UNITED NATIONS ENVIRONMENT PROGRAMME

ECONOMIC & SOCIAL COMMISSION FOR ASIA AND THE PACIFIC

SOUTH PACIFIC COMMISSION

SOUTH PACIFIC BUREAU FOR ECONOMIC CO-OPERATION

South Pacific Regional Environment Programme

SPREP/Topic Review 20

Original: English

Summary in English and French

RESOURCE ASSESSMENT REPORT

BLACK CORAL OF TONGA

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South Pacific Commission
Noumea, New Caledonia
November 1984

SPREP/Topic Review 20 November 1984

ORIGINAL: ENGLISH Summary in English and French

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SUMMARY

More than 60 kilometres of deep water habitat was surveyed for black coral throughout the Kingdom of Tonga. A single commercially valuable population of *Antipathes dichotoma* was located in Nuku'alofa Harbour with a maximum density of 9 specimens per 1000 square metres south of Fafa Island.

Low recruitment and high mortality from habitat destruction combined with slow growth and rapid harvesting indicated the stocks were endangered. Protective measures, including legislation and replanting experiments are recommended.

RESUME

Plus de 60 km de fonds sous-marins ont été explorés pour évaluer les ressources en corail noir du Royaume de Tonga. Seule une population d'*Antipathes dichotoma* ayant une valeur commerciale a été trouvée dans la rade de Nuku'alofa, la densité maximale étant de neuf individus par 1.000m^2 au sud de l'île de Fafa.

En raison de la faiblesse du recrutement et de la forte mortalité dus a la destruction de l'habitat, allant de pair avec une croissance lente et une exploitation rapide, la ressource est menacée. Des mesures de protection sont recommandées, au nombre desquelles une réglementation adaptée et des expériences de réimplantation.

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RESOURCE ASSESSMENT REPORT

BLACK CORAL OF TONGA

INTRODUCTION

In April of 1978 Tonga hosted a three day workshop on precious coral. A series of surveys followed the workshop (Fade, 1978, 1979; Halunen, 1980) in an attempt to discover stocks of deep water precious corals (Corallium) and the shallower black corals (Antipathes) in Tonga.
During four CCOP/SOPAC cruises, 55 dredgings were made in deep water and Corallium was found at two sites in about 300 meters of water east of the Ha'apai group (Eade, 1980; Grigg, 1981). The survey work for black coral was less extensive and only one colony was located.
Meanwhile, commercial exploitation of Tongan black coral began with the founding of IMUA PACIFICA by Jack Ackerman of Maui Diver's Inc., Hawaii.
Because of the rapid depletion of Black Coral stocks in other parts of the world, the Government of Tonga became concerned that the Tongan stocks might require protection. S.L. Tongilava, Superintendent of the Ministry of Lands, Survey and Natural Resources, wrote

"I would like to see Tonga's precious coral protected from over-exploitation by some suitable legislation" (20 August, 1981).

The Government of Tonga requested that the South Pacific Commission through the South Pacific Regional Environment Programme assist Tonga with a survey of the stocks of Black Coral in Tonga and with recommendations on methods for resource management.

From May to September of 1984, Dr. Richard Chesher, Consultant funded by SPREP, aboard the Research Vessel MOIRA, surveyed Tongan coastal waters for stocks of black corals, attempted planting of the more valuable species, and interviewed various people concerned with the industry.

METHODS

SITE SELECTION:

Tongan coastal waters cover some 362,500 square kilometers. Sites to be surveyed were selected according to the following parameters:

- Depth range (10 to 50 meters)
- Tidal currents (predicted by topography) Bottom type (slopes, cliffs, ridges)
- Sea exposure and proximity to people (ease of accessibility)

Thus, the search area was restricted to habitats known to be suited to black coral growth, close enough to people to be harvested, and not so deep as to endanger divers.

The 50 meter depth limit was 10 meters deeper than the recommended maximum depth for diving in areas without decompression medical facilities, and 20 meters deeper than the 30 meter maximum imposed by Mr. Ackerman on his divers. Black coral is known to live at deeper depths and although small colonies (not commercially valuable) have been seen at 100 meters, large colonies seem to occur at 90 meters or less and are most abundant from 20 to 60 meters depth (Grigg, 1976, personal observations).

SURVEY TECHNIQUES:

Because the length of time a diver can spend in deep water is severely limited by several factors, extensive deep water surveys require the use of remote sensing. The SPREP team employed an underwater, low-light television camera with a video recorder and television set operated from a surface boat (a Zodiac GTMII).

The unit was built by Dr. Chesher for surveys in depths up to 200 feet. The viewing angle can be adjusted from vertical (down) to parallel with the bottom and the camera can be "steered" from the surface to point towards - or return to - bottom areas or vertical coral cliffs.

Viewing along vertical cliffs is slower than surveying slopes or flat areas because of the need to maneuver around projections and overhangs.

Surveys along slopes, flat bottoms, ridges, and through passes were quantitative. The camera angle was set at 70 degrees, looking down and ahead. The picture viewed was then covering a width of about 4 meters, depending on water visibility and camera height. Except in turbid conditions, the camera was flown 3 meters off the bottom. It was raised and lowered based on what was seen in the video screen.

Colonies smaller than about 500-mm in height were not separable from other, non-commercial species using video and were recorded as NC for NonCommercial. Small specimens of *Aptipathes dichotoma* and *A. grandis* were recorded as S for specimens of 0.5 to one meter in height. Specimens larger than one meter height were marked C for commercial. Wire coral (*Cirrhioathes spp*.) was recorded as W.

No counts were made of the false black coral gorgonian, but its presence was noted on transacts where it was seen.

A recording depth sounder maintained a record of the bottom topography and marks were made on the recording paper to indicate colonies of black coral observed. Simultaneous position reports, and notes on bottom conditions were recorded on tape.

Position fixes were made with land bearings and, when necessary, with the use of a sextant on land bearings. Distance covered was measured from plots of the transacts on charts.
Some transect work and some SCUBA dives were made to 60 meters to examine deeper water populations. SCUBA dives were conducted when additional information was needed or when specimens were required for identification.

IDENTIFICATION OF SPECIES:

Identification of black coral requires examination of the small animal polyps which construct the colonies. Therefore, branch tips were snipped off with a knife and placed in plastic bags underwater. They were then transferred to a saturated sea water solution of magnesium chloride to relax the polyps. When the polyps were expanded the branch tips were transferred to 5% buffered sea-water formalin for preservation. The specimens were later examined and tentative identification made. They were then sent to the U.S. National Museum at the Smithsonian Institute for confirmation identification.

REPLANTING EXPERIMENTS:

Replanting experiments were carried out in Vavau with the assistance of David **McLean** and Bert Davis. A colony of *Antiipathes dichotoma* was located in *37* meters depth between the island of Kitu and Nua Popu (Figure 1). A branch about 1 meter long was cut off the colony and carried to the dive boat. Branch tips were cut and prepared as described in Figure 2.

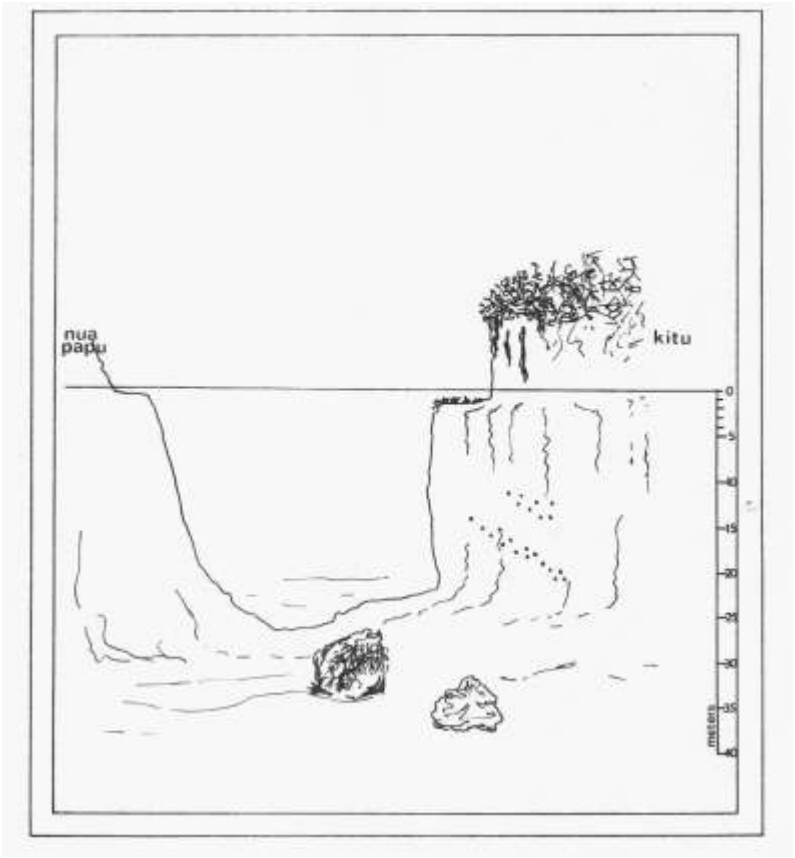

Figure 1. Replanting station area between Nua Papu and Kitu Islands showing the rock wall on which the branch tips were placed.

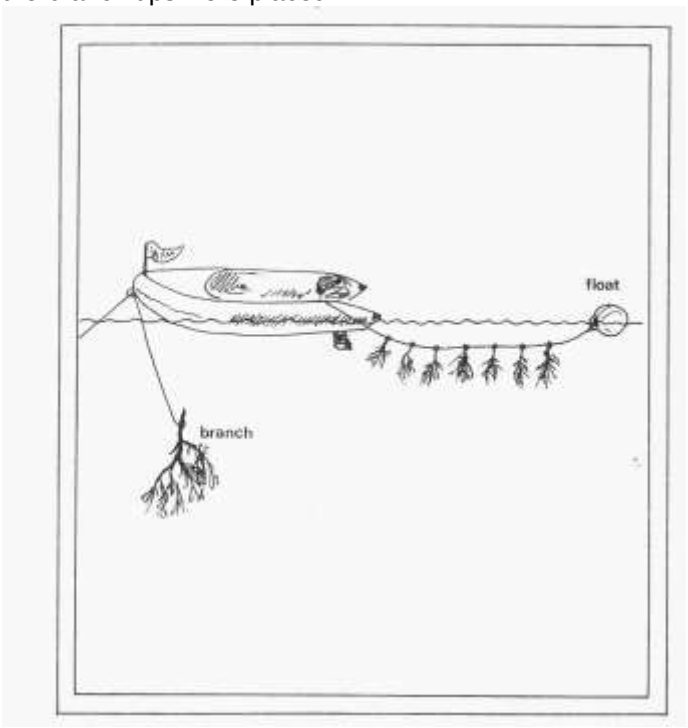

Figure 2. Replanting technique with branch and cuttings suspended underwater to prevent damage to the delicate polyps.

The branch was tied to a line and left in the water at all times because the polyps can be killed or injured by taking the colony out of the water. Care was taken not to touch the thin branch tips. Smaller branches of about 200-mm length were then carefully cut off the main branch with shears. A 200-mm

length of stainless steel leader wire with an aluminum tag attached was then wrapped around the branch stems and they were attached to a long string with a float on one end.

A diver then swam the cuttings down a vertical coral wall and attached them to the wall. Fifteen colonies were planted starting in 21 meters of depth and working diagonally to the west and upwards to a depth of 15 meters. Colonies 14 and 15 were attached with plastic straps to determine if plastic was better than stainless steel as a means of attachment.

The rock had many small holes in it and the diver would simply find a hole about the same size as the branch tip and then push the stem into the hole. Generally, because the holes were curved, the stem wedged itself in place. The stainless wire was then secured to the rock on the outside of the hole. Eight additional, untagged cuttings were pushed into holes in the wall without further attachment. This method was, of course, the fastest and easiest means of replanting but the colonies might be pulled loose by fish or current action before they have the opportunity to attach themselves to the substrate. Twenty three colonies were planted. Mr. McLean agreed to check the progress of the experiment in 6 months. He is to determine if the colonies survived, if they became attached firmly to the substrate, and if the removal of the branch damaged the main colony from which it was taken. Measurements of the surviving colonies (if any) will be made as well.

RESULTS:

The survey work began in Tongatapu and extended to Nomuka, the Haapai Group, and Vavau. Figure 3 shows the route of the R/V MOIRA. A total of more than 60 kilometers of deep water transects were conducted.

TONGATAPU

Twenty-three transects were conducted at the locations indicated in Figures 4 and 5. The transects covered a total of 16.503 kilometers of bottom. Most of the transect work centered in Nuku'alofa Harbour area as this was the location of the only significant population which our initial spot checks found. Table 1 gives the data for transects shown in Figures 4 and 5.

Figure 5 shows a detailed plot of the transects in Nuku'alofa Harbour. Figure 6 shows a contour plot of densities of Antipathes dichotoma and A. grandis , in Nuku'alofa Harbour. Commercial densities of black coral require a hard substrate and adequate water flow. While the lagoon is large, the proper habitat for black coral is limited. Since harvesting has been considerable and non-random, a total population estimate cannot be made by multiplying the plotted densities by the area covered. A rough estimate, probably greater than the actual population, yields a standing population of live, commercial specimens of about 2500 in the area covered by Figure 6.

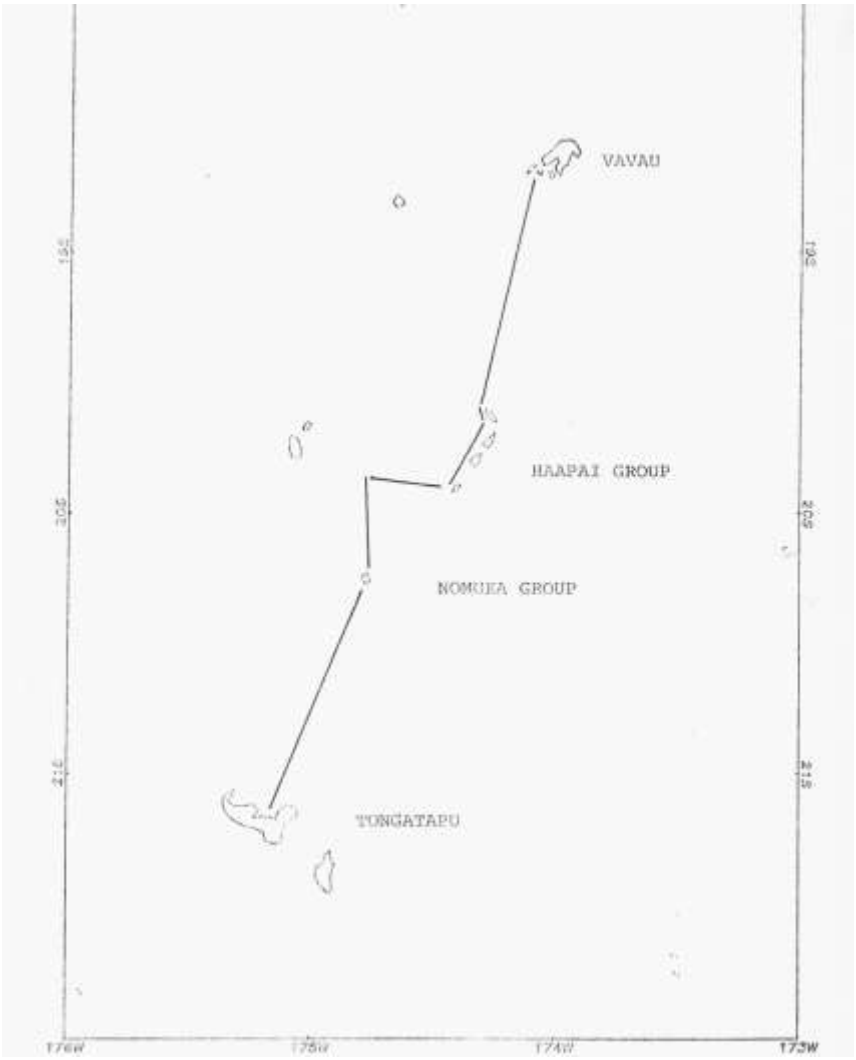

Figure 3. The Kingdom of Tonga showing the cruise plan of the Research Vessel Moira from May to September 1984.

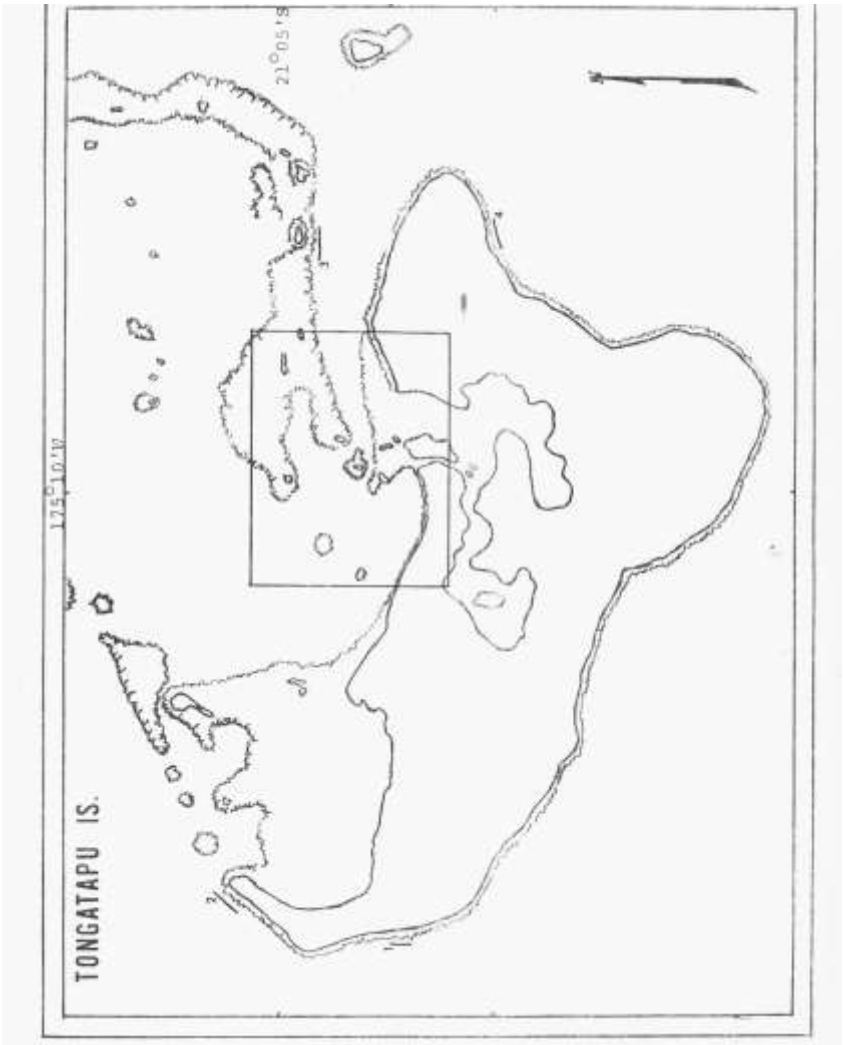

Figure 4. Black Coral Transects around Tongatapu. Harbour area shown in detail in Figure 5.

Figure 5. Black Coral Transects in Nuku'alofa Harbour.

TABLE 1

TONGATAPU BLACK CORAL TRANSECTS

TRANSECT	SPECIMENS SEEN	LENGTH (KM)	COMMENTS
1.	NC	.370	Off MonoTapu Beach area.
2.	NC	.463	N.W. Tip of Island.
3.	0	.370	Phia Passage, North Wall.
4.	0	.110	East (Windward) Coast.
5.	2C,1NC	.740	Phia Passage.
6.	NC	.463	Phia Passage along wall.
7.	2DC+NC	.648	Phia Passage along wall.
8.	0	.592	Phia Passage along wall
9.	0	.407	Phia Wall + Bottom
10.	0	.592	Narrows Entrance
11.	1DC	.925	Narrows Entrance
12.	9DC,10C,7S	3.44	Narrows to Fafa
13.	0	.740	Pangaimotu Pass
14.	1D	.555	Lagoon, Pangaimotu Ridge
15.	0	.407	Fafa, South
16.	0	.352	Narrows Lagoon Entrance
17.	1S	.888	Narrows Lagoon Entrance
18.	2DC,4C,5S	.925	Fafa, South
19.	1DC,2C	.925	Fafa, South
20.	0	.185	Alert Shoal
21.	0	.740	Monu Reef
22.	0	.555	Ualanga Lalu Reef
23.	0	1.11	North of Ualanga Reef

S = Commercially Valuable specimens .5 to 1 Meter high, too small for commercial harvest

NC = NonCommercial species or specimens.

C = Commercially valuable specimens over 1 metre high. D = Dead

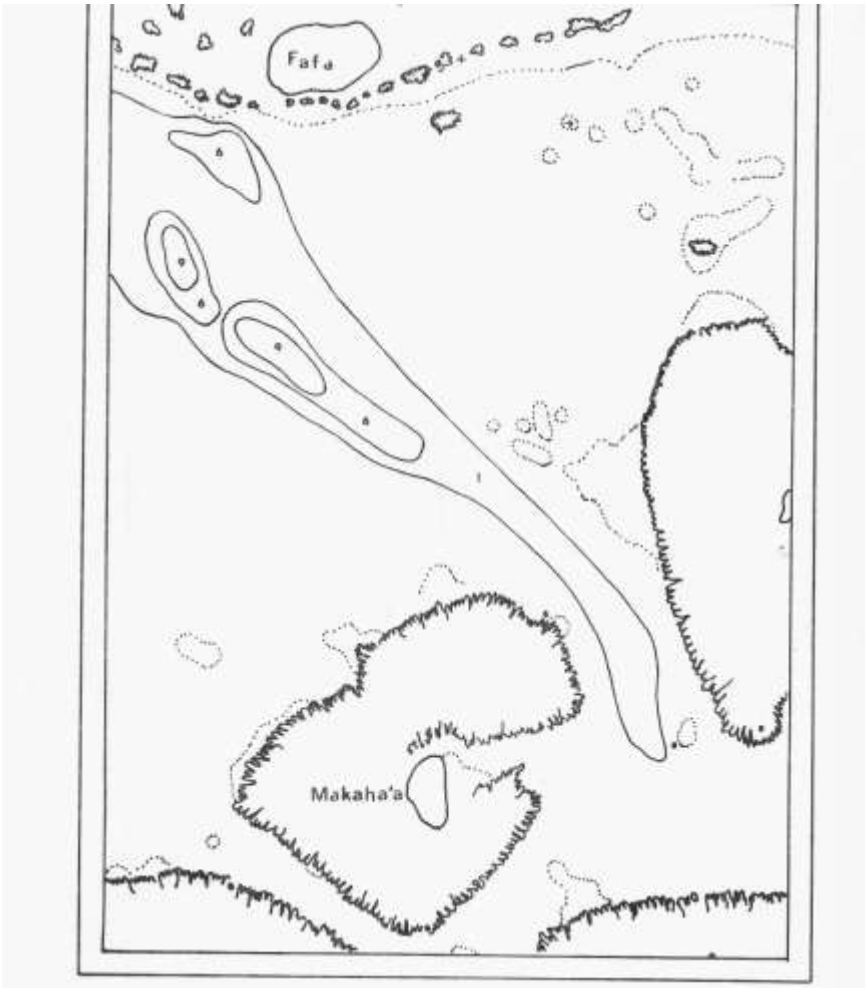

Figure 6. Density plot of Black Coral (*Antipathes dichotoma* and *A. grandis*) in Nuku'alofa Harbour. Numbers of specimens per thousand square meters.

Figures 7 and 8 show depth sounder records of places of maximum black coral population density. Figure 9 shows a diagrammatic view of the preferred habitat of Antipathes dichotoma in Nuku'alofa Harbour and its typical style of growing on the sides and tops of ridges and outcroppings.
Most of the commercially valuable black coral was located in 30 to 36 meters depth just inside the Narrows and south of Fafa Island. Reports of fishermen indicate it was found in shallower depths and along the Piha Passage wall a few years ago but this coral has apparently been completely harvested.

Some specimens were found along the north wall of Phia Passage but these were deep and widely scattered and dead.

Cliff faces are quickly harvested because they are easily accessible and divers can cover successive portions of the wall each day. The water is generally quite clear and a team of divers can take coral from the entire wall by searching at depths of 20 and 30 meters.

The lagoon population is more difficult to find. Divers generally do not have depth sounders to locate submerged outcrops and they may dive the same area several times because position fixing is difficult on an open lagoon.

One method used by Tongan divers to find black coral is to lay a long anchor line and drag this until it snags on a rock. The line is then shortened and a quick dive is made to see if there is any black coral. The divers said that, as the stocks have decreased, they make more non-productive dives onto rocks which they, or someone else, have already visited. As a result, they must make several dives in a day. Repeat dives are especially dangerous because of decompression problems and Mr. Ackerman, who supplies the divers with SCUBA tanks and regulators has warned the divers about the dangers of

repeat dives. Therefore, the decreasing success rate within a lagoonal situation means a higher chance of leaving some black coral to survive than along a vertical wall.

Divers were actively collecting black coral from scattered, isolated rock outcrops in the lagoon during the survey period. The black coral has been harvested from those harbour reefs which are visible from the surface.

HABITAT DESTRUCTION:

Thirty five percent of the black coral we observed, and 49% of the commercially valuable large colonies were dead. Mr. Ackerman stated that this situation existed when his company first began taking black coral from the lagoon, and that four out of five of the specimens his divers collected were dead. The dead specimens, he says, carve better and he encourages the divers to collect them.

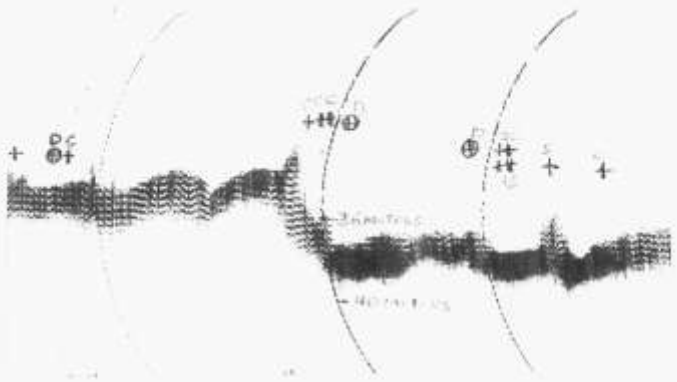

Figure 7. Depth Sounder Chart from high density area of Transect 12.

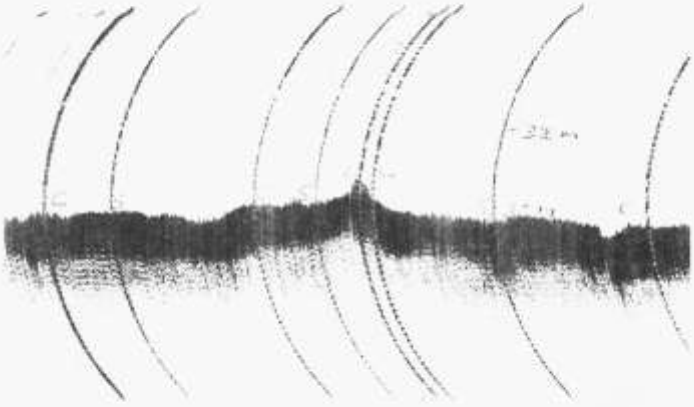

Figure 8. Depth Sounder Chart from high density area of Transect 18.

Figure 9. Habitat and position of growth of *Antipathes dichotoma* in Nuku'alofa Harbour.

We found a layer of heavily silted water in the lagoon extending from the bottom to 25 meters depth. The silty water increased dramatically following rain and its upper level raised to 20 meters depth. In some areas, after rainfall, the deep water was so turbid we could not conduct transects for fear of snagging the camera before we could see obstacles.

Construction activities have been conducted for many years along the Nuku'alofa waterfront. The Queen Salote Wharf, small boat basins, and sea wall construction includes dredging and filling with resultant silt production. There has been no attempt to prevent silt from these construction activities washing into the lagoon. Dredging activities were observed with no plugs or silt screens. Following rains a silt-plume was observed flowing from the construction sites into the lagoon.

Years of construction activities without silt protection measures have resulted in the long-term establishment of a layer of silty water in the deep parts of the Nuku'alofa harbour. This may explain the large proportion of dead black coral colonies observed.

We also found very few small black coral colonies in the lagoon and suspect silt covering the rock outcrops may lower successful larval settlement.

NOMUKA

Figure 10 shows the transects conducted in Nomuka. We found no black coral in Nomuka although we did observe numerous colonies of the false black coral gorgonian. A local diver said he knew where there was some black coral and later showed up with some of the gorgonians thinking these were what we were looking for.

We examined 6.28 kilometers of bottom area in the region of highest current and around rock outcrops and reefs. Table 2 gives the transect data for Nomuka.

SOUTHERN HAAPAI GROUP

Figure 11 shows the transects conducted in qua and Haafeva. We observed wire coral and gorgonians but these were not abundant and no black coral was observed in the 3.02 kilometers of bottom area examined.

Figure 10. Black Coral Transects at Nomuka.

TABLE 2

NOMUKA BLACK CORAL TRANSECTS

TRANSECT	SPECIMENS SEEN	LENGTH (KM)	COMMENTS
1.	0	.740	Shoal to Miu Fuiva
2.	W	.740	Around shoal off Miu Fuiva
3.	0	.740	Shoal to Miu Fuiva
4.	G	2.90	West Pass to Nomuka Iki
5.	0	1.16	South from East Nomuka

TABLE 3

SOUTHERN HAAPAI BLACK CORAL TRANSECTS

TRANSECT	SPECIMENS SEEN	LENGTH (KM)	COMMENTS
1.	0	.703	East of Oua
2.	0	.555	Luanamu Island
3.	W	.370	Haafeva Island
4.	W	1.40	Haafeva Island

TABLE 4

NORTHERN HAAPAI BLACK CORAL TRANSECTS

TRANSECT	SPECIMENS SEEN	LENGTH (KM)	COMMENTS
1.	W,2NC,G	1.11	0oleva Pass
2.	W,1C,1S	.740	Hakau Faha
3.	W	1.48	Hakau Faha
4.	W	.610	Lifuka Lagoon
5.	0	.222	Hakau Moikuku
6.	1S	.407	Crawshaw Reef
7.	0	.425	Haano Island
8.	0	.333	Haano Island
9.	3S	.555	Luahoko Island

W = Wire Coral, NC = NonCommercial Species or Specimens.

G = False Black Coral Gorgonian, C = Commercial Black Coral over 1 meter in height.

S= Commercial Black Coral under 1 meter in height.

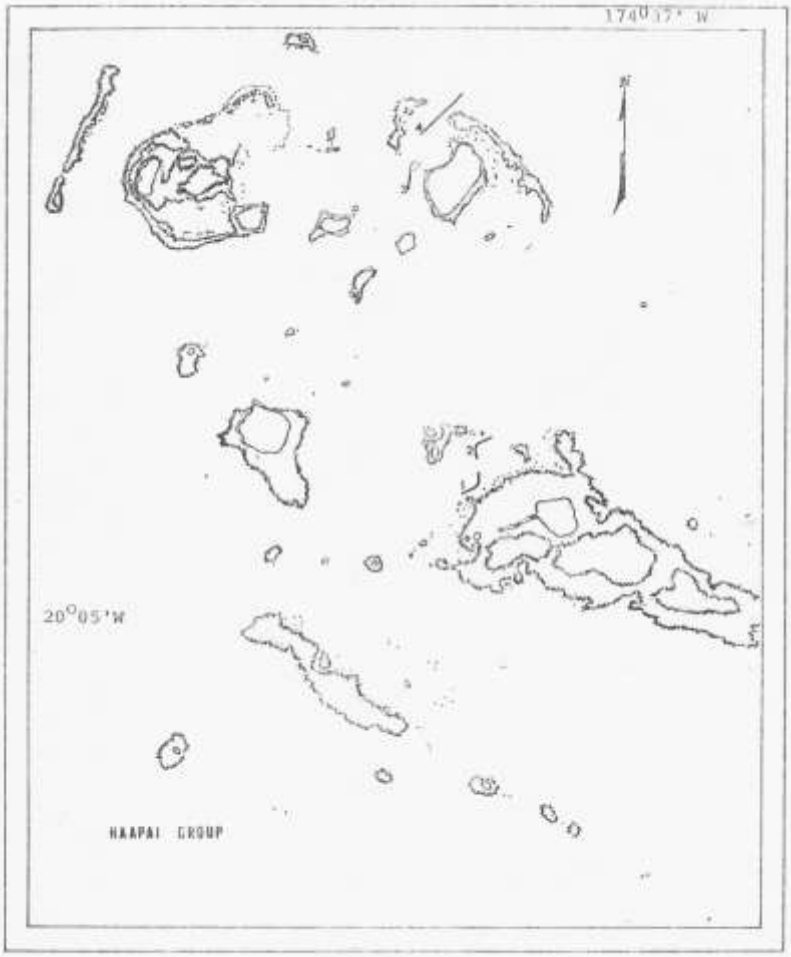

Figure 11. Black Coral Transects in the Southern Haapai Group.

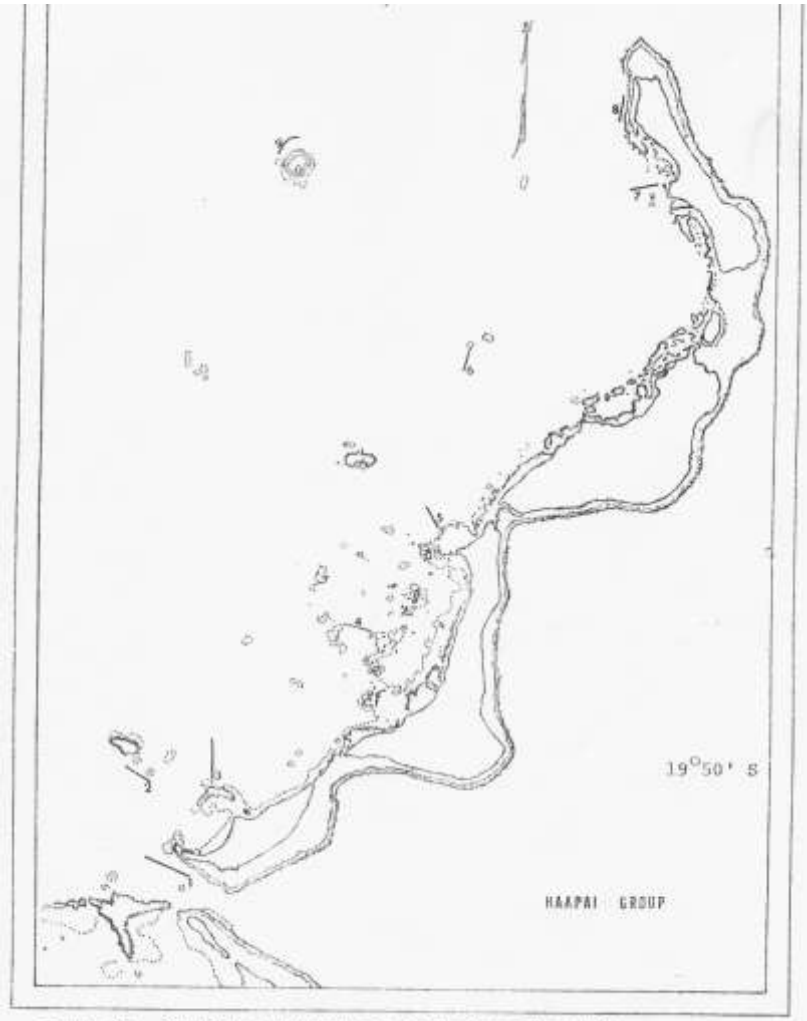

Figure 12. Black Coral Transects in the Northern Haapai Group.

NORTHERN HAAPAI GROUP:

Figure 12 shows the transects conducted in the Northern Haapai Group. Table 3 gives the data from these transects.

We found wire coral and gorgonians at Hakau Faha and Crawshaw reefs. Two black coral colonies were observed at the former and one at the latter reef and only one of these was of commercial size.

The pass south of Uoleva had wire coral and gorgonians and two small black coral colonies which appeared to be the non-commercial species. At Luahoko Island we found three small colonies of Antipathes dichotoma but these were not of commercial size. A resident of Haano Island said a Tongan fishing vessel from Nuku'alofa had visited Luahoko and taken all the large black coral colonies.

VAVAU GROUP:

Figure 13 shows the transects conducted in the Vavau group. Table 3 lists the data from these transects. Forty seven stations, or 29 kilometers, were examined in the depth range of 10 to 50 meters, including most of the areas which might be expected to have significant amounts of black coral.

Wire coral and black gorgonians were abundant in some areas of Vavau but nowhere did we find more than a few colonies of the commercially valuable Antipathes dichotoma, or A. grandis. None of those we found were as large as the Nuku'alofa specimens:

Local divers and black coral carvers who have been in Vavau for many years said that with one or two exceptions all of the large pieces of black coral used for carving in Vavau originated in Nuku'alofa.

Wire coral, which is taken in quantity, is used by craftsmen in Vavau for jewellery. It does not carve or polish as well as the more valuable black coral but it is useful for necklaces.
Where specimens of the valuable black coral species were found they lived in habitats similar to those of Nuku'alofa; ie. on the sides of rocks which were separated from the base of the rock wall in areas of strong currents.

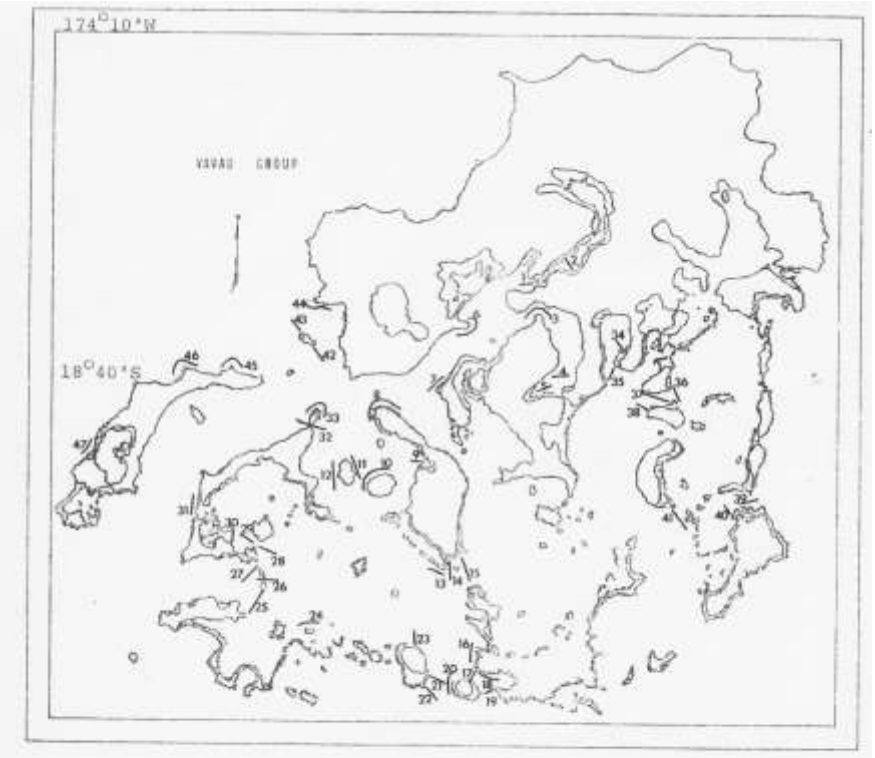

Figure 13. Black Coral Transects in Vavau.

TRANSECT	SPECIMENS SEEN	LENGTH (xM)	COMMENTS
1.	0	.647	Muitatau
2.	W	.555	Vaipuua Lagoon
3.	W	.740	Neiafu Pass
4.	0	.370	Neiafu Lagoon
5.	0	.740	Neiafu Lagoon
6.	W	.740	Teleki Point
7.	W	.56o	Otungake Point
8.	W,S,NC	2.03	Muifaitanga Point
9.	0	.555	Port Maurelle
10.	W, S	.980	Ava Island
11.	W	.550	Oto Island East
12.	0	.721	Oto Island West
13.	0	.647	Fangs ata Reef
14.	0	.462	Fangs ata Reef
15.	0	.462	Kapa to Taunga Island
16.	2C,lS,W	.555	Pau Reef
17.	w	.370	Pau to Eueila Island
18.	1NC,W	.721	Pau Reef
19.	1NC,W	.462	Eueila Pass, East
20.	1NC,W	.370	Eueila Pass, West

21.	1S'W	.740	Eueila to Euakafa
22.	0	.647	Euakafa outer reef
23.	0	.555	Euakafa inner reef
24.	0	.536	Mounu inner reef
25.	W	1.11	Ovaka Pass
26.	1S'W	.740	Ovaka Shoal
27.	1NC,W	.462	South of Langitau Island
28.	2NC	.439	East of Langitau-Laps Pass
29.	0	.277	West of Langitau-Laps Pass
30.	W	.462	Vakaeitu Lagoon
31.	W	.647	Vakaeitu-Nua Papu Reef
32.	3C,W	.647	Kitu-Nua Papu Pass
33.	W	.740	N. E. Tip of Kitu
34.	0	.277	Valiaavau Harbour East
35.	2S,W	.592	Valiaavau Harbour Entrance
36.	1C'1S'W	.407	Mafana to Otoua, East
37.	2C,1S,W	.943	Mafana E to Otoua W
38.	W	.370	Mafana West
39.	0	.380	Lolo Pass
40.	0	.277	inside Lolo Pass

TRANSECT	SPECIMENS	SEEN LENGTH (KM)	COMMENTS
41.	1NC,W	.740	Ofu Southeast
42.	0	•277	Tuungasika East
43.	0	.370	Tuungasika West
44.	W,G	.832	Fo tula-Port Refuge
45.	W, 2NC	.647	North Hunga
46.	W	.925	North Hunga
47.	1C,2S,W	.555	Kalau

C = Commercial Specimens over 1 Meter high,
S = Commercial Species less than one meter high,
NC = NonCommercial Species, W = Wire Coral,
G = false black coral Gorgonians.

GROWTH RATES:

Black coral grows very slowly. Some pieces of a large specimen of Antipathes dichotoma were obtained from the Black Coral Factory and a thin sections made from two branches.

Radiographic analysis and microscopic examination of these thin sections, revealed annual growth rings (Grigg, 1976). Based on the number of growth rings, a 51-mm wide branch required 63 years to form and a branch section 27-mm in diameter required 29 years to grow. A rough estimate of age is thus about one year per millimeter of branch width.

DISCUSSION

ABUNDANCE & DISTRIBUTION:

Large specimens of commercially valuable Antipathes dichotoma and A. grandis were rare except in Nuku'alofa Harbour. The large specimens of Nuku'alofa Harbour with thick, round branches 70-80-mm in diameter are old, probably in excess of 80 to 90 years and perhaps much older.

No specimens as large as the Nuku'alofa ones were located elsewhere in Tonga. In fact, the specimens observed in (and from) Nuku'alofa Harbour were among the largest and best formed black coral specimens the author has seen in tropical countries anywhere in the world. Because they are

rare, thick pieces of black coral are much more valuable than thin pieces. Statues carved from large branches are worth hundreds of dollars.

When black coral was found in the Haapai and Vavau Islands it was smaller and limited to very localized areas containing only 4 to 5 specimens.

Wire coral was abundant in some areas of Vavau. Although wire coral was found at many stations, the areas where wire coral was abundant were limited. Furthermore, it was often in shallow water, in depths ranging from just below the surface to 40 meters along rock walls and thus easily harvested.

False Black Coral Gogonians were common in some areas, generally in water shallow enough for surface diving. Like wire coral, the habitats were limited in extent.

EXPLOITATION:

The unique black coral population of Nuku'alofa Harbour is endangered by habitat destruction from siltation and perhaps other pollutants. It is also being harvested at a rapid rate. The slow growth rates and low recruitment to the stock cannot support rapid and prolonged harvesting.

Many of the colonies are, however, already dead and it does no harm to harvest these as quickly as possible to stockpile the resource on shore. Since Mr. Ackerman said 4 out of 5 of the colonies harvested were already dead and since the dead specimens are better for carving, it would not be a great hardship on the industry to prevent harvesting of live specimens of *Antipathes dichotoma* or *A. grandis* until a replanting programme is established.

It is easy to distinguish between live and dead black coral colonies. Live colonies are covered with a thin, slimy coating of flesh (usually red in color and it comes off if touched with the fingers) and live colonies have many thin branches. Dead colonies are generally coated with a hard white deposit and have very few thin branches.

Wire coral is much more abundant and widely distributed than the more valuable black coral trees. Evidence was found that even this resource is being overharvested. This is because it is most commonly found along cliffs or fringing reefs in relatively shallow water.
Black coral and wire coral along cliffs are easily overharvested. Because the coral is along a linear surface, a diver can work an area of coastline without missing any specimens and without repeating his efforts. Reports of large beds of whip coral being completely eliminated were made by David McLean and others.

Black coral colonies on a lagoon bottom are more difficult to harvest because knowing the exact area already harvested is more difficult. As the coral becomes less common unsuccessful dives increase and the dangers involved with deep diving also increase. Since divers do not make deep lagoon dives for any reason other than taking black coral it is probable harvesting will stop short of actual extinction of the resource. But not by much. And if remaining specimens happen to be found or snagged on fishing lines they will be taken. Since they grow so slowly, local extinction is a very real possibility.

REPLANTING:

The results of the Vavau replanting experiment will indicate if the resource can continue as a viable economic proposition. If black coral can be replanted from branch tips it would be possible to increase the black coral population by a very large degree.

As black coral is depleted in the Pacific, its value will increase. A replanting project could establish large populations of significant commercial value. It should be easier than forms of aquaculture which require breeding and rearing. The branch tips are of no commercial value and their use for aquaculture would not represent an economic loss (except for time spent planting).

A commercial harvest could be made in about 20 years, when the steam size would be about 20-mm diameter. This length of time is similar to that required for silviculture. Experiments in methods of specimen handling and habitat selection are required to maximize survival and growth rates. It may be possible to select faster rowing colonies and thus impose genetic improvement to the stock.

It is especially important to determine the spacing between the planted colonies; putting them too close together could result in disease problems.

A single large colony of Antipathes dichotoma or A. grandis could provide thousands of branch tips. The living colonies in Tonga should be preserved to form the stock to begin a replanting experiment. There are already too few in Haapai and Vavau to permit utilisation for any other reason.

HABITAT SURVIVAL:

It is useless to control harvesting of a species, or attempt replanting if the habitat is being destroyed. Precautions should be taken to prevent silt from continuously entering the harbour from construction activities along the waterfront. Dikes and plugs should be used when dredging and areas which are filled should be paved and layered with topsoil and planted. Pesticides should not be used on the coastal areas.

The northeastern wall of Phia Passage and the islands of Haapai and Vavau are free from the pollution problems of Nuku'alofa Harbour. If black coral plantings survive in these areas, the industry might survive the loss of the Nuku'alofa harbour population.

Figure 14. The Black Coral Factory at the Small Industries Centre in Nuku'alofa.

RESOURCE UTILISATION

IMUA PACIFICA is located at the Black Coral Factory in the Small Industries Centre (Figure 14). Tongan divers, artists, management and sales persons are employed in the gathering, caving, selling and exportation of black coral products for IMUA PACIFICA.

A number of Tongan carvers produce tourist items in black coral and sell them directly to the tourists from roadside and market stands. Most of the black coral for the independent artists comes from the Black Coral Factory or its divers.

Jack Ackerman, Feao Felioko, and David McLean all report that the owner of a guest house along the Nuku'alofa waterfront also buys large quantities of black coral but does not make carvings or sell the coral locally. The implication is that the raw product is being exported.

One carver told me his brother was a diver for black coral and had exported "many" boxes of black coral to Hawaii.

The IMUA divers collect (according to observers at the wharf) four to five black coral trees a day for several consecutive days, sometimes every week, sometimes every other week. Mr. Ackerman says his company obtains 4 to 5 black coral trees a week as an average.

David McLean, Feao Fehoko, and personal observations indicate that a single, large black coral tree will supply a good workman with enough raw product for between 4 to 6 months of carving.

The export value of the black coral is about US$34 a kilogram sold in Hawaii; less in Taiwan or Hong Kong. The cost of transportation and handling must be subtracted from this figure. At present, exports are not being reported and are being done primarily by non-Tongans. It may be assumed most of the funds derived from the export of raw product do not revert to Tonga or Tongans. The value received by Tonga for black coral sold as raw product is thus the funds paid to the diver or about T$2 to T$5 a kilogram.

The export value of wire coral is much less (about US$8 per kilogram in Hawaii) and the false black coral has no market value, but is sometimes used locally.

When carved into jewelry a kilogram of black coral will sell for $T2,000 or more depending on the skill of the artist (McLean, 1983). Local use for artistic work for sale in Tonga to tourists thus would bring the greatest income to Tonga and would not exceed the ability of the stocks to survive.
In Fiji, the price of finished black coral products is three to 10 times higher than Tongan prices, indicating some competitive marketing would bring an improved utilization of the resource.

CONCLUSIONS AND RECOMMENDATIONS

The black coral resource of Tonga was found to be limited and overexploited.
The most valuable species are endangered from overfishing and habitat destruction.
The more common wire coral has been harvested completely in some locations and is vulnerable to rapid extraction.
Export value of the raw product is (to Tonga) worth about T$2 to T$5 a kilogram. As a carved jewelry item sold locally to tourists, it is worth T$2000 a kilogram or more.

RECOMMENDATIONS:

1. Legislate against the harvesting of live specimens of Black Coral (Antipathes dichotoma or A. grandis), and the export of any black coral, raw or as carved products except via sales to tourists.

2. Expand replanting experiments to determine if colonies can be grown from branch tips in Phia Passage, Haapai, and Vavau.

3. Take preventative measures against siltation of the harbour areas through the use of dikes and plugs, silt screens and immediate planting of construction areas along the waterfront. Prohibit pesticide use in waterfront areas.

TONGAN BLACK CORAL

Addendum to Chesher 1984 Report

February 1986

In November of 1985 I re-examined the site of the black coral planting done in 1984. Three of the branches were still living. All three had been secured with stainless steel wire to rock projections and were located under overhangs. All the colonies planted on the open face of the vertical wall were dead. Future replantings should be sure to attach the colonies in locations where they are in shade, even if the overhanging projection is small.

A summary of my report was published in the Tongan Chronicle and subsequently reprinted in Islands Business Magazine's September issue. Jack Ackerman prevailed upon his friend Rick Grigg to join him in writing a pair of letters to the editor which are of some interest.

Aside from the numerous errors in the letters and the side issues which I have answered elsewhere (see attachments), there are two fundamental points which need clarification.

1. Are there forests of black coral waiting to be harvested in Tongan waters?
2. Does it matter if one resource in Nuku'alofa Harbour is overharvested?

Ackerman's (and it seems Grigg's) sales pitch is that black coral is abundant in and around the Tongan Islands. "Forests of black coral" is the common way it is said. This idea has two direct benefits for Ackerman, Grigg and others in the black coral story.

First, if there is a vast supply of Black Coral there is no need to worry, for the moment, about how much is being taken or where it being taken to.

Second, other island nations in the region, believing forests of black coral may bring future riches to them, too, are eager to support research and consulting and survey work.

It is, of course, possible there are other major concentrations of black coral in Tonga than those of Nuku'alofa harbour and its adjacent channels. The known resource, the one which is "proved" is the only one the Tongan Government can depend on until such time other commercially valuable populations are discovered, measured, and documented.

During my survey, and again this year, I heard stories of "forests of black coral Just off my village". When I investigated, the forests turned out to be stands of 6 to 10 colonies of commercial size which could have been harvested by a diving team in a day.

There are some areas which might be worthwhile to look at at some point in the future. I could not, after all, survey every possible site in the time available.
The second point, does it matter if the Nuku'alofa resource is depleted, is the one which needs immediate attention.

A proved resource of black coral, located in easy access to fishermen and in reasonably safe diving depths should be carefully managed. To allow get-rich-quick attitudes to strip out the population would be a great misfortune for the, future generations of Tongans who might otherwise have this resource to work with.

There are no diving decompression facilities in Tonga, and safe diving depths where there are no emergency hyperbaric facilities should not exceed 150 feet. Nuku'alofa harbour is shallower than this.

Recent reports of Tongan divers making 180 and 200 foot dives to collect black coral indicate the Nuku'alofa black coral population must have been severely depleted since my study 18 months ago or the divers would not need to be exposed to such hazardous diving conditions. If, as Ackerman and Grigg claim (but have not shown) vast reserves of black coral exist somewhere out there in the sea they should have no objection to regulating harvests from Nuku'alofa harbour and surroundings.

If Ackerman is as willing to work with the government as he says in his letter to the editor, he can begin by providing the government with accurate data on his harvesting activities and assist with a replanting programme.

Since Mr. Ackerman, personally, has evidently not been aware of either the amount of harvesting or the export of the products of his factory, government assistance in monitoring these should be most welcome.

The recommendation I made to ban collection of live specimens of Antipathes dichotoma which Grigg found so fantastic would not have impaired the normal use of the resource for the production of local handicrafts as some 40% of the commercially sized specimens we saw were dead. Ackerman, in an interview with me, reported most of the specimens collected for his factory were dead when collected and that he preferred these as they were "seasoned" and carved better than specimens which were collected live.

I would continue to recommend this, at least for the Nuku'alofa Harbour area.

Additional recommendations are:

1. The Tongan Government should enforce its statistical reporting requirements for all exported black coral products except those taken by tourists for non-commercial purposes.

2. Divers who commercially fish for black coral should be licensed and required to report their catch, the number of dives made, and the areas worked.

3. Breeding stocks of large colonies of live specimens of the more valuable "tree-type" black coral (Antipathes dichotoma) should be reserved in designated areas of Nuku'alofa Harbour. The density of adult colonies may be an important factor to restocking the population.
In addition, live, big black coral trees are an important tourist resource for the diving visitors who would like to see one alive. Arrangements should be made with local dive tour representatives to designate which black coral areas they wish to remain undisturbed.
I would recommend a major breeding stock be reserved just south of Fafa Island in-the area of greatest concentration of black coral as shown in my report.

4. Similar reserve areas should be established where replanting experiments are to be conducted.

5. No live specimens of the tree-type black coral (A. dichotoma) should be taken smaller than 4 feet high with a main stem diameter less than one inch. (see Grigg 1976's paper on Hawaiian Black Corals for justification of this size limit).

These recommendations will help establish the biological information needed to construct and maintain a management plan for black coral in Tonga.
I would also reconfirm my earlier recommendation, in order to maximize the long term benefit for Tonga, that unprocessed black coral should not be exported.

I would think it useful to discuss these and any other management plans regarding black coral with Jack Ackerman, other interests in the black coral industry and representatives of your Fisheries Division. Ackerman has shown his interest in cooperating with you on these matters, and says explicitly in his letter that he wishes to do so. I would be happy to answer any further questions about this matter.

Richard H. Chesher, Ph.D.
cc: Secretary General, South Pacific Commission

Comment on the 1984 Black Coral report - Island Business Magazine Sept. 1995. Page 45

Danger alert for black coral

Tonga's stocks of precious black coral are not large and are probably being over-exploited. This is the view of Dr Richard Chesher, a consultant to the South Pacific Regional Environmental Programme, who has assessed the stocks at the Tonga government's request.

The coral is used for manufacturing jewelry. Divers recently began harvesting it intensively. Near Nuku'alofa, Chesher found large specimens of the coral being threatened by commercial harvesting and harbour siltation. Other area of Tonga are not so well endowed and are "very vulnerable" to over-exploitation, Chesher said. He has urged the government to ban the harvesting of live black coral and the export of unworked coral. Jewelry-makers would have to rely on the collection of dead coral.

During his work Chesher initiated replanting experiments by snipping off the tips of live branches and wiring them to the reef. If they regrow, it should be possible to cultivate thousands of new branches from just one specimen. Black coral is worth $T2 to $T5 a kilo in its raw form. As carved jewelry, it can fetch more than $T2,000 a kilo.

Letter to the Editor of Island Business Magazine 25 November 1985 by Rick Grigg

Dear Editor:

I was surprised to read in your September issue an article sounding a danger alert for black coral in Tonga. The alert was sounded by Dr. Richard Chesher, a consultant to the South Pacific Regional Environmental Programme.

Chesher claims that Tonga's black coral stocks are being threatened by over exploitation and has recommended a harvesting ban to the Tongan government. First, I am shocked to hear such news coming from Dr. Chesher, who while having done some research on coral reefs, is not an acknowledged expert on black coral. Also I recall some 15 years ago that Dr. Chesher generated headlines around the world by claiming that coral reefs in the Pacific might be driven to extinction by outbreaks of the crown of thorn starfish. Today it is ludicrous, as is his claim about Tongan black coral. (There are over 300 islands in Tonga and only one has been commercially harvested for black coral. The area off one harbour at Nuku'alofa has been heavily dived but this hardly gives justification to sounding a danger alert. Chesher has again demonstrated his irresponsibility l but I hope that this time "crying wolf" will not mislead government agencies and the public into over-reacting to a non-problem.
DR. RICHARD W. GRIGG Marine Biologist University of Hawaii

Letter to the Editor Island Business Magazine - response to comments by Rick Gregg

BLACK CORAL AGAIN

Normally, when a scientist publishes critical remarks about another's work he has some important new facts to disclose. Naturally the scientist making the remarks should be completely familiar with the work being criticized and of the new facts.

Rick Griggs letter in Islands Business is a most interesting example of bad science. First, because he had not read my report but only a short 3 paragraph summary I did not write, review, or even know about.

Second, because the bulk of his letter is a personal attack against me about a subject totally unrelated to black coral. (Incidentally, if my 1969 concerns about the crown-of-thorns starfish were so ludicrous, why did the US Government allot 7 million dollars into researching and controlling the problem in 1969? Why has Australia recently mounted a multi-million dollar project to investigate the damage the starfish continues to do to the Great Barrier Reef?)

Third, the facts presented by the Pacific's most prominent acknowledged expert of Black Coral (perhaps there is only one?) are wrong.

He says;

1. "There are over 300 islands in Tonga and only one has been commercially harvested for black coral."

2. "The area off one harbour at Nuku'alofa has been heavily dived," (this is his 'fact') "but this hardly gives justification to sounding a danger alert." (this being his expert opinion).

So, how good are Grigg's scientific facts? Well, to begin with, he has roughly doubled the number of Tongan islands. Not too good so far. Also, the statement is misleading (deliberately) because an uninformed reader would think that black coral might be found around even tiny cays and rocks on tidal flats or reef complexes. This isn't true as Grigg knows perfectly well.

The second fact, that only one of the "300" islands has been commercially harvested is also wrong as there has been harvesting off many of the Kingdoms islands. Commercial harvesting has gone on in the Ha'apai and the Vava'u groups.

He errs again in the second sentence as there happens to be just one harbour off Nuku'alofa and this harbour, and its adjacent channels, contained (at the time of my survey - and until now as far as I know) the only proved concentration of black coral. It was convenient to get to, not too deep to dive safely, and could, if managed properly as any living- resource should be, support a Tongan black coral cottage industry for decades, maybe forever.

In other areas I examined during my 5 month survey from Tongatapu to Vava'u I found the populations small, scattered, and along escarpments which could quickly be picked clean. There may be other large and dense populations of black coral in Tonga, but there is a vast difference between a proved resource and an imaginary one.

Grigg's expert opinion, that the demise of the valuable Nuku'alofa resource is nothing to worry about, is an opinion I simply do not share.

I agree with Jack Ackerman's letter which appears side by side with his friend's outburst. People involved with the use of living resources should work together in harmony. But, I'm not sure the letters to the editor page of Islands Business is the place to do it.

Richard H. Chesher, Ph.D.
Marine Scientist Vava'u, Tonga