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A COST-BENEFIT ANALYSIS OF FADS IN THE ARTISANAL TUNA FISHERY IN RAROTONGA

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SUMMARY:

A year long creel-census of the artisanal offshore fishery of Rarotonga was conducted, in a effort to investigate the cost-benefit of FADs. An average coverage of 18.8% was effected.

Species and size compositions of catches were recorded, and volume and value of landings were estimable for each reef sector and FAD fished, and for each fishing method employed.

Trolling on FADs was NS$0.92/Line.Hour more productive than trolling elsewhere, resulting in increased landings worth $10,500. Down-fishing landings form FADs were worth $26,500. The three FADs were in operation for only 46% of the survey year, yet still produced a 312% return on expenditure.

1. Introduction

Fish aggregating devices have been deployed off Rarotonga since 1980 (see Table 1 and Figure 1). Since their deployment, there has been a marked increase in catches by the local trolling fishery, which targets mainly surface tunas and other pelagic fishes. These catch increases have been accompanied by reported increases in the cost-effectiveness and number of boats participating in the fishery. Similar benefits have been widely noted, and FADs represent an integral part of any strategy for enhancement of tropical surface fisheries.

Fishing trials by SPC Master-Fishermen and local Fisheries Officers, and the enthusiasm of local fishermen, have proved the success of the FAD programme in Rarotonga. An analysis of the FAD programme in Hawaii from 1980-82 provided catch estimates from 26 FADs. These estimates were evidently based on fishermen's reports, and although "about 900,000 pounds of fish were reportedly caught at the bouys, ... the actual amount ... probably exceeded 2.5 million pounds", (Anon, 1982, p2). A cost benefit ratio of 1:3 was estimated for the FADs deployed but benefits were considered as all catches taken at FADs, rather than real improvements in catch rates provided by FADs. Buckley (1986) had used test-fishing data to clearly demonstrate the enhancement value of FADs in American Samoa. A comprehensive study of the "bonitier" fishery in Tahiti (Depoutot, 1987) was, however, les conclusive, with better fishing (CPUE expressed in terms of number of fish per day), around flotsam and baitfish schools than FADs. Catches were analysed for species and size-class proportions, but no economic evidence was provided relating FADs to the fishery.

FAD programmes are still, then, often viewed as short-term development initiatives providing, perhaps, better catches, or perhaps simply disappearing down the outer-reef slope. Consequently, FAD programmes encounter some difficulty in attracting long-term financial support for the considerable capital costs involved. Administrators of national and external funding sources might be better persuaded by definitive evidence of the real economic benefits of FADs. This work attempts to provide a 'bottom line', by estimating the value of FADs to an actual fishery.

A survey programme of the Rarotongan artisanal tuna fishery was initiated in August, 1986. The primary aim was to determine the cost-effectiveness of FADs by examining the

effort, and landings of fishermen working the FADs, and to thereby determine the economic benefits FADs bring to the fishery.

2. Methods

The survey consisted of a year-long creel-census of fishermen working out of the three small-boat harbours of Rarotonga (Figure 1). Sampling was every second day, at alternate sides of the island (Town: Avarua and Avatiu harbours; and Ngatangiia harbour). Each harbour was, then, surveyed every fourth day, resulting in approximately 25% coverage.

Fishermen were interviewed upon return from trips, and information obtained on location (reef zones or FAD fished) effort, and catch (length and species), for each fishing method employed. A specimen data sheet is attached (Appendix 1).

Individual lengths were the easiest measure to obtain on the wharf or beach, and approximate weights were obtained from the lengths, for the purposes of this paper, by rough estimation. It is intended to re-analyse the data with more accuracy, and in greater detail, once length-weight plots for each species are compiled on a computer data-base.

The commercial values of fish were the average beach prices during the survey year. By-catch prices were estimated according to the average value, on the basis of the proportional species composition of the by-catch for each fishing method.

3. Results

3.1 Coverage

Data was collected over 137.5 survey days,with 400 trips recorded. Survey activities were cancelled for over a month, after Cyclone Sally hit Rarotonga (when little fishing took place, anyway), and another 45 days were either not surveyed, or the data was discarded as insufficient, or too inaccurate. Average coverage was then 18.8% giving a conversion-factor for full year estimates of 5.32.

3.2 Effort by Harbour

No-fishing days were highest at Ngatangiia in the east (facing the trade winds) where no trips occurred on 40% of the days surveyed. In town, only 7% were no-fishing days, as weather conditions were usually less inclement, and as both larger boats, and a greater number of boats work out of the harbours in town. Average number of trips on fishing

days and maximum number of trips on any one day were about three times higher in town than at Ngatangiia (See Table 2).

3.3 Trolling Catch and Effort

Trolling data shows that the south eastern zone produced far better catch rates (2.6 kg/line hr) than for other reef zones (average C.P.U.E. for all reef zones 1.5 kg/line hr). FADs proved the next most productive fishing area, with an average catch rate of 1.8 kg/line hr. (See Table 3 (A)). The greatest effort, however, was expended in the north western zone and at FAD No 1 (25.4% and 25.1% of total line hours), as these zones were closest to the town harbours, and in the lee of the trade winds. Notably, FAD No 1 was only in place for 124 days out of the entire year. Overall, FADs attracted 43.2% of effort, while the average period for each FAD to be operable was only 46% of the survey year. (See Table 1)

3.4 Trolling Catch Composition and Value

Although trolling around FADs produced a significantly higher number of fish than from around the reef, the greater size of fish caught off the reef means that FADs produced only 46.3% of total trolling landings in terms of weight. (Table 4 (A)) The average weight of yellowfin tuna from the FADs was only 7.2 kg while from the reef zones was 9.5kg. Further, a significant proportion of the catch from reef zones was wahoo (16.5% of number; 35.7% of weight), with an average weight of 23.6 kg.

The higher value of yellowfin and wahoo also increased the returns from trolling in reef zones, whereas FADs produced a greater proportion of less valuable skipjack. Only 45.9% of the value of trolling landings came from FADs. Nevertheless, the higher C.P.U.E. from FADs means that even though fish were smaller, and of less valued species, the average economic return from trolling around FADs was NZ$0.91/line.hour greater than that from trolling elsewhere.

3.5 Down-Fishing

All of the down-fishing catches were taken on FAD No 1, up until its loss on January 1st, in Cyclone Sally.

A total of 1,820 line hours were spent down-fishing, of which 69% was paru-ahi, and the remainder vertical long-lining (V.L.L.). Most boats which undertook V.L.L. usually dropped palu-ahi lines between V.L.L. sets.

V.L.L. proved far move productive, with catch and return rates of 4.3 kg/line.hour, and $21.20/line.hour respectively. Most V.L.L.s were rigged with between 8 to 15 hooks. As palu-ahi lines consisted of single hooks, the catch rate per hook hour was markedly greater for palu-ahi.

3.6 Total Landings

Total landings of 47.6 tonnes of fish, worth an estimated NZ$226,000, consisted of 42.1 tonnes from trolling, and 5.5 tonnes from down-fishing. This production figure from down-fishing, along with the 19.7 tonnes from trolling on FADs, gives a total volume of catches from FADs of 25.2 tonnes (53% of all landings), worth NZ$119,600. (see Tables 4(A) (iii) and (iv), and 4(B))

4. Discussion

4.1 Real FAD Value

In the absence of FADs, trolling effort will largely be directed elsewhere (although perhaps somewhat decreased), and so the figure given above for value of FAD landings does not represent the real benefit of FADs. Without considering variables such as the influences of FADs on fish behaviour or fishing patterns, a rough estimation of the real value of the FADs can be obtained by using the difference in economic returns per unit effort between FAD and non-FAD trolling.

With trolling returns $0.92/line.hour more productive than reef trolling, and 11,412 hours of FAD trolling throughout the year, the presence of FADs meant an extra $10,500 worth of fish were landed from trolling. With the further assumption that down-fishing activities did not cause a decrease in trolling effort, (as downfishing was usually conducted throughout the day, while most FAD trolling occurs on the dawn or dusk 'bite'), the total down-fishing returns of $26,500 may be added to give a total benefit from the FADs of $37,000.

If three FADs had been in place year-round, a 117% increase in these benefits could have been expected (with assumed null net influences of seasonal fish and fishing distribution patterns), with estimated returns of $80,500.

4.2 FAD Cost-Benefit Analysis

The costs for materials for a single FAD are around NZ$4,000. With increased fishing returns of $12,500 per FAD, returns of 312% on FAD expenditure are realized.

There are, of course, other minor costs for construction and deployment of FADs, but similarly, there are tangible and intangible benefits from a continuing FAD programme which reach far beyond actual value of fish landed. These benefits, which include increased employment opportunities, development of supporting industries, improved nutrition, and import substitution, make the returns from FADs of even greater significance to small Pacific Island countries.

5. Conclusion

Trolling around FADs produces higher returns, in terms of CPUE, and $PUE, than trolling in other areas. FADs also enhance the development of highly productive down-fishing activities.

For the survey period, landings from trolling on FADs were only slightly less than from other areas despite the fact that the three FADs were each only in place, on average, for less than half the survey period. With down-fishing landings included, FADs contributed the largest proportion of the volume and value of total landings, and realized an overall increase in landed fish value of $37,000. If three FADs had been in operation year-round, the increase in landed value would have been around $80,500.

On a cost-benefit basis, of material costs and landed value benefit, FADs provide returns of 312%, along with a range of flow-on benefits for developing fisheries and small-island country economies.

REFERENCES

ANON (1982) Hawaiian Fish Aggregating Bouys. Division of Aquatic Resources. Department of Land Natural Resources.

BUCKLEY, R. (1986) Fish Aggregating Device (FAD) Enhancement of Offshore Fisheries in American Samoa. SPC Fish. Newsletter No 37, p37-41.

DEPOUTOT, C.(1987) Contribution a l'etude des dispositifs de concentration de poissons a partir de l'experience Polynesienne. Notes et Documents No 33. ORSTOM, Tahiti.

TABLE 1

FAD HISTORY DURING SURVEY PERIOD

FAD No	1	4	5	Average
Deployed	Early '86	24/10/86	24/10/86	-
Lost	1/1/87 (Sally)	1/1/87 (Sally)	Still in place	-
Days in place	124	68	311	168
% Year in place	34%	19%	85%	46%

TABLE 2

FISHING EFFORT BY HARBOUR

	NGATANGIIA	TOWN	TOTAL
DAYS COVERED	65.5	72	137.5
% DAYS COVERED	17.9	19.7	18.8
TRIPS SURVEYED	105	295	400
TRIPS FOR YEAR	587	1,485	2072
AVGE TRIPS/DAY	1.6	4.1	5.7
MAX. NO. TRIPS FOR ONE DAY	5	13	-

TABLE 3

CATCH AND EFFORT

(A) TROLLING

	REEF ZONE				TOTAL	FAD NO.			TOTAL	
	NW	NE	SE	SW	REEF	1	4	5	FADS	TOTAL
VISITS	830	436	431	452	2149	580	118	388	1086	3235
LINE HRS	6703	3398	2681	2335	15117	6629	740	4043	11412	26529
% EFFORT	25.4	12.5	10.1	8.8	56.8	25.1	2.8	15.3	43.2	100
C.P.U.E. (KG/LINE HR)	1.32	0.93	2.58	1.49	1.48	1.60	1.86	1.90	1.72	-
$.P.U.E. (NZ$/line.hr)					REEF 7.24				FADS 8.15	

TROLLING DIFFERENTIAL: FADS-VS-REEF NZ$ 0.91 /line.hour

(B) DOWN-FISHING

	V.L.L.	PARU AHI
VISITS	106	176
LINE HRS	569	1218
C.P.U.E. (KG/LINE HR)	4.3	2.7
$.P.U.E.	NZ$ 21.2	NZ$ 13.2

TABLE 4

LANDINGS AND VALUE BY SECTOR AND SPECIES

(A) TROLLING

	REEF ZONES					FADS			
	NW	NE	SE	SW	TOTAL REEF	1	4	5	TOTAL FADS
(i) Total No. Fish									
YF	202	149	532	160	1043	569	133	798	1500
SJ	53	16	144	335	548	1266	0	628	1894
WH	202	69	48	21	340	0	0	5	5
ETC	69	11	27	21	128	27	37	5	69
TOT YEAR	526	245	751	537	2059	1862	170	1436	3468
(ii) Avge Wts (kg)					AVGE REEF				AVGE FADS
YF	12.7	9.8	8.1	9.4	9.5	8.7	6.9	6.2	7.2
SJ	4.9	3.6	6	3.7	4.4	4.2	0	4.1	4.1
WH	24.1	22.2	24	22.7	23.6	0	0	13.6	13.6
ETC	16.8	10.9	22.7	13	17.7	12.9	12.5	15.9	15.9
(iii) Total Catch (kg)					REEF CATCH				FAD CATCH
YF	2565	1460	4309	1504	9838	4950	917	4947	10815
SJ	259	57	864	1239	2420	5317	0	2575	7892
WH	4868	1531	1152	476	8028	0	0	68	68
ETC	1159	119	612	273	2165	348	462	79	890
Total for Zones	8852	3169	6938	3493	22453	10615	1380	7669	19666

TOTAL TROLL CATCH = 42,119 KG

(iv) Catch Value (NZ$)

Fish Prices: YF AND WH = $5.00/kg
: SJ AND ETC = $4.40/kg

Fish spp	Total Landed Value REEF	FADS
YF	49,194	54,078
SJ	10,651	34,724
WH	40,143	340
ETC	9,526	3,917
TOTAL	109,515	93,060

TOTAL TROLL VALUE = NZ$ 202,575 per annum

TABLE 4 (cont)

(B) DOWN-FISHING

	SPP	V.L.L.	PARU AHI	TOTAL
(i) Total No. Fish				
	YF	128	175	303
	ETC	11	42	53
(ii) Avge Wts (kg)				
	YF	16.8	15.9	
	ETC	22.7	9.0	
(iii) Total Catch (kg)				
	YF	2150	2782	4933
	ETC	250	378	628
	TOTAL (kg)			5561

(iv) Catch Value (NZ$)

Fish Prices : YF $5.00/kg
: ETC $3.00/kg

Total Landed Value = NZ$ 26,548

TOTAL LANDED VALUE TROLLING
AND DOWN-FISHING = NZ$ 229,123

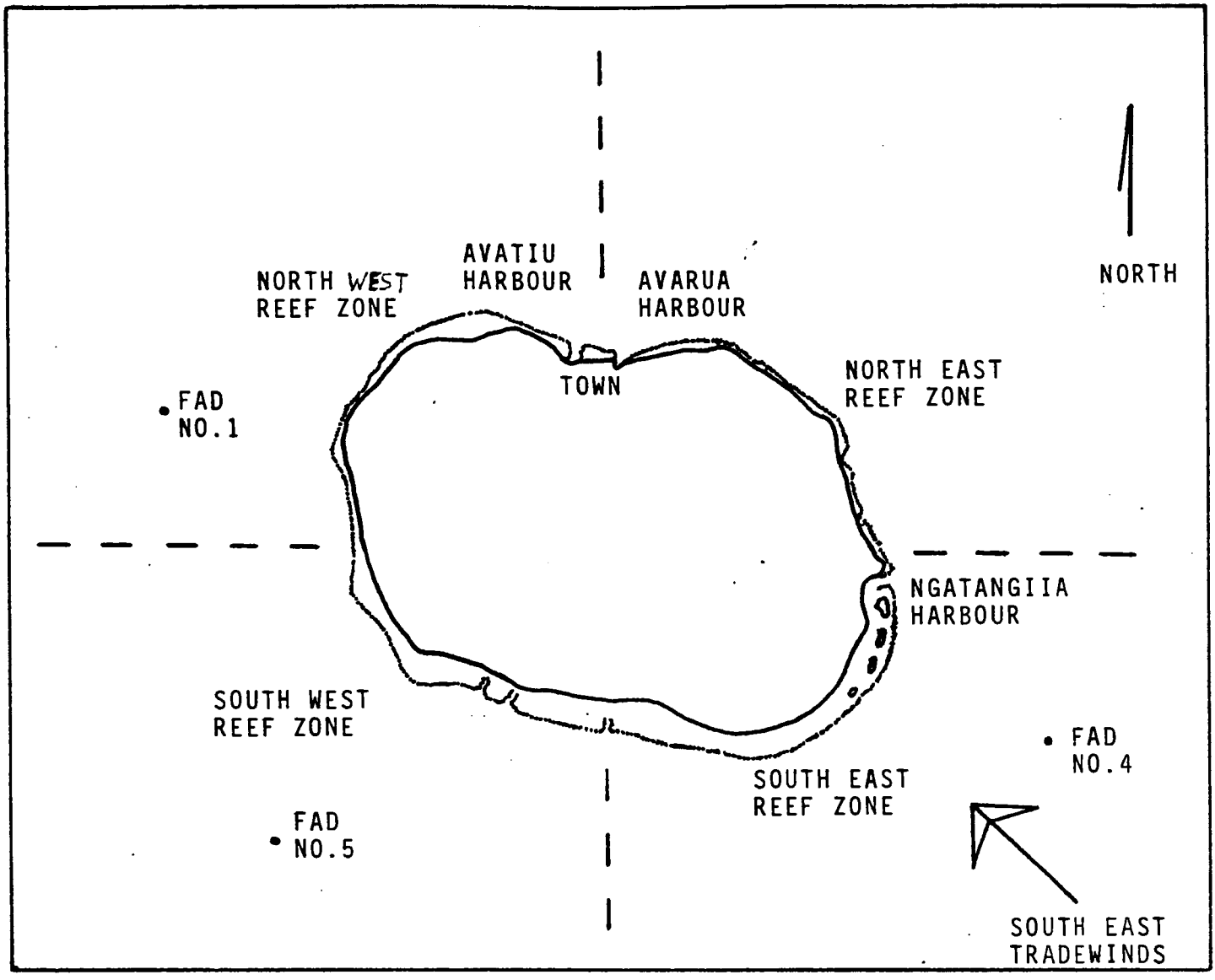

FIGURE 1: RAROTONGA, SHOWING FAD LOCATIONS, REEF ZONES AND HARBOURS