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MANAGEMENT PLAN FOR THE DEEP-WATER BOTTOMFISH FISHERY IN TUVALU

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MANAGEMENT PLAN FOR THE DEEP-WATER BOTTOMFISH FISHERY IN TUVALU

1.0 EXECUTIVE SUMMARY

Deep-water snappers, emperors, and groupers have been caught using lines and baited hooks in depths of over 200 m in Tuvalu. Results from this project and elsewhere suggest that the resource is fragile, involving slow growing species with long life-spans and limited habitats. Typical results of developing a fishery are that catch rates and fish sizes decrease with increasing exploitation. Bottomfish stocks are easily depleted by fishing.

During the most recent and indicative cruises, the mean catch rate of export marketable species was 3.3 kg per line hour, and of locally marketable species 1.8 kg per line hour, giving a total catch rate for all species of 5.1 kg per line hour (using four reels, equivalent to 20.4 kg per hour of fishing operation). A commercial operation could be expected to make catch rates of between 4 kg and 5 kg per line hour of export marketable species.

The high-value export species *Etelis coruscans, Etelis carbunculus,* and *Pristipomoides filamentosus* accounted for 49% of the catch. Export species were capable of attracting prices above A$9 per kg in Honolulu, but total transport costs amounted to A$5.80 per kg.

Using the length of the 200 m isobath as an index, the fishable habitat in Tuvalu is 248 nautical miles for all seamounts, and 128 nautical miles around islands, giving a total of 376 nautical miles of fishable habitat. Based on a conservative value of 0.2 mt yield per nautical mile, the sustainable yield for around islands is 26 mt and for the seamounts is 50 mt.

A likely fishing operation will be one in which a vessel completes 30 trips each year, 3 fishing days each trip, and uses 4 fishing reels for an actual fishing time of 6 hours each day. Based on a catch rate of 4 kg per line-hour for the main target species, a fishing operation would land an average of 288 kg per trip and 8.6 mt of exportable fish each year.

Although economic analyses are the subject of a separate report, indications are that an operation based on a moderately-sized vessel used within a 150 nautical mile radius of Funafuti would be profitable. The fish stock size within this area is likely to support up to 6 vessels on a sustainable profitable basis. However, a smaller number of vessels than this, perhaps only 3, would result in the maintenance of higher catch rates and greater profitability.

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The profitability of vessels initially in the fishery is likely to encourage others to enter the fishery. However, the addition of more fishing effort will necessitate vessels travelling further afield in order to maintain high catch rates, and to avoid overexploiting stocks closer to Funafuti. Travelling to the more distant fishing grounds (up to 250 nautical miles) is likely to require larger vessels (for safety reasons), and the increased costs may make fishing unprofitable.

It is therefore recommended that fishing effort in the fledgling fishery be restricted to an initial maximum of about 3 moderately-sized vessels which have low running costs, and could be used safely within a 150 nautical mile radius of Funafuti, in order to maximize economic yield and there by net profits in the form of foreign exchange to the country as a whole.

It is recommended that the number of vessels in the fishery be restricted by means of a licensing system. The license should in effect be an export license which permits the owner-operator of a suitable vessel to catch and export deep-water bottomfish from Tuvalu, subject to quality control procedures. A quality control inspection system is recommended to maximize the value of the catch, but this should not be such that it hinders the packing and transportation of fish. The success or failure of the Tuvaluan deep-water bottomfish fishery is highly dependent on maintaining a high reputation and market price for its products.

A permanent monitoring system is also recommended. It is proposed that the recording of catch and fishing effort by area in a fishing logbook should be a legal requirement of participation in the fishery. An additional option of allowing foreign fishing vessels access to stocks which are inaccessible to the Tuvaluan fleet in return for a negotiated fee is discussed. Some concerns expressed by the public regarding the development of a bottomfish fishery in Tuvalu are also addressed.

Factors which would put the development of the new fishery at risk include: 1) a reduction in catch rates, caused, for example, by too many vessels in the fishery; in general, the larger the number of vessels, the lower the catch rate of each; 2) a decrease in fish prices, caused, for example, by a failure of quality control or by a reduction in demand for the main species; and 3) an increase in costs, caused, for example, by larger vessels entering the fishery and causing over-capitalization or by any increase in freight charges.

2.0 INTRODUCTION

Deep-water snappers, emperors, and groupers are caught commercially using lines and baited hooks in depths of about 200 m in several countries of the South Pacific, including Western Samoa, Tonga, Vanuatu, Papua New Guinea and Fiji. In some cases, these fisheries were initially developed with the aim of relieving fishing pressure on the inshore reefs, and of increasing the supply of fish to the domestic market. In more recent years, however, the main aim of such fisheries has been to earn foreign exchange through exports. High-value species from several Pacific Islands are presently exported to Japan, New Zealand, and particularly, Hawaii.

Results from research suggest that deep-water bottomfish resources are fragile, involving slow growing species with long life-spans and limited habitats. Typical consequences of fishing such limited fish stocks are that fish size and stock weight (biomass) decrease markedly with increasing exploitation. The mean length of fish decreases as initial catches of larger and older fish are replaced by those of younger and smaller fish, and the small stock biomass is easily depleted by fishing.

This report contains:

- a brief summary of results from the most recent fishing surveys,
- a discussion of possible objectives for the development and management of the fishery, and
- an evaluation of the development and management measures which may be applied to the fishery in order to achieve the objectives.

3.0 FISHING AREAS

Deep-water snappers, groupers, and emperors are typically caught around the perimeters of islands and offshore seamounts, and most of the fish species targeted for export are taken in depths of about 200 m. In Tuvalu it would appear that the highest-valued exportable species are taken at depths of 200 m - 400 m. Using the length of the 200 m isobath as an index of fishable habitat, the combined lengths of these isobaths in Tuvalu is 248 nautical miles for all seamounts, and 128 nautical miles around islands, giving a total of 376 nautical miles of fishable habitat. The length of the 200 m isobath around Funafuti itself is about 40 nautical miles.

In comparison, the length of the 200 m isobath in Tonga is 294 nautical miles for all seamounts, and 930 nautical miles for all fishable habitats. The fishable area of Tuvalu is closest in size to that of Western Samoa, which has approximately 304 nautical miles of 200 m depth contour in which approximately 75 mt of deep-water snapper are caught per year. These data are summarized in Table 3-1.

Table 3-1. Fishable areas (length of 200 m isobath in nautical miles) for deep-water snappers in Pacific Island countries.

COUNTRY	SEAMOUNTS	TOTAL	REFERENCE
Western Samoa	---	304	King, 1989
Tonga	294	930	Langi & Langi, 1988
Tuvalu	248	376	Haight, 1994

4.0 TARGET SPECIES

In the initial part of the survey, fishing was concentrated in depths of 200 m, at which similar target species have been caught in other Pacific Countries. The final three cruises fished in greater average depths which resulted in a different catch composition and higher catches of desirable export species. Data from the last three cruises are therefore believed to be more indicative of catches from the proposed commercial fishery, and the catch composition from these cruises is shown in Table 4-1.

In Tuvalu, the high-value export species, including *Etelis coruscans, Etelis carbunculus,* and *Pristipomoides filamentosus*, account for 64.7% of the catch.

The composition of the most important export species differs in other countries. The following information is included for comparisons. In Western Samoa, the species, *Etelis coruscans, Aphareus rutilans, Paracaesio kusakarii*, and *Pristipomoides typus*, account for approximately 84% of the estimated 75.4 mt of deep-water snapper caught per year (King, 1989). In Tonga, *Etelis carbunculus, Epinephalus septemfaciatus, Epinephalus morrhua,* and *Pristipomoides filamentosus* are the most important export species.

Table 4-1. Species composition and catches (kg) per trip and mean CPUE (kg per line hour and as a percentage) from cruises 33, 34 and 35 of the project.

CRUISE>	33	34	35		
LINE-HOURS>	79.32	116.88	105.88		
	Catch (kg)	Catch (kg)	Catch (catch (kg)	mean CPUE (kg/line hour)	mean CPUE %
Export species (approximately US$3/lb or more)					
Etelis coruscans	61.7	173.6	106.2	1.1	21.6
Etelis carbunculus	91.1	61.4	101.6	0.8	15.7
Etelis radiosus	25.0	0.0	0.0	0.1	2.0
Pristipomoides filamentosus	79.4	2.6	96.4	0.6	11.7
Pristipomoides flavipinnis	26.3	1.9	27.5	0.2	3.9
Aphareus rutilans	19.6	40.9	29.0	0.3	5.9
Epinepheulus morrhua	22.2	7.5	16.4	0.2	3.9
	325.3	287.9	377.1	3.3	64.7
Other marketable species					
Caranx lugubris	26.2	0.5	246.1		
Pristipomoides zonatus	24.5	69.1	0.0		
Pristipomoides auricula	1.3	12.3	0.7		
Wattsia mossambica	10.5	0.0	16.2		
Gymnosardia unicolor	0.0	0.0	18.2		
Lutjanus bohar	0.0	0.0	24.0		
Aprion virenscens	9.1	0.0	18.8		
Paracaesio lausakarii	0.0	0.0	10.2		
Variola louti	0.0	3.3	5.1		
Seriola rivoliana	13.3	0.0	0.0		
Epinephalus miliaris	4.6	0.0	0.0		
Epinephalus chloristigma	2.5	1.0	0.0		
Thunnus albacare	0.0	0.0	11.8		
Prometh. prometheus	20.0	0.0	0.0		
Letrinus miniatus	0.0	1.2	0.0		
Seriola susmerlii	0.0	4.0	0.0		
unknown spp.	0.9	0.0	0.0		
TOTALS>	112.9	91.4	351.1	1.8	35.3
GRAND TOTALS>	438.2	379.3	728.2	5.1	100.0

5.0 SURVEY CATCH RATES

The unit of catch rate used in this report is catch per line hour--that is, the catch from one hour's use of a single reel of which four were used. Each reel was used approximately six hours per day. The mean catch per line hour by species is shown in Table 4-1. The catch rate of export marketable species was 3.3 kg per line hour, and of locally marketable species was 1.8 kg per line hour, giving a total catch rate for all species of 5.1 kg per line hour (using four reels, equivalent to 20.4 kg per hour of fishing operation); these data are summarized in Table 5-1.

Table 5-1. Mean catch rates (kg per line hour and kg per fishing hour) based on cruises 33, 34, and 35; for species included in each category, see Table 4-1.

Category	Catch per line hour (kg)	Catch per fishing hour (kg)
Export marketable species (>US$3 per lb)	3.3	13.2
Locally marketable species (<A$2 per kg)	1.8	7.2
All marketable species	5.1	20.4

It is expected that a commercial operation, with the benefit of project survey results and financial incentives would improve on these catch rates, and make catch rates of between 4 kg and 5 kg per line hour of export marketable species. These initial catch rates would be maintained only if the number of vessels entering the fishery is kept low, and the stock weight (biomass) is allowed to remain relatively high.

6.0 LIKELY SUSTAINABLE YIELDS

Stock assessment and likely sustainable yield will be the subject of a separate report, Tuvalu Bottomfish Project Final Biological Assessment (Haight, 1994), and the following brief notes are based on findings in other Pacific Islands.

Western Samoa, which has a similar total fishable habitat to that of Tuvalu, has an annual sustainable yield of 88 mt (King, 1989). In Tonga, the total annual catch of all bottomfish throughout the Kingdom is estimated to have reached a maximum of 514 mt in 1987, and subsequently to have declined to less than 200 mt. The most recent analysis of the data (King, 1993; Latu and Tulua, 1992) suggests that the maximum sustainable yield for the five main species is approximately 350 mt per year, and for the two major export species (*Etelis coruscans* and *Pristipomoides filamentosus*) is 210 mt per year. Yields in tons per nautical mile of 200 m depth contour have been estimated for several different countries, and these are shown in Table 6-1.

Table 6-1. Yields in tons per year per nautical mile of 200 m depth contour.

Country	Yield	Reference
Western Samoa	0.29 mt	King, 1989
Hawaii	0.27 mt	Ralston and Polovina, 1982
Mariana Archipelago	0.22 mt	Polovina, 1986

An initial estimate of sustainable yield for Tuvalu may be made by using the length of 200 m isobath as an index of fishable habitat, and a conservative value for sustainable yield of 0.2 mt per nautical mile. On these bases, the sustainable yield for around islands is 26 mt and for the seamounts is 50 mt. The annual sustainable yield for around the reef of Funafuti itself is likely to be 8 mt.

7.0 FISHING VESSELS USED IN OTHER COUNTRIES

Fishing vessels suitable for a developing Tuvaluan fishery are the subject of a separate report, Desired Characteristics of a Tuvalu Bottomfishing Vessel (Pasefika, 1994), and the brief notes provided here are taken from experiences in other Pacific Islands.

In Western Samoa, the FAO designed 8.9 m (28 ft) "*Alia*" catamaran is used, and up to 14 of these actively and consistently fish for deep-water snappers in depths greater than 100 m.

In Tonga, wooden dories between 6 m and 11 m in length, each fitted with four handreels and powered by a 20 hp Yanmar diesel engine, are used. Each fishing trip usually lasts between 3 to 5 days, depending on the distance of the seamount from the home port. Distant seamounts are up to 200 nautical miles offshore. In Tongatapu, Tonga at the beginning of 1993, there were nine 28 ft vessels currently fishing for export fish, together with three 35-45 ft vessels, two of which are equipped with electric reels, and a 50 ft vessel carrying 6 hydraulic reels. The further introduction of larger vessels is planned. In Tonga, there has been concern regarding the safety of vessels. Each vessel carries a radio with only a 25 km range, and often neglects to carry the sails designed to be used for backup propulsion. Lack of attention to safety, and the low maintenance of engines and gear, has led to vessels becoming unseaworthy. According to Fisheries Department records, six boats were lost at sea, one was destroyed by fire, and six were repossessed.

8.0 FISH QUALITY AND MARKETS

Catch handling and quality control will be the subject of separate reports, Improving Commercial Feasibility of Tuvalu Bottomfishing (Bartram, 1994a) and The First Export Marketing Trial (Bartram, 1994b). The brief notes provided here are taken from experiences in other Pacific Islands.

High-value species from fisheries in Pacific Islands are presently exported to Japan, New Zealand, and particularly, Hawaii. At present, more bottomfish reach the Honolulu market from Tonga than from other South Pacific island nations. There have been several reviews concerning the quality of bottomfish exported from the Pacific Islands to overseas markets (Elsy, 1984; Crossland, 1985; Roberts, 1991), and fish exported from Tonga, in particular, have suffered from a bad reputation in Honolulu markets. Major problems identified have included:

- poor handling of the fish at sea,
- lack of adequate ice carried on board vessels,
- poorly designed ice boxes, and
- frequent breakdown of onshore ice-making machinery.

A shipment of poor-quality fish not only fetches a low price, but more importantly gives the fish exports of the country a bad reputation which is difficult to redeem on overseas markets in the short term.

9.0 FISHERY DEVELOPMENT STRATEGIES

A likely fishing operation will be one in which a vessel completes 30 trips each year, 3 fishing days each trip, and uses each of the four fishing reels for an actual fishing time of 6 hours each day. Based on a catch rate of 4 kg per line-hour for the main target species (from Table 4-1), a fishing operation would land 288 kg per trip and 8.6 mt of exportable fish each year (Table 9-1). This assumes that catch rates can be maintained at the survey level. The expectation is that a commercial vessel will initially improve on the survey catch rates as higher densities of fish are targeted, but catch rates will slowly decrease as the stock biomass is markedly reduced by fishing.

Table 9-1. Fishing operational information and estimated catch per trip per year from 1 vessel.

Trips per year	Fishing days per trip	Line-hours per day	Catch (kg) per line-hour	Catch (kg) per trip	Catch (mt) per year
30	3	24	4	288	8.6

If fishing operations conform to the scenario suggested in Table 9-1, the sustainable yield of 76 mt from Tuvalu could be taken by approximately 9 vessels. A smaller number of vessels than this, would result in the maintenance of higher catch rates and greater profitability.

There are many alternative strategies for developing the deep-water snapper fishery in Tuvalu, but taking into account the high setting-up expenses, it is likely that only 1 or 2 purpose-built vessels will start fishing for deep-water snappers within the foreseeable future. Their fishing operations would ideally consist of fishing on seamounts within a 150 nautical mile radius of Funafuti when weather permits, and fishing around Funafuti only in unsettled weather. As the annual sustainable yield for Funafuti itself is perhaps 8 mt, it is essential to ensure that this more accessible stock is not overexploited.

Although economic analyses are the subject of a separate report, The Commercial Feasibility of Bottomfishing in Tuvalu: Final Economic Evaluation (Rowntree, 1994), early indications are that an operation based on a moderately-sized vessel would be profitable.

If the initial 1 or 2 vessels in the fishery prove successful, their profitability is likely to encourage others to enter the fishery. However, the addition of more fishing effort will necessitate vessels travelling further afield in order to maintain high catch rates, and to avoid overexploiting stocks closer to Funafuti. Travelling to the more distant fishing grounds (up to 250 nautical miles) is likely to require larger vessels (for safety reasons), and the increased costs may make fishing unprofitable.

For the reasons given above it appears prudent to restrict the number of vessels in the fledgling fishery to a maximum of about 3 moderately-sized vessels which have low running costs, and could be used safely within a 150 nautical mile radius of Funafuti.

10.0 MANAGEMENT STRATEGIES

Historically, the main objective of fisheries management has been the conservation of fish stocks. In modern fisheries management this limited aim has been extended to address additional economic, social and environmental objectives such as fishers' welfare, economic efficiency, the allocation of resources, and environmental protection. The broad objectives of fisheries management may, therefore, include the conservation of fisheries resources and their environment, the maximization of economic returns from the fishery, and payment of fees to the community from profits made by the exploitation of a public resource. Subsuming all these objectives is the need to ensure that fisheries are exploited on an ecologically sustainable basis. As the proposed fishery makes use of passive (non-towed) fishing gear in deeper water habitats which are ecologically divorced from traditionally exploited inshore ecosystems, there is likely to be little environmental and sociological impact in developing the fishery. Three broad and alternative objectives are maximizing either participation, sustainable yield, or economic yield from the fishery, and these are discussed briefly below.

10.1 Maximizing participation

Maximizing the participation of local people in the developing fishery would involve encouraging and providing training for local fishers to fish for deep-water bottomfish off nearby reefs. As the vessels used would be those already in existence, their size and range suggests that this fishing effort would most likely be concentrated on the 40 nautical miles of reef surrounding Funafuti lagoon.

This strategy would result in a large number of fishers using relatively inefficient and discontinuous fishing operations to catch small numbers of fish per trip. In addition, it would be difficult to maintain the quality of the catch, and to coordinate its landing and export. Also, the collective catch of these fisheries would almost certainly exceed the sustainable yield of Funafuti Atoll which is estimated at approximately 8 mt.

As this management strategy would undoubtedly result in local overexploitation, and a catch suitable only for local markets, it represents a waste of a resource which is potentially valuable to Tuvalu in terms of earning export income.

10.2 Maximizing sustainable yield

This strategy would involve maximizing the net financial returns from the fishery by allowing the entry of a relatively large number of vessels. The maximum sustainable yield of 76 mt for all of Tuvaluan fishing areas may be taken by approximately 9 vessels (assuming that these vessels fish according to the operation summarized in Table 9-1). W. Haight (1994), using an alternative assumed scenario, suggested that the maximum sustainable yield (76 mt) could be taken by as few as 6 vessels.

However, the disadvantage with this strategy is that, at this level of exploitation, catch

rates will be much lower than those obtained at lower rates of exploitation. Theoretically, catch rates in a fully exploited fishery are about half of those obtained initially. Such low catch rates are unlikely to cover the high costs of fishing, and at the point of maximum sustainable yield, financial returns (net profits) from the fishery are likely to be low or negative. (See Rowntree, 1994.)

10.3 Maximizing economic yield: The recommended option

Maximizing the net financial returns from the fishery and profit to the country, in general, requires a fleet which is small but efficient.

A strategy of maximizing profits will exclude the use of larger vessels with high operating costs, and require the use of smaller more efficient vessels. These could be used safely within a 150 nautical mile radius of Funafuti, but may not be capable of reaching the more distant grounds surveyed except in extended periods of good weather. An additional advantage of this strategy is that the level of fishing required is biologically conserving, and is unlikely to overexploit the fish stocks.

A disadvantage is that, in the longer term, the profits made by a few boats are likely to attract others into the fishery. However, the economic benefits from the fishery will only be maximized if the number of vessels in the fishery is restricted. At higher levels of exploitation, the average catch rates of all vessels will be reduced below that necessary to cover costs. In other words, the fishery will only be profitable if entry into it is restricted to a few efficient vessels.

In summary, management strategies which maximize participation in the fishery and sustainable yield may be appropriate in the case of artisanal inshore Pacific Island fisheries, where the resource provides employment or food for a large number of fishers; in this context employment and food gathering may be chosen in favor of efficiency. The deep-water bottomfish fishery, however, is a commercial export-based operation, and there is a strong case for maximizing foreign earnings to the country from the fishery.

It is therefore recommended that fishing effort is restricted in order to maximize economic yield. The most direct method of restricting access to the fishery is by means of a licensing system which is discussed in the following section. The number of vessels in the fledgling fishery should be restricted to a maximum of about 3 moderately-sized vessels which have low running costs, and could be used safely within the area of Tuvalu's distant seamount fishery. This number of vessels should ensure that high catch rates are maintained, and that the fishery has a good chance of being profitable.

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10.4 An additional option: Limited foreign access

The recommended fishery management strategy is to maximize the net financial returns from the fishery and to maximize profit to the country. This requires the use of smaller, low cost (<A$40,000; see Rowntree, 1994) vessels which have the capacity to exploit grounds, first within a 150 nautical mile radius and later within a 250 nautical mile radius of Funafuti. The use of smaller vessels may in effect leave the more distant but productive grounds unexploited.

One option available to the government is to allow foreign vessels to have access to stocks which are inaccessible, for cost reasons, to the Tuvaluan fleet in return for a negotiated fee. For example, Fiji-based fishers may be allowed to take fish up to a maximum allowable limit from seamounts located from 150 to 250 nautical miles from Funafuti. Access fees paid by the fishers would ensure that excess profits accrue to the government and people of Tuvalu.

The disadvantages include the burden of placing observers on board the foreign vessels to ensure that the total allowable catch is not exceeded. In addition, if foreign vessels landed their catches in Funafuti, they may compete with local fishers for limited ice and air-cargo space.

10.5 An additional management measure: Quality control

In any management strategy which relies on maximizing returns from exported fish, the maintenance of quality is essential. The poor sale value of fish exported from some Pacific Islands has been mentioned previously. The success or otherwise of the Tuvaluan deep-water bottomfish fishery is highly dependent on maintaining a good reputation and market price for its products. As a single shipment of poor-quality fish is likely to undermine the efforts of those who have been striving to maintain a good reputation for Tuvaluan fish exports, a quality control system is recommended.

A full quality control system would involve the government inspection of fish intended for export, and approval to export would be given only for fish reaching a defined minimum standard of quality. However, the requirement for inspection before exportation should not be such that it delays the air-shipment of a highly perishable product. An alternative to inspection of all exports would be the random inspection of fish being landed and packed.

11.0 FISHERIES REGULATIONS

Fisheries regulations are imposed on a fishery to support a strategy designed to achieve predefined objectives. Regulations are used either to reduce or contain effective fishing effort (*input controls*), or to restrict the total catch (*output controls*) to predefined limits. However, most regulatory measures traditionally applied to fish stock are inappropriate in the case of deep-water snapper stocks.

Legal minimum lengths, making it illegal to retain individuals smaller than a prescribed minimum size, is not suitable for deep-water species, as the survival of fish returned to the sea after being hauled to the surface from deep-water is low. This regulation is not recommended.

Closed seasons are sometimes applied to fisheries at the time of recruitment (when young fish are added to the stock), or during the spawning period to allow fish to breed without interference. However, there is no evidence that seasonal closures would be of any benefit to the bottomfish fishery, as the recruitment periods and spawning seasons of the species are not known. In addition, small fish (larvae) may be recruited to seamounts from other distant areas. This regulation is not recommended.

Rotational closures, in which different fishing grounds (seamounts) are periodically closed and opened to fishing on a rotational basis have been recommended for the bottomfish fishery in Tonga (Latu and Tulua, 1991). Potentially this allows fishing areas time to recover from intense fishing, and may result in an increased reproductive output. However, the efficacy of this depends on the time required for local seamount stocks to recover from heavy fishing. Because of the slow growth rates of the species, the recovery time is likely to be long, and individual areas would have to be closed for many years to be of benefit. Rotational closures are also expensive to enforce, and require the use of a sea-going patrol vessel. This regulation is not recommended.

Gear restrictions are common in many fisheries. In the case of deep-water bottomfish fisheries, regulations have been suggested which ban the use of more than four reels, and ban the use of electric or hydraulic reels. However, from an economic point of view, gear regulations lead to inefficiency, since they raise the cost of catching fish. These regulations may be appropriate in the case of artisanal inshore fisheries, where the resource provides employment or food for a large number of fishers. But as most deep-water bottomfish fisheries are export-oriented, there is a good economic case for allowing fishers to become as efficient as possible, in order to compete with the marketing of similar species from other Pacific Island countries. This regulation is not recommended.

Catch quotas are used to restrict the catch from a resource to a predetermined total allowable catch (TAC). Catch quotas have been recommended for deep-water bottomfisheries in other Pacific Islands, including the deep-water snapper fishery in Fiji. The main problem with such a measure is the difficulty in ensuring that quotas are not exceeded. If quotas are based on catches recorded in logbooks, there is a strong motivation for fishers to under-report catches. This regulation is not recommended.

License limitation has been introduced in fisheries in many parts of the world. Under this regulation, a limited number of vessels, or vessel owners, are given licenses to fish. The number of licenses issued is set at a level at which it is believed capable of imposing the fishing effort required to take some predetermined level of catch. **This regulation is recommended.**

Enforcement would involve periodic checks that vessels landing bottomfish export species held valid licenses. Enforcement would be simplified, and made more workable, if it were made illegal to export (rather than catch) deep-water bottomfish without a license. However, unlicensed fishers may attempt to circumvent the regulations by selling their catch through licensed fishers. A suitable deterrent would be that license holders engaging in this activity risk the possibility of losing their licenses.

The view may be held that the community, which has had to forgo its right to fish in favor of a few license holders, is entitled to share in the profits made from the fishery. In this case, excess profits from the exploitation of a public resource may be collected in the form of fishing license fees. This ensures that profits from the exploitation of a nationally-owned resource, are shared by the country as a whole, rather than remaining with a selected few licensed individuals. However, the profitability of deep-water bottomfish fishing in Tuvalu is not likely to be high, and a small license fee may be appropriate to amortize fishery management and monitoring costs.

In summary, it is recommended that participation in the fishery be restricted to a maximum of about 3 moderately-sized vessels by means of a licensing system. This would be the only regulation applied to the fishery.

The license should in effect be an export license which permits the owner-operator of a suitable vessel to catch and export deep-water bottomfish from Tuvalu, subject to quality control procedures. A small annual license fee should be imposed to amortize the costs of fishery monitoring and quality control; this license fee could be waived during the early years of development. Licenses should be issued with the conditions that the license holder must fill in and return fishing logsheets (recording catch, fishing effort and fishing area), and agree to allow a Fisheries Department observer on board during any fishing trip.

Regular enforcement would involve periodic checks (perhaps along with quality control checks) that bottomfish export species have been landed by those holding valid licenses.

12.0 MONITORING THE DEVELOPING FISHERY

Whichever options and management measures are selected, a permanent, even if low level, system of data collection should be established to monitor the "health" of the fishery, and to determine the effectiveness or otherwise of management strategies. Catch and fishing effort information are the basic data requirements, and these may be supplemented by the regular collection of length-frequency data. The completion and submission of fishing logs with catch and fishing effort by area should be a legal requirement of participation in the fishery. To monitor fishing effort, inventories of boats and fishing gear used in the fishery must be maintained and continually updated. A trend of falling catch rates may indicate that a fishery is being exploited above the sustainable rate, and a decrease in the mean length of fish in the catch (estimated from length frequency data) may indicate the same thing.

From a financial viewpoint, fishing costs and catch value should also be monitored. The early detection of trends, such as increasing fishing costs, or decreasing market values of the catch, for example, may suggest that a change in the fisheries management strategy is required in order to maintain profitability.

13.0 PUBLIC CONCERNS REGARDING THE PROPOSED FISHERY

Concern has been expressed that the development of a deep-water bottomfish fishery will have a negative impact on the fish stocks of local reefs. However, the deep-water and coral reef habitats are quite distinct, and the ecological links between the two are likely to be tenuous. For these reasons, fishing in deep-water will have little or no effect on shallow coral reef fish stocks, and the concern appears unfounded.

Another concern is in regard to the export of fish which could be consumed locally. However, the costs of catching deep-water fish are high, and above the price for which such fish could be profitably sold on local markets. Indeed, the development of a deep-water fishery is only possible if costs can be covered by the export of the high-value species. It should be noted that during the surveys, 35.3% of the landed catch consisted of less valuable but desirable species which were marketable locally.

There may also be public concern and jealousy regarding the profits made by the small number of boats permitted to operate in the fishery. Fisheries and government officials may be under considerable pressure to allow more vessels into the fishery. This pressure must be resisted in order to ensure the profitability of the fishery. A larger number of vessels will reduce average catch rates and profitability.

It is recommended that any increase in the number of vessels in the fishery be considered only after the Fisheries Department has reviewed catch-rates and profitability of the fishery after two years of operation and data collection.

14.0 VIEWS OF STAKE-HOLDERS

The following is based on discussions at a Bottomfish Management Plan Workshop conducted in Funafuti in January 1995, to discuss a range of issues relating to the development of a new deep-water bottomfish fishery, and to discuss an earlier draft of this present Management plan. Workshop participants included fishers, government officials, lending institution representatives and project personnel.

14.1 Licensing issues

Participants generally agreed that licensing a small number of boats to fish for bottomfish was necessary. However, some participants were concerned regarding the license fee, and whether licensing would restrict people from fishing in traditional areas close to islands.

Workshop participants were assured that the main purpose of licensing was to restrict the number of fishermen in the new deep-water bottomfish fishery in order to keep catch rates high and to maximize net profits to Tuvalu.

Government representatives claimed that license fees could be nominal; a fee of A$20 was suggested. It was also stated that licensing was not directed at those catching fish for local consumption or sale, but at those catching and exporting deep-water bottomfish.

14.2 The role of middlemen in the new industry

Participants suggested that middlemen can play an important role in the fishery, by taking responsibility for packing, marketing and shipment. However, it was also suggested that the likely profits are too modest to support an extra link in the commercial chain. Another point made was that the packing of fish for export could be done most effectively during the journey back from the fishing grounds.

14.3 The role of government

Participants suggested that government could play an important role by:

- regulating the fishery (e.g., by licensing),
- aiding in marketing negotiations,
- negotiating cheaper air transport fees (Funafuti to Nadi), and
- training those involved in the new industry.

There was also perceived to be a requirement for enhanced:

- port and docking facilities,
- maintenance and repair facilities,
- ice making capabilities, and
- training for skippers and engineers.

14.4 Role of foreign investors

The participants were in agreement that the deep-water bottomfish resources should be harvested by Tuvaluan nationals. Licenses should not be issued to foreigners, and joint ventures between nationals and foreigners should not be encouraged.

A bank representative stated that the investment and skills required are within local capabilities and that the Tuvalu Development Bank may consider partnerships between itself and local fishermen in order to reduce the loan required by an individual.

It was suggested in the workshop that the development of the deep-water bottomfish fishery is a totally different undertaking from that of the tuna fishery. In the bottomfish fishery, locally-owned ventures are not only possible but desirable, but in the tuna fishery, foreign investment and partnerships may be required because of the finance and expertise required. The two different fisheries should be disassociated from each other in future discussions.

However, it was suggested that some of the facilities reburied for developing a tuna fishery (docks, refuelling facilities, etc.) could also be used by fishermen in the deep-water bottomfishery.

In addition, it was suggested that some foreign assistance may be required to provide additional training programs related to the development of the bottomfish fishery.

15.0 RISK ASSESSMENT

Factors which would put the development of the new fishery at risk include:

- a reduction in catch rates, caused, for example by too many vessels in the fishery; in general, the larger the number of vessels, the lower the catch rate of each

- a decrease in fish prices, caused, for example, by a failure of quality control or by a reduction in demand for the main species, and

- an increase in cost, caused, for example, by larger vessels entering the fishery and causing over-capitalization, or by any increases in freight charges.

Many of these risk factors, including the number of participating vessels and fish quality issues, are within the direct control of the management authority in Tuvalu. However, other factors, such as airline freight charges, are beyond the direct control of Tuvalu, although the government may still be able to exert some pressure to control these.

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