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CONTENTS

Page

Deep water shrimp trapping
by James Crossland. 1

Sea turtle conservation strategy 8

Fiji fisheries work plan 1980 16

Films on fisheries 22

Fishes of the outer reef slopes
by James Crossland 26

Recent South Pacific Commission fisheries publications 36

872/80

DEEP WATER SHRIMP TRAPPING

James Crossland

INTRODUCTION

The crustacean order Decapoda[1], which contains many commercially valuable species, can be divided into the crawling forms Reptantia (crayfish, lobsters, crabs) and the swimming forms Natantia (shrimps and prawns). The natants can be further divided into two major lines, the Penaeidea and the Caridea. The penaeids include several species which form the basis for important fisheries or aquaculture ventures in the warmer parts of the world. The carids are more varied in form and habitat than the penaeids and can be found in fresh water, shallow coastal waters and deep offshore waters in midwater and on the bottom, down to depths of hundreds of meters. This article will be concerned with the benthic deep water carids of the family Pandalidae.

The world-wide stocks of deep water carid shrimps represent a considerable under exploited resource, according to Struhsaker and Aasted (1974), who speculated that possible global yields were in the order of 250,000 - 2,500,000 t annually. There are important fisheries for these shrimps in Europe, Japan, Chile and at various places along the west coast of North America, including Alaska. In their own area of study, Hawaii, Struhsaker and Aasted estimated yields of 1-2 t/km^2. More recently, in the Hawaii Fisheries Development Plan 1979 (Anon. 1979), the resource was considered to be worth at least US$ 10 million [per year][2]. Other places in the tropical Pacific where carid shrimp stocks have been investigated are Fiji (Brown and King 1979), Tahiti (CNEXO 1979), New Caledonia (Intès 1978) Guam (Wilder 1977) and the New Hebrides (Anon. 1980). Results from these studies have not been as encouraging as in Hawaii, but this may be because of sampling differences rather than a lesser abundance of shrimps.

FISHING GEAR AND METHODS

The greatest part of the world catch of shrimps, both shallow and deep water, is taken by trawling. Many different types of trawl gear are used. This method is of little use in the SPC region because, apart from the Gulf of Papua[3], there are no areas of continental shelf. Most of the potential fishing grounds consist of uneven or sloping bottoms unsuitable for trawling and fishing which can best be fished with traps.

Trap design

Types of traps commonly used for catching shrimps may be square in section (Fig. 1A), oblong (Fig. 1B), triangular (Fig. 1C) or in the shape of a truncated cone (Fig. 1D). Recent trials on the U.S. National Marine Fisheries Service research vessel *Townsend Cromwell* have used semi-cylindrical traps (Fig. 1E). In Tahiti both truncated conical and truncated pyramidal traps were used. Frames are of steel rod 6 - 10 mm in diameter, covered with square mesh metal netting, chicken wire or fibre netting, with mesh sizes of 12 - 20 mm. Plastic netting would probably also be suitable. Funnel entrances are fitted at both ends of the traps (or sides in the conical trap). These taper to an inner aperture 7.5 - 10 mm in diameter.

Traps are baited with waste fish held in containers made of mesh or in perforated plastic jars. Oily fish, such as skipjack, make good bait. According to Butler (1970), trials carried out at various places along the Pacific coast of North America showed that traps covered in solid materials, such as sheet metal or plastic, gave a higher catch rate. Covering the traps (except the ends) has the

1. Decapoda = ten legged
2. The period was not stated but it is assumed to be one year.
3. There is a trawl fishery for prawns in the Gulf of Papua. This is in shallow water for various penaeid species.

effect of concentrating the bait odour through the entrance funnels and directing the shrimps into the trap. Struhsaker and Aasted (1974) experimented with uncovered traps and traps covered with burlap and found that the catch rate of the covered traps was 2.5 -10 times greater. In the New Hebrides (Anon. 1980) statistical analysis of the results showed that the catch did not differ significantly between covered and uncovered traps.

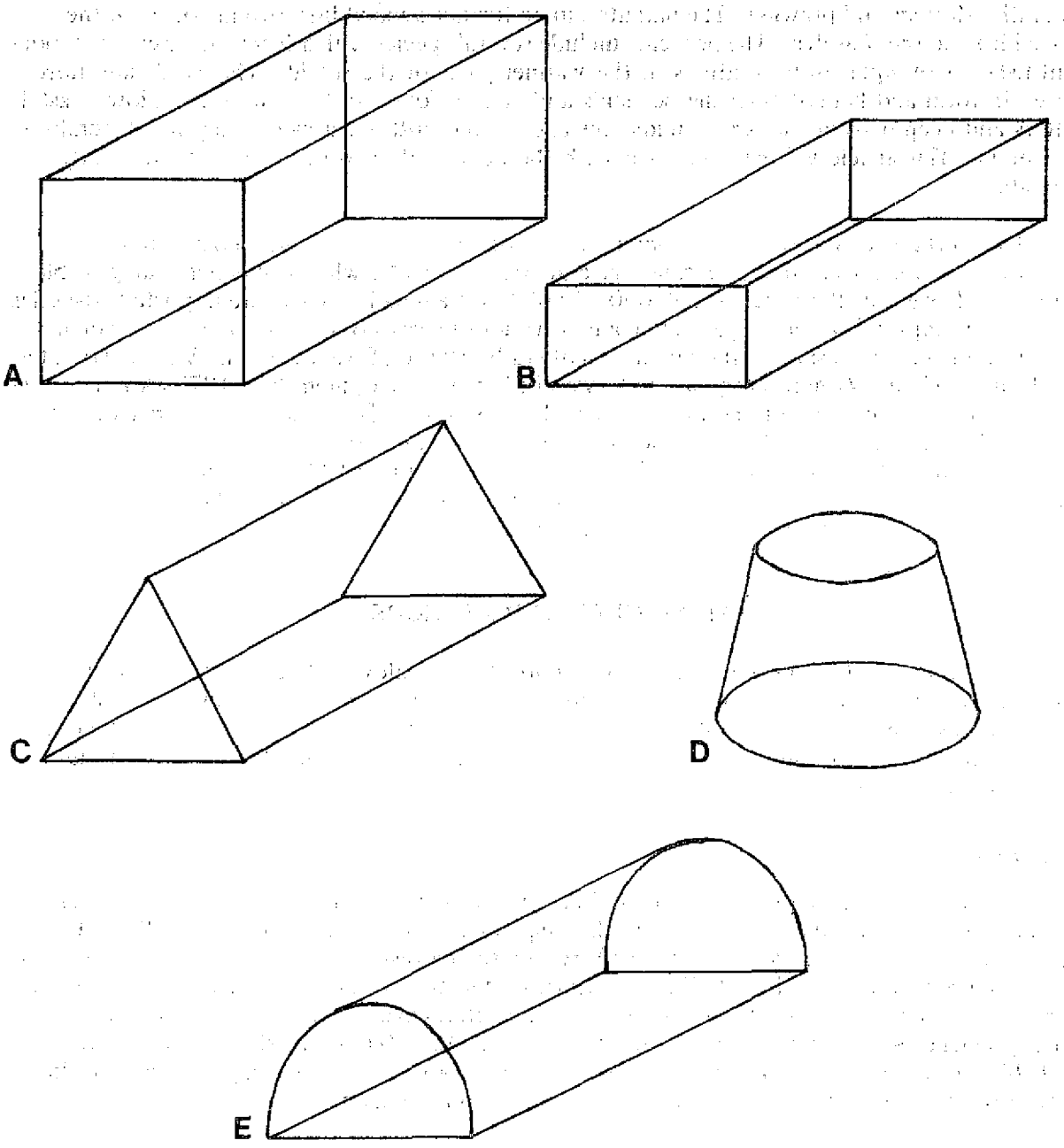

Fig. 1: Different shapes of shrimp traps: A: square; B: oblong; C: triangular; D: conical; E: semi-cylindrical. Funnel entrances, which are fitted at the ends (sides in the conical trap) are not shown.

Brown and King (1979) tested the effectiveness of the oblong[1], triangular and conical designs and found that the oblong and conical traps had similar catch rates which were both better than that of the triangular traps. They recommended the use of the conical traps because they were only about half the weight of the oblong traps and could be stowed more easily. Struhsaker and Aasted tried four designs - square, oblong, triangular and conical. Although not giving their full results they reported that catches of *Heterocarpus ensifer* were consistently lower from oblong and conical[2] traps than from square traps. In general escapes from traps decrease as the volume of the trap increases and it is likely that one of the reasons for the better catches of the square design was because its volume was twice as large as those of the other two. Three types of traps, triangular, conical and square, were used by Intès (1978). Intès, who was also interested in catching other benthic animals such as crabs, fitted large entrances to his square and conical traps. In the square traps the entrance funnels tapered to a rectangular opening 60 cm wide and 15 cm deep. The conical trap had a single cylindrical entrance on the top which was 30 cm in diameter. Intès did not directly compare the performance of the different trap designs. However, he recorded that the large aperture square traps gave very good catches.

Setting of traps

Traps are set in strings. In the commercial fishery for *Pandalus platyceros* in Alaska up to 40 traps are set on a string and boats fish a total of 50 - 200 traps (Butler, 1970). For exploratory fishing a greater number of strings with fewer pots per string is better. Also, long strings are not suitable for areas of uneven bottom because of the risk of losing gear. Struhsaker and Aasted fished 4-6 traps per string, Intès 4-5 and Brown and King 3 (one each of their three designs). Traps are usually spaced 25 m apart and joined by a short bridle to the groundline of 12 mm polypropylene rope. An anchor or weight is attached at each end of the string. The length of the buoy line should be at least 25 per cent greater than the depth of water to allow for the effect of tides or currents.

Traps are hauled using a line hauler once or twice a day, an overnight soak frequently being favoured.

Depths fished

The depths to be fished will depend on local conditions and the target species. The most productive depths appear to be in the 400 - 600 m range. Depth distribution for the different species will be discussed in more detail below.

SPECIES OF POTENTIAL ECONOMIC VALUE

Genus *Heterocarpus*

Species of this genus appear to offer the best prospects for commercial exploitation in the Pacific Islands. *Heterocarpus ensifer*[3] has been the species taken in the greatest abundance in the exploratory fishing carried out so far. In different places it is recorded over a depth range of 275 - 600 m (Fig. 2), being most abundant between 365 - 440 m in Hawaii, 400 - 500 m in New Caledonia, 440 - 500 m in Fiji and below 400 m in the New Hebrides[4]. In Tahiti, *Heterocarpus* sp. was recorded as being most abundant between 340 - 430 m. It is possible that temperature affects its depth distribution[5]. In Hawaii, Struhsaker and Aasted obtained catches varying from 0.9 - 15.9 kg per trap, with an average of 6.6 kg. Catches were much lower in Fiji, Tahiti, New Caledonia and the New Hebrides.

Individuals of this species average 9 - 10 g and reach a maximum weight of 16g. The tail muscle makes up 25 - 35 per cent of the total weight.

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1. They called their oblong traps 'square' though in section they measured 40 x 69 cm (see Table 1).
2. They called oblong traps 'flat' and conical traps 'round'.
3. Brown and King (1979) called this *H. sibogae (ensifer?)*.
4. As the deepest traps (650 m) were still catching considerable numbers of *H. ensifer*, it was not possible to determine the bottom of the vertical distribution.
5. Temperatures would be around 17°C at 300 m depth, 13.5° at 400 m, 11° at 500 m and 8° at 600 m.

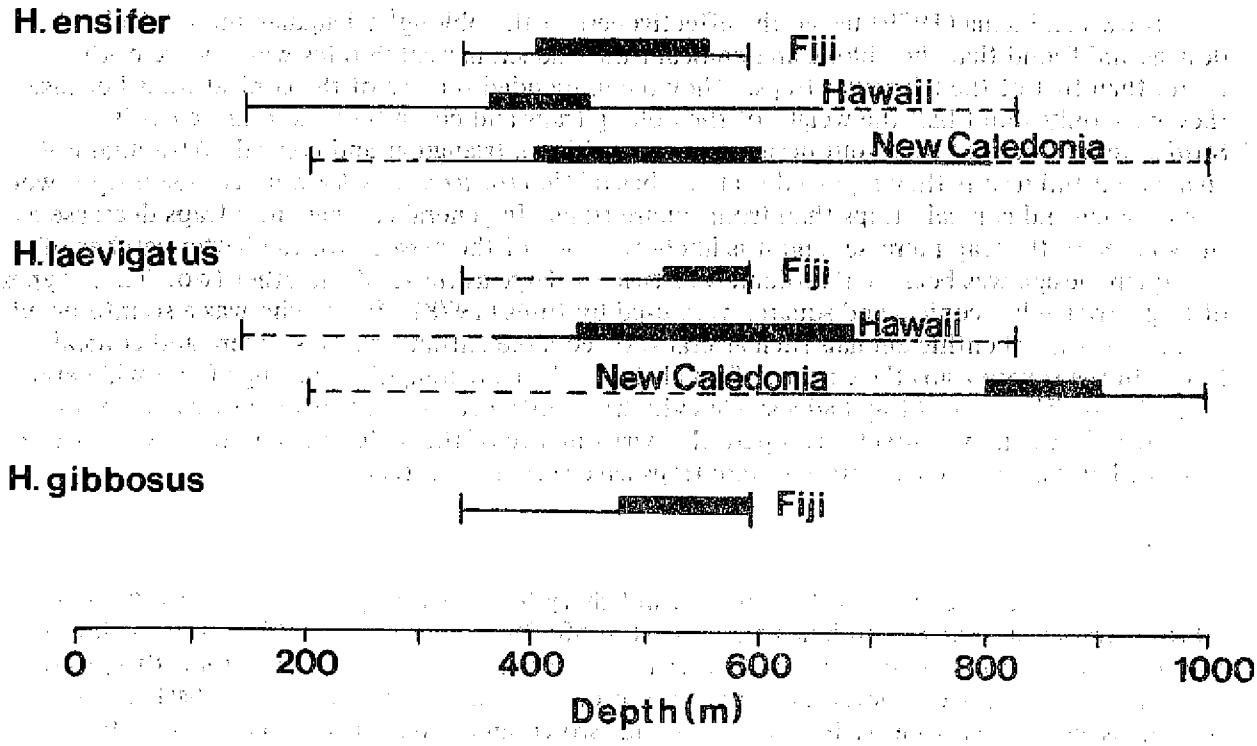

Fig. 2: Depth distribution of *Heterocarpus ensifer, H. laevigatus* and *H. gibbosus*. Thin lines indicate range of occurrence, thick lines ranges of maximum abundance and dashed lines depths investigated but species absent; vertical bars delimit sampling depths. Data are from Brown and King (1979) Fiji, Struhsaker and Aasted (1974) Hawaii, and Intès (1978) New Caledonia.

Heterocarpus laevigatus occurs in deeper water (Fig. 2) than *H. ensifer*, down to at least 1000 m (Intès 1978). In New Caledonia best catches have been obtained in the 800 m zone but in Hawaii, Struhsaker and Aasted recorded it to be most abundant between 440 and 680 m. In Fiji and the New Hebrides it occurred in depths greater than 470 m and became increasingly abundant down to 570 m, which was the maximum depth fished. Recorded catches of this species have not been as great as *H. ensifer* although this may reflect the depths which have been sampled and also the effectiveness of the traps. Intès found that catches of this large species (maximum size 22 cm[1]) were improved by fitting larger trap entrances. Average weight of the Fiji specimens was 17.9 g. No data is available on the meat recovery percentage but it could be expected to be similar to that of *H. ensifer*. Intès considered that *H. laevigatus* offered the best potential for exploitation in New Caledonia.

Heterocarpus gibbosus has so far only been recorded from Fiji in the shrimp trapping literature in the Pacific. Its depth range (Fig. 2) appears to be from 400 to at least 570 m (Brown and King 1979). Although not as abundant as *H. ensifer* or *H. laevigatus* it nevertheless made up 24 per cent of the catches of *Heterocarpus* species, and with its large size (average weight 13.5 g) could be a species of potential importance.

Plesionika longirostris is found in shallower water than any of the *Heterocarpus* species. In Fiji and the New Hebrides it was taken in the lower part of the depth range fished (330 - 400 m) and (240 - 460 m) respectively which suggests that its distribution extends into shallower water. In Hawaii it was not recorded by Struhsaker and Aasted (1974) but more recent surveys by the *Townsend Cromwell* have taken it in sets at 331 and 335 m. In the Hawaii Fisheries Development Plan (Anon 1979) *Plesionika* sp. is recorded as occurring from 110 - 460 m with quantities of 11kg per trap being taken at 460 m. This depth distribution plus the size of the Hawaiian specimens (7.1 - 14.2 g for larger individuals) compared to an average weight of 5.5 g in Fiji suggest that two different species may be involved. In Tahiti, *Plesionika* sp. is recorded from 80 to 500 m.

1. Maximum weight not known but would be about 70 g at this length.

Although *P. longirostris* is of small size, Brown and King considered it may be of commercial importance because its meat recovery rate is higher than that of the *Heterocarpus* species, and it is found in shallower water.

POSSIBLE FUTURE DEVELOPMENTS

Exploratory fishing surveys

The exploratory shrimp trapping so far carried out in the tropical Pacific has shown encouraging results in Hawaii and interesting, but less good results, in the other places. However, except in Hawaii, the effort has been very small and probably not with the most effective traps. The potential size of the deep water shrimp resource and its high value would suggest it is worthwhile to carry out further exploratory fishing in selected places. The results reported from Fiji were only the first phase of the Fisheries Division's deep water shrimp trapping project. Further investigations are planned to determine the geographical and depth distribution of the stocks. There are plans to carry exploratory fishing further in the New Hebrides. In New Caledonia it would certainly seem desirable to follow up the work of Intès. Another possible place not yet explored is Tonga, which has a large area of sea with depths under 1,000 m.

To carry out a useful exploratory fishing survey its objectives need to be carefully defined beforehand and it needs to be on a large enough scale to achieve them. Thus something more comprehensive than the trials already reported, though less exhaustive than a full scale resource assessment, must be considered. It would be desirable that any survey has the status of a full project rather than being done on an opportune basis in conjunction with other programmes.

The objectives should be set to obtain information under three main headings. The first concerns the distribution of the resource, and will include spatial and depth distribution, comparative abundance and seasonal changes in these. Other useful information to collect would be the type of bottom and the water characteristics (such as temperature) where shrimps are most abundant. The second kind of data concerns the catch rate and the factors affecting it. The calculation of an average catch rate per trap is essential if any projection is to be made concerning the commercial feasibility of shrimp trapping. Factors affecting the catch rate will include trap design, bait type, soak time and the number of possible fishing days. Thirdly, it may be desirable to collect some biological information. This should be done only for specific purposes and not just because 'it may be useful later'. However, it is essential that different species are recognised and correctly identified.

A first plan for a survey would be to map out potential fishing areas and to conduct initial trials over a fairly wide area. Subsequently, sampling could be carried out more intensively over a smaller area, where shrimps were found to be concentrated. If resources allowed it, one week's fishing per month could be done in the sub-area over a 12-month period. It would be wise in addition to sample the wider area three or four times a year, as the original survey might have been affected by seasonal variation or sampling error.

Based on the results previously reviewed the best choice of trap is the covered square design of Struhsaker and Aasted. This trap has twice the volume of their oblong design but requires only an additional 14 per cent of framing material and 30 per cent covering material for its construction. To carry out large scale trials it may be necessary to design a collapsible trap so that sufficient traps can be carried on the survey vessel. This should not be difficult with this simple design if the entrance funnels are made of fibre netting, in a similar manner to those illustrated in Figs 6 and 7 of Struhsaker and Aasted (1974).

The importance of keeping and publishing a proper record of the results of any exploratory survey cannot be overstressed.

A commercial fishery?

Deep water shrimp trapping will probably require a boat at least 8 - 9 m long so as to carry sufficient traps and to be able to operate in moderate sea conditions. A suitable boat could be similar to those used in New Zealand and Australia for rock lobster fishing. These have a small cabin or shelter right forward and a large, clear working deck. Initial investment in equipment - traps, ropes, buoys, line hauler - may be quite high, depending on the number of traps and the depth of water to be fished. For a given number of traps the amount and size of rope required will depend on the number of traps per string and the type of bottom. A few strings with many traps each will be more economical than a lot of short strings. However, the possible loss of a lot of gear at once, if a long string becomes fouled, must be considered. On the other hand, in areas with a smooth bottom a lighter rope could be used and this would reduce costs.

As well as a proven resource of shrimps, a viable commercial fishery will depend on other factors. Most importantly there must be an assured market for the catch. Because of the relatively small quantities involved for the effort expended, compared to other fishery products, shrimps must realise a high price to make fishing worthwhile. This requires access to a moderately large, urbanised home market or an export outlet. Also vital is the requirement for adequate preservation of the catch. The flesh of the *Heterocarpus* species does not keep well unless chilled or frozen as soon as caught. Probably the most practical preservation method for the Pacific Islands is the use of crushed ice.

The above factors would seem to limit the development of deep water shrimp fisheries to those grounds near main centres of population, at least for some years to come. Supposing shrimps are worth $5 per kg and a fisherman can work 100 traps per day catching 1.5 kg per trap, earnings per day will be $750.

Table 1: Sizes of different traps used in deep water shrimp trapping trials. Dimensions are in centimetres (for the conical traps, base diameter, top diameter and height are given); volumes in cubic metres (including entrances) are shown in brackets.

Reference	Place	Trap type			
		square	oblong	triangular	conical
Struhsaker and Aasted (1974)	Hawaii	60 x 60 x 120 (0.432)	30 x 60 x 120 (0.216)	60 x 120 (0.187)	86 x 60 x 36 (0.152)
Intès (1978)	New Caledonia	100 x 100 x 150 (1.5)	-	60 x 120 (0.187)	90 x 30 x 52 (0.162)
Brown and King (1979)	Fiji	-	40 x 69 x 90 (0.248)	60 x 120 (0.187)	75 x 52 x 40 (0.126)
CNEXO (1979)	Tahiti	-	-	-	100 x 30 x 70 (0.255)
CNEXO (1979)	Tahiti	-	-	-	90 x 30 x 80 (0.245)

1. In Tahiti two different types of conical traps were used.

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SEA TURTLE CONSERVATION STRATEGY[1]

SITUATION AND OBJECTIVES

Few groups of animals are more valuable and magnificent and at the same time misused than sea turtles. Able to serve as a source of protein for coastal peoples in the tropics, they have been over-exploited most frequently to feed, clothe and adorn the wealthy in Europe, North America, and eastern Asia. Populations are being lost through land development that destroys nesting beaches, through reef destruction, through the accidental drowning of turtles in trawl nets, and through the failure of states to join together to protect species that migrate from areas under one coastal jurisdiction to others. Even states intent on managing the resource wisely have destroyed sea turtle populations by developing management plans that ignored the biological needs of the species. Very few populations of sea turtles remain undiminished. The majority are depleted. Many are extinct. Six of the seven species are endangered.

The objective of this strategy is to develop conservation action based on the biology of the species that will return sea turtles to former abundance while allowing controlled exploitation for the benefit of generations of humans yet to come.

THE PROBLEM

The fate of the sea turtles in the modern world is being determined by the interaction of many factors. These include: 1) the use of sea turtles as food by peoples who live where sea turtles are found; 2) the use of sea turtle products in local commerce (for example, sea turtle eggs sent to local markets); 3) the international trade in sea turtle products; 4) the differing attitudes towards conservation in different countries; 5) the incidental destruction of sea turtles that occurs during the fishing of other species; 6) the effects of nesting beach alteration or destruction; 7) the effects of marine and land-based pollution; and 8) the natural recovery rates of the various sea turtle populations under different conditions of exploitation and incidental stress. The biological constraint (8) is in turn determined by such variables as growth rate, food resources, migratory habits, the fixity of nesting behaviours (including preference for certain nesting sites) and others.

Of these eight factors (there may be more) that determine the fate of sea turtles, only one, the biological factor, is non-negotiable in a conservation strategy. Sea turtles, even the most resilient of the species, mature very slowly compared with most commercially important species, and when mature their reproduction is vulnerable to disruption by many kinds of human activity in addition to ordinary turtle fishing. Among other widely exploited marine species, only the great whales, and possibly the sturgeons, show similar biological constraints on exploitation. In determining a conservation strategy, this ultimate limitation must be kept constantly in mind.

SEA TURTLE CONSERVATION POLICY

This document sets forth, in outline format, policy considerations for the conservation of sea turtles.

Habitat protection

Habitat conservation can be achieved through a variety of management techniques. These may include the creation of protected areas such as national parks or reserves, management efforts, or simple limitation of access or activities in specific areas at specific times. Management techniques need to be carefully evaluated for particular areas so that the measures selected are most appropriate. Habitats that should be protected are both terrestrial (nesting beaches, basking sites) and aquatic (inter-nesting areas, migration routes, feeding grounds, wintering grounds).

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1. This is an abridged version of a paper produced by the participants as a culmination to the World Conference on Sea Turtle Conservation held in Washington D.C., U.S.A. in November 1979.

Management

For the egg stage the best policy is simply protection. If intervention is necessary because of heavy predation, human exploitation or physical damage to the nesting beach, the least manipulative techniques are best. Thus it is preferable to protect the eggs *in situ*, rather than transplanting them to another site or to a hatchery.

For hatchlings the nesting sites should be protected by limiting beach traffic and disturbance at the vulnerable pre-emergence and emergence stages.

Adults and subadults require complete protection and prevention of interference with reproductive activities on nesting beaches and in internesting habitats. Prevention, reduction and control of exploitation are needed on migratory routes and in feeding and wintering grounds.

Control of exploitation

A. Commercial. As long as sea turtles remain endangered, the ending of commercial exploitation of all sea turtle products is a long-range goal or ideal of the conservation strategy. Turtles are listed as endangered species[1] in the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) in 1973 and 1976 and trade in turtle products is prohibited. However, not all countries are party to the treaty or implement it adequately. At the moment, highest priority should be given to ending:

1. The leather trade.
2. The trade in tortoiseshell.
3. The collection of eggs for sale in distant markets.
4. The trade in stuffed juvenile turtles.

After the demonstrated recovery of abundance of sea turtles, some level of exploitation may be possible. However, this must be based on the best available biological information and in accordance with national and international law.

B. Non-commercial hunting. This is defined as a traditional way of obtaining food for people living in a subsistence economy. It can be a valid activity, nevertheless some turtle populations are endangered even by legitimate non-commercial hunting. In these cases self-regulation and biologically sound conservation practices should be encouraged. Where non-commercial hunting is valid, subsistence users have first right to the resource.

C. Farming. It has been claimed that as well as marketing sea turtle products, farming has incidental conservation benefits. However, others feel farming can create the risk of increasing pressures on wild populations. At the present time more data are needed on the feasibility (biological and economic) of complete, closed-cycle farming with no dependence on wild populations for eggs or adult breeders. Turtle farming may create new markets and demand for turtle products. The establishment of new turtle farms must therefore be discouraged until it is certain that such operations will not cause, directly or indirectly, a further decline in turtle populations.

Incidental catch

This is a major threat to many sea turtle populations and must be eliminated or reduced to very low levels. Action to be taken should include restrictions on fishing in zones of high turtle concentrations, development of fishing techniques precluding the incidental catch of turtles, collection of data on the size of the incidental catch and the incorporation of appropriate regulations in international fishery conventions.

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1. *Except some Australian - Papua New Guinea populations.*

Research and population assessment

Data are needed on the location and sizes of all sea turtle populations. Information is also required on all aspects of basic biology such as age and growth, and on the effect of management techniques.

Conservation education

Local conservation organizations in different countries should be supplied with information on sea turtles. This will assist them to organise their own political and educational campaigns and to gather information on sea turtle populations and trade in sea turtle products.

Legislation

A. National. A worldwide inventory of turtle conservation laws is needed. Where gaps exist legislation should be enacted and implemented. Effective means for enforcement should be developed, including control of entry points for international commerce and the strengthening of penalties for breaches of national legislation.

B. International. All states should become parties to CITES without reservation, and vigorously implement their obligations. All states through whose jurisdiction sea turtles pass should enter into cooperative conservation programmes with particular emphasis on regional conventions. Existing conventions should be strengthened.

Cooperative efforts

The exchange of information and the development of joint conservation programmes among the many disparate and often isolated organizations and states should occur.

IMPLEMENTATION OF THE STRATEGY

A Standing Committee should be established to monitor and facilitate the further development and the implementation of the Sea Turtle Conservation Strategy.

This Committee should be associated with the Marine Turtle Specialist Group of the Survival Service Commission of the International Union for Conservation of Nature and Natural Resources (IUCN), and should include representatives from the various regions of the world. The IUCN and the World Wildlife Fund are requested to accept responsibility for the overall coordination of this Standing Committee; the active cooperation of the various elements of the IUCN, including the TRAFFIC Specialist Group, the Commission on Natural Parks and Protected Areas, and the Commission on Environmental Policy, Law, and Administration is essential.

International and national non-governmental organisations should assist with implementing the Strategy, as appropriate, and especially with public information and education and with the promotion of necessary governmental action.

Participation in the Action Plan by governmental agencies, and particularly those involved with marine turtle research and conservation, is requested, because such participation is essential to the successful implementation of the Action Plan. The United Nations Environment Programme and the United Nations Food and Agriculture Organization are encouraged to provide financial and programmatic support to this global conservation programme.

For the purpose of preparing a report assessing the progress made in implementing the Strategy, the Standing Committee should meet with the IUCN Survival Service Commission at its meeting immediately prior to the 3rd Conference of the Parties to CITES, in the first quarter of 1981.

ACTION PROJECTS

The full document goes on to list 141 action projects for the conservation of sea turtles. Those specific to the SPC region are:

46. Urge the South Pacific Commission to develop regional conservation programmes for the Pacific marine turtle populations for the sustained benefit of local people[1].

60. Encourage Australia and Papua New Guinea to conserve the marine turtle resources of the Torres Strait region for the local use of the indigenous people and to continue to prohibit any export trade to other regions.

61. Commend the government of Papua New Guinea for its marine turtle conservation, management and education programme, and encourage expansion of this work to include tagging projects.

85. Urge France to declare Scilly Atoll (French Polynesia) an inviolate breeding sanctuary.

103. Continue surveying and accelerate the development of a conservation plan for the Solomon Islands.

110. Undertake or continue surveys in the South Pacific (e.g., French Polynesia, New Caledonia[2], New Hebrides, northern Marshall Islands).

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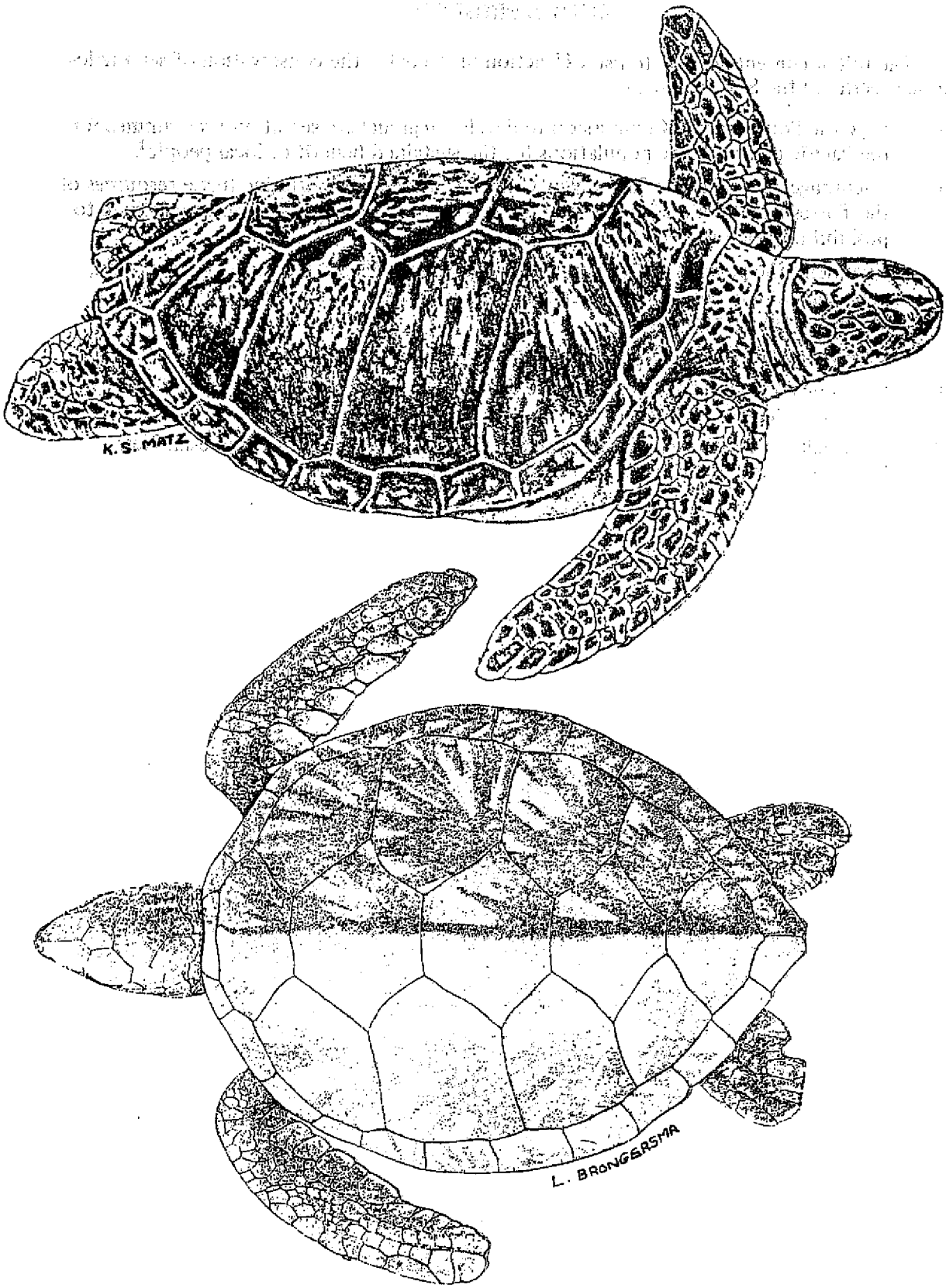
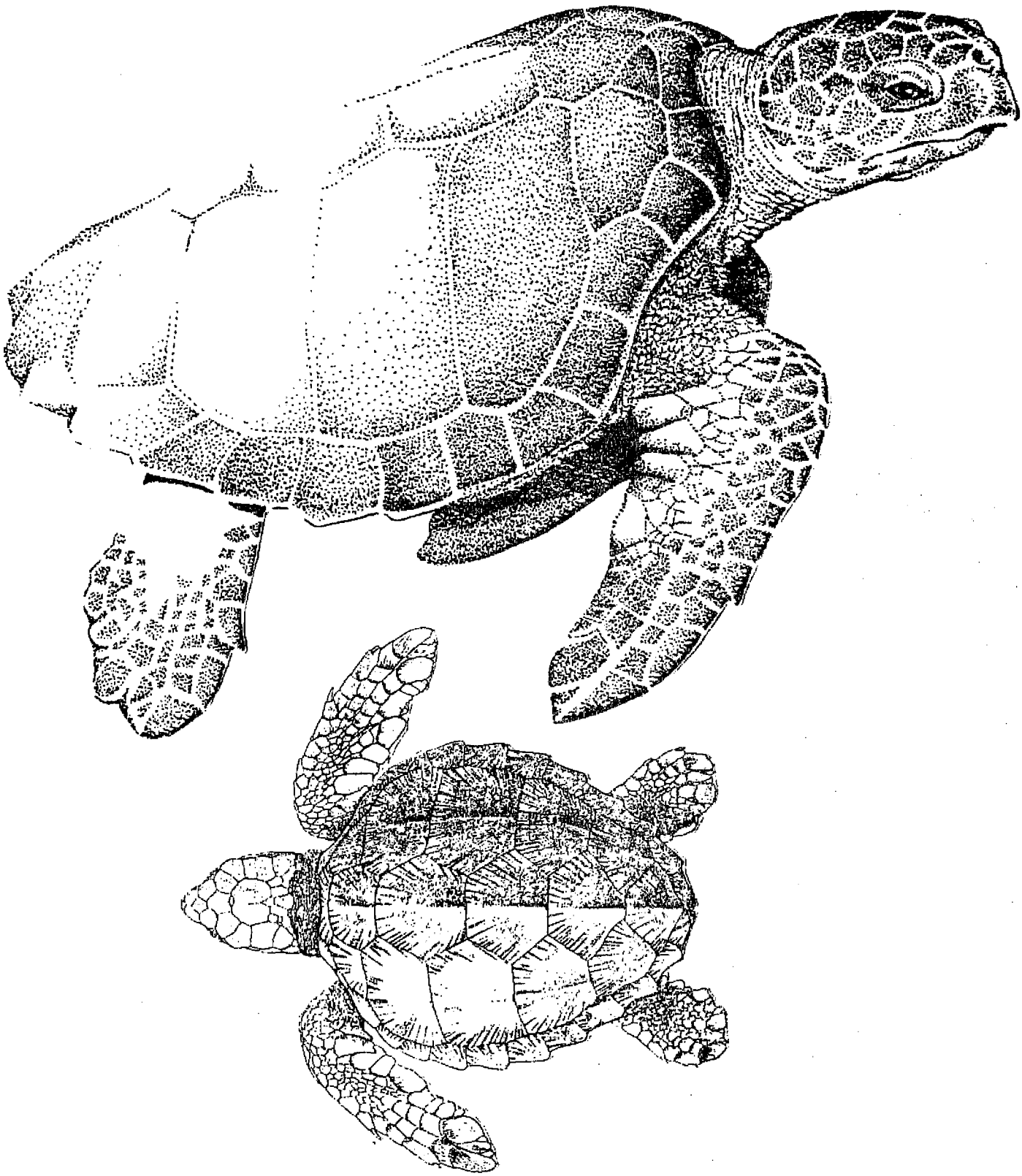
1. The South Pacific Regional Environment Programme began in January 1980. If countries of the region identify turtle conservation as requiring regional action it could be included in this programme. In June 1979 SPC produced a set of environmental education materials, including 42 *Environmental Mini-lessons* for schools. One of these lessons (No. 33) is devoted to sea turtles.

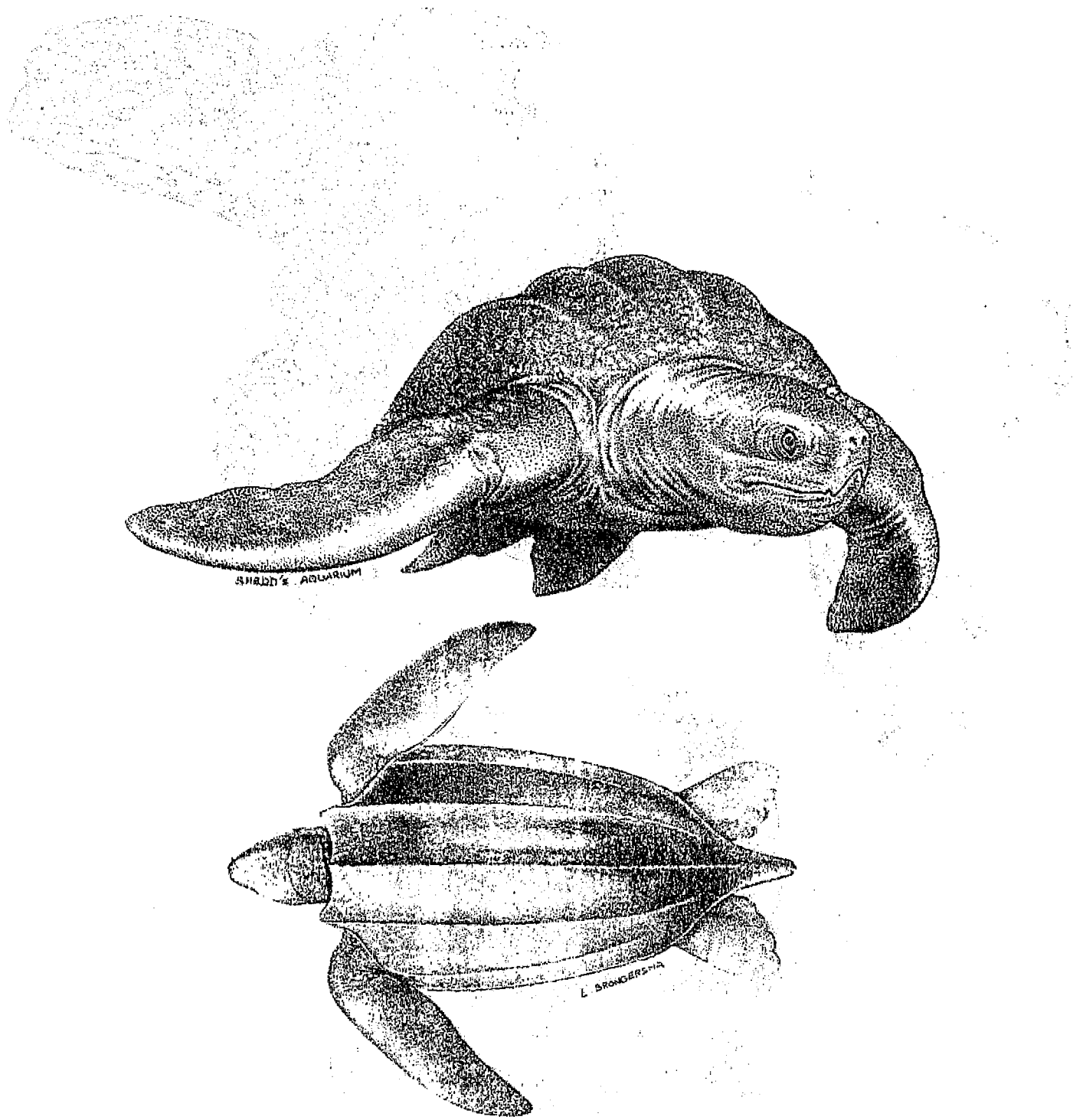
2. At the conclusion of the 1979 SPC/NMFS Workshop on Marine Turtles (see *Fisheries Newsletter* 20) a three day aerial survey of New Caledonia and its adjacent islands was made. Several important nesting areas were located.



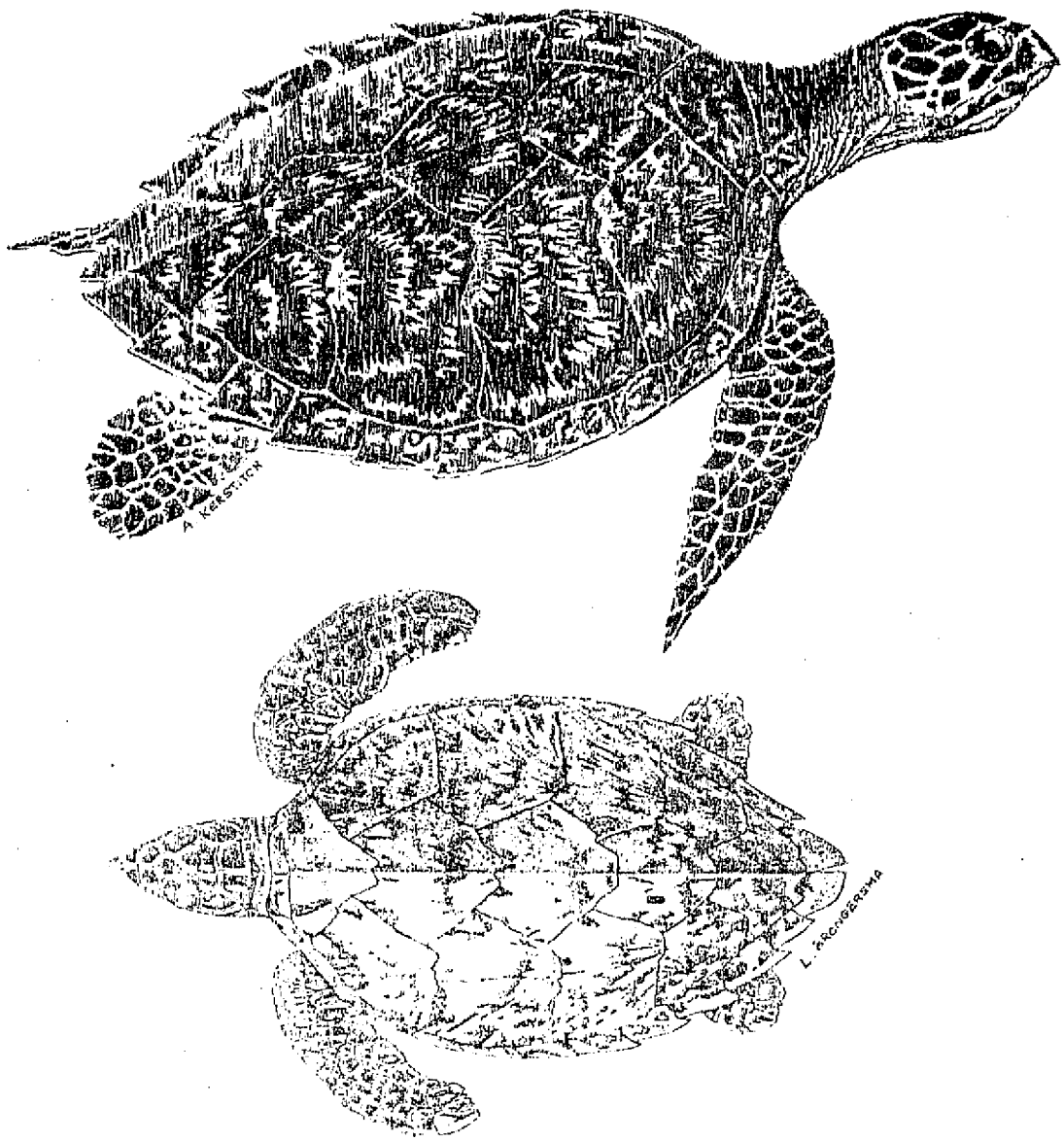
Green turtle
(Chelonia mydas)



Loggerhead turtle
(Caretta caretta)



Leatherback turtle
(Dermochelys coriacea)



Hawksbill turtle
(Eretmochelys imbricata)

FIJI FISHERIES WORK PLAN 1980

INTRODUCTION

Increased activity in the fisheries sector has resulted in increased production in both the low technology inshore fisheries and high technology export orientated fisheries. Fish imports have been marginally reduced but continue to be high and it is imperative that the potential resources are exploited to the maximum (optimum) in future years. The 1980 work programme is designed to concentrate on the development of fisheries in the rural areas where inshore potential is greatest and on encouraging further rapid development of the high technology fisheries. Major efforts will be made to encourage exploitation of offshore snapper and prawn resources and to identify new and monitor existing export resources (baitfish/skipjack, squid, longline tunas and small purse seine fishing). It is hoped that the long term result will be substitution of imports and increased exports.

Objectives

The overall objectives of the Fisheries Division are:

(a) To promote and consolidate the development of village and commercial fisheries in order to provide additional income in areas where fish resources are known to be adequate but agricultural potential low. To produce enough fishery products to satisfy local needs.

(b) To develop amongst the local people the capability to fish skipjack tuna through appropriate institutional arrangements.

(c) To carry into the commercial phase, the culture of fish, oysters, and other marine species of animals and plants including weed control.

(d) To continue exploring existing fisheries resources in Fiji waters and to undertake management of fishery resources in order to avoid over-exploitation of the resources available.

(e) To provide training for both fishermen and extension workers in the necessary skills required.

(f) To promote the importation, testing, modification and development of appropriate technology, to increase the efficiency of fisheries enterprises.

(g) To encourage the processing of fish and other fishery products within Fiji.

(h) To provide adequate and effective machinery for inspection, protection services, law enforcement and regulatory activities.

(i) To maintain close liaison with other agencies within the South Pacific region which are involved in investigation with a view to exploiting fishery resources.

Constraints

The constraints to achieving the defined objectives are:

(a) The resources have not been defined and their ability to withstand increased exploitation is not clearly understood.

(b) The sparsity of suitable boats and fishing gear at the village level.

(c) Inadequate servicing facilities for small motors, boats and fishing gear in rural areas.

(d) Absence of suitable port facilities for fishing vessels.

(e) Absence of an effective distribution and marketing network.

(f) The sparsity of experienced extension officers. An absence of efficient training programmes for commercial fishermen and extension officers.

(g) The lack of sufficient incentives and encouragement for more people to join the industry.

(h) The control of most inshore areas by local mataqalis[1] and the undisciplined allocation of permits which discourage long term capital investment by commercial fishermen.

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1. Land owning units.

(i) The lack of knowledge of fish processing techniques and the available overseas markets for processed fish.

(j) The absence of training facilities for pole and line fishing, engineers and shore management staff for the Ika Corporation.

(k) The capital restriction on rapid expansion of the Ika fleet to exploit the known tuna resources.

Fish production

A comparative analysis of fish catches in the years 1976-1979 and a projected catch for 1980 are given in Table 1.

Table 1: Fish production in Fiji, 1976 to 1980 in tonnes; bracketed figures are estimates.

Source	1976	1977	1978	1979	1980[1]
Commercial Market					
- fish	869	850	846	(853)	850
- non fish	(1032)	(1032)	1032	(885)	1000
National Marketing Authority	179	167	99	(154)	200
Other outlets	(650)	(656)	1024	(1100)	1200
Subsistence	(4000)	(4000)	4095	(5000)	6000
Ika Corporation	717	1711	2525	(4000)	5400
Miscellaneous	274	359	274	(300)	350
Totals	(7721)	(8775)	9895	(12292)	15000
Longline tuna catch[2]	4388	5956	8418	(7000)	6,000

1. Projected.
2. Landed by Taiwanese and Korean vessels to the Pacific Fishing Company cannery at Levuka.

Expenditure in 1980

Anticipated total expenditure in 1980 is F$ 3,100,000 comprising $ 2,802,600 in capital expenditure and $ 297,400 in operating costs.

EXTENSION ACTIVITIES

The 1980 programme is designed to assist rural subsistence fishermen and full-time commercial fishermen with supplies, services and advice on technology, marketing, and suitable fishing areas. The Division will coordinate activities in the industry and service all fishing requirements not available through the private sector.

Ice production and refrigeration

The 1979 work programme has consolidated existing facilities by establishing an efficient servicing programme; a new ice plant at Wainibokasi should be in full production (5 t/24 hrs) by January 1980. In 1980 new ice plants will be installed at Lami (10 t/24 hrs) and Savusavu (9 t/24 hrs), but these will only become productive towards the end of the year. Expected production in 1980 is 3,250 t compared with an anticipated 1,750 t in 1979. Five tonne blast freezers will be established at Labasa and Savusavu in the first quarter of 1980.

Fishing gear supplies

Fishing gear purchased in bulk will be available for cash sale to licensed fishermen at cost from Lautoka, Lami, Labasa, Savusavu and Wainibokasi. A capital allocation of $ 25,000 will be used to replenish diminished stocks of high demand gear (nets, monofilament lines, hooks) but the equipment will only become available in the second half of the year.

Vessel construction

The extremely successful programme of subsidised boat building will continue but with increased efficiency that should result in the completion of 12, 8.9 m, 20 h.p. diesel powered fishing boats with 580 kg capacity fish boxes by July 1980. Cost inclusive of fishing gear, stove, two anchors and anchor line is currently $ 5,200. A capital allocation of $ 30,000 will be used to provide labour and local materials with fishermen financing engines independently.

In the final four months of 1980, a rural training scheme will commence in which suitable candidates from rural areas of low agricultural production but with fishing potential will be selected in liaison with the Ministry of Fijian Affairs to join the Fisheries Division for a period of one year. They will construct an 8.6 m (28 foot) diesel powered boat in the first four months, construct and assemble fishing gear and receive basic instruction in offshore fishing methods, boat handling, maintenance of engines and safety at sea for the second four months. A final period of supervised fishing will be carried out before the trainees return to their community with a fully operational vessel. Initially six students each four months will start training (18 per year), but if the scheme is successful and facilities are adequate, this will be increased. Six vessels will be constructed under this scheme in 1980 and a further two demonstration and training vessels for Lautoka and Savusavu/Labasa will make a total construction of 20 vessels during the year. The numbers of vessels constructed in the boatyard in previous years have been two in 1977, six in 1978 and 12 in 1979. The rural training scheme is being funded for a period of three years by Japanese aid and includes a hostel for 20 people at Lami.

Workshop facilities

Provision is made for improved service to commercial and subsistence fishermen with the inclusion of workshop facilities at Savusavu and a fully equipped mobile workshop in the Northern Division. Tools will also be made available for vessel, outboard and net maintenance at Wainibokasi. Technical mechanical assistance will be available to all fishermen, particularly in areas where such work cannot be undertaken by the commercial sector. The workshops will also service all Fisheries Division vessels and be used as training centres.

Training

Eight one-week training courses will be available to subsistence and commercial fishermen at different places in Fiji. Each course will comprise the following:

(a) Outboard maintenance and repair.
(b) Net repair and hanging.
(c) Fish and marine produce handling, processing and marketing, fishing methods and boat maintenance and building; all illustrated by film shows.
(d) Loans, law enforcement and fishing regulations.

In addition, it is intended that five field days will be held during which advice on simple fishing techniques, processing methods, maintenance of outboards and vessels, fish handling and loans, regulations and law enforcement work will be given. The South Pacific Commission financed regional training in bêche-de-mer processing will be continued. A New Zealand Aid business management course will also be available to staff in February or March.

Fish processing

It has become increasingly difficult to motivate rural communities to participate in programmes encouraging the capture, processing and marketing of dried products although stocks, high demand and priced markets, and servicing requirements are all available. An increased

understanding of the distribution of the various bêche-de-mer species, quality required and the marketing network, and a determined desire to re-establish this industry will result in a major effort to achieve at least the 1977 record production in recent times.

Fish salting methods will also be demonstrated where appropriate. All areas will be encouraged to purchase smoking facilities from the Division, recoverable from crop proceeds. During the period of processing arrangements will also be made to catch fresh fish which will be delivered to the appropriate urban markets by the Fisheries Division.

Two small but sturdy fish processing vessels will be provided under New Zealand Aid. Surveys of bêche-de-mer stocks will also be made at other areas on request. The target for total bêche-de-mer production in Fiji for 1980 is 30 t.

Fish marketing

The Fisheries Division will continue to assist and service the National Marketing Authority in the maintenance of equipment, advising on fish quality and handling techniques, and identifying and assisting in distribution problems. A concerted effort will be made to demonstrate optimum methods for fish storage and the maximum benefits from ice usage by commercial fishermen. Wherever appropriate, a collection service will be operated for surplus catches in rural areas and a feasibility study will be made on the cost effectiveness of establishing a fish collection network throughout Fiji.

Fisheries division fleet

The fleet has been rationalised and by the end of the first quarter of 1980, all vessels will be suitably equipped for safe and efficient operation (Table 2).

Table 2: Work programme for Fiji Fisheries Division vessels in 1980

Vessel	Station	Work Programme	Servicing
Gonedau	Lami	All major extension programmes, training, fish processing and fish collection services.	All provinces with emphasis on Lau and Kadavu.
Tavuto	Lami	Squid and baitfish resource assessment. Subsistence surveys.	All provinces.
Kuita Qalo	Lautoka	General extension, prawn and snapper resource development.	Ba, Nadroga
Mata-ni-Civa	Lami	Prawn and snapper resource development. Longline fishing.	Tailevu, Rewa, Kadavu, Ra, Lomaiviti, Serua.
FC III	Savusavu	General extension, prawn and snapper resource development.	Bua, Macuata, Cakaudrove.
Japanese Aid Resource Development Vessel	Lami	Tuna longlining, baitfish assessment, skipjack and baitfish research, small purse seine fishing, deepwater trapping and shark fishing.	All provinces but particularly Lau and Kadavu
Sila Sila	Lautoka	Law enforcement and contingency.	Ba, Nadroga.
New enforcement vessel	Lami	Law enforcement.	Rewa.

An allocation of $ 10,000 is made for deep water trapping equipment (ropes, traps, buoys), $ 8,000 for operational equipment (anchors, fishing line and wire, snapper rigs), $ 9,600 for fishing machinery (fishing winches, outboards, hydraulic winch), and $ 14,000 for electronics including squid finder, fish finder, surface sea temperature recorder, radio base at Savusavu, radio telephone at Savusavu, 5 AM/FM receivers and underwater fish attraction lights. A fully equipped 28 t research and development vessel and a 7.4 m (24 ft) law enforcement vessel are being provided under Japanese and New Zealand Aid respectively.

Fisheries schemes

A concerted effort will be made to support and encourage existing and new fishing schemes both through normal training and extension work and with organised business management training. Many areas will be assisted.

RESOURCE ASSESSMENT AND DEVELOPMENT

General work programme

The overall objective is to provide information for the rational management of any fisheries resources and to investigate those new resources suitable for commercial and subsistence exploitation. All research programmes are applied and oriented toward immediate, practical exploitation and an increase in local fish production.

(a) *Market survey.* The detailed monthly analysis of market fish and non-aquatic product sales will be continued in the Western and Northern Divisions to establish baseline data for species composition, fluctuations in market price and demand at each market (including NMA). In the Central Division where such baseline data have been established, similar but less detailed analysis will continue to identify trends and species size distribution as well as seasonal changes in commercial catch by mataqali area will receive greater attention.

(b) *Other fish outlets survey.* As with the market survey a detailed analysis of fish distribution to hotels, butchers and supermarkets will be continued in the Western and Northern Divisions while in the Central Division a less detailed analysis will be continued to consolidate established baseline data.

(c) *Subsistence survey.* The established programme to determine annual subsistence catch will be continued. Detailed information is now available for each province and an analysis of techniques used and utilisation of available resources will be undertaken. The results will be interpreted to enable extension activities to be concentrated on underexploited resources and methods of increasing production in these areas.

(d) *Commercial catches.* Detailed analysis of commercial catches will be undertaken using a return log book; and analysis of catch per man day and vessel cost effectiveness will be undertaken to establish both the most efficient vessels, techniques and fishing areas.

(e) *Fishery statistics.* Detailed records of miscellaneous product exports (trochus, mother of pearl, live fish, bêche-de-mer, shark fin), longline catches by species composition and canned tuna production will be kept. The total annual fish exploitation will be determined from the analysis of fishing catch and effort. It is hoped that over- and under-exploited areas will be identified.

Specialist surveys

(a) *Live bait resources.* Research into the identification, distribution and general biology of the principal tuna baitfish species will be continued. It is now clear that the principal factor limiting the pole-and-line skipjack fishery will be the availability of baitfish species, particularly between October and December. As the Ika fleet increases it is imperative that long term analysis of the ability of the resources to sustain themselves be carried out. The *Tavuto* and the new Japanese Aid vessel will survey all known baitfish grounds in Fiji and investigate potential new areas.

(b) *Deep water prawn survey.* This will be continued in 1980, with emphasis being placed on geographic and depth distribution throughout Fiji waters, as well as seasonal variation in catch. October 1980 is the tentative date for the survey's completion.

(c) *Deep water snapper survey.* This survey will be continued in conjunction with the prawn survey voyages and will concentrate on locating productive fishing grounds for commercial fishermen.

(d) *Tuna catch data.* Accurate daily tuna and baitfish catch and tuna length and weight data are being collected and analysed. This work will be continued in the 1980 work programme and used as a performance indicator to the Ika Corporation vessels. These data will be required to be supplied to the South Pacific Regional Fishing Agency, if it is established.

(e) *Bêche-de-mer.* The SPC financed project on the population dynamics of bêche-de-mer will be continued in 1980. It is intended that the distribution and optimum exploitation of the principal commercial species will be determined.

(f) *Fisheries assessment.* Assessment of fisheries resources for compensation to native fishing rights holders will be prepared as required. A system of classification based on key species is being determined and work will continue throughout 1980 depending on staff availability.

(g) *Hydro-electric power development.* Surveys of streams in the Nadrau Plateau to determine the dependence of local villages on fish and the effect of the development on fish catches will be carried out.

(h) *Squid fishery.* A detailed survey of the distribution and density of squid, and economic viability of establishing a squid fishery will be carried out commencing in February. The *Tavuto* will be fully equipped for this project.

(i) *Longline tuna fishery.* A detailed survey will be made of the feasibility of establishing a tuna longline fishery in Fiji waters. The new Japanese Aid vessel will be fully equipped for long-line fishing operations.

(j) *Small purse seine fishing.* The feasibility of establishing a fishery will be investigated.

Aquaculture

Naduruloulou. Work on the rearing and breeding of grass carp to control submerged weed infestations will continue. Several hundred tagged juvenile carp were released into the Rewa River in 1979 and an intensive work programme designed to bring about mass spawning in the 1979-80 breeding season was initiated. Fingerlings produced during these spawnings will be stocked into the Rewa River in late 1980. Further species will be introduced into quarantine ponds at Naduruloulou in 1980.

Raviravi fish farm. Pending formal approval from the Lands Department, the proposed joint venture will be undertaken with one of the several interested private investors.

Oyster project. Information on the possibilities of commercial oyster or mussel culture will be made available to interested investors and the establishment of commercial farms encouraged.

Library and information services

The 1979 programme to establish a comprehensive and efficient library service for all fisheries staff will be continued and consolidated. This will include a system of selection and distribution of relevant extension material to all Fisheries Sections, establishment of an efficient internal communications system and preparation of information leaflets and visual aids on aspects related to the training programme and law enforcement work.

LAW ENFORCEMENT AND LICENSING

The 1980 objectives are:

(1) To identify and resolve all responsibilities contained in the Fisheries Act and liaise with all affected agencies.

(2) To continue licensing fishermen and vessels.

(3) To issue import and export licences.

(4) To patrol for illegal fishing and inspection of catches for undersized fish. An increased effort is required in this area and close liaison with the Police Department must be secured.

(5) To attempt to resolve the considerable problems associated with the issue of fishing permits in mataqali areas which are becoming so increasingly extensive and controlled that commercial fishermen are finding it difficult to secure suitable fishing locations.

(6) To implement the responsibilities contained in the Marine Spaces Act and Fisheries Regulations concerning fishing in the Exclusive Economic Zone. A centre for coordinating fishing boat movements and all EEZ matters has been established, but the implementation of the 200 mile limit and possible fishing agreements with foreign fleets will require considerably increased work input in 1980.

FILMS ON FISHERIES

The 1979 SPC Regional Technical Meeting on Fisheries requested SPC to provide information on fisheries films[1] relevant to the region.

Given below are the synopses of eleven films selected from the *FAO Film Loan Catalogue* (1979).

How to borrow films[2]

All films are available on free loan. Requests for film loans should be sent to:

FAO
Film Loan Library
Information Division
Via delle Terme di Caracalla
00100 ROME, Italy.

Titles should be quoted in full in the language of the original version. Films are sent by air freight at the expense of FAO so far as the outward journey is concerned. It is the responsibility of the borrower to pay the cost of their return journey by air freight to Rome. Films may be retained for up to one month. As copies may not be immediately available borrowers should indicate the period during which it would be convenient to make use of them.

How to purchase films

The costs of films, including air freight for films produced by FAO, are included with the synopses. These costs are approximate. Enquiries regarding the purchase of other films should be addressed to the producers/distributors whose addresses are listed with each film.

Film synopses

• 1. BUILDING A FERRO-CEMENT FISHING BOAT

Producer and distributor: United Nations/FAO

27 mins; colour; English; 1971.

Cost (March 1980) US$ 280.

Using techniques similar to those evolved by the Italian architect Pier Luigi Nervi, FAO builds a 37-ton fishing boat from cement and wire mesh. The advantages of this method are shown to include the relative cheapness of the raw materials as compared with conventional boat-building, less need for skilled labour and a greater resistance of the finished boat to deterioration. The film follows the construction step by step from the design to the sea trials. Filmed in Thailand.

Use: Educational/informative for fishing cooperations, extension workers and fisheries trainees.

• 2. CARIBBEAN SEA HUNT

Producer and distributor: UNDP/FAO.

19 mins; colour; English; 1972.

Cost (March 1980) US$ 190.

Illustrates the activities of a fisheries development project in operation jointly between the United Nations Development Programme, FAO and the governments of some 21 islands or countries

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1. Several films have been produced on specific topics such as pearl shell and pearl shell culture, crown-of-thorns starfish, turtles and lobsters. The titles are listed in the 'Union catalogue of films on fisheries and related subjects available in Australia', *Australian Fisheries Paper* 13 (Fisheries Division, Department of Primary Industry, Canberra, ACT, 2600, Australia). These films are held by several libraries in Australia. Many film libraries will not lend films to organisations outside their own State, although there are several exceptions. Inter-library loans are sometimes possible to arrange.

2. Although FAO will be pleased to assist training projects in the South Pacific as much as possible by the loans of films, the Chief, Current Information Branch, Information Division, FAO, suggested that information in the SPC *Fisheries Newsletter* be given with a view to encouraging the purchase of these films rather than borrowing from FAO, in view of the lengthy air shipment involved and the responsibility of the borrower for paying the cost of returning film to Rome by air freight. He also mentioned that it is not always possible for FAO to dispatch films immediately as the library usually has only one or two copies of each film.

in the Caribbean region. Referring to the need for development (more than $40 million a year are at present spent on importing fish from outside the area), the film goes on to document the resources survey being carried out from two 82 ft (25 m) vessels under the supervision of FAO personnel. Trainee fishermen are seen receiving practical instruction in tuna pole fishing, mechanical reel fishing for snapper and long line fishing for the under-utilized shark.

Use: Informative for fisheries trainees and marine study groups.

• 3. EXPLORING A FISHERY HARBOUR SITE

Producer and distributor: FAO.

23 mins; colour; English; 1974;

Cost (March 1980) US$ 150.

One of the problems of small coastal fisheries is the lack of harbours and fish handling facilities. This film shows what the Government of India has done to establish new fishing harbours along the Indian coast. A team of UNDP/FAO engineers is shown exploring a potential harbour site in Tamil Nadu state at the southern tip of the subcontinent. Aided by Indian counterparts, the engineers conduct surveys and soil samplings, prepare plans for piers and other installations for the construction of the proposed port for small and medium-sized fishing boats.

Use: For fishery studies and training courses.

• 4. FOOD FROM THE SEA

Producer and distributor: Perkins Engines Ltd., Film Library, Eastfield Factory, Peterborough, PE1 5NA, United Kingdom.

17 mins; colour; English.

Sri Lanka's traditional fishing sailboats have been gradually replaced by inboard and outboard motorboats and motorized fishing clippers. The Sri Lanka Fisheries Corporation decided to begin replacing old craft in 1960, and studies were made of equipment needs and of fish storage and marketing. FAO assisted in marine research and testing fishing craft. The U.K. Freedom From Hunger Campaign helped rebuild the fleet after craft were damaged by a typhoon. Catches have increased from 15 lb (7 kg) a day to from 500 to 1,000 lb (225 to 450 kg). Fish imports are no longer necessary, and now the goal is to supply export markets.

Use: Of interest to audience involved in fisheries mechanisation and development.

• 5. A HELPING HAND

Producer and distributor: Robert Halmi Inc., 222 East 44th St, New York, N.Y. 10017, U.S.A.

28 mins; colour; English; 1970.

The film illustrates the help being given by the United Nations Development Fund, through FAO, to fisheries projects in three Asian nations: India, the Republic of Korea and the Philippines. The meagre catch of the ancient dip-nets at Cochin, southwest India, is contrasted with the modern trawler in operation off-shore. This development is part of a joint Indo-Norwegian project. The work of the UNDP/FAO Coastal Fishing Training Centre at Pusan, Republic of Korea, in which cadet fishermen receive training on both land and sea, is shown. Experts from FAO are helping a government project to increase yields from the territorial waters of the Philippines - a country where the recent introduction of freshwater fish farming is also helping to increase production.

Use: Informative for general development aid groups and fisheries study groups.

• 6. JOURNEY OF THE STAR-KIST

Producer and distributor: Star-Kist Foods Inc., 582 Tuna St, Terminal Island, California 90731, U.S.A.

40 mins; colour; English.

The *Star-Kist* is the name of a large fishing vessel belonging to a company of the same name which cans tuna in San Diego, United States. The film follows the ship and its crew on a marathon

search for tuna which takes them from San Diego to Panama, the Galapagos Islands and international waters off the coast of Peru. The fishermen practise with weighted fishing rods in readiness for the strenuous task of fishing the tuna with pole and line. Bait is seined and kept alive on board. The ship passes through a hurricane, and wildlife on the Galapagos Islands is seen. Finally a large school of tuna is sighted and the film shows the fierce activity as 12 fishermen haul 360 tons of tuna - fish by fish - from the sea with pole and line.

Use: Informative for pelagic fishing trainees and for general audiences interested in wildlife and adventure.

• 7. PURSE SEINING - A NEW AUSTRALIAN FISHERY

Producer and distributor: CSIRO Film and Video Centre, P.O. Box 89, East Melbourne, Victoria 3002, Australia.

21 mins; colour; English;

The film shows how Australian fisheries earlier were mainly coastal fisheries with comparatively small returns. Diagrams of the purse seines and the actual setting and hauling of the net are shown in detail. The fishing was at times supported by a plane which assisted in locating the schools. Large catches of horse mackerel were obtained.

Use: Of general interest to audiences involved in the development of fisheries.

• 8. SHARK PROCESSING IN THE CARIBBEAN

Producer and distributor: UNDP/FAO.

13 mins; colour; English; 1972.

Cost (March 1980) US$ 150.

Shows part of a United Nations Development Programme/FAO fisheries development project aided by the Surinam Fisheries Foundation, in which sharks (an abundant fish in this region, but underutilised) are caught, processed and marketed. This experimental project is seen to be assisting in supplying fish needs in the Caribbean where two thirds of the demand must be imported at a cost of $40 million annually. The shark meat is seen being salted, dried and smoked, or prepared as a smoked salmon substitute.

Use: Informative for fisheries trainees, marine study and fish marketing groups.

• 9. AQUACULTURE 75

Producer: Ceres Film.

Distributor: CNEXO, Delegation à l'Information, 39 avenue d'Iéna, Paris 75016, France.

20 mins; colour; French; 1976.

Shows activities in aquaculture in France and French Polynesia. Research related to potential species for culture and various marine farming techniques are described. The film also features the activities of the Brittany Oceanology Centre, the Pacific Oceanology Centre, and the pilot stations of DEVA (Development, Demonstration and Evaluation of Aquaculture).

Use: For audiences of fishery research and training programmes.

• 10. RETAILING FISH

Producer: U.S. Department of the Interior.

Distributor: Audio-Visual Services, Bureau of Commercial Fisheries, 1815 North Fort Myer Drive, Arlington, Virginia 22209, U.S.A.

20 mins; colour; English.

Instructions are given on the best methods of managing a retail fish store. The film shows in considerable detail the cleaning of the whole store and its equipment and the arranging of the fish for display, both in store windows and in display cases inside. Information is also given on the best methods of storing supplies of fresh and frozen fish.

Use: An advisory film for fish retailers and merchants.

● 11. TUNA PACKING

Producer and distributor: Paul Hoefler Production, P.O. Box 1313, La Jolla, California 92038, U.S.A.

11 mins; colour; English.

Tuna are unloaded and flumed into the packing plant. They are brought on conveyors to scales, then cut open and the viscera are removed. Each fish is quality inspected, signs of spoilage being detected by smell. They are put on racks and steamed in horizontal, non-pressure retorts for three to eight hours, whereupon the fish are collected, trimmed and packed in cans.

Use: Informative for fish processing study groups.

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FISHES OF THE OUTER REEF SLOPES

James Crossland

INTRODUCTION

During the years 1974-1977 the SPC Outer Reef Artisanal Fisheries Project (ORAFP) carried out exploratory fishing in the Cook Islands, the New Hebrides, Solomon Islands, Tuvalu and Western Samoa. Since then, the project which developed from the ORAFP, the Deep Sea Fisheries Development Project (DSFDP), has operated in American Samoa, Kosrae, New Caledonia, New Hebrides, Niue (twice), Papua New Guinea, Palau, Tonga (twice), Truk and Yap. It is currently[1] operating at a further three places: Fiji, Kiribati and Wallis and Futuna. This wide area (Fig. 1), covered by the activities of the two projects and the six years spent in the field have enabled a considerable body of data to be accumulated on the demersal fish fauna of the outer reef slopes. Reports have been produced or are in preparation for each country visited[2]. An overall review of the project objectives and operations, including fishing methods is given in Crossland and Grandperrin (1980). Other information on outer reef or deep bottom fishing is given in Fourmanoir (1973, 1980) and Rancurel (1979). Mead (1979) provided data on depth distribution and the type of bottom favoured by the more common species.

This article will review the catch composition, the relative species abundance and their geographical distribution.

FISHING ACTIVITIES

Depths fished were generally from 50-400 m with most effort in the 100-300 m range. Fishing was mainly carried out during the day; night fishing was also done but not in all places. the SPC Master Fisherman in charge kept a record of times and depths fished and the numbers and weights caught by species. It should be emphasised that the data were collected primarily for fisheries assessment and development use and not for scientific purposes.

THE SPECIES

At least 100 identified species have been recorded from 17 families of bony fishes and 6 families of sharks. Classification into families follows Nelson (1976) who is conservative in designating family status compared to Munro (1967) and some other authors.

The number of species commonly caught is much less than 100 and only nine families are regularly represented (Table 1). Descriptions of the species will not be given here. Readers are referred to the books by Fourmanoir and Laboute (1976), Masuda *et al* (1975), Munro (1967) and, for sharks, Johnson (1978). Table 1 contains references where descriptions and, in nearly all cases, illustrations can be found for each species listed.

Table 1 also contains English and French names for each species. Where there are commonly recognised English names for species these have been used. There has often been no common or accepted name for a species; in these cases a descriptive name has been given. The French names follow Fourmanoir and Laboute (1976).

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1. 1 May 1980.
2. So far available - ORAFP reports: Cook Islands, New Hebrides, Solomon Islands, Tuvalu, Western Samoa; DSFDP reports: American Samoa, Kosrae, New Caledonia, New Hebrides, Niue, Papua New Guinea, Tonga (two) and Yap.

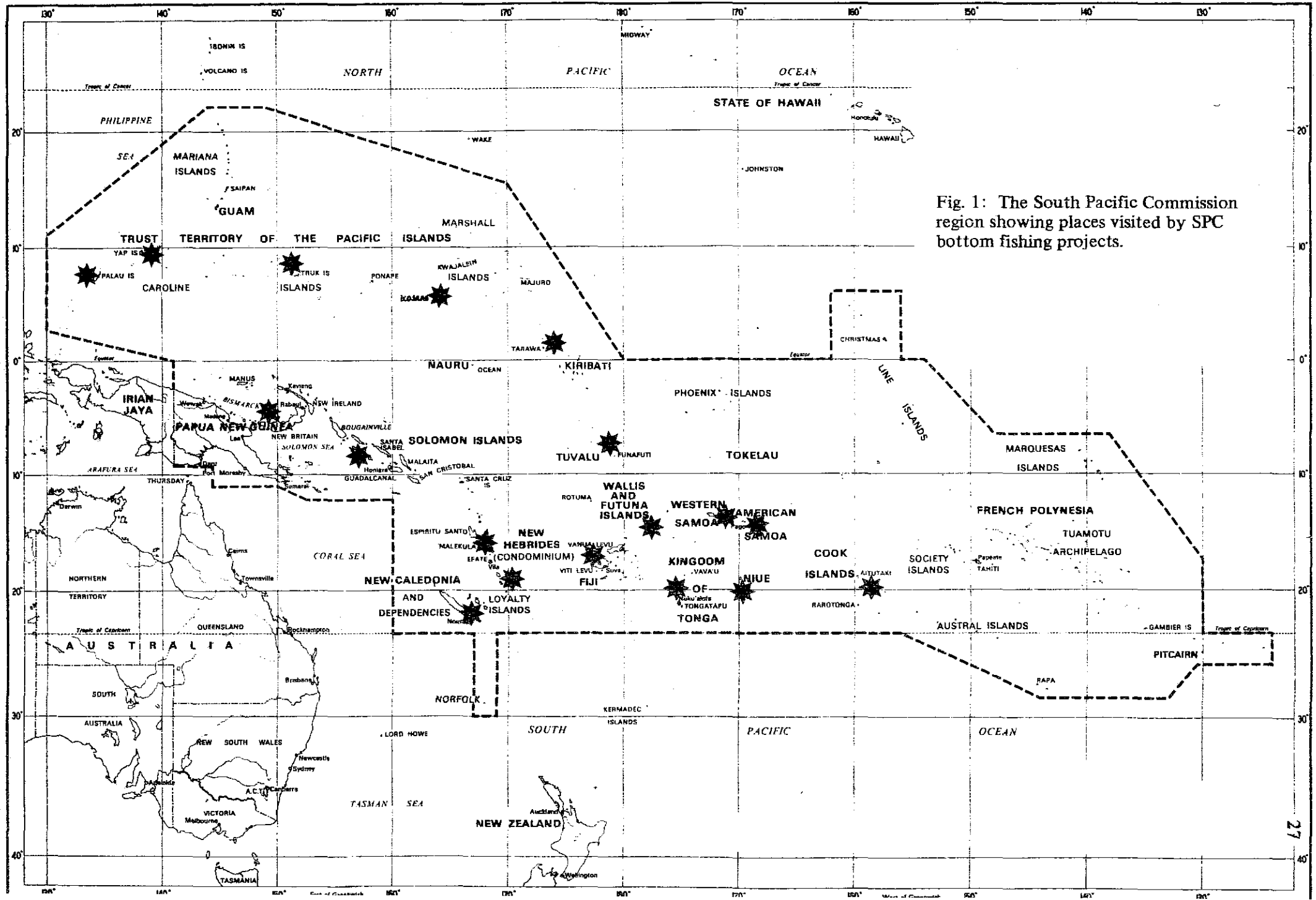

Fig. 1: The South Pacific Commission region showing places visited by SPC bottom fishing projects.

Table 1: Fish species most frequently caught by SPC bottom fishing projects[1]

Scientific name	English name	French name
SERRANIDAE		
Cephalopholis aurantius[2]	orange rock-cod	rouge batard
Epinephelus chlorostigma	brown-spotted grouper	loche pintade
E. dictyophorus[2]	spotted-finned grouper	-
E. hoedti	blue grouper	loche bleue
E. morrhua	brown-striped grouper	loche à bandes noires
E. retouti	red-banded grouper	loche rouge du large
Variola louti	lunartail rock-cod	saumonée hirondelle
CARANGIDAE		
Caranx ignobilis	lowly trevally	carangue à grosse tête
C. lugubris	black trevally	carangue noire
C. sexfasciatus	great trevally	carangue vorace
Seriola rivoliana[3]	deep water amberjack	carangue amoureuse
LUTJANIDAE		
Aphareus rutilans	small-tooth jobfish	latanier rouge
Aprion virescens	green jobfish	aprion verdâtre
Etelis carbunculus	short-tailed red snapper	vivaneau rouge
E. oculatus	long-tailed red snapper	vivaneau la flamme
Lutjanus bohar	red seabass	anglais
L. argentimaculatus	mangrove jack	rouget de palétuvier
L. gibbus	paddletail seaperch	lutjan bossu
L. kasmira[2]	blue-lined seaperch	jaunet
L. malabaricus	scarlet seaperch	perche écarlate
Paracaesio xanthurus	southern fusilier	ail du large
Pristipomoides auricilla	gold-tailed jobfish	vivaneau à taches jaunes
P. filamentosus	rosy jobfish	vivaneau blanc
P. flavipinnis	yellow jobfish	vivaneau à nageoires jaunes
P. multidens	large-scaled jobfish	poulet
Tropidinius argyrogrammicus	large-eyed flower snapper	cerf-volant
T. zonatus	banded flower snapper	vivaneau rayé
LETHRINIDAE		
Lethrinus chrysostomus	sweetlip emperor	gueule rouge
L. miniatus	long-nosed emperor	bec de cane malabar
L. nebulosus	spangled emperor	bec de cane
L. variegatus	variegated emperor	bossu rond
PENTAPODIDAE		
Gnathodentex mossambicus[2]	large-eyed bream	brème olive
Gymnocranius japonicus	naked-headed bream	bossu blanc à points noirs
SPHYRAENIDAE		
Sphyraena barracuda	barracuda	barracouda
GEMPYLIDAE		
Ruvettus pretiosus	castor oil fish	poisson huile
Thyrsitoides marleyi[4]	Marley's snake mackerel	-
SCOMBRIDAE		
Acanthocybium solandri	wahoo	thazard du large
Gymnosarda unicolor	dogtooth tuna	thon à dents de chien
CARCHARHINIDAE		
Carcharhinus amblyrhynchos	grey reef shark	requin gris

1. Except where otherwise indicated all species are described in Fourmanoir and Laboute (1976).
2. See Masuda, Araga and Yoshino (1979).
3. Called *S. dumerilli* in Fourmanoir and Laboute (1976).
4. See Smith (1965)

SERRANIDAE: groupers, rock-cods or sea-basses

Twenty two identified species of this large and diverse family have been recorded, including 16 species of the genus *Epinephelus*. Identification of serranids can be difficult because there are sometimes different colour forms in juveniles and adults and because of the abundance of scientific synonyms. The most common species overall are probably *Epinephelus chlorostigma* and *E. morrhua*.

CARANGIDAE: trevallies, jacks

Nine carangid species, of which four are common (Table 1), have been recorded. Of these, *Seriola rivoliana* is the most important. In the early reports this species was identified as *S. dumerilii* or *S. purpurascens*. Both these are synonyms for what is commonly called the amberjack; the common name deep water amberjack is proposed for *S. rivoliana* (Table 1). Correct identification is important, particularly as *S. dumerilii* can be ciguateric (Uchida *et al*, 1979)

LUTJANIDAE: snappers

This is the most important family of fishes found on the outer reef slopes. At least 27 species have been recorded with 16 of them occurring regularly (Table 1). Species of the genus *Lutjanus* are the most important in the shallower depths and those of the genera *Etelis* and *Pristipomoides* in deeper water.

The short-tailed red snapper *Etelis carbunculus* is identified as *E. marshi* in Masuda *et al* (1975), Kyushin *et al* (1977) and is also known under this name in Hawaii. The long-tailed red snapper *E. oculatus* is called *E. carbunculus* by these sources. However, the names used here and in all SPC reports follow Fourmanoir and Laboute (1976) and are based on Jordan and Evermann (1894).

The *Pristipomoides* species were not identified beyond the genus in some of the early reports. Also, *P. filamentosus* was sometimes recorded under its junior synonym of *Aprion microlepis*. Identification of the four species listed in Table 1 is not difficult, as each has distinctive features (Fourmanoir and Laboute, 1976; Fourmanoir, 1980). Full species descriptions can be found in Kami (1973) and Senta and Tan (1975).

LETHRINIDAE: emperors

Eleven species of lethrinids have been recorded. Four of these (Table 1) were reported from three or more places; easily the most important was *Lethrinus miniatus*. In the ORAFP reports the older generic name *Lethrinella* was used for some species.

PENTAPODIDAE: large-eyed breams

Two species have been positively identified (Table 1). They may be more common than reported because of confusion with the closely related families Lethrinidae and Sparidae.

SPHYRAENIDAE: barracudas

These fishes, commonly taken by trolling, are also regularly caught during bottom fishing in the upper part of the outer reef slopes. There are several species of which only one, *Sphyraena barracuda*, is regularly identified to species level.

GEMPYLIDAE: snake mackerels

Four species have been recorded, two of them commonly (Table 1). They are only caught at night. Although taken during bottom fishing trips these species are often caught in midwater. *Ruvettus pretiosus* is the most important species. Smith (1965) considered *Thyrsitoides marleyi* as rare, but this was probably because of lack of appropriate fishing effort.

SCOMBRIDAE: tunas, mackerels

Four species of this family of pelagic fishes have been recorded during bottom fishing the outer reef. Of the two most frequent species (Table 1), *Gymnosarda unicolor* is the more common.

CARCHARHINIDAE: Sharks

Most of the sharks caught belong to this family. At least seven species have been recorded, with *Carcharhinus amblyrhynchos* the most common.

Other families to have been recorded and the number of species (where known) are: Muraenidae, Holocentridae (several), Scorpaenidae (2), Branchiostegidae (1), Bramidae (1), Pomadasyidae (several), Sparidae (3)[1], Mullidae (1), Labridae (1), and six families of sharks.

GEOGRAPHICAL DISTRIBUTION AND SPECIES ABUNDANCE

The number of families represented at different places varied from three at Tanna (New Hebrides) and West New Britain (Papua New Guinea) to nine at Kosrae, Tonga and Truk (Table 2). Species numbers were lowest at Tanna (11) and highest at Palau (46). These data should be regarded cautiously, as factors such as the depths fished, time of day fished, sizes of hooks used, length of stay and geographical extent of the fishing area will have influenced the results. However, a few observations can be made. In general, more species were recorded from Micronesia than elsewhere; even the isolated island of Kosrae with 31 species was above the overall average (27.5). The low number of species at Tanna and in West New Britain is probably because of the nature of the bottom (soft bottom with a gradual drop off in Tanna; affected by runoff and silt, and with little coral in West New Britain).

Table 2: The number of families and species (excluding sharks) caught by SPC bottom fishing projects at different places. Figures in brackets are approximate.

Country	Families	Species	Country	Families	Species
American Samoa	8	(25)	Palau	6	46
Cook Islands[1]	7	20	Solomon Islands[6]	(8)	(30)
Kosrae	9	31	Tonga[4]	9	39
New Caledonia	8	32	Truk	(9)	(39)
New Hebrides[2]	7	27	Tuvalu	7	(22)
New Hebrides[3]	3	(11)	Western Samoa	9	(25)
Niue[4]	7	21	Yap	8	(30)
Papua New Guinea[5]	3	14			

1. Aitutaki
2. Malekula
3. Tanna
4. Two visits
5. West New Britain
6. Gizo

The composition of the catches by family (Table 3) shows that the Lutjanidae were by far the most important (average 53.3 per cent). In two places (West New Britain, Solomon Islands) they represented over 80 per cent of the weight[2] of fish caught. The family Lutjanidae appears to be more important in Melanesia than in other parts of the region. The most widespread lutjanid species was *Etelis carbunculus*, which was recorded from all 15 places shown in Table 2. At least one species of *Pristipomoides* was taken at 14 places, *Lutjanus bohar* also at 14 places, *Aphareus rutilans*[3] at 13, *Tropidinius zonatus* at 12 and *E. oculatus* and *Aprion virescens* at 11.

1. Possibly these were Pentapodidae.
2. Different results will be obtained if analysis by numbers is done but for surveying fisheries potential weights are more important.
3. Sometimes recorded (wrongly) as *A. furcatus*.

Table 3: Composition of the catches (as percentages by weight) by SPC bottom fishing projects at different places

	Lutjanidae	Serranidae	Carangidae	Lethrinidae	Gempylidae	Others
American Samoa	68.4	1.3	4.7	23.0	0.3	2.3
Kosrae	45.0	5.9	17.4	1.7	9.9	20.1
New Caledonia	43.7	13.7	3.7	27.1	0.0	11.6
New Hebrides[1]	69.2	19.8	2.1	0.0	0.0	8.9
Niue (1978)	45.6	25.1	1.6	25.3	0.0	2.4
Niue (1979)	45.5	17.4	0.0	0.0	18.1	19.0
Papua New Guinea[2]	80.3	0.2	7.9	0.0	0.0	11.6
Palau	53.2	13.6	13.1	3.4	4.8	11.9
Solomon Islands[3]	81.7	11.8	2.0	0.4	-[4]	4.1
Tonga (1978)	22.3	3.7	30.0	4.1	30.3	9.6
Tonga (1979)	46.8	8.7	5.4	9.8	-	29.3
Truk	67.1	3.3	19.2	4.3	1.6	4.5
Tuvalu	39.6	13.0	3.7	0.8	34.3	8.6
Yap	38.6	26.6	26.3	2.7	4.9	0.9
Averages	53.3	11.8	9.8	7.4	7.5	10.3

1. Tanna
2. West New Britain
3. Gizo
4. Less than 0.1 per cent.

The importance of the two genera *Etelis* and *Pristipomoides* to the catches at different places is shown separately in Table 4. These figures will be influenced by the depths fished. The zero catches of *Pristipomoides* at American Samoa and Niue (1979) are almost certainly because of this factor.

Table 4: Percentages (by weight) of the catches by SPC bottom fishing projects comprising deep water snappers of the genera *Etelis* and *Pristipomoides* at different places

	Etelis			*Pristipomoides*				
	carbunculus	*oculatus*	Total	*auricilla*	*filamentosus*	*flavipinnis*	*multidens*	Total
American Samoa	20.7	31.3	52.0	0.0	0.0	0.0	0.0	0.0
Kosrae	0.2	5.5	5.7	3.9	14.5	0.0	0.0	18.4
New Caledonia	1.0	3.9	4.9	0.0	25.2	7.9	0.8	33.9
New Hebrides	16.5	20.9	37.4	-	-	-	-	29.6
Niue (1978)	-[1]	-	22.5	-	-	-	-	5.8
Niue (1979)	23.0	21.1	44.1	0.0	0.0	0.0	0.0	0.0
Papua New Guinea	8.3	0.0	8.3	16.6	28.9	2.6	15.1	63.2
Palau	11.9	3.1	15.0	0.5	0.0	5.2	0.0	5.7
Solomon Islands	7.6	0.7	8.3	-	-	-	-	57.4
Tonga (1978)	5.3	7.9	13.2	-	-	-	-	16.3
Tonga (1979)	1.1	1.4	2.5	0.0	14.3	4.9	3.7	22.9
Truk	2.5	1.5	4.0	0.7	1.6	1.2	0.0	3.5
Tuvalu	7.1	1.7	8.8	0.0	0.0	7.4	0.0	7.4
Yap	5.9	0.0	5.9	1.1	1.0	0.0	0.0	2.1
Means			16.6					19.0

1. Details not available for individual species.

Catches of the other principal families were much less (Table 3) and showed much greater variation between places than the Lutjanidae. The Serranidae were important in all places except American Samoa and West New Britain (only four caught in three and half months fishing). The most widespread species was *Variola louti*, recorded at nine places. The Carangidae appear to be much more abundant in Tonga and Micronesia than elsewhere. *Seriola rivoliana* was the commonest and most widespread species (12 places). The contribution of the Gempylidae to the catches was greatly affected by the amount of night fishing done at different places.

The preceding discussion has not considered absolute comparative abundance. This is shown in Table 5, the overall catch rate for all species in different places, and in Table 6, the catch rate by family for different places. The variation in the catch rates for the two places the DSFDP has visited twice (Niue and Tonga), show that these data should be treated with caution.

Table 5: Catch rate in kg/reel/hour by SPC bottom fishing projects at different places

Outer Reef Artisanal Fisheries Project (electric reels)		Deep Sea Fisheries Development Project (hand reels)	
Cook Islands (Aitutaki)	3.5	American Samoa	4.4
New Hebrides (Malekula)	3.5	Kosrae	9.6
Tuvalu	2.5	New Caledonia	7.6
Solomon Islands (Gizo)	5.7	New Hebrides (Tanna)	3.1
Western Samoa (Savai'i)	4.1	Niue (1978)	2.8
		Niue (1979)	7.0
		Palau	3.3
		Papua New Guinea (New Britain)	4.9
		Tonga (1978)	3.6
		Tonga (1979)	5.7
		Truk	4.1
		Yap	6.9
Average	3.9	Average	5.3

Table 6: Catch rate in kg/reel/hour of the principal families of fishes caught by the Deep Sea Fisheries Development Project at different places

	Lutjanidae	Serranidae	Carangidae	Lethrinidae	Gempylidae	Others
American Samoa	3.0	0.1	0.2	1.0	-	0.1
Kosrae	4.3	0.6	1.7	0.2	1.0	1.9
New Caledonia	3.3	1.0	0.3	2.1	0.0	0.9
New Hebrides[1]	2.1	0.6	0.1	0.0	0.0	0.3
Niue (1978)	1.3	0.7	-	0.7	0.0	0.1
Niue (1979)	3.2	1.2	0.0	0.0	1.3	1.3
Papua New Guinea[2]	3.9	-[3]	0.4	0.0	0.0	0.6
Palau	1.8	0.4	0.4	0.1	0.2	0.4
Tonga (1978)	0.8	0.1	1.1	0.1	1.2	0.4
Tonga (1979)	2.7	0.5	0.3	0.6	-	1.7
Truk	2.8	0.1	0.8	0.2	0.1	0.2
Yap	2.7	1.8	1.8	0.2	0.3	0.1

1. Tanna
2. West New Britain
3. Less than 0.1 per cent.

REPORTS OF CIGUATERIC FISH

In general deep water fish are not ciguateric. However, both the ORAFP and the DSFDP have also fished in quite shallow waters at times and thus caught fish reputed or known locally to be poisonous. Each project report recorded whether any fish caught in its area of operations was reported to be ciguateric. This information is summarised in Table 7. The reported occurrence or non-occurrence of ciguatera (Fig. 2) showed it to be a problem in the central Pacific but to be unrecorded and, in some cases, unknown in the western Pacific.

Table 7: Reported occurrence of ciguatera in places where SPC bottom fishing projects have operated

No ciguatera reported	Ciguatera reported
Kosrae	American Samoa
Palau	Cook Islands[3]
Papua New Guinea[1]	New Caledonia
Solomon Islands[2]	New Hebrides[4]
Truk	Niue
Yap	Tonga
	Tuvalu
	Western Samoa

Species reported poisonous	Place
Lutjanus bohar	American Samoa, New Caledonia, New Hebrides[4], Niue, Tonga, Tuvalu, Western Samoa
Lethrinus chrysostomus	New Caledonia
Variola louti	New Hebrides[5]
Caranx sexfasciatus	New Hebrides[5]
Unidentified Serranidae	Cook Islands[3], New Hebrides[5], Tuvalu
Unidentified Lutjanidae	Tuvalu
Unidentified Acanthuridae[6]	Cook Islands[3]

1. West New Britain
2. Gizo
3. Aitutaki
4. Malekula and Tanna
5. Malekula
6. One small species

DISCUSSION

The fish fauna of the outer reef slopes is beginning to become better known at many places in the tropical Pacific due to the exploratory fishing surveys by SPC and through the development of artisanal fisheries for the deepwater species. As this review has shown, information on these fishes is scattered in the literature and sometimes confusing. There would therefore appear to be a need for an illustrated handbook on the common species likely to be caught on the outer reef slopes. Such a handbook would be a useful aid for fisheries departments wishing to collect basic catch statistics in places where deep bottom fishing is being developed. Apart from Western Samoa, most stocks can still be considered virtually unfished. It is at this early stage that the most valuable statistics, a measurement of the catch rate on the virgin stock, can be collected. If resources within the region permitted it, research into the biology and population dynamics of the deep water snappers would greatly add to the value of these statistics.

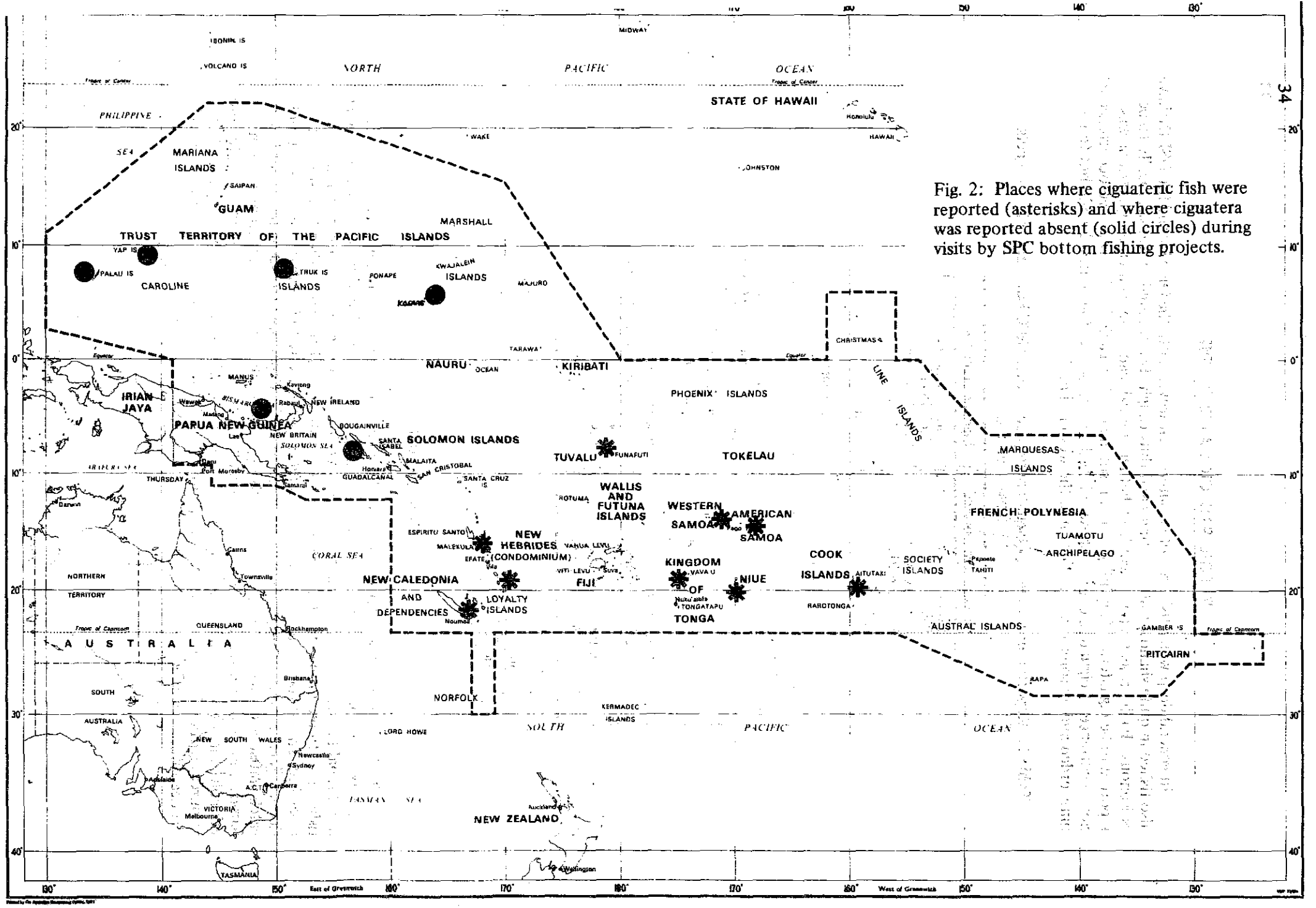

Fig. 2: Places where ciguateric fish were reported (asterisks) and where ciguatera was reported absent (solid circles) during visits by SPC bottom fishing projects.

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1. Also available in French.
2. Also to appear in French.
3. Also to appear in English.