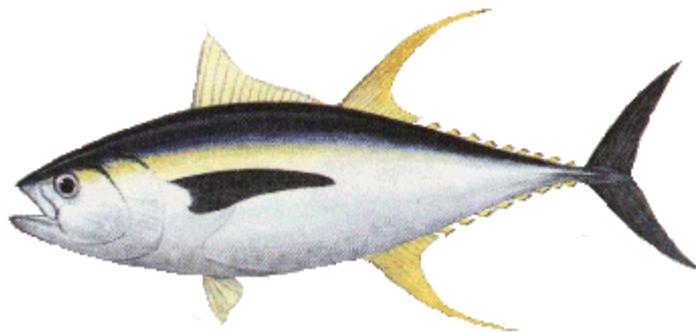


Summary

- A creel survey program on Rarotonga's artisanal coastal fishers was conducted during 1998 to determine the fishery production in terms of volume and value.
- Fishing trips were categorized into three methods, drop-line, vertical long-line and troll, with two locations, at the Black Rock FAD and along the reef coast.
- The most popular fishing method was troll fishing which comprised 94% of all trips covered with 412 trips made at the FAD and 366 trips made along the coast.
- Drop-line fishing proved to be the most effective with an average catch of 48.4 kg or NZD290 per trip.
- Average catch rate for vertical long-line was 32 kg or NZD190 per trip and troll fishing averaged 20kg or NZD120 per trip.
- Production for troll fishing was estimated as 5.2kg/trip/km⁻² at the Black Rock FAD and 0.6kg/trip/km⁻² for the coast.
- Yellow fin tuna formed a major component of the total catch for all methods during 1998.
- Total landings from troll fishing was estimated as 35mt worth an estimated NZD210,000. Sixty-one percent of total landings for 1998 came from the coast and 39% from the FAD.
- The cost of a single FAD is approximately NZD7, 000, with estimated returns during 1998 of NZD69, 000, this represents a ten-fold increase in the coast of deploying a FAD.



INTRODUCTION

Like many Pacific Island nations the Cook Islands have increased the national catch of tunas and associated species through the use of fish aggregate devices (FADs). The FAD program in the Cook Islands started in the early 1980s and there has been over 60 FADs deployed. Since the deployment of FADs there has been a marked increase in the number of fishing boats targeting primarily surface swimming tunas. The increase in fleet size has created local employment and has been accompanied by reported increase in the catches by artisanal fishers.

The artisanal fishery on Rarotonga is comprised of 80 small vessels (3-7 meters), powered by outboard motors between 25 – 70 hsp. The capital cost for a single fishing craft is within the order of ten to twenty thousand dollars (NZ). The boats are rigged mainly for trolling, and are generally manned by one to two fishers. Troll trips generally occur in the morning and afternoon using between 2 to 6 hooks. To further utilised the FADs the Ministry of Marine Resources has conducted several workshops based around the less practiced mid-water (drop-line and vertical long-line) fishing methods. Most verticals long-lines are rigged with 10 to 20 hooks and drop-lines consist of a single hook with ground bait. The two methods are occasionally conducted on a single trip where drop-line fishing occurs between vertical long-line sets. Fish caught by the artisanal fishery are generally sold whole and prices range from NZ\$5 to NZ\$7 per kilogram depending on species and supply.

A creel survey program on Rarotonga's artisanal fishery was initiated in 1996. The primary aim of the program was to determine the fishery production in terms of volume and value by examining effort and catch statistics of artisanal fishers working in the coastal zone of Rarotonga. This report is based on the fishing patterns, catch rates, composition and annual production of fishing along the coast and at the Black-Rock FAD¹ on Rarotonga during 1998.

A second objective was to use Rarotonga as a trail for conducting creel-census to gain insight into the problems associated with collecting fisheries information from a vast number of fishers which land their catch at various times of the day at a number of

¹ Two FADs are normally in place on Rarotonga, however due to financial constraints only the black rock FAD was in place during 1998

locations. This second objection will assist MMR staff in gaining experience in data collection, which will permit appropriate analyses and interpretation of results before embarking on a comprehensive nation wide fisheries production survey.

DATA COLLECTION AND ANALYSIS

Data for this report was obtained by annual creel-census of artisanal fishers on Rarotonga. Fishers were interviewed on a daily basis upon returned fishing trips, and information on the fishing location (FAD or along the coast), method (troll, vertical long-line, drop-line) and catch by species (numbers and mass in kilograms) were recorded. Fishes caught within a radius of one kilometre of the FAD were recorded as FAD caught or associated fish whereas coastal fishes were those not associated with FADs. Fish species captured were recorded on log sheets and logged in a data base having the following index 'ALB' albacore, 'YFT' yellow fin tuna, 'SKJ' skip jack tuna, 'MAR' all marlin species, 'WAH' wahoo, 'BAR' barracuda, 'MAH' maimai, and 'OTH' all other species combined e.g. sharks, rainbow runner etc. Data is continuously logged into a database on a monthly basis using Microsoft Access for analysis at the end of each year. Logged records currently number some 1350 from the year 1996 to December 1998 with 825 records for 1998.

A unit of fishing effort for each method was investigated by looking at the distribution of the pattern of each fishing trip by location and method. This included an analysis of average number of, (1) trip length (i.e. hours), (2) fishing trips per day and (3) fishing days per month, for each fishing method (i.e. drop-line, long-line and troll) by location (i.e. FAD and along the coast). Effort units were based on the number of fishing trips per day and fishing days per month and were crossed checked with anecdotal information provided by fishermen. Where large discrepancies lie between the sampled information and that reported by fishermen the sampled information were raised accordingly.

DISCUSSION OF RESULTS

Fishing Patterns

A total of 825 fishing trips were recorded over 217 survey days (1998 data only). Fishing trips could be categorized into three methods, 1) drop-line, 2) vertical long-line and 3) troll and with two locations, 1) FAD and 2) along the coast. Only eight drop-line trips occurred at the FAD over six days in the total sample during 1998. In comparison, there were 33 vertical long-line trips at the FAD and 5 trips occurred along the reef coast during the same period. But the most popular fishing method was troll fishing which comprised 94% of the fishing effort with 412 and 366 trips made at the FAD and along the coast respectively (Table 1).

There were notable differences between fishing methods. Average number of hooks used for long line were five to six times greater than that used for trolling. Also troll trips were generally half the duration of long line trips (Table 2). Excluding drop line fishing, the distribution of the average number of hooks and average trip lengths for each method by location showed little variability.

The recorded number of trolling trips sampled per day ranged from 2.2 to 2.4 for the coast and FAD respectively (Table 1). However fishermen reported an average of 5.2 trips per day for both locations. The trips sampled per day were 56% lower than that reported by fishers. The average number of troll fishing days sampled per month ranged from 15.4 for the FAD to 14.9 for the coast. These estimates were 8 and 11% lower than the average number of 16.7 fishing days per month reported by 11 regular fisherman. As a consequence of these discrepancies fishing effort i.e. the number of trolling trips per day and the number of fishing days per month sampled for trolling were raised accordingly for an estimate of monthly yield.

Fishing effort and associated discrepancies could not be defined adequately for vertical long line and drop line fishing due to the small and biased sample sizes.

Table 1. Number of days and trips sample by method of fishing at the FAD and along the coast at Rarotonga during 1998.

Location	Method	No. of days recorded	No. of trips recorded	Trips per day
FAD	Drop line	6	8	1.33
	V. L. L	20	33	1.77
	Troll	142	412	2.4
Coast	V. L. L	3	5	1.67
	Troll	153	366	2.2

Table 2. Average trip length and number of hooks used per trip for each fishing method carried out at the FAD and along the coast by Rarotongan fishers during 1998.

Location	Method	No. of trips recorded	Av. No. of hooks used	Av. trip length (hrs)
FAD	Drop line	8	1.4	4.9
	V. L. L	33	17.2	5.6
	Troll	412	2.9	3.7
Coast	V. L. L	5	18.0	5.6
	Troll	366	3.4	4.0

Catch and Effort by Method and Location

Table 3 shows that drop-line produced far better catch rates (48.4 kg per trip) than vertical long-line and trolling, however caution should be exercised in the use of this information. Drop-line fishing only accounted for 8 of the 824 fishing trips sampled; furthermore only six out of the 217 days sampled involved drop-line fishing. Seven of these trips occurred during mid August and one during early February 1998. For the remaining methods vertical long-line proved to be the most effective where catch rates (kg/trip) were 1.2 and 2 times greater than troll catch rates for fishing at the FAD and along the coast respectively. In addition fishes caught by vertical long-line were one and a half to threes times larger in terms of weight (kg) than those caught by trolling.

Troll fishing produced the most comprehensive data set in terms of the number of trips and species specific catch for both the FAD and along the coast. Catch rates (all species pooled) for trolling showed a similar pattern at the FAD and along the coast where there were peaks during January and September and low catch rates experienced during the pre winter and winter months, March to June (Figure 1 & 3) and pre summer (October – November). The low catch rates experienced at the FAD between March to June could be due to FAD replacement.²

On initial interpretation of the results the coast proved to be the most productive fishing area with an average catch of 42.2 kg per trip and 22.3 kg per trip for vertical long-line and troll fishing respectively. In comparison catch rates for vertical long-line and troll fishing were 22.1 and 16.2 kg per trip at the FAD. However it should be borne in mind that fishes caught within a radius of one kilometer from the FAD were recorded as FAD catch and coastal fishes were recorded as those caught along the reef slope circumference of Rarotonga. The respective fishing areas are calculated as 3.14 km² for the FAD and a conservative estimate of approximately 35 km² for the coast. Production during 1998 for trolling was therefore estimated as 5.2 kg/trip/km² at the Black rock FAD and 0.6 kg/trip/km² for the coast.

Table 3. Total catch and average catch rates in numbers and mass of fish by method and location for Rarotongan fishers during 1998.

Location	Method	Total Catch Nos. of/fish	Catch kg	Catch Rate Nos. fish/trip	kg/trip	Av. Fish.Wt (kg)	Gross Value per trip³
	Drop line	62	387	7.8	48.4	6.2	\$ 290
FAD	V. L. L	47	726	1.4	22.1	15.8	\$ 135
	Troll	1,338	6,490	3.3	16.2	4.9	\$ 95
Coast	V. L. L	21	211	4.2	42.2	10.1	\$ 255
	Troll	1,083	6,997	3.4	22.3	6.7	\$ 135

² During March 1998 the Black rock FAD was lost, a week later a second FAD was installed at the position of the previous FAD. FADs generally require some time in place before they become effective at aggregating fish.

³ Average gross value per trip is calculated as the average price per kilogram of fish (NZD6.00) multiplied by the average catch rate (kg per trip) for each method.

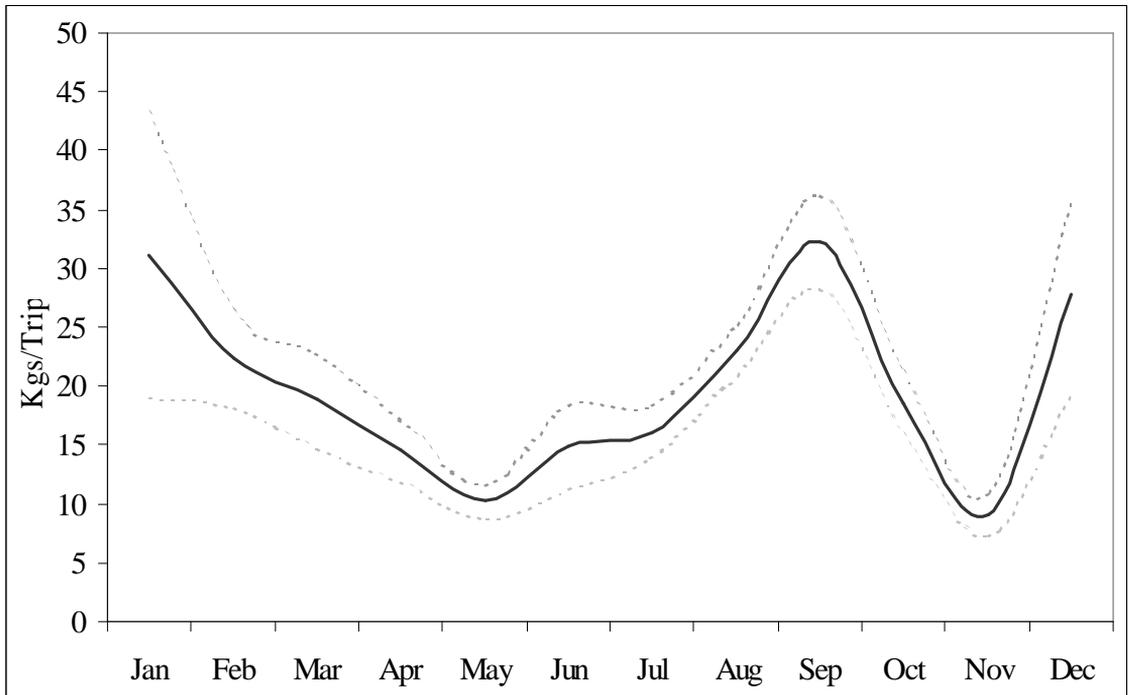


Figure 2. Combined average catch rates (kg/trip) for all species trolling at the FAD and along the coast by Rarotongan fishers during 1998.

Catch composition

The catch composition for drop-line fishing at the FAD and vertical long-line fishing along the coast were entirely made up of yellow fin tuna. For the remaining methods and locations with larger sample sizes, yellow fin tuna also dominated comprising 65% and 76% of the catch for trolling along the coast and at the FAD, respectively (Figure 4 & 5). Albacore tuna only occurred as catch for vertical long-line fishing at the FAD with an absence of skip jack tuna (Figure 3). Wahoo constituted 4% of the vertical long-line and 9% of the troll catch from the FAD, but comprised of 17% of the coastal catch from trolling (Figure 3, 4 & 5). Other species in catch composition for all methods, included marlin, rainbow runner, maimai, barracuda etc.

On a more seasonal basis, yellow fin tuna showed a clear dominance between July to September in the composition of catch for trolling at the FAD (Figure 6), however this

trend is less apparent in the coastal troll catch (Figure 7). There appears to be a general absence of skipjack tuna during the pre winter and winter months.

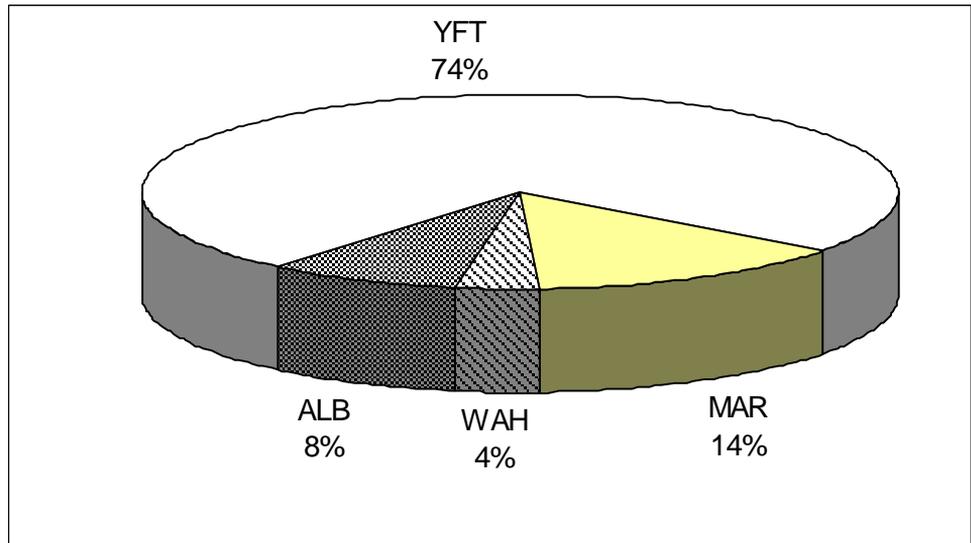


Figure 3. Catch composition for vertical long-line fishing at the FAD during 1998.

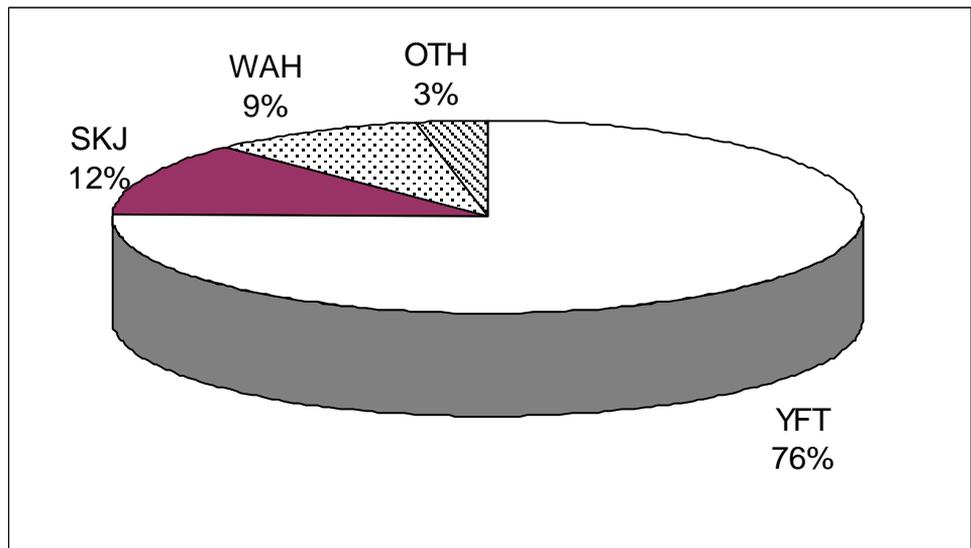


Figure 4. Annual catch composition for troll fishing at the black rock FAD.

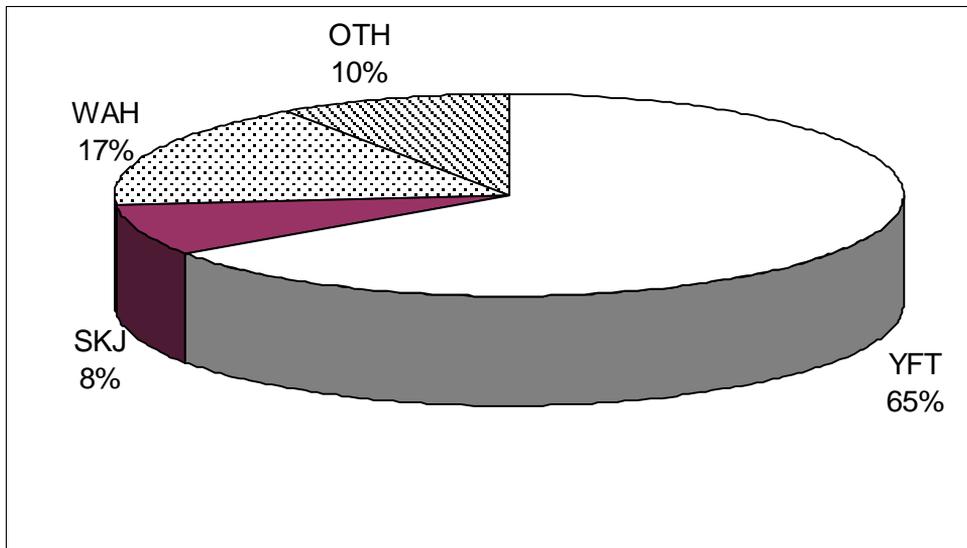


Figure 5. Annual catch composition for troll fishing along the coast of Rarotonga.

Total Production

Total landings for trolling during 1998 was estimated as 35 Mt of fish, worth an estimated NZD210, 000. Estimated production consisted of 21.2 Mt (61%) from trolling along the coast, and 13.7 Mt (39%) from trolling at the black rock FAD. These estimates were obtained by adjusting the raw data using the following formula to account for biases in the raw data.

$$\text{Monthly yield} = \text{Catch rate} \times \text{adjusted trips per day}$$

Where:

catch rate represents the weight of fish caught per trip.

adjusted fishing trips per day represents recorded trips per day raised by a factor of 56%⁴ for the FAD and the coast.

The numbers of fishing days recorded per month were not raised due to little discrepancies (average of ten percent) between fishing days recorded during data collection and those reported by fishermen.

Monthly yields were summed to derive annual yield.

Total production estimates from drop-line and vertical long-line were difficult to determine due to the sporadic nature of fishing effort. However judging by personal communication with fishers, annual total landings from mid-water fishing is probably within the order of 2 to 4 Mt.

⁴ Fishermen reported and average of 5.2 trips per day as opposed to and average of 2.3 trips per day recorded during data collection

Economic Implications

A rough estimation of the gross value per fishing trip showed that mid-water fishing methods produced higher returns ranging from NZD290 per trip for drop line fishing to NZD135 per trip for vertical long line fishing (Table 3). Troll fishing ranged from NZD 95 per trip to NZD135 per trip at the FAD and along the reef coast respectively. Although mid-water fishing methods produced higher returns they only accounted for 6% of the total fishing effort recorded for the Rarotongan artisanal fishery. This suggested that given the number⁵ of mid-water fishing workshops conducted on Rarotonga by the Ministry of Marine Resources, fishers have been reluctant to practice these more effective fishing methods. The availability of preferred bait and gear coupled with the uncompromising motion of the ocean that causes seasickness could however be contributing factors to the lack of mid-water fishing activities.

⁵ Since the establishment of the FAD program in the Cook Islands the Ministry of Marine Resources has carried out seven mid-water fishing workshops on Rarotonga.

The cost for a single FAD is approximately NZD7, 000, with estimated returns during 1998 of NZD69, 000⁶ from troll fishing. This represents a ten-fold increase in the cost of deploying a FAD. If two FADs had been in place year round, an increase in 25Mt could have been expected, with estimated returns of around NZD235, 000. This assumes fishing patterns remains consistent and there are no differences in fish distribution patterns. However in the absence of FADs, fishing effort will largely be distributed along the coast or perhaps a decline may be expected.

Other benefits of the FAD program include increased employment opportunities; support of tourist industry (e.g. supply of fresh fish to restaurants) improved availability of nutrition, and the shift of fishing effort away from the more fragile inshore fisheries resources.

Conclusion

The use of FADs in Rarotonga proves to be an effective tool as a means of assisting fishers. Although the Ministry of Marine Resources has an ongoing FAD program, limited funds are available for the purchase and deployment of FADs throughout the Cook Islands. Given the importance of FADs to artisanal fishers, it is essential that other sources of funds become available. One suggestion is that artisanal fishermen assist by means of providing funds. This could take place by means of licensing artisanal fishing boats or conducting FAD fundraising through fishing.

Rarotongan fishers are well equipped in general trolling techniques. However given the higher returns for mid-water fishing techniques, more emphasis should be placed on the utilization of vertical longline and drop-line fishing. To encourage mid-water fishing more it may appear necessary for the Fisheries Development Unit of the Ministry of Marine Resources to conduct more workshops or one-on-one training approaches.

⁶ This return was based on the estimated total catch of 11.5Mt for the second FAD deployed during mid March and which was lost during mid October.