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**FINAL REPORT
TONGA SMALL-SCALE TUNA
LONGLINE PROJECT**

Pacific Islands Marine Resources Project
Project No. 879-0020

Prepared by RDA International, Inc.
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ABBREVIATIONS

CHH	Catch Rate Per Hook Per Hour
DOF	Department of Fisheries
FAD	Fish Aggregating Device
FIMCO	Friendly Island Marketing Company
GOT	Government of Tonga
MRA	Marine Resources Adviser
OIC	Officer-In-Charge
PCC	Project Coordination Committee
PIMAR	Pacific Island Marine Resource
RDA	RDA International, Inc.
RDO	Regional Development Office
SP	South Pacific
USAID	United States Agency for International Development
USP	University of the South Pacific

TABLE OF CONTENTS

EXECUTIVE SUMMARY	viii
1.0 INTRODUCTION	1-1
2.0 GENERAL PLAN OF IMPLEMENTATION	2-1
2.1 Tuna Fishing Assessment	2-1
2.2 Baitfish Resource Assessment and Management Plan	2-1
2.3 Bottomfish Resource Assessment and Management Plan	2-1
2.4 Development of Small-Scale Tuna Fishing	2-1
2.5 Training	2-2
3.0 TUNA ASSESSMENT	3-1
3.1 1991/1992 Work Plan, Targets, and Results	3-1
3.1.1 Fishing Trials	3-1
3.1.2 Market Trials	3-2
3.1.3 Economic Analysis	3-2
3.2 1993 Work Plan, Targets, and Results	3-2
3.2.1 Fishing Trials	3-2
3.2.2 Market Trials	3-5
3.2.3 Economic Analysis	3-7
3.3 1994 Work Plan, Targets, and Results	3-7
3.3.1 Fishing Trials	3-7
3.3.2 Market Trials	3-8
3.3.3 Economic Analysis	3-9
3.4 Summary of Tuna Fishing Assessment	3-9
4.0 BAITFISH RESOURCE ASSESSMENT AND MANAGEMENT PLAN	4-1
4.1 1991/1992 Work Plan, Targets, and Results	4-1
4.2 1993 Work Plan, Targets, and Results	4-3
4.3 1994 Work Plan, Targets, and Results	4-5
4.4 Summary of Baitfish Resource Assessment and Management Plan	4-5
5.0 BOTTOMFISH RESOURCE ASSESSMENT AND MANAGEMENT PLAN	5-1
5.1 1991/1992 Work Plan, Targets, and Results	5-1
5.2 1993 Work Plan, Targets, and Results	5-1
5.3 1994 Work Plan, Targets, and Results	5-2
5.4 Summary of Bottomfish Assessment and Management Plan	5-2

6.0	DEVELOPMENT OF SMALL-SCALE TUNA FISHING	6-1
6.1	1991/1992 Work Plan, Targets, and Results	6-1
6.2	1993 Work Plan, Targets, and Results	6-1
6.3	1994 Work Plan, Targets, and Results	6-1
6.4	Summary of Tuna Fishing Development	6-2
7.0	TRAINING	7-1
7.1	1991/1992 Work Plan, Targets, and Results	7-1
7.2	1993 Work Plan, Targets, and Results	7-2
7.3	1994 Work Plan, Targets, and Results	7-3
7.4	Summary of Training Program	7-3
8.0	PROJECT ADMINISTRATION	8-1
8.1	1991/1992 Work Plan, Targets, and Results	8-1
8.2	1993 Work Plan, Targets, and Results	8-2
8.3	1994 Work Plan, Targets, and Results	8-3
8.4	Summary of Project Administration	8-4
9.0	PARTICULAR PROBLEMS AND LESSONS LEARNED	9-1
9.1	Provision of Project Vessels	9-1
9.2	Relationship with Ministry of Fisheries	9-2
9.3	Lack of Project Evaluation	9-3
9.4	Regional Impact	9-3
9.5	Project Dependence on Government Facilities	9-3
10.0	PROJECT ACCOMPLISHMENTS	10-1
11.0	APPENDIX	11-1

LIST OF TABLES

<u>Table</u>	<u>Page</u>
3.1 Summary of fishing trial tasks, targets and results	3-11

LIST OF FIGURES

<u>Figure</u>	<u>Page</u>
1 Unloading a 90 kg bigeye tuna from the <i>EKIAKI</i>	x
2 Chartered 35 foot fishing boat <i>Dora Malia</i>	xv
3 Chartered 28 foot snapper boat <i>Seini Koula</i> in its alternate role as village transport vessel	xv
4 Government of Tonga 52 foot fish carrier <i>Ekiaki</i>	3-4
5 Government of Tonga 35 foot baitfish purse seiner <i>Albacore</i>	4-2
6 Crew of <i>Albacore</i> loading the bait net	4-2
7 Local round scads (top) and sardines proved to be excellent bait	4-4



Figure 1 UNLOADING A 90 KG BIGEYE TUNA FROM THE *EKI*AKI

EXECUTIVE SUMMARY

The Tonga Small-Scale Tuna Longline Project, a cooperative venture between the Government of Tonga and the United States Government, is a component of USAID's Pacific Islands Marine Resources (PIMAR) program. The project was situated in Vava'u, a relatively undeveloped island group roughly 280 km from Tonga's Capitol, Nuku'alofa. The contractor, RDA International, Inc., signed the contract in September 1991 and began field operations in November 1991. Field work was completed on September 30, 1994, and final project reports were completed December, 1994. The project was completed on time and within budget, with excellent results. Methods and technologies developed and demonstrated have been enthusiastically adopted by the private sector and Tonga now has a profitable high-quality tuna export industry based on small-scale artisanal vessel operations.

The PIMAR program was originally designed by USAID as a five-year program of assistance for the development of small-scale marine resources activities in the South Pacific. The goal of this program, of which the Tonga project is part, was to increase income generating opportunities for men and women within the Pacific Islands through means which enhance the conservation and management of natural resources. The program purpose was to develop, demonstrate and replicate innovative technologies and strategies which increase the benefits to Pacific Island communities from sustainable, small-scale, private sector uses of marine resources. Within the Tonga project, with the exception of replication, both the goal and purpose of PIMAR were fully met. Successful replication of the Tonga project in other South Pacific countries is both possible and practical, but is beyond the scope of work of the contractor, RDA International.

The national purpose of this project was to develop small-scale offshore tuna fisheries in Tonga and to relieve pressure on bottomfish stocks. The regional purpose was to adapt and demonstrate a widely applicable technology for small-scale (artisanal) tuna fishing. RDA personnel had previously developed and tested such small-scale horizontal longlining techniques in Hawaii and in a USAID-funded project in the Sultanate of Oman, where we achieved some of the highest hook rates ever recorded for long-line gear. One of the principal objectives of the Tonga project was to demonstrate and establish the economic viability and commercial feasibility of these techniques in Tonga for artisanal fishermen using relatively small boats.

The outputs of the Tonga project were: 1) completion of trial tuna fishing operations; 2) assessment of the viability of small-scale tuna fishing vessels and methods, and appropriate technology published and widely distributed; 3) introduction of small-scale tuna fishing gear and methods to the existing fleet and/or design of a prototype vessel with appropriate gear and fishing methods

(depending on results); and 4) completion of assessment and preparation of a management plan for deep bottomfish and inshore resources (i.e., baitfish) in Tonga.

For convenience in reporting and administration, RDA divided the project into six components: tuna assessment, baitfish assessment, bottomfish assessment, tuna fleet development, training, and project administration.

All contracted tasks were undertaken and completed (including new tasks such as testing of a larger longline system). In all activities under contractor control, project targets were met and exceeded. Most importantly, project results were translated into private sector development. Two locally-owned small scale tuna longliners have now entered the fishery and are successfully using the techniques developed and demonstrated on this project.

The results of small-scale horizontal longlining (8 km line) were particularly encouraging. The catch from 50 fishing days exceeded 40 mt, including 20 mt of high-quality tuna. The catch rate of 10.6 fish per hundred hooks demonstrated on this project is approximately five times higher than catch rates recorded in regional longline fisheries using "regional standard commercial" longline gear and techniques. The greatest potential was at Capricorn Seamount, about 150 km from Vava'u. The catch at Capricorn exceeded 18 mt of *sashimi*-grade tuna from just 25 sets, with a tuna catch rate of over 13 fish per hundred hooks. The gear developed by RDA Master Fisherman Joe Marks proved to be economical and easy to use, and could be operated from a much smaller (and lower cost) vessel than those normally employed in tuna longline fisheries.

Comparison trials were also conducted with the longer 32 km longline gear. Results were not nearly as favorable. The total catch rates were only 2.02 fish per hundred hooks, which is about average for the region, but only one-fifth that with the RDA gear. The increased costs from using more hooks was obviously not offset by increased catches. In fact, the catch rate fell substantially because the longer gear could not fish efficiently around seamounts.

An economic analysis of Tonga commercial tuna longlining alternatives was completed in July, 1994. This study showed that a tuna fishing operation using a relatively small 40 to 45 foot vessel and the small-scale RDA gear demonstrated on this project could expect an internal rate of return exceeding 50%. On the other hand, vessels in the 50 to 55 foot range or larger, using standard 32 km longlines, could not operate at a profit in these waters.

The 126 days of small-boat trials using vertical longline and two types of handlines indicated that tuna are extremely seasonal around Vava'u, and that the small snapper boats can only do well during short seasonal peaks of tuna abundance.

The export market trials resulted in favorable prices from Japan, Hawaii, New Zealand, and Australia. The quality and size of the exported Tongan fish met the criteria of these markets, and created interest on the part of overseas buyers. A local fishing operation took advantage of the marketing corridor opened by the project, and began exporting tuna to Hawaii, Japan, and New Zealand.

The trials with frozen and fresh tuna loins were a technological success, but the economics of the export market will not support a viable loining operation at the present time.

The assessment of baitfish resources in Vava'u was an ambitious undertaking which resulted in one of the most thorough studies of large baitfish in the tropical Pacific. It is particularly interesting to note that this research effort was, and had to be, entirely self-sustaining, as neither MOF nor USAID had provided a budget for baitfish field sampling. All costs of these effort were met through sales of baitfish caught during the research program.

The three major species in the baitfishery proved to be excellent tuna baits, and were sold to the project and local fishermen for about half the price of imported bait. The results of the first year of sampling provided an optimistic outlook for the development of a commercial baitfishery. However, a decline in catch rates during year two indicated that the resource must be carefully managed, and that several vessels similar to the *Albacore* could produce excess fishing effort. The baitfish management plan prepared in the project concluded that the resource in Vava'u was sufficient to provide bait for a local tuna fishery, and could be harvested by one mini-purse seiner or several smaller craft.

The bottomfish element included data collection, assessment, and drafting of management options. Although unanticipated and unbudgeted, the additional field sampling undertaken in Vava'u provided a good basis for resource and economic comparison with the Tongatapu fishery. The overall picture of the deep bottomfish fishery was that of a fishery at the limits of economic viability. Catch rates were sustained only because the fleet continued to go further afield in search of new fishing grounds. The larger vessels added to the fleet in recent years have covered most of Tonga's territorial seamounts. Therefore, without strong management action the fishery will exceed optimum economic yield and go into a state of decline. A wide range of management options were submitted to MOF for consideration, but, for a variety of reasons, limited entry and limited effort were the only viable management measures.

A variety of tuna longline and handline techniques were tested during the project, and the results translated into commercial viability. On the basis of these findings, local fishermen and entrepreneurs were made aware of opportunities open to them. A number of local fishermen were trained in the various techniques, and adoption of

small-scale longlining and handlining was occurring. Two 40-45 foot vessels, using the project-developed longline system, joined the local fleet and were reported to be the most successful boats in the fishery.

After assessing the requirements for a developing tuna fleet, it became clear that a specific or unique vessel design was not required for the Tonga fishery. Instead general design guidelines were provided and described.

The training component consisted of long-term training for one fisheries diploma student at USP, three study tours (fisheries management, fisheries administration, fish marketing), and on-the-job training for two MOF counterparts. All of these tasks were completed within the project time frame except for the on-going diploma program. One element, a US masters degree program, was dropped when MOF could not field a candidate.

The normal range of project administrative activities were carried out with a minimum of confusion and mistakes. Procurement and delivery of equipment and supplies, although sometimes delayed, did not adversely affect completion of tasks. All required reports were submitted, and all personnel and subcontractors fulfilled their contractual obligations

As with most projects, there were particular problems encountered and lessons to be learned. Problem areas in the Tonga project revolved around government-provided fishing vessels and facilities, deletion of planned USAID evaluations, and minimal effort devoted to regional transfer of project findings and technology.

By the end of field operations, all of the contracted outputs were accomplished: extensive fishing trials were conducted; a new low-cost technology was demonstrated and transferred to the local fleet; and management options and plans were presented for bottomfish and baitfish resources.

In summary, this project met and exceeded design goals and objectives and is a good example of a successful USAID supported project.

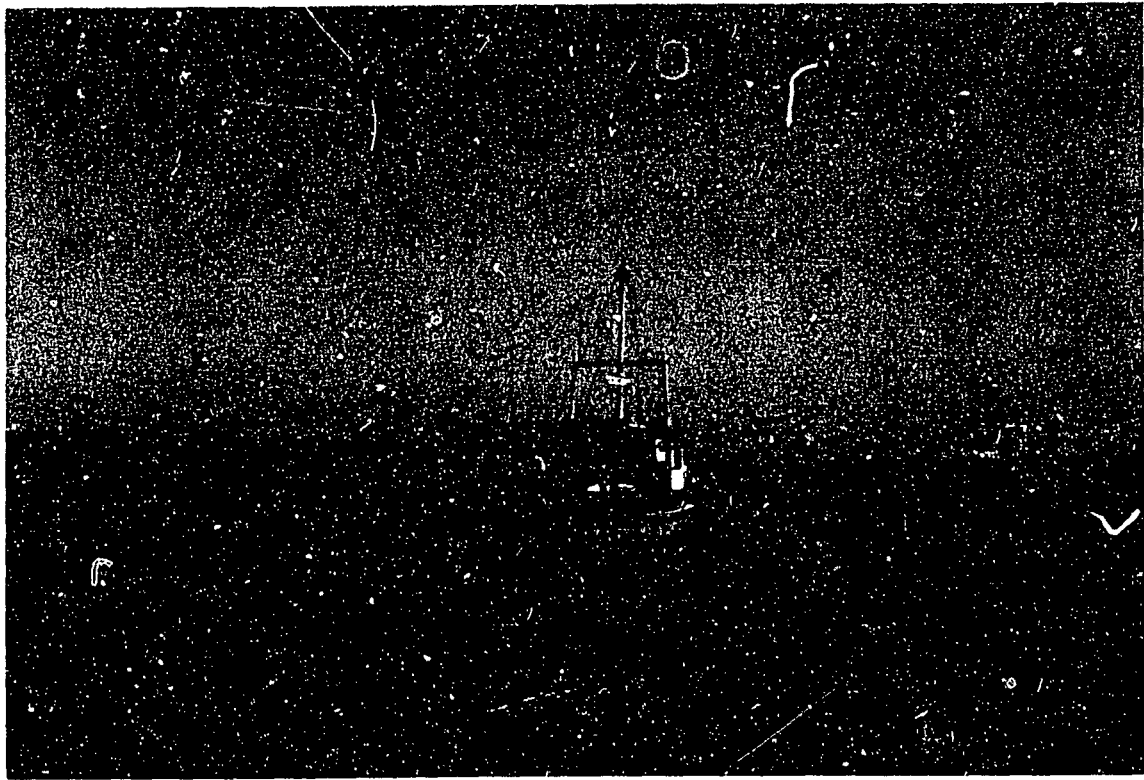


Figure 2 CHARTERED 35 FOOT FISHING BOAT *DORA MALIA*

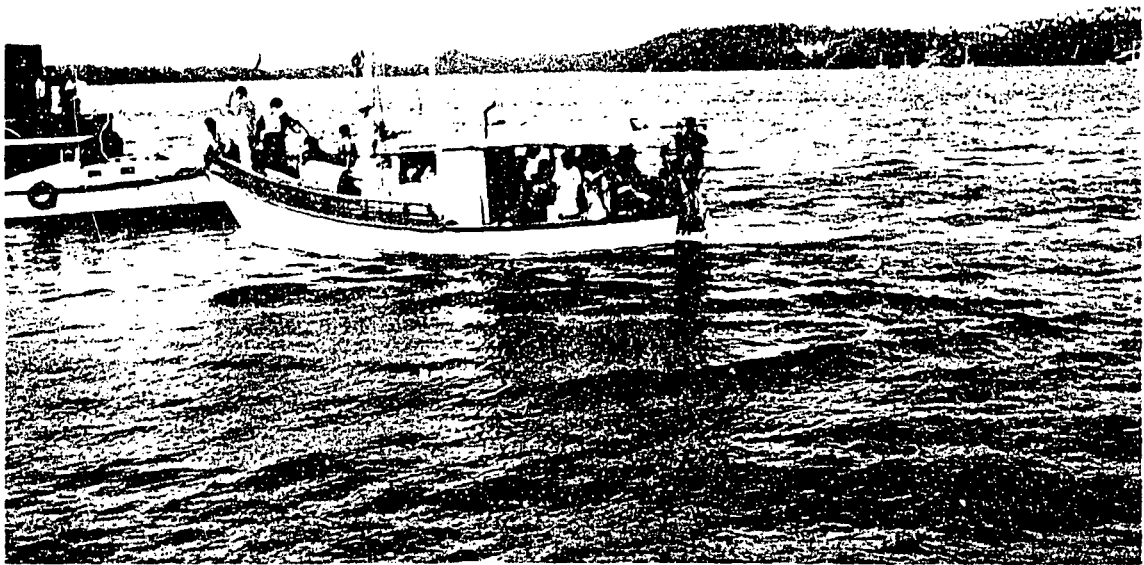


Figure 3 CHARTERED 28 FOOT SNAPPER BOAT *SEINI KOULA* IN ITS ALTERNATE ROLE AS VILLAGE TRANSPORT VESSEL

1.0 INTRODUCTION

The Tonga Small-Scale Tuna Longline Project, a cooperative venture between the Government of Tonga and the United States Government, is a component of USAID's Pacific Islands Marine Resources (PIMAR) program. The project was situated in Vava'u, a relatively undeveloped island group roughly 280 km from Tonga's Capitol, Nuku'alofa. The contractor, RDA International, Inc., signed the contract in September 1991 and began field operations in November 1991. Field work was completed on September 30, 1994, and final project reports were completed December, 1994.

The purpose of the project was to alleviate pressure on deep bottomfish stocks by introducing alternative fisheries to the local small-boat fleet. In general, the objective was to adapt large-boat tuna longline techniques to smaller boats, and to assess the commercial feasibility of these techniques.

The goal of the project as stated in the contract was to "... develop small-scale offshore tuna fisheries in Tonga and to relieve pressure on the bottomfish stocks." The contract also stated that the strategy of the project was to "... rationally utilize the three sectors of the Tongan fishery...". These are the inshore reef and lagoon fishery, the bottomfish fishery and the pelagic fishery, especially tuna. This project concentrated on the pelagic sector as a new source of jobs and income and as a means to relieve pressure on the bottomfish resource.

The contracted outputs of the project were:

- Completion of trial tuna fishing operations
- Assessment of findings on the viability of small-scale tuna fishing vessels and methods, and appropriate technology published and widely distributed
- Introduction of small-scale tuna fishing gear and methods to the existing fleet and/or design of a prototype vessel with appropriate gear and fishing methods (depending on results)
- Completion of assessment and preparation of a management plan for deep bottomfish and baitfish in Tonga

The inputs to be provided by each party were initially set out in the Project Grant Agreement and the Project Contract, and amended by five Contract Modifications. In addition, the Project Coordination Committee specified additional input changes that did not require contract modifications.

The contractual scope of work specified that the Tonga component had the following major elements and secondary components:

- Assessment of small scale tuna fishing
 - Increasing gear efficiency
 - Test lower cost fishing gear and equipment
 - Explore market opportunities having higher returns
- Test three sizes of vessels (28', 35', 40')
- Comparison of open ocean fishing with seamounts and fish aggregation devices (FADs)
- Introduction of small scale tuna fishing gear and methods
- Design of a prototype vessel for tuna fishing
- Assessment of bottomfish and baitfish stocks in Tongan waters
- Preparation of a management plan for deep-water bottomfish and baitfish resources of Tonga
- Other duties
 - Commodity procurement
 - Training
 - Annual work plans and training plans
 - Reporting
 - Coordination

The level of effort of the field staff and consultants, including local hires, was as follows:

Fisheries Development Advisor: Stanley Swerdloff . . .	38 mm
Master Fisherman: Paul Mead	30 mm
Master Fisherman: Joe Marks, Jr.	24 mm
Fisheries Biologist: Viliami Langi (local hire)	24 mm
Bottomfish Data Analyst: Sarah Langi (local hire)	6 mm
Shoreside Engineer: Henry Simpson (local hire)	16 mm
Secretary: Haia Vaitai (local hire)	30 mm
Sr. Biological Consultant: Michael King	4 mm
Marketing Consultant: Paul Bartram	5 mm
Fisheries Economist: Peter Phillipson	1 mm
Fisheries Economist: John Rowntree	2 mm

For convenience in reporting and administration, RDA divided the project into six components. These were:

1

- Tuna assessment
- Baitfish assessment
- Bottomfish assessment
- Tuna fleet development
- Training
- Project Administration

Sections 2.0 - 8.0 of this report review the general plan of implementation, tasks and targets as presented in the annual work plans, and the results for each component. Section 9.0 reviews particular project problems and lessons learned, and Section 10.0 summarizes project effectiveness.

2.0 GENERAL PLAN OF IMPLEMENTATION

The Plan of Implementation, developed in the first months of the project and approved by the PCC in April 1992, defined the scope and time-line of project activities. The general approach for each element is described below.

2.1 Tuna Fishing Assessment

Because little information was available on where and when various tuna species occurred in Tongan waters, the assessment of tuna fishing potential was to be separated into two elements-- exploratory and experimental. The exploratory phase was to begin in November 1991 and last for approximately sixteen months. The idea was to use relatively simple handline and longline gear from 35 foot and 52 foot vessels. After determining seasonal and spatial availability of tuna species, a twenty-nine month experimental phase would ensue, utilizing three sizes of boats and a variety of longline gear. Export market trials were to be conducted throughout the 36-month fishing period, and cost/income data were to be collected from all fishing and marketing activities.

2.2 Baitfish Resource Assessment and Management Plan

The objective of this element was to determine whether adequate baitfish stocks were available in Vava'u to sustain a developing tuna longline fishery. Baitfish research was to be conducted from a MOF-provided 38 foot mini-purse seiner, beginning in February 1992. Because neither MOF nor USAID had provided a budget for baitfish field sampling, the operation had to be self-sustaining, with fish sale revenues funding vessel activities. Baitfish caught in scientific sampling were to be used in the tuna longline fishing trials, with excess to be sold to the public. The sampling and analysis period was scheduled for twenty-four months.

2.3 Bottomfish Resource Assessment and Management Plan

Since an important aspect of the project was to optimize utilization of the deep bottomfish resources of Tonga, a detailed strategy for management of this valuable fishery was to be developed. This required an analysis of prior bottomfish studies and, if necessary, additional data collection.

2.4 Development of Small-Scale Tuna Fishing

Depending on the results of tuna fishing trials and an economic assessment of commercial feasibility, the development of a local longline fleet was to proceed in two areas: extension training of Vava'u fishermen and design of an optimal fishing vessel and gear.

2.5 Training

Training of Ministry of Fisheries staff was to be focused on areas related to project objectives. A training plan was to be prepared, with the specific elements including provision for a US Masters Degree candidate, a Fisheries Diploma candidate at University of the South Pacific (Fiji), short study tours, and on-the-job training.

3.0 TUNA ASSESSMENT

3.1 1991/1992 Work Plan, Targets, and Results

3.1.1 Fishing Trials

The initial phase of fishing trials was scheduled to encompass sixteen vessel-months of exploratory activities, including nine months from a chartered 35 foot vessel and seven months from a MOF-provided 40 foot vessel. The objective was to determine the seasonality and geographic/vertical distribution of major longline species within 100 miles of Vava'u.

The targets were 200 combined fishing days, catches of twenty tons of tuna, and collection of biological, oceanographic, and economic data from each trip.

RDA Master Fisherman Paul Mead arrived on-site in November 1991. His initial tasks were to assist in ordering the fishing gear which would be required during fishing trials. It was anticipated that he would run the chartered 35 foot vessel beginning in January 1993. Master Fisherman Joe Marks began his field assignment in March 1993, with the anticipation that a MOF vessel would be available for fishing trials in April.

The level of vessel effort actually realized was only 115 fishing and scouting days. The reason for the shortfall was that the 40 foot vessel to be provided by MOF proved to be wholly unsuitable. This was documented by the COP in a report to the PCC following thorough sea trials in January 1992. MOF agreed to make the 52 foot *Ekiaki* available in April 1992, but the vessel was not provided to the project until March 1993.

Most of the fishing days accrued during 1991/92 came from the 35 foot *Dora Malia*, which began operations on an "expenses only" basis in November 1991 and was converted to full charter in August 1992 (following open bidding procedures). *Dora Malia*, operated by Master Fisherman Mead, logged 105 fishing and scouting days in the first fourteen months of the project, and provided an accurate assessment of tuna occurrence within 40 miles of Vava'u.

The MOF baitfish vessel *Albacore* was used for tuna fishing during ten days under the direction of Master Fisherman Marks. The objective was to compare handline techniques used on the *Albacore* with the vertical longline and trolling techniques used by *Dora Malia*. The catch from both vessels totalled only 7.1 metric tons (averaging less than 100 kg per day), and reflected a low occurrence of yellowfin and albacore tuna during most of the year, and virtual absence of bigeye tuna within 40 miles of Vava'u. There were, however, four catches exceeding 350 kg/day (two by each vessel) that indicated both handlining and vertical longlining would work when tuna were available in good concentrations. Unfortunately, most of the tuna landed were under the desirable export size of 30 kg, with most in the 15-20 kg range.

3.1.2 Market Trials

Because few fish of export size were landed in 1991/92, no export trials were undertaken and site visits by the Marketing Consultant were postponed. However, virtually all fish caught by project boats were sold on the local market, with one shipment to the Tongan capital, Nuku'alofa. Net revenues of US\$5,200 were collected for the project revolving fund.

3.1.3 Economic Analysis

Fisheries Economist Peter Phillipson developed data collection formats in January 1992, and these were used to collect pertinent economic data, including all operating costs and revenues, for each fishing trip.

3.2 1993 Work Plan, Targets, and Results

3.2.1 Fishing Trials

With the fishing schedule lagging due to the late provision of the MOF vessel *Ekiaki*, the work plan was modified to increase *Dora Malia's* charter by five months through the end of 1993. *Dora Malia's* agenda was to concentrate on experimental fishing with vertical longlines around FADs and seamounts. *Ekiaki* was to provide nine months of mixed exploratory and experimental fishing to distances of 150 miles from Vava'u, using small-scale horizontal longlines and handlines.

The fishing trial targets were 200 sea days (100 for each vessel), definition of fishing grounds and seasonality, comparison of fishing techniques, landings of 20 mt of tuna, and gross sales revenues of T\$40,000. A system of six FADs was to be placed around Vava'u.

The bulk of fishing trials were conducted during 1993, and are reported in the separate RDA report, "Assessment of Small-Scale Tuna Longline Potential, Kingdom of Tonga", August, 1994.

During 1993 the *Dora Malia* and *Ekiaki* combined for 170 sea days (85% of target), landed 21 mt of tuna, provided T\$54,164 in gross revenues, completed definition of the fishing grounds and seasonality, and provided a comprehensive comparison of various fishing methods. Six FADS were constructed and deployed within thirty miles of Vava'u.

Ekiaki was made available in February 1993 and, following partial refitting and repair, began fishing operations in March under the supervision of Master Fisherman Marks. A spate of vessel and gear breakdowns and bad weather hampered operations in late April and May, but by June the vessel was operating on target.

The *Ekiaki* conducted tests of a novel 8 km monofilament longline system, previously developed by members of the RDA professional staff, on 34 trips during the nine month period mid-March to mid-December 1993. The 8 km system utilizes a multi-

purpose hydraulic reel, 700 lb monofilament mainline, and 200-300 droppers/hooks. The droppers are shortened to 3 fathoms, and a leaded swivel is introduced midway in the dropper. Because the system is weighted with leaded swivels, no line shooter is required. This modified small-scale system was particularly effective in areas of fish concentration, such as seamounts. The cost of the system was approximately one-fourth that of conventional "small" longlines, and operating costs were reduced proportionate to the number of hooks.

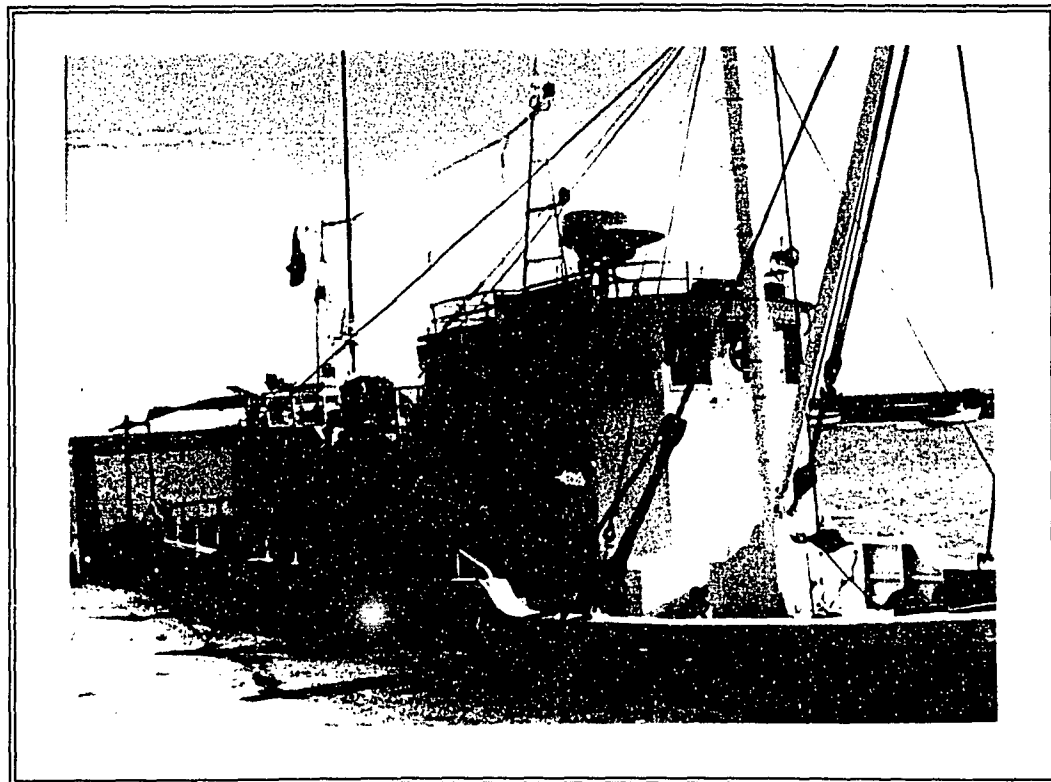
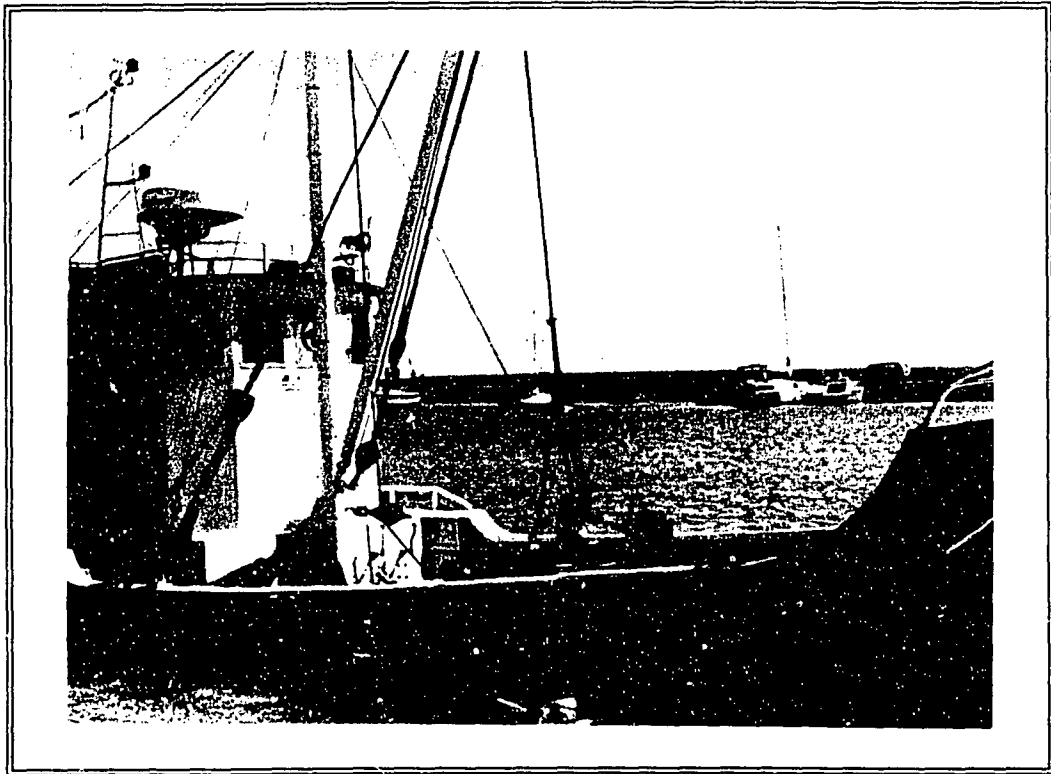
The vessel spent 85 days at sea, including 50 fishing days. The remaining days were running days. *Ekiaki* set the small-scale horizontal longline 50 times, 25 sets in the open ocean and 25 sets around Capricorn Seamount. A total of 12,870 hooks were deployed, an average of 257 per set. In the early trials, sets were made at different times of day and night. The pattern that emerged was that night-time sets were more productive than daytime, but large numbers of unmarketable fish (sharks and oilfish) were caught if the set was made before 3 AM.

The total catch from all 8 km horizontal longline sets was 1367 fish weighing 41,444 kgs. The catch of marketable species was 987 pieces weighing 21,919 kgs. The tuna catch was 921 pieces weighing 20,044 kgs. Approximately one broadbill swordfish was caught per set. Overall catch rate was 10.6 fish per hundred hooks (FPHH), but the catch rates between open ocean and seamount were significantly different.

The catch rates for the 25 open ocean sets averaged 5.2 FPHH, but the catch of marketable species was only 2.6 per hundred hooks. The tuna catch rate was 1.93 FPHH, primarily albacore.

The total catch rate for 25 seamount sets was 16.4 FPHH, with catch rates of 13.1 FPHH for marketable species and 12.7 FPHH for tuna species. Bigeye tuna (38% by number) and yellowfin (32% by number) dominated the catch, especially after the time of setting was modified to reduce incidental catch. The average tuna catch per fishing day was 701 kgs, including 415 kgs of bigeye and 232 kgs of yellowfin.

Figure 4 GOVERNMENT OF TONGA 52 FOOT FISH CARRIER *EKIAKI*



The average size of yellowfin tuna caught with horizontal longline was larger than fish caught on vertical longline, with the number of export-size fish being considerably higher. The bigeye tuna from the seamount averaged 27 kgs, with about 30% of export size.

The *Dora Malia* made 107 trips during the 18-month period August 1992-January 1994. The vessel spent 159 days at sea, using vertical longlines on 89 days. The remainder of sea time was spent scouting and trolling. About 90% of the 432 vertical longline sets were made around FADs, with the balance over sea-mounts.

The total catch from 8,390 vertical longline hooks was 547 fish (8,868 kgs), giving an overall hook rate of 6.52 FPHH. The average catch per day was 99 kgs, of which 82 kgs were marketable. The number of marketable fish was 508 (93%), and 383 (70%) of these were tunas. In terms of weight, 7,268 kg (82%) of the catch was marketable species, including 6,225 kg (70%) of tuna. The catch of *sashimi* species (yellowfin and bigeye) was 271 pieces weighing 4,044 kgs. However, only three of the tuna were of desirable export size; i.e., over 30 kgs. Thus, virtually all of the marketable catch was sold within Tonga.

3.2.2 Market Trials

The results of project market trials are described in detail in the RDA report "Marketing of Tuna From the Kingdom of Tonga, Final Report" submitted in July, 1994. A summary of pertinent information is related below.

Thirty-six shipments of fish were made during 1993 to overseas destinations including Australia, Hawaii, Japan and New Zealand. A total of 271 fish with a headed and gutted weight of 7,840 kg were exported.

Bigeye tuna comprised about three-quarters of the horizontal longline catch and exports during 1993 fishing trials. Yellowfin tuna accounted for most of the remainder. A few albacore were also caught. Bigeye tuna is preferred over the other two species in the *sashimi* market, so the species composition was favorable for export.

Small fish predominated in the catches made by vertical longline and handline gear in nearshore waters and around fish aggregation devices (within 50 nautical miles of Vava'u). Only horizontal longline and handline fishing on offshore seamounts produced a significant catch of exportable fish (> 18 kg). Typically, about 25% of the seamount catch was of prime export size (> 30 kg), 25% was of acceptable export size (18-30 kg), and 50% was too small for export (except to low-value specialty markets).

The quality of each tuna entering the *sashimi* market is evaluated by "grading" the flesh. This qualitative assessment, usually made at every level of tuna distribution, is directly linked to pricing and to consumer satisfaction. During the PIMAR/Tonga export trials, fish were graded according to the Hawaii scale of #1 through #4, where #1 is prime *sashimi*, #2 is acceptable *sashimi*, #3 is marginal for *sashimi*, and #4 is unacceptable for *sashimi* but satisfactory for cooking.

Tuna grading during the marketing trials was limited to fish exported to *sashimi* markets in Hawaii and Japan. Australian and New Zealand tuna buyers do not usually grade tuna flesh, so reports on grade composition were not available for shipments to the latter destinations. Tuna grades were determined in three ways: (a) inspection of fish by the PIMAR/Tonga Marketing Consultant in Vava'u prior to export; (b) inspection of fish by the PIMAR/Tonga Marketing Consultant after arrival in Hawaii; or (c) inference based on reports by Japanese marketers.

About 3,150 kg of tuna were graded. Of these fish, 24% were considered prime (#1, #2 +) *sashimi*, 46% were considered acceptable (#2) *sashimi*, 12% were considered marginal (#3) *sashimi*, and 18% were unacceptable for *sashimi* but suitable for cooking. This distribution of grades compares favorably to other established longline fisheries in the region (Hawaii, Marshall Islands, Fiji).

Since the export shipments were project trials, a special arrangement was made with three Nuku'alofa fish exporters in which the exporters fronted the 'risk money' for packing and shipping costs in return for 50% of the net sales revenues. Thus, returns to the project were artificially low, but the private exporters gained valuable experience in dealing with the tuna export market. Marketing Consultant Paul Bartram worked closely with the exporters and provided training in the handling and grading of export tuna.

Even with the unusual marketing arrangement, net return to the project averaged T\$2.26 per kg -- sufficient to supplement operating funds. If a normal marketing arrangement had been used, the adjusted net marketing revenues would have averaged T\$3.84 per kg.

Feedback from buyers in Hawaii, Japan, and New Zealand was almost always positive, but indicated that the inherent fat content of the bigeye was low for most of the year. Even so, the buyers all said that if steady shipments could be developed, the price would increase substantially.

Two substandard shipments were intentionally sent to Hawaii to prove a point to the *Ekiaki* crew and an exporter that high quality must be maintained. In both cases, the fish appeared fine externally, but internal temperatures exceeded guidelines. Both shipments were graded #3/#4 and the sales price barely covered shipping costs.

As most of the vertical longline and handline fish were below preferred export size, alternative market forms were sought. The primary alternative tested was frozen tuna loins. Over 900 kg of small and medium yellowfin and bigeye was processed into loins, blast frozen, glazed, and stored. The loins retained *sashimi* quality for three weeks, but then degraded to steak quality. There is a large market for frozen tuna steaks, but the current niche price is about US\$3.85/kg. It is estimated that US\$7.70/kg would be necessary for loining to be economically attractive in Vava'u.

3.2.3 Economic Analysis

Detailed cost and revenue data, using the format developed by Economist Peter Phillipson, were collected for all project fishing trips during the year.

3.3 1994 Work Plan, Targets, and Results

3.3.1 Fishing Trials

MOF, acting on advice from external advisors not associated with the USAID project, requested that the focus of the fishing feasibility studies be shifted from small-scale to medium-scale operations. Thus, the horizontal longline trials were altered to assess the feasibility of systems applicable to 45 to 55 foot vessels using 1,000 or more hooks. Because of procurement and refitting considerations, trials were to begin in March 1994 and continue for three to five months (duration dependent on revenues).

Application of longline technology to small boats was to continue with the charter of a 28 foot local snapper boat for a six-month period beginning January 1994. Both vertical and horizontal longlines, as well as handlines, were to be used on the vessel.

The targets for 1994 were 60 experimental fishing days, technical and economic feasibility tests of two boat sizes and three fishing techniques, landings of 10 mt of tuna, gross revenues of T\$20,000, and deployment of four additional FADs.

The *Ekiaki*, *Seini Koula*, and *Dora Malia* spent a total of 96 days at sea in 1994, including 68 fishing days. The three vessels landed 7,614 kg of tuna, and produced gross revenues of over T\$13,000.

The *Ekiaki* was refitted with a new 20-mile reel in March 1994 and tests of the monofilament longline system were made during 15 trips through July. A total of 29 sets were made during 45 sea days, resulting in a total catch of 444 fish weighing 13,885 kgs. The average catch rate for all sets was 2.66 fish per hundred hooks (FPHH), but the two trips to Capricorn Seamount resulted in a hook rate of 4.08 FPHH. The composition of the catch was 7,343 kgs (53%) marketable fish, and 5,425 kgs of tuna (39%). The average tuna catch per day was 187 kgs from the open ocean and 285 kgs from Capricorn Seamount.

Because the tuna generally disappeared from the FADs after February, the *Seini Koula* made only eleven trips on which vertical longlines were set. The total of *Seini Koula's* vertical longline catch was 536 kgs, with an average catch of 38 kgs per day (only 30 kgs per day of marketable species).

Tests of the Hawaiian handline techniques were limited, but productive. Both daytime and nighttime methods were used, and from small and medium vessels.

Only 14 days of daytime trials were conducted, using three lines for a total of 27.5 hours. All trials were around FADs. The catch was 56 fish weighing 947 kgs, including 807 kgs of marketable species. The catch consisted of mostly yellowfin, with a few albacore and one large bigeye. The average catch was 68 kgs/day, with a marketable catch of 58 kgs per day.

Night time handlining (the Hawaiian "ika shibi" technique) gave promising results, particularly for longer range vessels. Trials were conducted in the open ocean close to Vava'u, around FADs, and at Capricorn Seamount.

The small boat trials around Vava'u produced an average catch of 133 kgs per night, of which 110 kgs were marketable. It should be noted that the bulk of these trials were conducted during the tuna "off-season" when virtually no surface schools were seen in the daytime. One trial was made next to a FAD, and this produced 362 kgs in four hours.

Seven "ika shibi" trials were conducted at Capricorn Seamount in conjunction with longline sets, and all produced promising results. Typically, the vessel was put on sea anchor at the conclusion of setting the longline (about 4 A.M.). With the underwater light in place and chum dispersed, fishing commenced with six lines. The catch for 7 hours (approximately one hour per trial) was 7,061 kgs, almost all of which was bigeye tuna. The overall catch rate was 168 kgs per line hour, or 1,009 kgs per night. Fishing effort was limited by ice and hold space.

Following deployment of a seventh FAD in April 1994, MOF determined that the Vava'u area was saturated and that no further FAD deployments were required in those waters. However, MOF did set two additional FADs at Niua'toputapu and Niua'fo'ou, far to the north of Vava'u. Floats and materials for eleven additional FADs are stored at the Vava'u Fisheries Complex for future use.

3.3.2 Market Trials

Two trial shipments totalling 500 kg were exported during 1994. As the fish were combined with catches from a local fishing company, only general information was fed back. All of the fish entered the New Zealand and Japanese markets with good acceptance.

Marketing Consultant Paul Bartram made his third and final trip to Vava'u in May 1994, and completed data gathering and training activities at that time. His final marketing report was submitted in July, 1994, (RDA 94-03).

3.3.3 Economic Analysis

Cost and revenue data were collected from all fishing trips through the end of field activities. This information was sorted and analyzed by Fisheries Economist John Rowntree who, in July, completed his report "The Commercial Feasibility of Small-Scale Tuna Longlining in Tonga" (RDA report 94-05).

The economic analyses indicated that a tuna fishing operation using a 40 to 45 foot vessel and the gear developed in the project, and fishing around a seamount such as Capricorn, had a reasonable expectation of an internal rate of return exceeding 50%. On the other hand, vessels in the 50 to 55 foot range using standard 32 km longlines could not operate at a profit because of a relatively poor internal rate of return.

Further, vertical longlining and handlining were not viable full-time options for the local snapper fleet. Night-time handlining showed the most promise for the small-boat fleet, but only during periods of tuna abundance (about four to six months of the year).

3.4 Summary of Tuna Fishing Assessment

The tasks, targets, and results of the tuna fishing trials are summarized in Table 3.1. All tasks were attempted and accomplished (including new tasks such as testing of a larger longline system). In all activities, targets were met or exceeded. Most importantly, the findings (as described below) were translated into private sector development, as a local company began operating two successful tuna longliners using the techniques developed in this project.

The results of small-scale horizontal longlining (8 km line) were particularly encouraging. The catch from 50 fishing days exceeded 40 mt, including 20 mt of high-quality tuna. The catch rate of 10.6 fish per hundred hooks was roughly five times higher than those recorded in regional longline fisheries. The greatest potential was at Capricorn Seamount, about 150 km from Vava'u. The catch at Capricorn exceeded 18 mt of *sashimi*-grade tuna from just 25 sets, with a tuna catch rate of over 13 fish per hundred hooks. The gear developed by Master Fisherman Joe Marks proved to be economical and easy to use, and required a smaller (and lower cost) vessel than those normally employed in tuna longline fisheries.

The results from trials with the longer 32 km longline (800 hooks) were not nearly as favorable. The total catch rates were only 2.02 fish per hundred hooks, which is about average for the region. The increased costs from using more hooks was not offset by increased catches. In fact, the catch rate fell substantially because the longer gear could not fish efficiently around seamounts.

The 126 days of small-boat trials using vertical longline and two types of handlines indicated that tuna are extremely seasonal around Vava'u, and that the small snapper boats can only do well during short seasonal peaks of tuna abundance.

The export market trials resulted in favorable prices from Japan, Hawaii, New Zealand, and Australia. The quality and size of the exported Tongan fish met the criteria of these markets, and created interest on the part of overseas buyers. A local fishing operation took advantage of the marketing corridor opened by the project, and began exporting tuna to Hawaii, Japan, and New Zealand.

The trials with frozen and fresh tuna loins were a technological success, but the economics of the export market could not support a viable loining operation.

TABLE 3.1 SUMMARY OF FISHING TRIAL TASKS, TARGETS AND RESULTS

Activity	Target	Result
1) Test three vessel sizes 40' (actual 52') 35' 28'	100 days in 12 months 140 days in 17 months 50 days in 6 months	130 sea days 159 sea days 52 sea days
2) Compare seamounts, FADS, and open ocean fishing	No target set	30 seamount sets 51 open ocean sets 463 FAD sets
3) Compare horizontal and vertical longlines	No target set	79 horizontal sets 465 vertical sets
4) Procure and deploy FADs	Deploy 10; 10 in reserve	9 deployed; 11 in reserve
5) Compare imported and local baitfish	No target set	Direct comparison on 10 trips
6) Determine best setting time; set twice daily	Try different times	Experimented in first two months; early AM best; no rationale for two sets
7) Use different horizontal gear and retrieval methods	No target set	Used monofilament and tarred mainline; two types of hydraulic reels
8) Explore low tech processing	No target set	Fresh and frozen loins tested
9) Determine seasonality of large tunas	150 exploratory days	Task accomplished in 139 sea days
10) Reduce bulk of gear	Use various reels and shorter lines	Tested hydraulic and hand reels; successfully used 8 km, 200 hook rig
11) Reduce capital cost	Use smaller boats and reels	40'-45' vessel with 8 km reel proved commercially feasible
12) Find higher market returns	25 export trials	38 export trials to four countries
13) Other fishing targets	Landings of 20 mt of tuna Gross revenues of T\$40,000	Actual landings of 39 mt Revenues over T\$92,000

4.0 BAITFISH RESOURCE ASSESSMENT AND MANAGEMENT PLAN

4.1 1991/1992 Work Plan, Targets, and Results

The baitfish assessment effort was to focus on whether there were adequate stocks of baitfish in Vava'u to support a local longline fleet, and whether the available species would make good longline bait. The primary source of data for this assessment was to be fishing trials which would collect data on various population parameters, such as catch per unit effort, catchability, reproductive factors, growth, and seasonality. The baitfish caught during the biological assessment were to be used in tuna fishing trials on other project vessels.

The first step in the assessment was to determine data requirements and the experimental regime. Once these requirements were established, fishing trials and scientific sampling were to be conducted from the MOF baitfishing vessel *Albacore*, a 38 foot mini-purse seiner. The trials and sampling would be under the supervision of an RDA Fisheries Biologist.

The sampling regime was to include fourteen nights of fishing effort at various sampling sites during the dark moon phase of each month, a depletion experiment in one location, and one complete month of alternate day sampling to test the effects of moon phase on fishing.

In order to fund the operational costs of this elements, catches of usable baitfish were to be sold to the tuna fishing element of the project, local fishermen, and the public.

Although no specific targets were set, it was estimated that at least 90 sampling days could be completed, and gross revenues of T\$4,000 per month accrued.

Senior Fisheries Consultant Michael King visited Tonga in January 1992 to review available baitfish literature, determine data requirements, and develop the appropriate sampling regime. All of the sampling protocols were documented in his report "Assessment of Baitfish Resources in Vava'u, Tonga", drafted during January.

RDA Fisheries Biologist Viliami Langi arrived in early April 1992 (concurrent with arrival of the *Albacore*) and baitfish field operations began in late April. MOF assigned Fisheries Technician Siola'a Malimali as full-time data collector for the baitfish element.

The level of fishing effort by the *Albacore* did not come close to meeting the expectation of ninety nights. In fact, only 28 sampling trips were accomplished during the 8 1/2 work months of 1992. This shortfall was due to a combination of bad weather, vessel and gear breakdowns, and crew problems. Three elements of the baitfish program were negatively affected by the shortfall in effort. These were lunar month sampling, depletion experiments, and geographical distribution. However, the catches per trip were much higher than expected (606 kg per set; 16.2 mt total), and the quality of sampling data was excellent.

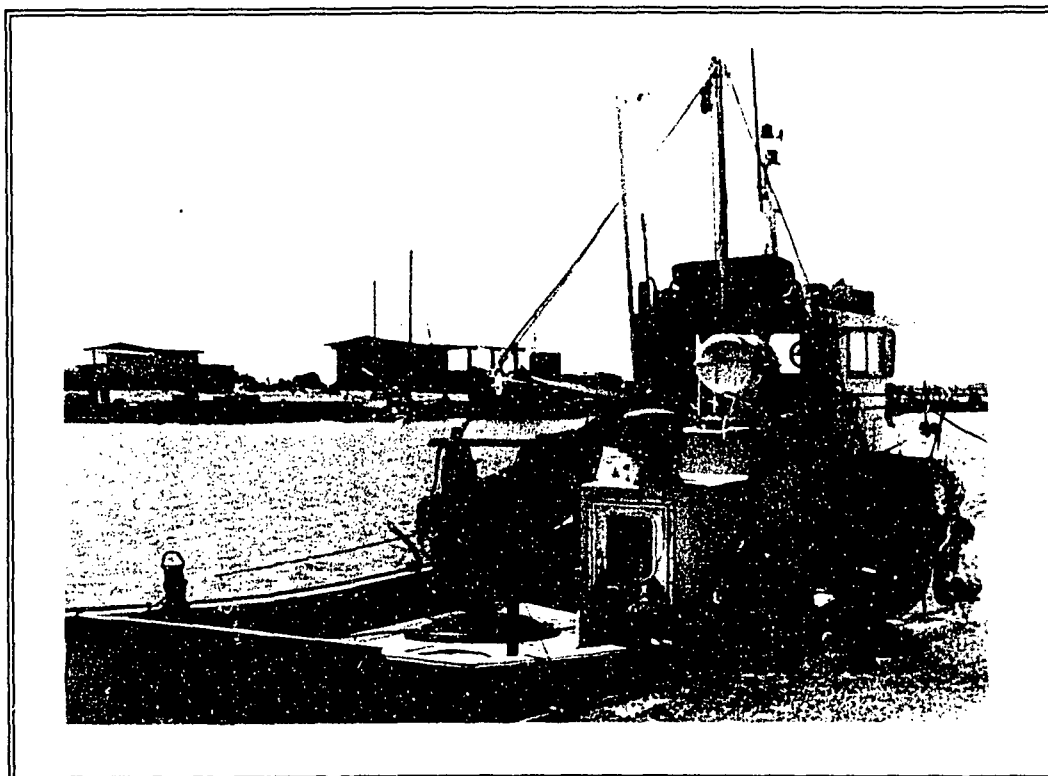


Figure 5 GOVERNMENT OF TONGA 35 FOOT BAITFISH PURSE
SEINER *ALBACORE*



Figure 6 CREW OF *ALBACORE* LOADING THE BAIT NET

Data collected through October were examined by a team of senior biologists at a Baitfish/Bottomfish Workshop held in November 1992 at Honolulu. The scientists concluded that, despite gaps in sampling continuity, a solid data base was being assembled for the two major groups of tuna baitfish-- sardines and scads.

Tuna fishing trials with sardines and scads indicated that both groups of baitfish were superior to the traditional imported Japanese saury and mackerel.

Even with the sub-par level of baitfishing effort, adequate revenues (T\$18,800) were generated from fish sales to pay all operational costs of the *Albacore*.

4.2 1993 Work Plan, Targets, and Results

The work plan for 1993 did not differ from the previous year in the types of sampling to be undertaken. These were: area surveys, lunar month survey, depletion experiment, and growth and gonad sampling. However, emphasis was to be placed on improving the frequency of fishing trips. Because of the encouraging catch rates, it was proposed that trial marketing of baitfish be undertaken in regional longline fisheries.

The targets for 1993 were 134 sampling trips, complete data for baitfish stock assessment, and adequate revenues to fund operating expenses.

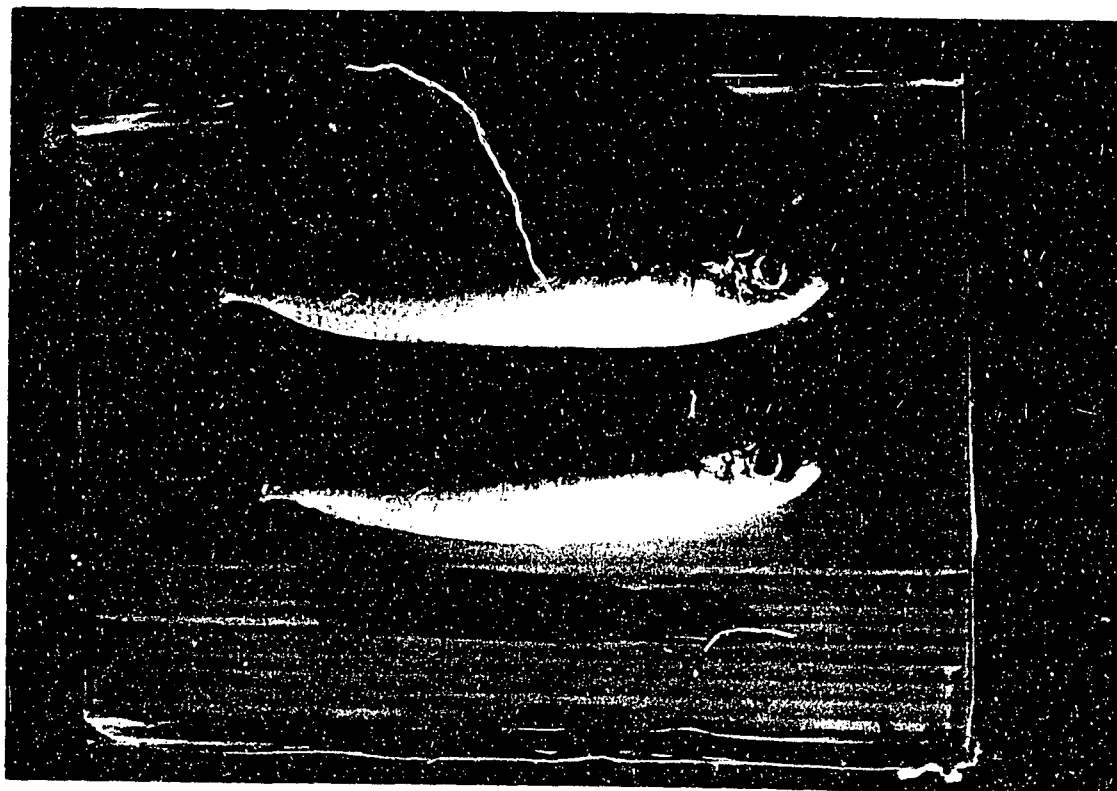
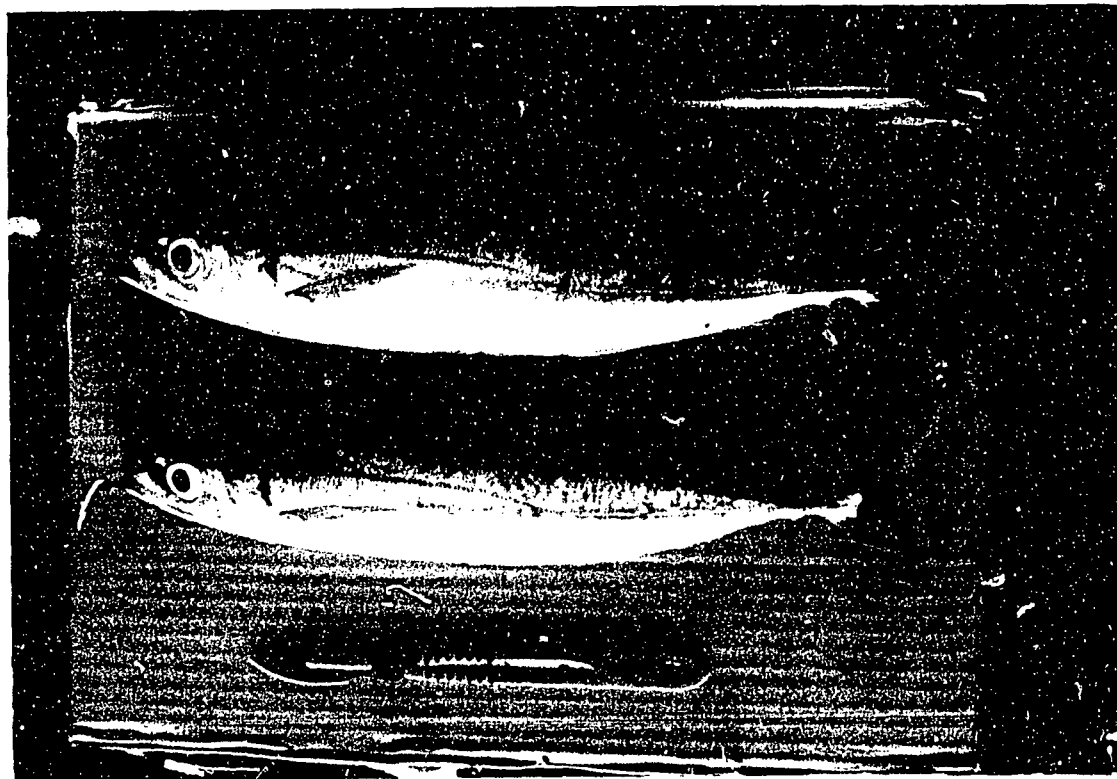
As in 1992, fishing effort by the *Albacore* fell far short of expectations. However, when the data was analyzed it became apparent that the 65 baitfishing nights accomplished in 1993 had provided more than adequate data for assessing the resource. Thus, baitfish sampling was essentially concluded in December.

A noticeable decline in catch rates was observed over most of the year, and the average catch per set decreased by 33% to 402 kg. The total catch of baitfish in 1993 was 27.8 mt, but the percentage of large baitfish decreased. However, even with the reduced catches, the amount of usable baitfish landed was far in excess of tuna fishing trial needs. Total baitfish sales revenues were T\$38,988, more than enough to cover operating expenses.

The effectiveness of sardines and scads as tuna bait was further tested aboard *Ekiaki* during direct comparisons with imported bait on ten fishing trips. The local bait, whether fresh or frozen, resulted in increased catches of 15%-40%.

Project Co-Managers Stan Swerdloff (RDA) and Pita Hurrell (MOF) travelled to American Samoa in April to determine if the large longline fleet based at Pago Pago was interested in buying Tongan baitfish. The Pago Pago fleet (and later the Fiji fleet) expressed great interest in Vava'u-produced baitfish; but, as catch rates dropped, the idea of exporting bait from Vava'u was abandoned.

Figure 7 LOCAL ROUND SCADS (TOP) AND SARDINES (BOTTOM) PROVED TO BE EXCELLENT BAIT



The depletion experiment was conducted in July, and indicated that intensive fishing pressure in a small area can deplete a local concentration of baitfish. Also, as expected, the lunar month sampling survey demonstrated that night-time catches decline with brighter moon phase.

4.3 1994 Work Plan, Targets, and Results

The main thrust of the 1994 work plan was the analysis of baitfish data and preparation of an assessment report. The work plan also called for additional baitfishing in January and February to fill in a few gaps in sampling continuity. In addition, if assistance was available from MOF, various low-tech baitfishing techniques would be tested for use by local fishermen.

The targets were: 15 baitfishing nights by *Albacore*, 15 gear-trial nights on skiffs, and 15 squid-fishing nights.

Analyses of the baitfish data were carried out in January by Fisheries Consultant King and Biologist Langi. Their final report, "Assessment of Baitfish Resources in Vava'u, Tonga" was completed in February, and is attached as Section 11.3. In brief, the report concludes that three tuna baitfish species occur in Vava'u waters in commercial concentrations. These are the scads *Decapterus macarellus* and *D. macrosoma*, and the sardine *Amblygaster sirm*. The report cautions that the populations of these species are somewhat fragile and that management of the resource is an important consideration. Management options are discussed, and recommendations for development of a small baitfishing fleet are presented.

Although the *Albacore* was scheduled to undertake baitfish sampling through February, the vessel left for Nuku'alofa in mid-January. The primary reason was that baitfish catches had been so low that the crew was no longer earning a bonus, and was unwilling to continue without one. Subsequently, MOF was not able to offer any assistance in baitfish sampling or gear trials. The *Albacore* did return in April to undertake commercial baitfishing operations, but catches remained generally low.

Project Manager Swerdloff conducted eight handline fishing trials for baitfish and six trials for squid between March and July. Although enough baitfish or squid was caught on each trip for tuna fishing trials, the amounts were too small to serve as the basis for even small-scale baitfishing operations.

4.4 Summary of Baitfish Resource Assessment and Management Plan

The assessment of baitfish resources in Vava'u was an ambitious undertaking which produced one of the most thorough studies of large baitfish in the tropical Pacific. The three major species in the baitfishery proved to be excellent tuna baits, and were sold to the project and local fishermen for about half the price of imported bait. The results

of the first year of sampling provided an optimistic outlook for the development of a commercial baitfishery. However, the decline in catch rates during year two indicated that the resource must be carefully managed, and that several vessels similar to the *Albacore* could produce excess fishing effort. The baitfish resource in Vava'u is sufficient to provide bait for a local tuna fishery, and could be harvested by one mini-purse seiner or several smaller craft.

5.0 BOTTOMFISH RESOURCE ASSESSMENT AND MANAGEMENT PLAN

5.1 1991/1992 Work Plan, Targets, and Results

The primary objective of this element was to prepare a management plan for the rational utilization of the valuable but heavily-fished deep bottomfish resources of Tonga. The first task was to review the results of an ongoing USAID-funded bottomfish study to determine whether the data were sufficient to form the basis for a management plan. If the data were deemed adequate, then a workshop would be held early in 1992 to analyze the data and formulate the elements of a management plan.

Senior Fisheries Consultant King analyzed the data and reports of the five-year bottomfish study during January 1992. Dr. King determined that information for the Tongatapu fishery was adequate, but that additional data was required for the Vava'u group. Thus, the 1992 Work Plan was modified by the PCC to include one year of bottomfish data collection in Vava'u.

Ms. Sarah Langi was hired as data coordinator for the bottomfish element and began data collection in July 1992. After five months of data collection and analyses, the bottomfish assessment was discussed in detail at the Baitfish/Bottomfish Workshop in Honolulu (November 1992). The team of fisheries specialists at the workshop determined that enough data had been collected in Vava'u to fulfill the analytical requirements for a bottomfish management regime. The fisheries specialists also developed a set of recommended options for the management plan.

Subsequent to the Honolulu Workshop, Ms. Langi drafted the final bottomfish assessment report (co-authored with Tevita Firiau and Sosaia Tulua of MOF). That assessment report provided the biological and economic information required to develop a management plan.

5.2 1993 Work Plan, Targets, and Results

The sole remaining task for the bottomfish element was the preparation of a resource management plan. This was scheduled for completion in July 1993.

Fisheries Consultant King prepared a preliminary draft of the bottomfish management plan in January 1993. After minor revision, the draft was informally submitted to MOF in April 1993 for discussion purposes. In July a formal letter was received from MOF indicating that the draft needed revision, but no specifics were given other than a request that the contractor discuss the management options with representatives of the fishing fleet. Fisheries Biologist Langi met with MOF staff in October to ascertain what revisions were required by government. The only clear cut direction, introduced by an advisor to MOF, was that the contractor should, instead of making recommendations to government, only provide options. Following this meeting, Mr.

Langi held two sessions with local snapper fishermen and exporters to determine their views on management options. The fishermen and marketers indicated they would respond to the various options in November, at which time MOF would give specific instructions to the contractor. By the end of 1993, no inputs had been received from either the fishing sector or MOF.

5.3 1994 Work Plan, Targets, and Results

In January 1994 Fisheries Consultant King and Fisheries Biologist Langi met with MOF staff to determine what changes to the draft were required by government. As the fishermen had not made any input, MOF requested only one significant modification -- that all recommendations be deleted from the plan. Following discussions with USAID, the report "Management Options for the Deepwater Bottomfish Fishery in the Kingdom of Tonga" was submitted to MOF in July 1994 with recommendations deleted (RDA Report 94-04, July, 1994).

5.4 Summary of Bottomfish Assessment and Management Plan

Although unanticipated and unbudgeted, the additional field sampling undertaken in Vava'u provided a good basis for resource and economic comparison with the Tongatapu fishery. The overall picture of the deep bottomfish fishery was that of a fishery at the limits of economic viability. Catch rates were sustained only because the fleet continued to go further afield in search of new fishing grounds. The larger vessels added to the fleet in recent years covered most of Tonga's territorial seamounts. In short, without strong management action the fishery would exceed optimum economic yield and go into a state of decline. A wide range of management options were submitted to MOF for consideration, but, for a variety of reasons, limited entry and limited effort were the only viable management measures. In the absence of strong management action, the outlook for this fishery is not optimistic.

6.0 DEVELOPMENT OF SMALL-SCALE TUNA FISHING

6.1 1991/1992 Work Plan, Targets, and Results

As development tasks would depend on results of fishing trials and economic analyses, no specific activities were planned for 1992. However, the fishermen were to be kept informally apprised of results as the trials proceeded.

6.2 1993 Work Plan, Targets, and Results

As in 1992, no specific activities were planned for this element. However, the two project master fishermen made it a point to discuss results of their fishing trials with the local fishermen.

6.3 1994 Work Plan, Targets, and Results

Three development tasks were to be undertaken in 1994. These were: 1) preparation of an assessment of tuna fishing potential and opportunities (June 1994); 2) preparation of an MOF extension plan and implementation of extension activities (February 1994); and 3) if warranted, design of a specialized vessel for the future Tongan longline fleet (July 1994).

The analyses of fishing and marketing trials were undertaken by Fisheries Economist Rowntree and Marketing Consultant Bartram during March-May 1994. Their reports provided the basis for the comprehensive "Assessment of Small-Scale Tuna Longline Potential, Kingdom of Tonga" submitted in August 1994. This document presents a detailed description of fishing trial and marketing results, an economic assessment of vessel and gear options, and recommendations for tuna fleet development.

An important finding of the fishing trials was that a 40 to 45 foot vessel, when using the small 8 km horizontal longline gear developed by RDA Masterfisherman Joe Marks and RDA Project Manager Stan Swerdloff and demonstrated on this project, produced by far the best economic results (an internal rate of return exceeding 50%). By contrast, a 45 to 55 foot vessel using a standard 32 km line had little chance of showing a profit. Not surprisingly, three of the four private longliners operating in Tonga prior to 1994 were using the 32 km gear, and all three were reportedly operating at a loss. This information was passed on to local Tongan entrepreneurs interested in entering the longline fishery.

One section of the assessment report deals specifically with vessel requirements for the recommended longline fleet. This analysis concluded that a considerable number of "off-the-shelf" vessels met the criteria for a suitable small-scale longliner. Thus, there was no reason to design a special vessel for the Tongan fleet. The PCC adopted this rationale at its September 1994 meeting.

Following several meetings with MOF staff, an informal extension training schedule was initiated in March 1994. MOF was unable to provide extension personnel for this activity, so all training was carried out by RDA staff. The objective was to train a few of the better fishermen in specific techniques that had proven viable during fishing trials. If these fishermen successfully adopted the new methods, then other fishermen would follow. The following extension activities were undertaken:

- Master Fisherman Mead conducted a two-day classroom and at-sea workshop on use of vertical longlines around FADs. The workshop was attended by thirteen fishermen.
- Tongan Fishing Specialist Fapiano Finau trained local fishermen from two boats in the use of vertical longlines.
- Master Fisherman Marks trained a total of twenty MOF crew in horizontal longline techniques. Seven of these fishermen began working on private longliners.
- Project Manager Swerdloff trained the crew of one local boat in the use of night-time handline techniques for tuna, squid, and baitfish.

Based on these training activities, an extension plan was prepared and submitted to MOF detailing specific areas in which government could aid the development of fishing personnel for the longline fleet.

By the end of project field operations, two small-scale longliners had entered the Tongan fishery and were using the modified gear developed by the project. In their first six months of operation, these two vessels were reportedly the most successful of the six-boat longline fleet.

The one local snapper boat trained in handline techniques had, by the end of August, switched to full-time tuna fishing. The vessel owner/captain indicated that his net income had improved, and that he fished much closer to home. Other local snapper boats were reportedly interested in adopting the small-scale techniques utilized in this project.

6.4 Summary of Tuna Fishing Development

A variety of tuna longline and handline techniques were tested during the project, and the results translated into commercial viability. On the basis of these findings, local fishermen and entrepreneurs were made aware of opportunities open to them. A number of local fishermen were trained in the various techniques, and adoption of small-scale longlining and handlining is occurring. Two 40 to 45 foot vessels, using the project-developed longline system, joined the local fleet and were reported to be the most successful boats in the fishery.

After assessing the requirements for a developing tuna fleet, it became clear that a specific vessel design was not required for the Tonga fishery.

7.0 TRAINING

7.1 1991/1992 Work Plan, Targets, and Results

The initial task for this element was the preparation of a training plan which encompassed long-term academic training, study tours, and on-the-job training (OJT). A draft of the training plan was completed in January, reviewed by USAID and MOF in February, and finalized in April.

The training plan made provision for one MS degree in Fisheries Science at a US university, one Fisheries Diploma at University of the South Pacific, four study tours involving about fifteen participants, and OJT for at least two MOF counterparts.

MOF nominated its candidate for the USP diploma program in April and, following the timetable and procedures set out in the training plan, Mr. Oti'nili Fasi'ikava began his studies at Suva, Fiji in December 1992. USAID's Training Office was responsible for candidate approval and supervision.

MOF was unable to identify a candidate for the US masters degree program and requested in June 1992 that this training element be eliminated. PCC and USAID concurred.

The first study tour, a fisheries management workshop, was conducted at Honolulu, Hawaii in November 1992. The participants included three MOF Fisheries staff, two project staff, two Government of Tuvalu staff, and three invited senior scientists. The workshop used the results of the Tongan baitfish and bottomfish research activities as the basis for discussing resource management options. Among the important outputs of the workshop were recommendations for the baitfish and bottomfish management plans, and suggested modifications to the baitfish and bottomfish resource assessment programs. A synopsis of the workshop/study tour was presented in the report "Proceedings of a Workshop on Baitfish and Deepwater Bottomfish" (RDA 93-01).

OJT for the MOF Biological Technician, Mr. Siola'a Malimali began in April 1992. Mr. Malimali worked directly under RDA Biologist V. Langi, and was involved in the day-to-day operations of the baitfish assessment program. Mr. Malimali was trained in a number of field and laboratory sampling techniques, and by year's end was able to conduct sampling activities without supervision.

OJT for a Fish Handler/Marketer was postponed until 1993 pending designation of a MOF counterpart.

7.2 1993 Work Plan, Targets, and Results

The tasks for 1993 were: 1) continuation of USP diploma studies; 2) two study tours (fish marketing and fisheries administration); and 3) continuation of OJT. The PCC, at its March 1993 meeting, deleted fisheries extension and fish ageing study tours.

Mr. Fasi'ikava completed his first two semesters at USP, but was transferred from a fisheries biology program to fisheries economics.

Both study tours were held in Honolulu and conducted by Paul Bartram, RDA Marketing Consultant. The fisheries administration/management tour took place in November, and included Secretary of Fisheries S. Tualau Mangisi and Vava'u Fisheries Manager Pita Hurrell. The two participants met with officials of the Western Pacific Regional Fisheries Management Council, the US National Marine Fisheries Service, the State of Hawaii Department of Aquatic Resources and the US Coast Guard. Topics included fisheries management regulations, procedures for developing regulations, fisheries research as related to management, and enforcement and surveillance. Additional elements of the tour included visits to the fish auction and markets, and a visit to a native Hawaiian mullet pond.

The fish marketing study tour was held in December, and included two participants from MOF Fisheries, two from FIMCO, and a private fish dealer. The tour concentrated on practical aspects of fish handling, processing, shipping, and sales practices. The participants were given hands-on training in grading, cutting, and packaging of export-quality tuna. Visits were made to the Honolulu Fish Auction (early each day), various fish markets, quarantine stations, and airport cargo areas.

Mr. Sio Ofanoa was designated by MOF as the project's fish handler/ marketing counterpart in March. Mr. Ofanoa received training from Marketing Consultant Bartram in April, and worked with Project Manager Swerdloff on a daily basis. Mr. Ofanoa became adept at handling sashimi-quality tuna, and was soon given responsibility for all shoreside handling activities, including fish tracking, packing, and shipping. In 1993, Mr. Ofanoa supervised the handling and sale of almost fifty tons of tuna and baitfish. Because of his consistently high performance, Mr. Ofanoa was included in the marketing study tour to Honolulu.

OJT for Baitfish Technician Malimali continued throughout 1993. In addition to sampling duties, Mr. Malimali was trained in analytical techniques and computer data programs. His performance remained uniformly good and his inputs were important to the success of the baitfish assessment program.

7.3 1994 Work Plan, Targets, and Results

The remaining training tasks included continuation of the USP diploma program and continuation of OJT for the Baitfish Technician and the Fish Handler/Marketer.

Mr. Fasi'ikava continued his diploma studies at USP and was still enrolled at the end of project field operations in September. He was scheduled to complete his diploma program in December 1995.

The 1994 OJT for Mr. Malimali focused on data analysis and data presentation. Mr. Malimali worked closely with Sr. Fisheries Consultant King and Biologist Langi in the preparation of the baitfish resource assessment report until its completion in April.

Mr. Ofanoa continued his involvement with the tuna marketing elements of the project through July, when fishing operations ended. Marketing Consultant Bartram provided Mr. Ofanoa with additional training in May.

7.4 Summary of Training Program

The training component consisted of long-term training for one fisheries diploma student at USP, three study tours (fisheries management, fisheries administration, fish marketing), and on-the-job training for two MOF counterparts. All of these tasks were completed within the project time frame except for the on-going diploma program. One element, a US masters degree program, was dropped when MOF could not field a candidate.

8.0 PROJECT ADMINISTRATION

Administration of the Tonga PIMAR Project was the responsibility of RDA's Director of Operations, with field activities supervised by the Project Manager. RDA's home office support staff prepared the technical and cost proposals, developed budgets, selected and mobilized field personnel, prepared financial and accounting reports, finalized reports, and provided technical support to the field. Procurement and shipping logistics were handled by two subcontractors, AMEG and Uno a Uno.

8.1 1991/1992 Work Plan, Targets, and Results

The following administrative tasks were planned for the first year of operations: 1) mobilization of key project staff (November and March); 2) preparation of office space and equipment (November); 3) preparation of equipment and supplies list (December); 4) develop radio base stations (April); 5) prepare Plan of Implementation (January); 6) initiate and manage revolving accounts for vessel revenue and expenditures; 7) arrange for three Project Coordination Committee meetings in first year; and 8) prepare and submit Quarterly Reports within one month of quarter's end.

Project Manager Swerdloff and Master Fisherman Mead arrived at the beginning of November 1991 to initiate field operations. Master Fisherman Marks arrived in March 1992, followed by Biologist Langi in April 1992. The Project Secretary, Haia Vaitai, was hired in April 1992.

Housing for the Mead family was prearranged and formalized in November. However, provision of houses for Swerdloff and Marks was difficult, as no available houses met the minimum criteria of fencing, insect screens, and hot water. Negotiations with two owners finally resulted in RDA fronting funds for renovation of living quarters in lieu of monthly rental. Renovation of the two houses was completed in January and June 1992, respectively.

MOF designated a small office (200 sq ft) in its Vava'u fisheries compound for project use. Desks, cabinets, and chairs were procured in November 1991, with computers, printer, photocopier, and fax arriving in April 1992.

Equipment and supplies lists were submitted to USAID and MOF in December 1991, with procurement orders prepared in January and February. Cancellation of service to Tonga by two shipping lines resulted in a three-month delay in delivery of fishing gear. The most vital equipment was air freighted in early May, with the rest arriving by sea in July 1992. A contract for construction of twenty FAD floats was let to a Tongan fiberglass company in June, and the floats were delivered by year's end. The other materials for FAD deployment were delayed four months because of a fire at the rope factory in the US. The specific rope required for the deep-moored FADs is a special order and relatively few factories produce it.

Bid announcements were developed in February for charter of a 35-foot fishing boat, bids received in April, and the contract finalized in July.

Three radio base stations (two VHF and one SSB) were developed in May to assure contact with project vessels. A weather facsimile machine was added to the SSB station to provide forecasts otherwise unavailable in Tonga.

Two revolving accounts were set up to handle the revenues from baitfish sales and tuna sales, respectively. The baitfish account was used to fund all field operating expenses of the baitfish assessment program. The tuna account was used to supplement the normal project budget, with categories of expenditure subject to the approval of PCC.

The Plan of Implementation was completed and approved by the PCC in January 1992, presumably opening the way for full field operations. However, one key element, the MOF tuna vessel, was not made available during the year, and this had a great impact on project schedules and personnel (see Section 9.0).

The Project Coordination Committee (PCC) held four meetings between November 1991 and October 1992. These sessions proved to be valuable forums for discussions of project progress and problems. However, no resolution was found for the problem of the unavailable MOF tuna fishing vessel.

Quarterly Reports were submitted for the five quarters November 1991 to December 1992. With the exception of one, all reports were submitted on schedule.

The home office support staff did an outstanding job of mobilizing all field personnel on schedule, placing orders for myriad supplies and equipment from an array of vendors, preparing and submitting financial reports and finalizing project reports.

8.2 1993 Work Plan, Targets, and Results

The administrative tasks for 1993 were essentially the same as for the previous year. These included: preparation of 1993 Work Plan, acquisition of required supplies and equipment, budget adjustment and fiscal reporting, appropriate use and accounting of revolving funds, timely submission of quarterly and consultant's reports, and a minimum of three PCC meetings.

The 1993 Plan of Implementation and Status Report was submitted in January 1993 and approved by the PCC at its March meeting. Among the revisions to the overall implementation plan were: 1) revamp the 1993 fishing schedule to compensate for lost fishing days in 1992; 2) extending the *Dora Malia* charter by five months; 3) extending the contract of Master Fisherman Joe Marks by four months; 4) creating a new position of shore engineer; 5) using project funds to repair MOF freezer facilities;

6) reduce the Senior Biologist consultancy by 40 man-days; 7) eliminate the Naval Architect consultancy; and 8) delay the hiring of the Tongan Fishing Specialist until January 1994.

The issue of a tuna fishing vessel was settled when MOF agreed to make the 52-foot *Ekiaki* available in March 1993. MOF and RDA signed a Letter of Understanding Regarding Vessel Use, and this was approved by USAID at the March PCC meeting.

Significant procurement activities included a 20-mile capacity hydraulic longline reel, freezer repair parts, vessel safety gear, and additional fishing supplies.

Four Quarterly Reports were submitted, along with consultant's reports on baitfish assessment, bottomfish management, and tuna marketing.

The two revenue accounts continued to provide funds for the baitfish assessment program and various extraneous expenditures (as approved by the PCC). A detailed accounting was submitted to MOF at the end of the year.

Only two formal PCC meetings were held during the year, in March and December. However, MOF requested a "consultation" with USAID in August to discuss "serious charges" against the Contractor and to press for alterations to the project (see Section 9.0). At this meeting held in September, USAID noted major and serious errors of fact in an unpublished report prepared by an MOF advisor, which contained the charges against RDA personnel. The meeting concluded that the "charges" were totally groundless and without foundation in fact, and the MOF stated that their "advisor's" report would be withdrawn and not distributed. At this meeting, USAID did agree to the purchase and testing of a medium-scale longline system, thus changing the scope of the project. RDA personnel were congratulated on their work and their assignments were expanded with this change in scope.

Near the end of 1993, USAID informed MOF and RDA that its Regional Mission would be closing in mid-1994. With the Tonga PIMAR project proceeding on or ahead of schedule, the PCC agreed that the project should complete field operations by the end of September 1994.

8.3 1994 Work Plan, Targets, and Results

In addition to the ongoing administrative tasks from the previous two years, the 1994 work plan involved project close-out. Among the requirements were final reports for the various field elements, final accounting for the two revolving funds, and a final project report.

To accomplish field objectives within the shortened time frame, a few changes in personnel schedules were adopted by PCC. The Tongan Fishing Specialist position

was shortened to eight months; Master Fisherman Mead's contract was decreased by two months; Master Fisherman Marks's contract was extended by one month; and Project Manager Swerdloff's contract was decreased one month.

The final reports for baitfish and bottomfish were submitted in May 1994, and the final consultant's reports for economics and marketing were finished in June. The draft assessment of tuna longline fishing was presented to the PCC in September.

Progress reports for the first two quarters were submitted on schedule, and the Final Assessment of Tuna Longline Fishing was submitted in late November.

Project field operations were terminated on schedule, 30 September 1994. In the last few weeks of field activities, all local government clearances were obtained, all outstanding local bills paid, bank accounts were reconciled and closed, and all remaining project equipment was inventoried and officially transferred to MOF.

The two revolving accounts were reconciled and closed with a zero balance in each fund. Altogether, the two accounts received, and expended, T\$162,321.47 in fish sales revenues. A detailed accounting for these two funds was presented to the PCC and MOF.

Project Manager Swerdloff returned to the RDA home office in early October to prepare the final project report.

8.4 Summary of Project Administration

The normal range of project administrative activities were carried out with a minimum of confusion and mistakes. Procurement of equipment and supplies, although sometimes delayed, did not adversely affect completion of tasks. All required reports were submitted, and all personnel and subcontractors fulfilled their contractual obligations.

9.0 PARTICULAR PROBLEMS AND LESSONS LEARNED

9.1 Provision of Project Vessels

Because of the USAID requirement that host countries provide a certain percentage of project costs in the form of in-kind contributions, it is not uncommon for these developing countries to provide vessels for use in fisheries projects. In the case of the Tonga PIMAR project, the contribution of a suitable tuna fishing vessel became a major stumbling block.

MOF, under the terms of the Grant Agreement, was to provide three vessels to the project: the 40-foot *Ngutulei*, the 52-foot *Ekiaki*, and the 38-foot *Albacore*. The *Ngutulei* and *Ekiaki* are fish carriers (not fishing vessels), while the *Albacore* is a mini-purse seiner designed for baitfishing operations. The project Statement of Work specified that the *Ngutulei* would be the primary vessel used in tuna longline trials, while the *Ekiaki* could be used for training and other support purposes. Apparently the Project Design Team made the assumption that the *Ngutulei* was suitable for tuna fishing without ever examining the vessel.

As it turned out, the *Ngutulei* was wholly inadequate for project purposes. Among many other shortcomings, the vessel had no crew's quarters and little working space on deck. If the vessel were to be used for multi-day trips as required in the contract, the crew (and RDA staff) would have to sleep in the fish hold, on top of the fish. Fortunately, the PCC agreed with RDA's strong recommendation that the *Ngutulei* not be used in the project.

That left the *Ekiaki*. RDA examined the vessel and found major shortcomings in terms of suitability for the project. Beyond the fact that the vessel was larger and more expensive to run than the specified 40-foot tuna boat, the *Ekiaki* was a purpose-designed fish carrier, and not an efficient fishing vessel. This obviously would negatively affect the results of the commercial feasibility studies. However, RDA agreed to use the *Ekiaki* so that MOF could meet its obligations under the Grant Agreement. Unfortunately, MOF was using the vessel for commercial bottomfishing operations in 1992, and was reluctant to release it for project tuna fishing. RDA and the PCC examined other options, and by the end of 1992 all parties had agreed that charter of a commercial fishing vessel would be the best solution. In the end, MOF reversed its stand and made the *Ekiaki* available as of February 1993.

All in all, the dependence on a government-supplied vessel presented a number of problems. First, the project timetable was set back by a full year. Second, with continuous reports that a vessel would be available momentarily, Master Fisherman Marks served the project on an ad hoc basis for eight months. Third, because the vessel was larger and more expensive to operate than anticipated for the small-scale longline system, the operating costs could not be used directly to assess commercial

viability of the system. Fortunately, operating costs from a local 40-foot vessel were made available for the analysis. Fourth, project staff had no control over the vessel's government crew. This resulted in many lost fishing days and a certain amount of inefficiency. Finally, MOF, acting on external advice, determined that a larger longline system should be purchased to match the size of the *Ekiaki*. Thus, a major objective of the project (developing small-scale techniques) was modified to suit the capabilities of a government-provided vessel. As noted earlier in Section 3.0, this ill-advised decision resulting in substantial operational losses, but did at least serve as a good example of what not to do.

All of these problems could have been avoided by chartering a suitable fishing vessel and hiring a commercial fishing crew. The costs would have seemed initially higher, but in the long run a great deal of time, money, and frustration would have been saved. The situation in the Tonga PIMAR project was not unique. RDA has experienced similar problems with government-provided vessels in other projects (e.g., Tuvalu). It is strongly recommended that USAID pay particular attention to vessel provision in future fisheries feasibility studies.

9.2 Relationship with Ministry of Fisheries

Although the project documents called for MOF counterparts for each of the contractor's key personnel, there were no on-site counterparts specified by position. The absence of counterparts, and a consequent lack of communication with MOF headquarters, was probably a major factor in misperceptions that threatened to terminate the project in mid-1993.

For reasons never specified to either USAID or the contractor, MOF tasked a then recently-arrived "advisor" to perform an internal review of the project. The advisor's report prompted the Secretary for Fisheries to ask that RDA replace several key personnel in the project. USAID reacted by sending its Marine Resources Advisor, Elisala Pita, to "review the review". Although the MOF report was not made available to USAID or RDA, Mr. Pita was allowed to scan a copy and make notes. He concluded that many of the issues and concerns raised in the report were in serious error, based on incomplete information or misunderstanding of project objectives, and that in general the project was appropriately managed and on track.

MOF, however, was sufficiently concerned by the report to request a "consultation" with USAID. This took place in September, and involved high level personnel from USAID, MOF, and RDA. Following extensive discussion of the issues and concerns presented by the MOF advisor, USAID requested that the report either be corrected or formally rescinded. MOF concurred and indicated the report would be withdrawn. The RDA personnel involved were subsequently congratulated on their work and extended.

The point here is that mechanisms must be in place so that the host government knows what is happening in a project at all times. As a result of the consultation, MOF designated its Vava'u Fisheries Manager as Project Co-Manager. This greatly improved communications, removed the misconceptions, and allowed the project to proceed to a successful conclusion.

Neither the contractor nor USAID can assume that the host government has reliable lines of communication with its field offices. Counterpart designations and day-to-day contact with senior government personnel must be specified in the project documents.

9.3 Lack of Project Evaluation

The single most important tool for critiqueing a project is the external evaluation process by objective, knowledgeable and unbiased experts. This project was designed to include two formal USAID evaluations, one at the project mid-point and one at project completion. Unfortunately for this project, both of the evaluations were eliminated by USAID due to overall USAID budget considerations. This is particularly unfortunate because this project has been particularly successful.

9.4 Regional Impact

An important aspect of the overall PIMAR project was the transfer of information and novel technology throughout the region. This was to be carried out by the South Pacific Commission through newsletters, workshops, and other mechanisms.

The small-scale tuna fishing technology developed by the Tonga PIMAR project could provide a significant alternative to the way tuna fisheries are developed in the region. Unfortunately, SPC's regional impact funding was terminated before it published a single item about the Tonga project. The only regional interchange concerning this project was made by the Project Manager in a ten minute presentation at the SPC Fisheries Technical Meeting in March 1994. The delegates from several Pacific Island countries expressed interest in the techniques and requested further information.

It was anticipated that a workshop would be organized to compare the results of this project, a similar project in Papua New Guinea, and experiences from the Fiji longline fishery. Apparently, no plans have been made for such a workshop, but it is the contractor's opinion that USAID is missing an excellent opportunity to introduce appropriate technology to the region.

9.5 Project Dependence on Government Facilities

As in most developing countries, much of Tonga's fisheries-related infrastructure has been built and maintained by the government. It was assumed in the project design that the fisheries freezer facilities in Vava'u would be available to the project in good

working order. In fact, only one of the three freezers assigned to the project was operable, and that one at only half capacity. Further, it was assumed that the vessels provided to the project by MOF would be kept in good working order. Unfortunately, neither MOF nor the project had a budget for freezer or vessel repair. This caused considerable problems throughout 1992, including discarding of valuable baitfish from large catches, and many lost fishing days.

The problem was rectified by the PCC in 1993 when RDA was allowed to hire a shore engineer and order necessary repair parts for the freezers and vessels. The cost of the engineer was more than compensated for by increased fish sales due to less vessel downtime and operable freezing facilities.

There is a tendency in fisheries project design to neglect the potential impact of poorly maintained facilities and vessels. Provision in the budget for a hands-on engineer and spare parts should be considered essential.

10.0 PROJECT ACCOMPLISHMENTS

The accomplishments of the Tonga PIMAR project can be measured in two ways: 1) whether the contractor contributed the necessary inputs and produced the required outputs; and 2) whether the End of Project Status targets were achieved.

RDA is confident that it has successfully completed all of its contractual obligations. All of the necessary inputs have been provided and documented. The outputs produced by the project include:

- Completion of trial tuna fishing operations,
- Publication and distribution of an assessment of findings on the viability of small-scale tuna fishing vessels and methods and appropriate technology,
- Successful introduction of small-scale tuna fishing gear and methods to the existing fleet, and
- Completion of assessments and preparation of management plans for Tongan bottomfish and baitfish resources.

The achievement of end of project targets is mixed. Of the three targets identified in the Contract Statement of Work (C4-5), only one was clearly accomplished; i.e., different vessels, fishing methods and marketing arrangements were tested for small-scale tuna fishing and results of these tests were made widely available.

The second target was that bottomfish catches were at sustainable levels. It is believed that *present* catches are within optimum sustainable yields; however, the Government of Tonga has not yet promulgated regulations that will assure the limitation of fishing effort. In fact, there was discussion as the project ended that MOF was endorsing a bottomfishing joint venture that would add substantial fishing pressure on the resource.

The third target was that the results of the activity were being transferred for use in small scale tuna fishing and marketing in other Pacific island countries. As discussed in Section 9.4, the regional impact component was not initiated and, as far as the contractor is aware, there are no plans to widely disseminate the information from this project.

11.0 APPENDIX

RDA INTERNATIONAL PIMAR/TONGA REPORTS (does not include Monthly Progress Reports)

- 9201 *Quarterly Progress Report, Tonga Small-Scale Tuna Longline Project Oct-Dec. 1991*, RDA International, Inc., January 1992.
- 9202 *Training Plan, Tonga Small-Scale Tuna Longline Project*, RDA International, Inc. March 1992.
- 9203 *Tonga Small-Scale Tuna Longline Project, Plan of Implementation*, Stan Swerdloff. RDA International, Inc. April 1992.
- 9204 *Assessment of Baitfish Resources in Vava'u Tonga*, Michael King. RDA International, Inc. March 1992.
- 9205 *Analyses of the Deep Water Demersal Fishery in Tonga*, Michael King. RDA International, Inc. March 1992.
- 9206 *Quarterly Progress Report, Tonga Small-Scale Tuna Longline Project Jan - Mar. 1992*, RDA International, Inc. April 1992.
- 9207 *Data Parameters for Economic Analysis*, Peter Philippon. RDA International, Inc. March 1992.
- 9208 *Quarterly Progress Report, Tonga Small-Scale Tuna Longline Project Apr-Jun 1992*, RDA International, Inc. July 1992.
- 9209 *Quarterly Progress Report Tonga Small-Scale Tuna Longline Project July-Sept. 1992*, RDA International, Inc. October 1992.
- 9210 *Quarterly Progress Report Tonga Small-Scale Tuna Longline Project Oct-Dec. 1992*, RDA International, Inc. January 1993.
- 9301 *Proceedings on a Workshop of Baitfish and Deep Water Bottomfish*, Michael King. RDA International, Inc. April 1993.
- 9302 *Draft Management Plan*, Michael King. RDA International, Inc. April 1993.
- 9303 *Tonga Small Scale Tuna Longling Project, Plan of Implementation 1993*, Stan Swerdloff. RDA International, Inc. April 1993.

- 9305 *Tuna Marketing Report*, Paul Bartram. April 1993.
- 9306 *Assessment of Baitfish Resources in Vavau Tonga*, Michael King. RDA International, Inc. April 1993.
- 9307 *Quarterly Progress Report Tonga Small-Scale Tuna Longline Project, Jan-Mar 1993*. RDA International, Inc. April 1993.
- 9303 *Quarterly Progress Report Tonga Small-Scale Tuna Longline Project, Apr-June 1993*, RDA International, Inc. July 1993.
- 9310 *Quarterly Progress Report Tonga Small-Scale Tuna Longline Project, July-Sept. 1993*, RDA International, Inc. October 1993.
- 9311 *Quarterly Progress Report Tonga Small-Scale Tuna Longline Project, Oct-Dec. 1993*, RDA International, Inc. January 1994.
- 9401 *Tonga Small-Scale Tuna Longline Project, Plan of Implementation*, Stan Swerdloff. RDA International, Inc. January 1994
- 9402 *Quarterly Progress Report Tonga Small-Scale Tuna Longline Project, Jan-Mar 1994*, RDA International, Inc. May 1994.
- 9403 *Assessment of Baitfish Resources in Vava'u, Tonga, Tonga Tuna Longline Project - Final Report*, Michael King, Viliami Langi & Siola'a Malimali. June 1994.
- 9403A *Marketing of Tuna from the Kingdom of Tonga, Final Report*, Paul Bartram. RDA International, Inc. July 1994.
- 9404 *Management Options for the Deep Water Fisheries in the Kingdom of Tonga*, Michael King & Viliami Langi. RDA International, Inc. July 1994.
- 9405 *The Commercial Feasibility of Small-Scale Tuna Longlining in Tonga*, John Rowntree. RDA International, Inc. July 1994.
- 9406 *Quarterly Progress Report Tonga Small-Scale Tuna Longline Project, Apr-June 1994*, RDA International, Inc. July 1994.
- 9407 *Assessment of Tuna Longline Potential in the Kingdom of Tonga*, Stan Swerdloff. RDA International, Inc. August 1994.
- 9408 *Final Report Tonga Small-Scale Tuna Longline Project*. RDA International, Inc. December 1994.

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- 9206 *Quarterly Progress Report, Tonga Small-Scale Tuna Longline Project Jan-Mar. 1992*, RDA International, Inc. April 1992.
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- 9308 *Quarterly Progress Report Tonga Small-Scale Tuna Longline Project, Apr-June 1993*, RDA International, Inc. July 1993.
- 9310 *Quarterly Progress Report Tonga Small-Scale Tuna Longline Project, July-Sept. 1993*, RDA International, Inc. October 1993.
- 9311 *Quarterly Progress Report Tonga Small-Scale Tuna Longline Project, Oct-Dec. 1993*, RDA International, Inc. January 1994.
- 9401 *Tonga Small-Scale Tuna Longline Project, Plan of Implementation*, Stan Swerdloff. RDA International, Inc. January 1994
- 9402 *Quarterly Progress Report Tonga Small-Scale Tuna Longline Project, Jan-Mar 1994*, RDA International, Inc. May 1994.
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- 9408 *Final Report Tonga Small-Scale Tuna Longline Project*. RDA International, Inc. December 1994.