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# THE COMMERCIAL FEASIBILITY OF SMALL-SCALE TUNA LONGLINING IN TONGA

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## ABBREVIATIONS

| | |
|---|---|
| FAD | Fish Aggregating Device |
| kg | Kilogram |
| m | Meter |
| mt | Metric ton |
| PIMAR | Pacific Islands Marine Resources |
| RDA | RDA International, Inc. |
| RDO | Regional Development Office |
| SP | South Pacific |
| T$ | Tongan dollars |
| USAID | United States Agency for International Development |

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## 1.0 EXECUTIVE SUMMARY

This report assesses the commercial feasibility of small-scale tuna longlining in the Kingdom of Tonga as part of the Tonga Small-Scale Tuna Longlining Project, a component of the USAID Pacific Islands Marine Resources Development (PIMAR) Project under Contract No. AID 879-0020-C-00-1229-00. In addition, the report assesses the economic and socio-economic implications of the expansion of a small-scale tuna longlining industry in Tonga and explores some of the policy options faced by government policy-makers.

Based on project fishing and export marketing trials, along with supplemental data provided by a private tuna fishing operation, it has been concluded that small-scale tuna horizontal longlining in Tonga is an attractive commercial investment opportunity. A commercial venture using a 40-45' vessel employing small-scale horizontal longlining, supplemented by a modest amount of handline fishing, for 108 fishing days per year, and exporting about 60% of the longline catch while disposing of the rest of the catch locally, should be able to generate an internal rate of return on investment in excess of 50% per annum. As tuna handling, packing, shipping, and marketing experience is gained, the expected annual internal rate of return on investment in small-scale tuna horizontal longlining could approach or even exceed 90-100%. Increasing experience at handling, packing, shipping, and marketing will bring higher prices which can offset lower catch rates. At achievable prices on exported tuna, a commercial longlining venture in Tonga should be able to reap an annual internal rate of return in excess of 50%, even if the annual catch rate should fall to 75% of project catch rates.

The results on the project vertical longlining trials on a traditional Tongan snapper vessel, by contrast, were discouraging. The project's vertical longlining trial vessel conducted 107 sea trials, but only 74 of those sea trials contained actual fishing trials. The catch rates of marketable fish were low and virtually no export quality fish were caught. On only 21 of the 74 sea trials containing actual fishing trials did fish sales revenues exceed operating costs, not including crew wages and provisions. Efforts to construct favorable fishing scenarios, assuming catch rates similar to those experienced on the 21 best project sea trials and assuming multiple days of fishing per fishing trip, consistently yielded negative rates of return on investment in vertical longlining in Tonga. It does not appear that employing the traditional Tongan snapper fleet in tuna longlining is an attractive investment opportunity.

The development of a small-scale tuna horizontal longlining industry in Tonga should be approached cautiously, particularly since the high expected rates of return on investment in this activity are based on limited experience and little is known about the robustness of the tuna stocks on available seamounts. A slow, methodical, and monitored expansion of the industry would allow early entrants to utilize the high

profitability to learn how most effectively to fish these stocks and to improve handling, packing, shipping, and marketing techniques to ensure continued high returns. Furthermore, the early profitability would permit operators to explore other areas for abundant tuna stocks.

On the basis of project experience it is projected that 5 small-scale tuna horizontal longliners could supply local markets with upwards of 250 mt of tuna and contribute US$1.5-2.0 million in foreign exchange gains. The locally consumed tuna would also contribute to improvement of the local diet.

The major constraints on the development of a small-scale tuna horizontal longlining industry are the limited availability of investment capital, the length of time it will take for new entrants to master fishing techniques and handling, packing, and shipping requirements of the fresh tuna export markets, the limited availability of personnel skilled in grading and marketing of fresh tuna for the targeted markets, and the uncertainty regarding government policies and the role of the parastatal Sea Star Fishing Co. LTD in the expanding tuna industry. A supportive policy environment will be required to encourage private sector investing.

In summary, the project has proven that small-scale tuna horizontal longlining to supply a fresh tuna export market has a promising future in Tonga if policy makers can address the constraints and risks inherent in the industry expansion.



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## 2.0 INTRODUCTION

The Tonga Small-Scale Tuna Longlining Project, a component of the USAID Pacific Islands Marine Resources Development (PIMAR) Project, has sought to alleviate pressure on the deep bottomfish stocks by testing alternative fishing opportunities for the local fishermen. The project has assessed Tonga's tuna resources, tested several small-scale tuna longlining techniques, and tested tuna export marketing alternatives, in addition to conducting several related activities, such as developing a bottomfish resource management plan, assessing the potential of Tonga's tuna longlining baitfish resources, and providing extensive training for local fishermen and government fisheries staff. Utilizing data collected by the project and other available data, this report presents an analysis of the commercial feasibility of small-scale tuna longlining in the Kingdom of Tonga, briefly assesses the economic and socio-economic implications of the expansion of a small-scale tuna longlining industry, and explores some of the policy options faced by government policy-makers.

Section 3.0 reviews the project's small-scale horizontal longlining trials and catch rates, examines local and export sales, provides a detailed analysis of export trial results, and summarizes the project's fishing and marketing trial costs. This is followed by a detailed analysis of the commercial feasibility of small-scale horizontal longlining in Tonga. Expected rates of return on investment in small-scale horizontal longlining are calculated for alternative catch, cost, and revenue scenarios.

Section 4.0 reviews the results of the project's vertical longlining trials in order to assess the feasibility of utilizing Tonga's snapper fleet in the tuna industry.

Section 5.0 assesses the opportunities for and constraints on the development of a small-scale longlining industry in Tonga.

Section 6.0 summarizes the conclusions of this investigation.

## 3.0 ECONOMICS OF HORIZONTAL LONGLINING

Assessing the economic, financial, or commercial feasibility of the potential of small-scale tuna horizontal longlining in the Vava'u group of the Kingdom of Tonga is faced with several obstacles. The main problem is that the cost and revenue data derived from the tuna trials are not representative of what can be expected under truly commercial fishing and marketing conditions. The vessel employed in the fishing trials was not appropriate for small-scale horizontal longlining; the crew members were government employees rather than fishermen and they were experienced neither in longlining nor in fish handling for export; the ice available for preserving the fish catch was inappropriate in quality and insufficient in quantity throughout most of the project; ferry transport service from Vava'u, the project headquarters and the catch landing site, to Nuku'alofa, the principal and largest local market as well as the location of the international airport from which the tuna may be air shipped to foreign markets, was limited; and the tuna export trial shipment costs were relatively high and the prices received were relatively low, as shipments were small, irregular, and infrequent, and buyers were inexperienced with the source. Thus, for a variety of reasons, the data generated by the project's fishing and marketing trials are, by themselves, an inadequate basis for evaluating the commercial feasibility of small-scale tuna longlining in Tonga.

The initial project results were so successful at catching and exporting tuna, however, that several commercial operations, seeing the potential profits to be made in small-scale horizontal longlining, entered the industry and sought to exploit commercially the potential proven by the project. Fortunately, one of these operations, which began tuna fishing in January 1994 and which employed project fishing techniques, shared with the author of this report all of its catch, cost, and revenue data from its first three months of operation. The fact that commercial operators have already entered the industry shows that the project's results on the prospect of small-scale horizontal longlining in Tonga are very promising. More importantly for the economic and commercial assessment of small-scale horizontal longlining in Tonga, however, is the fact that this report can incorporate some actual commercial experience in making the assessment.

First, the results of the project's fishing trials and the tuna catch will be reviewed. This will be followed by an examination of the domestic and export sales results. Lastly, an overview of the commercial feasibility of small-scale tuna horizontal longlining in Tonga will be presented.

### 3.1 Fishing trials and catch

The vessel employed by the project to conduct the small-scale horizontal longlining trials, the *Ekiaki*, was provided by the Government of Tonga as a contribution to the

USAID-funded project. The *Ekiaki*, a 52' fish carrier with large fish holds and limited work space and a typical government crew of 8-9, was fitted with horizontal longline gear designed for use on a much more fuel efficient 38-40' work vessel with a commercial crew of 4. Despite the inappropriateness of the *Ekiaki* as a small-scale tuna longlining vessel, particularly from the cost standpoint, the vessel accomplished the fishing trials with good results.

The standard project longline set consisted of 8 km of 3 mm monofilament mainline, with 200 branch lines and hooks attached at 40 m intervals, let out and retrieved from a 10 km capacity general purpose hydraulic reel. For more detail on the vessel, the gear, and the fishing techniques, see Hurrell and Swerdloff (1994) and other project reports.

The fishing trial results are presented in Table 3-1, which was taken from Hurrell and Swerdloff (1994). After several exploratory fishing expeditions, the project discovered an abundance of tuna on Capricorn Seamount, located about 110 miles, or about 14 hours running time for the *Ekiaki*, from Vava'u. (Capricorn Seamount is about 210 miles, or about 30 hours running time, from Nuku'alofa, while Vava'u is about 180 miles, or about 21 hours running time, from Nuku'alofa.) The project conducted 25 longline sets (with 51 days at sea) with an average of 249 hooks per set over 25 days of experimental small-scale longline fishing on Capricorn Seamount from June through December 1993. The *Ekiaki* crew also conducted 6 handline trials, each averaging 6 handlines for 5.5 line hours per fishing day on Capricorn Seamount while letting the longline sets soak. The project also conducted 25 trials with longline sets (with 34 days at sea) on non-seamount areas, principally around FADs.

These fishing trials produced some surprising results. The catch on Capricorn Seamount was extremely good. The 25 trial sets on Capricorn Seamount yielded a total of 1,021 fish weighing a total of 27,863 kg, of which 815 fish weighing a total of 18,123 kg were marketable. The total catch per hundred hooks was 16.41 fish, each weighing an average of 27.3 kg. Yellowfin and bigeye tuna accounted for 58% of the catch. The marketable fish catch rate per hundred hooks was 13.1. These catch rates are very high and are responsible for the strong rates of return calculated later in this report.



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**Table 3-1. Horizontal longline and handline trial catch rates**

## Horizontal Longline Trial Catch Results

| | Sea Days | Fishing Days | Number of Sets | Number of Hooks | Total Catch | | Yellowfin | | Albacore | | Bigeye | | MahiMahi | | Other Marketable | | Unmarketable | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | # | Kg | # | Kg | # | Kg | # | Kg | # | Kg | # | Kg | # | Kg |
| Capricorn Seamount | | | | | | | | | | | | | | | | | | |
| Total | 51 | 25 | 25 | 6220 | 1021 | 27863 | 331 | 5792 | 75 | 1368 | 387 | 10365 | 10 | 102 | 12 | 496 | 206 | 9740 |
| Average Per Fishing Day | | | 1 | 249 | 40.8 | 1115 | 13.2 | 232 | 3 | 54.7 | 15.5 | 414.6 | 0.4 | 4.08 | 0.48 | 19.8 | 8.24 | 390 |
| Catch Per Hundred Hooks | | | | | 16.41 | 447.96 | 5.32 | | 1.21 | | 6.22 | | 0.16 | | 0.19 | | 3.31 | |
| Non Seamount Areas | | | | | | | | | | | | | | | | | | |
| Total | 34 | 25 | 25 | 6650 | 346 | 13582 | 46 | 983 | 82 | 1536 | 0 | 0 | 13 | 154 | 31 | 1123 | 174 | 9786 |
| Average Per Fishing Day | | | 1 | 266 | 13.8 | 543 | 1.8 | 39 | 3 | 61.4 | 0 | 0 | 0.5 | 6.16 | 1.24 | 44.9 | 6.96 | 391 |
| Catch Per Hundred Hooks | | | | | 5.2 | 204.24 | 0.69 | | 1.23 | | 0 | | 0.2 | | 0.47 | | 2.62 | |
| Total | 85 | 50 | 50 | 12870 | 1367 | 41445 | 377 | 6775 | 157 | 2904 | 387 | 10365 | 23 | 256 | 43 | 1619 | 380 | 19526 |
| Average Per Fishing Day | | | 1 | 257 | 27.3 | 829 | 7.5 | 136 | 3 | 58.08 | 7.74 | 207.3 | 0.46 | 5.12 | 0.86 | 32.38 | 7.6 | 391 |
| Catch Per Hundred Hooks | | | | | 10.62 | 322.03 | 2.93 | | 1.22 | | 3.01 | | 0.18 | | 0.33 | | 2.95 | |

## Handline Trial Catch Results (Capricorn Seamount)

| | Fish Days | Number of Lines | Number of Hooks | Line Hours | Total Catch | | Yellowfin | | Albacore | | Bigeye | | MahiMahi | | Other Marketable | | Unmarketable | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | # | Kg | # | Kg | # | Kg | # | Kg | # | Kg | # | Kg | # | Kg |
| Total | 6 | 36 | 5.5 | 33 | 380 | 5890 | 2 | 40 | 0 | 0 | 378 | 5850 | 0 | 0 | 0 | 0 | 0 | 0 |
| Average Per Fishing Day | | 6 | 0.92 | 5.5 | 63 | 982 | 0.33 | 6.67 | 0 | 0 | 63 | 975 | 0 | 0 | 0 | 0 | 0 | 0 |
| Catch Per Line Hour | | | | | 11.52 | 178.48 | 0.06 | 1.21 | 0 | 0 | 11.45 | 15.39 | 0 | 0 | 0 | 0 | 0 | 0 |

The catch rate (per hundred hooks) on the non-seamount areas was only 5.2 fish, less than one-third of that on Capricorn Seamount, and the marketable catch rate (per hundred hooks) was only 2.58 fish, less than one-fifth of that on Capricorn Seamount. Furthermore, the fish caught on the non-seamount areas were significantly smaller and much lower valued than those caught on Capricorn Seamount. While on Capricorn Seamount about 37% of the catch was bigeye tuna and almost 21% was yellowfin tuna, on the non-seamount areas no bigeye were caught and only slightly more than 7% of the catch was yellowfin tuna.

Table 3-1 also shows the results of the handlining trials which were conducted on Capricorn Seamount. There were 6 days of trial handlining, each of which employed 6 lines (with an average of 5.5 hooks per line) for an average of 5.5 line hours. The catch was quite good, yielding 11.52 fish per line hour, with the catch being almost all bigeye. While the handlining catch weight was low, averaging 15.5 kg per fish as compared with 27.3 kg per fish for the longlining catch, the fish were entirely marketable locally, and provided a useful addition to the total catch and total revenues of each fishing trip.

## 3.2 Revenues

### 3.2.1 Total sales

The total project longline catch on Capricorn Seamount was 27,863 kg, of which 65% was marketable, as compared to the total project longline catch on non-seamount areas of 9,786 kg, of which only 28% was marketable. The total project handline catch was 5,890 kg, of which, by contrast, 100% was marketable. Out of the total project catch of 41,445 kg, 27,809 kg, or about 67% of the total, was marketable. Out of the 27,809 kg of marketable fish, almost 82%, or 22,738 kg was actually sold. Some of the waste was due to loss when the ice machine was malfunctioning and the project simply did not have sufficient ice to preserve the catch. Another large share of the waste was due to several export shipments which went unsold because of the low quality. (In fact, the project intentionally shipped several shipments of some lower quality tuna in order to demonstrate the uselessness of shipping lower quality product.) In addition, probably about half of the waste of marketable fish was due to gutting and heading at the time of sale and to a portion which was shared with the crew following each fishing trial.

Table 3-2 summarizes the total project fish sales. A total of 8,885 kg were sold locally in Vava'u at an average price of T$2.04, for total sales revenues of T$18,108. Another 5,975 kg were (shipped to and) sold in Nuku'alofa at an average price of T$2.00, for total sales revenues of T$11,924. Finally, the project exported a total of 7,879 kg at an average return (net to the project) of T$1.04 per kg, for total export revenues of T$11,034. These sales revenues require some explanation.

Table 3-2. Total project fish sales

| Fishing Trials | Longline Catch | Handline Catch | Total Catch | Total Sales | | Local Sales, Vava'u [a] | | Local Sales, Nuku'alofa [a] | | Export Sales [b] | | Export Trials |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| # | Kg | Kg | Kg | Kg | T$ | Kg | T$ | Kg | T$ | Kg | T$ | # |
| 1 | 39 | 0 | 39 | 39 | $71 | 39 | $71 | 0 | $0 | 0 | $0 | 0 |
| 2 | 50 | 0 | 50 | 50 | $121 | 50 | $121 | 0 | $0 | 0 | $0 | 0 |
| 3 | 103 | 0 | 103 | 103 | $88 | 103 | $88 | 0 | $0 | 0 | $0 | 0 |
| 4 | 29 | 0 | 29 | 29 | $55 | 29 | $55 | 0 | $0 | 0 | $0 | 0 |
| 5 | 20 | 0 | 20 | 20 | $43 | 20 | $43 | 0 | $0 | 0 | $0 | 0 |
| 6 | 510 | 0 | 510 | 125 | $242 | 125 | $242 | 0 | $0 | 0 | $0 | 0 |
| 7 | 637 | 0 | 637 | 0 | $0 | 0 | $0 | 0 | $0 | 0 | $0 | 0 |
| 8 | 2327 | 0 | 2327 | 535 | $1,045 | 268 | $378 | 206 | $515 | 61 | $153 | 1 |
| 9 | 462 | 0 | 462 | 105 | $261 | 105 | $261 | 0 | $0 | 0 | $0 | 0 |
| 10 | 169 | 0 | 169 | 54 | $131 | 54 | $54 | 0 | $0 | 0 | $0 | 0 |
| 11 | 2699 | 0 | 2699 | 715 | $1,634 | 177 | $427 | 359 | $688 | 179 | $519 | 2 |
| 12 | 2881 | 0 | 2881 | 81 | $173 | 81 | $173 | 0 | $0 | 0 | $0 | 0 |
| 13 | 675 | 0 | 675 | 366 | $914 | 366 | $914 | 0 | $0 | 0 | $0 | 0 |
| 14 | 745 | 0 | 745 | 235 | $586 | 235 | $586 | 0 | $0 | 0 | $0 | 0 |
| 15 | 1568 | 0 | 1568 | 158 | $384 | 158 | $384 | 0 | $0 | 0 | $0 | 0 |
| 16 | 1374 | 0 | 1374 | 327 | $758 | 327 | $758 | 0 | $0 | 0 | $0 | 0 |
| 17 | 1831 | 0 | 1831 | 1516 | $3,231 | 958 | $2,075 | 558 | $1,156 | 0 | $0 | 0 |
| 18 | 228 | 0 | 228 | 242 | $475 | 242 | $475 | 0 | $0 | 0 | $0 | 0 |
| 19 | 515 | 0 | 515 | 170 | $340 | 170 | $340 | 0 | $0 | 0 | $0 | 0 |
| 20 | 693 | 0 | 693 | 194 | $337 | 194 | $337 | 0 | $0 | 0 | $0 | 0 |
| 21 | 247 | 0 | 247 | 217 | $382 | 217 | $382 | 0 | $0 | 0 | $0 | 0 |
| 22 | 2202 | 0 | 2202 | 1004 | $1,383 | 189 | $473 | 440 | $910 | 375 | ($38) | 4 |
| 23 | 2438 | 0 | 2438 | 1686 | $3,940 | 818 | $1,787 | 387 | $734 | 481 | $1,419 | 2 |
| 24 | 1207 | 0 | 1207 | 187 | $417 | 187 | $417 | 0 | $0 | 0 | $0 | 0 |
| 25 | 3009 | 981 | 3990 | 1964 | $4,307 | 640 | $1,529 | 566 | $1,095 | 758 | $1,683 | 4 |
| 26 | 1874 | 0 | 1874 | 945 | $1,866 | 0 | $0 | 367 | $759 | 578 | $1,107 | 3 |
| 27 | 613 | 0 | 613 | 209 | $528 | 116 | $251 | 93 | $277 | 0 | $0 | 0 |
| 28 | 1000 | 739 | 1739 | 1137 | $2,290 | 390 | $897 | 459 | $867 | 288 | $525 | 3 |
| 29 | 2030 | 493 | 2523 | 1155 | $2,353 | 314 | $779 | 305 | $625 | 536 | $949 | 6 |
| 30 | 3019 | 411 | 3430 | 2255 | $4,648 | 243 | $578 | 991 | $1,875 | 1022 | $2,195 | 3 |
| 31 | 817 | 0 | 817 | 72 | $166 | 72 | $166 | 0 | $0 | 0 | $0 | 0 |
| 32 | 880 | 0 | 880 | 673 | $1,240 | 7 | $18 | 62 | $124 | 604 | $1,099 | 3 |
| 33 | 3257 | 1726 | 4983 | 3910 | $5,060 | 1993 | $3,051 | 609 | $1,150 | 1308 | $859 | 3 |
| 34 | 1297 | 1540 | 2837 | 2262 | $1,713 | 0 | $0 | 573 | $1,147 | 1689 | $566 | 2 |
| Total, all trials | 41445 | 5890 | 47335 | 22738 | $41,182 | 8885 | $18,108 | 5975 | $11,924 | 7879 | $11,034 | 36 |
| Average, all trials | 1219 | 982 | 1392 | 669 | $1,211 | 261 | $533 | 176 | $351 | 232 | $325 | 1 |
| Average T$/Kg | | | | | $1.81 | | $2.04 | | $2.00 | | $1.40 | |

[a] Landed value. [b] Net return after deducting all packing, shipping, and marketing costs.



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The price of tuna in Tonga is essentially determined by the tuna distribution and pricing policies of Sea Star Fishing Co., LTD, Tonga's parastatal tuna fishing company. The company was created about 2 years ago in an effort to centralize the tuna industry in Tonga. The government established the company and gave over to the company the *MV Lofa*, a traditional horizontal longlining vessel which has been exporting albacore tuna principally to the Pago Pago cannery. Private investors have since been allowed to purchase shares in Sea Star, but the government is still the dominant share holder in the company. Sea Star has recently purchased two more traditional horizontal longliners and is planning to purchase an additional two vessels. While Sea Star was initially given exclusive licensing and marketing rights to Tongan tuna, this exclusivity has since been rescinded. Although most of Sea Star's catch is sold to the cannery, the company now sells tuna locally when the ships are in port, and has conducted several fresh tuna export marketing trials. The company now sells tuna locally at T$2.50 per kg. Even though this is clearly a subsidized fish price, given the costs of the traditional longliners, and even though this is less than the usual price of local reef fish and bottomfish, selling at this low price is a method by which Sea Star discourages local competition at the same time that it is justified as wise state policy to encourage the consumption of fish rather red meat or rather than cheap imported fatty mutton which has been coming in from New Zealand. Even though reef fish and bottomfish usually sell at 25% to 50% higher prices, and until recently bottomfish fillets were being sold to restaurants for 2-3 times the price at which Sea Star sells fresh tuna locally, government (and Sea Star) policy now supports the fresh tuna subsidy. Until recently, Sea Star sold fresh tuna only when the vessels landed in Nuku'alofa, which was only once every month or so. Now with more tuna longliners, Sea Star expects to be selling fresh tuna locally on a regular basis. In any case, the Sea Star whole fresh tuna price of T$2.50 per kg sets a ceiling to the local fresh tuna price, even as it suppresses local reef fish and bottomfish prices. Allowing for waste and the selling of the heads and other lower valued cuts at lower prices, receiving an average price of about T$2.00 is what can be expected.

The average return to the project on tuna sold in its export marketing trials was only T$1.40 per kg, but the financial arrangements and other aspects related to the fact that these were project trials were responsible for the low returns. The following section will explore the nature of the returns to export marketing in more detail.

### 3.2.2 Export trial results

The project conducted 36 export marketing trials during 1993. However, five of these export marketing trials were either intentional trials of smaller, lower quality tuna or were shipments of tuna which were generally unmarketable by the time they reached the destination market (due to inadequate packing or unanticipated shipping delays). Thus, the following analysis of the export marketing trial results includes only 31 of the 36 actual trials conducted.

Table 3-3 shows the results of the export marketing trials. The results are organized to show the distribution of exports by country and by species. Out of the total 31 successful export marketing trials, there were 9 successful export marketing trials to New Zealand, 15 to Hawaii, 6 to Australia, and only one to Japan. There were 14 of the export marketing trials, totaling 3,308 kg, or 71% of the exported fish by weight, containing bigeye tuna. Another 15 trials, containing 1,217 kg, or about 26% of the exported fish by weight, were of yellowfin tuna. There were only two small export trials with albacore tuna.

The net return to the project for the exported fish in these 31 trials averaged T$2.26 per kg. The returns ranged from T$1.95 and T$1.96 per kg for exports to Australia and New Zealand, respectively, to T$2.50 per kg for exports to Hawaii and T$5.26 per kg for shipments to Japan. The two albacore shipments reaped only T$2.05 per kg, while the 15 yellowfin export trials yielded an average T$2.21 and the 14 bigeye export trials yielded an average T$2.28 per kg.

Since these export shipments were project trials, the marketing arrangements do not reflect those that could be obtained by a commercial fishing operation. The project made an arrangement with a fish exporter in Tonga to front the funds necessary to pay for the packing materials and to share in the risk involved in the trial shipments. In return, the exporter received 50% of the net return over packing and shipping costs. For this reason, the net returns received by the project for the exported tuna was artificially lower than those obtainable by a commercial operator. One current arrangement between a Tongan commercial fishing operation and a Tongan fish exporter is for the commercial fishing operator to pay up front for the packing and shipping (including labor) costs, to absorb the risk of the exporting, and to pay to the exporter only 15% of the net return over packing and shipping costs. Had the project used this type of commercial exporting arrangement in its export trials, it would have received approximately 70% more in net returns over packing and shipping costs than it did. While the project collected precise data on the net price per kg received on tuna shipments, the data collected on the gross price received on the shipments, packing costs, and shipping costs were insufficient to make detailed calculations of the intermediate costs and the average spread between gross and net revenues. However, some estimates on typical packing, shipping, and marketing costs on tuna exports are presented in Bartram 1992 and Bartram 1994.

## Table 3-3. Results of export trials

| | No. of TRIALS | KG | T$ | T$/KG | Adjusted T$ | Adjusted T$/KG |
|---|---|---|---|---|---|---|
| **EXPORTS BY COUNTRY** | | | | | | |
| **EXPORTS TO NEW ZEALAND** | | | | | | |
| BIGEYE | 4 | 215 | $448.04 | $2.08 | $761.67 | $3.54 |
| YELLOWFIN | 5 | 464 | $880.00 | $1.90 | $1,496.00 | $3.22 |
| TOTAL | 9 | 679 | $1,328.04 | $1.96 | $2,257.67 | $3.32 |
| **EXPORTS TO HAWAII** | | | | | | |
| BIGEYE | 7 | 1748 | $4,460.75 | $2.55 | $7,583.28 | $4.34 |
| YELLOWFIN | 6 | 412 | $993.01 | $2.41 | $1,688.12 | $4.10 |
| ALBACORE | 2 | 125 | $256.52 | $2.05 | $436.08 | $3.49 |
| TOTAL | 15 | 2285 | $5,710.28 | $2.50 | $9,707.48 | $4.25 |
| **EXPORTS TO AUSTRALIA** | | | | | | |
| BIGEYE | 3 | 1345 | $2,647.36 | $1.97 | $4,500.51 | $3.35 |
| YELLOWFIN | 3 | 290 | $548.57 | $1.89 | $932.57 | $3.22 |
| TOTAL | 6 | 1635 | $3,195.93 | $1.95 | $5,433.08 | $3.32 |
| **EXPORTS TO JAPAN** | | | | | | |
| YELLOWFIN | 1 | 51 | $268.31 | $5.26 | $456.13 | $8.94 |
| TOTAL | 1 | 51 | $268.31 | $5.26 | $456.13 | $8.94 |
| **GRAND TOTAL** | **31** | **4650** | **$10,502.56** | **$2.26** | **$17,854.35** | **$3.84** |
| **EXPORTS BY SPECIES** | | | | | | |
| BIGEYE | 14 | 3308 | $7,556.15 | $2.28 | $12,845.46 | $3.88 |
| YELLOWFIN | 15 | 1217 | $2,689.89 | $2.21 | $4,572.81 | $3.76 |
| ALBACORE | 2 | 125 | $256.52 | $2.05 | $436.08 | $3.49 |
| **GRAND TOTAL** | **31** | **4650** | **$10,502.56** | **$2.26** | **$17,854.35** | **$3.84** |

In order to obtain a better assessment of the possible returns from exporting fresh tuna from Tonga, the net revenues in Table 3-3 were adjusted to the expected yield if the commercial exporting arrangement described above had been used instead of the arrangement actually used by the project. The adjusted net revenues on tuna exports are shown in Table 3-3 as "Adjusted T$/KG". The adjusted net return ranged from T$3.32 per kg for exports to Australia and New Zealand, to T$4.25 per kg on exports to Hawaii, and to T$8.94 per kg on the one shipment to Japan. The average adjusted net return on albacore tuna shipments was T$3.49 per kg, while that for yellowfin tuna was T$3.76 and that for bigeye tuna was T$3.88.

The average adjusted net return on all tuna shipped by the project during the 31 successful export marketing trials came to T$3.84 per kg. This is a particularly good result in view of the conditions under which the project operated. Throughout most of these trials, ice was not of a good quality flake ice, and it often bruised and dented the fish skin in shipment, thereby reducing the value. In addition, ice was often in short supply. The fish were transported from Vava'u to Nuku'alofa by ferry, so the tuna shipment schedule was at the mercy of the ferry schedule. This often meant that the time lag between catch and exporting was lengthened by 1-3 or more extra days, again reducing the quality and the price received at the final market destination. Discussions with the RDA Marketing Advisor have resulted in the view that improving the quality of the ice and making an effort to be somewhat more careful in coordinating catching and shipping schedules, even with fish handling, icing, and packing and everything else continuing as usual, would result in annual net export revenues over packing and shipping costs of at least T$5.00 per kg. As all parties learn how to catch, handle, pack, and ship a higher quality product, and as more attention is paid to current supply and price trends in particular markets so that shipments are timed and targeted more profitably, the annual net export revenues over packing and shipping costs could reach as much as T$7.00 or more per kg, a net return now being achieved by some fresh tuna exporters in neighboring South Pacific countries. [See the Tuna Export Marketing report prepared by the RDA Marketing Advisor in December 1992 (Bartram 1992), in which the estimated net return on Grade #1 tuna exports from Tonga to Hawaii was T$7.07 per kg. That report also reviews a host of export marketing concerns not dealt with in this report. See also the Marketing of Tuna from the Kingdom of Tonga Final Report (Bartram 1994).]

## 3.3 Costs

The project fishing trial expenses are presented in Table 3-4.



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## Table 3-4. Project fishing trial expenses

| Fishing Trials | Longline Catch | Handline Catch | Total Catch | Expenses | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Fuel | Oil | Ice | Bait | Gear | Marketing | Total |
| # | Kg | Kg | Kg | T$ | T$ | T$ | T$ | T$ | T$ | T$ |
| 1 | 39 | 0 | 39 | $140 | $14 | $25 | $60 | $0 | $0 | $239 |
| 2 | 50 | 0 | 50 | $114 | $11 | $25 | $60 | $0 | $0 | $210 |
| 3 | 103 | 0 | 103 | $144 | $14 | $25 | $100 | $20 | $0 | $303 |
| 4 | 29 | 0 | 29 | $129 | $13 | $25 | $60 | $0 | $0 | $227 |
| 5 | 20 | 0 | 20 | $129 | $13 | $45 | $100 | $0 | $0 | $286 |
| 6 | 510 | 0 | 510 | $478 | $48 | $145 | $300 | $40 | $0 | $1,010 |
| 7 | 637 | 0 | 637 | $675 | $68 | $175 | $400 | $900 | $0 | $2,218 |
| 8 | 2327 | 0 | 2327 | $627 | $63 | $163 | $400 | $100 | $0 | $1,352 |
| 9 | 462 | 0 | 462 | $815 | $81 | $100 | $160 | $140 | $0 | $1,296 |
| 10 | 169 | 0 | 169 | $501 | $50 | $75 | $140 | $0 | $0 | $767 |
| 11 | 2699 | 0 | 2699 | $752 | $75 | $200 | $280 | $70 | $0 | $1,377 |
| 12 | 2881 | 0 | 2881 | $382 | $38 | $75 | $140 | $50 | $36 | $721 |
| 13 | 675 | 0 | 675 | $191 | $19 | $125 | $140 | $40 | $17 | $532 |
| 14 | 745 | 0 | 745 | $191 | $19 | $125 | $220 | $25 | $18 | $598 |
| 15 | 1568 | 0 | 1568 | $206 | $21 | $88 | $200 | $40 | $0 | $554 |
| 16 | 1374 | 0 | 1374 | $213 | $21 | $81 | $200 | $20 | $0 | $535 |
| 17 | 1831 | 0 | 1831 | $550 | $55 | $250 | $240 | $70 | $80 | $1,245 |
| 18 | 228 | 0 | 228 | $208 | $21 | $75 | $220 | $20 | $0 | $543 |
| 19 | 515 | 0 | 515 | $208 | $21 | $200 | $220 | $45 | $0 | $693 |
| 20 | 693 | 0 | 693 | $208 | $21 | $125 | $210 | $20 | $0 | $583 |
| 21 | 247 | 0 | 247 | $415 | $41 | $175 | $400 | $40 | $0 | $1,071 |
| 22 | 2202 | 0 | 2202 | $830 | $83 | $280 | $400 | $60 | $80 | $1,733 |
| 23 | 2438 | 0 | 2438 | $993 | $99 | $280 | $400 | $60 | $120 | $1,952 |
| 24 | 1207 | 0 | 1207 | $204 | $20 | $100 | $120 | $40 | $0 | $484 |
| 25 | 3009 | 981 | 3990 | $962 | $96 | $625 | $400 | $480 | $150 | $2,713 |
| 26 | 1874 | 0 | 1874 | $205 | $20 | $375 | $120 | $40 | $0 | $760 |
| 27 | 613 | 0 | 613 | $582 | $58 | $375 | $280 | $20 | $0 | $1,315 |
| 28 | 1000 | 739 | 1739 | $1,091 | $109 | $500 | $400 | $210 | $80 | $2,390 |
| 29 | 2030 | 493 | 2523 | $1,091 | $109 | $390 | $620 | $50 | $120 | $2,380 |
| 30 | 3019 | 411 | 3430 | $1,164 | $116 | $293 | $468 | $120 | $80 | $2,241 |
| 31 | 817 | 0 | 817 | $728 | $73 | $8 | $280 | $25 | $0 | $1,113 |
| 32 | 880 | 0 | 880 | $1,310 | $131 | $325 | $280 | $40 | $0 | $2,085 |
| 33 | 3257 | 1726 | 4983 | $1,091 | $109 | $450 | $600 | $0 | $170 | $2,420 |
| 34 | 1297 | 1540 | 2837 | $873 | $87 | $369 | $300 | $25 | $200 | $1,854 |
| Total, all trials | 41445 | 5890 | 47335 | $18,395 | $1,840 | $6,690 | $8,918 | $2,810 | $1,151 | $39,804 |
| Average, all trials | 1219 | 173 | 1392 | $541 | $54 | $197 | $262 | $83 | $34 | $1,171 |
| Average T$/Kg | | | | $0.39 | $0.04 | $0.14 | $0.19 | $0.06 | $0.02 | $0.84 |



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The cost data of the project's fishing and export trials are even more problematical than were the revenue data. The project cost data do not reflect the probable cost of a commercial venture largely because the vessel employed, as noted above in Section 3.1, was not an appropriate fishing vessel. Over-sized and much over-powered for its fishing task, the modified fish carrier vessel, the *Ekiaki*, used far more fuel than would be required by a more suitable vessel. Since the ice used was not of the appropriate type, the cost of the ice to the project was not representative of the probable cost of a commercial venture. Gear costs included only miscellaneous expenditures over the course of the half year during the project's fishing trials being analyzed here, and do not represent actual gear replacement costs. Recorded marketing costs represent only a fraction of the total marketing costs, as they generally include only some additional packing and ferrying costs of getting the tuna from Vava'u to Nuku'alofa as part of the export marketing trials. Costs were recorded for neither the crew nor the provisions. The crew, which numbered about twice the size of a crew which would be required by a commercial venture, was made up of government employees, and their wages would not reflect ordinary fishing crew wages. All in all, only the bait costs, which came to only about 22% of the total recorded fishing trial expenses in Table 3-4, are representative of the costs which would be incurred by a commercial operation.

As can be seen in Table 3-4, the project recorded fishing trial costs of T$39,804. This compares with the total project fish sales revenues of T$41,182, so that, with the limitations noted in the preceding paragraph, the project in its fishing trials brought in more revenues than it incurred in costs.

## 3.4 Commercial feasibility of small-scale horizontal longlining in Tonga

Since the *Ekiaki* is not an appropriate style or size of vessel, evaluating the commercial feasibility of small-scale tuna longlining would have been a matter of substantial guesswork but for the fortunate circumstance that, due to the success of the fishing and marketing trials, a commercial operator recently began operating. The commercial operator shared his cost and revenue data with this investigator. This presented a unique opportunity to evaluate the commercial feasibility of small-scale tuna longlining in Tonga.

The commercial operation is employing a suitable 40' steel vessel equipped with a 6 km monofilament longline using 200 hooks per set, as compared with *Ekiaki*'s 8 km of monofilament longline using an average of 249 hooks per set during the 25 fishing trials on Capricorn Seamount. In the first three months of 1994, with a relatively inexperienced crew, two different skippers and several expeditions with very bad weather, the commercial operator was successful in catching, by longlining, 55% as much fish by weight per fishing day as the *Ekiaki* did in its Capricorn Seamount trials - with only 76% as many hooks. In other words, the beginning commercial operation caught slightly more than 63% (by weight) of that caught in *Ekiaki*'s trials per hook. But the results are actually more impressive than the above suggests. When the

fishing expeditions involving engine trouble, skipper changes, and extremely bad weather are excluded from the available data, so that only the "normal" 6 fishing trips with 18 days of actual fishing are examined, one finds that the commercial operator had catch rates comparable to those of the project's fishing trials with the *Ekiaki*. This newly formed commercial operation confirms the tuna longlining potential established by the *Ekiaki*, and provides the basis for better evaluating the commercial potential than would be feasible with project data only.

A review of the experience of the new commercial operation is appropriate here. The data have been adapted to facilitate the presentation, but the data are firmly based on an actual commercial experience. First, the investment and fixed costs will be examined. This will be followed by a brief discussion of the variable fishing costs, including fuel, ice, bait, crew, provisions, and marketing costs, comparing these with project trial experience where appropriate. Finally, an assessment of the commercial feasibility of small-scale horizontal longlining in Tonga will be made.

### 3.4.1 Investment and fixed costs

An overview of representative investment and fixed costs of small-scale horizontal longlining in Tonga is presented in Table 3-5. These data are based on the actual costs of a commercial tuna fishing operation in Tonga. The vessel was purchased in the fall of 1993 and conducted tuna fishing out of Vava'u, Tonga, during the first three months of 1994. The numbers have been rounded for clarity.

Initial investment costs included vessel and vessel acquisition costs, hydraulic and other equipment, fishing gear, and operating capital. The vessel cost approximately T$105,000, but there were additional vessel acquisition costs of roughly T$25,000. The hydraulic reel and other equipment cost T$22,000; fishing lines, hooks, buoys, and other gear cost T$24,000; and approximately T$50,000 in operating capital was invested in the enterprise. This brought the total initial investment to T$226,000. The commercial operator obtained a development loan with a 5-year payback period from the Tonga Development Bank to finance the investment. Discussions with Tonga Development Bank officials suggested that there was likely to be some flexibility in the payback schedule. While a commercial loan would have cost in the vicinity of 12% or more interest, the development loan was obtained at the rate of 10.5%.



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**Table 3-5. Representative investment and fixed costs**

| INVESTMENT COSTS | |
|---|---|
| Vessel | $105,000 |
| Vessel Acquisition | $25,000 |
| Equipment | $22,000 |
| Gear | $24,000 |
| Operating Capital | $50,000 |
| Total Investment Costs | $226,000 |

| ANNUAL FIXED COSTS | |
|---|---|
| Annual Capital Costs | |
| Vessel Depreciation (15 yr. st. line dep.) | $7,000 |
| Equipment Replacement (20% per yr.) | $4,400 |
| Gear Replacement ( 33.3% per yr.) | $8,000 |
| Repair & Maintenance (10% of value of | $10,500 |
| Insurance (6% of value of vessel) | $9,060 |
| Total Annual Capital Costs | $38,960 |
| Other Annual Overheads | |
| Management Expenses | $12,000 |
| Miscellaneous Expenses | $3,000 |
| Total Other Annual Overheads | $15,000 |
| Total Annual Fixed Costs | $53,960 |

Based on these investment costs, a projection of annual capital and other overhead costs was made. The vessel is about 10 years old and probably can provide some 15-20 years more good service; however, for planning purposes, a 15-year life was assumed, with a roughly 20% salvage value at the end of the 15-year period. (Of course, when the expected rate of return on this investment was calculated, a separate annual depreciation cost was not included in the annual cash flow projections.) The operator must plan for annual equipment replacement at the rate of about 20% of the value of the equipment, annual gear replacement at the rate of about 33.3% of the value of the gear, annual vessel repair and maintenance costs of approximately 10% of the value of the vessel, and annual vessel insurance premiums of 6% of the value of the vessel. These annual capital costs come to approximately T$38,960 per year. In addition, Table 3-5 includes a modest estimate of other overhead expenses. Management expenses were estimated at T$1,000 per month and miscellaneous expenses were estimated at T$3,000, bringing the total other annual overhead expenses to T$15,000. While the management expenses of T$12,000 can hire a manager to tend to management and administrative affairs, there was no accounting for the expenses of a bookkeeper, rental on office space, and other ordinary business expenses. It was presumed that a single manager could tend to the affairs of at least two fishing vessels, so that if the fishing business expanded, there

might be the need to hire a secretary and rent an office, but the T$15,000 in annual other overhead expenses is a fair estimate of the per vessel management expenses. Clearly, some of these expenses vary according to fishing effort, but since they are not directly related to particular fishing trips, it facilitated the analysis to categorize these expenses as annual fixed costs.

### 3.4.2 Costs and returns

Fishing costs vary with, among other factors, the fishing effort, the catch, and the average revenue received for the fish. For example, fuel requirements per day of fishing vary according to the number of days of fishing per fishing trip. Bait costs vary according to the number of hooks used per set. Wages vary because, in addition to a base wage for the crew, there are usually bonuses paid according to the value of the catch. Hence, any representative costs of fishing are based on the assumptions made regarding the amount of fishing, the catch, and the prices received for the catch.

The representative fishing operation examined here assumes that a commercial venture would experience catch rates similar to the project's results with the *Ekiaki* and with those of the commercial operation discussed above. While the *Ekiaki* usually fished only one day per fishing trip, the commercial operation discussed above has been fishing three days (one set per day) per fishing trip. In order to develop a set of representative costs, it is assumed that a commercial venture would set one longline set per fishing day for a total of 108 fishing days per year. Conducting three fishing days per fishing trip, the venture would undertake 36 fishing trips per year. A commercial venture operating on Capricorn Seamount and using 200 hooks per set per fishing day, would catch, at project catch rates, roughly 625-650 kg of marketable fish per day. Supplemented by a modest amount of handline fishing, as demonstrated by the project trials, the results of which were shown in Table 3-1, roughly 2 hours of handline fishing per day on Capricorn Seamount would bring the total catch to roughly 1,000 kg of marketable fish per fishing day. In summary, a commercial venture, duplicating project catch rates while using 200 hooks per longline set and a modest amount of handline fishing, should be able to catch 108,000 kg of marketable fish per year.

While the project actually exported in trial shipments about 45% of its horizontal longline catch, it is assumed that under commercial conditions 60% of the longline catch would be exportable. The entire handline catch would be sold locally. Based on project marketing experience and presuming that the higher quality of ice now available to commercial operators in Vava'u continues to be available, it is reasonable to assume that fish sold locally would bring an average revenue of T$2.00 per kg and that exported fish would yield an average revenue (net over packing and shipping costs) of between T$5.00 per kg and T$7.00 per kg.

Based on these assumptions regarding fishing effort, catch, marketing and expected average revenues, the expected fishing costs for a commercial venture can be estimated. Based on the actual cost experience of the commercial operator, representative costs per fishing day were developed and are shown in Table 3-6, below:

**Table 3-6. Representative costs per fishing day**

| Item | Cost |
|---|---|
| Fuel | $259 |
| Ice | $200 |
| Bait | $140 |
| Provisions | $51 |
| Base Wages | $204 |
| Crew Bonus | $393 |
| Miscellaneous | $18 |
| Total | $1,265 |

Since the estimated fuel costs are based on the experience of a 40' fishing vessel rather than the *Ekiaki*, the fish carrier used in project trials, the estimate of fuel costs here is less than half that of the project average. The costs for ice and bait (when adjusted for the number of hooks per set), on the other hand, are comparable to those experienced in the project trials. The cost of provisions is based on actual experience of the commercial operator in Vava'u; however, since the commercial operator is transporting the catch to Nuku'alofa, the actual fishing days per fishing trip are less than half of the sea-going days. This makes the costs of crew provisions per fishing day more than twice the actual daily cost of provisions. The base wages vary from about T$4,000 per year for an ordinary crew member to twice that for the skipper. The base wages for a crew of 4, including the skipper, an engineer, and two other crew members, comes to T$204 per fishing day. The bonus arrangements currently used by the commercial operator are to share among the crew 20% of the value of local fish sales and T$0.50 per kg for exported tuna. Based on catch and average revenue assumptions, the crew bonus comes to about T$393 per fishing day. Finally, miscellaneous expenses are estimated at T$18 per fishing day. This brings the total representative costs of a commercial fishing operation to T$1,265 per fishing day.

This is the cost framework which is used below in determining the expected rate of return from a tuna fishing venture in Tonga.

Representative annual costs and returns may now be calculated as based on project catch rates and commercial investment and annual fixed costs as shown in Table 3-5 and operating costs per fishing day as shown in Table 3-6. The results, along with expected annual rates of return on investment are shown in Table 3-7. In the simplest terms, a commercial operator achieving project catch rates and continuing to export 60% of the longline tuna catch at expected prices for a whole year can expect to receive an annual internal rate of return on investment over cost of 57.8%. This is a healthy rate of return, especially in view of the fact that one commercial tuna operator has already received a Tonga Development Bank loan at an interest rate of 10.5% and other operators should be able to obtain loans in the vicinity of 12%. Furthermore, this rate of return is based on continuing business as usual. There is every reason to believe that net revenues on export sales of up to T$7.00 per kg or more can be obtained as fish handling, packing, and shipping experience is gained, and as more careful monitoring and targeting of markets is done. Tonga has South Pacific neighbors who are currently achieving such net revenues on fresh tuna exports to Hawaii, so higher returns are certainly possible. As is shown in Table 3-7, if average net export sales revenues of T$7.00 per kg are obtained, the annual rate of return on investment rises to 94.6%.

It is worth noting that the expected annual rates of return on an investment in small-scale tuna horizontal longlining in Tonga are rather robust. A 25% increase in initial investment costs only reduce the expected annual rates of return to 75.7% and 46.1% at net export revenues of T$7.00 per kg and T$5.00 per kg, respectively. Alternatively, if the expected catch rates should fall to 75% of those proven possible by 6 months of project trials, the expected annual rate of return falls to 26.8% if export sales net revenue remains at T$5.00 per kg, and falls only to 55.1% if export sales net revenue rises to T$7.00 per kg.



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Table 3-7. Representative annual costs and returns based on project catch rates and commercial costs

| Annual Costs and Returns | Based on 108 Fishing Days Per Year | |
|---|---|---|
| | Export Revenue = T$5.00/kg | Export Revenue = T$7.00/kg |
| Total Catch (Kg) | 108000 | 108000 |
| Local Sales (Kg) | 54271 | 54271 |
| Export Sales (Kg) | 41574 | 41574 |
| Total Sales (Kg) | 95845 | 95845 |
| Waste and Share (Kg) | 12155 | 12155 |
| Total Revenue on Local Sales, T$ | $108,541 | $103,541 |
| Average Revenue on Local Sales, T$/Kg | $2.00 | $2.00 |
| Total Revenue on Export Sales, T$ | $207,870 | $291,018 |
| Average Revenue on Export Sales, T$/Kg | $5.00 | $7.00 |
| Total Revenue on Total Sales, T$ | $316,411 | $399,559 |
| Average Revenue on Total Sales, T$/Kg | $3.30 | $4.17 |
| Total Operating Cost, T$ | $136,647 | $136,647 |
| Margin on Total Operating Costs, T$ | $179,764 | $262,912 |
| Less Total Annual Capital Costs, T$ | $145,704 | $228,852 |
| Less Total Other Annual Overheads, T$ | $130,704 | $213,852 |
| Annual Rate of Return on Investment, % | 57.8% | 94.6% |

While potential investors often decide whether an investment opportunity is attractive or not by comparing the rate of return on the investment with rate of interest at which capital may be obtained, economic planners frequently prefer to assess the attractiveness of investment opportunities by examining the net present value of revenues over costs. These results are equally impressive. In the representative fishing operation described above, the net present values of revenues over costs are T$597,563 at an assumed net export sales revenues of T$5.00 per kg and T$1,103,197 at an assumed net export sales revenues of T$7.00 per kg.

### 3.4.3 Summary of commercial feasibility

The commercial feasibility of small-scale tuna horizontal longlining in Tonga has been demonstrated not only in the rate of return (and net present value) calculations made above but also by the fact that several commercial operators, seeing the potential returns, have already begun fishing operations. The commercial operation which shared the cost and revenue data with this investigator has already acquired a second fishing vessel which will soon be fishing in the same manner as the initial vessel. While visiting Tonga in April 1994, this investigator heard reports of at least 2 more fishing ventures which were beginning to engage in small-scale tuna horizontal longlining in Tonga. It is quite clear that the potential returns are quite high and that entrepreneurs have recognized that potential.



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There are several unknown factors which can positively or negatively affect the expected rates of return calculated above. On the positive side, as noted above, new tuna operators can be expected to learn from experience. As in other longline fisheries, the operations may be able to set more than one longline per day. This would eliminate the need to supplement the longline catch with handline fishing, and would substantially increase the exportable fish, and commensurately, the revenues and expected rates of return. Greater care with handling, packing, and shipping of exportable fish, which can be learned from experience, will gradually increase net export revenues. Improved targeting of export shipments can also substantially increase net export revenues. All things considered, the rates of return calculated above are modestly conservative estimates.

There are several precautionary concerns also to be noted. No one knows for sure how rich these tuna fishing grounds really are. It is simply not known how much fishing effort it would take to significantly reduce the catch rates to date experienced on Capricorn Seamount. Perhaps 1-2 vessels are all that could be supported over the long term by the fishery as it is now understood. On the other hand, perhaps 10 or more vessels could experience many years of highly profitable fishing. There are examples of particular seamounts which produced tuna in abundance for a few years after which the resources were essentially depleted. High rates of return can bring into the industry an extraordinary number of new fishing entrepreneurs in a rather short time. Fishing yields can fall precipitously, making the activity unprofitable for all. Furthermore, the increase in the number of fishermen can lead to gear conflicts. In addition, there has been too little fishing experience on Capricorn Seamount and related seamounts to know how seasonal the catches will be. Evidence from Hawaii's longline tuna fisheries suggest that seasonality may be a significant factor. (Regarding these experiences and precautionary concerns, see Boggs 1991, Boggs and Ito 1993, and Skillman, et al. 1993.)

There are several implications to be drawn from these unknowns and their possible serious negative impacts on the fishery and its profitability. It is most important that the fishery be expanded slowly and methodically. Such a careful expansion of the longlining industry is challenged by the high initial expected rates of return which will tend to draw in large numbers of entrepreneurs and create a "gold rush" mentality. The high rates of return can allow fishing ventures to conduct more exploratory fishing on other nearby seamounts in an effort to find more productive fishing grounds. While a rapid expansion of the fishing industry on the already proven productive seamount could lead to an undermining of the sustainability of these tuna resources, a slower, more methodical expansion could lead to continuing discoveries of additional productive fishing grounds and ultimately lead to a sizeable small-scale horizontal longline fishery in Tonga.

This examination of the commercial feasibility of small-scale tuna horizontal longlining in Tonga has been based on only 6 months of project fishing trials and 3 months of a commercial operator's experiences. Because of this limited experience and some of the unknown factors outlined above, the projected rates of return should be viewed with some caution, despite the promise for this industry's development that they suggest. A fuller discussion of the opportunities for and constraints on the future development of a fresh tuna export industry in Tonga based on small-scale horizontal longlining is found in Section 5.0.



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## 4.0 ECONOMICS OF VERTICAL LONGLINING

The project also conducted vertical longline trials with a 35' vessel, the *Dora Malia*. The *Dora Malia* is a wooden-hulled larger version of the Tongan 28'-30' snapper vessels, with an effective range of about 120 km. While fully equipped with a 2 KW color echo sounder, GPS, and SSB and VHF radios, it has no hydraulic capabilities, so all gear was hauled by hand or hand reels. The vessel used vertical longline gear consisting of a 400# test - 400 m monofilament line. In addition to vertical longlining, the vessel also conducted trolling, short horizontal longlining (1.6 km, manually pulled), and daytime handlining. A fuller description of the gear and fishing techniques employed is found in Hurrell and Swerdloff (1994).

These trials were an effort to explore the advisability of using the Tongan snapper fleet in the developing tuna industry. It was thought that either some of the vessels could possibly be effectively and economically redeployed from bottomfishing to tuna fishing, or that tuna fishing could serve as a source of supplemental catch and income for the fleet, assisting in reducing some of the fishing pressure on the bottomfish stocks.

Table 4-1 shows the catch results of the *Dora Malia* over 107 fishing expeditions made over an 18-month period from August 1992 to January 1994. The crew conducted 89 days of vertical longline fishing. The total catch from 8,390 hooks was 547 fish, weighing 8,859 kg, for an overall catch rate per hundred hooks of 6.52. 93% of the number of fish and 82% of the weight of the catch were marketable. The catch rate for marketable fish per hundred hooks was 6.06. Tuna accounted for 98% of the marketable fish and 92% of the marketable weight. Only three tuna weighed over 40 kg, so virtually all of the marketable catch was sold in Tonga. The one export trial (two shipments) of the vertical longline catch lost money.

Table 4-2 shows the vertical longline trials revenues and costs. The revenues and expenses are shown both for the total number of trips and for those trips during which actual fishing was undertaken. There is little reason for exploring implications of the specific expense line items, since it is obvious that the total revenues received from the catch from all 74 sea trials during which fishing was conducted barely exceeded the total expenses. In fact, net revenues over expenses were positive for only 21 of those 74 sea trials which included actual fishing time. Furthermore, it can be noted that these expenses included neither allowances for crew wages or bonuses nor for capital costs.

Despite the discouraging results of the vertical longlining trials, an effort was made to explore a best-case scenario. A hypothetical fishing operation was constructed from the catch, revenue, and cost data from the *Dora Malia's* 21 sea trials (with 26 fishing days) in which net revenues exceeded expenses. A snapper vessel, like the

*Dora Malia,* was assumed to cost T$60,000, fully equipped. The vessel was assumed to have a crew of three persons, with base wages similar to those assumed above in the case of the horizontal longlining and bonuses of 20% of the value of the catch. Each fishing trip was assumed to contain 3 fishing days. This exercise revealed that even under these favorable assumptions the expected revenues would barely cover the operating costs, leaving little or no surplus to cover the investment and annual fixed costs. Calculated net present values and annual rates of return were all negative. It was not possible to construct a fishing operation scenario from the *Dora Malia* fishing trial results which would yield positive returns. Accordingly, on the basis of the vertical longline trials with the *Dora Malia*, it is concluded that vertical longlining with the Tonga snapp fleet is not an economically viable option.

Table 4-1. Vertical longline trials catch rates

| | Sea Days | Fishing Days | Number of Sets | Number of Hooks | Total Catch | | Yellowfin | | Albacore | | Bigeye | | MahiMahi | | Other Marketable | | Unmarketable | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | # | Kg | # | Kg | # | Kg | # | Kg | # | Kg | # | Kg | # | Kg |
| Total | 159 | 89 | 432 | 8390 | 547 | 8859 | 267 | 3975 | 112 | 2181 | 4 | 69 | 116 | 816 | 9 | 227 | 39 | 1600 |
| Average Per Fishing Day | | | 4.9 | 94.3 | 6.15 | 99.5 | 3 | 44.7 | 1.26 | 24.5 | 0.04 | 0.78 | 1.30 | 9.17 | 0.10 | 2.55 | 0.44 | 17.98 |
| Catch Per Hundred Hooks | | | | | 6.52 | | 3.18 | | 1.33 | | 0.05 | | 1.38 | | 0.11 | | 0.46 | |

Table 4-2. Vertical longline trials revenues and costs

| | Trips | Catch | Sold | T$/Kg | Revenue | Fuel | Oil | Ice | Bait | Gear | Packing | Freight | Marketing | Expense | Net |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total, all trips | 107 | 8,859 | 7,002 | $2.14 | $15,010 | $5,340 | $525 | $9,605 | $1,572 | $1,519 | $40 | $181 | $8 | $18,791 | ($3,781) |
| Average, all trips | | 83 | 65 | $2.14 | $140 | $50 | $5 | $90 | $15 | $14 | $0 | $2 | $0 | $176 | ($35) |
| Total, fishing trips | 74 | 8,859 | 7,002 | $2.14 | $15,010 | $3,620 | $353 | $7,365 | $1,490 | $1,210 | $40 | $181 | $8 | $14,267 | $743 |
| Ave., fishing trips | | 120 | 95 | $2.14 | $203 | $49 | $5 | $100 | $20 | $16 | $1 | $2 | $0 | $193 | $10 |

## 5.0 OPPORTUNITIES AND CONSTRAINTS

The above discussion has suggested numerous opportunities for and constraints on the development of small-scale tuna longlining activities in Tonga. This section will highlight those opportunities and constraints that are particularly important and will suggest others which have not yet been discussed.

Small-scale horizontal longlining has been demonstrated to be commercially feasible in Tonga. Tonga has the tuna resources, they can be exploited economically, and export trials have clearly demonstrated that exporting fresh tuna from Tonga is feasible and can be profitable. It is also clear that exploiting these tuna resources will require a new type of fishing fleet, employing larger boats than have previously been available in Tonga and employing fishing gear previously unused in Tonga. The small-scale horizontal longlining gear used by the project and already used by new entrants to the tuna fishing industry was designed for use on 40-45' fuel efficient vessels capable of taking long sea excursions. This is a new fishing opportunity now proven to be open to Tonga fishermen and fishing industry investors.

One of the project's objectives was to determine whether small-scale longlining was a viable alternative fishing technique for the 28-30' snapper boat fleet which was developed in the 1980s. On the one hand, these boats are too small to accommodate the small-scale horizontal longlining gear and cannot safely or speedily travel to the most productive distant seamounts where this gear has proven to be very effective. On the other hand, the small-scale vertical longlining gear tested by the project has not proven to be as effective or as profitable as one may have hoped. The catch from the small-scale vertical longlining trials has neither produced tuna large enough to warrant being exported nor a volume large enough to economically justify this fishing method on a full-time basis.

So, while the existing 28-30' snapper boat fleet will not be able to benefit directly from the newly proven tuna fishing opportunities, the fact that a new type of fishing industry - the small-scale horizontal longlining industry - is now taking shape in Tonga will offer alternative employment opportunities to fishermen as an effective bottomfish resource management system systematically limits the size of the snapper fleet to that which will ensure the sustainability of the bottomfish resources. Additional jobs in fish handling and packing for export are also anticipated as the small-scale horizontal longlining fleet expands and exports grow.

One of the key questions regarding the expansion of a small-scale tuna horizontal longlining industry in Tonga concerns how large the industry can become, in particular, how many fishing vessels can be profitably and sustainably employed in the new industry? Unfortunately, there is no clear answer to this question. As noted above in Section 3.4.3, it is not known exactly how productive the export tuna

fishery is or will remain once fishing effort becomes more intense. Nor is there any evidence on the seasonality of the tuna catches in the range of the Tongan fishery. Boggs (1991) shows high seasonal variability in Hawaii's longline fishery. Unfortunately, the seasonal variation of tuna catches in Tonga will simply have to be learned by experience. Similarly, the robustness and catchability of the Tongan tuna stocks will also have to be learned through experience. Nonetheless, there are some cautionary guidelines which may assist policy makers in establishing a regulatory framework for this nascent industry.

Tuna are migratory and the South Pacific tuna stocks are viewed as part of a common stock. The aggregation of tuna stocks along current convergences or along seamounts is observed but is not a well-understood phenomena. Minor fishing effort on a seamount may not have any serious impact on the available tuna stocks or on the catchability. On the other hand, heavy fishing pressure can seriously reduce catches and even alter the availability of tuna on a seamount for long periods. In the absence of knowledge about the stocks themselves, policy makers would best be guided by the dynamics of the industry itself. High catch rates during the initial phase of opening up the new tuna resources in Tonga can be protected by a slow, careful, methodical expansion of the industry. It would be prudent, particularly from a financial viewpoint, to allow only a few vessels to enter the industry in the first several years. These vessels would have the opportunity to definitely prove the profitability of the industry. In fact, the early profits could be used to improve fishing technique; handling, packing, and shipping; and marketing strategy. Early profits can also be utilized to allow the fleet to explore neighboring areas and seamounts for current convergences which may harbor additional substantial tuna stocks. A methodical industry expansion guards against an unsustainable development, i.e., against a rapid expansion followed by industry-wide losses due to over-capacity or depletion of the available stocks so that the entire industry is put in jeopardy. Without having a firm basis for determining the optimum size of the industry (i.e., the optimum number of fishing vessels), it would probably be wise to limit the number of vessels allowed to fish on Capricorn Seamount to only 4-5 vessels at first. The success of these operations may lead to the discovery of additional fishing grounds, and ultimately the Tongan small-scale tuna horizontal longline industry may be able to support several times that number of vessels.

Management of this quite distant fishery will be a substantial challenge to fishery authorities in Tonga. Good management will require the cooperation of the fishermen themselves. Much of the policing will have to be self-policing by the participants in the industry. Nonetheless, limiting the number of entrants and limiting the number of days each vessel can fish per year on Capricorn Seamount will be essential to an industry development that can avoid a serious bust following an initial boom.



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A further benefit to the Kingdom of Tonga deriving from the expansion of the small-scale horizontal longlining industry will be the additional tuna available for local consumption. Each small-scale horizontal longlining vessel may be able to supply the local market with upwards of 50,000 kg of tuna each year. Five such vessels could supply the local markets in Vava'u and Nuku'alofa annually with something on the order of 250 mt of tuna which would be valued at roughly half a million Tongan dollars. The newly introduced tuna would be marketed at prices substantially below the fish produced by the more traditional reef fishery, which may relieve some of the fishing pressure on these over-fished resources.

The development of this fresh tuna export industry, based on a small-scale horizontal longlining fleet of 5 vessels, could contribute the equivalent of US$1-1.5 million in foreign exchange earnings to the Tongan economy. Furthermore, these tuna would be quite competitive in prices of the low cost fatty mutton now imported from New Zealand. This would simultaneously reduce requirements for foreign exchange, perhaps yielding in excess of US$0.5 million in import substitution, and improve the nutritional characteristics of the local diet simultaneously.

All the benefits to be derived from the expansion of this newly proven investment option by the Tongan people, its fishing industry, and the economy as a whole warrant a brief examination of some additional constraints which may hinder the industry's development.

While several potential tuna fishing locations have been identified, by far the most productive area proven by project trials is on Capricorn Seamount. This seamount is, unfortunately, about 210 miles from Nuku'alofa and about 180 miles from Vava'u. While smaller, lower quality tuna can be marketed in Vava'u, the exportable tuna must be shipped out of Nuku'alofa. While the exportable tuna could be transported via ferry from Vava'u to Nuku'alofa, the limited ferry schedule, combined with the fact there is no fishing on Sundays, restricts the required scheduling flexibility and timeliness for exporting fresh tuna. The commercial tuna fishing operation discussed above actually transports its tuna to Nuku'alofa onboard the fishing vessel. Approximately 25% of its crew and vessel costs should be attributed to shipping the fish to Nuku'alofa rather than to fishing. Furthermore, long steaming times are extremely taxing on both the crew and the fishing vessel. If there were an efficient fish ferrying service from Vava'u to Nuku'alofa, the commercial operation would be able to increase the number of fishing days, and presumably its catches, by about one-third, significantly increasing the expected rates of return. While this presents a serious constraint on the early development of the small-scale tuna horizontal longlining industry in Tonga, after a number of fishing vessels are in operation, it is likely that a commercial fish transporting operation will develop which would allow the fishing vessels to off-load their catches to a fish carrier, enabling them to increase their actual fishing days and total annual catches. Nonetheless, the long distances

to the tuna fishing grounds are a serious constraint on the development of the fresh tuna export industry in Tonga. Some of these concerns are discussed in the project reports on tuna export marketing (Bartram 1992, 1994).

The limited availability of loan capital is a further constraint on the development of a small-scale horizontal longlining industry in Tonga. The Tonga Development Bank has already shown interest in this opportunity by making development loans for some initial fishing vessels. While bank officials have suggested that they will be flexible about pay back schedules, the initial loan period for vessels has been 5 years, with only a month or two grace period. This is a very short loan period for a vessel which has 15-20 or more years of productive life. The particular constraint on industry development that this short pay back period presents is that it gives new longliners very little time to learn how most effectively and efficiently to catch and market the tuna. It may take a new operator several months or even much of the first year to actually achieve good catch results consistently. This difficulty is compounded by the experience that must be gained in the marketing and exporting end of the business. High monthly payments to the bank before enough fishing and marketing experience is gain to ensure high monthly net returns will limit entry to those entrepreneurs with substantial non-bank sources of capital.

The role of the parastatal Sea Star Fishing Co. LTD in the development of the tuna fishing industry remains somewhat unclear. In principle there is no reason for the traditional longlining to constrain the development of the new small-scale longlining industry. However, despite the fact that the exclusive rights to tuna initially granted to Sea Star have been eliminated, there remains some likelihood that the government and Sea Star could cooperate to limit competition from the newly developing small-scale longliners. Sea Star vessels have not yet reliably proven the profitability of traditional longlining in Tongan waters. The *MV Lofa*, which has been operating and disposing of its catch primarily in Pago Pago since the early 1980s, has been unable to cover its full costs of operation in most years and has been subsidized by the government. The new, smaller, more fuel efficient longliners recently purchased by Sea Star are likely to prove more profitable than the MV Lofa, but the low catch rates of the traditional longlining techniques, as compared with the significantly higher catch rates of the small-scale longlining techniques used by the project, are likely to continue to plague the company with low returns. With Sea Star increasing the scale of its longlining operations, increasing its sales of tuna locally, and now beginning to export fresh tuna to foreign markets, growing competition between the public and private sector certainly poses an increasing threat to the development of the new tuna industry.

New U.S. health and inspection regulations on imported fish which are coming into force over the next couple of years are likely to present an additional challenge to the development of a small-scale tuna longlining industry in Tonga. Exports of fresh tuna

to the U.S. will need to be inspected in Tonga prior to shipment. Policy makers will need to design inspection facilities and methods which meet U.S. regulations but at the same time do not impose undue constraints on small-scale tuna exporters.

The RDA Marketing Advisor has reported on a number of constraints on the developing industry, mainly dealing with tuna handling, packing, and shipping matters (Bartram 1992, 1994). These are constraints which can be addressed primarily by increased experience in the industry Even the best packer and shipper of fresh tuna in Tonga is still relatively new to tuna exporting. The successful expansion of the fresh tuna exporting industry in Tonga will require that extensive attention be paid to fish quality. Fishermen, handlers, packers, and shippers all face a difficult learning period. One of the most serious constraints on the development of the fresh tuna export industry is the lack of grading and marketing experience. One of the most crucial requirements is acquiring the grading experience to insure that only high quality product is shipped. The international fresh tuna market is also a rapidly changing one. Specialists in marketing will be required to ensure that fresh tuna shipments are targeted on a daily basis to the markets yielding the highest returns. In brief, handling, packing, shipping, and marketing constraints on the developing longlining industry are certainly as serious as the constraints on the size of the resource base and on the ability of fishermen to catch exportable tuna.

The foregoing discussion has emphasized that, while commercial small-scale tuna horizontal longlining appears to be a profitable investment opportunity, there are many public and private sector support policies, skills, and services which must develop in tandem with the expansion of fishing activities if the industry is to grow and flourish.

## 6.0 CONCLUSIONS

Small-scale tuna horizontal longlining to supply fresh tuna to export markets has been shown to be a highly attractive investment opportunity in the Kingdom of Tonga. Rates of return in excess of 50% per annum are obtainable at project catch rates and current handling and marketing practices. Higher rates of return are feasible as fishing and marketing techniques improve. These rates of return are rather robust under alternative catch, cost, and revenue scenarios. The development of this industry will require larger vessels than have been used in the past in Tonga's fishing industry. The development faces numerous constraints, such as the limited availability of investment capital, the lengthy learning period for new entrants to the industry, inexperience in this style of tuna fishing, and a shortage of knowledgeable fish graders, packers, shippers, and marketing agents. In addition, there are uncertainties regarding the policy environment, private-public sector conflicts, and the nature of the resource management regime that may be established. Too rapid an expansion is likely to undermine the easily assessable and known tuna stocks and the profitability of the industry. Nonetheless, a careful and methodical expansion of the industry is likely to prove successful. Potential gains to Tonga from 5 small-scale tuna horizontal longliners include a substantial number of jobs in fishing, packing, and marketing tuna, upwards of 250 mt of fresh tuna annually for local consumption, and a net improvement of US$1.5-2.0 million annually in Tonga's balance in foreign exchange. In summary, there is great potential in the development of a small-scale tuna horizontal longlining industry in Tonga.

The prospects for utilizing the Tonga snapper fleet in the developing tuna industry by employing vertical longlining techniques, by contrast, are not attractive. Based on project fishing and marketing trial results, there were no fishing, cost, and revenue scenarios which yielded positive rates of return on investment in small-scale tuna vertical longlining with the snapper vessels.

## 7.0 REFERENCES


Bartram, P. 1992. Tuna export marketing. Pacific Islands Marine Resource Project, Tonga Component, RDA International, Inc., Placerville, California, December 1992.

Bartram, P. 1994. Marketing of tuna from the Kingdom of Tonga final report. Pacific Islands Marine Resource Project, Tonga Component, RDA International, Inc., Placerville, California, July 1994.

Boggs, C.H. 1991. A preliminary examination of catch rates in Hawaii's troll and handline fisheries over a period of domestic longline fishery expansion. Administrative Report H-91-05. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Honolulu Laboratory, Southwest Fisheries Science Center, Honolulu, Hawaii, May 1991.

Boggs, C.H., and Ito, R.Y. 1993. Hawaii's pelagic fisheries. *Marine Fisheries Review*, 55(2), 1993.

Hurrell, P., and Swerdloff, S.N. 1994. A preliminary report on the Tonga small-scale tuna longline project. Pacific Islands Marine Resource Project, Tonga Component, RDA International, Inc., Placerville, California.

Skillman, R.A., Boggs, C.H., and Pooley, S.G. 1993. Fishery interaction between the tuna longline and other pelagic fisheries in Hawaii. NOAA Technical Memorandum NMFS-SWFSC-189. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center, Honolulu, Hawaii, October 1993.