken to reach either of the two FADs is just over one hour, on calm conditions. Crossing through the Pass can be restricted during ebbing tide due to high standing waves at the entrance, dangerous for the wooden dhows.

5.1.3 Fisheries data

Fishing trials conducted in July and October confirmed that tuna species were in the general area, though none were caught at the FAD sites themselves. In October, small tuna were seen in surface feeding schools close to the reefs south of Mnemba Island off Matemwe and outside the Kinasi Pass of Mafia. The fishing landing at Nungwi village also confirmed the presence of tuna, though quantities were small as expected for that period (see Annex 9 and Annex 2 Plate 4a,b).

Fisheries data collections were made for all fish caught during the trials, and length measurements taken of all tuna landed at Nungwi in the mornings during one eight day dark lunar period in July, and for a few days in September and October. Over 680 fish were measured, including about 200 yellowfin tuna and 350 kawakawa (see below).

Catch rate: For nine consecutive days in July, all offshore fishing boats at Nungwi were sampled (see Annex 2 Plate 1 a,b). Of the 94 boat trips in total, 25 returned with yellowfin tuna. This confirms the low availability of tuna at the time of the trials. In October, more yellowfin were landed at Nungwi but for many days sea conditions significantly reduced fishing effort.

Species composition: From the visits to Nungwi, Matemwe and Mafia, especially to fish landing sites, a range of species exist depending on sites. At Nungwi, commonly caught fish include tuna, dorado, caranx, manta rays, kingfish, sailfish, marlin and sharks. At Matemwe, a greater contribution to species composition comes from reef fish, with larger numbers of surgeonfish, parrotfish, rabbitfish and emperors. At Mafia, so few fish are landed at Utende that no generalisations can be made on quantities and species, though most of the fishing takes place inside the sheltered lagoons and bays with resulting catches being small reef fish species.

The fishing trials generated a number of catches at most sites sampled. Table 2 lists the main species of commercial importance caught during trials held in October, 2005.

Species Name	FAO English name*	Family	Location
<i>Caranx melampygus</i>	Blue-spotted trevally	Carangidae	Mafia Island
<i>Caranx ignobilis</i>	Giant trevally	Carangidae	Mafia Island
<i>Seriola lalandi</i>	Yellowtail amberjack	Carangidae	Mafia Island
<i>Elegatis bipinnulata</i>	Rainbow runner	Carangidae	Kipwani, Unguja Is.
<i>Epinephelus chlorostigma</i>	Brown-spotted grouper	Serranidae	Mafia Island
<i>E. tukula</i>	Potato grouper	Serranidae	Mafia Island
<i>Cephalopholis sonnerati</i>	Tomato hid	Serranidae	Mafia Island
<i>Plectropomus maculatus</i>	Spotted coral-trout	Serranidae	Mafia Island
<i>Pristipomoides filamentosus</i>	Blue-spotted jobfish	Lutjanidae	Mafia Island
<i>Macolor niger</i>	Black and white snapper	Lutjanidae	Mnemba, Zanzibar
<i>Lutjanus sebae</i>	Red snapper	Lutjanidae	Mafia Island
<i>Lutjanus sanguineus</i>	Red snapper	Lutjanidae	Mafia Island
<i>Lutjanus bohar</i>	Two-spot red snapper	Lutjanidae	Mnemba, Zanzibar
<i>Aprion virescens</i>	Green jobfish	Lutjanidae	Mafia Island
<i>Aphareus ritulans</i>	Small tooth jobfish	Lutjanidae	Mnemba, Zanzibar
<i>Lethrinus elongatus</i>	Long-face emperor	Lethrinidae	Mafia Island
<i>Lethrinus conchylatus</i>	Red-axil emperor	Lethrinidae	Mafia Island
<i>Montaxis grandoculis</i>	Humpnose big-ete bream	Lethrinidae	Mafia Island
<i>Scomberomorus commersoni</i>	Narrow-barred mackerel	Scombridae	Mafia Island/Nungwi
<i>Thunnus albacares</i>	Yellowfin tuna	Scombridae	Mafia Island
<i>Euthynnus affinis</i>	Kawakawa	Scombridae	Mafia Island
<i>Sphyrnaea barracuda</i>	Giant barracuda	Sphyrnaeidae	Nungwi 1 FAD
<i>Carcharhinus melanopterus</i>	Black-tip reef shark	Carcharinidae	North Mnemba Island
<i>Trionodon obesus</i>	White-tip reef shark	Carcharinidae	Mafia Island

Table 2 Important fish species caught during fishing trials in October, 2005. * From Bianchi (1985).

Product size: The following three tables reveal a summary of the measurements taken at the Nungwi landing site (for yellowfin tuna and kawakawa), and for red snappers caught during fishing trials on Mafia (see Annex 9 for full details). From the tuna data shown in Tables 3 and 4, there is some indication that yellowfin and kawakawa landed at Nungwi are slightly larger in October compared to July, with fish reaching about 90 cm and 65 cm respectively.

Date	n	Mean length (cm)	SDev.
06/07/05	30	72.83	9.60
10/07/05	17	67.12	7.78
11/07/05	27	68.04	14.44
13/07/05	5	97.00	19.20
15/07/05	18	85.56	15.42
16/07/05	26	70.38	8.76
29/09/05	33	89.03	12.08
30/09/05	30	91.10	10.62
01/10/05	19	86.37	7.92
07/10/05	18	91.67	12.31

Table 3 Mean total length for Yellowfin tuna at Nungwi, Jul-Oct. 2005 (n = 225).

Date	n	Mean length (cm)	SDev.
06/07/05	110	59.77	3.60
10/07/05	25	62.88	4.15
11/07/05	21	61.00	4.38
12/07/05	17	65.59	3.91
13/07/05	40	62.40	6.41
14/07/05	18	60.22	6.76
15/07/05	36	65.00	4.59
16/07/05	44	64.50	7.64
29/09/05	13	66.46	6.63
01/10/05	9	67.33	3.77
07/10/05	27	65.07	7.43

Table 4 Mean total length for Kawakawa at Nungwi, Jul-Oct. 2005 (n= 31).

Species	n	Weight (kg)		Length (cm)	
		Mean	SDev	Mean	SDev
<i>Lutjanus sebae</i>	53	4.22	1.26	64.74	7.09
<i>Lutjanus sanguineus</i>	20	3.96	1.00	63.65	6.57

Table 5 Mean total length and weights for two species of high-value red snapper from Mafia, for October 2005 (see Annex 9 and Annex 2 Pl. 6 d,e).

For the two red snapper species (*L. sebae* and *L. sanguineus*) caught from bottom fishing at Mafia Island (away from the FADs), the data in Table 5 shows that almost all fish caught are mature and exceed the length at first maturity (ca. 50 cm) and the minimum size limit set by Australian authorities (56 cm for *L. sebae*) for this species (see Anderson & Ngatunga, 2005). These findings suggest that a more detailed stock assessment may conclude that this fishery may withstand some level of exploitation.

5.1.4 Tuna fisheries in the western Indian Ocean

A brief review of the pelagic resource was presented in the precursor study FMSP R8249 (see Richmond *et al.*, 2003). A more recent analysis is derived from the latest IOTC publications. For all tuna species, key regional scientific and management research is managed by the Indian Ocean Tuna Commission (IOTC), based in the Seychelles. The IOTC's Scientific Committee meet annually to undertake stock assessment activities and to develop management guidelines for the Commission. The following information is derived from the IOTC SC's eighth annual meeting report (IOTC, 2005).

Yellowfin Tuna - This species is cosmopolitan, distributed mainly in tropical and subtropical oceanic waters where it forms large schools. The sizes exploited in the Indian Ocean range from 30-170 cm fork length (see Fig. 6). Smaller fish (juveniles) form mixed schools with skipjack and juvenile bigeye tuna and are mainly limited to surface tropical waters, while larger fish are found in surface and sub-surface waters.

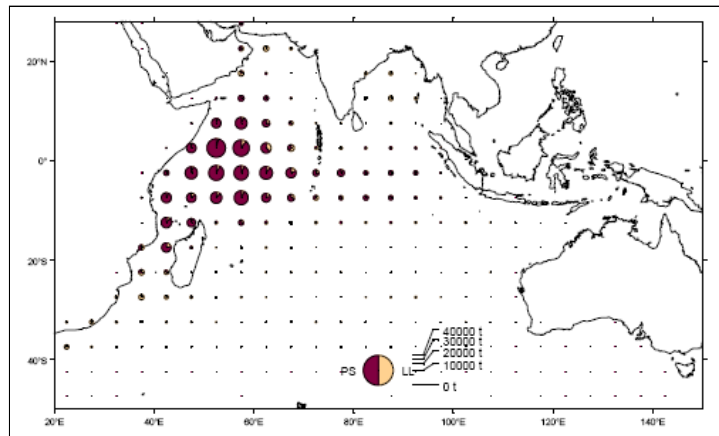


Fig. 6 Mean distribution of Yellowfin tuna catches 1998-2002.

Catches of yellowfin tuna in 2003 and 2004 were substantially higher than in previous years (458,800 mt compared to 343,000 mt), with the catch in the waters off East Africa being particularly high (see Fig. 7 for 2003 data). IOTC reports that there are two major possible explanations for the high catches; that there were large recruitments to the population in the late 1990's and early 2000's although during that period there were no evidence (in terms of large numbers of juvenile tunas being caught from the surface fisheries) to suggest this. A second possible explanation is either a concentration in the resource or a change in fishing efficiency. There were large concentrations of the crustacean *Natosquilla investigatoris* and the swimming crab *Portunus trituberculatus* upon which yellowfin feed, as well as some indication that the thermocline was shallower than usual which would have the effect of concentrating the yellowfin in the upper water column and therefore within reach of purse-fleets. The IOTC conclude that the increase was most likely due to both an increase in catchability and some increase in recruitment.

The Scientific Committee reported that total catches in 2003/4 were substantially above MSY. If this is because of the increased recruitment then this will not adversely affect the conservation status of the species, although more high recruitment will be needed to sustain the level of catches seen in those two years. If the increase was due to increased catchability then there are negative consequences for the species. The IOTC recommended avoiding any further increase in fishing effort and catch above the levels in 2000 (IOTC, 2005).

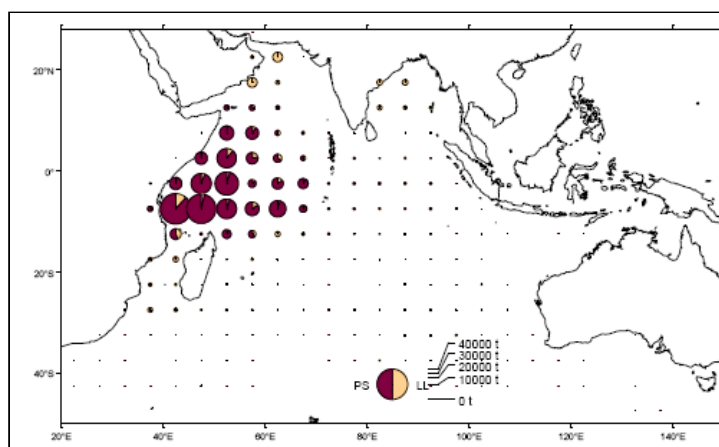


Fig 7 Mean distribution of yellowfin tuna catches 2003.

Bigeye Tuna - This tropical tuna species occurs in surface waters to about 300 m depth or more (see map for distribution). Juveniles frequently school at the surface underneath floating objects in single-species groups or in aggregations with yellowfin and skipjack. Of the three large tropical tuna species, bigeye tuna lives the longest (more than ten years) making it the species most vulnerable, in relative terms, to over-exploitation. Bigeye start reproducing when about three years old, at a length of about 100 cm. The analyses of the IOTC

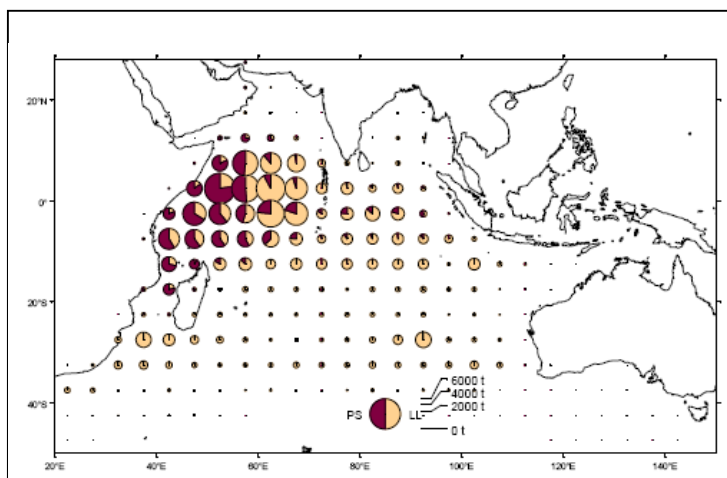


Fig. 8 Mean distribution of Bigeye tuna catches 2000-03.

Scientific Committee indicated that it is likely that current catches are still above MSY and it is possible that fishing effort has exceeded the effort that would produce MSY. There is also concern over the number of juvenile bigeye (<10 kg) being caught by purse-seine vessels. The Committee recommended that ‘a reduction in catches of bigeye tuna from all gears, eventually to the level of MSY, be started as soon as possible and that fishing effort should be reduced or, at least, it should not increase further’ (IOTC 2005).

The high catches of 2003/04 led to substantial rise in interest amongst deep-water fishing fleets in gaining access to Tanzania’s EEZ, coinciding also with a much improved national MCS capability largely supported by the EU. In 2004 for example there was a 144% increase in the number of licences purchased. The current (2005) licensing profile is presented in Table 6, below.

Licensing authority	Vessel type	No. vessels
Dar es Salaam	tuna longliner	57
Dar es Salaam	tuna purse seiner	85
Zanzibar	tuna longliner	43
Zanzibar	tuna purse seiner	7

Table 6 Licensing arrangements and details for Tanzania’s EEZ fishery (source: SADC-EU MCS Programme).

Given the IOTC's general concerns about tuna catches there might be a case for 'allocating' some of the tuna resource currently taken by foreign vessels in Tanzanian waters to a new, domestic artisanal fleet to supply a tuna export market. The development of such a domestic-fleet could be supported both by the World Bank's Marine and Coastal Environment Management Programme (MACEMP) and by the forthcoming South-west Indian Ocean Fisheries Programme (SWIOFP), which includes under Component Four (Assessment and Sustainable Utilisation of Pelagic Fish) research activities *and* investigations of gear optimization. This could arguably include the development of new domestic pelagic fisheries utilising as part of their options the FADs deployed under this programme.

5.2 Output 2: Physical assets

Objective: *Establish guidelines on fishing gears and deployment methods for FAD Programmes in East Africa.*

5.2.1 FAD design

The SPC Indian Ocean FAD buoy system In Volume II (Gates *et al.* 1996) of the SPC FAD manual was recommended and used in the present trials. This design was used in many countries in the late 1990s and early 2000s, but, some problems were encountered with the wire cable breaking where it came out of the PVC coating. In other instances, it was believed that when the buoy system was pulled under by the current to a depth where the purse-seine floats were being crushed, they did not retain enough flotation to bring the buoy system back to the surface. The new design, specifically for deployment in areas where strong currents are common, is rigged by stringing 15 hard plastic pressure floats and 14 soft purse-seine floats alternately on an 18 m length of 28 mm nylon 3-strand rope.

The design used in the present project relies on a single line of 25 pressure floats with 20 kg buoyancy each, separated by a thick rubber spacer, strung along the 30 m, rubber-coated steel wire (see Fig. 9, and Guideline 3, Annex 3 for component details and Annex 2 Pl. 1-2 for images). The buoyancy and low drag of this type of buoy system places less strain on the mooring under the effect of strong surface currents. In extreme currents, the buoy system submerges without damage and resurfaces when currents ease. This was noted during FAD monitoring, at times with the fishing vessel directly above the FAD but the nearest buoys about 2 m below the surface. Ropes are nylon and polypropylene, used in the lengths and proportions shown in Table 7.

To the lower 10 m of the steel wire section 20-40 PVC packaging strips were attached, serving to increase surface area for growth of marine fouling (e.g. algae, barnacles, soft corals, etc.) which in turn attract small fish for shelter and increases the presence of the FAD in the water column.

A flagpole was attached to the end eye of each FAD. The attachment was made using 16 mm nylon rope to a 6 m treated-wooden pole weighted at one end, floated in the middle by three purse-seine floats. The poles stood about 2 m high out of the water and at sea in a local vessel the poles could be seen from one mile distance. To the upper portion of the poles were secured a tube-model radar reflector. At Nungwi 2 after deployment, the reflector was recorded on the MT Solsky radar screen for 5 miles.

FAD Name	Length (m)	Nylon (m)	Polyprop. (m)	Depth (m)	Scope
Nungwi 1	410	0	410	300	1.36
Nungwi 2	862	262	600	650	1.43
Matemwe 1	550	165	385	400	1.37
Matemwe 2	875	275	600	650	1.32
Kinasi	800	240	560	500	1.50
Juani	875	275	600	530	1.62

Table 7. Rope lengths and depths for the six Tanzania FADs deployed in March 2005.

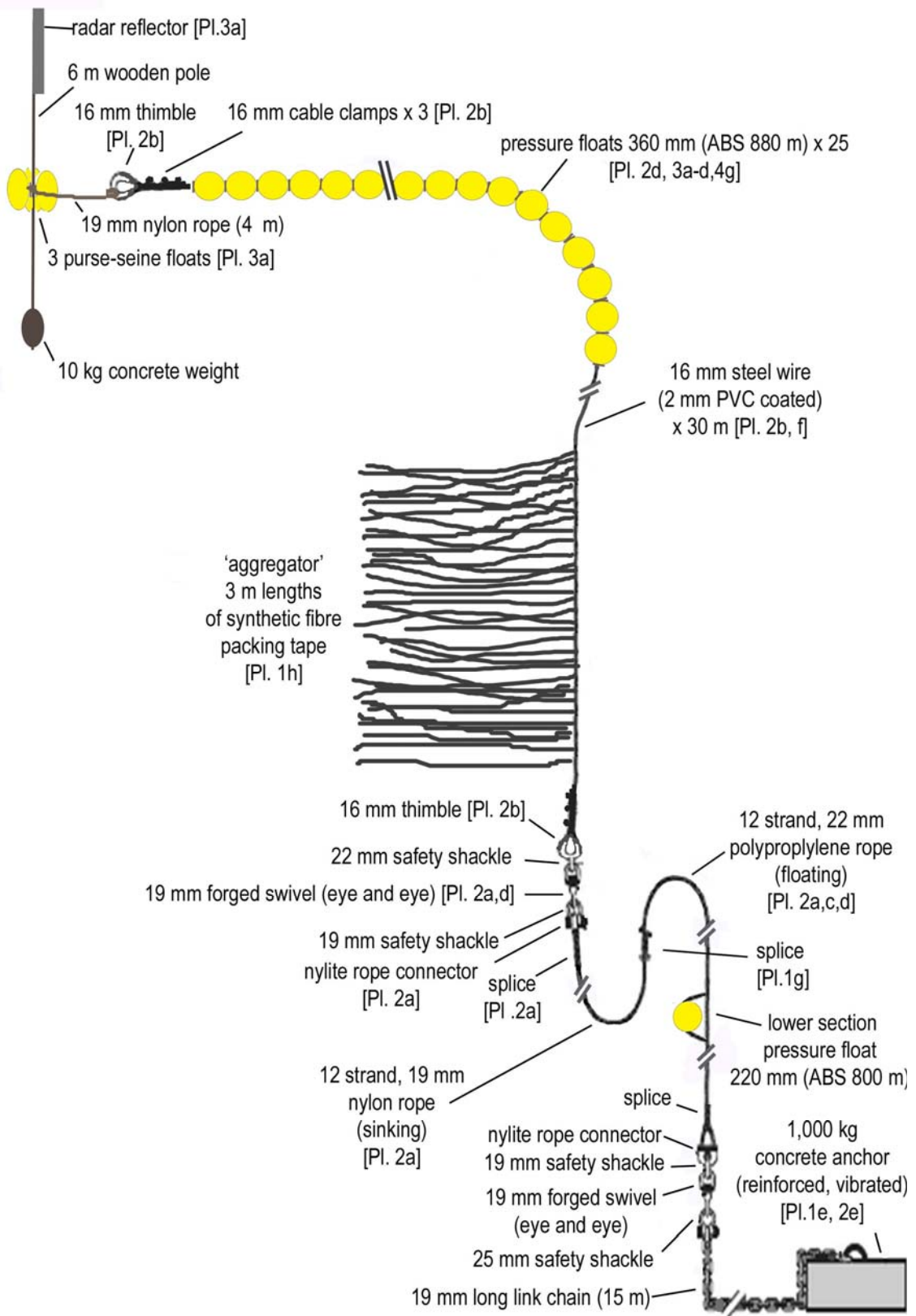


Fig. 9 Design and components of the FADs deployed in Tanzania in March 2005, with four FADs off northeast Unguja Island (Zanzibar) and two off southeast Mafia island. Not to scale. Reference to photographs on plates in Annex 2 are include in square brackets e.g. [Pl. 2a]. See also Annex 3 Guideline No. 3.

5.2.2 FAD deployment options

Importation and clearance of FAD equipment was effective but delayed due to changes importation regulations in Tanzania (see Guideline 1, Annex 3). A period of up to two months should be comfortably allowed for clearing goods.

There are only three types of vessels suitable for FAD deployment in Tanzania. The single-vessel operation may be conducted by one of the following:

- MV Mafunzo training trawler (Mbegani Training Centre) (see Annex 2, Plate 2c)
- MT Solsky tugboat (Alpha Logistics Tanzania Ltd.) (see Annex 2, Plate 2d,e)
- Fishing trawlers, including side and stern (20-30, various owners)

Other arrangements might use a barge with crane and small tugboat, depending on distances. It is important that vessels have Seaworthiness and Survey Certificates.

5.2.3 Fishing gears

The choice of gears benefited from inputs from the Seychellois, British and Canadian master-fishermen, local fishers and from the SPC Manual (Preston *et al.*, 1998) (see also Guideline 5, Annex 3, and Annex 2 Plate 4c). Comparative pricing of fishing gears was also obtained from different sources, namely Seychelles, UK, Tanzania and South Africa. For all items, cost data was recorded for importation, construction and deployment. The basic arrangements of gear for use around FADs are:

- Hand line - For use in 30-70 m depth; large hooks (size 12-14).
- Drop line - Use in 60-300 m depths; 25 hooks; size
- Trolling line - Usually 3-4 can be rigged per vessel.

An additional item to the list presented in Table 8 is an echo-sounder or fish finder. For the October fishing trials, a Garmin 250, with greyscale 8x8 cm display and 4000 Watt (peak to peak) transducer, was mounted on the local vessel prior to each fishing or FAD inspection trip. At a cost of about US\$ 450, the sounder worked very well and is recommended, especially for determining the depth of the tuna around the FAD (not proven in the present study) and if new grounds are being sought (e.g. Mafia for bottom fishing).

Item	Quantities	Price (US\$)
Braid line (4 mm, nylon, woven)	3 x 400 m roll	195
Circle hooks (size 13/0)	100	25
Nylon monofilament (no. 180)	100 m roll	12
Swivels (No. 5)	50	70
Tuna S.S. snaps	30	6
Buoys (10 litre buoyancy)	10	65
Trolling lures	10	80
Clips	50	30
Cold box (for bait)	1	40
Steel gaff	2	30
	Total	553

Table 8 Standard fishing gears and equipment ideal for FAD fishing, sufficient for one local vessel such as those used in the present trials.

The development of the FAO or Samoan reel started in early in December with the visit of the Masterfisherman during FAD construction. Eight reels and two mountings were constructed and the reel was tested at sea for a few hauls, on a single day in June, 2005. The reel and mountings performed well (though no fish were caught). When the fishing trials began in July, 2005, the reels were not used so as to reduce the equipment to be carried each day from shore to vessel, and to reduce the amount of new technology during the trials. It was agreed that when too many fish were being lost from failure to manually haul, then the applicability of the Samoan reel would be re-examined. Images of the trials are included in Annex 2, Plates 4-6.

5.3 Output 3: Financial assets

Objective: *Provide economic analyses (VPUE/ Fixed/variable costs/IRR/ NPV).*

All costs associated with fishing trials and monitoring trips to sea were recorded and are useful to begin to calculate the economic analysis of the FAD initiative. However, with only relatively few fishing days and mostly during the SE Monsoon season, a true analysis of the financial assets associated with the project cannot be made.

In general, fuel was the highest individual cost associate with each fishing trip. An average of US\$ 30-40 of fuel was spent each day, using a 15 or 25 HP outboard on the wooden dhows. Bait was relatively inexpensive, between US\$ 5-10 per day, depending on the lunar period and whether fresh or stored (frozen).

In most case, fishers participated and were paid a small honorarium of US\$ 5 for their time. Though small, this amount was readily accepted, and being the fasting month of Ramadhan, alternatives to FAD fishing trials were perhaps not so attractive due to the season and weather.

5.4 Output 4: Social assets

Objective: *Establish guidelines on the management of access to FADs, including experiences with conflict minimization/resolution.*

While initial steps were taken to establish linkages between industry and fishers, and through discussions with Tanpesca (fish buyers/processors) on Mafia Island, the absence of enough fish product from the FADs precludes any further progress in designing guidelines.

5.5 Output 5: Human assets

Objective: *Improved/ diversified skills amongst fishers.*

Skills within national fisheries institutions (MFDC and DFMR (Zanzibar)) were diversified and improved through experience of involvement with the project, firstly in FAD construction and deployment, and secondly through fishing training. On Zanzibar, staff from DFMR were active in distribution of Swahili flyer and in procurement of bait, gears, fuel, arrangement with fishers and numerous aspects of the trials.

5.5.1 Training in FAD construction

Training in FAD construction and deployment skills were conducted at MFDC (in April 2004, and March 2005) to the benefit of their staff and MFDC staff that came over especially for the work. Crews of the MV Mafunzo and the MT Solsky also participated in FAD construction and in deployment (see Guideline 4 of Annex 3; Plates 1 - 2 of Annex 2).

5.5.2 Fishing training

July 2005 witnessed the first phase of fishers training with the gear technologist from SFA and 40 fishers involved, including five from Mafia. The second phase in October 2005, involved 53 fishers, with a significant increase in the number of fishers from Mafia (see Annex 9). The focus of training was on deepwater/FAD fishing skills, as recommended in the SPC Manual (see Preston *et al.*, 1998). Gears were primarily hand-lines using circle hooks, but fish bleeding, boat anchor design and bait were also addressed.

Mindful that the magnitude of this output was reduced due to the delayed deployment and only short period of training, at the end of the project, the training was successful. On Mafia success was mainly due to the application of the FAD gears in another environment, on the seabed between 70-100m. The participating fishers and WWF staff were encouraged by the results and fishers benefited from an additional five days of training requested by the WWF.

5.5.3 Training materials

Delayed fishing also impacted development of specific training materials, but numerous materials were developed or adopted, some independently (see Annex 8), under three product themes.

Basic FAD design: Three printed media were prepared. A two-sided 'theme sheet' included in the 80-sheet manual, *Toolkit for Marine Protected Areas of the Western Indian Ocean* (IUCN, 2004, and also available from www.wiomsa.org). The 40-page, *Tanzania Fisheries Observer Handbook* (in press) includes a one-page description of FADs in Tanzania, and the 2 sided flyer, Swahili "Notice to Mariners" (see Annex 4) was copied (x300) and distributed to fishing villages in northern Zanzibar by DFMR staff. The flyer was also included in the bulk posting by the Tanzania Port Authority to 64 Tanzania-based shipping and freighting agencies and companies.

FAD Deployment: The procedure for deployment was followed by communication with the Tanzania Port Authority (THA). The English DRAFT "Notice to Mariners" was submitted to the THA who forwarded the details and letter to the UK Hydrographic Office for wider dissemination (see Annex 4). Actual practical methods of deployment, including necessary skills, are basic elements of good seamanship and already possessed by the captain and crew of the Mbegani training centre (MV Mafunzo) and by the commercial logistics company (MT Solsky).

Fisheries gear: The project considered the need for training materials specific to FAD fishing, but in practice, the SPC manual (Preston *et al*, 1998) was closely followed and promoted by both Masterfisherman Paxton (from Canada) and Gear technologist Polite (from Seychelles). Bound copies were provided to all project partners. A brief Guideline (No. 5) was also produced (see Annex 3), but there was no need to develop new materials. There may be some value in translating the SPC manual into Swahili for wider use - an activity not undertaken in this project.

5.6 Communication media

The research products developed during the project include bathymetry data, FAD access details, FAD design and deployment and skills required for their use. Some of these have been communicated through the media described below. A comprehensive collection of footage (video) and still images of all aspects of FAD programme has also been being collated (see Annex 4).

5.6.1 Research products

MEDIA	Year	Audience
PRINTED MATERIAL		
2-page theme sheet "14 Fish Aggregating Device" in <i>Managing MPAs: A Toolkit for the Western Indian Ocean</i> . IUCN- EARO.	2004	Regional MPA staff
SADC Fisheries Observer Handbook (in press)	2005	National fisheries staff
TELEVISION		
BBC World Earth Report - 3:44 min. video of construction and deployment, entitled "Not Just a FAD" Real2Reel for HandsOn.	2005	Global satellite users
INTERNET		
http://www.wildwatch.com/magazine/eyesonwild.asp Promoted by the private sector partner, CC Africa.	2005	Global, internet users
http://www.handsonTV.info/ Promoted in Programme 1 (of 10) - 'Africa Works'. "Not Just a FAD - Tanzania].	2005	Global, internet users
UK Hydrographic Office website (Notice to Mariners)	2005	Global, internet users
DAILY NEWSPAPER		
<i>Zanzibar Leo</i> newspaper, January 25, 2005 (front page).	2005	National, general public
<i>Zanzibar Leo</i> newspaper, April 24, 2005 (front page).	2005	National, general public
<i>Zanzibar Leo</i> newspaper, May 24, 2005.	2005	National, general public
NEWSLETTER/OTHER		
Two FAD Tanzania Programme 2-page newsletters (Apr, Jun, Nov)	2005	Project partners
FAD Programme 2-page Swahili flyer (May). (see Annex 5.2).	2005	Project partners
Tanzania Port Authority Letter (encl. Swahili flyer & UKHO details)	2005	Local shipping agents

5.6.2 Comments on Communication Matrix

Communication stakeholders	Research Product / message to be communicated	Comments
Poor fishers	<p>Opportunities from using FAD technology and associated fishing gears to improve access to valuable pelagic fishery resources, including information on:</p> <ul style="list-style-type: none"> Seasonality Catch-rates Species composition Product size Economic Returns FAD-Effective Gears <p>Increased price per-unit, and improved access to markets, resulting from improved post-harvest treatments.</p> <p>PIPs: Equitable access to FADs. Threats and Vulnerabilities: e.g. vandalism.</p>	<p>The Swahili flyer was distributed to all relevant villages in the Zanzibar, and Mafia fishers visited Zanzibar in July to benefit from training (sea conditions on Mafia at that time limited access to FADs).</p> <p>Fishers at two sites experienced first-hand the deployment and later fishing around FADs in July and October, 2005. During meetings, sea trials and shore-based training, fishers were informed on FAD technology and fishing practices, possible influences on seasonality, catch-rates and species.</p> <p>Due to delayed second deployment, effective project life was reduced to seven months; weather hampered access and catches were low; therefore markets and PIPs not applicable.</p>
Processors/ traders	<p>Potential new/expanded business opportunities with fishers/fisher cooperatives.</p>	<p>Meetings held with managers of Tanpesca and hotel on Mafia; both positive towards FAD-caught fish, and awaiting progress.</p>
DoF/NGO fisheries management and extension staff	<p>Guidelines on fishing gears and deployment methods for East Africa.</p> <p>Improved/diversified skills within fisheries institutions.</p> <p>Economic Analyses of FADs (including FAD capital costs etc).</p> <p>PIPs:</p> <ul style="list-style-type: none"> The potential for local FAD levies; Access by-laws; The import process; The value of the new export option for mainland Tanzania. <p>Threats and Vulnerabilities (including modalities of ordering of FADs; deployment protocols; seasonal submersion).</p>	<p>Various general and deployment materials distributed (see 5.6.1). See also FTR Annex 3 and 8.</p> <p>Staff from MFDC, DFMR (Zanzibar) and MIMP experienced first-hand the deployment of FADs in July and October, 2005.</p> <p>During meetings, sea trials and shore-based training, MIMP and DFMR staff were informed on FAD technology and fishing practices, and involved in monitoring seasonality effects on FAD performance. All costs associated with construction, deployment and monitoring are recorded.</p> <p>IUCN, WWF and EPOPA informed on project details and potential outcomes.</p> <p>MBREMP incorporated FADs into their 2005 workplan.</p> <p>Earth Report documentary "Not just a FAD".</p>
DC Policy makers	<p>The opportunities for new fisheries management technologies to contribute to national and international development and conservation objectives.</p>	<p>Through NGO promotion of the FADs project (e.g. WWF and IUCN-EARO).</p> <p>Earth Report documentary "Not just a FAD".</p>
International Stakeholders	<p>The opportunities for new fisheries management technologies to contribute to national and international development and conservation objectives.</p>	<p>Indirectly, through NGO promotion of the FADs project (e.g. WWF and IUCN-EARO).</p> <p>Earth Report documentary "Not just a FAD".</p>

5.7 Transforming Structures and Processes in Tanzania

The project sought to determine the opportunities and the constraints to developing FAD fisheries in Tanzania from a number of perspectives. The availability of tuna resources, the suitability of fishing vessels and gears, the seamanship skills of the fishers themselves, and the market opportunities for example are discussed elsewhere. This section examines the characteristics of the *transforming structures and processes* and how they influenced the work of the project. In general these elements of the livelihoods framework are understood by development practitioners to affect people's access to the various types of capital such as credit for new fishing boats, access to technical support and training opportunities, or to a cooperative that might control access to cheap fishing gear or a fishing group. They also affect whether an individual, household or village etc can effectively influence decision-makers or other sources of influence: for example, what influence might a local community have over the activities of a newly established hotel seeking to gain exclusive rights of access to a coral-reef for tourists to enjoy. Or they may affect whether a community or larger group can influence the proposed contents of a local development plan. On the other hand, a village council may be able to affect an individual's access to new sources of capital by hindering or facilitating the work of development NGOs or other organizations seeking to work directly with individuals.

5.7.1 Structures

In the context of this report, 'structures' is a term that covers the various organizations, involved either directly or indirectly in fisheries in Tanzania and includes executive fishery agencies, legislative bodies (from local to national and international) commercial fishing and processing companies, civil society organizations and NGOs (DFID, 1999).

Executive Agencies: Perhaps the most influential feature of fisheries agencies structure in Tanzania is that there are two distinct state fisheries agencies, one for mainland Tanzania and one for Zanzibar. The project therefore effectively had to deal with two departments of fisheries that are quite distinct in size and operation. Mainland Tanzania has a relatively well-developed Fisheries Division (under the MNRT) within which there are a number of different sub-units working in marine fisheries including the MFDC, TAFIRI and the MPRU. The Fisheries Division is well-resourced, largely because of the important employment, export revenues and royalty wealth generated by the Lake Victoria Nile Perch fishery. Overall, freshwater fisheries in Tanzania yield an annual catch of 350,000 mt, the largest in the SADC region and more than 50,000 fishers are employed on Lake Victoria alone, as well as many thousands in processing factories on the shores of the Lake (SADC, 2001). Exports of Nile Perch fillets were 30,000 mt in 2004 worth US\$ 76 million in foreign exchange, with a royalty value worth US\$ 5 million to the Government of Tanzania (Anon., 2005a). There is also an important trade in fishery products from Lake Tanganyika to DRC, Zimbabwe and Zambia. The value of these export fisheries has encouraged the establishment of a relatively well-organized quality control section within the Fisheries Division mainly to ensure processing companies operating in Tanzania meet HACCP standards and can continue to access the valuable American and European Union markets. This has had some positive spin-offs on the export trade in marine fishery products and will no doubt facilitate the development of other marine fishery exports from Tanzania, including FAD-caught tunas.

On the coast of mainland Tanzania there is a small but valuable prawn fishery concentrated in the Bagamoyo and Rufiji districts of northern and central coastal Tanzania respectively. This fishery yields about 2,000 mt per annum of which roughly half is landed by an industrial fishery, the other half by an artisanal, small-scale fishery. Again, prawns are a valuable product (and the country is able to meet HACCP standards), with 956 mt of prawns exported in 2004, worth nearly US\$ 4 million in foreign exchange (Anon, 2005a). The marine finfish catch is estimated at between 40,000 and 50,000 mt per annum and the vast majority is landed by the 20,000 or so artisanal fishers (Anon., 2001) although most is sold on the domestic market. The total value of marine fishery exports (including octopus, seaweeds, lobster/crabs, squid, beche-de-mer and the prawns) was US\$ 12 million in 2004 (Anon, 2005a).

With the prawn and the Lake Victoria fisheries together the value of fisheries far exceeds the costs of fisheries management on the mainland, and the Fisheries Division will therefore continue to enjoy a reasonable level of budgetary (and political) support from the mainland Government (either directly or by funding derived from donor inputs). The forthcoming World Bank/GEF Marine

and Coastal Environment Management Programme (MACEMP) which includes a US\$60 million loan to the Government of Tanzania will further enhance and extend the work and effective influence of the Fisheries Division to effect fisheries management. But a key feature of the government structure is that the Fisheries Division, physically located in Dar es Salaam, the commercial capital of Tanzania, is primarily a policy-making, research and management agency rather than an implementation agency, with the exception of the quality control work. It is the district fisheries staff who are expected to implement fisheries management and other natural resource policies (as well as any district-level by-laws). These staff are employed by the Ministry for Local Government, not directly by MNRT, and are typically poorly-resourced and largely unable to provide the various extension services for which they are mandated. In practice the lack of resources in most district fisheries offices means that staff are largely confined to their offices unless additional funds, for example from an NGO, are available.

To address this reality, the Fisheries Division policy has to facilitate the establishment of a number of collaborative partnerships with donor agencies and NGO or NGO-type organizations that can bring technical, managerial and financial resources to the districts. The Fisheries Division has collaborated with IUCN since 1994 in the Tanga Region. Collaboration also exists between the Fisheries Division's MPRU and the WWF, and between MPRU and IUCN in MBREMP, in southern Tanzania. A number of different donor agencies (and companies) are also involved in these programmes including DCI, FFEM, DFID, the GEF and VodaPhone-UK.

In contrast to the mainland, Zanzibar has relatively few fishery resources with no freshwater or prawn fisheries at all and a very limited marine finfish production with perhaps only 12,000 mt landed each year (c. 25% of the volume caught on the mainland) although there are similar numbers of marine fishers to the mainland (estimated at 21,000 fishers, see Jiddawi & Yaheh, 2003). Zanzibar's DFMR has therefore, until recently at least, not been particularly well-resourced by the Government of Zanzibar. It has also recently undergone something of a restructuring so whereas it was formally a sub-Commission it is now a department in the Ministry of Agriculture, Natural Resources, Environment and Cooperatives (MANREC) with a new Director of Fisheries in place since 2004. However, there are some similarities between Zanzibar and the mainland with two NGOs involved in coastal management collaboration with the Government, namely CARE on Misali Island, Pemba Island (part of Zanzibar) and WWF in Menai Bay on Unguja Island, although these are far less extensive programmes than exist on the mainland.

The project therefore sought to take best advantage of the better-resourced Tanzania Fisheries Division and the more developed marine fisheries management arena in general in a number of ways. The Fisheries Division voiced immediate support for this FADs programme at its inception, and at a practical level provided the project team with access to some of the staff and facilities of their MFDC. The Centre was utilized as a base for constructing the FADs, and for storing FAD components and the cooperation extended to allowing the project to charter their research/training vessel 'MV Mafunzo' for the deployment of the first tranche of FADs. The Fisheries Division and its sub-units also facilitated the project's subsequent collaboration with donor agencies and NGOs in the field.

On Zanzibar, similar technical facilities are not available and many of key staff at DFMR are often engaged in SADC-EU MCS project that was running more or less concurrently with the R8331, or overseas on training assignments. However, key contributions from DFMR were advice on the protocol for communicating with district and village (*sheha*) authorities and thereby opening communications pathways with these local-level government officials, and active participation of DFMR staff in all aspects of the trials.

Commercial Companies: The presence of viable commercial activities is a critical aspect of the development of a FAD fishery. As has happened elsewhere in the world, FADs are expected to attract not just the artisanal fishers but larger operations as well. A competitive and diverse fishing and marketing industry that can offer different solutions to the exploitation of FADs is now developing, particular off Mafia Island. There are likely to be a number of levels of complexity in commercial participation in FAD fisheries, as in the other fisheries in Tanzania, although it is too early to describe these in any detail. At the simplest level, fish brought to landing sites are either processed by family members or sold on for immediate processing by others. Small-scale middle-men will also be involved by supplying vessels and equipment to FAD fishers and purchasing their catch, as they do in all other fisheries in the country (Anon, 2001; Jiddawi & Yayah, 2003).

A higher level of commercialization is now quietly developing as a commercial fishing company in the country (name withheld as the information is commercial-in-confidence) has started to investigate the opportunities for establishing its own FAD fishery, including the purchase and deployment of additional FADs and the introduction of improved vessel technology. A second company has recently purchased three long-liners for tuna fishing in the EEZ. It remains to be seen exactly how these developments unfold and the extent to which the crew is employed from within the local pool of manpower or sourced from within the company's existing staff (i.e. from outside the locality) with the obvious implications for the subsequent distribution of incomes from the fishery. Some hotels and resorts operating around Mafia Island and Zanzibar are also starting to take advantage of the new dive and fishing opportunities that FADs offer and although perhaps unlikely to deploy FADs as a dive-site or a fishing site they are an important economic asset to the economy and dive operators may be able to influence future government involvement in FAD fisheries in Tanzania and Zanzibar. It may also be that groups of hotels could work together to contribute towards the costs of FAD deployments, something that has been seen for example in the Mamanuca Group of islands in Fiji, in the South Pacific Ocean (Poni, *pers comm.*). In On Zanzibar, two other beach hotel have expressed interest in participating and possibly supporting continued monitoring.

R8331's activities on Zanzibar were largely managed through the MNRT, but the project did develop a relationship with a commercial hotel enterprise, CCAfrica/Mnemba Island Resort who provided funds for the purchase of two FAD units. CCAfrica saw FADs as a means to contribute towards local community development and to balance some of their impact on local communities, in this case the closure of the island and some of its surrounding marine resources (see section 5.7.2). Adjacent villages had historically used the Island as a fishers' camp and the reef for fishing and the closure represented an important loss of access to marine space and marine resources for these villages. The main act of this annexation had taken place prior to CCAfrica's involvement with Mnemba Island, when the government of the day (1989) was perhaps less sensitive to the needs of local communities, but nevertheless the closure has persisted. CCAfrica very has had little involvement in the project but since the March deployment has assisted with FAD monitoring and is supportive of the project.

Civil Society Organizations: Civil society is relatively new in Tanzania as a result of the political history of the first three decades of independence. But there are rapid developments currently taking place and a burgeoning of cooperative and advocacy organizations. This project has not worked directly with any civil society organizations.

NGOs: Direct collaboration with the Fisheries Division was in fact less than with Zanzibar's MNRT but this reflected the larger role of non-governmental organizations in coastal zone management on mainland Tanzania; in this case WWF. Mafia Island Marine Park is under the direct management of MPRU and the Warden-in-Charge is MPRU's representative on the ground with the Park's activities being part-funded and managed by WWF's Tanzania Country Office (WWF-TCO). FADs were seen by WWF and the Park's management as an opportunity to reduce the negative economic impacts of their gear-exchange programme, which ultimately seeks to remove all beach-seine gear from within the Park. The major contact point of R8331 and MIMP, and the main drive behind the additional funding R8331 received was WWF's Technical Advisor based at Utende on Mafia Island. In this case it was more efficient for the project to work through the advisor, as a single point of contact, rather than directly through the Warden-in-Charge, the Board of Trustees of MPRU or the Fisheries Division itself. MIMP provided counter-part staff, generally better paid and motivated than most local government staff, who brought a range of skills and assets including important local knowledge, established communications pathways and whom facilitated local logistics on Mafia; MIMP provided the line-management of these staff.

In the final few months of the R8331 a third NGO, EPOPA (Export Promotion of Organic Products from Africa, funded by SIDA) began expressing an interest in the development of FAD fisheries, including the procurement of vessels and gears to establish some sort of small-scale commercial fishing operation. At the time of writing it is not possible to comment further on how this development will take shape or the role that EPOPA will play.

A number of NGO and NGO-type organizations such as WWF and IUCN on the mainland and CARE on Zanzibar are taking an important partnership role in coastal zone management in Tanzania. Usually these NGOs have a strategy to bid directly, often in competition with other

similar organizations, for coastal zone management contracts offered by the government (usually supported by donor agencies). The financial resources and technical and management skills they can bring to the local resource management arena contrasts strongly with the typically under-resourced district natural resource offices, a feature that future FAD programmes may depend on.

5.7.2 Processes

In the context of this report, 'processes' covers policies, legislation, institutions, culture and the relationships determined by aspects such as age and gender (DFID, 1999).

Development Policy: In general the policy environment is largely conducive towards development of FAD fisheries, both on Tanzania mainland and Zanzibar, with FADs explicitly included in Zanzibar's fisheries legislation. The National Strategy for Growth and Reduction of Poverty (NSGRP, Anon, 2005b) states that *'efforts need to be stepped up to reduce the proportion of the rural population below the basic needs poverty line from 38.6 percent in 2000/01 to 24 percent by 2010 and food poverty line from 27 percent in 2000/01 to 14 percent by 2010'*. The Strategy indicated that increased contributions were expected *'from wildlife, forestry, and fisheries, to incomes of rural communities'*. The NSGRP encourages policies and strategies that promote:

- The creation of an enabling environment for good governance, effective coordination and people's participation; and,
- Capacity-building for enhancing economic growth and equity through conducive macro-economic, sectoral and infrastructural policies and strategies.

These are all features of the FADs programme in Tanzania under R8331.

Fisheries Policies: Development policy themes support the development of FAD fisheries in general. More specifically there are a number of provisions in the mainland Fisheries Act (Anon., 2003) that provides additional policy and institutional support for a number of aspects of FADs fishery development. For example the Act states that:

'The Director shall, in cooperation with other appropriate agencies and divisions or departments of the Government, promote, encourage and support all initiatives leading to the development and sustainable use of the fish stock and aquatic resources through such measures as:

... (f) encouraging the involvement of stakeholders in the planning, development and management of fishery resources;

... (j) pursuing continuation and introduction of fisheries integrated programme of effective management of coastal zone to meet the ecological and social economic needs of the presents and future generation'

Source: Anon., 2003 Part III Development of the Fishing Industry (Section 9, Paragraph 1)

The Fisheries Act also provides support for any fisheries-related restrictions on the use of particular gears, marine-space, size or other characteristic of the target species. For example, the Act states that:

'The Minister shall by notice published in the Gazette impose conditions that are necessary for the proper management of fisheries which are:

... (e) restricting the number, size and age of fishing vessels in any fishery;

... (f) prohibiting the use of certain types of fishing vessels and gears;

... (n) examining the performance of the existing fishing gear, methods and substituting for them those which are consistent with responsible fishing;

... (p) ensuring that...[the] needs and interests...of local fishing communities which are highly dependent of fisheries resources for their livelihood are given due regard.

(Source: Anon., 2003 Part V Management and Control of the Fishing Industry (Section 17, Paragraph 1).

The spirit of this Act may be applied to maintaining access to FADs and adjacent marine space for artisanal fishers in the case where larger commercial interests seek to establish monopoly access rights, such as may occur if commercial companies establish their own FAD fisheries. Similarly, if there are issues related to conservation of resources, the Act also provides support of small-scale rather than larger commercial interests. Similar policies exist for Zanzibar.

Current policies towards participation and recognition of the rights of local people to access fishing grounds are obviously grounded in good faith and partly reflect the growing democratization of Tanzania's politics. But artisanal fishers are typically not a strong political body, particularly in Tanzania and there are other usually more influential commercial interests competing for favourable terms of access to resources. A good example of a negative outcome of such competition was the Zanzibari Government's supportive policy towards the first owners of the US\$ 500 per night Mnemba Island Resort who secured the closure of Mnemba to fishers who previously camped on the island, and for the closure of a 200 m wide zone surrounding the island (including some small patch reefs). When the adjacent Matemwe Village learnt that a part of the funding for the FADs was from CCAfrica a connection was made by some groups within the village between the biased access policy of the government, the island's current managers CCAfrica and R8331. The catalyst for this only short-lived conflict with the project may have been something as prosaic as the language used to describe FADs, which were referred to as buoys or *boyas* in Kiswahili. As it happens, the 200-metre exclusion zone around Mnemba Island was also marked with buoys or *boyas*. Some individuals made the obvious link between the restrictions associated with the marker buoys and the CCAfrica-funded FADs.

This is one example of where one policy (to promote economic development in the form of a luxury hotel) seems to run counter to policies designed for equitable access for poor fishers. Another slightly different example of such a contradiction was observed in Tanga Region, on the north coast of mainland Tanzania. The Tanga Coastal Zone Conservation and Development Programme (TCZCDP) provided one potential area of cooperation for R8331. TCZCDP started operating at the beginning of the implementation of the national policy of decentralization, in the mid-1990s and looked to support those policies directly with technical support managed by IUCN and with important financial support from DCI (DCI's funding still contributes around 90% of TCZCDP operating budget (Wells et al., *in prep*)). Villages, district authorities and programme staff began to work together to establish 'Collaborative Management Areas' (or CMAs) and to close reefs and control illegal fishing gears. As part of TCZCDP's (and the CMAs') activities to develop additional livelihood opportunities a number of inshore FADs had already been tried some years prior to the initiation of R8331, although the equipment was stolen and the research was subsequently abandoned (Horrill *et al.*, 2001). The R8331 project team was initially approached by TCZCDP to seek information about a potential collaborative FAD deployment; however IUCN, who at that time provided technical support, finally chose to advise TCZCDP not to participate in this FADs trial on the basis that there was insufficient knowledge on the status of tuna stocks in Tanzania's waters (TCZCDP, *pers comm.*) although this was a decision that was not universally supported across TCZCDP. In this case the conservation policies of IUCN outweighed the immediate development needs of the local fishers even though at the same time the Fisheries Division policy was to issue purse-seine fishing licenses for DWFN vessels to operate in the EEZ. Such vessels are capable in a single 24-hour period to land tuna likely to exceed the expected *entire annual* artisanal FAD catch. While it is recognized that the exploitation of stocks of some tuna species in the Indian Ocean is approaching a maximum sustainable level (IOTC, 2004) there is a case for at least some of the available tuna fishery resources to be ear-marked for the domestic artisanal fleet, even though the immediate revenues to the State will be less direct, immediate and quantifiable.

Fisheries Export Policy: There are no restrictions on the export of marine finfish from Zanzibar, although the current market is dominated by marine invertebrates rather than finfish. On the mainland however, export of marine finfish was proscribed until 2004, although there is some debate as to whether this ban covered tuna and tuna-like species or only demersal finfish species. But a new directive has recently been issued by the Fisheries Division to offer, for a period of one year in the first instance, four export licenses (Anderson & Ngatunga, 2005). One of the key features of the Fisheries Division policy in relation to the development of the export fishery and alleviating poverty is that the commercial processing industry will not be allowed to develop their own fishing capacity but will have to buy directly from *independent* artisanal fishers.

Recognising the limitations of the current fishing fleet in terms of vessel and gear technology, the Fisheries Division proposes that the industry invests in local fisheries by providing new fishing technology to allow fishers to access fishing grounds/resources previously out of their range of operation, as well as to improve post-harvest treatment (Section 5, Anon, 2003). Abila (2003) noted that a relatively limited number of companies own or control the other enterprises relating to fish supply acquisition, transportation, product distribution and export marketing on Lake Victoria. Just how independent artisanal FAD fishers would remain is open to question, but the experience from Lake Victoria is not necessarily very encouraging. Bokea & Ikiara (2000) indicated that the dominance of the processing (export) trade by few large commercial interests led to fishers being controlled by their credit relationships with large buyers, and because individual fishers contribute only a small amount to the total daily landings, they are 'price-takers'. There are sound economic reasons for vertical (and horizontal) integration, because such companies will inevitably profit from economies of scale that can provide for efficient acquisition, in the required quantities, to satisfy the demands of the export market. Well-established companies will also be in a better position to cover the transaction costs of establishing a new market (Anderson & Ngatunga, 2005). Whether this pro-artisanal strategy will affect the development of a FAD-based fishery by commercial companies in mainland Tanzania remains to be seen.

6 RESEARCH ACTIVITIES

6.1 Site survey

The one-week survey, from SV Amarula, was undertaken in February 2004. A deep-water sounder (model JRC NJA-1130) with a 3 KW transducer was mounted specially for the survey. A pre-drawn grid was navigated, with sounder readings synchronized with the GPS (see Plate 1d, Annex 2), producing the 3-D charts output of the seabed surveyed (see Guideline 2, Annex 3). All sites were previously visited with local fishers using their vessels (see Plate 1a, Annex 2).

6.2 FAD construction

Importation and clearance of FAD equipment was effective but delayed due to changes in importation regulations in Tanzania (see Guideline 1, Annex 3). Equipment, including anchors, was transported and stored at MFDC and in March 2004, six FADs were constructed with local counterparts, under the supervision of the Masterfisherman from Canada. Once all materials are in place, construction of the six FADs requires 2-3 days and some experience in splicing 12-ply ropes (see Annex 2, Plate 1g). Failure of original design with loss of three FADs, resulted in a second importation, construction exercise, again supervised by the Masterfisherman, in December 2005.

6.3 FAD Deployment

The first deployment departed from MFDC with six constructed FADs aboard the MV Mafunzo in April, 2004. Following the discovery of the design problem, after the loss of three FADs, the vessel returned to port and the remaining three FADs were unloaded and stored.

In January 2005, the MV Mafunzo was taken to dry dock for welding of water-line plates. With uncertainty about the date of repair completion, a private company was approached, and the second deployed was successfully completed on March 22-25, 2005, again departing from the MFDC jetty, but this time with the MT Solsky tugboat from a private sector marine logistics company. Deployed with local partners, four FADs were set off Zanzibar and two off Mafia (see Figs. 2 and 3, and Guideline 4, Annex 3).

6.4 Monitoring of FAD performance

With the previous experience of FAD submersion and failure to re-surface and the strong influence of ocean currents on the design at the forefront of considerations of FAD behaviour,

special efforts were made to monitor the six FADs at every opportunity, especially in the initial months. In addition to boosting the involvement of the various project partners, contact was also made with a private game fishing operator, within two weeks of the deployment date, all six FADs had been inspected (see FAD Inspection Report, Annex 10).

Between deployment in March to end of project in October, 28 visits were made to inspect the FADs. Monitoring involved various stakeholders: MIMP, Mnemba Island (CCAfrica), DFMR Zanzibar, local fishers and a private sport fishing operator. Details reported included the number of buoys at the surface, an indicator of current velocity, GPS data on position of float section and other observations (see FAD Status forms, Annex 10). The outer two FADs at Zanzibar and the two at Mafia were inspected least. By the end of the project, the southern of the two FADs at Mafia “Juani”, has not been inspected.

The first inspections revealed two main issues. Firstly, three of the four Zanzibar FADs had, within ten days, lost their flagpoles. Theft is suspected and not surprising. The UV proof purse-seine floats are a very versatile product that can be cut and adapted to numerous uses. The second, potentially more important discovery from initial monitoring was evidence of slippage of the three cable clamps in the final section (see Annex 2, Plate 3b, d). Following discussion with various marine experts, the consensus was that the slippage was expected and could only continue to the point where the final meter of steel cable is twisted and crimped so tightly it will never shift. Seven months later, this indeed seems to be the case.

6.5 FAD Fisheries Training

6.5.1 Fishing gears, boats and bait

Training in the use of fishing gears specific for FADs was conducted on two occasions, in July from a base in Nungwi, and later in October at all three sites of Nungwi, Matemwe and Mafia. All the hand-lining gear was sourced from the Seychelles.

Training was led by the fishing gear technologist from SFA, Antoine Polite, who visited Tanzania for a total of 50 days, during which 33 days were spent at sea (see Fisheries Trials Summary table, Annex 9). On all days at sea, two motor-sailing ‘mashua’ were chartered, carrying between 10-12 fishers in total.

The first training took place between July 2-21 and was restricted to Nungwi because of all the three sites, Nungwi allowed the best possible chances of access to the Nungwi 1 FAD, all other FADs being further offshore or more exposed (especially on Mafia). Fishers from Matemwe and Mafia were involved in the first Nungwi trials. Some days were spent on the Nungwi 1 FAD, but much of the trial took place to the more sheltered west side of Nungwi, towards the mainland (see Fishing Trials Location data in Annex 9).

The second set of fishing trials took place between October 4 and November 5, starting in Nungwi for five days, then Matemwe for five days and then shifting to Mafia. On Zanzibar, the field-based training in FAD fishing gear rigging and use also included representatives DFMR, while on Mafia the MIMP-WWF staff were involved. While on Mafia, despite the weather conditions preventing access to the FADs sites, following successful exploration of alternative sites, the MIMP and WWF requested that Mr. Polite continue for a further five days to continue with the training.

After the 50 days of sea trials in the three sites, under various sea conditions, and using the standard offshore local vessels (a 8-11 m wooden dhow or ‘mashua’), some important comments on vessel use are needed. Firstly, the vessels are well-built, and apparently do not sink even when flooded (due to weight of the timber in seawater). Secondly, the capability to carry both sail and engine is a benefit that normally allows for at least one passage (to or from the fishing grounds) to be made under sail, thus saving fuel. The sail also serves as a reserve means of propulsion should there be engine problems - a feature relied upon on one occasion. However, there are some negative aspects attributed to the ‘mashua’ vessels that relate to the weight, manoeuvrability, speed and fuel consumption. Based on the recent experience, it is suggested that fishers consider the much lighter, faster and more manoeuvrable fibre-glass open boat

powered by a 40 Hp outboard. Annex 2 (Plate 6g) shows an image of hand-line fishers in Papua New Guinea and their equipment for vertical long-lining in deep water.

The practicalities of obtaining good quality, ideally squid (but also Indian mackerel or sardine), was a regular challenge, but at all locations mechanisms were developed or adapted to provide bait, with only two fishing days lost for failure to secure bait.

6.5.2 Alternative uses of FAD fishing gears

There were days during both visits of the gear technologist that fishing near the FADs was not possible due to sea conditions. Alternatives were examined and the conclusion was to continue fishing with the same gears, but as drop-lines for bottom fishing in deep water, thus fishers would still benefit from the experience of using the deep-water lines and circle hooks - the main components of the gears for use around FADs.

In July, such rough-weather days were spent fishing in the shallower, but more sheltered west of Nungwi (see Fishing Trials Summary, Annex 9). In Mafia in October, access through the Kinasi Pass was not always possible, with high oceanic swell and 15 knot easterly wind. After a few attempts, it was agreed that the gears should be tested in alternative sites, notably the more sheltered areas to the south of the main Island, beyond Tutia reef. At all three sites, FAD gears were rigged for bottom-fishing at 70-120 m. The results were most notable at Mafia where about 300 kg of red snapper was caught.

6.6 Communication Activity

The delayed successful deployment resulted in a reduction in the scale and impact of this activity. Numerous avenues were nevertheless pursued in order to communicate the findings and activities to fishers, project partners and interested private sector.

The Tanzania FAD Programme newsletters (see Annex 7) were disseminated in April, June and November 2005 to all partners, as email attachments and/or hard copies (locally). The November update is in preparation. Video footage of construction and deployment was taken by Real2Reel for the Hands On (BBC) Programme in March and June, and the final 3:44 min DVD was produced and is being distributed. Additional video footage was taken of October fishing trials. It is hoped that this will be combined with the previous footage to produce a final DVD of the entire project. Three newspaper articles about the FAD project, deployment and fisheries potential were released in the local paper "Zanzibar Leo" (January, April and May 2005). The project is currently responding to requests for information on FADs by the local private sector and by NGOs with donor support (e.g. EPOPA).

6.7 Local facilities

Three principal institutions and facilities were used to implement the project. The MFDC, 20 km north of Dar es Salaam, for FAD construction and loading of deployment vessels, the DFMR (Zanzibar) for staff and assistance with Zanzibar logistics and preparations, and the MIMP office and WWF facility on Mafia for local logistics and preparations.

7 CONTRIBUTION TO FMSP'S PURPOSE AND OUTPUTS

7.1 Contribution of R8331 to the FMSP Purpose and Outputs

Project R8331 had the following expected outputs:

- Information on the presence and accessibility of large pelagic resources in trial sites, including data on catch-rates, species composition and product size;
- Guidelines on fishing gears and deployment methods for FAD Programmes in East Africa;

- Economic analyses of FADs (VPUE/Fixed/variable costs/IRR/NPV);
- Guidelines on the management of access to FADs, including experiences with conflict minimisation/resolution
- Improved/diversified skills amongst fishers at trial sites, and at additional sites through exchange visits. Improved/diversified skills within national fisheries institutions;
- A series of outputs related to transforming structures and processes, using a number of media, targeting decision-makers. To include briefs on legislation, decision-making processes to improve the contribution of local levies, cooperatives, access management by-laws and the export of large pelagic species, and import tariffs on fishing gears and FAD equipment; and,
- An improved risk evaluation for future FAD programmes.

7.1.1 Purpose OVI

DFID define the purpose of the FMSP as bringing *benefits to poor people by the application of new knowledge to fisheries management systems* and identified the following as possible indicators of achievement of that purpose:

Indicator 1: Fisheries productivity increase/improvement for enhanced fisheries leading to increased livelihood benefits.

The early problems the project experienced have been described above and it is argued that these delays are sufficient to explain the lack of FAD-related productivity increases. Access to marine fishery resources is always highly dependent on benign weather and sea-conditions and there is strong seasonality of access experienced by fishers of the East African coast, with access between April and October largely being constrained by the SE Monsoon. This seasonality likewise affected the project's activities; to implement the training activities and build the confidence of fishers to explore new fishing grounds a consistent and somewhat lengthy period of access would be required. The project, like potential FAD fishers, therefore had a limited number of windows of opportunity to successfully operate during the research period and also had to operate in sub-optimal conditions to try to complete as much of the expected project activities as possible. R8331 has not been able to demonstrate increased livelihood benefits resulting from the presence of FADs off the coast of Tanzania. At the close of the project six FADs have been in place for seven-months and expectations are high that the expected benefits will come on stream during the more benign weather and sea-conditions of the forthcoming NE Monsoon (from October 2005).

Indicator 2: Improved fisheries employment (numbers, income, quality).

Following on from the previous observations for Indicator 1, R8331 is not able to demonstrate improved fisheries employment.

Indicator 3: Improved access by poor people to fisheries knowledge generated by the FMSP.

The project has however introduced a wide variety of stakeholders to the concept and potential of deep-sea FAD fisheries, previously tried (unsuccessfully) in Tanzania in 1984. These include poor people (fishers) but also institutions supplying services to the poor (national and district government; national research institutions and NGOs), employers of the poor (fishing and processing companies) and policy-makers (national governments). The project has been able to demonstrate some of the technical requirements for fishing around FADs and this has encouraged at least two NGOs and a successful commercial company to further investigate the potential of investing in FADs beyond the life of R8331.

Information on the potential of FADs, and skills to tap this potential, has been successfully disseminated to poor fishers through active participation in the planning and deployment of six FADs and through the various training activities that they have participated in.

7.1.2 Output OVIs

FMSP Output: existing FMSP research outputs relating to: the contribution of capture and enhancement fisheries to the livelihoods of the poor; fisheries management tools and strategies that could benefit the poor; and, the means to realise improved management, further developed, disseminated and promoted to relevant stakeholders at all levels.

The relevant OVI for Project R8331 is: pro-poor enhancement fisheries management strategies actively promoted into at least four target institutions in two target countries and widely promoted (nationally and internationally) by 31 March 2006.

The project's target institutions were defined in R8331's logical framework as:

- Fisheries Division, Tanzania;
- Department of Fisheries and Marine Resources (DFMR), Zanzibar;
- Mbegani Fisheries Development Centre (MFDC);
- Institute of Marine Sciences (IMS); and,
- Mafia Island Marine Park (MIMP).

The Fisheries Division and DFMR have been closely involved in the project at all stages, although the Fisheries Division's practical involvement was largely through MFDC and the MPRU staff based in the Mafia Island Marine Park. Staff from MFDC were primarily involved in construction and deployment of the FADs and in fact a representative of MFDC who was involved in the first deployment on the centre's own 'MV Mafunzo' subsequently participated as a key advisor in the second deployment that took place from another vessel, the 'MV Solsky'. MIMP/MPRU staff, previously with no experience of FADs, participated in the pre-deployment survey, the deployment itself and in all the subsequent fishing trials working alongside representatives of the Marine Park's fisher community. Senior DFMR staff were involved in FAD planning and particularly in establishing communication pathways with districts and villages. DFMR staff also participated in the pre-deployment surveys, the deployments themselves and the subsequent fishing trials. IMS were invited to participate early in the project and a fisheries scientist from IMS played a key role in describing the project to fishers with whom she had already worked in Zanzibar. However, there are many new and well-funded research activities underway in Zanzibar and these proved sufficiently more attractive to IMS staff additionally burdened with academic supervision commitments.

Apart from the internal reporting of staff back to their respective line-managers key events in the calendar of the project have been reported in various briefing documents and the FAD Project Newsletter and distributed to all institutional stakeholders through both email and hard copies.

In terms of a wider national and international promotion of FAD fisheries, the project contributed a section to the SADC-EU MCS Programme's (Tanzania Office) Fisheries Observer Handbook (SADC-EU MCS, 2005). R8331 also contributed a FADs theme sheet to IUCN's Managing Marine Protected Areas - *A Toolkit for the Western Indian Ocean* (IUCN, 2004), see Annex 8. This has been distributed to all marine parks in the Western Indian Ocean as well as reaching a wider audience at various international forums in which IUCN participated during 2005. FAD programme concepts were captured for a wider international audience by the HandsOn production 'EarthWatch'; a narrated package was screened in July 2005 on BBC World.

7.2 Impact of the project

The project OVIs to be completed by the end of project were:

1. Two FAD programme trials sites, with 6 FADs, over 12 months.
2. At least 5 policy briefs disseminated by various media.

On the first indicator, the project has been largely successful despite a design problem in the first

deployment of FADs. Although the sixth FAD at Juani, Mafia has not been inspected for six months due to adverse weather and termination of the project, there is no reason to suspect that all six FADs are not in place and performing as expected. Seasonal total submersion was witnessed and documented. Over the seven months of the life of these six FADs, including a full SE Monsoon season, and 28 inspections, there is nothing to suggest that the current design has any faults. These FADs are expected to remain for several years.

Achievements against the second indicator were not successfully produced, though a set of five guidelines (see Annex 3) have been formulated, and a range of media have been used to transmit the development of the project, the design and (soon), the results. Policy briefs remain absent from the document because it was felt they required information gained from experience, which was only partly achieved, thus important new information was not contributed, because the FAD fishery has not been developed. The policy brief on export of large pelagic fish products, became largely irrelevant when the government approved the directive to allow trial exports of marine finfish during 2005, possibly influence by the policy brief from R8249

7.3 Further work

1. Arrange and conduct a 'wind-up' meeting with fishers in Zanzibar and project partners and discuss future options.
2. Seek funds to combine the recent October 2005 video footage of fishing trials with the previous footage (of FAD construction and deployment, as used by HandsOn for the Earth Watch series), to produce a final product of the whole trial. The final product should be 25-20 min. duration and be a valuable training tool, possibly translated into Swahili.
3. Provide information and details of the project to private companies and EPOPA.
4. Seek support to continue monitoring the fishery and conduct a third phase of trials in the next few months to fully test whether the FADs attract tuna that can be caught with the gears used. By conducting more fishing trials during the coming five months of the NE Monsoons this will provide much more data than presently collected, to determine whether or not the FADs function as a fishery enhancement tool.
5. If continued monitoring can be coordinated for the coming six months, over a full NE Monsoon fishing season, then it might be possible to prepare some of the policy briefs originally proposed. In particular, significant information and data would be generated on access, gear performance and tariffs, marketing and export issues, and cooperatives.
6. Design a FAD monitoring and maintenance schedule, and circulate to project partners.

Final note: The conclusion from the South Pacific Commission (SPC) is that "vertical long-lining around FADs can be a productive and potentially lucrative activity". As such the SPC is actively promoting FAD-based vertical long-lining to draw greater benefits from their tuna resources, improve quality of food available to the population, and divert fishing effort away from logon stocks that are often over-fished. We believe this situation, and potential, is equally applicable to much of East Africa.

8 PUBLICATIONS AND OTHER COMMUNICATIONS MATERIALS

- (a) Peer-reviewed publications (published). *None*.
- (b) Peer-reviewed publications (in press or submitted). *None*.
- (c) Non peer-reviewed publications and reports and communications materials.
 - IUCN (2004) MPA Toolkit. 2-page theme sheet "14 Fish Aggregating Device" in *Managing Marine Protected Areas: A Toolkit for the Western Indian Ocean*. IUCN-EARO (see Annex 8).

- Tanzania Fisheries Observer Handbook (see Annex 8).
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 - <http://www.handsontv.info/> Promoted in Programme 1 (of 10) - ‘Africa Works’. “Not Just a FAD - Tanzania]. (see Annex 8).
 - <http://www.wildwatch.com/magazine/eyesonwild.asp> Promoted by the private sector partner, CC Africa.
 - Two FAD Tanzania Programme 2-page newsletters (April, June and November 2005) (see Annex 7).
 - FAD Programme 2-page Swahili flyer (May). (see Annex 4).
- (d) Verbal presentations and project dissemination and other workshops.
- Verbal presentation by J. Anderson (previous PI) at MACEMP Stakeholder Workshop, Zanzibar (November, 2004) organised by the World Bank.
- (e) Other types of project output (e.g. literature reviews, databases, software etc).
- Collection of stills and video footage of all aspects of the project, from December 2003 through November 2005.

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10 PROJECT LOGFRAME

Hierarchy of Objectives	Objectively verifiable indicators	Means of Verification	Important Assumptions
<p>Goal</p> <p>Improved understanding of marine and freshwater capture and enhancement fisheries and their contribution to the livelihoods of the poor developed and promoted.</p>	<p>Improved understanding of the importance of capture and enhancement fisheries within complex livelihood strategies of the poor and the factors influencing their livelihood choices in target countries by 2003.</p>	<ul style="list-style-type: none"> - Satisfactory final reports received from contractors. - Peer review, publications, reports, manuals and software produced. - Requests for manuals and databases received. - Uptake of research results by target institutions monitored in Annual Programme Reports. - National fisheries statistics and sectoral plan. - Quarterly and Annual reports 	<ul style="list-style-type: none"> - Policies as researchable constraints for development remain constant. - Data collection strategies cost effective and socially appropriate.
<p>Purpose</p> <p>To test the mechanisms for implementing successful FAD programmes in East Africa, and to communicate that success to relevant stakeholders.</p>	<p>Two FAD programme trial sites, with 6 FADs, for 12-months completed by EOP.</p> <p>At least 5 policy briefs disseminated by various media completed by EOP</p>	<p>Final Technical Report and Peer Review</p>	
<p>Outputs</p> <p>1.1 Information on the presence and accessibility of large pelagic resources in trial sites, including data on catch-rates, species composition and product size.</p> <p>1.2 Guidelines on fishing gears and deployment methods for FAD Programmes in East Africa.</p> <p>1.3 Economic analyses of FADs (VPUE/Fixed/variable costs/IRR/NPV).</p> <p>1.4 Guidelines on the management of access to FADs, including experiences with conflict minimisation/resolution.</p> <p>1.5 Improved/diversified skills amongst fishers at trial sites, and at additional sites through</p>	<p>1.1 Completed by EOP</p> <p>1.2 Completed by EOP</p> <p>1.3 Completed by EOP</p> <p>1.4 Completed by EOP</p> <p>1.5 Completed by EOP</p>	<p>1.1 Final Technical Report</p> <p>1.2 Final Technical Report; Guidelines Documents</p> <p>1.3 Final Technical Report</p> <p>1.4 Final Technical Report; Guidelines Documents</p> <p>1.5 Final Technical Report; Reports on Training Activities</p>	<p>Cooperation of communities in study sites</p>

<p>exchange visits. Improved/diversified skills within national fisheries institutions.</p> <p>2. PIPS - A series of outputs, using a number of media, targeting decision-makers. To include briefs on legislation; decision-making processes to improve the contribution of local levies; cooperatives; access management by-laws and the export of large pelagic species; and import tariffs on fishing gears and FAD equipment.</p> <p>3. Threats and Vulnerabilities - An improved risk evaluation for future FAD programmes.</p>	<p>2. At least 5 policy briefs (using various media) completed by EOP</p> <p>3. Completed by EOP</p>	<p>2. Final Technical Report; Policy Briefs</p>	
<p>Activities</p> <p>1.1 Capturing Natural Assets:</p> <ul style="list-style-type: none"> • Site survey, FAD construction and deployment; Monitor seasonal and spatial characteristics of pelagic fish resource distribution generated from catch, effort and biological monitoring on-board selected local vessels under long-term charter to project. <p>1.2 Evaluation of Physical Assets in relation to FADs:</p> <ul style="list-style-type: none"> • Monitor the comparative efficiency of fishing gears deployed around trial FADs. • Monitor the performance of existing and trial storage and performance of existing transport infrastructure • Monitor post-harvest losses. <p>1.3 Access to, and Performance of, Financial Assets:</p> <ul style="list-style-type: none"> • Monitoring performance of financial assets of fishers and the project itself. • Facilitate access to credit and/or funding opportunities beyond project contributions <p>1.4 Response of Social Assets:</p> <ul style="list-style-type: none"> • Monitor the response of fishers in terms of development of cooperative economic relationships. • Monitor the performance of existing fishermen's' groupings, cooperatives and other formal or informal 	<p>See Financial Summary</p>	<p>Final Technical Report Submitted to DFID.</p>	

<p>institutions for collective action</p> <ul style="list-style-type: none"> Facilitate improved performance where necessary <p>1.5 Promote development of Human Assets of coastal fishing communities:</p> <ul style="list-style-type: none"> Undertake training activities in the development of fishing skills within target and associate fisher groups. Monitor application of new learning related to post-harvest activities. Develop FADs training materials. Monitor and facilitate market performance and market knowledge within fishing communities and of other stakeholders in marketing FAD-caught fish. <p>2. PIPS - Facilitating the institutional context to deployment of FADs</p> <ul style="list-style-type: none"> Develop detailed briefs on legislative requirements related to deployment of FADs / ownership issues. Develop detailed briefs on legislative requirements related to export of pelagic species. Develop detailed briefs on legislative requirements related to the legal context of cooperative ventures. Develop detailed briefs on tariffs associated with fishing gears related to FADs. <p>3. Monitor the Impact of Threats and Vulnerabilities</p> <ul style="list-style-type: none"> Monitor the impact of local oceanography and seasonal weather that prevents access to the FADs. Monitor for conflict between user groups. Develop practical responses to conflict, including building on work carried out in FMSP Project R7334 and the activities of the World Fish Centre. 			
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11 KEYWORDS

Fisheries Development; Fisheries Training; Fish Aggregation Devices; Large pelagic species; Tanzania; Technology transfer.

12 LIST OF ACRONYMS

CCAfrica	Conservation Corporation Africa (Mnemba Island)
CMAs	Collaborative Management Areas
DFiD	Department for International Development
DFMR	Department of Fisheries and Marine Resources (Zanzibar)
DRC	Democratic Republic of Congo
DWFN	Distant Water Fishing Nations
EEZ	Exclusive Economic Zone
EPOPA	Export of Organic Products from Africa
EU	European Union
FAD	Fish Aggregation Devices
FFEM	Fonds Français pour l'Environnement Mondial
FMSP	Fisheries Management for Science Purposes
GEF	Global Environment Facility
HACCP	Hazard Analysis Critical Control Point
IMS	Institute of Marine Sciences
IOTC	Indian Ocean Tuna Commission
IUCN	The World Conservation Union
MACEMP	Marine and Coastal Environment Management Project
MALNR	Ministry of Agriculture, Livestock and Natural Resources (Zanzibar)
MANREC	Ministry of Agriculture, Natural Resources, Environment and Cooperatives
MBREMP	Mnazi Bay Ruvuma Estuary Marine Park
MCS	Monitoring, Control and Surveillance
MFDC	Mbegani Fisheries Development Centre
MIMP	Mafia Island Marine Park
MNRT	Ministry Natural Resources and Tourism
MPA	Marine Protected Area
MPRU	Marine Parks and Reserves Unit
MRAG	Marine Resources Assessment Group
MSY	Maximum Sustainable Yield
NGO	Non-Governmental Organisation
NSGRP	National Strategy for Growth and Reduction in Poverty
SADC	Southern Africa Development Community
SPC	South Pacific Community
TAFIRI	Tanzania Fisheries Research Institute
TCMP	Tanzania Coastal Management Partnership
TCZCDP	Tanga Coastal Zone Community Development Programme
URT	United Republic of Tanzania
WWF	World Wide Fund for Nature

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14 ANNEXES