

SOUTH PACIFIC COMMISSION
TURTLE PROJECT

A CONSTRUCTIVE REVIEW AND EVALUATION
WITH RECOMMENDATIONS FOR FUTURE ACTION

prepared for

The South Pacific Commission
Noumea, New Caledonia

by

G. H. Balazs
Hawaii Institute of Marine Biology
P. O. Box 1346
Kaneohe, Hawaii 96744

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1. INTRODUCTION

Terms of Reference

1.1 This report is the result of a request made by the South Pacific Commission (SPC) for me to undertake an on-site review and evaluation of the agency's three year old special project on marine turtles. The Terms of Reference, dated 19 January 1977, and communicated by Dr. R. Grandperrin, SPC Fisheries Adviser, were as follows:

"To advise the South Pacific Commission on the future of the South Pacific Commission Turtle Projects based in Fiji and the Cook Islands. The short-term consultant will:

- (a) visit the SPC Turtle Project based at the University of the South Pacific in Fiji,
- (b) contact Dr. U. Raj, in Fiji, who is running the Project,
- (c) contact Mr. R. Stone, Chief Fisheries Officer, Ministry of Agriculture, Forest and Fisheries, in Fiji,
- (d) visit the SPC Turtle Project based in Rarotonga, Cook Islands,
- (e) visit the location chosen in Aitutaki, Cook Islands, to set up a semi-intensive turtle farm,
- (f) contact Mr. D. Brandon who is running the Project in Rarotonga,
- (g) contact Mr. T. Marsters, the Director of Fisheries in Rarotonga,
- (h) submit an appraisal of the above two projects or otherwise for continuation of the Projects,
- (i) advise the South Pacific Commission on other possible actions on turtles (farming, conservation, clearing house, workshop, information, publication, etc.),

(j) report to the South Pacific Commission before the end of April 1977."

1.2 As an additional responsibility, I also considered it necessary to carry out a literature review of SPC's historical involvement with turtles, and to examine the status of several related turtle projects undertaken by other agencies. My objective in this respect was to bring together in one document salient points on which to base sound recommendations for future action.

1.3 The fieldwork portion of the assignment was conducted between 21 February and 12 March 1977, as shown in Appendix A. During the course of the trip, information relevant to the review and evaluation was also obtained from individuals other than those specified in the Terms of Reference. A list of the additional persons consulted appears in Appendix B.

1.4 Although not required by the Terms of Reference, a two day visit was made to Western Samoa for the purpose of examining the Government sponsored hawksbill turtle hatchery and gathering information from personnel of the Fisheries Division.

Background Material Available

1.5 Upon acceptance of the assignment, I requested that all written background material on the project be sent to me from SPC headquarters in Noumea. The literature received consisted of the following:

- (a) progress reports of the SPC Turtle Project prepared separately by Dr. Raj and Mr. Brandon,
- (b) reports of the SPC technical meetings on fisheries,
- (c) selected copies of *The SPC Fisheries Newsletter*,
- (d) selected copies of *The South Pacific Island Fisheries Newsletter* issued by the now defunct South Pacific Island Fisheries

Development Agency (SPIFDA), a special project funded by the United Nations Development Program (UNDP),

- (e) two reports on marine turtle resources in the Pacific (Hirth, 1971a; Hendrickson, 1972) prepared by SPIFDA consultants.

1.6 In addition, the following material was also at my disposal:

- (a) reports of the second and third meetings of the SPIFDA Fisheries Consultative Committee obtained from the Pacific Collection, Sinclair Library, University of Hawaii,
- (b) copies of correspondence which I had exchanged between 1973 and 1976 with Mr. R. H. Baird (former SPC Fisheries Adviser, deceased) and Mr. Brandon,
- (c) a copy of the paper entitled, Special Project on Inshore Fisheries Development, supplied by Mr. Baird,
- (d) a copy of Mr. Brandon's contract with SPC, provided during my visit with him in Rarotonga,
- (e) substantial literature and correspondence on marine turtles from my personal reference library.

1.7 Background information was also available from discussions of marine turtles carried out during 1976 over the satellite communications system, PEACESAT. Mr. Brandon in Rarotonga, as well as representatives of other Pacific areas, were contributors to this seminar series.

2. HISTORICAL ASPECTS

Chronology of SPC/SPIFDA Involvement with Turtles

2.1 Interest in marine turtles by the South Pacific Commission formally commenced in 1968 at the SPC Technical Meeting on Fisheries. This resulted in part from a working paper of the meeting which stressed the importance of conserving turtle resources in the Pacific (Hendrickson, 1968). In Agenda Item 5 entitled, Survey of Marine Turtle Resources and Possibilities of Turtle Farming for Protein and Luxury Export Products, the meeting noted that:

"...the green turtle (*Chelonia mydas*) in particular is a valuable source of food in the Pacific but that there is a danger of the stocks being over-exploited. It was agreed unanimously that a survey of marine turtle resources should be instituted and the possibilities of turtle farming be investigated." (SPC, 1968).

2.2 Acting apparently on the meeting's recommendations, questionnaires on turtles were subsequently distributed to fisheries departments (Anon., 1969), and two consultants (Drs. H. F. Hirth and J. R. Hendrickson) were contracted by SPIFDA for short periods in 1970 and 1971 to provide expert assistance.

2.3 Dr. Hirth's assignment was: to prepare a synoptic review of Pacific turtle stocks (Hawaii, Tahiti, Samoa, New Caledonia, Tonga and Fiji); to draft preliminary programs for assessment studies; to train local authorities for implementing these programs; and "to give general advice on the practicability of turtle farming." Hirth's (1971a) final report provided important preliminary information and recommendations for these aspects. On the subject of turtle culture, it was specifically recommended that:

"any ranching or farming be attempted only on a very *small scale* and *only* if scientific expertise is available. Considering that only about ten species of freshwater fish have been successfully farmed, some discretion must be exercised before pursuing any form of marine farming."

Furthermore, it was recommended that:

"In order to provide base-line data for turtle mariculture, the turtle grass pastures in Fiji should be studied."

This aspect was emphasized because, in Dr. Hirth's opinion:

"There are thousands of hectares of turtle grass pastures around the world which could be utilized by mariculturists provided base-line data...are available. In order to start a program of this nature, a turtle expert is needed in Fiji...."

2.4 As a short-term consultant to SPIFDA, Dr. Hendrickson's assignment was: to inspect and report on the commercial turtle culture enterprise (Mariculture, Ltd.) on Grand Cayman Island in the Caribbean; to supplement Dr. Hirth's review of Pacific turtle stocks; and "where feasible, to design programmes with detailed instructions for the establishment of turtle farms and give training to local personnel in the implementation of these programmes."

2.5 The report covering Dr. Hendrickson's inspection visit to Mariculture, Ltd. was never made available for distribution by FAO, the executing agency of SPIFDA (see SPIFDA, 1972, page 68).

2.6. Hendrickson's (1972) published report on the other aspects of his assignment included findings and recommendations for Micronesia and Papua-New Guinea, and provided information on a turtle farming experiment

on Darnley Island (Torres Strait) that had been initiated in early 1971, approximately six months prior to his visit. The report states that:

"The cottage-industry level to which the Darnley Island farms are adjusted is considered the more logical level for most Pacific Island turtle farms in the foreseeable future (as contrasted with the capital-intensive system of Mariculture, Ltd. farm in the Caribbean) and is the only existing example of such activity known to the consultant."

It was therefore recommended that:

"Dr. Bustard (the Principal Investigator) should be invited to prepare a fairly detailed description, with black-and-white photographs, of his experimental farms on Darnley Island for circulation to interested governments and private individuals in the South Pacific as a model of one way to approach the problem of turtle culture at cottage industry level. Insofar as possible, and explaining clearly that his project is not represented as an accomplished success at this stage, he should be encouraged to provide a manual which anticipates minor practical questions and describes the solutions chosen on Darnley Island."

For reasons which will be described in 4.2-4.8, such a manual was never prepared.

2.7 Hendrickson's (1972) report also recommended that:

"...in Micronesia the establishment of private turtle farms as business investments should be discouraged until such a time as the resource has been subjected to a careful inventory, the

techniques for farming have been demonstrated elsewhere, and the market forecast can be shown to be favourable."

However, for Papua-New Guinea it was recommended that:

"...an attempt should be made to encourage...a small number of farms more or less following the Darnley Island pattern... This programme should be under the supervision of the Government, because it will, for some years, involve more research than applied practice,"

It should be noted that the difference in recommendations for the two areas was also based in part on the tentative conclusion that Melanesians, in comparison to Micronesians, were more motivated economically toward "independent, demanding activities such as would be involved in successful turtle farming" (Hendrickson, 1972).

2.8 It must be stressed at this point that, although both the Hirth (1971a) and Hendrickson (1972) reports listed several important recommendations relating to the possibilities of turtle culture, the *principal* recommendations set forth by these consultants concerned the need for long-term surveys and assessments of Pacific turtle resources.

2.9 At the next (1970) SPC Technical Meeting on Fisheries following the 1968 meeting referred to in 2.1, official mention of turtles appeared only in a recommendation urging that "turtle culture, farming and conservation" be the subject of one of six technical marine symposia that should be held during the following three year period, 1971-1973 (SPC, 1970). Such a symposium was never held.

2.10 In early 1971, experiments on the rearing of hawksbill turtles (*Eretmochelys imbricata*) were started in Koror, Palau under the partial

auspices of SPIFDA (Doumenge, 1973a). The principal objective of this work was to raise hatchlings to a large enough size where high predation could hopefully be avoided when the turtles were released into the wild. Growth and food conversion ratios were also examined in an effort to determine future possibilities for capture culture (McVey, 1972).

2.11 The next event of significance involving turtles took place in late 1971 when the Second Meeting of the Fisheries Consultative Committee of SPIFDA approved a proposal for a defined and formal Marine Turtle Project. The recommendations of Drs. Hirth and Hendrickson were, to a large extent, responsible for this action. In granting approval, the Committee stated that:

"turtles constitute an important but endangered resource in the South Pacific region and...that little background material is available for wise management of this resource."

Three overall objectives were listed for the Project: to produce a basic handbook on turtle management; to initiate comprehensive turtle-tagging programs in selected territories; and to compile, summarize and circulate pertinent turtle information using the framework of SPC (SPIFDA, 1971).

2.12 It is important to note that in the organizational plan for the various SPIFDA projects, the Marine Turtle Project was categorized by itself, and did not come under the sectional designation of Aquaculture (SPIFDA, 1971).

2.13 Between late 1971 and mid-1972, many of SPIFDA's activities had to be suspended while a review of the entire program took place by UNDP.

Full implementation of the newly created Marine Turtle Project consequently

did not occur. Nevertheless, during this period of abeyance it was possible for SPIFDA to provide some assistance to the tagging of turtles at several Pacific locations (Doumenge, 1972a, 1972b). Also, on Dr. Hirth's advice, it was decided during this period to postpone publication of a turtle handbook until further data were available.

2.14 Review of the SPIFDA program was carried out by Mr. R. S. Croaker, special consultant to the Administrator of UNDP. Results and recommendations of Mr. Croaker's investigation were discussed at the Third Meeting of the Fisheries Consultative Committee (August 1972); the full text of his report appears in SPIFDA (1972). The alternatives available to UNDP for the future of SPIFDA were: to terminate the program immediately or at the conclusion of its term in July 1973; or to support the program adequately with funds and personnel. The Croaker Report recommended that the program should be supported adequately with funds and personnel, and that concentration should be placed on three principal areas of work in order to "...achieve substantial results in a minimum of time." The three areas of work recommended were:

- "(a) Development of aquaculture techniques for fish, molluscs and crustaceans in the inner lagoons and turtles on the beaches;
- (b) Development of fishing in the river deltas and mangrove areas;
- (c) Development of bottom and surface fishing along the outer edge of the outer reefs."

Such areas were selected for emphasis because in Mr. Croaker's estimation, they were

"...the three potentially most productive activities that had been identified during SPIFDA's Phase I or feasibility survey period."

With respect to turtle aquaculture referred to in (a), no literature or other reference sources were cited to support such a conclusion. However, unsubstantiated statements on the status of turtle aquaculture published by Doumenge (1973a, pages 6 and 10) may have been at least partially responsible for Mr. Croaker's recommendation. Another contributing factor may have been the reprinting of a list of potential species previously compiled at a small invitational conference on aquaculture held in Hawaii (Doumenge, 1973b). Turtles were rated high on this list on the basis of a verbal report given by a former consultant to the company Mariculture, Ltd. This information was later found to be incorrect.

2.15 As an added recommendation, the Croaker Report indicated that the "small-scale turtle tagging project" should be continued, particularly in view of the fact that SPC, as a counterpart agency, had agreed to pay (\$2,700) for this work through July 1973.

2.16 The final decision by UNDP was to not provide additional funds or personnel to SPIFDA, thereby allowing the program to terminate in July 1973. Activities with turtles by SPIFDA between August 1972 and the termination date were limited to some further assistance in tagging, mostly in French Polynesia (Doumenge, 1972c, 1973c).

3. THE SPC TURTLE PROJECT PROPOSAL

Origin of Proposal

3.1 Termination of the SPIFDA program resulted in an absence of support for projects under its auspices. As a counterpart, SPC was the logical agency to assume responsibility. Project proposals on "mariculture continuation and outer reef fishing developments" were therefore submitted to the SPC Sixth Technical Meeting on Fisheries (July 1973) in order "...to continue and extend the work started by SPIFDA on a regional basis" (Baird, 1973a). "Turtle farming" was the title of one of the sub-projects proposed at this meeting (SPC, 1973), and was undoubtedly considered to be a continuation of the work (or proposed work as per the Croaker Report) of SPIFDA.

Project Outline and Objectives

3.2 Correspondence (dated 19 December) which I received from Mr. Baird in 1973 stated that SPC would have "a small turtle farming project starting in 1974," and that a "copy of the project outline" was enclosed for information purposes. The project outline referred to consisted of Working Paper 11 of the SPC Thirteenth South Pacific Conference entitled, Special Project on Inshore Fisheries Development (Anon., 1973).

3.3 Working Paper 11 consists of three parts (body, summary and addendum), with sections covering lobsters; beche-de-mer (*Holothurians*); reef, lagoon and mangrove fish; molluscs; turtle farming; and fish. The latter three topics appear under the heading, Aquaculture. No literature or other reference sources are given in the paper.

3.4 In the body of the paper, the section on turtle farming states:

"13 In areas where nesting turtles occur, turtle farming by means of hatcheries and rearing has been shown to be a congenial

and effective operation at the village level, producing both protein food and cash, while at the same time contributing substantially to conservation of turtle stocks.

14 An investigation of the feasibility of this operation in one or two Pacific islands is considered a well worthwhile low cost project. A reasonably successful farming operation could be used as a demonstration centre and a substantial industry could be built up in the Pacific area for turtle products.

15 Turtles have the advantage, like Beche-de-mer and possibly lobsters, of being able to be held in remote areas awaiting collection for processing and marketing without the need for high cost freezing equipment."

This section also appeared in Baird (1973b).

3.5 In the summary of the paper, the section on turtle farming states:

"Some considerable success has been achieved with Green Turtle farming in the Torres Straits and with Hawksbill Turtle rearing in Western Samoa. In many territories where there is no great tradition of fishing but some considerable tradition of farming, such culture could produce satisfactory results in terms of protein and cash. The possibilities should be investigated in one or two territories."

This section also appeared in SPC (1973).

3.6 The addendum of the paper states that:

"(i) The proposal set out (in the body and summary) was examined in detail by the SPC Sixth Fisheries Technical Meeting which was held from 23 to 27 July 1973.

(ii) The proposal was strongly supported by the meeting.
 (iii) However, the meeting considered that effort under this project should be concentrated on:

(a) The Development of Lobster Fisheries

(b) Turtle Farming

(iv) The meeting recommended that:

(a) in view of the great importance placed upon turtle conservation and the prospective value of turtle farming, the turtle sub-project should be expanded to ensure that consultant services should be made available throughout the duration of the project, to permit visits to interested territories."

Furthermore, the addendum contains the "Secretariat Comments" which state:

"The Secretariat recommends that the views of the SPC Sixth Fisheries Technical Meeting be adopted, and proposes the following revised (expanded) Budget for the Project:

<u>Turtle Farming Sub-project</u>	
Consultant-Travel Costs	\$A5,000
Research Officer (on secondment or volunteer) - Allowances:	4,000
Travel Costs:	2,000
Equipment and Materials	5,000
Training Fellowship	<u>4,000</u>
Total Annual Cost	20,000"

The duration of the project is given as three years (1974-1976).

3.7 To my knowledge, there are no other documents (i.e., formal research proposal) which define the overall objectives of the SPC Turtle Project.

3.8 Based on the statements referred to in 3.3-3.6, the specific overall objectives of the project are assumed to be:

- (a) to investigate on a Pacific island the feasibility of village level turtle farming for the purpose of producing high protein food and cash income, while contributing substantially to the conservation of natural turtle stocks;
- (b) to use any resulting successful turtle farm as a demonstration center for expanding such an industry in the Pacific.

Methods

3.9 To my knowledge, there are no documents which define the research methods to be used to achieve the project's overall objectives.

Responsibilities

3.10 Correspondence (dated 19 December) which I received from Mr. Baird in 1973 stated that:

"I had discussed with Professor McInerney of USP (University of the South Pacific) the possibility of USP doing some basic work on feeding with particular reference to use of coconut meal in the diet. John McInerney put me in touch with Dr. Raj who has tentatively agreed to undertake some of this work with some funding by SPC. The main experimental farming will be done in the Cook Islands, with a graduate volunteer as Project Officer."

3.11 Dr. Raj consented to accept responsibility for some of this basic research, as indicated by his first progress report (Raj, 1974):

"Following discussions with the Fisheries Officer of the South Pacific Commission, Mr. R. H. Baird, the author undertook to carry out aspects of research on marine turtles at the University of the South Pacific, in Fiji. The research program was commenced in January, 1974. It was agreed that the initial effort should be concentrated on the study of the factors affecting the growth of hatchlings and young turtles. The studies were to include aspects of diet, density factors, the effects of light, tolerances to reduced salinities (mainly for evaluating health problems and the minimum salinity required to inhibit fungal growth) and effective tagging of smallest individuals."

3.12 Baird (1974a) subsequently announced in *The SPC Fisheries Newsletter* that:

"...preliminary investigations have been set up with the University of the South Pacific in Suva, where turtle-holding tanks for feeding experiments are being constructed and collection of eggs and/or turtle hatchlings are being made. Funds have been made available to the University of the South Pacific for this purpose."

3.13 Statements referred to in 3.10-3.12 are of value in that, to my knowledge, there is no formal research contract or proposal between SPC and Dr. Raj which delineates responsibilities of the involved parties.

3.14 Responsibilities for 'experimental farming in the Cook Islands' (referred to in 3.10) were delegated by SPC in July, 1974 with the appointment of

Mr. Brandon, a volunteer with a recent Bachelor degree in zoology. Under the Duties and Responsibilities section of Mr. Brandon's formal contract with SPC (Betham, 1974) it is stated:

"You will be responsible to the South Pacific Commission Fisheries Adviser to:

- (a) set up a small experimental and demonstration turtle hatchery and farm in the territory in which you will work;
- (b) liaise closely with the University of the South Pacific in Suva on experimental feeding work in relation to turtles;
- (c) oversee and assist in the building and operation of hatcheries and turtle ponds, using local materials and skills, where possible;
- (d) prepare progress reports and reports suitable for dissemination to the Territories from time to time;
- (e) work with and train Territorial personnel."

3.15 Although it appears to have been implied that the SPC Fisheries Adviser would serve as coordinator, to my knowledge there was no assignment of responsibility for overall leadership or direction of the two segments of the project.

Selection of Geographical Locations

3.16 There is no indication of the methods used to select the location for doing basic feed formulation and other growth related research. The selection of USP Fiji does not appear to have been based on prior experience or expertise in the areas of marine turtle biology or applied nutrition.

3.17 Selection of a location to conduct experimental fieldwork appears to have been based, to a large extent, on the fact that no SPC fisheries project existed in the Cook Islands at the time the Turtle Project was proposed. In my discussions with Mr. Marsters in Rarotonga, it was indicated that, at the Sixth Technical Meeting on Fisheries (1973), he made a request for the SPC Turtle Project to be located in the Cook Islands. His stated objective in doing so was to establish what he thought at the time was a worthwhile project which would significantly benefit turtle stocks, thereby bringing recognition and respect to his country.

4. A REVIEW OF SOME RELATED TURTLE PROJECTS

General

4.1 A worldwide interest presently exists in marine turtles due to the combined factors of their economic value and rapidly declining numbers. At many locations research efforts are underway to gather baseline data for devising plans of protection and rational utilization. Only a few of these projects have considered it justified to place major emphasis on culturing turtles. For the three years of its existence, however, the SPC Turtle Project has concentrated almost totally on such investigations even though very little in the way of basic stock surveys and assessments have been carried out in the SPC region. The rationale for this emphasis is stated in the project outline (3.4-3.5) and relates to certain successes (biologic, economic, conservational and cultural) thought to have been achieved by other captive culture projects. A review of these related projects will therefore be beneficial for clarification purposes.

Northern Australia (Torres Strait)

4.2 Torres Strait and certain other areas of Australia contain some of the world's largest remaining stocks of marine turtles. In 1970 the Commonwealth Government provided a grant for \$27,730 to initiate a three year investigation of the turtles of Torres Strait (Anon., 1970). The study was undertaken by Dr. H. R. Bustard, Australian National University, with the objectives of analyzing the population ecology of the turtles, and introducing turtle culture as a possible industry for native people of the area (Bustard, 1972).

4.3 By 1973, over 100 islanders were receiving training salaries to independently rear groups of 150-250 green or hawksbill turtles for a government-subsidized culture project under Dr. Bustard's supervision (referred to in 2.6). The husbandry techniques consisted of obtaining hatchlings from natural nesting beaches and raising them in various types of land based containers on a diet of chopped fresh fish. Sea water in the containers was changed twice daily by hand and fish were obtained from adjacent waters. Conservation of the naturally occurring turtle stocks was claimed to be achieved by releasing, at one year of age, 10% of the hatchlings taken. The farming plan called for turtles to be grown in this "cottage industry" fashion to a juvenile size (estimated 15-25 lbs), at which time some would be stuffed for the curio trade, and the remainder transferred to sea pens for rearing to a market size of 100 lbs or more. Design and construction of the sea pens, however, had not started. Furthermore, it was undetermined what methods and food resources would be used to feed the larger turtles once placed in the pens.

4.4 Nearly \$575,000 had been spent on this scheme by 1973, and a request was made for an additional \$1,500,000 for future activities. The entire project subsequently became the topic of an investigation by the Australian Attorney-General's Department, the Auditor-General, and consultant scientists (Drs. A. F. Carr and A. R. Main) who were asked to conduct an independent review of the ecological implications (Toohey, 1973).

4.5 The resulting report by Carr and Main (1973) indicated that the project had "complex ramifications" and cautioned against "simplistic or wishful thinking in assessing its achievements and in planning for its future."

In the consultants' judgement, "Solutions for several fundamental problems cannot now be seen and these impart uncertainty to the outlook of the enterprise." The key problems identified were: devising a technology for penning the larger turtles in the sea; achieving self-sufficiency in egg and hatchling production; developing a selected strain of farmed turtle that could be readily differentiated from wild turtles; conducting proper experiments to test the efficiency of the basic conservation claim of the project; managing production and marketing in a way to avoid stimulating new markets and thus causing increased pressure on natural stocks; and winning the confidence of world conservation organizations in the validity of the project's conservation claims.

4.6 One of several other areas of concern identified in the Carr and Main (1973) report was that the size of the fish resource used to feed the turtles was unknown. Although seemingly abundant, severe doubt was expressed that it could support an increasing turtle farming project and an expanding human population. Few records on feeding rates (or any other aspects) had been kept on the project, however it was estimated that Darnley Island alone was using 1,700 lbs of fish daily for feeding turtles. If fish comprised the major food source for larger turtles raised in sea pens, the total farming effort would probably require 12,000 lbs daily. On the subject of utilizing the green turtle's herbivorous feeding habits, Carr and Main (1973) stated:

"Ideally, the green turtles would be held on turtle-grass flats, where natural vegetation would furnish most of the feed required. The feeding area needed to support a green

turtle is not known, nor is anything known of the regenerative capacity of heavily grazed, underwater vegetation."

4.7 Carr and Main (1973) praised the native farmers for their "initiative" and "resourcefulness," stating "The dedication and good sense that they are putting into the project is one of its main assets." It was cautioned, however, that:

"on ecologic and conservational grounds we consider it unlikely that the present project will prove suitable for expansion as the whole or even the principal economic support of the Torres Strait Islands. We therefore suggest that other appropriate occupations that will allow these deserving people to remain in their island communities be sought."

4.8 In mid-1976 I wrote to Dr. K. Radway Allen, Chief of Division of Fisheries and Oceanography, CSIRO, Cronulla, N.S.W., requesting information on the status of the Torres Strait project. Correspondence (6 July 1976) received from Dr. Allen stated:

"Following the Carr-Main report on the original turtle farming project which was under the control of Dr. Bustard, the operation was placed in the hands of a government-owned company, Applied Ecology Pty. Ltd. of which I am one of the Directors. The function of this company is to carry out research and investigations on the possibility of developing improved use of the natural resources by the native peoples of Australia and Torres Strait, in ways which are consistent with their existing manner of life. The turtle project is one of

several which we have under study at the present time. We have only been able to proceed slowly with this since a great deal of re-organization was necessary and we had to establish good means of working with the Torres Strait Islanders. We are however making useful progress, I believe, in two directions...Our two approaches are to develop farming techniques which are applicable to the particular social conditions existing in the islands, and to gain data on the state of the stocks of green turtles, so that we may be able to assess to what extent we can safely draw on these in establishing farm stock."

Western Samoa

4.9 In February 1971 the Fisheries Division of the Government of Western Samoa initiated a small turtle research project in order to gather information on the native hawksbill population and, if possible, replenish the declining stocks (Witzell, 1972a, 1972b).

4.10 Nesting was found to occur only on three offshore islets at the eastern end of Upolu Island. In an effort to reduce predation from both human and natural causes, an experimental hatchery scheme was started whereby egg clutches were transplanted for incubation in a protected facility close to the nesting islets. The resulting hatchlings were then reared in tanks for one month on a diet of chopped fresh fish and clams. During this period in captivity, the turtles increased from approximately 4.0 cm to 5.6 cm in shell length and were therefore considered to be less vulnerable to predation and have better chances for survival in the wild. Prior to release, a selected marginal shell plate was notched to identify the year of hatching (Witzell, 1972c; correspondence from A. C. Banner, April 1972).

4.11 In conjunction with the hatchery program, interest subsequently developed in the possibility of establishing an export industry by raising hawksbills to a size suitable for stuffing as curios (Banner, 1971). However, experiments in raising the turtles for periods of more than a few months revealed the existence of many problems that could not be satisfactorily solved. Difficulties encountered included the need to frequently change sea water in the tanks due to fouling, and the presence of disease which caused serious tissue necrosis. This infliction was aggravated by the turtles' constant biting of one another. Food was also found to be a major problem. On this subject, Witzell (1972a) stated:

"We experimented with most of the local food sources but found nothing suitable which was cheap, easy to obtain and good for the turtles."

4.12 The plan for establishing an industry in hawksbill curios was abandoned, however a request for funds to do further experimentation was made to SPC by one of the Peace Corps Volunteers working on the project (Witzell, 1972c). No funds were granted for this purpose. It should be noted that the statement by Doumenge (1973a) that "an experimental green turtle farm" was being built by the Fisheries Division in Western Samoa was erroneous.

4.13 In August 1974 personnel of the Fisheries Division reconsidered the possibilities of culturing hawksbills in conjunction with the hatchery. Such a proposition was found to be "not realistic," and it was recommended that the facility's original purpose of experimental restocking for conservation purposes be continued (Anon., 1974).

4.14 During my recent visit to Western Samoa, the hawksbill hatchery was found to be still fully in operation. The success of the restocking effort, however, continues to be inconclusive although cautious optimism exists due to the recovery of several juvenile shells bearing notches.

Micronesia (U. S. Trust Territory)

4.15 As an experimental conservation measure, the Marine Resources Division of the U. S. Trust Territory conducted a hawksbill rearing project on Koror, Palau between 1971 and 1973 (referred to in 2.10). The methodology consisted of collecting hatchlings from natural nesting beaches and raising them in tanks with running sea water for periods of up to six months before release. During this time, various kinds of fish were used for food; benthic algae were offered but only traces were consumed (McVey, 1972).

4.16 As in Western Samoa, one of the difficulties encountered was the turtles' habit of frequently biting one another, thereby causing ulcers that in turn served as targets for further aggression. Another problem was the persistent growth of algae on the turtles' shells which softened the plates and created a generally unhealthy condition (correspondence from R. Simandle, Dec. 1972).

4.17 With respect to the feasibility of turtle culture, McVey (1972) stated:

"Raising young hawksbill turtles in captivity appears to be possible on a limited scale...Whether or not these animals can be raised economically will depend on the proximity of a cheap protein source (for food)."

4.18 Correspondence (dated 15 February 1977) which I received from Dr. J. P. McVey, Chief of the Micronesian Mariculture Demonstration Center, Koror, Palau, indicated that, to his knowledge, no formal projects dealing with marine turtles presently exist in the U. S. Trust Territory.

Grand Cayman Island

4.19 Much of the interest in commercial turtle culture that has come about over the past eight years can be attributed directly to the activities and publicity of a privately owned company on Grand Cayman Island known originally as Mariculture, Ltd. (referred to in 2.4-2.6 and 2.14). Numerous complex and controversial issues of a biologic, economic and conservational nature have surrounded the enterprise since its establishment in 1968.

4.20 The original concept of this endeavor was to raise hatchling green turtles to one year of age for release into waters around Grand Cayman Island where they were suppose to reside, feed and grow on the abundant flats of turtle grass. Ownership of the turtles by the company was to be shown by the presence of identification tags. Eggs for this scheme were obtained from natural nesting beaches in Costa Rica and Ascension Island for incubation and hatching at the company's facility. However, it was the intention to become self-sufficient through captive breeding at some point in the future (R. E. Schroeder quoted in Bustard, 1972).

4.21 The plan for "open-range ranching" of underwater pastures subsequently changed to a heavily capitalized, totally land-based system of tanks in which the turtles were raised from hatchlings to market size on an artificially prepared diet. Exchange of seawater was achieved by diesel

powered pumps, and a high protein pelleted food consisting principally of soybeans and fish meal was imported from a feed manufacturer in the United States (Indiana). A general description of the culture facility and husbandry techniques has been presented by Hendrickson (1974), while more detailed information on the incubation and hatching of eggs can be found in Simon (1975).

4.22 Some of the crucial questions that have been raised by several conservation organizations and research scientists during the course of the company's development are:

- (a) the effects of its worldwide marketing program, removal of eggs, and other activities on the conservation of naturally occurring turtle stocks;
- (b) the validity of its various conservation claims;
- (c) the ability of the scheme to become totally self-sufficient in the production of eggs and hatchlings (become a true farm);
- (d) the validity of claims made in promotional literature as to the biologic and economic "successes" achieved in turtle culture.

Carr (1972), Carr and Main (1973) and Ehrenfeld (1974) have discussed many of the associated problems, and expressed concern as to the possible outcome.

4.23 In November 1974 the International Union for Conservation of Nature and Natural Resources (IUCN) convened a meeting of a specially constituted task force to review the commercial exploitation of marine turtles, and to give particular attention to the status and implications of turtle culture. An inspection visit to the facility on Grand Cayman Island was carried out in conjunction with this meeting. Three of the important findings resulting from this visit were:

- (a) "that Mariculture, Ltd. has made claims and statements which are misleading and demonstrably incorrect;
- (b) that the present operations of Mariculture, Ltd. cannot be regarded as being in the conservation interests of the green turtle;
- (c) that the viability of its turtle culture operation has yet to be proved, as indeed has that of turtle farming in general."

The full text of the report on the inspection visit appeared in Balazs (1976a).

4.24 The major accomplishment of the IUCN task force meeting was the formulation of a set of 'Principles and Recommendations' for the utilization and conservation of marine turtles. This useful document has been reprinted by Dahl (1975a) for dissemination in the SPC region.

4.25 In May of 1975 Mariculture, Ltd. declared bankruptcy and was placed in receivership. However, liquidation and closure of the facility did not result due to the purchase of remaining assets in May 1976 by a consortium which is 75% owned by the Mittag family of Dusseldorf, Germany. In this transaction, the public shareholders of Mariculture, Ltd. lost all of their investments, a total of approximately \$C13,500,000 (Anon., 1976a).

4.26 The company on Grand Cayman Island is now known as Cayman Turtle Farm, Ltd., and controversy involving respected scientists on both sides of the issue continues to exist. In recent years some success has been achieved in the breeding of adults obtained from the wild (Simon *et al.*, 1975), and in the summer of 1976, 617 eggs but only 51 hatchlings were produced from stock raised on the premises (Anon., 1977). The majority of the hatchlings continue to be obtained from eggs acquired from natural nesting beaches in South America.

5. FINDINGS

Overall

5.1 In view of the information presented in Sections 2-4, I find that there was no valid justification for SPC to initiate a turtle project in 1974 which placed major emphasis on captive culture. The project was conceived on erroneous assumptions and/or inaccurate information which, at the time, served to establish mistaken priorities. This focus of research has nevertheless continued to exist for over three years, at the apparent expense of previously recommended assessment studies of naturally occurring turtle stocks.

5.2 *Given the fact that captive culture was selected as the basis for the SPC Turtle Project,* I find that no written material of a scientific nature existed initially or was subsequently prepared to delineate objectives, rationale, methodology, responsibilities or any of the other aspects normally required in a research endeavor, particularly one involving the allocation of funds. Among other complicating factors, this has resulted in significant confusion and misunderstanding as to the intent and objectives of the project and, in some quarters, a questioning of the credibility of involved parties.

5.3 With no acceptable documents to serve as the project's foundation, the single most important factor responsible for the continuation of confusion and misunderstanding between involved parties has been the serious lack of communication at all levels.

5.4 Very little coordination of efforts has existed between the project counterparts in Fiji and the Cook Islands. In the absence of overall

direction, the two segments of the project have proceeded virtually independent of one another, with only minimal communication.

5.5 Essentially no new information on the captive culture of turtles has resulted from the SPC project during its three years of existence. The assumed principal objective (referred to in 3.8a) of 'investigating the feasibility of village level turtle farming' could have been accomplished during the first few months of the project by:

- (a) comprehensively reviewing the literature on turtles;
- (b) corresponding with several turtle specialists and soliciting expert opinions;
- (c) visiting other related projects to evaluate results and experiences;
- (d) conducting a preliminary inventory of turtle stocks at the selected field site;
- (e) conducting a preliminary inventory of realistic food sources available for feeding turtles at the selected field site.

5.6 The project was clearly allowed to proceed for too long a period of time before being subjected to review and evaluation. Many of the complex problems which now exist could have been averted had outside assistance been formally requested at the end of the project's first year; nearly all of these problems could have been avoided had a formal outside review been undertaken at the time the project was originally conceived.

Fiji Islands

5.7 I find that inadequate consideration was given to the availability of green turtle (*Chelonia*) eggs and hatchlings in Fiji prior to the assignment

of basic research responsibilities to this location. It was subsequently not possible for Dr. Raj to obtain such specimens, thereby resulting in nearly all experimentation at USP being conducted with hawksbill (*Eretmochelys*) eggs and hatchlings. Any results obtained were therefore of reduced value to his counterpart, Mr. Brandon, in the Cook Islands where only green turtles were available. A group of 15 green turtle hatchlings was later (January 1976) transferred to USP Fiji from the Cook Islands, however the results of experiments with the nine surviving animals are not yet available.

5.8 Basic research on turtles at USP has dealt principally with the artificial incubation and hatching of eggs (full results presented in Raj, 1976), and aspects of the growth of hatchlings. General descriptions of these investigations, but only some of the actual results and data obtained, have appeared in three progress reports to SPC (Raj, 1974, 1975, 1977a). The incidence of disease, mortality, and aggressive biting considerably hindered progress on the research of hatchling growth; the full results of this work are not yet available.

5.9 Chopped fish and the flesh of other marine animals were the main food items used in the investigations undertaken. No feeding work was conducted using different experimental diets formulated from potential turtle food ingredients readily available in Fiji. Two such byproduct ingredients are coconut meal (referred to in 3.10) and 60% protein fish meal which were found to cost 4.8 and 18.0 cents per lb, respectively, at the time of my visit. A technique for binding dry meal ingredients into water stable pellets suitable for experimental feeding has previously been illustrated (Siu, 1972) and described (Balazs *et al.*, 1973).

5.10 A small building containing several concrete aquaria was constructed at USP in 1976 with funds provided through the SPC Turtle Project. This facility was intended for use in further investigations of hatchling growth. However, the progress report for 1976 (Raj, 1977a) strongly implies that disease and mortality factors associated with the poor quality of sea water from the adjacent bay make the facility unusable for such purposes. At the time of my visit, the facility contained the nine green turtles previously acquired from the Cook Islands, and two older turtles (one green, one hawksbill) captured in Fiji. Most of the Cook Island turtles had large portions of their hind flippers missing from biting one another. There were no experiments in progress at the time, but the animals were being regularly maintained by an employee supported by SPC funds.

5.11 Several hundred young turtles used at USP during the course of the project have been released from captivity without tags or other means of identification. Fifteen adult and subadult turtles were also released in 1976 following the abandonment of plans to establish a captive breeding colony (Raj, 1977a); it is unknown if tags were affixed to these larger animals.

5.12 There has been no "turtle data bank" established at USP, as referred to by the technical meetings on fisheries (SPC, 1974, 1975). Dr. Raj indicated that information was not forwarded to him from countries in the SPC region.

5.13 The "Turtle Resource Manual" which was previously reported (Raj, 1975) to be in preparation is still apparently in a very preliminary stage, as no sample draft pages were available during my visit.

5.14 No report or other written material resulted from the January 1976 trip that Dr. Raj made with Mr. Baird to the Cook Islands. One of the apparent purposes of this 10 day visit was to inspect the tentative culture site on Aitutaki that had been selected by Mr. Brandon. It should be noted, however, that Mr. Baird passed away only two months after this trip.

5.15 The preliminary bibliography of marine turtle literature, recently assembled by the USP Library (Singh, 1976) and distributed by Dr. Raj at the recent SPC technical meeting on fisheries, lists many publications that will be of interest to researchers of marine turtles. When finalized, this compilation will be a worthwhile addition to all libraries.

5.16 The opinions expressed and priorities advocated in the paper entitled, Turtle Farming for the South Pacific (Raj, 1977b), presented at the recent SPC technical meeting on fisheries, suggest an incomplete understanding of the complexities of the subject. This may be due in part to an unfamiliarity with the applicable literature, particularly information given in Carr (1972), Carr and Main (1973), Dahl (1975), Ehrenfeld (1974), Hendrickson (1974), Hirth (1971b), IUCN (1971) and other references which I have cited in this report.

5.17 Although financial records of SPC allocations and expenditures were not available during my visit, Dr. Raj estimated that over the past two years he had not used between \$10,000 to \$15,000 of the funds placed at his disposal by SPC. This estimate was found to be correct. Correspondence (dated 21 March 1977) which I received from Dr. Grandperrin indicated that, for the years 1975 and 1976, \$4,971 and \$3,000 (estimate), respectively, had

been spent at the USP Fiji segment of the project. In addition, apparently no funds at all were spent at this location in 1974. Assuming that half of the funds appropriated in the original annual budget for the Turtle Project (referred to in 3.6) were designated for research at USP Fiji, this would indicate that, for the project's three year duration, \$22,029 of the \$30,000 were not spent. Further verification of these figures should be made by SPC.

5.18 It was probably unrealistic of SPC to anticipate that Dr. Raj would be able to commit himself to the extent called for as the project counterpart responsible for basic research. As Senior Lecturer and Assistant Head of the School of Natural Resources, his duties at USP consist of a heavy teaching schedule, as well as considerable administrative and committee work. Furthermore, in addition to turtles, he has made commitments to several other areas of research. Dr. Raj informed me that he nevertheless intends to continue his laboratory experiments of hatchlings, with special emphasis on physiological aspects. He has asked for and apparently received a commitment of \$3,100 from SPC for work in 1977, however, thereafter no further funds will be requested (see Shameem, 1977).

5.19 The Government Fisheries Department has virtually no interest in the SPC Turtle Project as it now exists. In the national plan for fisheries development, turtle culture has no priority. This is due mostly to the absence of proven, economically viable husbandry and conservation techniques. Furthermore, the opinion was expressed by Mr. Stone that, in general, the citizenry of Fiji has no real interest in turtle culture. The Fisheries Department would, however like to see a thorough study conducted to identify

and assess all breeding and feeding stocks of turtles in the Fiji Islands. Research areas of higher priority and limited financial resources prevent the Department from undertaking such an extensive and long term project at this time.

Cook Islands

5.20 I find that inadequate consideration was given to the status of turtle stocks in the Cook Islands prior to selecting this location as the project field site for experimental culture. Virtually no information of a scientific nature exists on turtles in the Cook Islands. In view of the fact that the project could have resulted in the greatly expanded exploitation of the resource, an impact study involving thorough stock survey and assessment should have preceded all activities.

5.21 When the Government of the Cook Islands requested and subsequently agreed to the establishment of the project, there is every indication that it did so on the premise that SPC specialists were knowledgeable of the biology and ecology of turtles, and the state-of-the-art of turtle culture. Furthermore, in the absence of formal qualifying documents for the project, the belief existed in some quarters of the Government that the endeavor was chiefly conservational in nature. In partial support of such an interpretation, it should be noted that the 'project outline' (referred to in 3.3) makes reference to "...contributing substantially to conservation of turtle stocks," in addition to "...producing both protein food and cash." The Government has become exceedingly disenchanted with the project as time has progressed. However, some optimism was expressed due to the outside review being undertaken.

5.22 Even if the project had been well conceived, it was unrealistic of SPC to assign responsibilities for such an experiment to Mr. Brandon or any other individual who did not have extensive expertise in aspects of marine turtles and/or aquaculture. This is especially true in view of the fact that even periodic consultant visits for guidance from such a specialist were not available to Mr. Brandon. Mr. Brandon informed me that when accepting the assignment he assumed that SPC specialists were knowledgeable of turtles and techniques of turtle culture. He was also under the impression that considerable written information on the subject existed at SPC headquarters in Noumea. Both of these assumptions were later found to be incorrect.

5.23 The brief outline of Duties and Responsibilities presented in Mr. Brandon's formal contract with SPC (referred to in 3.14) is not commensurate with the complexities of the project.

5.24 According to Mr. Brandon, Mr. Baird verbally indicated that an overall review of the project would be conducted at the end of the first year. However, there was no further mention of such a review and Mr. Brandon did not formally request one. Mr. Baird visited the Cook Islands on two occasions, in December 1974, and January 1976 (with Dr. Raj).

5.25 Mr. Marsters informed me that he has never been provided with any formal documents from SPC relating to the Turtle Project. Also, he has never seen a copy of Mr. Brandon's contract.

5.26 During the course of the project, Mr. Brandon has independently made efforts on several occasions to obtain outside assistance and advice from other researchers of marine turtles. This has involved both written correspondence and discussions over the PEACESAT satellite communications system.

5.27 Experimental culture efforts in the Cook Islands have consisted of the following: obtaining and transporting eggs and/or hatchlings from the outer islands to Rarotonga; constructing a facility for rearing turtles; obtaining and testing possible food substances; and combating mortality, disease and aggressive biting. A description of these activities, along with results and data obtained, appeared in a single progress report to SPC (Brandon, 1977). For the most part information in this report is logically presented, however several inaccuracies exist. The only other written material dealing with the work is a brief article which previously appeared in *The SPC Fisheries Newsletter* (Brandon, 1975).

5.28 All of the project activities listed in 5.27 involved significant problems, many of which were not resolvable. Food for the turtles was the most critical problem on a day to day basis. According to Mr. Brandon, Mr. Baird instructed him to attempt to find local food substances that produced good growth, and at the same time were either inexpensive or free. A number of items were tested (i.e., cabbage, bananas, *Leucaena*, bread, fish), but none were found to meet these criteria. There was apparently no provision in the budget for purchasing food from an overseas area. This prevented the use of a nutritious diet (i.e., commercial trout food) as a baseline comparison with the local items tested.

5.29 Under Mr. Brandon's direction, a small building containing concrete aquaria was constructed on Rarotonga at the site of an earlier aquaculture experiment (see Anon. 1972). This was to serve only as a temporary turtle culture facility until arrangements were completed to move to a permanent

site selected on Aitutaki. At the time of my visit there were 48 turtles at the facility, all of which were in a state of semi-starvation. Some were extremely emaciated, and many had ulcers and sections missing from their flippers. The animals averaged approximately 5 lbs in weight and represented the survivors of 450 hatchlings brought from Palmerston in December 1974.

5.30 The site selected on Aitutaki has no ecologic or any other advantage which makes it acceptable for establishing an experimental culture facility. Among other unsuitable attributes, the absence of sea grass or algal pastures make it impossible to even attempt an underwater fencing scheme. Nearly all of the problems encountered on Rarotonga, as well as some new ones, would exist on Aitutaki. The plans to move to this location should have been formally terminated at an early date; more appropriately, no such plans should ever have been made. According to Mr. Brandon, no instructions or recommendations were given to him when Mr. Baird and Dr. Raj inspected the Aitutaki site in January 1976.

5.31 The "small scale population study" considered by Mr. Brandon as "being within the scope of the Turtle Project" (Brandon, 1977) was never carried out.

5.32 For the greater portion of the project's duration, the Government Fisheries Department has funded an assistant to work with Mr. Brandon. This has involved several different individuals, the most recent of which is a Mr. T. Paitai. Shortly after Mr. Paitai was hired he was selected by FAO/UNDP to undertake a two month training program in turtle conservation management in Torres Strait. Mr. Paitai departed for this location during late January 1977. I recently wrote to Dr. Allen (CSIRO) to obtain further

specifics on this subject. Correspondence dated 7 April 1977 was subsequently received from Mr. R. D. Copper, Secretary of Applied Ecology Pty. Ltd. (referred to in 4.8). Mr. Copper advised me that their organization was not really in a position to give "training in turtle conservation management," however, during the past two months they had been pleased to show Mr. Paitai their turtle farming research and associate him with post nesting and tagging activities.

5.33 Correspondence (dated 21 March 1977) which I received from Dr. Grandperrin indicated that for the years 1974, 1975 and 1976, \$900, \$9,445 and \$7,611 respectively, had been spent at the Cook Islands' segment of the project. The low expenditure for 1974 is due, in part, to the late recruitment of Mr. Brandon, whose assignment commenced in July 1974. An estimated \$8,310 has been tentatively budgeted for the year 1977.

6. RECOMMENDATIONS

6.1 In view of the findings set forth in this report, I recommend that the present SPC Turtle Project be terminated at the earliest date feasible for each location.

6.2 Termination of the Fiji segment of the project may not be practicable before the end of 1977 due to the prior commitment of funds referred to in 5.18. Dr. Raj should therefore be asked to submit to SPC a short but detailed research proposal covering the work he intends to accomplish during the remainder of 1977. At the end of this year, Dr. Raj should be requested to prepare a summary report on the results and data of experiments which he has undertaken since the project's inception.

6.3 The Cook Islands' segment of the project should be concluded when Mr. Brandon's contract expires in July 1977. During the interim, I recommend that efforts be directed toward improving the condition of the remaining captive turtles, principally through the use of nutritious foods. Funds should be immediately allotted for this purpose. Mr. Brandon should also be requested to prepare a summary report on the results and data of experiments undertaken during his tenure with SPC.

6.4 Upon completion of the project at each location, both Dr. Raj and Mr. Brandon should be commended by SPC for their efforts on turtle culture, under circumstances which I consider to have been difficult for all parties involved.

6.5 I recommend that no further funds be allotted by SPC at this time for projects on turtle culture. The lack of success in such efforts, the priority need for assessment studies of turtle stocks in the SPC region,

and the limited financial resources of SPC all indicate that investments in captive culture are not presently justified. I believe it is important, however, for SPC to keep apprised of the status and findings of culture projects undertaken by other agencies. I recommend that this be accomplished through periodic inquiries to at least the following individuals:

Dr. K. Radway Allen (for Torres Strait)
 Chief of Division of Fisheries & Oceanography
 CSIRO
 P. O. Box 21
 Cronulla, N. S. W. 2230
 Australia

Dr. W. A. Johnson
 Chief Executive
 Cayman Turtle Farm, Ltd.
 P. O. Box 645
 Grand Cayman Island, B.W.I.

Dr. A. F. Carr
 Chairman
 IUCN Marine Turtle Specialist Group
 Department of Zoology
 University of Florida
 Gainesville, Florida 32611 USA

6.6 At the earliest feasible date, I recommend that SPC constitute a new and long-term project on marine turtles which places major emphasis on:

- (i) active assistance in the collection of baseline ecological information on turtle stocks for the purpose of improved management and conservation; and
- (ii) fostering a better understanding and awareness of marine turtles by disseminating scientific and educational information throughout the SPC region.

Establishment of this project would be in accordance with the recommendations covering marine turtles which resulted from the recent SPC-IUCN symposium on conservation of nature held in Western Samoa (Anon., 1976b). In constituting

such a project, SPC should be fully aware that research of turtles, and the ultimate wise management of turtle stocks within the region, present a number of complicating problems which will not be easily resolved. Four of the more important problems will be:

- (a) the large number of what are likely to be distinct populations of several species in which life cycles are carried out within the SPC region, but involve migrations across international boundaries. The limited amount of information on the movements of green turtles in the Pacific islands (see Balazs, 1976b; Bustard, 1972; Doumenge, 1973c) thus far suggests long range travels equivalent to or greater than those reported for more intensively studied areas of the world. Carr (1972) has described the great difficulties of obtaining agreements among nations on the management of such populations.
- (b) the many and diverse local conditions (involving both turtles and people) in the SPC region, thereby indicating that research and management plans will almost certainly have to be developed individually for each area;
- (c) the scarcity of turtle specialist in the Pacific area to provide direction for the research;
- (d) the scarcity of individuals in the Pacific area that are both trained in research techniques and have the interest and enthusiasm in turtles to actually go out and conduct the demanding field studies required. In this respect, the project's undertakings may have to be developed more around capable and interested people than around geographical locations.

6.7 As a foundation document, I recommend that a formal proposal be prepared for the new SPC marine turtle project. In addition, resulting sub-projects which involve the allocation of funds should entail the preparation of scholarly proposals which can later serve as reference documents. As a minimum, such proposals should include detailed sections on objectives, justification, methods, responsibilities and, if warranted, a concise review of the applicable literature. All involved parties should be supplied with copies of the proposals for reference purposes. Furthermore, a system for the review of both proposed and ongoing sub-projects should be established, whereby outside specialist can provide written evaluations.

6.8 I recommend that the new marine turtle project be commenced by the involvement of SPC in a survey and assessment study of turtle stocks in the Cook Islands. Priority should be given to this location for the following reasons:

- (a) the absence of scientific information on turtle stocks over this large, and potentially important, ocean area lying immediately to the west of the major Pacific island breeding site of Scilly Atoll;
- (b) the importance of turtles to the native people of the northern group of the Cook Islands, and the indication that such turtles are rapidly declining;
- (c) the less than desirable results obtained from the present SPC turtle project;
- (d) the continuing interest in turtles expressed to me by Mr. Marsters, and the recent exposure of one of his employees (Mr. Paitai) to turtle research techniques;

- (e) the likelihood that Mr. Brandon, who now has a basic knowledge of turtles, may gain employment as a biologist for Mr. Marsters (this is *assuming* the continuation of harmonious relations which existed at the time of my visit).

This study should be under the supervision of a specialist who can visit the Cook Islands at periodic intervals to provide on-site direction of tagging, monitoring and other data collection activities. A well conceived project proposal covering this work should be submitted to the newly established World Wildlife Fund of New Zealand for partial financial assistance (see Feslier, 1977). Also, formal inquiries should be made by SPC on the distinct possibilities of conducting aerial surveys of turtles in conjunction with regular missions of the New Zealand Air Force and Civil Aviation Division of the New Zealand Ministry of Transportation.

6.9 An initial part of the study in the Cook Islands should be the release of the remaining turtles presently in captivity on Rarotonga. This should involve the recording of weights and measurements, and individual identification with permanent tags of a size appropriate for young turtles. I recommend that the turtles be released in the large lagoon of Manaue a normally uninhabited atoll that was recently declared a marine park (see Allen, 1975). Only turtles that are vigorous and healthy should be released; any remaining sick animals should be destroyed due to the possibility of disease introduction. The nine turtles from the Cook Islands that are presently at USP Fiji should remain in captivity and not be released at either location. Further details for conducting the release in the best possible manner should form the basis for a discussion over the PEACESAT communications system. Recoveries resulting from this experiment could provide valuable information on the growth, survival and travels of turtles reared during their early years in captivity.

6.10 I recommend that SPC assign some priority to locating an individual with expertise in marine turtle research (preferably a graduate student to work on an advanced degree) who would spend a two to three year period locating and surveying the nesting and feeding areas of the Fiji Islands. Such a study was previously recommended by Hirth (1971a), and continues to have excellent potential in view of the fact that the Fisheries Department would give logistic support *provided* outside funding was available. To the extent feasible, Dr. Raj and other faculty members of USP should be involved in this study.

6.11 Due to its longevity and focus on hawksbill turtles, the experimental restocking effort in Western Samoa is a unique project that warrants careful attention by SPC. I recommend that close communications be maintained in order to assess progress and to identify any possible needs for assistance.

6.12 I recommend that SPC not establish a regional center for data on turtle tagging, or distribute standardized turtle tags throughout the region at this time. Individual fisheries departments and/or researchers should retain such responsibility on a local basis. However, SPC should be amenable to purchasing tags for individual countries which bear their own inscribed return address. The subject of what constitutes the best turtle tag was a recent topic of lengthy discussion on the PEACESAT communication system, and should be afforded close attention by SPC.

6.13 A manual dealing with turtle "resources" or "management" should not be prepared by SPC. To the extent that it exists, this information already appears in several excellent publications. I recommend that reproductions of the following publications be bound in durable folders

for distribution to the appropriate agencies in the region: Carr (1972), Carr and Main (1973), Dahl (1975), Hirth (1971b) and Pritchard (1971).

To facilitate species identification, SPC should produce a short, inexpensive pamphlet containing black and white pictures of turtles found in the Pacific.

6.14 I recommend that SPC assume responsibility for placing the names and addresses of all appropriate agencies in the region on the mailing list for the IUCN/SSC *Marine Turtle Newsletter*. This recently initiated, informative publication will be issued several times a year at no cost to recipients.

The request should be directed to:

Dr. N. Mrosovsky
Editor
Marine Turtle Newsletter
Departments of Zoology and Psychology
University of Toronto
Toronto, Ontario M5S 1A1
Canada

6.15 I recommend that the SPC Media Project be commissioned to produce a series of educational presentations dealing with the basic life history of marine turtles.

6.16 I recommend that SPC sponsor a Pacific Islands Symposium on Marine Turtles in conjunction with the next technical meeting on fisheries.

During the interim, the PEACESAT communications system should be used for informal seminar discussions on turtles at four months intervals, and as the need arises.

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APPENDIX A. Itinerary

Monday, 21 February, 1977	0115 departed Honolulu
Tuesday, 22 February	0530 arrived Nadi 0710 departed Nadi 0750 arrived Suva
Monday, 28 February	0820 departed Suva 0900 arrived Nadi 1315 departed Nadi
Sunday, 27 February	1805 arrived Rarotonga
Thursday, 3 March	0800 departed Rarotonga 0910 arrived Aitutaki
Saturday, 5 March	0925 departed Aitutaki 1030 arrived Rarotonga
Monday, 7 March	1230 departed Rarotonga
Tuesday, 8 March	1445 arrived Nadi
Thursday, 10 March	1145 departed Nadi
Wednesday, 9 March *	1620 arrived Apia
Friday, 11 March *	1600 departed Apia 1645 arrived Pago Pago
Saturday, 12 March	0115 departed Pago Pago 0730 arrived Honolulu

* The Apia and Pago Pago portions of the trip were not required by the Terms of Reference. I personally paid for the additional costs incurred.

APPENDIX B. Persons interviewed in
addition to those specified
in the Terms of Reference

Fiji Islands

Mr. H. Sperling, Jr., Regional Fisheries
Coordinator (South Pacific), UNDP/FAO

Professor T. White, Head, School of Natural
Resources, University of the South Pacific

Mr. H. Douglas, Media Project, South
Pacific Commission

Cook Islands

The Honorable Mr. W. Estall, Minister of
Agriculture, Government of the Cook Islands
(interview suggested and arranged by
Mr. T. Marsters)

Mr. T. Wichman, former Principal Fisheries
Officer, Government of the Cook Islands

Western Samoa

Mr. A. Phillip, Fisheries Division, Government
of Western Samoa

Mr. O. Gulbrandsen, Fisheries Adviser, UNDP/FAO

Mr. G. Feldman, Peace Corps Volunteer,
Fisheries Division, Government of Western Samoa

APPENDIX B (continued)

Mr. T. Poutoa, Aleipata Hawksbill Turtle
Hatchery, Fisheries Division, Government
of Western Samoa

Mr. S. Siaki, Aleipata Hawksbill Turtle
Hatchery, Fisheries Division, Government
of Western Samoa