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SOUTH PACIFIC ISLANDS - MARINE TURTLE RESOURCES

A report prepared for the  
Fisheries Development Agency Project

by

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## 1. INTRODUCTION

### 1.1 Background and Objectives

The following report is based upon interviews with government and fishery officials and visits to sites of turtle activity such as nesting grounds, feeding areas, market places, turtle fisherman camps, etc.

In 1969, the South Pacific Commission (SPC) and the South Pacific Islands Fisheries Development Agency (SPIFDA) sent Marine Turtle Questionnaires to Fishery Departments in the South and Southwest Pacific and the few replies provided some background information on turtle resources. In most cases the respondents to the questionnaire were interviewed by the consultant and the information verified; the pertinent data are included in this report.

The Terms of Reference of the consultant are given below:

"To prepare a synoptic review of the stocks of marine turtles of the South and Southwest Pacific; to draft preliminary programmes for local stock assessments and evaluation studies; train local authorities for the implementation of these programmes and collection of data upon which future management programmes can be based; to give general advice on the practicability of turtle farming."

In view of these Terms of Reference and the relatively short time spent in each territory, the consultant also considered one of his primary duties was to indicate localities where future indepth studies should be made.

## 2. U.S.A. (TUCSON)

### 2.1 Synopsis of Activity and Planning

Since it was impossible for Mr. Tubb (Director SPIFDA), Dr. Hendrickson and the consultant to have a joint meeting for discussions on the marine turtle survey of the South Pacific, the consultant spent three days in Tucson, U.S.A. with Dr. Hendrickson who has spent several years in Malaysia conducting sea turtle research and has also first hand experience of some aspects of the turtle work performed in the Hawaiian Islands. They discussed the relative merits of turtle farming (unit completely independent from wildstock, mate in captivity, eggs laid on artificial beaches), and turtle ranching (unit dependent upon wild population for eggs) and both agreed that ranching, if at all attempted, must only be a temporary scheme, the reason being that a natural population will not withstand "parasitization" of its eggs. The ultimate in turtle culture is farming. However, there are basic biological problems to be worked out before large scale farming can be recommended.

Scientifically controlled, pilot attempts at farming are appropriate (emphasizing the green and hawksbill turtles firstly). Emphasis should be to determine if mating, egg laying and the complete rearing under fence is possible and practical. The largest turtle farm (green turtles) now in operation is on the Island of Grand Cayman in the Caribbean and they are some years away from commercial marketing of turtle. Fishery officials in the South Pacific should be cognizant of the progress and problems of the Grand Cayman scheme before attempting programmes of their own.

Some of the factors to consider before initiating a turtle farm (or ranch) are the following: initial financing, ample finances to survive the inevitable set-backs, elimination of predators and competitors in enclosures and on nesting beaches, protection from pollutants and poachers, availability of veterinarians or parasitologists to advise on disease problems, year around availability of natural food (in nature, green turtle hatchlings are chiefly carnivorous and adults are herbivorous), growth rates obtainable with commercial feed, water and sanitary requirements, optimum density, transportation to processing plants, expertise on how to utilize all turtle (flesh, fat, oil, skin and shell) and facilities to conduct scientific experiments concomitantly with farming.

A key list of marine turtle reports and books was drawn up. Territories in the Pacific were encouraged to obtain these publications for background information. This list is given in Appendix 5.

In addition, a series of species accounts is being prepared by a group of marine turtle experts under the auspices of the International Union for the Conservation of Nature and Natural Resources (IUCN). As of this date, none are published but the account of the trunkback or leatherback (*Dermochelys*) written by Dr. P. Pritchard is expected to be available in 1971 (IUCN, HQ, Morges, Switzerland). The consultant is also currently writing a synopsis of the green turtle (*Chelonia mydas*) for the Food and Agriculture Organization and this should be available towards the end of 1971 (FAO, HQ, Rome).

## 2.2 Recommendations

- (i) The consultant recommends that any turtle ranching or farming be attempted only on a very small scale and only if scientific expertise is available. Considering the fact that only about ten species of freshwater fish have been successfully farmed, some discretion must be exercised before pursuing any form of marine farming.
- (ii) Before Dr. Hendrickson commences his tour of the Pacific he should travel to Grand Cayman to observe techniques of turtle culture being used there.

- (iii) It is recommended that an expert be appointed to cull all the pertinent information on marine turtle conservation and management and prepare a succinct "field manual" for fishery personnel in the field. Preparation of such a manual would take an expert about four to six months. The texts of the publications given in Appendix 5 may serve as a starting place in the preparation of such a guide.

### 3. HAWAII

#### 3.1 Synopsis of Activity

The consultant discussed with personnel of the Department of Fish and Game and the U.S. Bureau of Sport Fisheries and Wildlife, aspects of marine turtle biology, management, assessment of and characteristics of marine turtle feeding and breeding grounds, migration, restocking programmes, developmental migrations, re-nesting cycles, imprinting, methods of measuring turtles and taxonomic problems. Slides of the green turtle tagging programme in the Hawaiian Leewards under the direction of Mr. Kridler were examined (the slides indicated a good deal of colour variation in this population). The consultant travelled by air to Hana on Maui Island (with Mr. Breese) to investigate reports of turtle feeding grounds and conducted surveys of feeding areas by skin-diving (2 days). He observed green turtles in the Oceanic Institute Aquarium (in this place adults are fed with squid and herring; unfortunately, no growth records were available). Identification and growth rates were discussed with Dr. Doty. The consultant studied herbarium specimens at the University of Hawaii and carried out diving operations off Waikiki Natatorium Reef where he learned how to identify algae in the field and to estimate biomass and cover of algae (with Mr. Allender).

#### 3.2 Findings

The most common marine turtles in the Hawaiian Islands are green turtles. They nest in the Hawaiian Leewards, especially on French Frigate Shoals, Pearl and Hermes Reef, Laysan, Lisianski and Kure Islands. For the most part, the nesting beaches are made up of coarse sand. The peak nesting season is May through August but basking takes place throughout the year (sometimes on the same nesting beaches).

There are some hawksbills in Hawaiian waters but no big concentrated nesting sites. There is an authentic record of hawksbill nesting on Halawa Beach, Molokai Island on 12 October 1969. A few leatherbacks (Dermodochelys) have been sighted in the waters around the large islands.

In contrast to green turtles in the Caribbean and Indian Ocean where most mature individuals feed on marine spermatophytes, the majority of Hawaiian green turtles feed on several species of algae (locally called limu).

Green turtles are caught feeding on algae near Puuiki Point and Makaalae Point on Maui Island. Most of them weigh about 20-25 kg (range 5-100 kg). The local people catch turtles by (1) diving and seizing them while they are sleeping, (2) by use of "spinners" (i.e. casting rods) and (3) by spearing (from the land when the turtles come near to the rocks to feed, and underwater with the "Hawaiian-sling"). The consultant's underwater survey indicated that there are not enough algae to support a large resident population here. According to local fishermen, the green turtle (known as honu) is most abundant between June and August but it is also seen and caught throughout the year.

All marine turtles are completely protected in the Hawaiian Leewards but there are no turtle regulations on the main Hawaiian Islands. On Midway it is illegal to take any turtle less than 24 in in carapace length. Most green turtles caught off Midway are in the 10-25 kg size class.

In the main Hawaiian Islands, green turtles are eaten for meat but there is a slowly growing tourist demand for stuffed sub-adult greens which have a carapace streaked with brown-orange-black-yellow. These types sell for about \$40 to \$75.

The commercial catch of turtles in the State of Hawaii in 1969 was 10 175 lb, valued at \$2 820. These were mostly of the green variety. These figures are minimal because many of the turtles caught by fishermen, skin-divers, and scuba-divers go unreported.

According to Dr. Doty, not much is known about growth rates of algae and therefore care must be taken when discussing turtle ranching utilizing natural vegetation. The fact that there is seasonal variation in some alga must also be taken into consideration.

### 3.3 Recommendations

- (i) The sale of stuffed marine turtles of all sizes should be prohibited and turtle meat and soup eliminated in hotels and restaurants.
- (ii) An in-depth study should be made on one or several of the nesting atolls in the Hawaiian Leewards, during the peak nesting season. Special emphasis should be placed on the numbers nesting (i.e. after two weeks the tagged ones should be returning). The Hawaiian Leewards are probably the biggest green turtle rookeries in the United States.
- (iii) A tagging project should be started on the feeding areas off Maui to determine whether immature individuals remain there throughout the year and if adults remigrate to the Leewards for breeding. Stomachs of individuals caught by local fishermen should also be analysed (Mr. Daniels could do all this if necessary financial support is given).

- (iv) Mr. Kridler should publish his information on the green turtle in the Leewards. He has tagged over 500 (males and females) and has six long-distance recoveries. This would be an important contribution to the ecology and taxonomy of the little known central Pacific green turtle.
- (v) Cooperation between personnel in the United States Fish and Game Department and that of the United States Sport Fisheries and Wildlife, Hawaii Branch, is essential on matters concerning turtles, since the green turtles nesting in the Hawaiian Leewards (under the jurisdiction of the latter) may well be the same individuals feeding off the main Hawaiian Islands (under the jurisdiction of the former).

#### 4. TAHITI

##### 4.1 Synopsis of Activity

The following people were instructed in turtle biology and management: Mr. P. Angeli, Mr. L. Lenoir, Mr. S. Stein, Mr. J. Tapu and Mr. J. Drollet. The consultant carried out diving operations off beaches near Pirae and Papeete to check for turtle grass/algae. The main market in Papeete was checked alternate mornings for the abundance and price of turtle meat. Tourist shops were checked for stuffed specimens and shells. Many local fishermen were interviewed. Ten green turtles caught by fishermen near Motu-Honu were measured and Mr. Tapu was instructed in tagging and measuring techniques. Several stomach contents were analysed. The consultant saw a French T.V. film on sea turtles. Aerial surveys of nesting beaches and localities around Mopelia, Scilly and Tupai were made. Manihi Atoll in the Tuamotu Archipelago was visited and turtles and turtle kraal were inspected there.

##### 4.2 Findings

As everywhere else in the world the numbers of green turtles in French Polynesia are decreasing rapidly. The consultant however believes that reasonably large populations still exist around some of the more inaccessible atolls. Whether these are resident or migratory populations is unknown.

The most common sea turtle in the area is the green turtle (French: tortue; Tahitian: honu). One of the principal nesting grounds is Scilly. Other important nesting sites are Mopelia, Bellinghausen, Tupai and some of the Tuamotu atolls. The peak nesting season in Scilly, Mopelia, Bellinghausen and Tupai is October through December. Reports indicate that some turtles can be found throughout the year off Scilly. The hawksbill turtle is sometimes taken by fishermen. There is one authentic record of a leatherback caught in a seine. On 24 September, the consultant counted 20 green turtles in the water around Mopelia (but there were no tracks on the beach), and 42 around Scilly, including 12 in a village kraal. He also noticed fresh tracks and nests on Motu Honu (islet of Scilly).

Local inhabitants of Manihi collect green turtle eggs, hatch out the turtles and raise them in village kraals for local consumption. They are fed on coconut meat and fish and between 3-3 $\frac{1}{2}$  years of age they grow to carapace length of 20 to 28 inches.

Many males and some gravid females are speared as they mate off the nesting beaches on the atolls. Tahitian fishermen report a sex ratio in favour of males. The turtles sold in Papeete market in September were mostly males. Green turtle meat is considered a delicacy and sells for about \$3 per kg in the Papeete market but there is no market for eggs. A few cured shells are sold in tourist shops at \$25 but the demand is insignificant.

There are no regulations in French Polynesia concerning marine turtles.

Stomachs examined by the consultant were chiefly empty but a few contained a little green algae and one harboured a long piece of plastic. In the limited survey carried out by the consultant he did not find any extensive algae beds or grass flats.

Fisheries Department records indicate that between 1953 and 1967 from 24 (1954) to 262 (1962) turtles caught at Scilly were sold annually in the Papeete Market.

The consultant believes that he was able to build up a "turtle consciousness" in Tahiti as when he left, including the Governor and several Assemblymen.

#### 4.3 Recommendations

- (i) A thorough four-month study (October-January) should be centred on Scilly Atoll. Emphasis should be placed on training a local counterpart in stock assessment, tagging, and if predation on eggs and hatchlings is high, then training is necessary in the establishment of an egg hatchery. This would ensure that the maximum number of hatchlings reach the sea. A boat would be needed in order to check nesting densities on Mopelia and Bellinghausen during the same period. (The World Wildlife Fund might be interested in supporting a project such as this, at least in part).
- (ii) It would be best to prohibit the commercial sale of green turtles until a study can be made of local stocks. However, people on atolls who depend upon turtles and their eggs for their source of protein should be allowed to take a moderate number for local consumption.

- (iii) The Fisheries Department should map out all the nesting beaches in its territory with special emphasis placed on the seasonality of nesting.
- (iv) The Government should show the T.V. film on sea turtles to school children. This film depicts nesting behaviour as well as predation on hatchlings.

## 5. WESTERN SAMOA

### 5.1 Synopsis of Activity

The consultant discussed with the following people the ecology, management and restocking of marine turtles: Messrs. W. Travis, J. Huntsman, K. Enari, E. Slaven, A. Banner and F. Suafoa. He described the different management programmes in Costa Rica and Sarawak and the relative merits of each, to fishery personnel. He conducted aerial surveys around the coasts and reefs of Upolu, Savai'i, Manono, Apolima, and the four islets of Fanuatapu, Namu'a, Nu'utele and Nu'ulua. The beaches and offshore water at the east end of Upolu near Mutiatele were surveyed and the consultant camped and surveyed beaches on Nu'utele Island (with Messrs. Suafoa and Banner). He surveyed Namu'a Island and conversed with various fishermen, especially those from the village of Luatuanu'u who are considered to be the best turtle fishermen. He conducted diving surveys for algae.

### 5.2 Findings

Fishery officials and local fishermen believe that the most common turtle in Western Samoan waters is the green turtle (Samoan = laumei) and that the hawksbill is the second most abundant. There are no major nesting grounds on the two main islands of Upolu and Savai'i.

Green turtles and to a much lesser extent hawksbills still nest in the Tokelau Islands (September-October) but their numbers are said to be rapidly decreasing.

The consultant did not see any beaches which he would consider to be major nesting beaches although it might have been somewhat early for nesting (the peak of the nesting period is presumed to be from middle October to early January). He found however, two hawksbill nests of eggs, one on the islet of Nu'utele and the other on Namu'a. On aerial surveys he counted several green turtles between the islets of Nu'utele and Namu'a and also saw two individuals around Cape Oloinomo, one near Manono and one near Safotu.

The consultant did not observe any extensive algae or grass flats but lack of time prevented an intensive study. A list of algae and flowering marine plants found in Samoan waters is shown in Appendix 4. The list indicates that Posidonia occurs in Samoa and this plant is readily eaten by green turtles in the Indian Ocean. The green alga, Valonia, is

sometimes eaten by Hawaiian Green Turtles. Turtle fishermen are confident that some green turtles remain in Samoan waters throughout the year. Local people eat both the meat and the eggs. As far as the consultant knows, the first green turtle ever tagged in the South Pacific Ocean was tagged and released on 9 October 1970 at Solosolo. It was a mature female (carapace length =  $37\frac{1}{2}$  in, weight about 215 lb). It had been caught by Messrs. Travis and Banner on 7 October between Namu'a and Nu'utele Islands.

Mr. Travis has started a good turtle conservation programme in the local schools and he is drawing up a turtle hatchery scheme which revolves around collecting eggs from Samoan beaches and releasing hatchlings in Samoan waters (eliminating predation on eggs and hatchlings).

Few turtles reach the main market in Apia. It was a rare occasion when the consultant saw two immature green turtles (carapace lengths 18 in and 22 in) in the market, selling at a price of \$8.40 each. These were caught off the village of Lefagaoali'i in Savai'i. Fishermen there say that they can catch turtles of this size, but only of this size, at any time of the year.

Some hawkbill jewellery is sold in shops in Apia; the demand for it is moderate. The workmanship is good but the consultant could not determine if the articles were made locally.

There are no regulations in Western Samoa pertaining to sea turtles although Mr. Travis hopes to arrange for a regulation to be passed shortly which would provide complete protection for all sea turtles and their eggs.

### 5.3 Recommendations

- (i) A tagging programme should be instituted, especially since all sea turtles may soon be completely protected.
- (ii) The vegetation which is encroaching on the nesting beaches on Nu'utele and Namu'a should be cleared back.
- (iii) Turtle fishing activity off the village of Lefagaoali where certain size turtles are caught regularly should be investigated.
- (iv) Isolated beaches on Cape Mulitapuili should be checked for possible nesting sites.
- (v) The breeding and feeding areas should be mapped out in detail. (The U.S. Peace Corps Volunteers (PCV) and Agriculture Extension Workers are willing to help in this matter). The underwater diving gear of the Fisheries Department should be used to evaluate pastures and study feeding behaviour.

- (vi) The cooperation of the village Matai (chiefs) should be solicited since there are still many customs regarding turtles (e.g. meat being given to the chief who then redistributes it). In fact, any turtle scheme in the South Pacific must operate in close harmony with local customs.
- (vii) Facilities and personnel are available to conduct some important biological experiments such as (a) determining if penned females will lay eggs on artificial beaches and determining viability of such eggs, (b) burying green and hawksbill eggs in complements of 50-75-100 to see if per cent hatch is better with certain complements (in Malaysia, leatherbacks have a high hatching rate when reburied in groups of 50), (c) raising a few hawksbills and greens on different food and combinations of food (green hatchlings are chiefly carnivorous) to get an idea of relative growth rates in captivity, (d) rearing groups of turtles for different lengths of time (perhaps one week to twenty weeks), marking, releasing and trying to determine by recapture if any size group has a survival advantage, (e) making a film of sea turtle conservation, (f) developing a method of marking hatchlings for future identification and (g) working on methods of sexing hatchlings.

Note 1. Eggs for any hatching scheme must come from Western Samoan beaches and not from other territories. The reasons for this are obvious: i.e. as in the case of turtle ranching (see Section 2) wild, nesting populations will not withstand parasitization of their eggs and furthermore once such cannibalization starts it is difficult to stop.

Note 2. The scientific basis for and success of restocking schemes (either by transplantation of eggs or hatchlings) has yet to be established. After nine years of restocking (one hundred thousand green hatchlings) in the Caribbean, there is still no evidence of success.

## 6. AMERICAN SAMOA

### 6.1 Synopsis of Activity

The consultant camped on Rose Atoll (with Mr. Swardloff) on the night of 7 October 1970. This Atoll is located between 14°31' and 14°34' S between 168°08' and 168°10' W.

## 6.2 Findings

The Atoll has two turtle nesting sites, Rose Islet and Sand Islet. At Sand Islet the consultant counted 35 pits of varying age. Some tracks indicated much wandering around before final nesting and many 'false' nests; the beach consists of coral fragments and a few shells. On Rose Islet the consultant counted 301 pits of varying age and the beach is again composed of coral fragments. It must be a formidable task for a turtle to dig a nest in this kind of substrate. No turtles nested on the night of 7 October. Fishermen in Pago Pago say that the nesting season on Rose Atoll is between August and September. The consultant was unable to identify the species from the nest holes but Sachet (1954, A Summary of Information on Rose Atoll : Atoll Res. Bull. No. 29: 1-25) quotes an early account which states that the green turtle is the most common nester on the atoll and that hawksbills are fewer. This author also quotes that when the time comes for the young to hatch, the sea is full of sharks who avidly eat the hatchlings. Many species of birds also nest on both islets. The island is uninhabited and landing is prohibited without governmental clearance. The island swarms with rats (possibly *Rattus exulans*).

## 6.3 Recommendations

- (i) The consultant recommends that Rose Atoll be set aside as a fully protected nature reserve. It is uninhabited and should remain so. This atoll would be an ideal site for an ecosystem study. Aid should be solicited from the British Royal Society or the U.S. National Academy of Sciences or the U.S. Smithsonian Institution.

## 7. NEW CALEDONIA

### 7.1 Synopsis of Activity

The consultant spent most of the first period of his stay writing a report of his activities during the previous month. He interviewed local fishermen and discussed plans for the next stop in Noumea. He visited the Noumea Aquarium and Ile Ouen for two days and conducted a turtle census there. During the second period the consultant worked in the SPC offices writing final drafts of his first and second reports. He carried out diving operations with Mr. Val Hinds in Baie des Citrons and around islands in Noumea harbour. Turtle grass (*Cymodocea* and *Halophila*) was collected but the consultant concluded that there is not enough grass in the above named places to support a turtle ranch.

## 7.2 Findings

Six hawksbills and one loggerhead were seen in the Noumea Aquarium (all caught locally). There are a few authentic reports of trunkbacks in the area. Inhabitants of Ile Ouen say that three kinds of turtles are found in the local waters. This was substantiated when the consultant identified three kinds of preserved shells (green, hawksbill and loggerhead) in the Turtle Club Hotel. The nesting season in Ile Ouen area is "summer" (i.e. December-January). A few turtles nest at Ile Ouen but most nesting is performed on several islets off Ouen.

## 7.3 Recommendations

- (i) A thorough study of nesting populations on the islets off Ile Ouen is recommended during December and January.
- (ii) A survey of Ile Ouen and Ile Surprise near Récifs d'Entrecasteaux should be carried out since there are numerous reports of turtles nesting there. Sites of concentrated nesting should be followed up with a tagging programme.
- (iii) Turtle questionnaires should be distributed among fishermen. This would provide the groundwork for future indepth studies.

## 8. TONGA

### 8.1 Synopsis of Activity

The consultant discussed methods of turtle assessment, management and conservation with personnel in the Department of Agriculture and especially with Mr. David Fusimaloki, his counterpart. He also discussed turtle resources of Tonga with His Majesty, Taufa'ahau Tupou IV, King of Tonga, and with Mr. Ve'chala, Governor of Ha'apai. Fishermen were interviewed in every village on the coast of Tongatapu Island and crews of many boats both large and small were questioned. The main market (Talamaku) in Nuku'alofa was checked for the presence of turtle meat, eggs and shell curios and the women's cooperative (Langa Fonua) was checked periodically for occurrence of turtle shells. Surveyed beaches included those near Ha'atafu, Monotapu, Fahefa and Anahulu. Surveys of turtle grass pasture were also conducted off Nuku'alofa and around the islands of Pangaimotu, Oncata and Nukunukumotu. Grass pastures in a lagoon on Tongatapu were also reconnoitered, especially those off the villages of Patangata, Halafou, Talafou and Kawaii. Stomach contents of green turtles were analysed. A talk on turtles was given to members of the Rotary Club of Nuku'alofa. A brief account of the work of the consultant was broadcast from the local radio station.

## 8.2 Findings

The Kingdom of Tonga consists of approximately 150 islands and islets (of which about 45 are inhabited), lying between latitudes 18°01' S and 21°28' S and longitudes 173°54' W and 175°25' W. The population (1967 census) is about 80 000. The Kingdom is divided into three main groups of islands: Tongatapu group (the most southerly), Ha'apai (middle) and Vavau (the northern group). Tongatapu is the main island in the southern group and is the site of the capital Nuku'alofa. Tonga has no Fisheries Department. There is one full-time fishery officer specializing in boats and deep sea fishing and one Peace Corps Volunteer who is engaged on general fishery duties and both officers are within the Department of Agriculture.

Three species of marine turtles are found in the Tonga Islands: the green turtle (local names: Fonu, Fonu Tu'a'uli, Fonu Tu'akula, Fonu Tu'apolata, Tuai Fonu); hawksbill (Fonu Kolaa) and loggerhead (Tu Fonu). The vernacular names vary from village to village. Some fishermen have additional names for the colour phases and various sizes and sex of each species. The green turtle definitely nests on islands in the Ha'apai group, chiefly on the uninhabited ones. The consultant was unable to determine whether the other two species nest in the Kingdom.

Interviews with local fishermen, immigrants from the outer islands, crewmen, agriculture personnel and Peace Corps Volunteers all lead to the conclusion that most marine turtles are found in the Ha'apai Group and that the period of nesting is in the summer (November-February) with December being the peak month for oviposition.

Turtles (especially green turtles) can be caught throughout the year in the Ha'apai Group as well as in the Tongatapu group.

Tongans eat turtle meat (as well as the stomach, intestine, brain and most of the plastron) and eggs. Eggs are eaten by the inhabitants of the nesting beaches and no eggs are found in markets on Tongatapu. Turtle meat itself is rarely sold in the market in Nuku'alofa because turtles are usually butchered and sold on the beaches as soon as they are landed. There is usually at least one turtle being butchered on Thursday, Friday or Saturday night on the beach adjoining Vuna Road in Nuku'alofa, for the most part during the summer months. Fishermen were informed of ways to kill a turtle humanely before carving it up.

If a large number of turtles are brought in (usually from Ha'apai on private boats) the meat is sold in the Government market. It is all sold within one or two hours after the market opens. Turtles sell for between 5-40 c per lb, depending upon whether the piece for sale is meat and bone, meat-bone-fat, intestine, etc. Turtle meat is not a regular item on the menu in any hotel or boarding house but when available, the price is \$3.50 for a steak.

Carapaces of adult green turtles and loggerheads sell for between \$8 to \$16 in the main market and tourist shops in Nuku'alofa. The carapace of hawksbills sells for between \$8 to \$25 depending upon the size. The best hawksbill shells are sold to local craftsmen who make the usual jewellery - rings, bracelets, combs etc. The workmanship is fair. Not much hawksbill jewellery is sold in the main market in Nuku'alofa as compared with the main market in Suva. The demand for it by locals is small although the tourist demand is growing slowly. At least one craftsman in Nuku'alofa sends some of his jewellery to Suva to be sold. Craftsmen get their shells from sundry fishermen and there is no one steady supplier of shell.

Green turtles (some loggerheads and rarely hawksbills) are caught on the feeding pastures off Tongatapu Island. One of the best pastures is north of Nuku'alofa and east of the islands of Paloa, Alakipeau, Tufata and Atata. The most common method of capture is by spear gun. Occasionally, nets are set and only very seldom are special turtle fonocs built. The latter method, however, was common a couple of decades ago (see current turtle regulations). Fences are seldom used now because turtles are rarely seen at present on the feeding pastures close to the shore. According to the best turtle divers, females are more common than males on the grass flats. Turtles can be caught all the year round on the pastures and some turtle fishermen claim that the best months are from November to March when the "grass" is especially lush. Furthermore, again according to the local fishermen, the grass goes through cycles when it is very lush and then sparse. Divers also state that green turtles smaller than "plate-size" (i.e. about 10 in carapace length) are not seen on the feeding pastures.

Three men, working from a small boat and diving all day for turtles on the Nuku'alofa pastures will call it a "very good day" if they manage to get two or three green turtles. The most common method of catching turtles in the Ha'apai group is with nets. These usually have a 12-in mesh. A few fishermen chase turtles with motorboats and after the reptile becomes tired or has been chased into shallow water, a man jumps overboard and catches the turtle by hand.

Several men living on Vuna Road in Nuku'alofa are considered excellent turtle fishermen; there are two well-known turtle fishermen in the village of Ha'akame on the southwest coast of Tongatapu and one good turtler in the village of Kolonga on the east coast. All these men use spear guns. Sometimes a sleeping turtle is simply hooked with a barbed hook attached to the fishline and pulled up out of the water.

The following remarks deal with turtle grass pastures and acknowledgements are made to these scientists for their aid in the identification of plants:

- Dr. John Parham, Botanist, Agriculture Dept., Suva
- Dr. Maxwell Doty, Professor, Dept. of Botany, University of Hawaii, Honolulu, and
- Dr. C. den Hartog, Rijksherbarium, Leiden, Netherlands.

Turtle grass pastures (Syringodium isoetifolium and Halodule uninervis) encompassing at least a square mile, are found off the coast of Nukunukumotu. These spermatophyte pastures, along with those in Fiji, are the best the consultant has seen on the survey, although it should be emphasized that he did not make extensive surveys for pastures throughout the South Pacific.

The consultant ran several transects in the lagoon on Tongatapu and studied grass composition, distribution and cover. Turtle grass (Halodule) off Patangata, at one of the entrances to the lagoon, is sparse. The pasture off the village of Halafoou is made up entirely of Halodule, and in many places the substrate is 80% covered by this species. In addition, much Halodule was washed up on the strand. The pasture at Halafoou is at least several hectares in extent. The pasture off Talafo'ou is composed of both Syringodium and Halodule, each equally abundant. Cover was calculated at 40%. However, the pastures are not extensive here. There may be more Syringodium in deeper water.

Syringodium was the only species present at Kauvai. In some places the beds were dense (cover up to 90%) but the beds are not extensive enough to consider this as a site for turtle ranching.

According to some fishermen, a few turtles (the species are not known) still occur in the lagoon but they are not so abundant as in former days. The consultant could not determine the extent of turtle fishing in the lagoon at the time of writing these comments but he is of the opinion that turtling here would be very unprofitable. In some areas the water is extremely polluted.

Fishermen on Pangaimotu Island used to keep adult turtles in a kraal feeding them with turtle grass (Syringodium and Halodule) which washed up on the beach. They declared that the turtles ate this grass readily and the consultant saw large amounts of turtle grass of both species washed up on shore in October.

Turtle grass between Vuha wharf and American wharf off Nuku'alofa had an average cover of 52%/m<sup>2</sup> (20% Syringodium and 32% Halodule). The average wet weight of the grass (clipped at ground surface) was 600 g/m<sup>2</sup>. Ten samples were taken at random in the middle of a pasture about five hectares in extent.

The consultant examined the stomachs of two green turtles caught during the week of 19 October on the feeding pastures in the main channel off Nuku'alofa and both were full of Syringodium. One stomach also contained a few pieces of Halophila ovalis. The Tongan name for turtle grass, as well as for algae, is limu.

Since green turtles are caught regularly on the feeding grounds off Tongatapu (but do not nest on Tongatapu) and since green turtles are known to nest in the Ha'apai group -- it may be that there is a nesting-feeding migration between the two groups. The consultant dissected two adult green turtles (caught on the feeding pasture off Nuku'alofa during the week of 19 October) and both contained hundreds of small developing eggs which appeared to be about one month away from being shelled. Both turtles also possessed large amounts of fat which might indicate a pre-migratory condition.

Turtle regulations currently in force are the following (from the Law of Tonga, Revised Edition, Vol. 2, 1967, prepared by C. Wylie):

1. Turtles and eggs are fully protected from 1 December through 31 January.
2. A license is required for erecting a fence to catch turtles.
3. It is unlawful to erect fences to catch turtles the
  - (a) mesh of which is less than  $1\frac{1}{2}$  in across
  - or
  - (b) width of which at any point exceeds 450 ft
  - or
  - (c) length of which from base to base along the beach exceeds 450 ft
  - or
  - (d) depth of which from the beach toward the sea exceeds the number of feet specified in such a license.
4. The use of poison other than the method known as aukava (i.e. poison from local seeds and used only in limited areas) and dynamite to catch turtle is prohibited.

Fishery Regulations of Tonga are, however, currently under revision and if approved by the Government, the following regulations will go into effect:

1. No person shall at any time dig up, use, take or destroy turtle eggs of any species or in any way molest, take or kill any turtle the shell of which is more than 35 in in length. No person during the months of January, February, November or December in any year shall in any way molest or take or kill any turtle of any size. This regulation shall not apply to turtles kept as pets or in aquaria.

2. No person shall be in possession of, sell, offer or expose for sale or export any turtle the length of which is greater than 35 in.
3. No person shall in any way molest, take, kill or be in possession of the species Dermochelys coriacea (leatherback) of any size at any time.

### 8.3 Recommendations

- (i) The consultant recommends that the new turtle ordinances (contained in the new Fishery Regulations now pending Government action) be approved.
- (ii) A thorough study of the Ha'apai group with special emphasis on nesting population is also recommended. This should be conducted between mid-November and mid-January. The study should be carefully planned because there are no regular boats scheduled other than between the main islands of each group. Small boats within each group should be chartered in order to reconnoitre uninhabited beaches (the Governor of Ha'apai has agreed to help coordinate matters there).
- (iii) A thorough study of turtle grass pastures around Tongatapu (and the Ha'apai group if grass is present there) should be made. Emphasis should be on primary productivity and, if possible, secondary productivity. The survey should include an assessment of zooplankton (hatchling food).
- (iv) If concentrated nesting is discovered on any one of the uninhabited islands then the island should be declared an inviolate faunal reserve. The King could arrange for this by royal decree. The consultant would like to see several uninhabited islands in the South Pacific treated as turtle sanctuaries.

## 9. FIJI ISLANDS

### 9.1 Synopsis of Activity

Management, farming and conservation of turtles were discussed with fishery officials in Suva and Lautoka. The operation of an egg hatchery was described by the consultant and he pointed out to fishery officials that the book by Parsons (1962, *The Green Turtle and Man*, U. Florida Press, Gainesville) gives a pictorial account of egg farming.

Fishermen were instructed on methods of measuring, identification and tagging turtles. Markets in various towns and cities were checked and many fishermen interviewed. The source of turtle meat was tracked down in various hotels and motels. A number of green and hawksbill turtles were measured and the consultant attempted to "fit these populations into the Indo-Pacific picture", taxonomically. Turtle grass specimens were studied in the Department of Agriculture Herbarium.

Numerous diving surveys were conducted in turtle grass pasture off Suva and Tomberua Island. Underwater pictures were taken of the grass pastures.

In a chartered flight from Suva to Nandi, the consultant looked for signs of turtle activity and potential rearing sites on islands off the east coast, the northern coast, Yasawa Islands and Mamanutha Islands. He made a survey of Nandi waters in the Fisheries Department boat, the DAVUI, including stops at Vunivandra Island, Tavarua Island (he camped there on the nights of 13 November and 4 December), Namotu Island and Viwa Island (two nights of camping). He reconnoitered the coast between Lautoka and Vaileka, including Malake Island.

## 9.2 Findings

There are about 330 islands in the Fiji group of which about 100 are inhabited. The population is about 500 000.

The two most common turtles are the green turtle (Fijian - Vonu Damu, Vonu Loa, Mako Loa and Ika Damu) and the hawksbill turtle (Fijian - Taku). There is talk of loggerheads in Fijian waters - the consultant saw one loggerhead shell in Malake village. One leatherback was found in January 1968 on the beach near the village of Naidi.

Hawksbills are fairly common inside the north loop of Great Astrolobe Reef in Kadavu (according to David Owens, a Peace Corps Volunteer). Freshly laid eggs (the species are unknown) have been found in January on several islands in the above-mentioned "loop" and peak of nesting may be in January. Turtles in Kadavu are usually taken by nets or by spearing but there is no one in that area fishing solely for turtles.

A fishery officer reconnoitred Vatu-I-cake Island in November and reported five old nests and fishery officials report that green and hawksbill turtles nest in the southern Lau group in the summer.

Aerial reconnaissance indicated that the islands of Ngau, Nairai, Wakava and the northern islets between Vatu Ira channel and Charybdis should be checked for turtle nesting. The consultant doubts however that any of these places will have green turtle nesting equal to that of the Sarawak or the Philippine Turtle Islands. The largest turtle nesting sites are likely to be in the Yasawa Islands, the Mamanutha Islands and the Lau Islands.

Many people state that there is nesting on the uninhabited islands of Tavarua and Namotu in Malolo Pass and that the best month for oviposition is December. Mr. Stone and the consultant camped on Tavarua on the nights of 13 November and 4 December and no nesting occurred but six old nests were discovered, including one with 157 eggs (hawksbill - probably deposited on 2 December).

A few resorts keep some green and hawksbill turtles in semi-kraals for the benefit of tourists. Both species are usually fed with scraps of fish. At one such place (Vunivandra Island) 18 hawksbills were raised from hatchlings and after two years all of them had carapace lengths of between 7 and  $7\frac{1}{2}$  in.

The following kinds of turtle grass (Fijian - Vutia) are found in the Suva area inside the barrier reef: Halodule pinifolia (varied from 20 to 40% cover); Syringodium isoetifolium (provided from 50 to 90% cover; and from an area where it accounted for 90% cover, the wet weight cropped at ground level was 600 g/m<sup>2</sup>) and Halophilia ovalis (occasionally eaten; may be ingested unintentionally as the turtle grazes on the above two species). The magnitude of these pastures is unknown (see recommendations). On 10 November a young green turtle, carapace length  $15\frac{1}{2}$  in weight 21 lb) was captured as it fed on Syringodium. Subsequent dissection also revealed a piece of plastic in its stomach. The best turtle grass pastures that the consultant has seen on the entire trip were off the southern coast of Viti Levu. It should however be remembered that the consultant did not have time to make thorough surveys of pasturage in all the islands.

Fishermen on Malako Island catch green turtles in feeding pastures off the north-central coast of Viti Levu. They caught 80 turtles in October. Green turtles around Viwa subsist largely on red and green algae. Spear guns and seines are used to catch turtles here.

Many hawksbill curios are sold in Suva shops and in the market. The workmanship is fair to good. The price of the curios varies from 35 c for a spoon to \$30 for a cured hawksbill carapace. The demand for tortoise shell jewellery is growing because of the ever increasing numbers of tourists in Fiji. Green turtle meat is sold in the market but there is no steady supply. Red meat sells for about 30 c per lb and is considered a delicacy. Green turtle steak is available sometimes in the first-class hotels. It costs approximately \$2.50 per plate.

As of 10 September 1969, export of turtle shell (all species) is proscribed unless a special permit is obtained from the Director of Fisheries. The reason for this is to encourage locals to make shell curios. A tourist, however, can still buy a complete shell in the Suva market. Up to the time of writing this report most shell was exported to Japan. Green turtle shell (both carapace and plastron) was sold at \$1.85 per lb. Hawksbill shell was \$5 per lb. Locally, the shell is usually separated into thick shell (hawksbill carapace), thin shell (green carapace), "hoof" (posterior marginal scute of both green and hawksbill) and "belly" (plastron of both species). Until the time of the new 1969 ordinances, the total weight of hawksbill shell which could be exported in any one year was set at 500 lb. In 1969, 302 lb of turtle shell was exported of which 193 lb was hawksbill. In 1968, 593 lb of shell was exported of which 172 lb was hawksbill.

The present legislation and proposed legislation in Fiji is as follows:-

PRESENT LEGISLATION

Spearing of Turtle 9. No person shall harpoon any turtle unless the harpoon is armed with at least one barb of which the point projects not less than  $3/8$  inch from the surface of the shaft, measured at right angles to the long axis of the shaft.

20. No person shall at any time dig up, use, take or destroy turtle eggs or any way molest, take or kill any turtle the shell of which is less than 18 inches in length. No person during the months of January, February, November or December in any year shall in any way molest or take or kill any turtle of any size. This regulation shall not apply to turtles kept as pets or in aquaria.

PROPOSED LEGISLATION

Spearing of Turtle 13. No person shall harpoon any turtle in the inland or territorial waters unless the harpoon is armed with at least one barb of which the point projects not less than  $3/8$  of an inch from the surface of the shaft, measured at right angles at the long axis of the shaft.

Turtle 25. (1) No person shall at any time dig up, use, take or destroy turtle eggs of any species or in any way molest, take or kill any turtle the shell of which is more than 35 inches in length. No person during the months of January, February, November or December in any year shall in any way molest or take or kill any turtle of any size. This regulation shall not apply to turtles kept as pets or in aquaria.

(2) No person shall be in possession of, sell, offer or expose for sale or export any turtle shell the length of which is greater than 35 inches.

(3) No person shall in any way molest, take, kill or be in possession of the species Dermochelys coriacea (Leatherback Turtle) of any size at any time.

### 9.3 Recommendations

- (i) The newly proposed turtle ordinances should be passed.
- (ii) As a great deal of scattered information exists and as the Fiji group includes about 200 uninhabited islands, the consultant recommends a long-term project to map out nesting and feeding areas. Emphasis should be placed on delineating the season of nesting (by species) and upon feeding behaviour. With regard to the latter, divers (there are many to be found in the Fiji Islands) should set up experiments to elucidate the amount of turtle grass eaten per unit time and to determine primary and, if possible, secondary productivity of the turtle flats. The physical parameters of the grass pastures should also be studied. This work is basic to turtle mariculture. A few significant references concerning the biology of and productivity of turtle grass communities can be found in Hoese and Jones (1963, Seasonality of Larger Animals in a Texas Turtle Grass Community; Publ. Inst. Marine Sci., Texas, vol. 9, p. 37-46) and in Randall (1965, Grazing Effect on Sea Grasses by Herbivorous Reef Fishes in the West Indies, Ecology, 46:255-260). Such projects would seem appropriate for students in the University of the South Pacific as well as for the U.S. Peace Corps Volunteers and for Volunteers Service Abroad. Biologists in the School of Natural Resources, the University of South Pacific, are willing to cooperate on turtle matters.
- (iii) A tagging programme is recommended. This would help clarify whether turtles feeding in Fijian waters also nest in Fiji. The cooperation of the local chiefs must be obtained for this project.
- (iv) If for some reason turtle research in Western Samoa is unpractical (see section 5. Western Samoa), then such research is recommended to be carried out in Fiji. Facilities and personnel are available in Fiji to carry out the experiments described in the Western Samoa section as well as those given in (ii) above.

## 10. CONSOLIDATED RECOMMENDATIONS

- (i) A succinct "Turtle Field Manual" for fishery personnel should be prepared. This manual should emphasize marine turtle identification, conservation and management. Preparation of such a manual would probably take an expert from four to six months. The texts and publications listed in Appendix 5 may serve as a starting place in the compilation of this guide. It is recommended that one of the following two scientists might be asked to prepare such a manual (Dr. Archie Carr, Department of Zoology, University of Florida, Gainesville, U.S.A. or Dr. John Hendrickson, Department of Biological Sciences, University of Arizona, Tucson, U.S.A.). A draft outline of the "Manual" has been submitted to FAO for consideration. (See Section 2.1 Tucson).
- (ii) Rose Atoll should be declared a fully-protected nature reserve. It is an important breeding ground for two species of marine turtles (hawksbill and green). It is now uninhabited and should remain so. The atoll is currently "protected" by the Government of American Samoa. No further protection is required except to disseminate the information that Rose Atoll is "protected". In this regard, Rose Atoll would remain a breeding nucleus for sea turtles in the South Pacific in much the same way that Aldabra Atoll is now a fully-protected breeding reserve in the western Indian Ocean and as Ascension Island in the South Atlantic.

Because of its protected status, its isolation and its relative ecologic simplicity, Rose Atoll would make a good site for an ecosystem study. The aid of the following organizations should be solicited in this regard: British Royal Society, U.S. National Academy of Sciences, U.S. Smithsonian Institution and the International Biological Programme. (See Section 6. American Samoa)

- (iii) As there may still be reasonably large turtle populations in French Polynesia, a thorough four-month (October-January) nesting census and tagging study should be conducted on Scilly Atoll. Nesting densities on Mopelia and Bellinghausen should also be checked during the same period. On Scilly, emphasis should be placed on stock assessment and tagging. The consultant believes that Mr. Jean Tapu (Fishery Assistant in Papeete) and one local man on Scilly could census the turtle populations and tag the turtles. The Fishery Department in Papeete could supply the local manpower, boats and gasoline for the field work. They may also be willing to supply some camping and cooking equipment, wire and hardware cloth for hatchery fencing and lumber to build a few retaining pens.

If predation on eggs and hatchlings is high, then a local counterpart should be trained in the establishment of an egg hatchery. This would ensure that the maximum number of hatchlings reaches the sea. A turtle expert (or graduate student) would be needed to provide the expertise in the egg hatchery programme. The expert should have a working knowledge of French. In addition to expertise, outside help would be required in purchasing turtle measuring and tagging equipment, turtle tags (1 000 inscribed and numbered) and reference books (see Appendix 5). The approximate cost for a four-month turtle survey, including the services of an expert and the establishment of an egg hatchery would be about \$7 500. The World Wildlife Fund might be interested in supporting a project such as this, at least in part.

- (iv) A series of small-scale turtle-rearing experiments should be conducted in Western Samoa. This kind of work is needed because there are still some basic biological problems to be worked out before large-scale turtle farming or restocking can achieve any form of commercial success.

The experiments which should be undertaken are described in the body of this report (See Section 5. Western Samoa) and some are briefly reiterated here: (1) to determine if penned females would lay eggs on artificial beaches and determine the viability of such eggs, (2) to determine optimal complement of hatchery eggs, (3) to study growth rates in captivity on different foods, (4) to determine optimal age (or size) at which to release hatchlings, (5) to develop a method of marking and sexing hatchlings.

Physical facilities for pilot rearing experiments are available in Western Samoa. Auxiliary manpower is readily available in the form of the U.S. Peace Corps Volunteers. Most of the experiments described above could be carried out under the supervision of local fishery officials and by correspondence with turtle experts. Site visits of one week duration by turtle experts may be required once each year after the research is in full operation.

Extra-territorial help needed immediately includes laboratory equipment (scales, microscope, dissecting equipment, thermometers, aquaria, reference books), pump (for filling saltwater tanks), feed and fencing.

The consultant believes that the work outlined above could also be successfully undertaken in the Fiji Islands (but at a slightly higher initial cost because of the lack of physical facilities at the present time). (See Section 9. Fiji Islands)

- (v) In order to provide base-line data for turtle mariculture, the turtle grass pastures in Fiji should be studied. Major emphasis should be placed on studies of primary and secondary productivity (the following papers should be scrutinized for comparative purposes: Burkholder et al., 1959, Some chemical constituents of turtle grass, Thalassia testudinum, Bull. Torrey Bot. Club, 86:88-93; Westlake, 1963, Comparison of plant productivity, Biol. Rev. 38:385-425; and the two articles cited in this report, page ). Studies should also be conducted on (1) the physical parameters of the pasturage, i.e. what makes a good turtle feeding pasture, (2) surveys should be made on zooplankton in pastures since the green turtle hatchling is a carnivore for the first few months of life, and (3) underwater studies should be made on feeding behaviour because data are still lacking on such basic things as the amount of vegetation eaten by unit of time.

There are thousands of hectares of turtle grass pasture around the world which could be utilized by mariculturists provided base-line data such as that enumerated above are available. In order to start on a programme of this nature, a turtle expert is needed in Fiji and in this regard the following scientists might be contacted:

Dr. Archie Carr, Dept. of Biology, University of Florida, Gainesville;  
 Dr. John Hendrickson, Dept. of Biological Sciences, University of Arizona, Tucson; Dr. Robert Bustard, R.S.B.S., P.O. Box. 475, Canberra City, ACT 2601, Australia. Immediate equipment needs include the following: motorized boat, bomb calorimeter, underwater camera, thermometers, depth gauges, Secchi discs, salinity hydrometers, conductivity metres, nylon seines, bottom dredges, Nansen bottles, aquaria and wire fencing - approximate cost, U.S. \$10 000.

Fishery expertise is already available in the Fishery Department in Suva. Scientific expertise (in primary productivity work) is available in the Department of Natural Resources, University of the South Pacific. There is plenty of manpower available in the form of U.S. Peace Corps Volunteers and the New Zealand Volunteers for Service Abroad and many of these Volunteers have had extensive experience in marine biology. The turtle work outlined above would also make excellent research projects for students at the University of the South Pacific. There are also many local divers who possess a wealth of information on the natural history of turtles. (Fishery officials in Suva can make these contacts.)

Scientific expertise, as well as financial help, should be solicited from the International Biological Programme (IBP) which has, as one of its major goals - productivity of marine ecosystems. The U.S. Ford Foundation as well as the Rockefeller Foundation may be interested in supporting a turtle programme of this kind, especially if it is partly connected with the University.

Although some extensive turtle grass pastures were discovered in Tonga and conceivably the work described above could be conducted in Tonga, Fiji is considered as the better site mainly because of the scientific expertise available at the University of the South Pacific and the presence of an active fishery department and a good herbarium in Suva.

- (vi) There seems to be a lack of interest in turtle management in New Caledonia at the present time. This may result from the fact that the marine resources of the area are relatively unknown. Therefore, basic studies such as the following are recommended:
- (a) distribution of turtle questionnaires to the fishermen.  
(The questionnaire already made up by SPIFDA is adequate.)
  - (b) survey of nesting grounds off the northern and southern extremities of the main island.

Immediate needs include a turtle biologist or graduate student, to make the necessary surveys of nesting concentrations. Concomitant with this should be a tagging project. Evidence indicates that most nesting in New Caledonia occurs in December and January. Therefore this project is mainly in need of a biologist on an assignment of two months, and some tagging equipment. The investigator should have a working knowledge of French. Transportation should be available from SPIFDA headquarters in Noumea.

APPENDIX 1 -- ITINERARY

Monday, 7 September	1130	Departed Salt Lake City
	1310	Arrived Tucson
Friday, 11 September	0730	Departed Tucson
	1210	Arrived Honolulu
Thursday, 17 September	1415	Departed Honolulu
	1940	Arrived Papeete
Sunday, 27 September	2130	Departed Papeete
	2335	Arrived Pago Pago
Monday, 28 September	1030	Departed Pago Pago
	1115	Arrived Apia
Wednesday, 7 October	0900	Departed Apia
	1000	Arrived Pago Pago
Thursday, 8 October	1500	Departed Pago Pago
	1600	Arrived Apia
Sunday, 11 October	1430	Departed Apia
Monday, 12 October	1720	Arrived Nadi
Tuesday, 13 October	1130	Departed Nadi
	1325	Arrived Noumea
Monday, 19 October	1500	Departed Noumea
	1800	Arrived Nandi
	1830	Departed Nandi
	1915	Arrived Suva
Wednesday, 21 October	0730	Departed Suva
	1030	Arrived Tonga
Thursday, 5 November	1540	Departed Tonga
	1650	Arrived Suva
Thursday, 12 November	1000	Departed Suva
	1330	Arrived Nandi
Wednesday, 18 November	2045	Departed Nandi
	2300	Arrived Noumea
Monday, 30 November	1450	Departed Noumea
	1730	Arrived Nandi
Tuesday, 8 December	1035	Departed Nandi
	1330	Arrived Noumea
Thursday, 10 December	0800	Departed Noumea
	1100	Arrived Nandi
	2305	Departed Nandi
	0800	Arrived Honolulu
Monday, 14 December	1145	Departed Honolulu
	1800	Arrived Los Angeles
Tuesday, 15 December	1100	Departed Los Angeles
	1400	Arrived Salt Lake City

APPENDIX 2 -- PERSONS INTERVIEWED

TUCSON	Dr. John Hendrickson, Professor of Biology, University of Arizona, Tucson
HAWAII	Mr. Paul Breese, Division Fish and Game, Honolulu Mr. Daniel Woodside, Division Fish and Game, Honolulu Dr. Kenji Ego, Division Fish and Game, Honolulu Mr. Joe Daniels, Deputy Warden, Fish and Game, Maui Mr. Lowell Thomas, Retired News Commentator Mr. Eugene Kridler, Chief, U.S. Bureau Sport Fisheries and Wildlife, Hawaii Branch Dr. Max Doty, Professor, Dept. Botany, University of Hawaii, Honolulu Mr. Bruce Allender, Grad. Student, Dept. Botany, University of Hawaii, Honolulu Mr. Wayne Collins, Vice-President, Oceanic Foundation Dr. John Randall, Bishop Museum, Honolulu
TAHITI	M. Pierre Angeli, Governor, Tahiti M. Jacques Drollet, Directeur de l'Ecole de Tipaerui, Papeete M. Sixte Stein, Director of Fisheries, Tahiti, French Polynesia M. Jean Tapu, Technical Agent, Fisheries Dept., Tahiti M.L. Lenoir, Chief, Dept. of Planning, Tahiti
WESTERN SAMOA	Mr. William Travis, Fisheries Adviser, Govt. Western Samoa Mr. William Hussey, Regional Representative, UNDP, Apia Mr. Michael Priestley, Secretary, UNDP, Apia Dr. Judith Huntsman, U.S. Scientist, Tokelau Islands Mr. Karanita Enari, Secretary to Government, Apia Mr. Ed Slaven, Director of Peace Corps, Western Samoa Mr. Fili Suafo'a, Fishery Assistant Mr. Al Banner, Peace Corps Volunteer Mr. Alan Bergquist, Peace Corps Volunteer Mr. Mat Mudd, Peace Corps Volunteer
AMERICAN SAMOA	Dr. Stanley Swardloff, Director, Dept. Fisheries, American Samoa

NEW CALEDONIA

Mr. J.A. Tubb, Director, SPIFDA  
 Mr. V.T. Hinds, Co-Director, SPIFDA, Fisheries Officer,  
 SPC  
 Dr. R. Catala, Director, Noumea Aquarium  
 Madame R. Catala, Co-Director, Noumea Aquarium  
 Mr. K. Muller, Manager, Turtle Club, Ile Ouen  
 Mr. J. Eude, Director, Maritime Services

TONGA

H.M. Taufa 'Aha'u Tupou IV,  
 King, Kingdom of Tonga.  
 Mr. Ve 'Ehala, Governor, Ha 'apai  
 Mr. John Pittman, Director,  
 Dept. of Agriculture, Nuku 'alofa  
 Mr. Tom Simiki,  
 Senior Agricultural Officer, Nuku 'alofa  
 Mr. David Fusimaloki, Hirth's counterpart  
 Mr. Don Maculsay, PCV in Agriculture  
 Mr. Jack Riechelmann, Boat owner and  
 Manager of Beach House, Nuku 'alofa  
 Mr. Manu Mapuaho,  
 Merchant and Turtle fisherman, Nuku 'alofa  
 Mrs. June von Donop, Manager, Crayfish  
 Project, Ha'apai  
 Mr. Puiati Lofa, employee, Agriculture Dept.  
 Mr. Saulala Mapi, Publications Officer,  
 Agriculture Dept.  
 Mr. Taimani, Craftsman, Hawksbill jewellery  
 Nuku 'alofa.  
 Mr. Moeaki, Craftsman, Hawksbill jewellery  
 Nuku 'alofa  
 Mr. Lowell Williams, ex-PCV, living on Tongatapu

FIJI ISLANDS

Mr. Albert E. Adams, Director, Fisheries Dept.,  
 Suva  
 Mr. B. Vunibobe, Director, Agriculture Dept., Suva  
 Dr. John Parham, Botanist, Agriculture Headquarters,  
 Suva  
 Mr. John Spottiswode, Fisheries Officer, Suva  
 Mr. Robert Stone, Fisheries Advisor, Suva  
 Dr. John Glude, SPIFDA, oyster expert

Dr. Ray George, SPIFDA, crayfish expert  
Mr. David Owen, PCV, Suva and Kadavu  
Mr. Al Bahner, PCV, Suva and Lambasa  
Prof. A. Clapham, Dean, School of Natural  
Resources, University of South Pacific, Suva  
Dr. Peter Beveridge, Director of General  
Studies, University of South Pacific, Suva  
Mr. Rob Wright, Merchant and Diver, Suva  
Mr. J.E. Costello, Manager, Beachcomber Cruises,  
Lautoka  
Mr. Eliko Vatuloka, Senior Fisheries Officer,  
Lautoka  
Mr. Joe Tuitai, Captain of Fishery Vessel  
Davui, Lautoka  
Ratu Semisi Rabusou, Chief, Viwa Village  
Samuela Bolaca, Head Fisherman, Viwa Village

APPENDIX 3

QUESTIONNAIRE ON MARINE TURTLE RESOURCES OF THE PACIFIC

Following are some general and some specific questions concerning the marine turtles and the turtle fishery of your area. It would be greatly appreciated if you would answer these to the best of your ability, keeping in mind the fact that we know in advance it will not be possible for any one set of questions to fit the particular circumstances of any one person or any one area. We need all the information we can get, so please feel free to modify the questions to suit your own situation, if this will help. Also, please add any additional information which does not seem to be called for here, but which you think might be of interest. In return for your cooperation, we will send you a report on the general findings of this inquiry and will undertake to refer on to an authority any questions which you may have concerning marine turtles. Please feel free to use the reverse side of the paper or add additional sheets.

1. Area covered by this response:
2. Name, address and position of Reporter:
3. Do marine turtles occur in your area?                      What kinds?
4. Do they nest in your area?
5. Indicate any nesting sites of particular importance.
6. Any particular concentrations other than around nesting beaches?  
(Please locate such areas.)
7. If nesting occurs, is it seasonal?  
When does the season begin?  
When does it end?  
What would you estimate as the peak of the nesting season?
8. If no nesting in your area, any knowledge or suspicion of where local turtles go to nest?
9. Are there any persons or companies specializing in turtles?  
  
Can you give either figures or estimates of the volume of their business?  
  
Any other pertinent information?

10. Can you give any information on how turtles are captured in your area (nets, gigging, capture of nesting females, etc.)?
  
11. If turtles are captured in the water, can you give any indication of average size?  
  
Smallest sizes?  
  
Largest sizes?
  
12. Do you have clear knowledge of special turtle feeding grounds in your area?  
  
Where?  
  
Any estimates of abundance?  
  
Seasonal or year-round?
  
13. Are there any prejudices against killing or eating turtles or their eggs?
  
14. Are there any local laws or customs which tend to give any protection to sea turtles or their nests?
  
15. Do you have any particular recommendations on how one might best proceed to get accurate information on the local turtle populations and the size of the annual harvest?

APPENDIX 4. LIST OF ALGAE FOUND IN WESTERN SAMOA

- Ref. 1. Lecture by Mr. Drumgoole (Botany Dept. of University of Auckland)
2. Samoan and Scientific Names of Plants Found in Samoa, compiled April, 1935 by E.H. Bryan (curator of Bernice P. Bishop Museum) for the Governor of American Samoa
3. Pratts Grammar Dictionary
4. Samoan Dictionary by G.B. Milner

<u>Samoan Name</u>	<u>Scientific Name</u>	<u>Eng. Common name/or description</u>
limu-tai		general name of algae
limu		general name for lichens, algae sea-weeds, river weeds, river weeds and mosses
limua'a		a seaweed (Pr.)
limu a'aea		a seaweed (Pr.)
limu'ava		edible seaweed (Pr.)
limu'ula		edible seaweed (Pr.)
limu fuafua	<u>Caulepa oalvifers</u> (CHLOROPHYTA - green algae)	edible small green sea alga
limu lupani		
limu mea	<u>Usnea articulata</u> Hoffu	
limu lauago		a seaweed (Pr.)
limu laumei		a seaweed (Pr.)
limu lau taliga		a seaweed (Pr.)
pa'a taliga	<u>Halimeda</u> sp. (CHLOROPHYTA -green algae)	green alga aids information of coral sand
limu limu		detached seaweed; duck-weed (Pr.)
limupata		a seaweed (Pr.)

limu sa		a seaweed (Pr.)
limu taemoa		a seaweed (Pr.)
limu tala	<u>Sargassum anapense</u> (PHAEOPHYTA = brown algae)	gulf-weed in rock pools
limu to'o		a seaweed (Pr.)
limu vai		fresh water algae
limulimu 'ula	<u>Trentepohlia aurea</u>	orange coloured felt like alga found on trunks of bread-fruit trees, and other trees
punau	<u>Dictyosphaeria versluysia</u> (CHLOROPHYTA = green algae)	

Algae identified by Mr. Drungoole

RED ALGAE

	<u>Halymenia</u>	
	<u>Gracilaria</u>	
	<u>Achtinotchia</u>	
	<u>Lithophyllum</u>	
ma'ave	<u>Lithothamnium</u>	bushy coralline algae (Kr.)
	<u>Melobesia</u>	
	<u>Centroceras</u>	
	<u>Chronidris</u>	(very useful for eliminating <u>Ascaris</u> , a round worm found in the intestine of man and pigs)

(some red algae contain algin for stabilizing ice cream etc.)

GREEN ALGAE

Enteromorpha  
Rhizocolonium  
Rotyosphaeria  
Valonia  
Halimeda  
Caulepa

BROWN ALGAE

Turbinaria (the brown pigment outside appears brown but when turbinaria is put inside hot water the Fucoxanthium (= brown pigment) is dissolved and the green colour appears, due to Phyococynium (= green pigment))

Padina  
Pocockeilla  
(Halopteria)

(FLOWERING PLANTS GROWING IN THE SEA)

limu-limu (Mil.)

Halophilia ovalis Hook (aquatic plant growing  
on sand of sea (Mil.))

Rhizome

Posidonia

grass-like

D. Garlovsky  
28.4.70

APPENDIX 5. BIBLIOGRAPHY - MARINE TURTLE PUBLICATIONS

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