Sea Turtles of Fiji

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Foreword

The South Pacific Regional Environment Programme has been running a Regional Marine Turtle Conservation Programme (RMTCP) since 1990. The overall aim of the Programme is:

> *"To conserve marine turtles and their cultural, economic and nutritional values for the coastal peoples of the countries served by the South Pacific Regional Environment Programme".*

The RMTCP has resulted in projects for information exchange, management-related research, recognition of traditional knowledge, conservation measures and education and publicity. Countries involved have included Federated States of Micronesia, Fiji, French Polynesia, the Marshall Islands, New Caledonia, Palau, Papua New Guinea, the Solomon Islands and Vanuatu. Implementation of the Programme has been made possible by the kind assistance of the Canadian and Australian Governments.

The information in this report was obtained during research carried for a Master of Science degree at the University of the South Pacific in 1979-1980. While the project was never completed, it is evident that a great deal of valuable information was obtained.

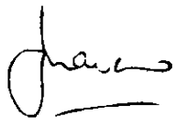
The value of Mr Guinea's work was recognised during the course of the Second Meeting of the South Pacific Regional Marine Turtle Conservation Programme in Noumea in 1991. A formal Resolution on Information in Fiji turtle Conservation was passed at that Meeting as follows:

> ***Recognising** that Michael Guinea surveyed the distribution of marine turtles in Fiji in the late 1970s, using his own resources;*
>
> ***Noting** that little detailed data on the distribution of marine turtles in Fiji is available in published form;*
>
> *The Steering Committee of the Regional Marine Turtle Conservation Programme:*
>
> ***Invites** Mr Guinea to submit a formal report of his Fiji turtle surveys to SPREP for consideration for publication.*

This report is the result of that resolution.

While the views expressed in this report do not necessarily reflect those of either SPREP or the Fijian Government, I would like to congratulate Mr Guinea on his contribution to the sum of knowledge about marine turtles in Fiji.

Publication of this document has been funded by the (then) International Centre for Ocean Development (ICOD) of the Canadian Government, to which we give many thanks for its continuing support for the RMTCP.



Vili Fuavao

Director

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Abstract

Three species of sea turtle nest in Fiji. In order of abundance they are the Hawksbill or **taku** (*Eretmochelys imbricata*); the Green or **vonu dina** (*Chelonia mydas*) and the Leatherback (*Dermochelys coriacea*). Two other species, the Loggerhead or **tuvonu** (*Caretta caretta*) and the Olive Ridley (*Lepidochelys olivacea*) are known from the region but there are no records of their nesting. Aerial surveys indicate that Hawksbill turtles nest widely throughout the Fiji Islands, but Green turtles nest only on the islands of the Ringgold and Heemskercq Reefs in Northern Lau. Leatherbacks nest sporadically on the Natewa Peninsular.

Many more turtles were killed for the market than nested during the time of the survey. Sea turtle harvesting has been relatively unchecked for over one hundred years. Recruitment to feeding grounds is believed to come from other Pacific countries.

Effective conservation measures are required and recommendations include that Leatherbacks be completely protected; existing legislation be enforced; the Heemskercq and Ringgold Reefs and their islands become sea turtle sanctuaries; land owners prohibit the removal of turtles from the islands and reefs under their control; and the Fiji Government seek international assistance in initiating sea turtle conservation programmes within the country.

Introduction

The Country

The islands of Fiji are scattered between 15°S and 21°S, and straddle the meridian from 175°E to 177°W. The island of Rotuma (12°S, 177°E), although politically a part of Fiji, sits outside the area addressed by this study. The number of islands and islets number about 800 of which about 100 are inhabited (Clunie, 1984). The extent of human settlement is controlled by geological and climatological factors, however resources such as copra, fish, clams, trepang, sea turtles and birds and their eggs determine the timing and duration of any temporary habitation of islands too small to support permanent human occupation.

Viti Levu and Vanua Levu are the major islands and contain the majority of the 18,270 sq km land area (UNEP/IUCN, 1988). The summer months (December to February) are hot (mean monthly temperature = 27 °C) and wet. July and August are the cooler months (mean monthly temperature = 23 °C). The annual rainfall is unevenly distributed due to the rain shadow effect of the mountains on the larger islands. The prevailing winds are from the South-East and rainfall is usually around 3,000 mm per year on the southern and eastern sides of the higher islands. The tides are semidiurnal in that two cycles occur in approximately twenty-four hours. The maximum tidal range is 2.1 m.

Fijian Orthography

Spelling follows conventional Fijian standards (Derrick, 1951; Parham, 1972; Clunie, 1984). Although anglicised spellings appear on some Fijian maps, the names of animals, plants, places and objects referred to herein are given in Fijian spelling without phonetic emphasis but in bold type. The vowels are pronounced similar to those in German, Spanish and Italian and the consonants are pronounced as follows:

b is pronounced as mb as in timber e.g. Nukubalati is pronounced as Nukumbalati.

c = th *in mother, e.g. Laucala = Lauthala*

d = nd *in tender, e.g. Nadi = Nandi*

g = ng *in singer, e.g. Nagara = Nangara*

q = nng *in hunger, e.g. Qamea = Nngamea.*

Historical Overview

Fijian culture is rich with references to sea turtles. The practice of turtle calling is still a feature of village life on Koro and Kadavu. Turtle motifs are featured in wood carvings and utensils (Derrick, 1974). Captain James Cook named the island of Vatoa "Turtle Island" in 1774, showing that sea turtles were abundant at that time. Vatoa has been identified as a major turtle rookery (Parsons, 1962). However, there was no indication from Cook's journal of this. It is believed that the name "Turtle Island" arose because of the numbers of turtles seen on the reef (Derrick, 1974, 33).

During the 1800s, the island of Vomo was renowned for its tortoise shell (Parsons, 1962). The tortoise shell trade had started by 1819 and grew steadily with tortoise shell adding to the export of Beche-de-mer and sandalwood (Turbet, 1942). In 1840, the *Glide* took on 300 lb of tortoise shell collected in little over a month. By 1866 tortoise shell ranked amongst the top five of Fiji's exports and in that year was worth £1,000 to the country (Derrick, 1974).

By the 1940s, Fiji had not only a thriving tortoise shell export industry but also a cottage industry which carved and fashioned the shell for toilet sets, cigarette cases, jewel boxes and numerous other articles including saltspoons (Levey, 1942). After over a century of exploitation, the Government of Fiji imposed a closed season of four months from November to February to help protect sea turtle stocks (Levey, 1942).

Turtle farms or ranches were seen as a suitable strategy for the conservation of sea turtles in Fiji (Anon, 1970). The practice of keeping turtles in kraals, pens or landlocked lakes was well established in Fiji and turtle ranching had the potential to replenish natural stocks. Visits by consultants were limited in time, and despite the best intentions, they visited only a few localities (Bustard, 1970; Hirth 1971). The islands of the Heemskercq Reef were recognised as significant areas for Green turtle nesting and were proposed as turtle sanctuaries (Bustard, 1970).

Changes to the legislation were recommended to conform with neighbouring countries. These recommendations were made to protect nesting sized adults by having a maximum catch size limit of 35 inches (90 cm); and the complete protection of the Leatherback (Hirth, 1971).

The consensus was that Fiji's exploitation of sea turtles was out of proportion with its known breeding population. The amount of Green turtle flesh traded in the markets was around 45 tonnes in 1974 and 10 tonnes in 1979 (see Fig. 1). Little was known of the movement of sea turtles in the Pacific, and the major breeding sites were supplying Fiji's domestic market thought to be in the remote parts of the Fiji Group; Yasawa, Mamanuca or Lau Islands (Hirth, 1971).

Vast sea grass pastures of *Syringodium*, *Halodule* and *Halophila* are present in many parts of Fiji and should provide a plentiful amount of food for the Green turtle (Hirth, 1971). A small but significant (by Fiji's standards) nesting population of Green and Hawksbill turtles utilise Nanuku Levu and Nanuku Lailai on the southern end of the Heemskercq Reef (Bustard, 1970). Success in artificially hatching eggs (Raj, 1976) paved the way for proposals to initiate sea turtle farming in Fiji (Raj, 1977). An extensive bibliography on sea turtle biology was prepared (Singh, 1979) but little headway was made in establishing any programme. The island of Makodroga was listed as a possible reserve because of the sea turtles that nested there (Dahl, 1980).

This Study

This work represents 18 months of part-time research into the biology, exploitation and management of the sea turtles of Fiji, undertaken as a MSc project at the University of the South Pacific (USP) but abandoned because of: (a) the cost of travelling to the outer islands to investigate sea turtle nesting populations; (b) the lack of a suitable air craft at affordable prices to complete the aerial surveys; (c) the paucity of information about feeding populations near Suva; and (d) the difficulty of conducting aerial surveys during the summer months, which coincide with the cyclone season.

Aspects of this work have been made known to sea turtle researchers (Pritchard, 1982). However, enclosed is a compilation of data, references and correspondence on sea turtle biology in Fiji from 1979 to 1982, and other references and incidences that have come to my attention since 1982. The transcripts of the aerial surveys were prepared from voice recordings made during the flights, and indicate turtle nesting beaches and descriptions of the geomorphology, vegetation and sea birds abundance.

Aims of Project

The project was an investigation into the biology, exploitation and management of the sea turtles of Fiji. The project objectives correspond with the recommendations of Bustard (1970) and Hirth (1971), and complement sea turtle research in Fiji with that being conducted by Dr C. Limpus in Queensland and Dr G. Balazs in Hawaii.

1. To establish the status of known and presumed breeding species of sea turtle in Fijian waters.
2. To locate the major nesting beaches, mating areas and feeding grounds.
3. To ascertain the importance of sea turtles and eggs in the traditional village subsistence economy.
4. To determine the importance of sea turtles and their products as items of trade and income in urban regions of Fiji.
5. To elucidate the sub-population (stock) structure of sea turtles in the region.
6. To investigate the suitability of natural enclosures for turtle ranching programmes.
7. To compare the sizes of present populations with those indicated by historical accounts, and to determine the effectiveness of existing legislation.
8. To investigate the biology, physiology, genetics and ethology of sea turtles.

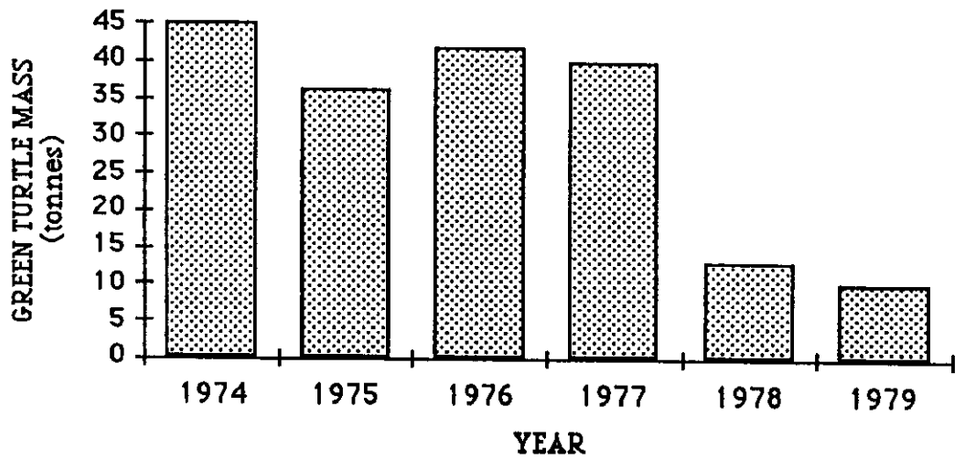


Fig. 1: The weight of Green Turtle meat sold through the municipal markets of Fiji, 1974 to 1979. (FAO Statistics)

Methods

Interviews were conducted in Suva with people who were familiar with Fijian waters and who had an interest in the biology of marine vertebrates. The results of these interviews indicated where field work should begin. The general consensus was that if undisturbed populations of sea turtles were to be found it would be on islands away from habitation.

Opportunistic trips were made with colleagues from USP to familiarise myself with Fiji and the protocol required to conduct surveys in villages, and to refine the resources and questions that were required for these surveys. On arrival at a locality, the villagers and/or owners of the island were interviewed using laminated colour photographs of sea turtles which illustrated aspects of their biology (see Annex 1). The photographs showed Green, Loggerhead, Hawksbill and Leatherback adults, some of which were nesting. Scenes of a beach covered with turtle tracks, hatchlings, subadults and an adult male were included. The photographs and comments on their use in Annex 2. The interviews sometimes resulted in trips to beaches where turtles were known to nest, but there were always discussions of feeding grounds and traditional and present-day exploitation.

Beach surveys of Namena, Nanuku Levu and Leleuvia were conducted on foot. Data were collected on the suitability of the beaches for turtle nesting and the extent of rocky outcrops and fringing reef. Evidence of sea turtle activity included tracks of nesting females, body pits, hatchlings or their tracks, emerged nests or the presence of feeding turtles off shore. Snorkel diving and a manta board towed by a boat were used to assess the number, species, size and, if possible, sex of the turtles using the feeding grounds in Suva Harbour.

Aerial surveys were made of Suva Reef, the Astrolabe Lagoon and the islands of the northern Lau Group (Annex 3). In each case the plane was flown at a height of between 60 to 150 m and about 100 m seaward of the beach at around 190 km/h. The Fiji Fisheries Department conducted several market surveys at the end of 1979 to establish the extent of sea turtle harvesting.

Results and Discussion

Legislation

The regulations relating to the methods of capture, minimum size, closed seasons and the sale of turtle shell are contained in the Government of Fiji's Fisheries Regulations:

"Part III: Prohibited Methods and Areas, para. 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.

"Part V: Size and Limits of Fish and Prohibitions, para. 20:

(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 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.

(2) No person shall be in possession of, sell, offer or expose for sale or export any turtle shell the length of which is less than eighteen inches. (Inserted by Regulation 8th June, 1966)

"Para 23:

No person shall export from Fiji-

(b) turtle flesh

(Fisheries Regulations 8 June 1966)"

The export of turtle shell has been banned since 1 January 1991 (Daly, 1991).

Few persons have been prosecuted under these regulations (Bustard, 1970). Although traditionally reserved as food for chiefs (Derrick, 1974), many Fijian citizens view sea turtles as of the common property. Taboos associated with transgressions into waters belonging to other villages seem not to dissuade modern day turtle hunters (or poachers). Many believe the law to be nonsensical as stories of mother turtles eating their own young when they enter the water are common (Levey, 1942). Although none of the people interviewed had observed it, many believed it to be true. This story is not a traditional story in Fiji and is believed to have originated since European contact (Steno Vueta, turtle fisherman, pers. comm. 1980). The story has no validity.

Fiji has excellent fisheries regulations in place which should provide protection to sea turtles during the nesting season, while allowing the sale of turtle flesh in provincial markets. The enforcement of the legislation leaves much scope for improvement as at the time of this study there was only one part-time fisheries inspector (Gentle, see p.10), and many remote localities lacked police enforcement altogether. Policing may have been effective in urban areas, but most sea turtle resources were located in remote localities which were plundered without fear of being reported or apprehended.

Researchers apprehensive about the plight of sea turtles in Fiji (Bustard, 1970; Hirth, 1971) urged that the legislation be enforced. The Fisheries Division was aware of the decline in sea turtle stocks and issued a memorandum (File No. 34/4/7) on 26 November 1975 to all Fisheries and National Marketing Authority (NMA) staff. The memorandum was from Dereck J. Robinson, Chief Fisheries Officer and stated;

"In the interest of turtle preservation it has been decided that the following rules should be followed by this Ministry

1. *Only Green Turtles may be taken. All other species should be protected.*
2. *The taking of turtles by chasing them until they become exhausted should be banned.*
3. *Taking turtle eggs is banned. Also certain nesting beaches should be protected.*
4. *No turtle with a carapace (shell) less than 45 cm (18") long or more than 90 cms (35") long should be taken. This is intended to protect over-small turtles and breeding turtles.*
5. *The season during which the taking of turtles is banned should be extended to stretch from October 1st to March 31st."*

It will be some time before these rules are included in Fisheries Law. In the meantime the NMA will follow the rules as if they were already law.

All staff should remember that NMA will not purchase any turtle which breaks these rules".

The overexploitation of Fiji's sea turtles and the need to implement scientific and educational programmes was addressed by a report to the Fisheries Division by Robert Stone (undated but assumed to be in 1971).

"The Turtle and Turtle Research in Fiji

During the last month (Dec., 1970) a turtle survey has been carried out to investigate,

(1) Turtle species occuring in Fiji,

(2) Nesting season,

(3) Nesting beaches and number of nests/beach,

(4) Presence identification and abundance of turtle grass, *Vutia sp.*

There appears to be 5 species of turtle nesting in Fiji. They are-

The Green: Vonu dina, *Chelonia mydas*,

The Hawksbill: Taku, *Eretmochelys imbricata*,

The leathery turtle: *Dermochelys coriacea*,

The loggerhead: *Caretta caretta*,

The Ridley: *Lepidochelys coriacea* (sic),

Of the 5 species the Green and the Hawksbill are easily the most common, the green turtle can be seen in September in large numbers at night in the passages around Suva where they sleep under the ledges. On the night of September 19th over 20 large greens were seen at night outside Namuka passage. The Hawksbill, although not seen at night can be readily seen during the day feeding just off the reef in about 5 fathoms of water.

The leathery and loggerhead turtle have been reported from Fiji but were not seen during the turtle survey. A Ridley was reported from the Great Sea Reef near Moli Passage on November 17th.

Nesting Beaches

Since the 1st week in November visits have been made to Islands that are known nesting beaches. These were Namena lala, Vatu-i-cake, Komo, Ogea, Mana, Tavarua, Islands of the Astrolabe lagoon and Namotu. On Vatu-i-cake two old hawksbill nests were seen and on Tavarua five nests were seen. Only one recent nest was seen on the 4th of December on Tavarua and this again was a hawksbill.

Islands where Hawksbill turtles are reported to nest, and were not visited are Caqalai, Leleuvia, Nasautabu, Nairi, Fulanga, Vatoa; the islets of Vanua Mbalabu (sic), Nanuku leve (sic) and Nanukulailai, Wailangilala; and islets off the Dreketi River - Naiviti, Vomo and Yabu. There is no doubt a large number of other islands, especially in the Lau and Mamanuca groups support Hawksbill nesting.

The Green turtle appears to be a little more elusive. It's nesting habits are more selective than the Hawksbill, preferring to nest on the beach rather than in the vegetation. Beaches that would permit Green turtle nesting need to be high and broad beach platform, so that the eggs will not get wet. This sort of beach is usually associated with high energy wave systems of the open ocean so that Islands where Greens nest are usually exposed and adjacent to deep Oceanic water e.g. Komo, Wailangilala, Nanuku lailai and Tavarua.

Nesting Season

From observations it appears that the nesting season begins early in December with a peak at the very end of December trailing off into January. Hatching no doubt occurs towards the end of January and during February.

Research

Initial research into the turtle population should be concentrated first on an assessment of the following factors·

(a) Green turtle nesting beaches in Fiji,

(b) The abundance, locality, relative biomass of the turtle grass pastures in Fiji.

(c) A tagging programme should be started immediately using turtle-tag pliers and tags already available and it is recommended that, a reward of $5.00 be offered for the return of tags.

Statements to this effect should be stamped on the tags (As a guide W. Samoa; Carribean, Arabia and other countries are already paying $5.00).

(d) SPIFDA will be used to co-opt the assistance of the consultative services of Hawaii's Bureau of Commercial Fisheries, blood testing group for the setting up of an Immunological tagging programme. Testing of blood groups of turtles will help elucidate sub-population structure of marine turtles in the South Pacific.

(e) An experiment turtle hatchery programme for restocking purposes should be commenced. Turtle eggs collected at Nanuku-lailai, or Tavurua could be transferred by boat to Matai (sic) or Nadi and flown by Fiji Airways to Nausori. A boat could pick the eggs up at Wainibokasi and transfer them to Makaluva (sic) where it is proposed to set up a turtle hatchery. Makaluva (sic) has the advantages of-

(1) Being an old turtle nesting beach,

(2) Uninhabited,

(3) Close to Suva,

(4) Close to deep water for release of turtle, and

(5) Near the University.

This would involve legislation to designate Makaluva (sic) as a sanctuary.

In conjunction with the Tuna programme and Oceanographic work on the eddy Structure formed behind oceanic islands all reports and observations on turtles, found should be measured, weighed and located. This will help world turtle research workers in their quest to discover more about the so called 'lost year' of the turtle.

In 1971 "Broadcast to Schools" should be run explaining the need for conservation and re-stocking of turtle populations. Emphasis should be placed on prohibiting the eating of turtle eggs and turning of nesting turtles on the beaches.

Pamphlets, (In Fijian and English and Hindustani) will be distributed to Fiji Marine boats, especially the light house tenders, and to the outlying Fijian schools, and fishermen emphasising conservation and the benefits of re-stocking.

The second phase will be directed towards schools in the Lau Group with the object of running re-stocking programmes. This could be done as part of a native study programme eggs will be transferred to a beach near the school, the hatchlings kept in shaded aquaria located on the beach and then released to the sea when a week or two old.

Robert Stone."

The above report urges the establishment of a turtle population on Makuluva. Although this is a commendable suggestion, Makuluva is a very dynamic island and has been subject to considerable erosion and change of position on the reef (Wright, 1969). This change in shape and position is dramatically indicated by photographs in Derrick (1957, 25 - Plate 1) and in 1979 (Plate 2). It would be unwise to try to establish a breeding population imprinted on to an island that has changed so much over several decades, and with the potential to disappear in the near future.

The island of Vuaqava in the Southern Lau Group had been linked with turtle farming and had the historical and cultural infrastructure to support the establishment of an experimental village-based turtle farming endeavour. The following is a transcript of an undated document made available by W. Travis of the Fiji Fisheries Division.

"Vuaqava Island Lake Turtle Project

Traditionally, Vuaqava island and its lake of sea water has been used as a place to keep turtles by the owners of the Island from the village on the larger island of Kabara nearby. Turtles have been put in the lake from time to time since 1925 and harvesting has taken place occasionally, the last one realising 85 large turtles. Turtles nest on the outer beach of the islands so that a supply of young turtles will be available each year.

It is felt that the lake which has no visible outlet but access from the sea so that tidal influence is regular could be used to produce commercial quantities of turtles. The Mataqali who owns the island is particularly keen on trying out growing turtles on a pilot scale to show that it is an economic proposition. The leader of the Mataqali has made representation over a period of about one year and fostered a strong interest among his people. With this kind of interest the opportunity to carry turtle culture to village level should be taken advantage of and there is every possibility of success.

Dr Raj of the University of the South Pacific who is conducting a turtle Project for the South Pacific Commission has an interest in supervising this village project and will be available for consultation to the villagers.

Objectives

1. To carry out an experimental transplant of young hatchling turtles to the lake at Vuaqava Island, providing them with initial care until a release stage is reached and then letting them free in the lake and maintaining a watch and record of their survival and growth.
2. To Keep records of costs and eventual returns from harvesting to evaluate economic feasibility.

Project Operations

1. A bure for the Project Leader, Mr. Vosa and watchmen would be built on the island in a strategic location near the lake.
2. Records would be made of the number of turtles already in the lake and other fauna and flora present.
3. A survey of the ecology of the lake would be made under the supervision of Dr. Uday Raj of USP who would act as consultant to the Project.
4. Sand would be brought from a seaward side of the island and a sandy beach constructed at the lakeside. This would be at least 20 metres long and 1m deep.
5. During the turtle season nests of turtles would be looked for on the seaward beaches of the island.
6. Some of the eggs would be taken from each nest as soon as possible after laying and buried in the sand of the lakeside beach. Some eggs would be left in each nest.
7. Visitors to the island would be allowed to land at one site only near the Leader's bure.

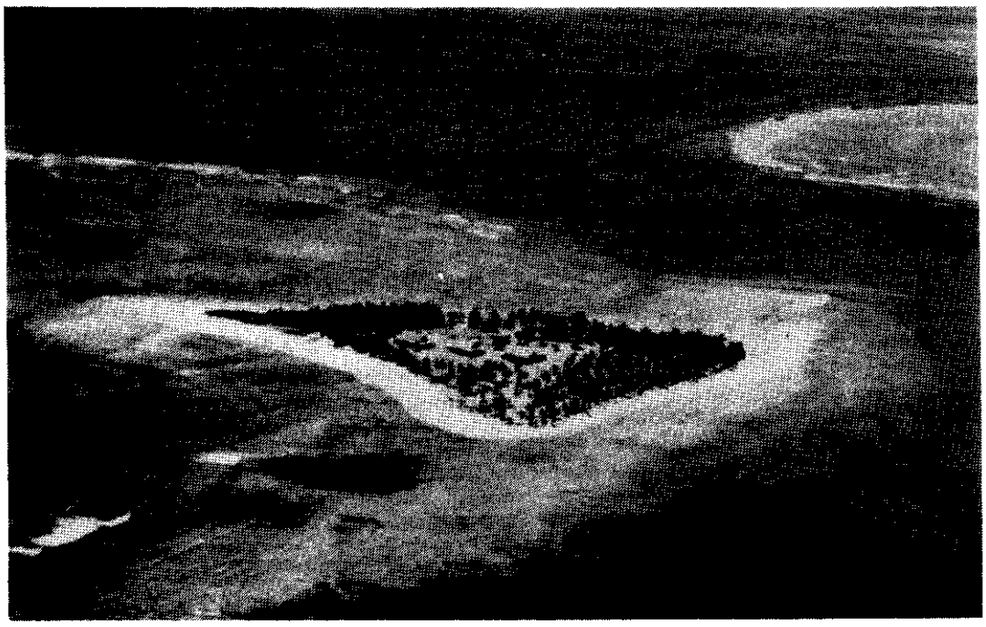


Plate 1: The island of Makuluva (Derrick 1957, 25).

Plate 2: The island of Makuluva in 1979. The island had changed in shape. The concrete structures are water tanks that were in the interior of the island in Plate 1.

8. The lakeside beach would have a wiremesh fence surrounding it so that the hatchling turtles would be protected or fed until they were large enough for release in the lake (15 cm long).

9. Hatching turtles would be fed on fish or shellfish obtained from nearby reefs by members of the project team at the lake.

10. Records of amount of food given daily and growth of the turtles each week would be kept; also a record of the survival and total harvest in 3 years.

11. Costs involved in the operation of the project would be recorded and audited.

12. A report to Government and funding agency would be made available at the end of the project.

13. A yearly stock of about 1,000 turtle hatchlings would be added each year developing techniques of handling.

14. Harvesting of three year olds would be done at the end of the project.

Project Costs

Salaries	*Total*
Project Leader (Mr. Vosa) 36 m/m @ $2,400 pa	$7,200
Village headman 36 m/m @ 1,040 pa	$3,120
5 villagers 36 m/m $780 pa = $3,900 pa	$11,700"

The project was not successful in attracting funding and did not go ahead.

The need for conservation of the sea turtles in Fiji was raised again in 1979 with a plan of action being prepared by Mr Mark Gentle who was a South Pacific Commission (SPC) consultant with the Fiji Fisheries Division. Mr Gentle's plan (below) was not implemented.

"Turtle Conservation in Fiji: A Plan of Action

Present Conservation Measures

Marine turtles in Fiji are given legal protection by the fisheries Regulations which specify: (As seen on page 5 in this report)

In addition Hirth in his 1971 report recommended *maximum size* restrictions of 35 inches and proposed the complete protection of the leather back turtle. His suggestions have never been enacted into law.

Excellent though these regulations are on paper, they are not enforced, and (as noted by Bustard) they are openly flouted. Moreover there *is* no way to enforce the regulations since there is only one part time fisheries inspector in the whole of Fiji and no police at all on any of the remote islands where turtles nest. Although no survey of turtle stocks has ever been carried out in Fiji, there is no doubt that the stocks have declined to the point where they now face imminent extinction.

Proposed Conservation Measures

The following ideas are put forward as *practical steps* towards the conservation of turtles:

(1) *A programme of public education*

Simple clear information about turtles should be made available to all schools in the outer islands. It is suggested that, as a first step, an informative and eye-catching wall poster be produced. A comic strip format would probably be best since it would appeal particularly to children. Captions would be in Fijian.

Radio broadcasts should be prepared both for schools (in "the World We Live In" series for classes 5-6 and the "Current Events" series for classes 7-8) and for adults in the "Rural Magazine" programme (broadcast in all languages). Information on turtle conservation might be incorporated in the proposed "Archers" - type family drama educational serial.

(2) *Collection of Basic Biological Data*

An aerial survey of nesting beaches during the breeding season should be the ultimate objective of ecological research. Regrettably there seems little prospect of such work being carried out in the near future. However many hundreds of turtles are bought and sold every year by the National Marketing Authority, yet no data of any kind are at present recorded. It is proposed therefore that a standardised system of data collection be instituted without delay in each of the main centres. It is proposed that this work be carried out by Fisheries Division market survey staff, under the guidance of Mr Michael Guinea of USP.

(3) *Egg Farming*

Egg farming may be a means of augmenting turtle stocks. However, any decision about the value of such projects should await a scientific evaluation of the results of the egg farm now in operation in Western Samoa. A detailed report on this project by Mr W. Travis will be presented at the SPC Turtle Workshop in November. The advice of turtle specialists will be sought at this time.

M.T. Gentle
SPC Consultant Marine Biologist
29 August 1979"

The above correspondence reveals that the Fisheries Division of Fiji were aware of the lack of knowledge regarding the biology of sea turtles in Fiji but were ineffective in gaining funding for surveys into their size and population dynamics. The spiritual and cultural values of sea turtles were not translated into a reluctance to purchase their meat from the markets. The significance of sea turtles to Fijian people has been poorly documented. The following is a collection of comments and references that have been bought to my attention.

Folklore of Turtle Calling

The custom of turtle calling at the village of Namuana on Kadavu is based on an ancient legend which is still passed down from father to son.

"Many, many years ago in the beautiful village of Namuana, there lived a very lovely princess called Tinaicaboga who was the wife of the chief of Namuana village. Tinaicaboga had a charming daughter called Raudalice and the two women often went fishing on the reefs around their home.

On one particular occasion, Tinaicaboga and Raudalice went further afield than usual and waded out on the submerged reefs which jut out from the rocky headland to the east of the bay. They became so engrossed with their fishing that they did not notice the stealthy approach of a great war-canoe filled with fishermen from the nearby village of Nabukelevu. This village is situated in the shadow of Mount Washington, the highest mountain on Kadavu Island.

Suddenly the fishermen leapt from their canoe and seized the two women, bound their hands and feet with vines and tossed them into the bottom of the canoe and set off in great haste for home. The cruel warriors from Nabukelevu were deaf to the pleadings and would not listen to the entreaties of the women.

The gods of the sea, however, were kind and soon a great storm arose and the canoe was tossed about by the huge waves which almost swamped it. As the canoe was foundering in the sea, the fishermen were astounded to notice that the two women lying in the water in the hold of the canoe had suddenly changed into turtles and to save their own lives, the men seized them and threw them into the sea.

As they slipped over the side of the canoe the weather changed and there were no more waves. The Nabukelevu fishermen continued their journey back to their home village and the two women from Namuana who had been changed to turtles lived on in the waters of the bay.

It is their descendants today who rise when the maidens of their own village sing songs to them from the cliffs. The translation of the strange song which is chanted on such occasions is as follows:

'The women of Namuana are all dressed in mourning,

Each carries a sacred club, each is tattooed in a strange pattern,

Do rise to the surface Raudalice so that we may look at you,

Do rise to the surface Tinaicaboga so we may also look at you.'

The women of Namuana village still preserve the strange ritual of calling turtles from the sea. All the maidens of the village assemble on the rocks above the water and begin to sing a melodious chant. Slowly, one by one, giant turtles rise to lie on the surface in order to listen to the strange chanting."

Anon, 1971

On the island of Koro it is the men who call the turtles but the legend behind the ritual is unknown to me. Having never witnessed the turtle calling on Koro or Kadavu, I cannot comment on its success. It is possible that the areas used for calling are feeding grounds and should the turtles be free from hunting pressure and harassment they may be present when ever the callers assemble.

The protection of turtles in these areas is commendable and could be used for tourism, as the vital elements of ritual and the chance of seeing turtles in the wild are present.

Fijian Classification of Sea Turtles

The names below came from interviews with turtle hunters, and the confusion is probably introduced by geographical differences in nomenclature. The names and descriptions have been left as they were recorded so as not to introduce any subjective bias.

There are two lineages of turtle based on morphology, colour, sex, diet, suitability for eating and general behaviour. The **ika bula** is the general name for turtles and refers to the spirit of the animal, the living fish. The **ika bula** is difficult to kill. It is also the Green turtle when it is used in traditional ceremonies.

Ika dina comprises the Green turtle **vonu,** both **bala** (male) and **mino** (female), and the **makaloa** which is a very big turtle with a thin black shell that resembles the surface of a bitumen road. It is usually seen outside the reef and is very rare. **Maloi** is another large variety of **ika dina**.

Other varieties of **vonu** include **ika damu** or **vonu damu**, the sub adult with a red back or sun ray pattern on the carapace; **dakarosawa**, with black and white on the carapace; and **bala kai sovu** or **todro** which is a cross between a male and female, presumably a sub-adult male, and is prized for eating because it contains a lot of fat. **Vonu dina** is sometimes used to describe any large turtle, including the Leatherback.

The other lineage includes the Hawksbill **taku**, the **guru**, the **tuvonu** and the **tanoa**. These are described as a listless lot and not good for eating. The **taku** has several varieties: **taku loa** (black), **taku damu** (red) and **noco**, an unspecified variety. The **guru** has a thin shell and looks like a Hawksbill with a big head, but the turtle itself is not large. It feeds on stones, not coral. The **tuvonu** has a big head and strong jaws and feeds on clams, trochus and thorny oysters. The large ocean going varieties are known as **vonu ni Tonga**, or **vonu ni Lau**. The **tanoa** is like the **tuvonu,** but has a massive head which is totally out of proportion with the rest of the body. It has a high domed carapace and is not common. The **balabala** is a large solitary turtle seen only on the reef. It looks like an **ika dina,** and comprises males and females.

Sea Turtle Species

Green Turtle

(*Chelonia mydas*) **Vonu dina**

This species is the prized food of Fijians, and an important gift for feasts and special occasions such as opening of an airport (Plate 3) or traditional ceremonies associated with chiefs and heads of Government (Plate 4). During Independence celebrations in 1970, approximately 100 adult Green turtles were transported from Vanua Levu for presentation to the Queen and use in ceremonies (D. Owens in litt.).

Traditionally the turtle was eaten only by the chiefs. Now it can be consumed by anyone as long as prescribed parts are offered to the chief of the village or to the owners of the island. The green fat of these animals (the origin of their name) is highly prized and is offered to the chief as is the heart, the head, parts of the digestive tract and blood from the flippers. The eggs are considered to be at their best when eaten raw.

With a weakening of the traditional social hierarchy, and the movement of many chiefs from the islands to Government positions in Suva, turtles are killed and eaten whenever they are encountered. The fear of either traditional reprimand or legal action is minimal.

Evidence of Green turtle nesting was seen on the islands of the Heemskercq and Ringgold Reefs (see Annex 3). Twelve tracks were seen on Nukubalati (Plate 5) and another four on Nanuku Levu in early January 1980 (Fig. 2). At about the same time the previous year there were nine Green turtles nests on Nanuku Levu (see field notes) which was about the same number as the eight Green nests on Nanuku Levu and Nanuku Lailai recorded by Bustard (1970) a decade before.

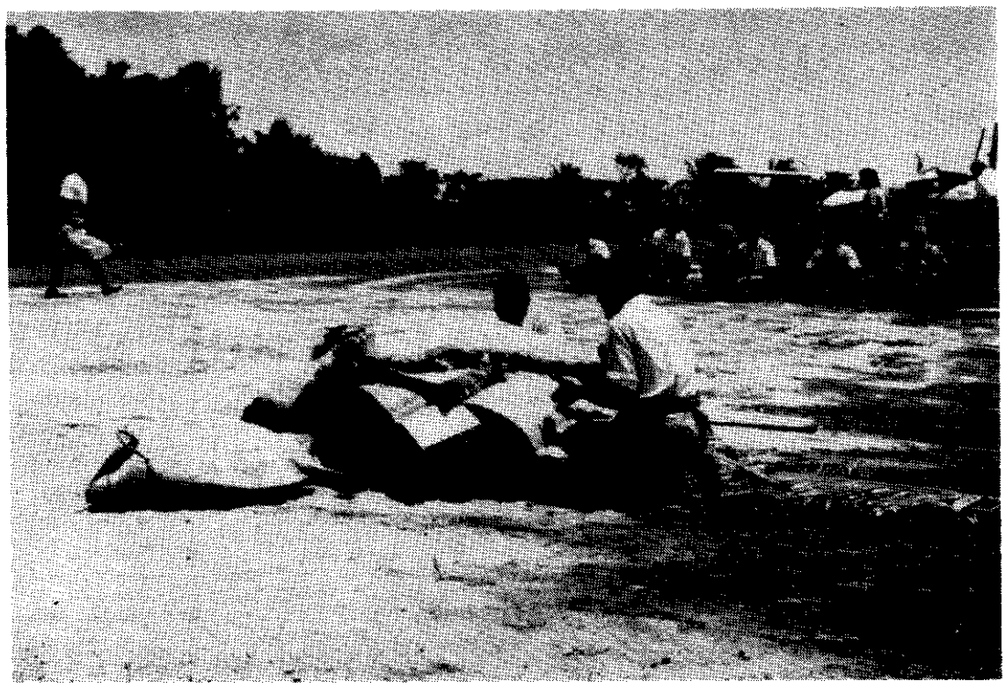


Plate 3: The official opening of Ono-i-lau airport in 1980 was accompanied by the traditional utilisation of sea turtles in the accompanying ceremonies (photo: M. Tighe).

Plate 4: A traditional ceremony in the Rewa region in 1980 featured the presentation of gifts amongst which were sea turtles (photo: M. Tighe).

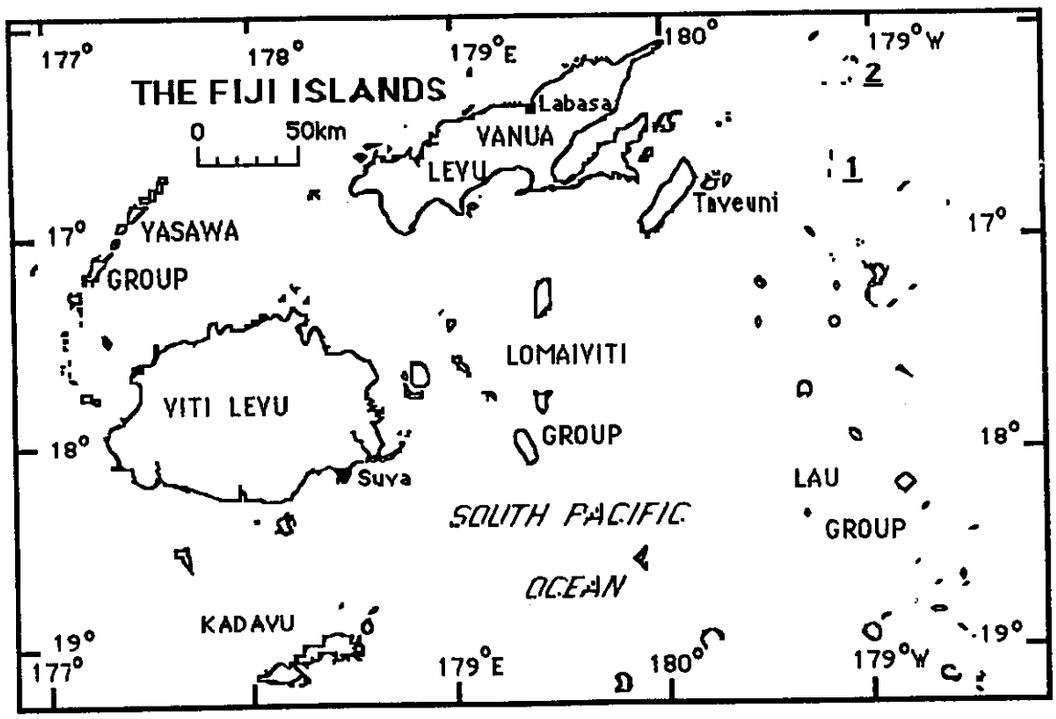


Fig. 2: Localities of major Green Turtles (*Chelonia mydas*) nesting sites in the Fiji Islands. Numbers refer to the localities of:

1. Nanuku Levu, Heemskercq Reef.

2. Nukumbalati, Ringgold Reef.

Hawksbill Turtle

(*Eretmochelys imbricata*) **Taku**

The Hawksbill in Fiji is not reputed to be toxic in as in other parts of the world. There is only one case of villagers being adversely affected by eating turtle flesh (see section on Turtle Flesh Poisoning). Traditionally this species and its eggs have been as source of protein. The shell was used as decoration, and the thick scutes carved into a variety of fishing lures. The scutes provide the commercial "tortoise shell".

Hawksbills are usually associated with coral or rocky reef habitats where they feed on sponges, soft coral and ascidians. Nesting in Fiji appears to be dispersed over a wide area with few well defined large rookeries. Females will nest on almost any small sandy beach, even Nukubuco Islet (Sand Bar - Plate 6), Laucala Bay, near Suva. A Hawksbill hatchling was found tangled in grass on the sand bar on 22 April 1979 (J. Brodie, pers comm.).

The islands of the Heemskercq and Ringgold Reefs support Hawksbill nesting (see Annex 2). Nukusemanu and Nanuku Lailai (Plate 7), and the unvegetated sand cay on Duff Reef (Plate 8), had Hawksbill tracks and nests (Fig. 3). Other known nesting sites described in the field notes include Namena (Derrick, 1957), Yadua, islands of the Astrolabe Lagoon (Namara, Yaukuve Levu and Qasibali - D. Owens in litt.), and Vanua Kula, Nananu-i-ra and Leleuvia.

Leatherback Turtle

(*Dermochelys coriacea*)

Leatherback turtles were reported nesting on a beach in Vivili Bay near Savusavu (Fig. 4) in 1967 and 1971 (Plate 9), where they were captured by the villagers (Anon, 1971). In 1968, another specimen was caught on the beach near Naidi village near Savusavu (Wright, 1969). Another Leatherback on an unknown date nested and was caught by villagers on the beach at Vanaira, Natewa Peninsula (G. Morrison, pers. comm.). A single non-nesting specimen was killed near Qoma village on Viti Levu (Watling, 1986).

Because of its large size the Leatherback draws attention to itself whenever it is seen or caught. An individual caught in Yaro Passage near Kia Island in December 1990 (Plate 10) made front page news (Anon., 1990).

The distribution of sightings indicate that Leatherbacks are transients passing through Fijian waters on the westerly moving ocean currents that flow to the north of Vanua Levu, and between Vanua Levu and Viti Levu. They may represent the remains of a relict population which used the South Equatorial currents and bred sporadically on the southern coast of the Natewa Peninsular.

Loggerhead Turtle

(*Caretta caretta*) **Tuvonu**

There are no reports of Loggerheads nesting in Fiji. Although not common, this species is known to many of the coastal villagers. Fig 5 shows where specimens were either captured, seen or reported to be present. The Fijian name, **tuvonu**, refers to a large turtle (Capell, 1973), but was a consistent response by those people who were interviewed and shown a photograph of a Loggerhead. Photographs of a Loggerhead turtle were found in the library of the Fiji Times, although there was no accompanying story (Plate 11). The adult male turtle had been caught in Laucala Bay at Nesese on 6 March 1971 and appeared from the photographs to be dead.

A single specimen from Aiwa Reef near Lakeba (Lau Group) was returned to USP on 28 August 1979 courtesy of Mr M.T. Gentle of the Fiji Fisheries Department. The presumed adult female (Plate 12) had a curved carapace length of 89.5 cm and a curved carapace width of 84.0 cm, and was held for several days in a pool to collect faeces samples. The faeces showed that its diet consisted almost entirely of *Oostrombus giberelus gibbosa* with particles of *Cerithium terabelli*, *Atacotodia sp*, another species of *Strombus*, and some small fragments of *Acropora*. The animal was painted to aid short term recognition and released in Nukubuco Channel in Laucala Bay. There was no positive sighting of the animal again, although a Loggerhead was sighted in the same region of the bay three weeks later (N. Penn, pers.comm.)

Loggerhead distribution in Fiji appears to be patchy. This is probably a reflection of preferred habitat and a lack of hunting pressure in certain areas. On Natewa Peninsula the turtle hunter, Steno Vueta, had caught only five or six in his many years of hunting in the area. Yet on the south-eastern coast of Taveuni and Qamea, Loggerheads are reported as being present in some numbers as usually one is seen on every fishing trip (W. Stolz, pers comm.).

Plate 5: **Nukubalati on the Ringgold Reef is a known nesting area for Green turtles.**

Plate 6: **Nukuboco Islet in Laucala Bay was used as a military target, but has recovered and supports a low level of Hawksbill nesting (photo: N. Penn).**

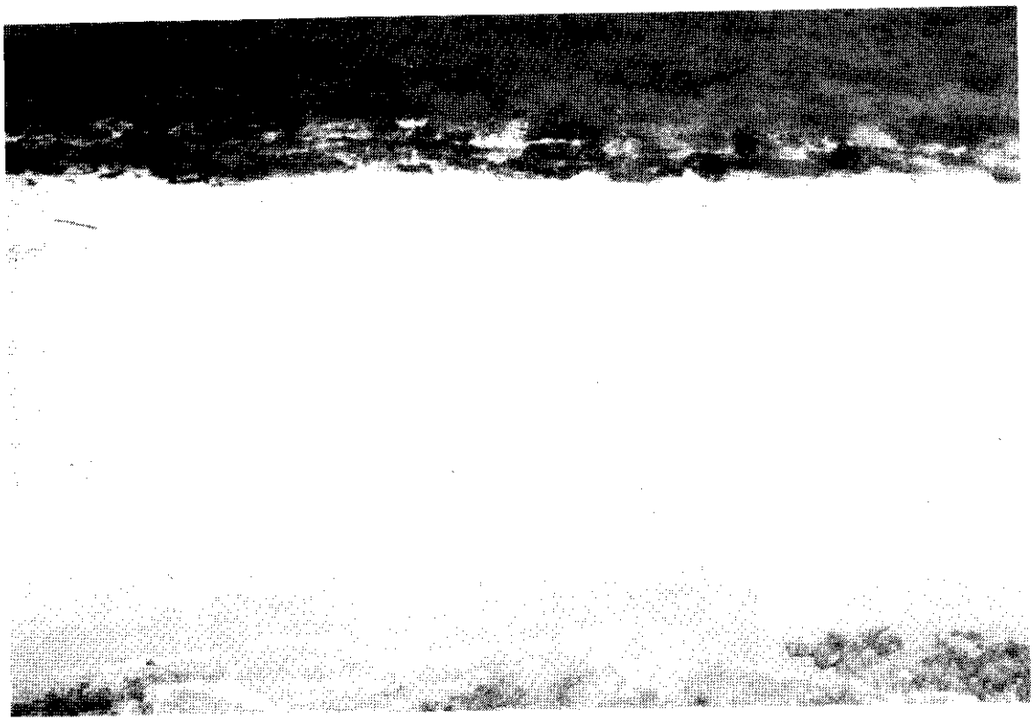


Plate 7: Nanuku Lailai, the unvegetated sand cay on the Heemskercq Reef, supported Hawksbill nesting.

Plate 8: The sand cay on Duff Reef supported some Hawksbill nesting.

Plate 9: In 1967, 1968 and 1971 Leatherbacks were reported nesting at Naidi Bat area near Savusavu. This specimen was caught by villagers in 1971. (*Fiji Times* photo: Anon, 1971).

Plate 10: Non-nesting Leatherback killed in Yaro Passage near Kia Island in December 1990. (*Fiji Times* photo: Anon, 1990).

Plate 11: Male Loggerhead caught at Nesese, near Suva, in March 1971 (*Fiji Times* photo).

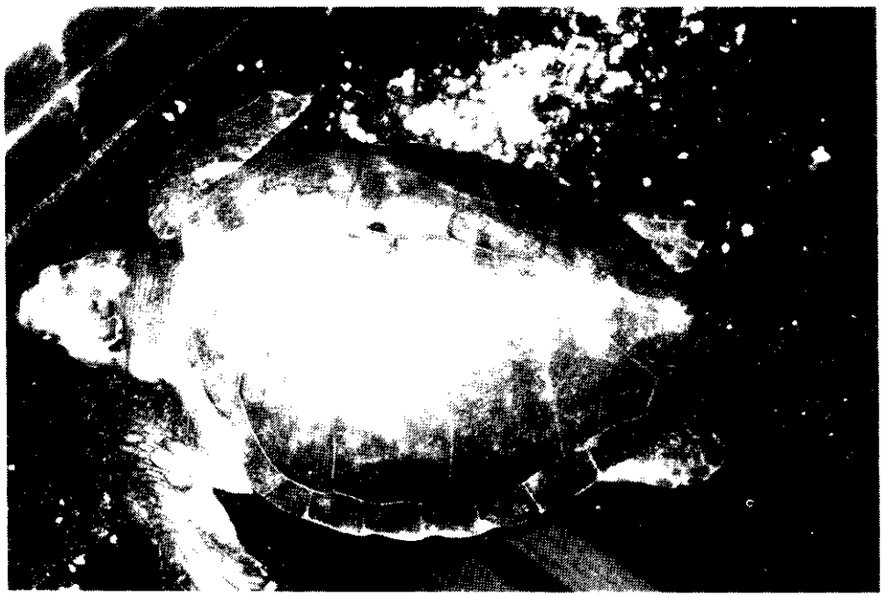


Plate 12: Presumed adult female Loggerhead caught at Aiwa in Lau and released in Nukubuco Passage in Laucala Bay.

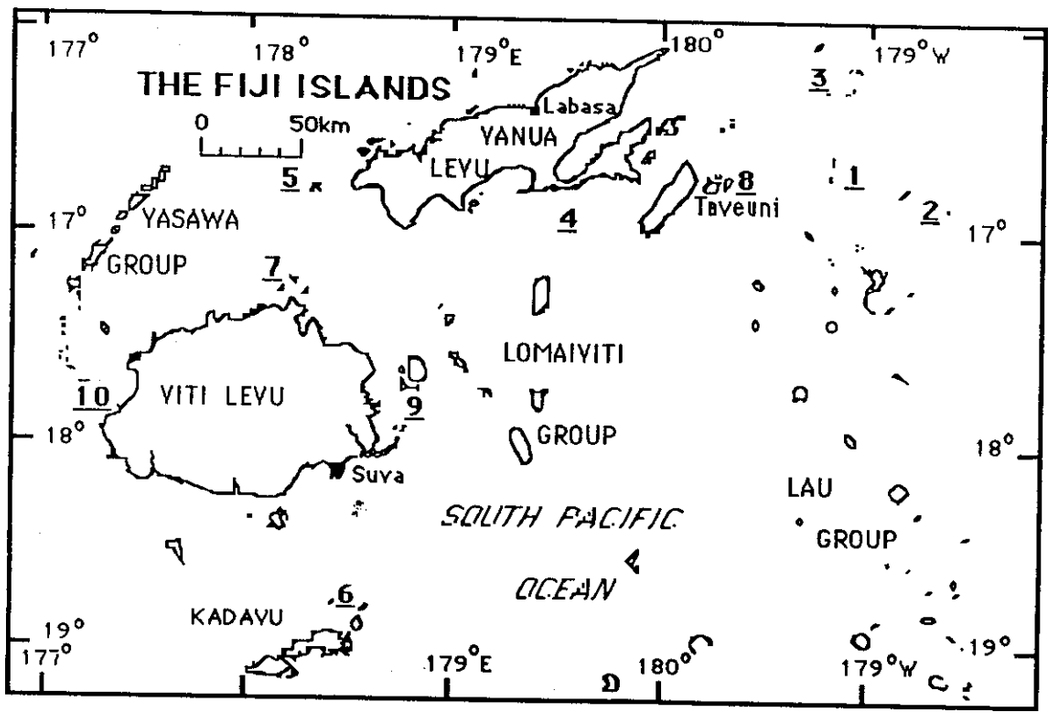


Fig. 3: Localities of major Hawksbill turtle (*Eretmochelys imbricata*) nesting sites in the Fiji Islands. Numbers refer to localities of:

1. Nanukulailai and Nanuku Levu, Heemskercq Reef
2. Duff Reef sand cay
3. Nukusemanu, Ringgold Reef
4. Namena, Namena Barrier Reef
5. Yadua
6. Islands of the Astrolabe Lagoon (Namara, Yaukuve Levu, Qasibali, Vanuakula)
7. Nananu-i-ra.
8. Laucala Island
9. Leleuvia
10. Tavarua (Hirth, 1971).

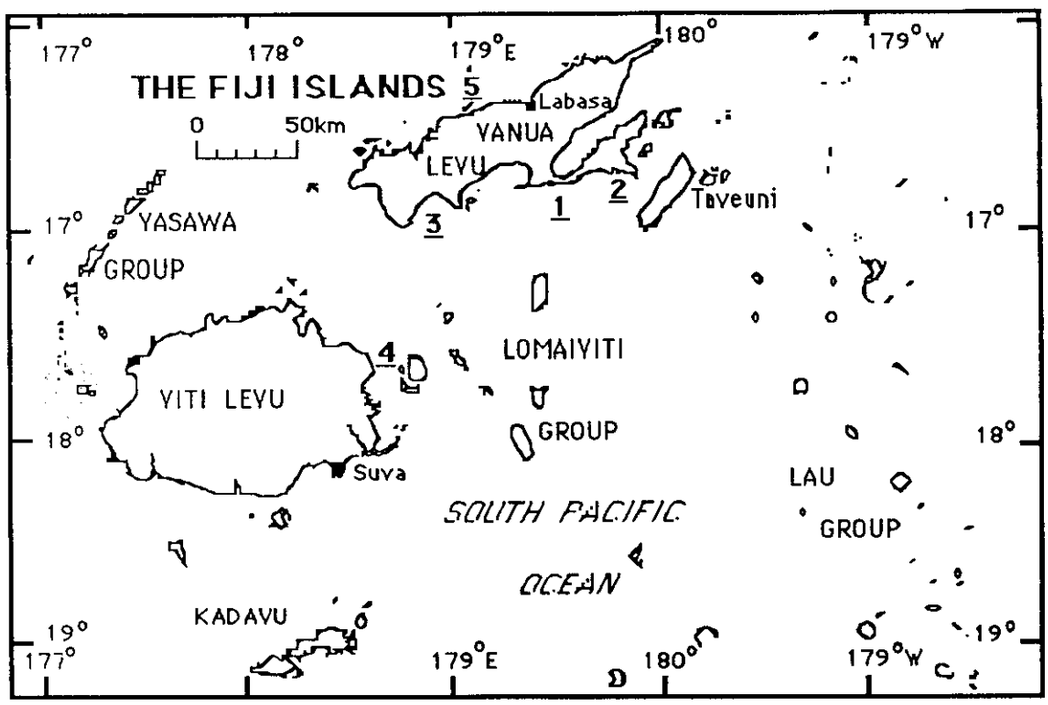


Fig. 4.: Localities of the Leatherback turtle (*Dermochelys coriacea*) nesting and sightings in the Fiji Islands. The numbers indicate the localities-of:

1. Savusavu Region (Vivili Bay, Naidi Beach)

2. Qoma (Watling, 1986)

3. Yaro Passage (Anon, 1990)

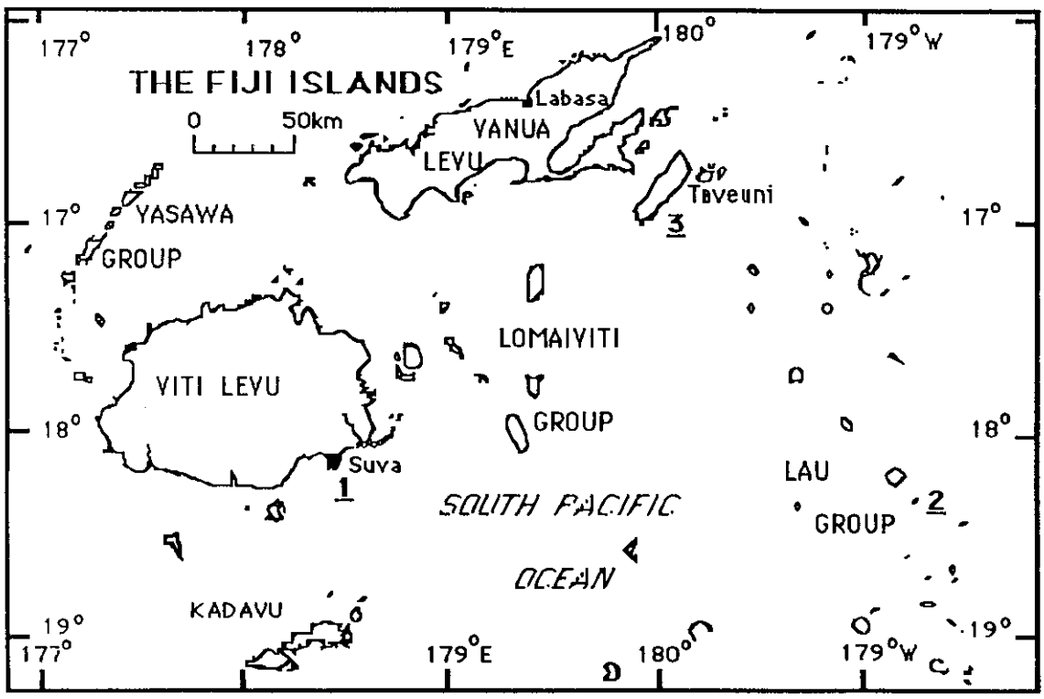


Fig. 5: Localities where Loggerhead turtles (*Caretta caretta*) have been recorded in the Fiji Islands. The numbers refer to the localities of:

1. Nesese, Suva
2. Aiwa, Lau Group
3. Taveuni.

Olive Ridley

(Lepidochelys olivacea)

The Olive Ridley turtle is not known to nest in Fiji. The inclusion of this species from Mali Passage (Fig. 6) in the report of Robert Stone is the first record of its presence in Fiji. Considerable time was spent questioning turtle fishermen about the presence of Olive Ridleys in their hunting areas.

Lacking suitable photographs in combination with my personal unfamiliarity with this species, and my inexperience in formulating suitable questions to separate Olive Ridleys from Loggerheads, my interviews were hampered. Questions regarding an increased number of scutes and small size were met with negative or ambiguous responses.

Olive Ridleys would fit within the **taku** lineage of Fijian classification of sea turtles. **Noco**, **guru** and even **tanoa** could also apply. However, without a specimen or photograph, such speculation is questionable.

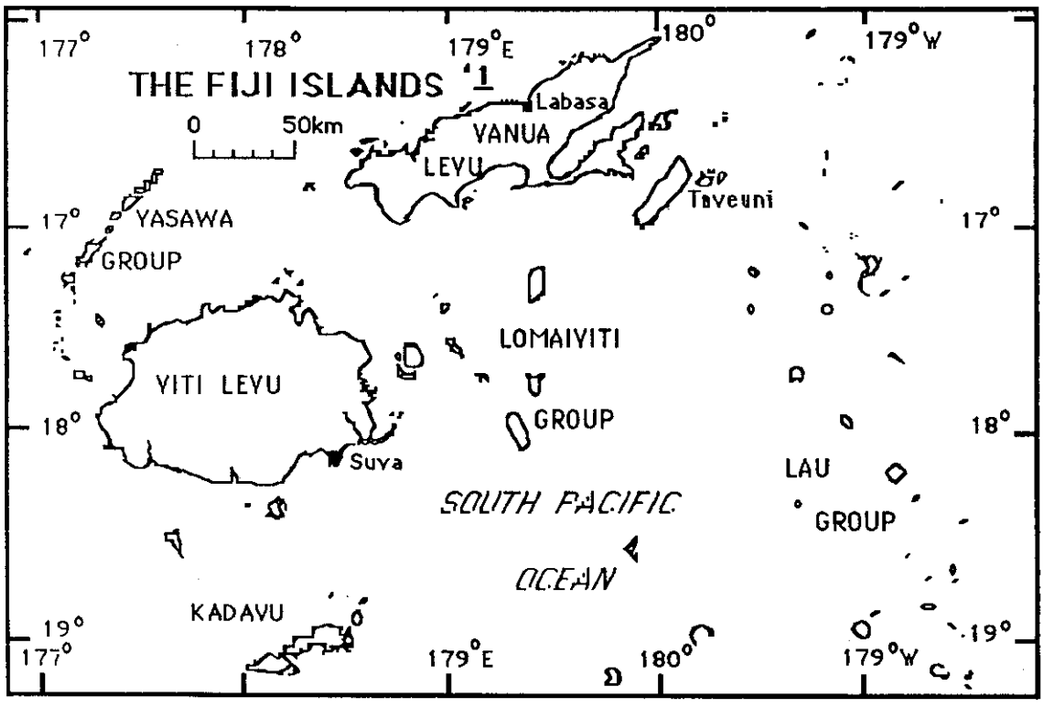


Fig. 6: Known sightings of the Olive Ridley turtle (*Lepidochelys olivacea*). The number refers to the locality of:

1. Mali Passage (Stone, see p. 6)

Exploitation

Traditional Turtle Hunting

Traditionally, turtle hunting was one of the duties of the **mataqali** (clan), who were called **gone-dau ni ika** with the **tudau** as the leader. These people were expert fishermen, and were responsible for supplying turtles at the request of the chief for special occasions, as well as fish. They were well educated in the natural history and traditional taxonomy of sea turtles. Hunting was conducted by night and by day. Nesting turtles were taken at night. The **gone-dau** knew those that were missed would return to the beach in two weeks time.

During the day, a turtle that was sighted from a boat was chased until it was exhausted. It was then kicked on the posterior of the carapace with the heel to direct it towards the surface and the waiting boat. Alternatively, when a turtle was seen on a reef or in shallow water, a large mesh (60 cm diagonal) turtle net **lawa ni vonu** or **lawa tabu** made of coconut fibre (**magi magi**) was spread at the most likely point of escape, and the **gone-dau** would circle the turtle and beat the water to frighten the animal into the net.

Turtles were caught on the sea grass beds at night with a net in a process called **tara tara**. At low tide during the day poles were driven into the mud. These would support the turtle net that would be set at night on the high tide. The surface of the water was then beaten to drive the turtles into the net.

Another night hunting technique called **rabe** involved about twenty people who carried the turtle net, still bundled up, onto the reef or sea grass bed. When a turtle was detected, usually by its phosphorescence as it moved through the water, the net was spread to encircle the animal.

The use of a set net which would capture turtles by night or day is referred to as **sau moce**.

Turtles were also speared from boats. The turtle spear, **moto ni vonu**, was a straight spear with a single point. Traditionally it was made of timber from **makita salusalu** (*Parinari sp*), **mulomulo qase** (*Thespesia populnea*) or **bitu sanisani** (*Bambusa vulgaris* or *Schizostachyum glaucifolium*) (Parham, 1972). Pens used to keep the turtle alive until required are called **nai vi laca** in the Rewa region although **bi** (Capell, 1973) is also used.

Male turtles have been seen attempting to mount and mate with swimmers and persons fishing (Steno Vueta, pers. comm.). Female turtles tethered in shallow water close to the shore would attract male turtles that were lured to where they could be speared (C. Anthony, pers. comm.).

Modern Turtle Hunting

With the removal of traditional restrictions on who, where and when turtles could be hunted, many Fijians and Indians feel that sea turtles are now common property. Hunting is in large part unregulated and uncoordinated and the sale of turtle meat is dictated by demand, market price and the relative ease of obtaining other sources of income. Turtles are hunted in the Suva region by set net with a diagonal mesh size of approximately 50 to 60 cm constructed of monofilament nylon, anchored to the bottom by concrete blocks and buoyed by segments of bamboo. Such nets were a regular sight on the northern reef slope of Makuluva, and were assumed to belong to commercial turtle hunters of Vatuwaqa Creek, Laucala Bay, where the turtles were penned and awaited market in Suva.

Throughout Fiji the practice of night spear fishing had a great impact on the fish and turtles of the reef crests and channels. Several hunters were involved in a night fishing party. One stayed in the punt while the others (up to five or six) used underwater torches and spearguns to hunt whatever was edible or marketable. The punt was not anchored but moved along the reef with the hunters. The speared fish or turtle was carried back to the punt where the attendant passed a fresh-loaded spear gun to the hunter, and then removed the spear from the catch and reloaded the spear gun, ready for the return of the next hunter.

This was a very efficient technique as sleeping fish and turtles make easy targets, and the catch could be at the market early in the morning, eliminating the need for refrigeration. In April 1980, three juvenile Green turtles (carapace lengths 40-60 cm) were taken in this manner in a couple of hours at Namuka Reef near Suva (N. Penn, pers comm).

When villagers encountered a nesting turtle, both the female and her clutch were taken for consumption. Although this is illegal, many openly admitted to doing so. In some cases the reason for the trip to the island was specifically to hunt sea turtles and collect their eggs.

Sea Turtles as Pets

It is common practice in coastal communities for sea turtles to be kept as pets. The animals are usually acquired as hatchlings and raised in either salt water or fresh water containers. Owners were often attached to their pets, feeding them a variety of food including, in one instance, ice-cream (Anon., 1981). Most were fed on fish and shell fish (N. Douglas, pers. comm.; C. Anthony, pers. comm). In a number of cases the turtles were released, however legislation allowed for captive turtles to be killed and eaten during the closed season.

Turtle Flesh Poisoning

In many parts of the Pacific, Loggerhead and Hawksbill turtle flesh have a reputation for containing toxins (Likeman, 1975). In Fiji, Hawksbills were not known to be poisonous. However, Wainika Village, Vanua Levu, had one occurrence of turtle poisoning. The turtle (species unknown) had a soft shell, and when eaten the whole village became sick and many nearly died. The scraps produced similar poisoning in the dogs and the fowls (Steno Vueta, pers. comm.). The incident occurred before the birth of the elderly gentleman who related the story to me.

Field Notes and other Reports on Sea Turtles

Namena

(6 - 11 February 1979)

Namena had been mentioned as a significant sea turtle nesting locality. Coastal vessels moving between Suva and Vanua Levu stopped there for turtles and their eggs. During my visit to Namena a single Hawksbill nest was laid on the southern beach on the night of 8 February. Two subadult Green turtles were seen one afternoon feeding close to shore on the high tide in the inlet on the northern side of the island. There was no evidence of Green turtle nesting.

Yadua

(12 April 1979)

The late Dr John Gibbons (USP) and I were guests in the village of Denimanu on Yadua on our way to Yadua Taba. We were informed by Master Sakaraia Navunisinu, a school teacher on the island, that Hawksbills nested on the long beach near Yadua Taba. The weeks just after Christmas had the greatest nesting frequency with about four turtles nesting a night. The people on Yadua do not eat much turtle except when fish are scarce, when someone comes across one or when there is a special feast. The villages use all of the meat but the shells are taken to the mainland where the Indian traders buy them.

The Green and Loggerhead turtles are known to the people of the island but they do not nest there. Villagers think that the Hawksbill is the mother of these two species as well - with some eggs turning into Loggerheads, others into Green turtles and others into Hawksbills. The Leatherback is known only from pictures in books, although there are reports of a Leatherback being caught in Wainunu Bay.

Master Sakaraia had a turtle net made of rope which he used to catch two turtles in 1978. The carapace of an adult Green turtle hung on the wall of his bure. There was no concentrated turtle hunting effort by the villagers of Denimanu, but they knew that offshore of the village of Baulailai on Vanua Levu there was a reef where on a high tide at the full moon numerous turtles, Green and Hawksbill, came to feed.

Yandua Taba

(14 April 1979)

On the high tide (0735), two juvenile (30 - 50 cm in size) Green and one Hawksbill turtle fed in the small bay at the northern end of the island. On occasion hatchling turtles have been seen by the people of Denimanu, drifting in the currents around Yadua Taba.

Nananu-i-ra

(31 August -2 September 1979)

This island supports low density Hawksbill nesting (C. Anthony, pers comm.). A few Hawksbills nest each year at Nawawa at the northern end of the island. Hawksbills have been seen mating in the area, and mating by Green turtles is also assumed to occur, as a female Green was once captured and tethered to a tree by means of a hole drilled in the carapace with a length of strong rope attached. Three males were then caught near her. The female was later released. Turtles are commonly seen while diving in the area (C. Anthony pers comm).

Nanuku Levu

(11-19 January 1980)

This Island and its unvegetated neighbour, Nanuku Lailai, are on the southern part of the Heemskercq Reef. The island was visited by Dr Bustard in January 1970 (Bustard, 1970), and is one of the few localities in Fiji where data on numbers of nesting turtles are available. In December 1979, several nesting turtles were reported to have been killed on Nanuku Levu and taken to Qamea. During my stay on the island no turtles nested and no hatchlings emerged onto the beach. There was a total of 24 nests on the beach at the time of my arrival. Nine belonged to Greens, 14 to Hawksbills and one unidentified. Of these, two Greens and one Hawksbill had nested since the last full moon. New moon occurred during my visit on 18 January. Twelve of these nests had been dug into by Fijians. There was no indication of their success in removing the eggs. The three recent nests had not been raided.

About 20 m inland from the beach on the southern end of the island stood a tree with large oval leaves, which my companions Apete and Caucau called **buabua ni sawana** (*Guettarda speciosa*). They informed me that custom was for the head of the first turtle caught on any trip to the island to be placed at the base of the tree (Plate 13). The turtle should be then baked in the **lovo** (Fijian earth oven) on the island. The purpose of the custom was to keep away the devils, thank the owners of the island for the turtle, and to ensure that more turtles will come ashore. At the base of the tree there were eight Hawksbill skulls and a single Green skull. None of the skulls were from this season as all were bleached by exposure to the elements.

The island had a circumference at the vegetation mark of 1,000 m, and a sand spit (Plate 14) about 200 m in length projecting northward towards Nanuku Lailai. The coarse carbonate sand gave way to beach rock on the eastern side. The western beach was steeply sloping with a drop of approximately 4 m from the strand vegetation to the low water mark, 17 m from the shore. A lagoon approximately 200 m wide surrounded the island. Strand plants included *Scaevola taccada, Terminalia sp, Acacia simplicifolia, Cassytha filiformis, Ipomoea pes-caprae brasiliensis, Clerodendron inerme* and *Canavalia maritima*. At night lesser frigate birds circled the island and red footed and brown gannets roosted in the trees.

On Sunday 13 January, the Douglas family arrived from Laucala Island and took me to Nanuku Lailai. The sand cay is completely unvegetated. It is approximately 300m in length and 50 m wide with its longest axis in a northerly direction (Plate 7). The line of pumice indicated that during high seas the cay would be completely awash. Five Hawksbill nests were present, one laid since the last set of spring tides. Approximately 300 common noddy terns nested on the sand (Plate 15), and eggs and chicks were frequently encountered as we walked around the cay. Other terns using the cay but not nesting include the crested tern and the black naped tern. The Fijians have egg collecting trips to this cay in February and March. The brown gannets nest on the sand at that time. Eggs are collected by the wasteful technique of walking over the cay and throwing all eggs into the water, thereby ensuring that the eggs collected in the next couple of days will be freshly laid.

Matagi Island

(21-23 January 1980)

Matagi Island has one beach used occasionally by nesting Hawksbills (Bustard, 1970). However there has been no nesting there since the early 1970s.

Qamea Island

I was informed that there were two beaches on Qamea where Hawksbills and Greens used to nest. One of these beaches was Moikabaka Beach, where I was informed of a Hawksbill taken while nesting. On the last day of 1979 a mating pair of Hawksbills were taken from Qamea, but none had nested during the summer of 1979/1980.

Laucala Island

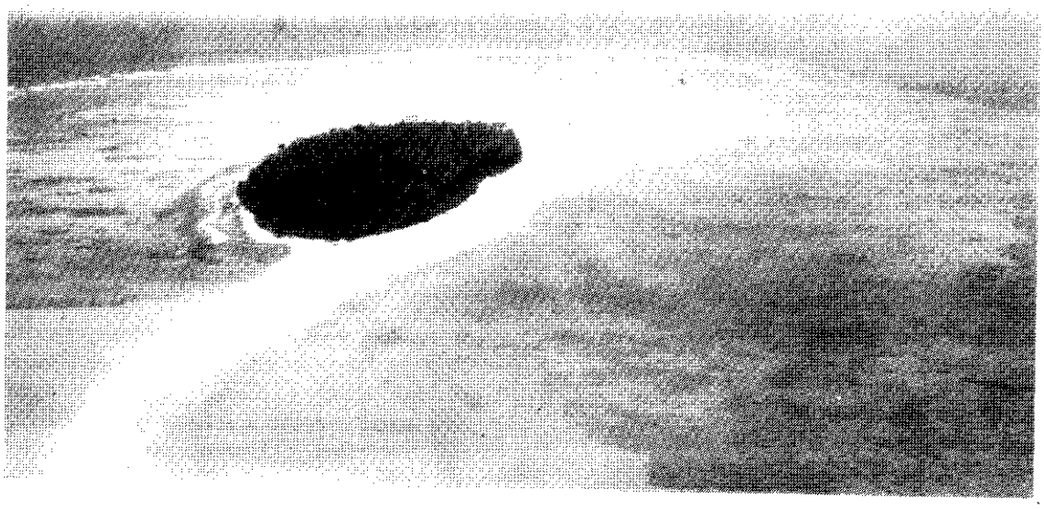
Turtles seldom nest on Laucala Island, however on 10 January 1980, a Hawksbill nested on the northern beach. The eggs were collected by the villages for consumption.

Lau Group

Tavunuku-i-vanu, Yaroua and Tuvuca are localities where Greens and Hawksbills were seen nesting in February and March 1980 (Lee pers. comm., 1980). Katafaga and Vekai are reported by Derrick (1957, 308) as areas where turtles nest and are hunted respectively. Nukutolu islets are reported by (Derrick 1957, 306) as a place where the people of Yacata go to hunt. Vuaqava is used by the people of Kabara as a pen for live turtles which are kept in a tidal lake of salt water (Derrick 1957, 20). The island has been the focus of a proposal to utilise the lake for turtle rearing (See Vuaqava Lake Project).

Cakau Levu is possibly the locality referred to in the following quotation. "Rob Stone was informed by Gordon Elliott (aboard a fishing vessel) that approximately 60 Green turtles were seen at a sand cay two miles northeast of Yagasa Levu in the Lau Group. All sizes of turtles were present and they reportedly displayed very little fear of man. Nesting was not recorded. Seven turtles were taken, presumably for food. Based on the information which I received, it was unclear if these turtles were in the water or on land - possibly basking." (Dr G. Balazs, in pers., 28 January 1980).

Plate 13: On Nanuku Levu the skull of the first turtle killed and eaten on each trip to the island was placed at the base of a Buabua tree (*Guettarda speciosa*) to ward off spirits, thank the owners of the island and to ensure that more turtles would come ashore.



Plates 14 (a) and (b): Nanuku Levu, with its prominent sand bar, supports Green and Hawksbill nesting.

Plate 15: Nanuku Lailai, the unvegetated sand cay on the Heemskercq Reef, supports Hawksbill nesting along with numerous sea birds, e.g. Common Noddy Tern (shown here) and the Brown Gannet.

Conclusion

The Fijian people to whom I spoke were keen to talk about sea turtles. Many admitted to killing sea turtles regardless of size and eating the eggs regardless of the legislation. This uncontrolled exploitation has been going on since the early nineteenth century when sea turtles became a marketable commodity, and the cash incentive conflicted with traditional utilisation of sea turtles. All admitted that there were fewer turtles now than they could remember from the days of their youth. They saw little correlation between their hunting practices and the decline, either real or imagined, in the number of sea turtles. As there were always some turtles to be had whenever they went hunting, and to the best of their knowledge the remote islands in Lau contained a bountiful supply of nesting turtles, they saw little need for concern.

Lack of information on the biology of sea turtles and their status in the Pacific allowed people to think that although scarce, sea turtles were not in danger of extinction because over the horizon on unnamed, remote islands, female turtles were continuing the supply of young turtles for market and for feasts.

The Status of Nesting Populations

I searched for the remote, bountiful islands that supplied the country with sea turtles. *"Should the islands north of Taveuni not support large nesting populations of Green turtles, then Fiji does not have such a resource"* (D. Owens, in litt.) were the comments of Dr David Owens who spent two years on Bulia in the 1970s. My visits to Nanuku Levu, and the aerial survey of the islands of Northern Lau failed to find the rookeries. I estimate that fewer than 20 Green turtles nest on the islands of the Northern Lau group each year.

1980 and 1981 were years when above average Green turtle nesting occurred on the Great Barrier Reef, where the El Nino Southern Oscillation causes yearly variations in the nesting population (Limpus, pers. comm.). If the Fijian turtle population is subject to similar fluctuations, then in the years of my survey elevated numbers of nesting females could be expected. Given that each female may nest on three or four occasions at fortnightly intervals during summer, and that each clutch of eggs may number up to 120, around 10,000 Green turtle hatchlings enter Fijian waters each year.

Survival rates to maturity are anticipated to be about one in one thousand, which is a potential recruitment in 50 to 60 years time into the Fijian Green turtle population of 10 individuals, some of which will be males. In 1979 ten tonnes of green turtle meat were marketed in Fiji (FAO Statistics). Assuming that 30 kg of meat (a conservative estimate) were obtained from each animal, then the harvest is in the order of 300 to 400 adult individuals in 1979. The rate of harvesting is many times that of the recruitment rate.

The obvious question is "Where do these turtles come from?". A clue can be found in the tag recovery of sea turtles that were marked nesting in other Pacific Ocean countries. Sea turtles were tagged while nesting and feeding on Scilly Island, Society Islands, French Polynesia. Of the ten that were recaptured in Western Pacific countries (Pritchard, 1982), four were recaptured in Fiji; three from Vanuatu; two from New Caledonia and one from Tonga. A female Green, which was tagged while nesting on Scilly Island, was captured by Steno Vueta at Napuka, Vanua Levu, just 87 days after it was tagged 1725 miles to the east in French Polynesia (Wright, 1972). The Green turtles sold in the markets of the major towns in Fiji, in all likelihood, were hatched on the shores of other Pacific countries.

The shallow waters of Fiji provide a large and, in present times, under-utilised feeding ground for sea turtles. The sea grass pastures dominated by *Syringodium isoetifolium* along with *Halodule uninerva, H. pinifolia* and *Halophila ovalus* are of immense proportions and provide a feeding ground for Green turtles on trans-oceanic migrations.

The Fiji Group is in the path of the South Equatorial surface currents which have been associated with the biogeographical distribution of terrestrial iguanas and mangroves (Gibbons 1981). The currents flow from the North East into the Fiji Islands and pass through Bligh Water between Viti Levu and Vanua Levu. It is in this general area that Leatherback turtles are commonly seen. The numerous reefs and lagoons provide under utilised feeding space for subadult Green and Hawksbill turtles that may take up residence during their pre-reproductive years. The same lagoons and reefs provide food (molluscs and coral) for adult Hawksbills and Loggerheads.

The waters of Fiji provide an unoccupied habitat for any sea turtle that moves with or against the ocean currents into that area. Hence the sea turtles that are harvested in Fiji are probably migrating transients or new recruits to the sea grass and reef habitats.

The Green turtles that nest on the islands of the Ringgold and Heemskercq Reefs may represent the remnants of the indigenous genepool or a mixture of endemics and migrants from other South Pacific countries. The genetic composition of the nesting Green turtles could be tested by modern techniques that trace maternal lineages, e.g. mitochondrial DNA studies. The same techniques could decipher the origin of the sea turtles that pass through the markets of Fiji. Regardless of their genetic origins, the turtles that nest in Fiji are Fiji's brood stock. They and their eggs should be protected, as they constitute the nucleus from which Green turtles could eventually increase in numbers.

The Hawksbill turtle has been heavily exploited for at least 150 years in Fiji. Many of the comments regarding the Green turtle apply also to this species. The annual breeding population of Hawksbills is probably in the order of 100 individuals. Using the same logic as applied to the Green turtle regarding recruitment, Fiji could expect a recruitment into the adult Hawksbill population of about 50 individuals in about 50 years time.

The export of "tortoise shell" from Fiji in 1987 was 2,008 kg, representing the harvesting of 2,000 to 3,000 adult individuals. Again, the harvest pressure is several times greater than the recruitment from native populations. The ban in 1990 on the export of unworked tortoise shell should reduce the hunting pressure on this species (Daly 1991).

The Leatherback turtle appears to be a migratory species in Fiji and should be given safe passage through the islands. Nesting is sporadic and opportunistic on those beaches that have a narrow fringing reef, such as along the southern Natewa Peninsula coast. This species is threatened with extinction on a global scale. The individuals that are caught and killed in Fiji are of curiosity value only to the villagers. If the Leatherback and its eggs were totally protected in Fiji then none of the coastal villages would be disadvantaged as this species is of neither commercial nor subsistence nutritional value. However, as **ika dina**, it holds great importance in Fijian culture and should not be killed.

Recommendations

1. Fiji has in place excellent legislation regarding the harvesting of sea turtles. I recommend that the regulations be amended so that the Leatherback turtle and its eggs receive total protection throughout the year. This would grant this species freedom to pass through Fiji waters and nest unmolested.
2. The legislation should be enforced. The plan of action (Gentle 1979) highlighted the difficulties, particularly the lack of personnel.
3. I endorse the recommendation of Dr. Bustard (1970) that the islands of the Heemskercq Reef be made a turtle sanctuary. I propose that the islands of the Heemskercq Reef (Nanuku Levu and Nanuku Lailai) and the Ringgold Islands (Nukubasaga, Nukusemanu and Nukubalati) and their surrounding reefs be declared a marine park for preserving sea birds (Clunie 1985) and sea turtle nesting and feeding. The area is rich in history (named by Able Tasman in 1643) and contains the only known Green turtle rookery, as well as significant colonies of sea birds, e.g. red-footed gannets, brown gannets frigate birds and common noddies (Clunie 1985).

4. I urge the Chiefs and other land owners to consider placing prohibitions on the removal of sea turtles and their eggs from the islands and surrounding reefs. This would restore the importance of the **gone-dau ni ika** in modern Fijian society. This need not be a total ban, but may be lifted for ceremonial occasions or at intervals at the discretion of the owners and chiefs.

5 I urge the Government of Fiji to seek international aid for monitoring sea turtle populations within Fiji. Australia became a signatory to the "Convention on the Conservation of Migratory Species of Wild Animals" (Bonn Convention) in 1991. In so doing it adopted the resolution on assistance to developing countries to promote financial, technical and training assistance and to give priority to the management and conservation of migratory species of wild animals in developing countries. The Green, Loggerhead, Leatherback and Hawksbill turtles are listed in Appendix 1 of the Australian vertebrate list.

Fiji is in a position where it may attract foreign funds to compensate land owners for lack of income and inconvenience caused by declaring the waters and islands of the Ringgold and Heemskercq Reefs protected areas. This is similar to proposals being initiated by the National Trust for Fiji for the island of Yanua Taba and its Crested Iguanas. The control of hunting of sea turtles within Fiji is unrealistic without the funds to enforce the legislation. The preservation of the islands of the Ringgold and Heemskercq Reefs is a positive and comparatively low cost measure which will ensure the the conservation of the sea turtles that nest there, and so those that belong to Fiji's present and future generations.

Acknowledgements

I thank the people of Fiji for their cooperation and the courtesy that was extended to me during the time of my visit. I am grateful to Dr Uday Raj for his support during the study. The Douglas Family of Laucala Island were particularly generous for which I thank them. Field work was enhanced with the assistance of Dr Nicholas Penn and the late Dr John Gibbons. I am grateful for the help and encouragement given by my wife Nirmala in the preparation of the manuscript. This study was funded by research code R 164 from the University of the South Pacific.

Annexes

Annex 1: List of People Interviewed

Fergus Clunie	Fiji Museum
Ratu Meli Ramatai	Nabouwalu
Master Sakaria	Yadua
Gwyn Watkins	Orchid Island
Mark Gentle	Dept of Fisheries
Bill Travis	Dept of Fisheries
Akuila Vuakaca	Dept of Fisheries
Annabelle Lee	University of Hawaii
Sakaraia Navunisinu	Denimanu, Yadua
Stan Brown	Fiji Navy
Charlie Anthony	Nananu-i-ra
Mr MacDonald	Nananu-i-ra
Keith Edwards	Bua
Ram Shama	Savusavu
Ray Haines	Savusavu
Doug Corey	Kubalua, Natewa Penn.
Gordon Edris	Mumu Point, Natewa Penn.
David Simpson	Tuvamila, Buca Bay
Anne Girardot	Savusavu
Silio Bokoi	Napuka
Steno Vueta	Nailou
Andrea	Koroko
Silvia Vuicakau	Korovonu
Senio Vuicakau	Korovonu
Esava Namusudroka Vunivalu	Kubalua, Bua
Noel Douglas & Family	Laucala Island
George Morrison	Taveuni
William Stolz	Naselesele
Duncan Peterson	Naselesele
Rarasika	Navakacoa
Leno & Sam	Qamea
Caucau	Laucala Island
Apete Bogidua	Laucala Island
Enoke	Namuka Island

Annex 3: List of photographs (with comments) used during interviews

All photographs are by M.L. Guinea, except where otherwise acknowledged. The notes are an indication of the comments that were prompted by the photographs during interviews with villagers. Those who were engaged in fishing and turtle hunting were more prominent in the conversation. However everyone in the village was interested in viewing the photographs and learning about them.

Plate 1. Sub-adult Hawksbill turtle.

Locality Wreck Island Queensland.

Notes This photograph was easily recognised and named correctly as **taku** by the villagers. It is readily eaten by the people but it is the Green turtle that is favoured for feasts and special occasions.

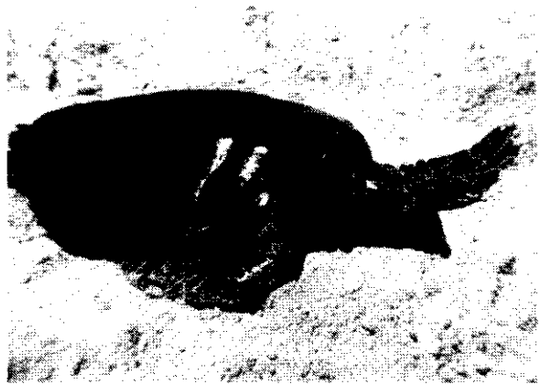


Plate 2. Sub-adult Green turtle (photo: Bill Wood)

Locality Heron Island Queensland.

Notes Many villages correctly identified this photograph as that of a Green turtle **vonu,** with some being more precise and identifying it as a sunray **vonu damu**.

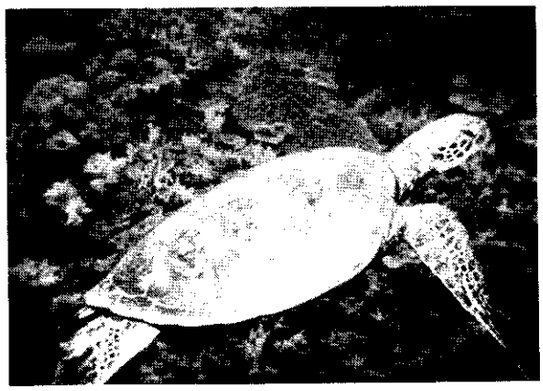


Plate 3. Female Loggerhead turtle.

Locality Wreck Island Queensland.

Notes This species was commonly identified correctly as **tuvonu** by those being interviewed. It is not commonly eaten because the flesh is found to be distasteful. None of those interviewed knew of this species nesting in Fiji.

Plate 4. Adult Female Leatherback (Photo: *Fiji Times*, 13 November 1971)

Locality Naidi Beach Savusavu Fiji

Notes This is a rare visitor to Fiji and the photograph was of considerable interest to those being interviewed. The gentleman astride the turtle in the photograph is the late Willy Fong who worked for the Cakadrove Co-operative and is well remembered by the people of the district.

Plate 5. Adult male Green turtle

Locality Heron Island Queensland.

Notes The Fijian word for this turtle is **bala,** which refers to the long tail which houses the penis. There are no Fijian names for the male Loggerhead and Hawksbill although these are also known to the villagers. The male sea turtle rarely, if ever, comes ashore. On two occasions villagers reported that they had heard of male and female turtles coming ashore to bask on some of the remote islands in the southern Lau Group. These reports have not been substantiated.

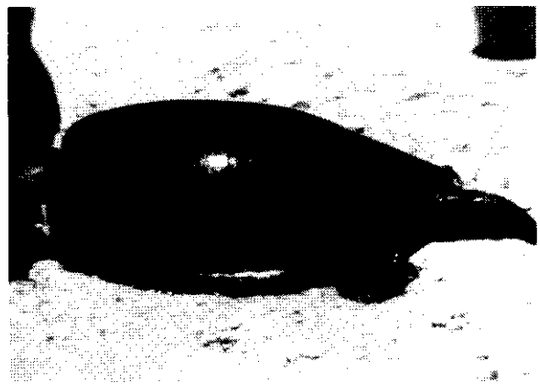


Plate 6. Turtle tracks on beach

Locality Wreck Island Queensland.

Notes All of those interviewed wanted to know where was this place and if it was in Fiji. Only one indicated that he had seen something like this on the Ringgold Islands (W. Stolz, pers. comm.)

Plate 7. X-ray of juvenile Green turtle

Locality Townsville Queensland.

Notes This captive turtle had been feeding on algae and in so doing had ingested sand which outlines the digestive tract. Conversations regarding the contents of the digestive tracts of young and old Green and Hawksbill turtles were prompted by this photograph. It was not unusual to find sand and pebbles in the digestive tracts of these animals.

Plate 8. Loggerhead laying eggs

Locality Wreck Island Queensland

Notes See Plate 9.

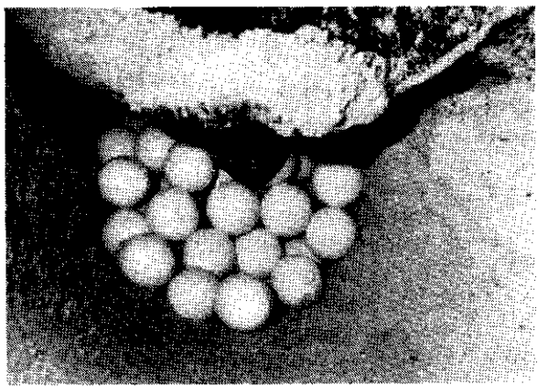


Plate 9. Emergence of Green turtles from the nest.

Locality Heron Island Queensland

Notes These two photographs were used together to identify the times of the year when eggs are laid and when the hatchlings can be seen on the beach. Many Fijians had never seen egg laying and had heard of it from others. Of the people interviewed only two had ever seen the eggs being laid and only one had watched the entire procedure of digging the nest, laying and filling in afterwards. Turtles found on the beach were not given the chance to lay as the animal and the clutch were taken to be eaten. A few had encountered hatchlings which they kept for some time as pets.

Plate 10 Sub-adult Green turtle with metal tag.

Locality Heron Island Queensland

Notes See Plate 11.

Plate 11 Tagging a Loggerhead.

Locality Heron Island Queensland

Notes In the 1970s several tagged turtles were caught in Fijian waters. These had been tagged on nesting beaches in French Polynesia. The villagers were well aware that some sea turtles carry numbers and were on the look out for them.

Plate 12 Sub-adult Green turtle with carapace damage.

Locality Heron Island Queensland

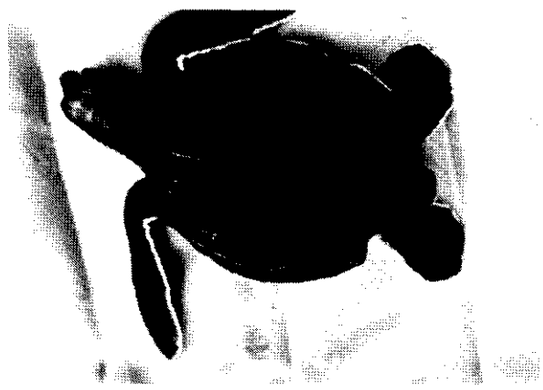
Notes See Plate 13.

Plate 13. Pen-reared Green turtle carapace marks

Locality Townsville, Queensland

Notes Hundreds of thousands of hatchlings have been marked by clipping scales from the edge of the carapace to indicate the year in which they were born (Limpus, pers.comm.). Plate 12 is a sub-adult Green which was thought to have been clipped. Although not so it indicates what the clipped carapace may look like in a turtle caught some years later.

This photograph shows the binary pattern used in carapace marking. Those who were interviewed had not seen such damage to any of the carapaces that they had seen. Larger and more extensive damage had been noticed but this was attributed to shark attacks or other predator damage while in the juvenile stage. Opportunistic surveys of the carapaces in markets and shops revealed that none were carrying carapace markings.



Annex 3: Aerial Surveys

Aerial Survey no. 1: Laucala Bay to Namuka

Date: 8 December 1979

Personnel: John Cummins (pilot), Nicholas Penn (photographer), John Gibbons (photographer), Michael Guinea (recorder), and Lilly Wong and Chris Wright (observers)

Air Craft: Widgel flying boat (Sea Bee)

Time:	Locality:	Notes:
0725	USP	We depart from campus using the breakwater and headed for Nukulau.
0730	Nukulau	Water visibility excellent outside the reef. Visibility in the air was in the order of 25 miles. At an altitude of 500 ft and speed of 120 knots we fly about 70 m seaward of the reef crest. There was no sign of turtle nesting.
0735	Makuluva	There was no sign of turtle nesting on this island so we headed west along Suva Reef, across the harbour to Namuka Reef.
----	Namuka	There was no sign of turtle nesting on Namuka. The time allotted for the survey had expired and we return to Laucala Bay.
0755	Land at USP	In the 30 minute flight four Green turtles were seen on the surface. Two of these were on the Main Suva Reef the other two were in Namuka Channel and near Namuka Island respectively.

The aim of the flight was to assess the islands of Nukulau, Makuluva, Namuka and Nucuboco for turtle nesting, and to assess the suitability of the high wing Sea Bee for aerial surveys. There was no sign of nesting on any of the localities. All had human foot prints along their shores from the previous night. The Sea Bee, although comfortable enough and with high wings, had limited visibility due to small windows that were high relative to passenger head height. The aircraft was expensive and not suitable for the limited budget. An alternative aircraft would be sought.

Tide Data for 8 December 1979

Time	*Tide Height*
0338	0.4 m
0957	1.6 m
1548	0.7 m
2156	1.7 m

Phases of the moon for December 1979

December 3	Full Moon
11	Last Quarter
19	New Moon
26	First Quarter

Aerial Survey no. 2: Islands of the Astrolabe Lagoon

Date: 25 February 1980

Personnel: Graeme Southwick (pilot), Nicholas Penn (photographer), Michael Guinea (recorder).

Air Craft: Piper Cherokee Archer II (low wing)

Time:	Locality:	Notes:
1032	Nausori	We departed Nausori and climbed to 700 ft with an air speed of 110 knots. Visibility was about 60 miles.
1037	Suva	We passed the USP hangar and headed south.
1040	Suva Reef	Kadavu was just visible in the distance. The interface of the turbid lagoonal water and the clear oceanic water was 2 miles south of the main Suva Reef. We circled and photographed the interface and continued in the direction of Kadavu.
1054	Kadavu Passage	Solo lighthouse was clearly visible.
1059	Solo Lighthouse	We made a pass along the eastern edge of the reef. The seas were very calm. One adult Green turtle was feeding on the reef. One sub-adult Green Turtle was on a small reef offshore. Altitude 250 ft and heading south along the western reef. One Hawksbill and one sub-adult Green with a dark clean carapace was observed on the reef crest. A school of large dark fish was feeding on the reef crest.
----	D'Urville Channel	We crossed the channel and headed for the Astrolabe Lagoon.
----	Usborne Pass	Large coral heads were visible in the clear water. It looked like a good dive spot. Parrot fish were feeding on the reef crest.
----	Vanuakula	We inspected the beaches on the northern side at an altitude of 250 ft. This is a volcanic island with a very steep shore of basalt blocks, not good for nesting. The island appeared dry (without surface fresh water) and cut by volcanic dykes. One Hawksbill track (several days old) was high on the beach on the northern side of the island.
----	Dravuni	We passed northwards along the beach on the western side of the island at an altitude of 200 ft and airspeed of 80 knots. There was no sign of nesting on the western beach. A coastal trading ship was at anchor at the village. Large sea grass (*Syringodium*) beds extended along on the western side of the island. The northern end of the island had a blocky basalt shoreline. We headed south along the eastern beach. The most northern section is lined with coconuts and ends at a volcanic outcrop. South of the outcrop there was a single Hawksbill track some days old. Human tracks were common along the beach.
----	Qasibali	The island consisted of two volcanic plugs joined by an isthmus of white sand. The name refers to turtles crawling over the isthmus during nesting. The northern beach contains coral shingle and coral blocks. The southern beach had a narrow but deep water approach between the reefs at each end of the island. The hills were vegetated with coconuts. There was no sign of tracks on the island however from 500 ft five clearings in the vegetation were visible which could be attributed to turtle nesting.
----	Namara	This was a rocky island with beaches at the south, north, north-western and eastern sides. On the eastern beach there was a single Hawksbill track from last night with the difference between the lengths of the tracks clearly visible. In addition there was another Hawksbill track, some days old, in the vicinity of the first track. On the western beach there was some disturbance to the sand and vegetation which could have been attributed to turtles nesting but there were no visible tracks.

----	Yanu yanu-i-loma	There was one beach on the southern side of the island. The sand was very dark, almost black, with lighter patches. There was no sign of turtle tracks or nests.
----	Yanu yanu-i-sau	There were no beaches on this island.
----	Yaukuve Levu	There was no sign of turtle tracks on the beach on the western and north-eastern sides of this volcanic island. The crew from the IKA boats called into this island about Christmas for turtle eggs so there must have been some nesting going on then. The most southern beach on the eastern side has had some erosion but no sign of turtle tracks. A small stream, now dry, cut the dune on the most northern beach on the eastern side of the island.
----	Yaukuve Lailai	The island had a small beach on the north-western end of the island joined by a fault to another on the northern side by a pass (fault). The latter had areas of black sand. There was no sign of nesting on either beach.
----	Bulia	The island was inhabited and showed signs of recent destruction by a cyclone. The village had been reconstructed using galvanised iron. Many of the coconut palms were broken off some metres above the ground. There was no sign of turtle tracks on any of the beaches. A stone fish trap was constructed on the southern beach.
----	Vuro	This was an uninhabited island with a reef along the southern edge. The sand was stained orange from a soil oxide. A small stream entered the sea on the southern beach. The northern beach was stepped due to erosion by waves. The pine trees had been destroyed. There was no sign of nesting although the beaches look suitable.
----	Yabu	This was an uninhabited island. Gannets were nesting in the trees in the south-west of the island. The soil was red due to weathering of the basalt. The only beaches suitable for nesting were on the eastern side, but there was no sign of nesting. There was an algal bloom in the water, very close to the shore.
1145	Astrolabe Reef	We changed course to head north along the eastern side of the Great Astrolabe Reef past Bulia. Heading north at 750 ft and at 100 knots along the main reef, we sighted a large Green turtle at some depth. There was a very large algal area on the lee of the main reef almost due east of Dravuni with possible sea grass beds below it, and behind the patch reef. There were no turtles visible on this algal area, which extended for some miles north and south. We left the Astrolabe Lagoon and headed to Solo Lagoon. I was struck by the general paucity of turtles on this reef. There were ideal algal beds yet no Green turtles. We headed north past Solo - still no turtles seen.
1206	Solo Reef	We headed for Nagara and Namuka.
1220	Nagara	There was no sign of turtles in Nagara Passage. There were numerous large holes in the reef. The island had extensive mangroves and sea grass beds. We headed to Namuka. The reef was marked with large holes containing deep water. Namuka Island was surrounded by turbid coastal water with a slight ripple caused by the wind. There was no sign of turtles.
1242	Nausori	Landed.

Tide Data for Monday 25 February 1980

Time	*Tide Height*
0222	1.6 m
0813	0.7 m
1439	1.6 m
2108	0.6 m

Phases of the moon for February

Feb. 1	Full Moon
9	Last Quarter
16	New Moon
23	First Quarter

Aerial Survey no. 3: Islands of the Northern Lau Group

Date: 12 January 1981

Personnel: Graeme Southwick (pilot), Nirmala Nath (observer), Michael Guinea (photographer and recorder).

Aircraft: Cessna 172 (high wing)

Time:	Locality:	Notes:
1705	Nausori	We departed and headed for Laucala Island. Wind was at 12 knots from the south-east, visibility about 15 miles.
1735	Wakaya Is	We passed over Wakaya at 400 ft. There was no sign of any nesting on the western side and there was little in the way of suitable beach on the eastern side. We headed south along the island. There was no sign of any nesting on the four beaches south of the airport. There were numerous human foot prints on the beach but no sign of turtles. We headed south along the western side of the longest beach which was backed by a fresh water lagoon. Again there was no sign of nesting. The vegetation was very close to the high water mark and most of the tracks, if any, would have been obliterated by this afternoon's high tide. There was nothing to indicate that there was any large scale nesting going on at this time of the year at Wakaya.
1740	Koro Island	We had difficulty in finding Koro due to low cloud and approaching darkness. No survey of the beaches was possible and we headed to Taveuni as soon as radio contact was made with Nausori. Again we had difficulty in finding Taveuni due to low cloud and poor light. We sighted Taveuni and made radio contact with Mate on Taveuni. Visibility was very poor due to low cloud and scattered showers. We passed to the eastern side of Taveuni and lost radio contact with Mate and Nausori. We sighted Qamea covered in low cloud and rain. When we sighted Laucala Island we then regained radio contact with Mate. Darkness was setting in.
1845	Laucala Island	The Douglas family light the runway with vehicle headlights. We stayed overnight at Laucala Island as guests of Noel and Flora Douglas and family.
13 January 1981		
0911		We refueled the aircraft and waited for the weather to clear until we departed Laucala almost two hours later than anticipated. Wind was from the east, visibility was about 30 kilometres. Sunny with scattered cloud and showers around the larger islands.
0920	Raranitiqa	The island was a small rocky mass of uplifted limestone which dipped to the west. A few small terns were roosting on the bare rock. There were no beaches.
----	Beka	There were small beaches but no sign of nesting. We circled westwards around Maqewa. There was no sign of turtle nesting.
----	Yanuca	At 400 ft we experienced considerable turbulence around the island. The island was inhabited and planted with coconuts. There was no sign of turtle nesting and the high water mark from last night was easily distinguishable. The water was very clear with spectacular reefs.
----	Yavu	There was no sign of nesting either last night or previously on the beaches on the eastern side of the island.
----	Cobia	This was the cone of an extinct volcano. The lagoon was fully enclosed with a mangrove fringe. There was no sign of suitable nesting beaches on the lagoon and the beach on the southern side of the island had no sign of turtle nesting.

0946	Nukusemanu	As we approached the island from the west at 800 ft and 100 knots, visibility was about 30 kilometres. The island was a sand cay with coconuts growing to a height of 60 ft. The south-eastern side was lined with beach rock and the most suitable nesting beach was on the northern side of the island. Vegetation consisted of coconuts, *Pisonia* and *Messerschmidia*. The island supported numerous sea birds, white capped noddies, gannets roosting in trees and frigate birds. After the first pass over the island the frigate birds took flight and prevented any further low level pass over the island. A school of skip jack tuna worked the passage near the island. One fresh set of Hawksbill tracks from last night with another two sets since the last set of spring tides were visible on the beach.
----	Nukubalati *	This was a small sand cay with coconuts and numerous sea birds. Beach rock was present on two sides. One set of Green tracks from last night and another eleven Green tracks from previous nights were on the northern beach. Large numbers of brown gannets and terns were in the air over the island and prevented us from flying lower.
----	Nukubasaga	This was a larger sand cay with coconuts and a larger forest of *Messerschmidia* and *Pisonia* on the south east side of the island. There were numerous sea birds (white capped noddy terns, brown gannets, frigate birds and red footed gannets in the trees). The beach was limited to mainly shingle and beach rock, with sand on the south western side and a sand spit on the western end. There was no sign of turtle nesting on any of the beaches.
1010	Qelelevu	This reef had a very large lagoon and a village on the western side and a lighthouse on the eastern side of the island. The island was of uplifted limestone with an undercut shore on the eastern side. When we climbed to 2,000 ft to contact Mate, three brackish water lakes in the interior of the island were clearly visible. Their waters appeared stagnant, with a green algal growth and mangroves. There was no sign of turtle nesting on any of the beaches.
----	Tai ni beka	This was an uplifted coral island with no beach and no sign of turtle nesting.
----	Taulalia	This was an uplifted coral island with brackish lakes in the interior. There was no beach and no sign of turtle nesting.
----	Vetauua	This was a shingle island with a sand spit on the western side. The island was very rocky. Numerous white capped noddys and frigate birds filled the air after our first pass and made subsequent passes more dangerous. There was no sign of turtle nesting although the island looked ideal, especially the northern side. Although the island was uninhabited there were human foot prints along the beach. Graeme Southwick said that there was a 28 ft fishing boat from Suva at this island yesterday which explained the footprints and indicated that there was no recent turtle nesting. The trees, *Pisonia* and *Messerschmidia* were white with red footed gannets nesting. A dark bird like a shearwater was flying over the water. We headed south along the Heemskercq Reef towards Nanuku.
1105	Nanuku Lailai	This was the unvegetated sand cay on the southern Heemskercq Reef. There were eleven sets of Hawksbill tracks with numerous body pits.
----	Nanuku Levu	There were four Green tracks on the island since the last set of spring tides. One set was on the southern beach and three sets were on the western beach, two of which were from last night. It appeared to be similar to what I observed last year.

* Nukupureti (Clunie, 1985)

1122	Wailagilala	This island and its neighbouring sand cay, Cakadrove, have been planted extensively in coconuts. The beaches were very long, at least several hundreds of metres, and very wide which enabled good visibility for tracks. East of the light house there were numerous human tracks but no sign of turtle nesting. The eastern side of the island had extensive beach rock. There was no sign of turtle nesting on the isthmus. There was one old turtle track, too old for species identification, on the western side of the larger island. There was a small house near the light house that did not appear to be inhabited. A flock of noddys were sitting on the sand spit on the southern end of the island. The islands that form Wailagilala did not appear to be used by turtles to any great extent. We headed to Duff Reef.
1136	Duff Rf.	The sand cay on Duff Reef was much smaller than Nanuku Lailai and appeared to be little more than one metre above the high water mark. No turtles were seen in the lagoon. The cay had 8 sets of tracks of which many seemed to be without body pits although one Hawksbill track terminated with a body pit. We were low on fuel and a cyclone warning had been issued for the Fiji Group. We intended to survey as many islands as possible on our way back to Nausori. We headed for Kibobo Islets.
1145	Kibobo Islets	These consisted of three islets sitting inside the reef crest. The highest was 190 ft. They did not look promising as the largest islet had a sand beach backed by rock and no well formed sand dune. The smallest islet had a poorly formed very rocky beach behind which the vegetation was intact and there was no sign of turtle nesting. We were running short of time and headed for Malima.
1158	Malima	This consisted of two islands. There was one set of Hawksbill tracks from last night on the smaller island. In the lagoon of the larger island there was an adult Hawksbill at the surface. The tide was rising high on the beach but human tracks were visible on the larger island as were the remnants of an old set of unidentifiable turtle tracks. There was a large amount of air turbulence around the island so we headed to Vatu Vara.
1210	Vatu Vara	This was an uplifted limestone mountain about 350 m high. There were beaches on the south-east and south-west sides. The remainder of the island was a rocky limestone cliff under cut by wave action. There was no sign of nesting on any of the beaches. The hinterland of the beaches formed into two gullies that supported the greenest vegetation, possibly rain forest, on the island. The lagoon on the western side of the island had beaches but with no sign of turtle nesting. A dilapidated corrugated iron and timber house was situated amongst the coconuts, about 100 m from the beach. The island looked uninhabited. The channel to the lagoon entered from the north through a break in the reef. The entrance was nothing more than a groove, 15 m wide running parallel to the beach. We experienced strong air turbulence in the lee of the island. We headed towards Nausori at 1228.
1330	Ovalau	The sand cay between Ovalau and Mabualau had large numbers of terns resting on the sand but no sign of turtle nesting. There were a large number of black naped terns resting / nesting? on the wreck which was high on the reef north of Mabualau.
1340	Mabualau	Numerous red footed gannets were nesting in the trees but there was no sign of turtle nesting. We headed for Nausori.
1400	Nausori	Landing.

We were due to continue the survey of the Lau Group the next day. However with the cyclone warning in force, the plane is required to return to Nadi where it was secured. During Cyclone Arthur the next day, the Cessna 172 was extensively damaged and was unserviceable for some months.

Tide Data for Monday 12 January 1981

Time	*Height*
0452	0.3 m
1116	1.6
1726	0.5
2327	1.6

Tuesday 13 January 1981

Time	*Height*
0544	0.3 m
1211	1.6
1825	0.5

Phases of the Moon for January

January	6	New Moon
	13	First Quarter
	20	Full Moon
	28	Last Quarter

Note:

On 14 January 1981, Cyclone Arthur damaged the Cessna 172 which we had used on the initial leg of the survey. As the plane had extensive damage to the wing the survey was postponed until repairs could be arranged. The repairs took considerably longer than anticipated and the survey was rescheduled for December 1981. However on 23 November 1981, the Turtle Airways Cessna 172 crashed in Lami Bay during bad weather. The plane was destroyed, the passenger killed and the pilot / mechanic injured. There was considerable delay in finding a suitable and affordable plane to survey the southern Lau Group which was rescheduled for late January 1982. Cyclone Hettie passed through southern Lau hitting Ono-i-lau on 29 January 1982. The navigation beacon on the island was damaged and the area was closed to civil aviation. The proposed aerial survey of the islands of Southern Lau was cancelled.

List of latitudes and longitudes of localities mentioned in aerial survey.

Beka	16°30'30" S, 179°39'45" W
Bulia	18°50'15" S, 178°32'30" E
Cobia	16°27'30" S, 179°39'45" W
Dravuni	18°46'00" S, 178°31'45" E
Duff Reef	16°50'45" S, 178°56'00" W
Kibobo Islets	16°03'30" S, 179°01'00" W
Laucala I.	16°45'00"S, 179°40'00" W
Mabualau	17°59'00"S, 178°46'00" E
Malima	16°07'30" S, 179°11'00" W
Maqewa	16°30'00" S, 179°40'15" W
Makuluva	18°11'15"S, 178°31'40"E
Mate (Taveuni)	16°41'00" S, 179°52'00"W
Nagara	18°10'00" S, 178°17'00"E
Namara	18°47'15" S, 178°30'15" E
Namuka	18°09'00" S, 178°21'00" E
Nanuku Lailai	16°42'30" S, 179°26'15" W
Nanuku Levu	16°43'15" S, 179°26'30" W
Nausori (Viti Levu)	18° 01'00"S, 178°33'00"E
Nukubalati (Nukupureti)	16°18'30" S, 179°15'30" W
Nukubasaga	16°18'00" S, 179°14'30" W
Nukusemanu	16°20'00" S, 179°24'30" W
Ono	18°52'45" S, 178°29'30" E
Ovalau	17°40'00"S, 178°48'00"E
Qamea	16°45'00" S, 179°45' 00" W
Qasibali	18°48'00" S, 178°30'15" E
Qelelevu	16°05'15" S, 179°09'30" W
Raranitiqa	16°32'30" S, 179°41'30" W
Solo Lighthouse	18°38'15" S, 178°32'20" E
Vanuakula	18°44'15" S, 178°30'45" E
Vatu Vara	17°26'00" S, 179°31'00" W
Vetauua	15°57'00" S, 179°24'00" W
Vuro	18°51'45" S, 178°31'45" E
Wailagilala	16°45'00" S, 179°06'00" W
Wakaya	17°37'00" S, 179°01'00" E
Yabu	18°50'45" S, 178°30'30" E
Yanu Yanu-i-sau	18°46'40" S, 178°30'30" E
Yanu-i-loma	18°46'50" S, 178°30'15" E
Yanuca	16°30'00" S, 179°41'00" W
Yaukuve Lailai	18°48'45" S, 178°31'45" E
Yaukuve Levu	18°48'00" S, 178°32'00" E
Yavu	16°30'15" S, 179°42'15" W

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