SOUTH PACIFIC COMMISSION

FISHERIES NEWSLETTER

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Photo: Kevin Bailey

BEGINNING OF *TE TAUTAI*'s FIELD ACTIVITIES FOR 1991

Original text: English

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FISH HANDLING AND PROCESSING PROJECT

Post-harvest Fisheries Study Tour to Pacific Latin America

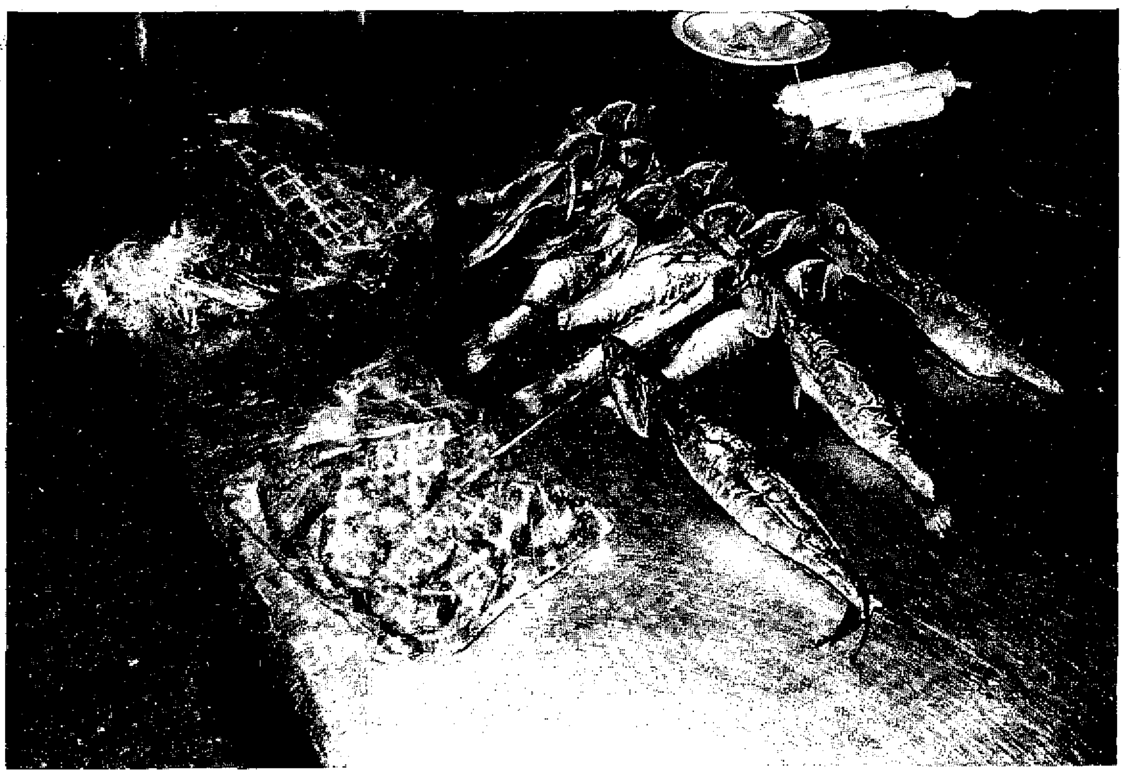
A team from the Pacific Island region undertook a study tour to Pacific Latin America during April to study and evaluate the expertise available and the technologies developed in post-harvest fisheries in Mexico, Ecuador, Peru and Chile.

The study tour was funded by the Canadian International Development Agency (CIDA), and was the first activity under the Trans-Pacific Fisheries Consultative Committee (TPFCC) since its creation in July 1990 at a meeting in Port Moresby. The TPFCC is an informal body designed to facilitate co-operation in the area of fisheries between countries of Pacific Latin America and the Pacific Islands. It is based at the headquarters of the Comision Permenente del Pacifico Sur (Permanent South Pacific Commission), Santiago, Chile. It has a similar function to the Western Pacific Fisheries Consultative Committee, which fosters co-operation between the countries of Pacific South-East Asia and the Pacific Islands.

The general objectives of the study tour were to explore areas of post-harvest fisheries technology expertise in Pacific Latin America which can be of benefit to Pacific Island countries and to evaluate the potential for utilising this expertise to assist training and applied research activities.

The study tour participants were Mr Steve Roberts (study tour leader), Post-harvest Fisheries Adviser, South Pacific Commission; Mr Maciu Lagibalavu, Acting Principal Fisheries Officer, Fisheries Division, Fiji; Mr Satalaka Petaia, Fisheries Extension and Development Officer, Fisheries Division, Tuvalu; and Mr Nadarajah Rajeswaran, Senior Resources Development Officer, Department of Fisheries and Marine Resources, Papua New Guinea. The tour was also joined by Dr Gordon Munro, Coordinator PECC Task Force on Fisheries Development and Cooperation, and Señora Lola Dulanto de Soldi from Peru, who acted as interpreter.

The study tour members identified a number of areas where the impressive level of technical expertise in the Latin American countries visited could assist the Pacific Islands. These include training in quality control and inspection services, particularly in Ecuador and Chile, solar tent fish drying technol-



Samples of smoked fish produced at the National Fisheries Institute, Guayaquil, Ecuador.

ogy in Ecuador, low-cost fish smoking and salting techniques in Ecuador and Peru, technical assistance at a regional workshops (e.g. SPC's regional workshop for the chilled fish sector) and a whole range of literature and product formulations (burgers, sausages, smoked products, etc.), which were collected in each country visited. It was also recognised that the establishment of the Regional Post-harvest Fisheries Centre in Suva, Fiji within the next two years will provide a focal point for co-operative applied research projects and exchanges among scientists and trainers.

The study tour representatives from the three Pacific Island countries were impressed with the high degree of commitment to the post-harvest fisheries sector in each country and felt that the Pacific Islands need to expand their activities in this important technical area if they are to benefit fully from their marine resources.

Funding is potentially available for technical experts (with a good understanding of English) for specific projects and for training opportunities in Latin America. A report outlining these opportunities will be published and countries in the region interested in any of the areas described can apply for such technical assistance. Those interested should inform SPC's Post-harvest Fisheries Adviser.

Study tour team members Maciu Lagibalavu, Fiji (top left), Satalaka Petaia, Tuvalu (bottom left) and N. Rajeswaran, PNG (third from right) watch fish research technologist Ramon Montano of the National Fisheries Institute in Guayaquil prepare mahi-mahi for salting and smoking.

Women's Fisheries Programme starts at SPC

On 15 May Shirley Steele joined the South Pacific Commission as the Women's Fisheries Programme Officer within the Post-Harvest Fisheries Project.

For the past three years Shirley has been living in Kavieng, New Ireland, Papua New Guinea. Her initial assignment in PNG was with the New Ireland Provincial Council of Women in the capacity of Executive Officer. Her more recent job was as lecturer in Business Studies and English at the National Fisheries College in Kavieng.

Prior to living in PNG, Shirley worked in various Canadian colleges and universities, primarily as a programme co-ordinator and counsellor. She has also worked as a youth consultant and employment equity consultant with the Canadian Federal Government.

As the Women's Fisheries Programme Officer, Shirley will be responsible for developing, co-ordinating and enhancing post-harvest fisheries activities relating to women throughout the South Pacific. Much of her time during the next six months will be spent in Papua New Guinea providing support and assistance to the ICOD-funded Women-in-Fisheries Support Project.

DEEP SEA FISHERIES DEVELOPMENT PROJECT NOTES

Canadian Peter Watt, who has worked with the Project as a consultant for some time (see Fisheries Newsletter #56) was engaged as a full-time Masterfisherman in March, bringing the Project's field-staff complement to three.

Peter brings to the Project extensive experience in Pacific Islands fisheries, having worked for more than four years in Vanuatu under the Village Fisheries Development Project. He also holds certification as a vessel master and has wide commercial fishing experience. Apart from his native English, Peter is comfortable in both French and Bislama.

His present duty station is Western Samoa, where, following the success of the tuna longlining trials already reported in these pages, he has developed a manual vertical longlining system suited to the local alia catamaran fleet.

Fishing trials to date have proven to be more productive than those conducted from the Fisheries Division vessel. Some ten alia crews have now adopted this longlining method and are typically landing catches of prime tuna of about 200 — 300 kg a trip.

Marketing of these catches by airfreight to Hawaii and the U.S. West Coast is now under way and it appears that the fishery will expand rapidly.

A practical SPC manual on vertical longlining and a training video are presently in preparation.

Masterfisherman Peter Watt and the wooden hauling drum he has developed for vertical longlining in Western Samoa.

FISHERIES INFORMATION PROJECT

SIG Information Bulletins

The concept behind Special Interest Groups (SIGs) is to establish networks of individuals working in similar subject areas, so as to encourage the sharing of information and ideas in the region.

The SIGs are being established in response to the needs of Pacific Island fishery scientists and development workers, as expressed at the SPC Workshop on Pacific Inshore Fishery Resources in March 1988 and at the 21st Regional Technical Meeting on Fisheries in August 1989. In both cases, representatives of the Commission's 22 Pacific Island member countries and territories urged SPC to become more active in the collection, repackaging and dissemination of information on the key fishery resources of the region, as a step towards reducing the problems of isolation and poor communication faced by fisheries workers in the islands.

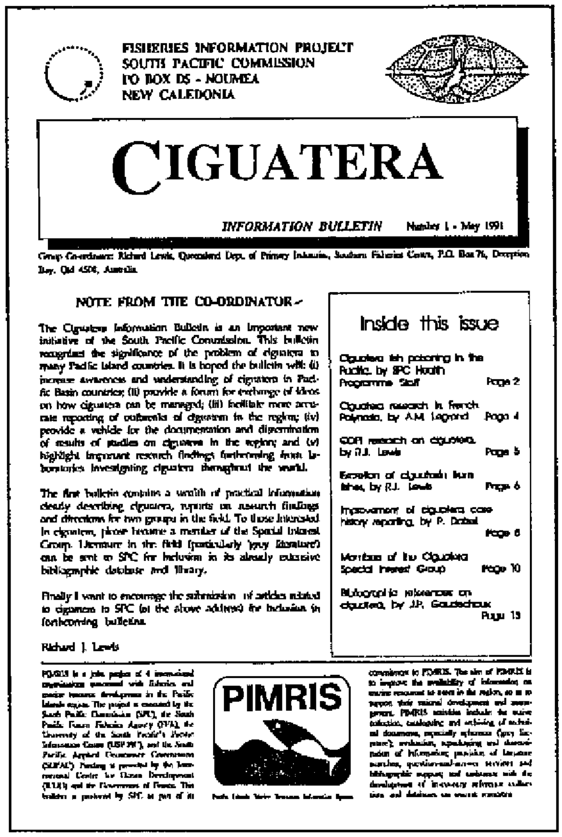
As a first step, SPC circulated questionnaires on the establishment of SIGs to the fisheries establishments of the region and beyond. The questionnaire responses were used to gauge the relative interest of different subject areas to Pacific Island fishery workers, and to identify individuals who might provide technical information.

More than 300 reponses to the questionnaire have been received to date, 80 per cent from within the SPC region, and returns are continuing.

As part of the support offered to each SIG, SPC undertakes to circulate literature, technical materials, and correspondence relevant to the interests of group members on an occasional basis, mainly in the form of this type of bulletin. In return, **SPC asks group members** to keep it informed of their own activities in the subject field, and to send it single copies of any material or information that may be relevant to the interests of other members of the group.

The third Special Interest Group, on ciguatera, is now running. The other two concern beche-de-mer and pearl oyster.

The *Ciguatera Information Bulletin* is an important new initiative of the South Pacific Commission. This bulletin recognises the significance of the problem of ciguatera to many Pacific Island countries. It is hoped that it will increase awareness and understanding of ciguatera in Pacific Basin countries; it will also provide a forum for exchange of ideas on how ciguatera can be managed.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SOUTH PACIFIC COMMISSION
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CIGUATERA

INFORMATION BULLETIN Number 1 - May 1991

NOTE FROM THE CO-ORDINATOR

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Richard J. Lewis

PIMRIS

The first bulletin contains a wealth of practical information clearly describing ciguatera, and reports on research findings.

Efforts will be made to increase the number of SIGs gradually towards the target level of twelve active groups. The establishment of three more SIGs has been decided, concerning resource enhancement, trochus and shell industry (business and marketing aspects) and fish aggregation devices.

INSHORE FISHERIES RESEARCH PROJECT

Shallow reef fish stock assessment in the outer Islands of Yap State, FSM

Yap State in the Federated States of Micronesia is comprised of the small high island of Yap proper and a number of atolls to the east, between Yap and Chuuk State. Fish is one of the major resources of these atolls and shallow reef fish have been and continue to be a major dietary staple there. However, the remoteness of these atolls on outer islands has meant that they have been largely ignored with respect to fisheries resources investigations. However, the abundance of fish stocks of the shallow reefs in the lagoon of Woleai Atoll was recently assessed by a project jointly undertaken by the Yap State Marine Resources Management Division (MRMD) and the SPC Inshore Fisheries Research Project (IFRP).

This stock assessment project was the culmination of two years of planning between SPC (IFRP) and Yap State MRMD. The idea for the project was first proposed in 1989 after IFRP scientist Paul Dalzell met Andrew Smith, who at the time was working on the collection of traditional fisheries information for the Yap Institute of Natural History. Mr Smith had spent a considerable amount of time in the Yap outer islands, in an attempt to record formally the traditional fishing knowledge of these islanders. While on Woleai, Mr Smith had photographed the use of a leaf sweep method for drive-in net fishing on shallow reefs. Smith and Dalzell felt that the use of this fishing method would enable them to estimate standing stocks through a series of stock reduction experiments.

These experiments are designed to reduce the standing stock of fish in a given area by concentrated fishing effort over a short period of time and to observe the resulting decline in catch per unit of effort (CPUE).

The rate of decline is proportional to the initial standing stock and over a short time period is unlikely to be influenced by the compensatory processes of growth and immigration. Amongst the many methods of fishing practiced by Woleaian men were community leaf sweeps ('roop' in Woleaian) and spear fishing ('hapungapung'). Both these methods can be adapted readily to repeated fishing on a given site. Further, the use of familiar, traditionally practised fishing methods facilitates the logistics of an enterprise involving such a large number of people.

During May and June, Smith and Dalzell conducted on Woleai two fishing experiments on reefs in the western and eastern lagoons of Woleai, using both 'roop' and 'hapungapung' techniques in each area on Woleai. The eastern lagoon is bordered by the most heavily populated islands and the most frequently fished shallow inner reefs. By contrast, the islands of the larger western lagoon are more sparsely populated and contain about one third of the 770 people who inhabit the atoll. As a result fishing pressure on the reefs around these islands is less than in the eastern lagoon.

Marked reductions in CPUE were noted over the 3—5 days of the different fishing experiments. This made it possible to estimate total standing stock of fish and of different components of the catch, such as surgeonfish and parrotfish. Besides the catch data, a large amount of biometric data (lengths and weights) was collected on individual species in the catch, and some observations of reproductive activity were made. Estimates of the standing stocks of the fishable shallow reef biomass and some of the more common species components were computed from these data. Given the selectivity of the two methods, the biomass estimates refer not to the total biomass of fish on the reef, but rather to those fishes vulnerable to the gears employed. These biomass estimates were then expressed in kilograms per hectare and extrapolated to the total shallow inner lagoon reef area.

Other observations carried out over this period on Woleai included spear fishing and handline fishing carried out by villagers as part of their normal daily activities, and an inventory of boats and fishing gears at the atoll. Mr Smith also performed a trochus survey to see if the stock densities were high enough to permit harvesting. Trochus were transplanted to Woleai in 1984 from Yap, but as yet none have been harvested.

A report of the Woleai stock assessment project and ancillary work is currently in preparation. It will include estimates of standing stocks and suggested potential yields from the shallow reef areas, together with notes on the biology of the various dominant families and species groups.

Workshop on Trochus Resource Assessment, Development and Management (May — June 1991)

This workshop was held in Vanuatu in May — June 1991, in response to a recommendation from the 22nd Regional Technical Meeting on Fisheries. The workshop was structured as three one-week modules:

— *Week 1* consisted of presentations and discussion on logistical and economic aspects of the international shell trade, as well as trochus biology, ecology, aquaculture and resource assessment. Forty-five individuals participated in this module, which took place at the Centre for International Relations in Port Vila.

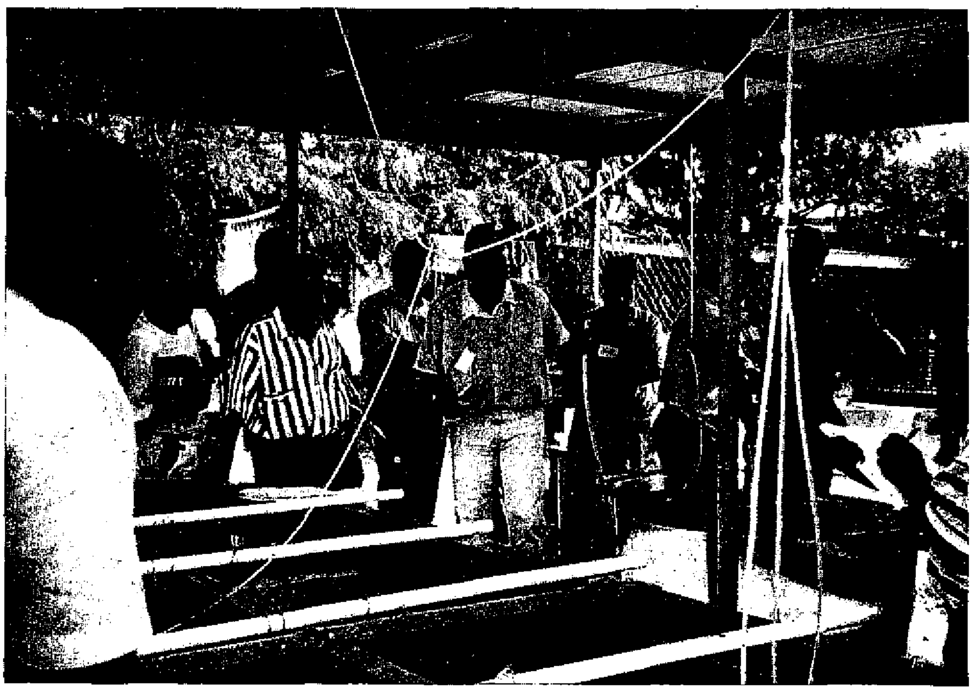
— *Week 2* consisted of training and practical exercises in the application of basic survey methods to reef organisms. Participants studied the statistical considerations underlying sampling design and stratification, carried out survey work on selected reef areas, and performed analysis of data using a variety of techniques. Twenty-four individuals participated in Week 2, which was carried out at Erakor Island on the outskirts of Port Vila.

— *Week 3* extended the Week 2 training by giving participants an opportunity to carry out trochus survey work in the field during a simulated management exercise at the island of Aneityum, in the south of the Vanuatu archipelago. Participants worked in groups to gather and interpret data on the resource, with the aim of producing a hypothetical management plan for the island's fishery. Eighteen individuals participated in this module, based on board a chartered vessel which sailed to Aneityum for the field-work component.

The workshop provided a large body of information not currently available in a published form, especially on aspects of the trochus button and shell trade, and on aquaculture work being carried out in Japan and elsewhere. This is presently being edited into a workshop report and will be published in due course.

In addition to the survey work, a release experiment was performed during Week 2, using over 1,000 juvenile trochus reared in hatchery facilities run by the Vanuatu Fisheries Department. All Week 2 participants assisted with the experiment, tagging the trochus, placing them in four different release areas, and subsequently searching for and recording those that could still be found. Initial results of the experiment were more encouraging than expected: mortality rates were low and growth rates extremely high — some 15 mm animals had grown an additional 5 mm after just 10 days. The Vanuatu Fisheries Department will continue to monitor the released trochus over the coming months and a detailed technical report will be written up once some longer-term conclusions can be drawn.

The workshop discussions also led to several recommendations for future action by the Commission in assisting Pacific Is-



Vanuatu Fisheries Department Resource Officer Moses Amos (centre) shows workshop participants around the trochus hatchery.

land countries to assess and manage resources of trochus and of other marine invertebrates. The main recommendations were that the Commission should:

— Assist Pacific Island countries to make use of remote sensing and image processing in survey work on trochus and other marine resources, especially benthic invertebrates;

— Establish a new Special Interest Group (SIG) on shells and the shell trade, focusing especially on trochus;

— Encourage the detailed study of the Aitutaki trochus fishery as a case study, in order to provide management-related information that will be applicable to the developing fisheries in other atolls of the region; and

— Encourage the adoption of standardised survey techniques for trochus and other benthic marine invertebrates in Pacific Island countries, to enable comparison of results by different workers and from different areas.

The recommendations will be discussed by the forthcoming SPC Regional Technical Meeting on Fisheries with a view to defining the ways in which they can be implemented.

A tagged juvenile trochus, about 20 mm diameter (estimated), newly released on the reef. The dark spot on the tip of the shell is a blob of pink-coloured cyanoacrylate glue, used to help find the tiny shell after release.

Twenty-third SPC Regional Technical Meeting on Fisheries (RTMF) to be held in August

This annual meeting, which reviews the Commission's fisheries activities for the last 12 months and sets future directions for the programme, will be held from 5 to 9 August at SPC's headquarters in Noumea, New Caledonia. The draft agenda for the meeting, subject to modification, is shown below.

The meeting will review several important issues, including the draft strategic plan for the Tuna and Billfish Assessment Programme for the next five years and progress on establishing a regional fishery post-harvest research and training facility.

The one-day special interest workshop that is normally held as part of the meeting will this year focus on 'People, society and Pacific Island fisheries development and management'. The workshop will consist of presentations and discussion on the roles of traditional practices and knowledge, cultural mores and values, and of different sectors of the community, especially women, in modern-day fisheries development and management. The aim of the workshop, which has attracted a great deal of interest in the region, is to identify ways in which fisheries development and management can proceed while remaining compatible and in harmony with the lifestyles of Pacific Island peoples.

The RTMF will be preceded by a two-day meeting of the Pacific Island Marine Resources Information System (PIMRIS) Steering Committee on 1 and 2 August. PIMRIS is an inter-agency project involving SPC, FFA, USP and SOPAC, and aims to provide a variety of information services to regional marine resource workers.

Following the RTMF, the South Pacific Regional Environment Programme (SPREP) will be hosting a two-day workshop on marine turtle research, management and conservation, which will focus on SPREP's current efforts to promote national-level turtle research and management activities in the region. Fisheries officers attending the RTMF are welcome to arrive early, or leave late, if they wish to participate in the other two meetings.

Draft agenda — 23rd SPC Regional Technical Meeting on Fisheries

5 August

Opening formalities
- Opening address
- Administrative arrangements
- Adoption of agenda and timetable
- General introduction SPC Fisheries Programme

SPC Fisheries Programme review — open-day display
(Fisheries Programme activities will be presented in the form of interactive displays and presentations, and staff will be available to discuss their activities in detail with meeting participants.)

SPC Tuna and Billfish Assessment Programme review — plenary discussion session
- Overview
- Regional Tuna Tagging Project
- Tuna Research Project
- Fisheries Statistics Project
- Albacore Research Project
- Report of Fourth Standing Committee Meeting on Tuna and Billfish
- Draft Strategic Tuna Research Plan, 1992—1996

6 August

SPC Coastal Fisheries Programme review — plenary discussion session
- Overview
- Deep Sea Fisheries Development Project
- Gear Development Sub-Project
- Offshore Fisheries Development Sub-Project
- Regional Purse Seine Test Fishing Sub-Project

Inshore Fisheries Research Project
Fisheries Information Project
PIMRIS Steering Committee and progress report
Fish Handling and Processing Project
Women-in-Fisheries Project
Report on Latin American study tour
Post-harvest fisheries facility — progress report
Fisheries Training Project

Human resource development in the fisheries sector in Pacific Island countries

7 August: **One-day Workshop: People, Society, and Pacific Islands Fisheries Development and Management**
Introduction, workshop aims and outline
Traditional systems of resource management and control in the 20th century — case studies worldwide
An overview of customary systems of marine resource management in Oceania, and ways in which these can be put to use in today's fisheries management context
Applying traditional knowledge of marine resources to their management
Developing a resource management system in Palau
Traditional knowledge and management of marine resources in Tokelau
Fisheries development in Papua New Guinea — involving the people
Other country interventions
The role of women in Pacific Island fisheries
Improving opportunities for women to participate in the development process
Fisheries as a part of integrated rural development
The role of extension and communication skills in fisheries development
Future needs in research on, and application of, traditional and social systems and knowledge in the Pacific
Recommendations for action in this area by national and international agencies

8 August: **Aquaculture and marine resource enhancement**
Introductions of marine species in the Pacific
Quarantine protocols for the transfer of biological material from aquaculture facilities
SPC/ SPRADP Reef Reseeding Project
Trochus reseeding experiment
Enhancement of spiny lobster populations through habitat modification
Fifth International Conference on Artificial Habitats for Fisheries

Development of Pacific Island pearl oyster resources

Issues relating to safety at sea in Pacific Island fisheries

9 August: **Reports by other organisations**

Other business

Closing formalities

TUNA AND BILLFISH ASSESSMENT PROGRAMME

Regional Tuna Tagging Project (RTTP)

The tagging vessel began 1991 field activities in Papua New Guinea in the first week of February after major repairs in the engine-room were completed in Australia. The vessel operated in PNG waters for most of February, apart from a brief trip to the Kapingamarangi Islands in Pohnpei towards the end of the month.

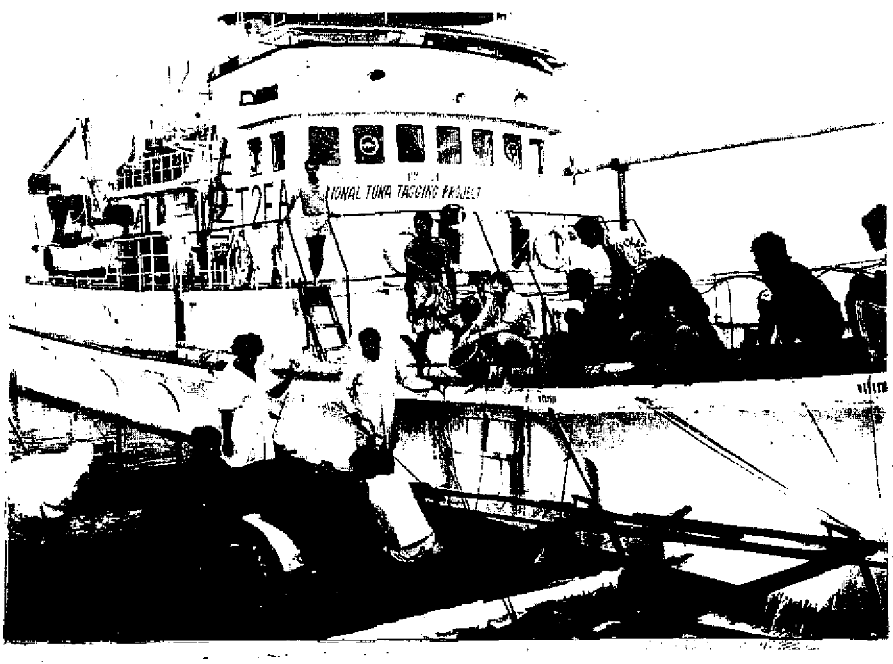
The first week was spent fishing along the south-east coast of the PNG mainland and in the Solomon Sea amongst the islands of the Louisiade Archipelago. A total of 6,940 tuna was tagged in this time (1,576 yellowfin, 5,179 skipjack and 185 bigeye), with over 90 per cent of the releases coming from a network of Philippines payaos anchored in the Solomon Sea. During the second week, 225 releases were made near Rabaul (120 yellowfin, 102 skipjack and 3 bigeye) and 1,794 releases were made on seamounts to the south of Dyaul Island in the Bismark Sea (807 yellowfin, 966 skipjack and 21 bigeye). Over half of the Dyaul releases were double tagged.

Following a visit to Kavieng, the vessel undertook a long-range trip, fishing around Tench Island, north to the Equator, and then west to the Kapingamarangi Islands. A total of 1,535 fish was tagged on the outward leg of this trip, comprising 7 yellowfin, 1,527 skipjack and 1 bigeye. Two nights were spent baiting in the Kapingamarangi lagoon. Small but sufficient quantities of bait were caught to enable a brief search around the islands and for the return trip to New Ireland. One drifting log was located near Kapingamarangi, but produced only seven releases (5 yellowfin, 1 skipjack and 1 bigeye). On the return trip, 336 skipjack were tagged.

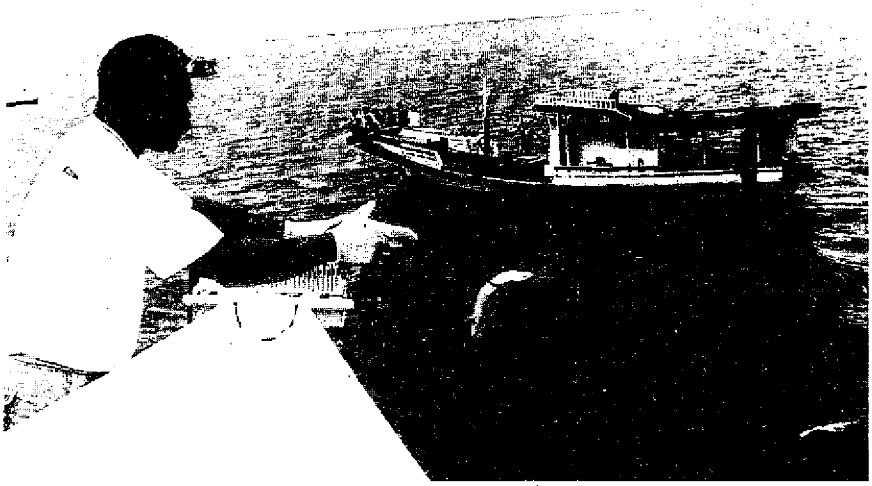
Bad weather plagued the remaining days of February. Both a return visit to the Dyaul Island seamounts and the transit from New Ireland to Manus Island were severely hampered by heavy seas, with the former producing 94 releases (57 yellowfin, 32 skipjack and 5 bigeye), and the latter 339 skipjack releases.

The *Te Tautai* began operations in Indonesian waters on 6 March 1991, when the vessel crossed into Irian Jaya from Papua New Guinea. Activities during the first week were hampered by rough seas and high winds generated by Hurricane Sharon. After embarking three Indonesian observers in Biak, the vessel worked westwards finding large schools of yellowfin tuna south of Waigeo Island. The schools were feeding actively on surface baitfish, so chumming attempts were unsuccessful. Searching farther west, the ship had excellent fishing results on anchored FADs and drifting logs between Gag and Gebe Islands and excellent baiting in Aljui Bay. Good fishing on unassociated schools was also encountered during a trip to the south between Ceram and the Irian Jaya mainland.

The vessel then found excellent fishing off south-east Waigeo, but poor fishing and extremely strong north-west currents north of Waigeo. A return trip to the FADs near Gag Island the following week produced 33 recaptures by the tagging vessel in one day and a new RTTP record number of releases



Indonesia — purchasing live bait from local lift net boats (*bagons*).



SPC specialist fisherman, Eroni Dolodai, tagging in Indonesia — Indonesian pole-and-line boat fishing on FAD.

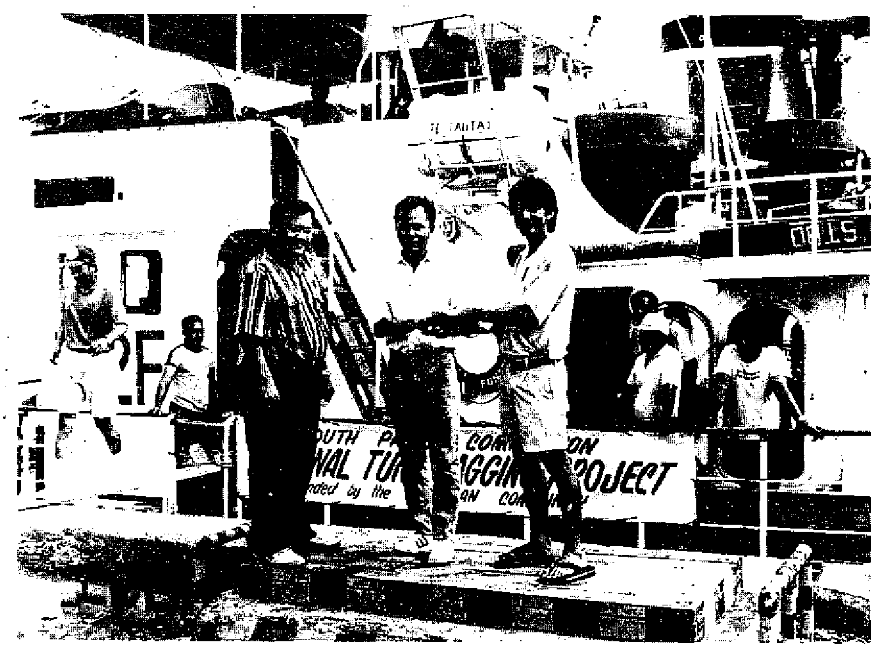
(1,747) for a single day. Moving West to Maluku near Bacan and Mandioli Islands, the vessel released good numbers of tuna on FADs south of Bacan, but baiting was poor. Fishing farther west off eastern Sulawesi was poor, but quantities of fish were located in central and northern Tomini Bay just before the ship cleared from Indonesia and headed for the Philippines. The project acknowledges the vital role the Indonesian observers played in assisting with port clearances and supplying the ship with accurate fishing and baiting information.

The *Te Tautai* spent 19 days in Philippine waters between 29 March and 16 April, entering the zone from Indonesia and the Celebes Sea. Four thousand tag releases were made, consisting of 830 yellowfin, 3159 skipjack and 11 bigeye tuna. Two fishery scientists from the Bureau of Fisheries and Aquatic Resources in Manila joined the cruise and participated in tagging and data collection activities.

Three days were spent in the west and central Moro Gulf, where dozens of anchored payaos were examined, but few held any tuna schools and very few tuna schools were sighted. Baiting in southern Mindanao was also poor, although full moon conditions may have contributed to the poor catches. The vessel moved to the west and conducted a thorough survey of the Sulu Sea basin for the next ten days. A productive payao was located near Tubbataha Reef, where 800 releases were made. Several payaos near Puerto Princesa and Honda Bay in Palawan were checked out but only large quantities of dolphin fish were present.

Searching north along the northeast coast of Palawan was also unproductive, but the Palawan baitgrounds supplied enough bait for daily operations. Tuna were also absent from the fishing grounds and payaos south of the Chuyo Islands in the northern Sulu Sea.

An extremely productive baitground was discovered in



SPC Fisheries Scientist, David Itano, hands over first prize in an annual lottery for Philippine tag returns.

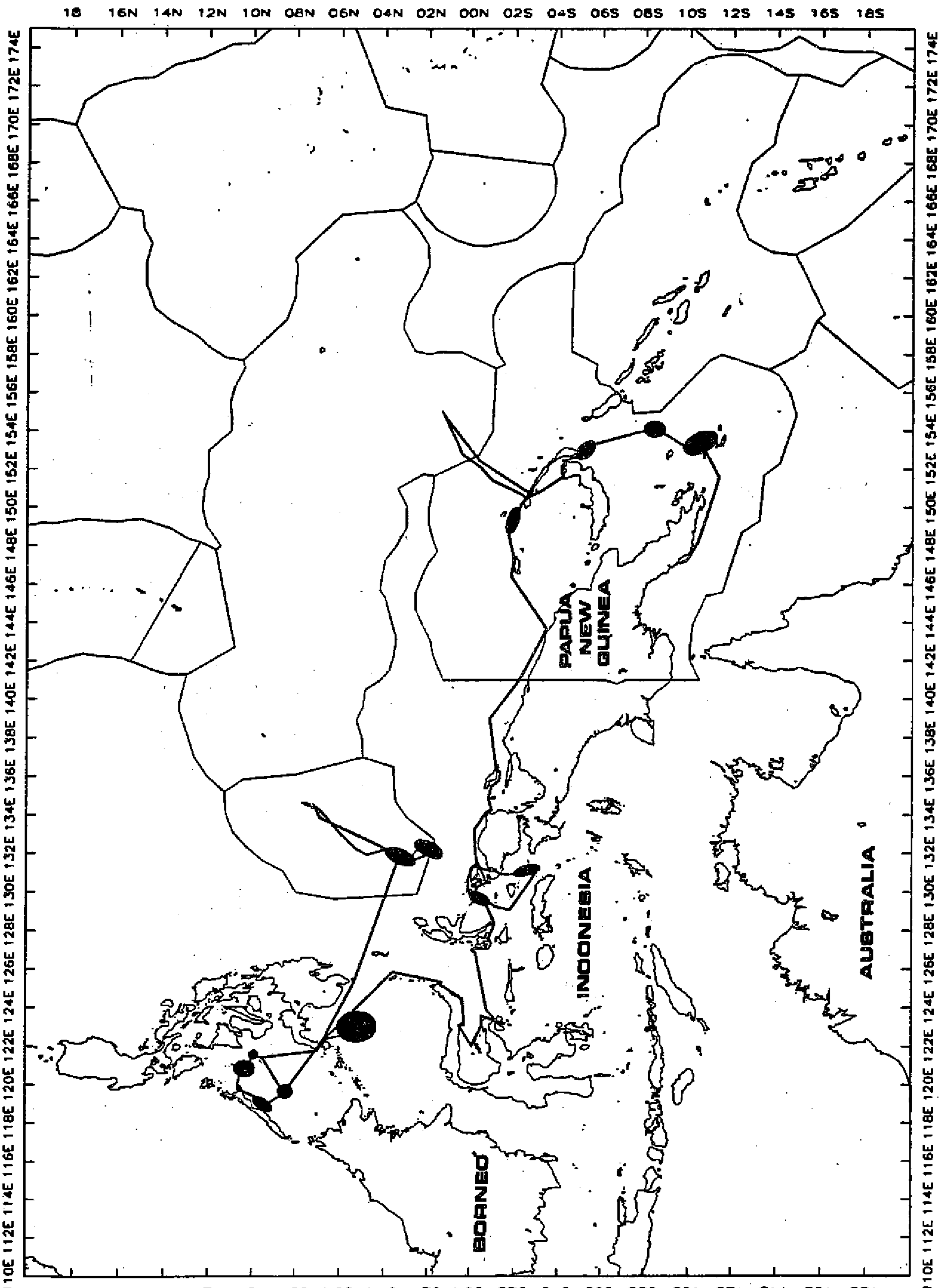
the lagoon of Cagayan Atoll, where large quantities of sprats were caught. This bait was used to release almost 1,200 skipjack near Cagayan Island and over 1,800 yellowfin and skipjack tuna on two payaos near Tubbataha Reef. Ninety-seven tuna tagged during this cruise were recaptured by the *Te Tautai* crew on the Tubbataha Reef payaos. On 15 April, the ship cleared from the Philippines, crossing the Moro Gulf and searching the nearshore waters of southern Mindanao. No schools were encountered and the vessel continued toward Helen Reef in southern Palau.

The remainder of April was spent in Palau waters, where 2,320 tuna were tagged (928 yellowfin, 1,388 skipjack and 4 bigeye tuna). Six days were spent operating out of the Helen Reef baitground, fishing on surface schools of skipjack and yellowfin south of Helen Reef and on log-associated schools to the north. Two days were then spent fishing around the small islands of Merir, Pulo Anna and Sonsorol, before the vessel arrived in Koror. Two final days were spent south-east and south-west of Koror, fishing on a large unassociated skipjack school and one log-associated school where a high percentage of yellowfin were released.

The table below (total as at 30/4/91) summarises the releases and recoveries to date, by species.

RELEASES				
Yellowfin	Skipjack	Bigeye	Other	Total
23,221	40,994	1,111	82	65,408
RECOVERIES				
Yellowfin	Skipjack	Bigeye	Other	Total
1,330	3,671	84	-	5,085

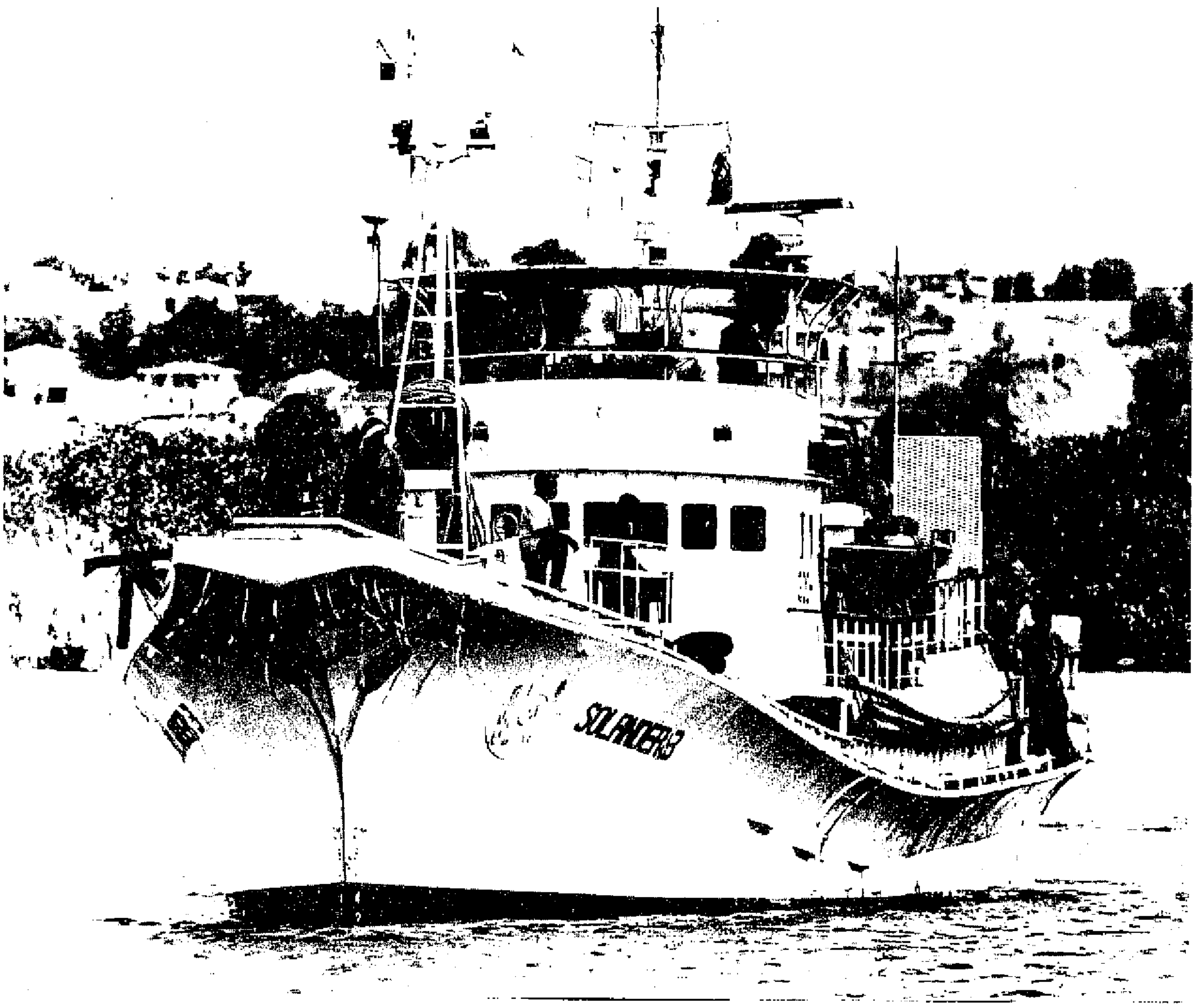
Joel Opnai and John Hampton, SPC Fisheries Scientists, bio-sampling tunas



Places visited by *Te Tautai* during February — April 1991

South Pacific Albacore Tagging Project

The 1990 — 91 SPC Albacore Tagging Project ended in Nelson on 26 March. The final ten days of the project were spent in New Zealand (NZ) waters, coinciding with the end of the season.



***Solander 3*, dual purpose vessel, chartered for the programme**

Solander 3, a Fijian dual-purpose pole-and-line-cum-troll fishing vessel chartered for the programme, had begun its work, after a minor delay invoked by Cyclone Sina in Fiji, in Whangerei, New Zealand on 13 December 1990.

Tagging proceded first in the waters around the east, then west, coasts of northern New Zealand and progressed south to the Vitti Canyons off New Plymouth. With few releases here, the programme was off to a disappointing start, though this was no surprise so early in the season. But if Cruise 1 was to be considered disappointing, Cruise 2 at best had to be thought of as depressing. This cruise began on the West Coast, South Island of New Zealand and moved into the mid-Tasman area traversing almost as far as the Australian Fishery Zone. It was beset by horrendous weather conditions which drove most other fishing vessels to port, exposed some weaknesses in our own vessel and left the Fijian crew, who mostly lacked experience of southern climes, wondering what they had let themselves in for. However, despite these discomforts and the consequent morale-sapping, meagre fishing, the crew held up remarkably well.

After a two-day break for repairs and reprovisioning in Nelson, Cruise 3 began with baiting in the Marlborough Sounds, then moved east to albacore grounds off the Wairarapa and Hawkes Bay regions of the North Island of New Zealand and on to the

Chatham Islands. The release rate started to pick up, with some particularly good fishing on the South Madden Bank. Although the cruise had to be interrupted for further repairs to an errant radar, prospects for the project were looking brighter. A last-night baiting before the ship left the coast also produced excellent results, with a fine haul of pilchards (*Sardinops neopilchardis*), some sprats (*Sprattus antipodum*) and some Jack mackerel (*Trachurus novaezelandiae*).

The last land-based refuelling, before the major cruise of the programme, took place in the Chatham Islands. Land would not be sighted again for another 40 days. Reprovisioning during the extended Subtropical Convergence Zone (STCZ) cruise was to be made at sea. During this extended portion of the project, advantage was taken of an offer from *Solander 3*'s owners to place a tagger aboard another of their vessels engaged in commercial operations in the same fishery.

A crewman, Jona Ravasakula, who had worked on the SPC skipjack tagging project aboard the *Hatsutori Maru 5* in the late 1970s, was swiftly recruited and his work aboard the *Daniel Solander* (referred to as Cruise 5) made a substantial contribution to the overall success of the project. Cruises 4 and 5 extended east of the Chathams in the STCZ to the south of French Polynesia. More than half the total releases for the project were made during these cruises, the bulk of them in a 5-degree square 700 miles southwest of French Polynesia and more than 1,500 miles east of New Zealand.

A secondary objective of the programme, to assess the viability of a pole-and-line fishery, had, until this stage, met with unsuccessful results. Schools encountered had mostly seemed to be invulnerable to that method of fishing. The day arrived, however, when a suitable school was met and fished most successfully until the remaining bait reserves were exhausted. Unfortunately, evolving appropriate methods to gather bait in the STCZ was never quite achieved and so this very productive day was never repeated.

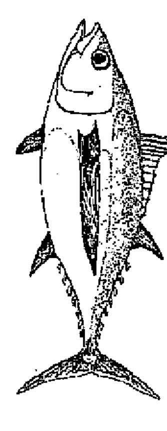
The exercise did demonstrate very clearly the well-held belief that fish released after capture on pole-and-line gear are in far superior condition to those released after troll capture. There is a very real need for South Pacific albacore mark-recapture data and if a means to release more pole-and-line-captured albacore could be developed, it would help to achieve that end.

An effort was also made to observe interaction between troll fishing and driftnet fishing fleets and all fish landed were recorded for presence (or not) of driftnet marks. Overall there were very few encounters with driftnetters, whether *Solander 3* was working alone or amongst the troll fishing fleet, as was the norm. SPC staff who had worked the two previous seasons in the fishery noted that there was markedly less visible driftnet activity this year.

There were enough occurrences of marked fish, however, to indicate that driftnetters were still an influence in the fishery. Data are in the process of being combined with those from SPC observers aboard commercial vessels for further analysis. (European Community-funded observers were placed aboard commercial vessels to collect length-frequency and driftnet/troll vessel interaction data.) Cruises 6 and 7 were short and took place back in New Zealand on the east and west coasts respectively.

A total of 2,701 albacore and 22 skipjack was tagged. The programme was conducted jointly with the MAF research vessel *Kaharoa*, resulting in more than 3,100 albacore being released for the 1990—91 season. As yet no recoveries have been reported, but we eagerly await returns as the fish recruit into the Asian longline fishery. The project has already provided a valuable base on which to develop improved strategies for obtaining the mark-recapture data necessary to assess the status of the resource and interactions among the fisheries.

Recovered tags should be returned to a local fisheries office or sent to: South Pacific Commission, B.P. D5, Noumea Cedex, New Caledonia. If possible, each tag should be accompanied by a record which includes the tag number, a description of where, when and how the tuna was caught, the fork length and the name and address of the tag recoverer. Rewards will be sent for every tag recovered.



SURVEY OF SAFETY-AT-SEA ISSUES IN PACIFIC ISLAND ARTISANAL FISHERIES

The FAO/UNDP Regional Fishery Support Programme recently carried out a survey to determine how large the problem of safety at sea is for small-scale fishermen and what could be done to improve the safety situation. The Programme surveyed 16 Island countries and territories in the Pacific region and interviewed 167 fishermen and government officials.

The survey estimated that there is a total of 25,000 non-motorised and 16,000 motorised artisanal fishing vessels in the region. Approximately one distress incident per day related to the operations of these vessels comes to the attention of officials concerned with search and rescue in the countries surveyed. Because of problems of communication in many countries and remoteness of many islands and villages, this probably represents only a fraction of the actual incidents. Likewise, the known fatalities attributed to these incidents, about 60 per year, is probably far less than the actual total. It is estimated that the region spends close to US$1 million on efforts to locate lost fishermen.

In the past several programmes have attempted to address problems of outboard engine repair. However most institutional courses in the region are designed for people involved in commercial or industrial fisheries, not artisanal activities. Many officials in countries surveyed believe that the public does not really consider the safety problem for fishermen to be large, and therefore educational programmes aimed at increasing public awareness would be worthwhile.

A report of this study is available from the Regional Fishery Support Programme (UNDP Mail Bag, Suva, Fiji).

(Source: R. Gillett — FAO/UNDP)

FAO PACIFIC ISLANDS FISHERIES CONSULTANCIES

During the period January 1986 to February 1991, 111 consultancies and staff missions were carried out either directly by the FAO/UNDP Regional Fishery Support Programme or indirectly through regional organisations. The following table summarises this work. Reports for the regional missions are available from the FAO/UNDP office. Enquiries for country-specific reports should be made to the country concerned.

Area	Consultant/Staff	Work
Regional	Cillauren (1990)	Lectures at USP course
Cook Islands	Savins (1990)	Collect information for re-design of flying fish boats
Cook Islands	Savins (1990)	Conduct boatbuilding course
Cook Islands	Gulbrandsen (1990)	Design flying fish vessel
Fed. States of Micronesia	Sibert (1990)	Assess tuna fishery
Fed. States of Micronesia	McCoy (1990)	Advise Yap State on industrial fisheries development
Fiji	Gulbrandsen (1990)	Produce plans for 28-ft vessel
Fiji	Watts, MacInnes (1990)	Review IKA Corporation manpower situation
Kiribati	Savins (1990)	Build new-design vessel and carry out emergency sail rig trials

Kiribati	Gulbrandsen (1990)	Produce plans for emergency sail rig
Marshall Islands	Medlin (1990)	Install new computer system and provide training; in conjunction with FFA
Niue	McCoy (1990)	Advise on fisheries development plans
Palau	Crossland (1990)	Advise on fisheries planning
Papua New Guinea	Hartong (1990)	Produce information for re-designing vessels
Papua New Guinea	Gulbrandsen (1990)	Design plank on frame fishing vessel, propose design changes to existing plans
Solomon Islands	Gulbrandsen (1990)	Re-design fishing catamaran
Tokelau	McCoy (1990)	Advise on fisheries development plans
Tonga	Walton (1990)	Review boatbuilding project
Tonga	Dunlop (1990)	Review longliner design
Tonga	Mead (1991)	Instruct in FAD planning and deployment
Tuvalu	Savins (1990)	Advise on boatbuilding training requirements and on repair of Government vessel
Tuvalu	Savins (1991)	Provide boatbuilding training, introduce new fishing vessel designs
Vanuatu	Savins (1991)	Provide boatbuilding training
Western Samoa	Gillett (1990)	Transplant trochus
Western Samoa	Crossland (1990)	Advise on structure and function of Fisheries Division

(Source: R. Gillett — FAO/UNDP)

HAWAIIAN ORNAMENTAL REEF FISH REARED IN CAPTIVITY COULD BOOST WORLDWIDE MARKET

Hawaiian ornamental reef fish for the aquarium trade are bring successfully raised in captivity for the first time at the University of Hawaii's Hawaii Institute of Marine Biology (HIMB) on Coconut Island in Oahu.

'There's an obvious need for this because there is a very large industry based on the collection and export of wild ornamental reef fish', said Christopher Brown, associate professor of marine biology at the University. 'That industry's practices are badly depleting the wild population, so somebody should work on rearing reef fish in captivity.'

The worldwide market for ornamental reef fish is estimated at US$ 100 million annually. Up to 250,000 fish are taken from Hawaiian reefs each year, primarily for export, with about 30 species of Hawaiian reef fish exported regularly.

While rearing methods for some species such as clownfish and neon gobies have been developed, none of the Hawaiian reef fish have ever been raised in captivity.

Now, two species of damselfish, *Dascyllus albisela* from Hawaii and *D. arunus* from Guam, have been reared to marketable size under laboratory conditions in just ten weeks. In the wild, these fish take a full year to reach market size.

Brown and Bret Danilowicz, a graduate student at Duke University, have collaborated in developing new feeding techniques for the damselfish at the critical larval stage of development. Following larval biology research funded by the UH Sea Grant College Program, Brown and Danilowicz's experiments demonstrated that reef fish can survive in-tank rearing from the egg to the hardier juvenile stage if a complete food chain is provided during early development.

The conventional method of rearing larval fish has been to set up a small tank with the fish eggs in it. Upon hatching, the larvae are placed in a large tank. In still another tank, under controlled lighting, cultures of algae and other microorganisms are grown as food and transferred into the larval tank daily.

Brown and Danilowicz have tried a different approach. Instead of the conventional method, they are culturing the algae, along with small live foods such as rotifers and copepods, in the same tank as the larval fish.

Bright lights are used to stimulate the algae growth and sustain an entire food chain, thereby giving the larvae a choice of assorted food organisms from which to choose.

This differs from the conventional method of daily feeding in which food organisms may not be eaten immediately and, without their own nutrition source, begin to starve and lose their nutritional value. With the new method, food organisms are placed in the tank with the active larvae culture, so the food chain remains intact and its components nutrient-rich.

The Hawaiian damselfish was chosen as a model for initial experiments because it is readily available in Kaneohe Bay, its eggs are relatively large, it is an inexpensive mainstay of the aquarium trade and it is popular as an export.

'What we've done here is a demonstration on a very small scale to show that rearing ornamental reef fish in captivity is not impossible. It's just a matter of giving them the food they need.'

(Source: *The Garden Island*)

SEDIMENTATION THE MOST CRITICAL REEF PROBLEM

The most critical problem affecting coral reefs on Guam and throughout the Pacific Islands is sedimentation. With the recent passage over Guam of typhoons Mike, Owen and Russ, the enormous amount of sediment being dumped in the coastal environments was visible to all.

Red plumes were seen originating from streams, rivers and outfalls. In addition to the visible sediments, many other substances toxic to marine life were present in the runoff.

This article summarises the problems caused by sedimentation and runoff, how these affect marine animals, and what can be done to prevent unnecessary damage to precious coastal resources.

All rock, coral limestone and sand grains that make up an island are subject to erosion. Erosion is the process by which material is broken down and moved by the forces of nature.

For most islands, the eventual destination of runoff and sediment is the coastal zone, including bays, lagoons and reefs. After heavy rain, both dissolved and solid materials travel down streams and enter the ocean. The goal of most engineers and planners is to move the water as quickly as possible off the roads and land.

The runoff enters the ocean directly through the aquifer (the underground water supply). On islands like Guam, this can have serious and damaging effects. If the water contains toxins, such as herbicides, pesticides and petrochemicals, it will poison the drinking water or the marine life unless proper precautions are taken.

Sediments affect reef animals in several ways. For corals, the most obvious damage comes from burial and eventual death. Sediment also stops sunlight penetrating the water. Because corals contain plant cells and use them as their energy source via photosynthesis, corals can starve if they are shaded by silt in the water.

Fish also respond to sediment by avoiding plumes and moving away from dead areas. Fish that normally spawn in reef channels were found to stop all activity or move elsewhere on the reefs of southern Japan when sediment was present. Once a reef dies, the related edible reef resources disappear as well.

The question then becomes: can anything be done to prevent sedimentation and control runoff? Fortunately, the answer is yes. Project design is one area where improvements can work. The use of adequate ponding basins, slope stabilisation, phased clearing, mulching and grading are all methods that can be used and modified to fit the conditions of a particular project.

Timing also is important, concentrating certain activities during the dry season. Communication among developers, government agencies, technical experts and legislators is critical to the success of preserving Pacific Islands reef resources while enabling development to occur.

Mistakes have been made, but they can be valuable if we learn what went wrong and direct efforts toward solutions. We know that sedimentation and runoff kill coral reefs and the mechanisms by which the death occurs are known.

(Source: *Pacific Daily News*)

OTOLITH REVEALS ALL TO FISH RESEARCHERS

Canadian researchers say that fisheries management worldwide can benefit from research work on the otolith — the half-inch long 'earbones' of fish.

Patterns on the otholith seen under a compound microscope are like the swirls of a thumbprint, say scientists with the Canadian Department of Fisheries and Oceans (DFO).

A mass of information is available when the otolith is examined closely. This includes:

- Fish's age. Up to one year of age, a ring is formed for each day of life. After one year, the daily rings continue but become intermittent. However, yearly rings are also formed and can be read right up until the time of death.
- Date of hatch. By identifying the very first ring at the otolith's core, research scientists can calculate the fish's birth-date.
- Fish's growth rate: the thicker the daily ring, the greater the growth on that corresponding day.
- Migration patterns. By analysing the chemical composition of the different rings of the otolith, scientists can discover when the fish swam in warm water (such as near shore) and when it swam in cooler water (such as offshore).
- The most stressful times of the fish's life. Check lines indicate major stress. Examples include spawning, and times when the fish may have been caught and then thrown back into the water.
- Age — even when the traditional method of counting rings cannot be used.

(Source: *Fishing News International*)

Otoliths of bigeye tuna (*Thunnus obesus*) x 5.5

Otoliths of red snapper (*Etelis* sp.) x 6.5

Report on a market survey on giant clam products in selected countries
by Y.C. Shang, C. Tisdell and P. Leung

The natural stocks of giant clams have been so seriously depleted, mainly because of over-harvesting, that most species are now listed as threatened. The recent advances in culture techniques make giant clam farming possible. With the anticipated expansion in giant clam production, marketing information is urgently needed. The lack of published trade data on giant clam products made it necessary to collect basic market information by field interviews.

The purpose of this study was to evaluate the existing market for giant clam products in Japan, Taiwan, Hong Kong, Australia and the United States. Most of the information for this study was obtained through interviews with seafood importers/distributors, restaurant owners, aquarium species distributors and shell distributors who have had experience in handling giant clam products. The interviews were conducted during the latter part of 1989 and early 1990.

The preliminary market survey ascertained that markets exist for five types of giant clam products: food, aquarium specimens, seedstock, broodstock and shell. The largest potential market for giant clam products appears to be as food.

Markets for giant clams as food already exist in Okinawa, Taiwan, Australia and the Pacific Islands. The food market in Okinawa may absorb up to 5,000 t of giant clams in-shell—mainly for use in sashimi and sushi dishes. People in Okinawa prefer *Tridacna crocea*. Whether other giant clam species could penetrate the Okinawa market would depend on the price and taste of the product. If *Tridacna derasa* were to be exported to Okinawa, the price for a two-year-old clam would have to be much lower than *T. crocea*'s current price of US$1.43 to $2.38 to be acceptable.

In Taiwan, a market for fresh or frozen giant clam adductor muscles exists, with a potential of about 240 t annually. The economic feasibility of producing the large-size clam muscles at competitive prices needs to be studied further.

In Australia, there is a market for giant clams among immigrants from the Pacific Islands and their descendants.The use of giant clams for food is unknown in the Japan mainland, Hong Kong and the United States; the market potential should be explored.

A limited market potential exists for giant clams as aquarium specimens in Japan, Australia and the United States. The market for giant clam shells appears good. A limited market also exists for giant clams as seedstock and brood-stock in the Pacific Islands.

Giant clams are treated as threatened species, and trade of naturally caught giant clam products between the signatories of the Convention on International Trade in Endangered Species (CITES) is restricted. Although cultured giant clam products are not restricted for trade, it is difficult to distinguish between naturally bred and cultured clams. Therefore, certification that the giant clam products were cultured may be necessary, and an import permit is required to ship giant clam products to the member countries of CITES.

The book is published by the Center for Tropical and Subtropical Aquaculture, University of Hawaii, Makapu'u Point, Waimanalo, HI 96795, USA.

Artificial reefs for marine habitat enhancement in Southeast Asia
by Alan T. White et al.

Can sunken junk replace coral reefs? Old tyres, bamboo barges, junk cars and other scrap materials are gaining widespread use as artificial reefs in Southeast Asia, where they help improve commercial and small-scale fisheries by attracting fish.

Within Asia, countries like Brunei Darussalam, Indonesia, Malaysia, the Philippines, Singapore, Taiwan and Thailand have established national programmes to construct and submerge artificial reefs in selected areas.

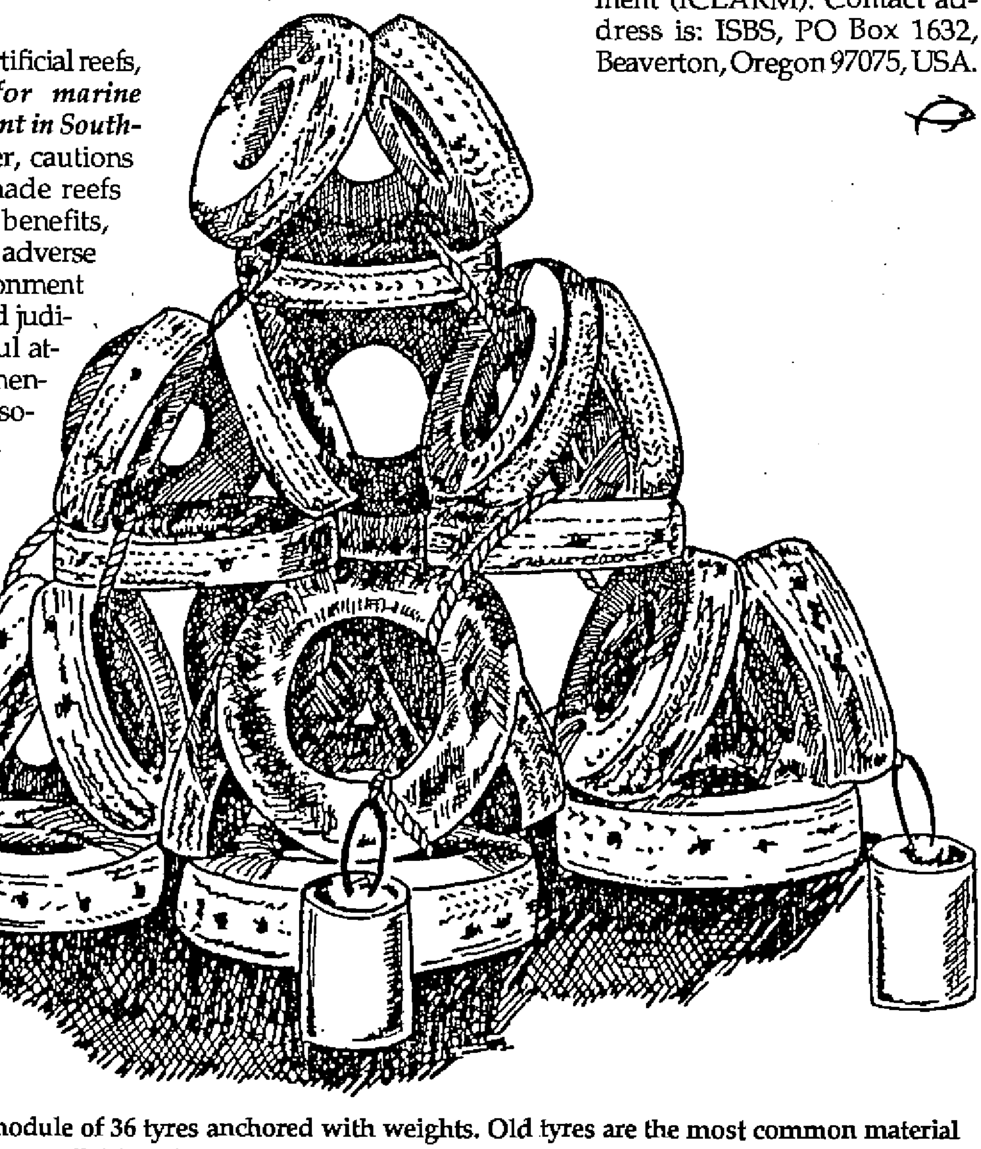
A new primer on artificial reefs, ***Artificial reefs for marine habitat enhancement in Southeast Asia,*** however, cautions that while man-made reefs offer immediate benefits, they may also have adverse effects on the environment and should be used judiciously, with careful attention to environmental, economic and social considerations.

The book offers guidelines for the effective design and use of artificial reefs and recommends that these be employed within the broader context of coastal resources management.

'Artificial reefs can and do attract fish; they can be deployed for commercial, subsistence and recreational purposes. But the present state of knowledge cannot as yet give a clear understanding of their biological and ecological functions, which is essential if they are to be more efficiently used.'

The book compares the features of natural and artificial reefs from the fishes' point of view and illustrates some basic structures and construction materials. The authors say that 'proper planning and design of artificial reefs are a must for a successful outcome'.

The book is published by the International Center for Living Aquatic Resources Management (ICLARM). Contact address is: ISBS, PO Box 1632, Beaverton, Oregon 97075, USA.



An artificial reef module of 36 tyres anchored with weights. Old tyres are the most common material used because they are available at low cost, are easy to handle and are physically and chemically stable under water.

REMOTE SENSING AND IMAGE ANALYSIS IN PACIFIC ISLAND FISHERIES RESEARCH

by G.L. Preston
South Pacific Commission
Noumea, New Caledonia

Introduction

Since 1988, when I attended an Australian conference on 'Remote Sensing and the Coastal Zone', I have been trying to inform myself about the ways in which my work and the work of my Pacific colleagues could benefit from the use of remote sensing. At that point my knowledge of remote sensing was nil, but there seemed to be all kinds of potential applications for this technology and I wanted to know how practicable these were. Since that time I have attended further technical conferences dealing with remote sensing, and become involved in using remote sensing and digital image analysis technology in quantitative fisheries work on two occasions, with a third project under way.

It seems that I am not the only one interested in this subject. Fisheries departments, environmental agencies and universities in the region are becoming more aware of the availability of remote sensing technology, and fisheries-related projects that make use of it are under way in French Polynesia, New Caledonia, Papua New Guinea and Vanuatu, with others planned in Palau, Tuvalu and elsewhere. However, I believe we are still at an early stage in the process of learning what this technology can do for the region, and what it cannot. In this article I will try to summarise some of the more important points that I have discovered from my personal experience of applying remote sensing to fisheries work.

Basic concepts

What is remote sensing? Essentially it is observing, making measurements of, and deriving information about the earth from a distance. Remote sensing is not a new technology: for many years man has been ascending from the earth in order to observe it from above. Aerial photography is the oldest and best established form of remote sensing. However, the development of new types of sensors, digital instruments and data transmission techniques, and satellites, have all combined to offer new remote sensing possibilities.

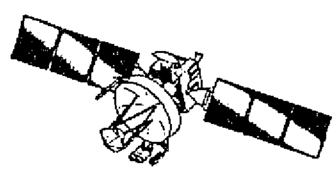
Any airborne platform offers the possibility of remote sensing, and aerial photographs have been and continue to be taken from balloons, aircraft, space craft and satellites. Aerial photographs use conventional optical components (lenses and mirrors) and films that are sensitive to light or other sorts of radiation. A photosensitive film is coated with tiny crystals that undergo a permanent reaction on exposure to radiation. The crystals are distributed randomly on the film and the combination of the colours that they produce go to make up the image that our eye perceives. Although the resolution of these instruments can be very high, the film has to be returned to the ground for processing. The difficulty of doing this in some cases, especially with satellites, has made it necessary to use technology that permits the transmission of images in the form of signals. Most recently, the development of digital technology has allowed the rapid transmission of large volumes of data with relatively low rates of error.

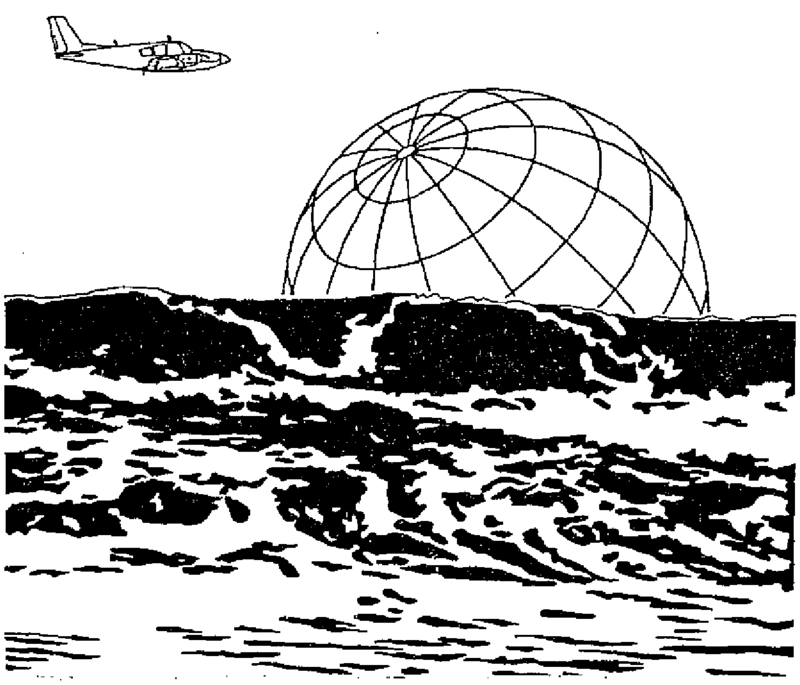
Digital images can be produced by scanning ordinary photographs, but in the case of remote sensing it is more usual to employ an instrument that captures the image directly in a digital form. Typically, the instrument scans the image a tiny bit at a time, dividing it into a grid made up of numerous picture elements, or 'pixels'. For each pixel, the instrument records one or more numbers that describe the intensity of the radiation being reflected at given frequencies. These numerical data can then be transmitted to earth, where the image can be recompiled, based on the size of the pixels and their characteristics.

Pixel size has a critical effect on the resolution of the image, and therefore its usefulness for different purposes. The pixel size that the instrument uses in capturing the image determines how finely detail can be seen by the user — whether he can gather information on parts of trees, or whole trees, or groups of trees, or forests. Some users need high resolution, while others may be able to sacrifice precise detail in favour of the large 'footprints' of satellite instruments. A typical satellite image would be a square whose side is between 60 km and 200 km, giving an area coverage of over 40,000 km^2. As aerial photographs are more typically 2 km by 2 km, or 4 km^2, the economies of scale become quickly apparent.

Although they often use analogue rather than digital technology, home video cameras record information in a similar way to a satellite instrument, pixel by pixel, and the image is reconstituted when played back to a TV or monitor. Look closely at the TV screen and you can see that the image is made up of lots of tiny elements that contain varying intensities of three colours (blue, green and red). The video camera has recorded, for each pixel, the brightness of each of these colours. By recombining these three, it is possible to generate just about every shade and colour the human eye is capable of perceiving, as well as some things, such as infra-red wavelengths, that it cannot perceive. The higher the resolution of the screen, the better the digital image will be reconstituted and the easier it will be to recognise or delineate the features that make up the image.

Satellite remote sensing technology makes use of digital imagery because it can be transmitted rapidly and received electronically in large volumes by satellites and ground stations. Because of its numerical format, it can also be assimilated by computers and thereby subjected to various kinds of analysis routines and enhancement.





Remote sensing is observing, making measurements of, and deriving information about the earth from a distance...

Image analysis has no exclusive connection with remote sensing. A computer can be used to study and alter the characteristics of any digital image, whether it's a satellite view of the Gobi desert or a picture of Marilyn Monroe. However, the types of study and alteration that might be wanted would be different in the two cases: in the former case the purpose of analysis might be to look for certain spectral characteristics that indicate the presence of water or vegetation, while in the latter the aim could be to improve skin tones, remove an unwanted pimple, and generate a final image suitable for publication in a glossy magazine. As a result, some specialised image analysis techniques and procedures have been developed that are mainly used in the remote sensing field.

Remote sensing technology

Instruments and satellites

As well as optical cameras on aeroplanes and spacecraft, the heavens are full of satellites carrying various types of remote sensing instrument. These transmit data to ground receiving stations, sometimes via another satellite. The station records the data on tape or other media and from there it is made available to users, sometimes free, sometimes commercially, and often on a restricted basis. In some cases the amount of data being transmitted is so great that it would cost a fortune for the media needed to store it all, so unless someone has specifically ordered the data, or it is of known usefulness, it is not kept.

Modern satellites may carry several instruments which are used variously for telephone communications, data transmission, TV transmission, astronomy, experimental work, and for many other purposes, both civilian and military. Remote sensing comprises only a part of the overall use of many satellites, and remote sensing instruments are often considered distinct from the satellites that carry them.

Table 1 shows a list of some instruments used in remote sensing projects that relate to the ocean or coastal zones, the data they gather, and the satellites that carry them. The most potentially useful for inshore and coastal work are the Thematic Mapper (TM), carried on each of the LANDSAT series of satellites, and the two High Resolution Visible (HRV) instruments carried on each SPOT satellite.

Table 1: Remote sensing satellites and instruments

Satellite	Instrument	Nominal scene size	Resolution	Type of radiation detected
LANDSAT 1 — 3	Multi-spectral Scanner (MSS)	189 km x 189 km	79 m	2 visible 2 near infra-red
LANDSAT 4 — 5	Multi-spectral Scanner (MSS)	189 km x 189 km	83 m	2 visible 2 near infra-red
	Thematic Mapper (TM)	185 km x 170 km	30 m 120 m	6 visible 1 near infra-red
SPOT	High Resolution Visible (HRV)	60 km x 60 km	20 m 10 m	3 visible 1 visible
NOAA Polar Orbiting Operational Satellites	Advanced Very High Resolution Radiometer (AVHRR)	2,600 km x 2,600 km	4 km 1.1 km	1 visible 1 near infra-red 3 thermal infra-red
NIMBUS-7	Coastal Zone Color Scanner (CZCS)*	-	-	5 visible/ near infra-red 1 thermal infra-red

* no longer operational

LANDSAT

The American LANDSAT programme has been operating since the 1970s, although Pacific coverage in the early days of the programme was poor. LANDSAT 4 and 5 are presently fully operational, and LANDSAT 6 is planned for launch in 1992.

Of the two instruments carried on the recent LANDSAT satellites (multi-spectral scanner [MSS] and thematic mapper [TM]), the latter is of interest to marine workers because of the blue band. TM data comprise information on seven frequencies of radiation collected for each pixel sampled. One of these frequencies, within the blue part of the visible spectrum, is close to optimum for water penetration, and so this frequency gives the greatest amount of information on submerged features in coastal areas. Other light frequencies penetrate water less well than the blue band: red and near-infra-red light are quickly attenuated by water, so penetration is poor, and infra-red radiation is totally absorbed by less than 1 cm depth of water.

Unfortunately, historical TM data is not available for much of the Pacific region, since it was out of range of the region's nearest ground receiving station, in Australia. However, new ground receiving stations and relay satellites have been deployed and LANDSAT can now provide coverage of the whole region.

The TM sampling unit, or pixel size, is a 30 m x 30 m square (except for the thermal infra-red band, which is 120 m x 120 m). A full TM scene is 185 x 170 km, or about 32,000 sq. km, and consists of about 3,000 pixels in each direction, or about 9 million pixels in total. These dimensions vary somewhat depending on the latitude at which the image was taken, and according to customer needs, since various types of sub-scene can be ordered. TM data are good for looking at large scale features or fairly extensive coastal areas, but because of their poorer resolution, are less useful than SPOT for looking at small-scale features.

SPOT

The SPOT satellite programme was established in 1986, and now consists of two operational satellites, with SPOT 3 due for launch in 1992, and SPOT 4 in the planning stages. SPOT data offer better resolution than LANDSAT, but each image covers a smaller area, about 60 km by 60 km. In multispectral ('colour') mode, SPOT pixel size is 20 m x 20 m, improving to 10 m x 10 m in panchromatic ('black-and-white') mode. At this latter resolution, small features such as buildings and gardens can be clearly seen, while in multispectral mode it still remains possible to detect small coral patches and general features of reefs.

The biggest disadvantage of SPOT data for those interested in the coastal zone is that the HRV instrument does not have a blue band, and therefore cannot achieve very good water penetration. Of the three frequencies used in multispectral mode—yellow/green, red and near infra-red, the first achieves the best water penetration. If the water is exceptionally clear, penetration may be up to 25 m; 12—15 m is more typical, however , and this may be reduced further if the water has a heavy sediment load.

Data types, availability and application

The two main types of practically useful remotely sensed data for our purposes are:

digital data: these include all computer-compatible data derived from remote sensing instruments, as well as photographs that have been digitised using a scanner;

hard-copy data: these include prints of aerial photographs, and the colour outputs from digital image processing, such as thematic maps and charts and products derived from these.

These two data types are dealt with separately below.

Digital data

Digital data are usually delivered in a computer-compatible format (tapes or discs) and loaded onto a computer hard disc for study and analysis. Image analysis packages are now commonly available for micro- and mini-computers. Depending on the sophistication, the cost may range from a few hundred to a few thousand dollars. In addition, in order to use them effectively, the computer must be equipped with a high-resolution colour monitor (often in addition to the standard monitor), and will probably also need a large hard disc, a graphics card and and, for hard-copy output, a colour printer or plotter.

Important image analysis procedures for remotely sensed data include:

— Rectification and correction of images to conform to existing maps or to fit together into mosaics. Because satellites and aircraft are moving when images are taken, because the earth's surface is not flat, and because the image may have been taken from an oblique angle instead of from overhead, there are various corrections that may need to be made to make the image conform to cartographic standards or to topographic reality;

— Classification of the image according to the characteristics of its pixels. It would normally be expected that features that look the same or similar on the ground will have the same or similar spectral characteristics on the image (in the same way that two pixels with the same values of blue, red and green on a TV screen will give the same colour to the eye). Using computers it is quite easy to classify pixels into related groups based on their similarities, and then to count them up to obtain, for instance, estimates of the area of a given type of ground feature;

— Image enhancement (for example by the production of false-colour images to emphasise certain features). If different colours are assigned to represent pixels that have particular sets of characteristics, different types of ground features can be made more apparent and distinguishable to the eye. By masking out certain groups of pixels, or emphasising their boundaries, line maps or contour maps can be produced.

The cost of carrying out in-house image analysis is now within the means of government departments and small companies, and some are starting to use the technology. The real cost, however, and one that is often overlooked, is not necessarily in setting up the equipment, but in training the personnel to carry out sometimes quite sophisticated analysis work, and in acquiring data.

Hard copy data

Hard copy is needed so that data can be annotated, examined by groups of people, carried into the field, and incorporated into documents. Additionally, most people who are used to working with maps are more comfortable working with a paper product derived from digital data, than they are with a screen image that may require the use of sophisticated computer software to look at and manipulate. Producing hard copy by printing out products based on the digital data mentioned above is an essential part of image processing. Photographic output is better than what can be achieved using a colour printer or plotter, but is also more expensive.

The other major category of hard-copy data is aerial photography. Aerial photographs exist, mostly in black-and-white, in many countries of the Pacific Islands region. However, they may be old, the coverage may be incomplete, and, importantly for fisheries workers, the photographs may not extend beyond the coast into lagoon and inshore waters. Where they are available, however, I believe aerial photographs, especially colour ones, are by far the most valuable type of remotely sensed data, and are useful for all kinds of things, especially the detailed planning of field work, as well as for getting simply a feel for the nature of the area.

Aerial photographs are normally held by the lands and surveys department or equivalent agency in the country concerned. However, I have found on more than one occasion that aerial photographs of an area in which I am working are effectively not available because they have been borrowed, misplaced or deteriorated in storage.

One could always try to get replacement photographs from the agency that took them in the first place. It is normal for these bodies to archive negatives so that new prints can be made when needed. Dr Dan Claasen has recently published a list of potential sources of aerial photographs and other data types in the region[1]. However, I have never tried to obtain replacement photos, having been deterred by the potential effort, time and cost involved. Working in a regional body, I tend to be involved mainly in short-term work and do not focus on any one area for more than a short time. I therefore have no need to establish my own collection of aerial photographs (nor do I usually have a lot of time before and after a project to devote to following up such things). However, if I were working in a single country or area, I would make it a priority to organise my own set, or access to a set, of existing aerial photographs of the coastal and inshore area involved.

The uses of standard aerial photographs in fisheries are similar to the uses of marine charts and maps. They are normally consulted when planning visits by vessels and field projects, to estimate likely productive fishing spots, to identify physical characteristics such as passes, areas of coastal access, watercourses, centres of population density, etc., all of which are (or should be) used in planning and developing fisheries activities.

There are some purposes for which maps and aerial photographs are not commonly used by fisheries departments in the region. In particular, an instrument called a planimeter (Figure 1), which measures the perimeter or area of irregularly shaped objects on a flat surface, makes it possible to estimate the surface areas of certain marine features (coral formations of various types, seagrass beds, mangroves, bathymetric contours, etc.). This is a laborious and time-consuming procedure, especially where there are numerous ground features in small patches, as is often the case with coral reefs. However, the information obtained is valuable for resource assessment and management, as it permits us to quantify the habitat of certain resources. If we have an idea of the density and distribution of the animals in their habitat, then we can use this to estimate their likely stock size.

1. Claasen, D. (1990). *A guide to remote sensing data types and sources for the developing countries of the south-west Pacific region.* Produced by the Institute of Natural Resources, University of the South Pacific and the ESCAP/UNDP Regional Remote Sensing Programme (UNDP RAS/86/141)

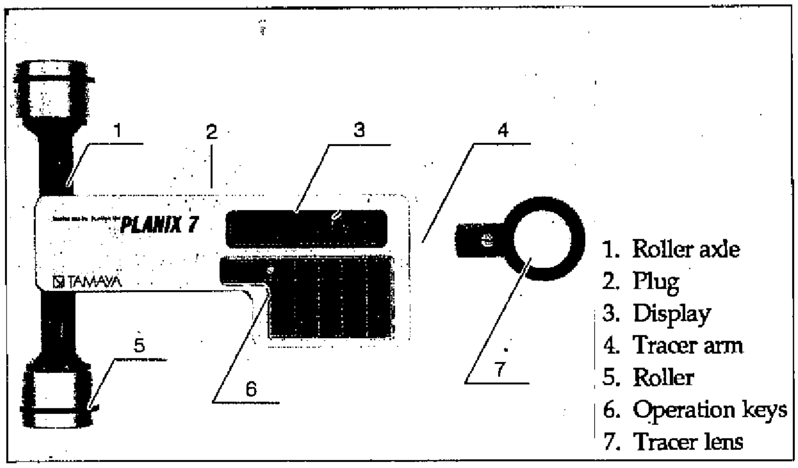


Figure 1: Digital planimeter

Both these uses are also applicable to digital data, but the use of image processing software can improve the efficiency with which the required information can be extracted from the image. In the former case (planning), features of interest can be enhanced by the application of false colours to emphasise contrast between areas, boundary demarcations, etc. In the latter case, the surface areas occupied by different ground features are represented by similar pixels. Once the features of interest have been characterised, the pixels that represent them can be quickly tallied by the computer to give a measure of surface area that will probably be a good deal more accurate than one derived using a planimeter.

Applications for inshore fisheries

How can all these techniques and technologies that are available to us be put to work in the inshore fisheries field? To illustrate the possibilities, and also some of the problems, I will describe two examples of work I have been involved in, then several from other people.

Palmerston Atoll survey

In 1988 I assisted with a survey of the marine resources of Palmerston atoll in the Cook Islands. The other 12 participants in the survey included an FAO consultant, fisheries staff from the Cook Islands Ministry of Marine Resources, the Forum Fisheries Agency and the Fisheries Divisions of Kiribati, Tuvalu and Fiji. As part of that exercise, we ordered a SPOT image of Palmerston. Dr Willy Bour of the New Caledonian Image Analysis Laboratory (LATICAL), based at ORSTOM in Noumea, agreed to carry out some preliminary classifications to identify major features of the reef and lagoon for survey planning purposes. After our visit, when we had had a chance to gather data in the field, we would look at the possibility of doing further work to quantify the areas covered by the features we had observed on the ground.

Unfortunately, the image tape arrived too late for the classifications to be done in time for the survey. As a result, the plans for the data were not fulfilled. Lesson number one: a long time can elapse between ordering satellite data and actually getting it, so allow plenty of lead time. Many things can intervene, one of the most important of which is cloud. Like LANDSAT, SPOT cannot see through clouds, and only passes by once every few days. Depending on how the weather is, many weeks may pass without a suitable image being acquired. Competing programming requests for the satellite (unlikely over Palmerston but a big problem over developed countries) can also mean that it's a long time before it has a chance to look your way. Having missed our chance in the field, we at least tried to get something useful from the image. I asked the LATICAL staff whether they could derive a bathymetric map of the lagoon from the SPOT data, and the result of their efforts is shown at Figure 2.

For comparative purposes, a bathymetric map based on echo-sounding and produced by the New Zealand Oceanographic Institute (NZOI) is shown in Figure 3 (this was the only map of Palmerston we had). The SPOT data indicate the approximate positions (these were not verified in the field for the reasons mentioned above) of the 5 m and 10 m contours in two colours of purple, as shown on the New Zealand map. Because of the rather milky water in the lagoon, SPOT cannot distinguish anything below this depth, but it does show major coral pinnacles in the lagoon (the purple spots).

Like the NZOI map of Palmerston, most standard maps and charts do not show all the pinnacles and coral heads that exist in a lagoon. These are hard to cover using

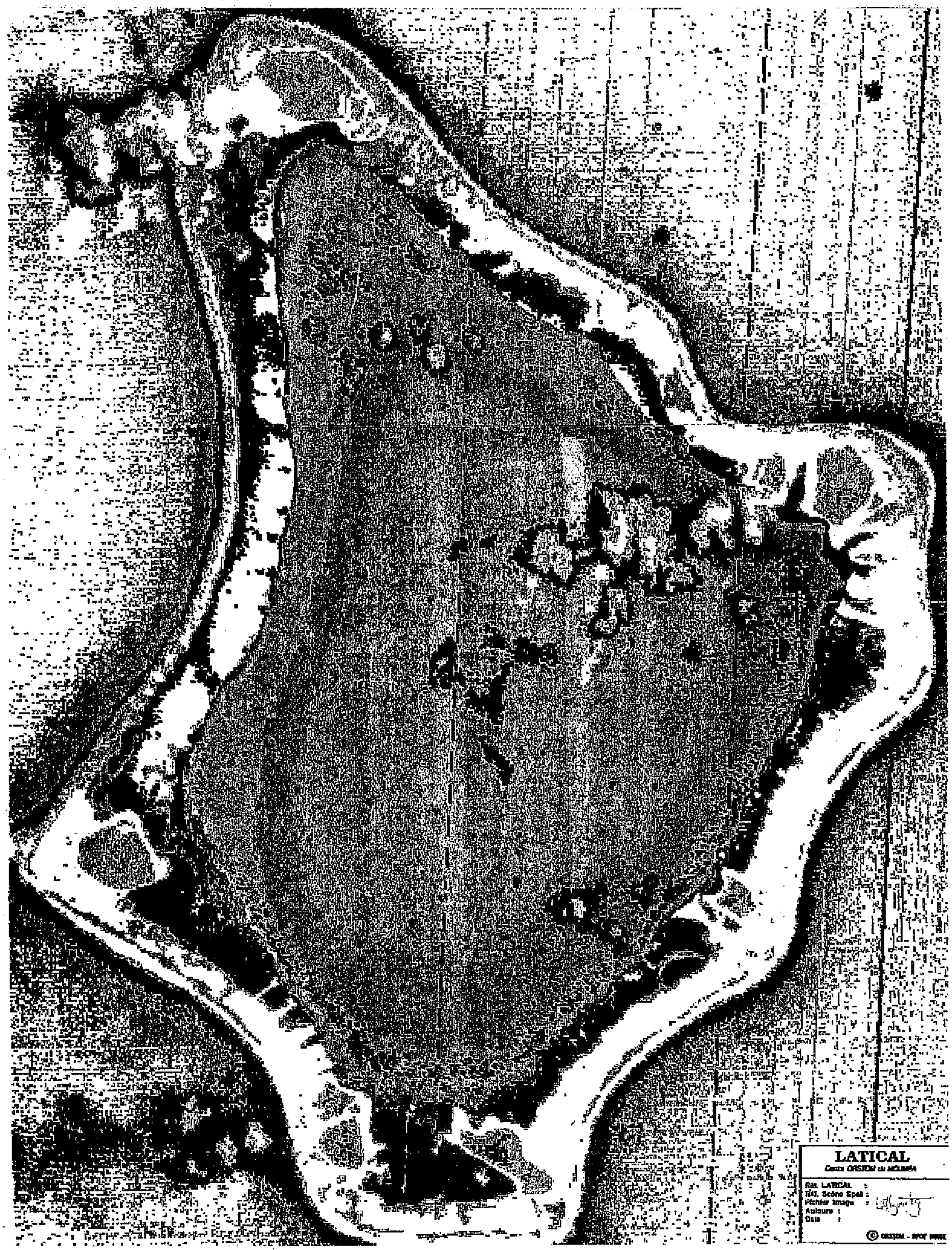


Figure 2: SPOT image of Palmerston

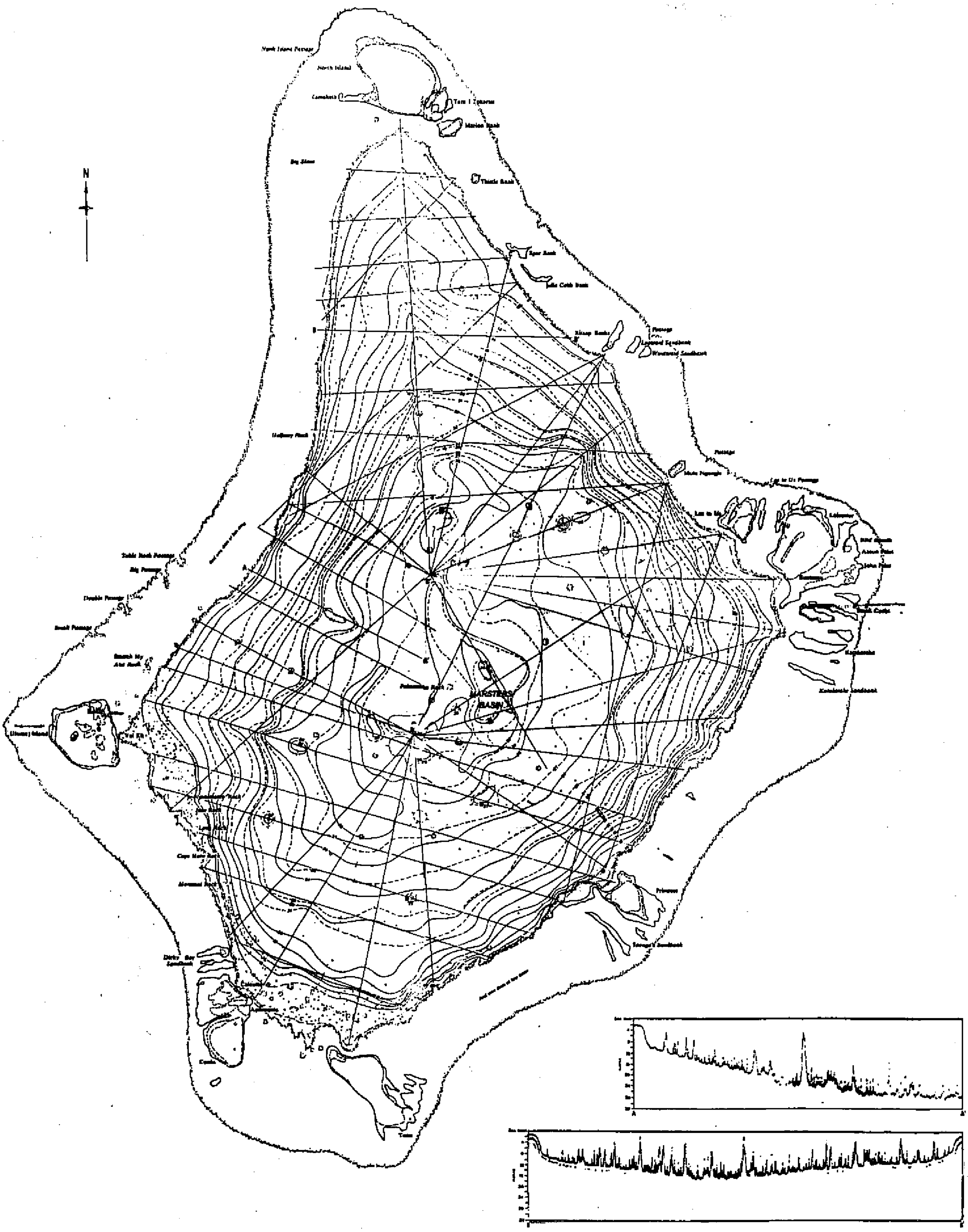


Figure 3: NZOI bathymetric map of Palmerston

standard echo-sounding techniques. (Where they are shown, they have usually been added from aerial photographs.) There may nevertheless be several fishery-related reasons why people want to know where they are.

In French Polynesia, the number, type and location of coral heads in a lagoon is used as one of the factors used in determining the number of pearl oyster farming licences to be authorised in that lagoon, since the pinnacles represent the major part of the habitat for adult pearl oysters. In Kiribati, the national pole-and-line fishing company Te Mautari at one point (before it closed down) enquired about obtaining SPOT image data of lagoons in Kiribati to help pinpoint good baiting sites, since its boats baited very close to pinnacles.

Another reason for wanting to know about coral pinnacles is navigation. The information in many marine charts is incomplete or dated and dangers to boats are not shown in full. Remotely sensed data are a quick, easy way to gather supplementary information on shallow water features for addition to maps and charts. This is also considerably cheaper than sending a survey ship to resurvey an area, or flying planes around to take aerial photographs.

The Polynesian Remote Sensing Station (SPT) in Tahiti is presently using just this approach to improving maps of the 120 atolls of the Territory, many of which are not very comprehensive. A sample of one of SPT's maps is shown at Figure 4: while not strictly a fishery-related product, it represents an improvement on the marine charts and maps currently available, and as such is a useful information source for fisheries workers.

Returning to the Palmerston example, we also attempted to quantify a feature of the reef that appeared to be important for the fishery in Palmerston: the emergent reef-crest of the eastern side of the atoll that appeared to be a major feeding-ground for parrotfish at high tide, and where all the parrotfish fishing was carried out. That particular zone was characterised by the presence of an encrusting coralline alga, *Lithothamnion*, which we thought would be distinguishable on a SPOT image.

In fact, there were a couple of problems. The alga is mainly distinguished by the fact that it contains chlorophyll, which gives a characteristic spectral signature. Unfortunately, this signature is at the red end of the spectrum, and red light does not penetrate water well. As it happens, the tide must have been fairly high when the satellite took that particular image of Palmerston. Most of the alga was submerged, and thus invisible. There is a strong line of breakers, which, being pure white, reflect very brightly, and prevent observation of what is underneath. And, where the alga does emerge, its spectral signature seems to be quite similar to that of the vegetation on the small islets around the atoll.

It may be possible to solve this latter difficulty by further ground-truthing of the image, but it could be a while before anyone is able to go to Palmerston to do that. In the meantime, these problems combined to prevent LATICAL from estimating the surface of the emerged eastern reef edge. Finally, we recently received an enquiry from Cook Islands to ask if SPC had any information on the actual surface areas of coral reef present in that country. While no information of this kind existed at SPC, it was a relatively simple matter for LATICAL scientist Didier Lille to measure the reef surface at Palmerston. By manually masking out non-reef areas, and then having the computer count the number of pixels left, he made an estimate of reef down to 2 m deep in about 2 hours. (The figure, by the way, was 2,139 ha.)

Survey of beche-de-mer resources in Ha'apai, Tonga

In July 1990, a fishery scientist from Papua New Guinea and I assisted the staff of the Tonga Fisheries Division to carry out a survey of beche-de-mer resources in the Ha'apai group of islands. To plan for the field work we had three British Admiralty marine charts, which cover the whole area of interest.

The charts were used to decide the areas in which we would dive to gather field data on sea cucumber abundance, and the selected sites were then checked with an echo-sounder and if necessary changed before we went in the water. Standard navigational equipment (compass, sounder and rangefinder) was used to determine our positions, which were then plotted on the charts.

During the 6 days of actual field work, we completed 45 SCUBA dives and sampled transects in a way that allowed us to estimate the densities of commercially important sea cucumbers. There was a fairly clear depth stratification for the most important species which, together with the limits on individual

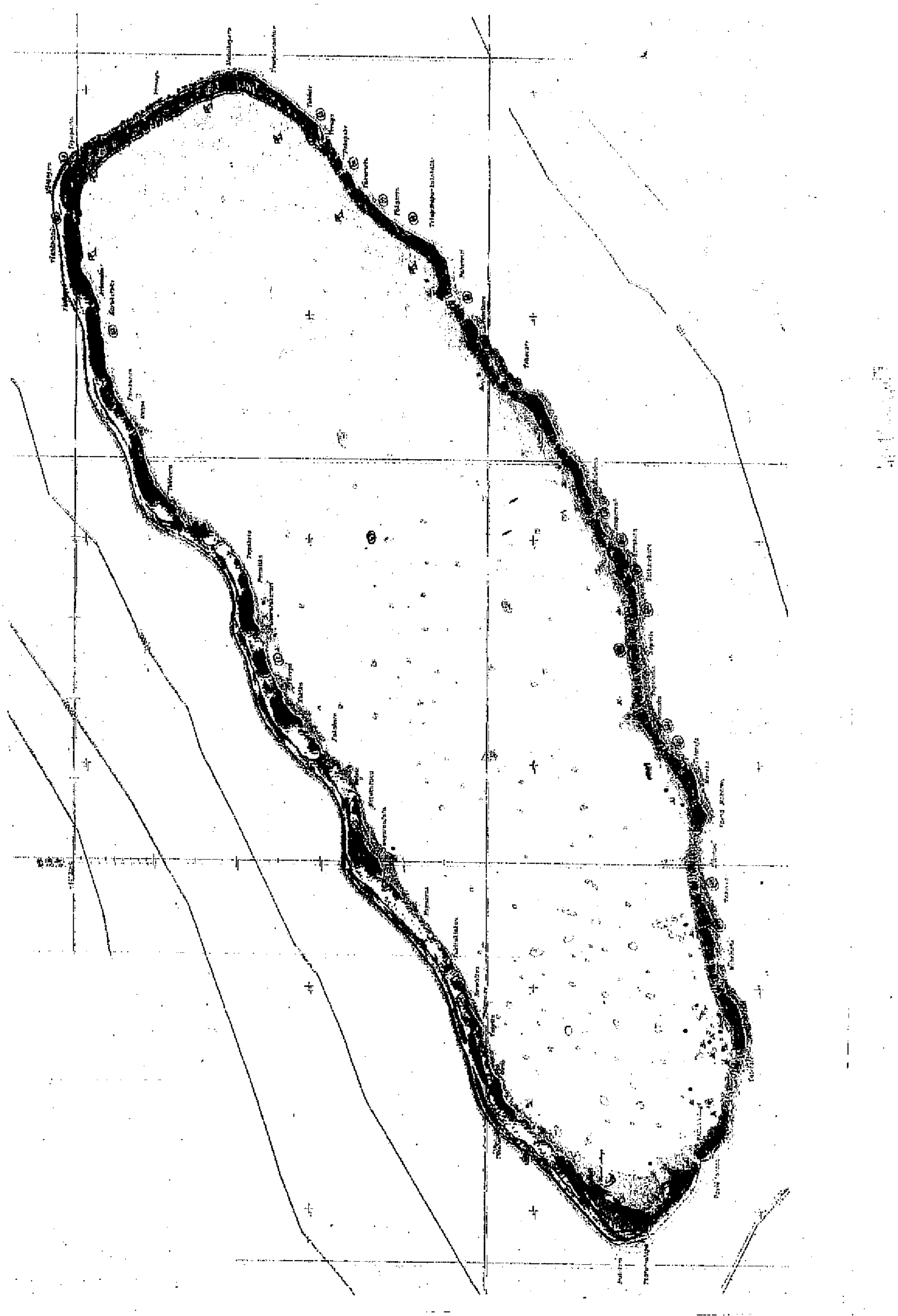


Figure 4: SPT map of Manihi, incorporating remotely sensed data

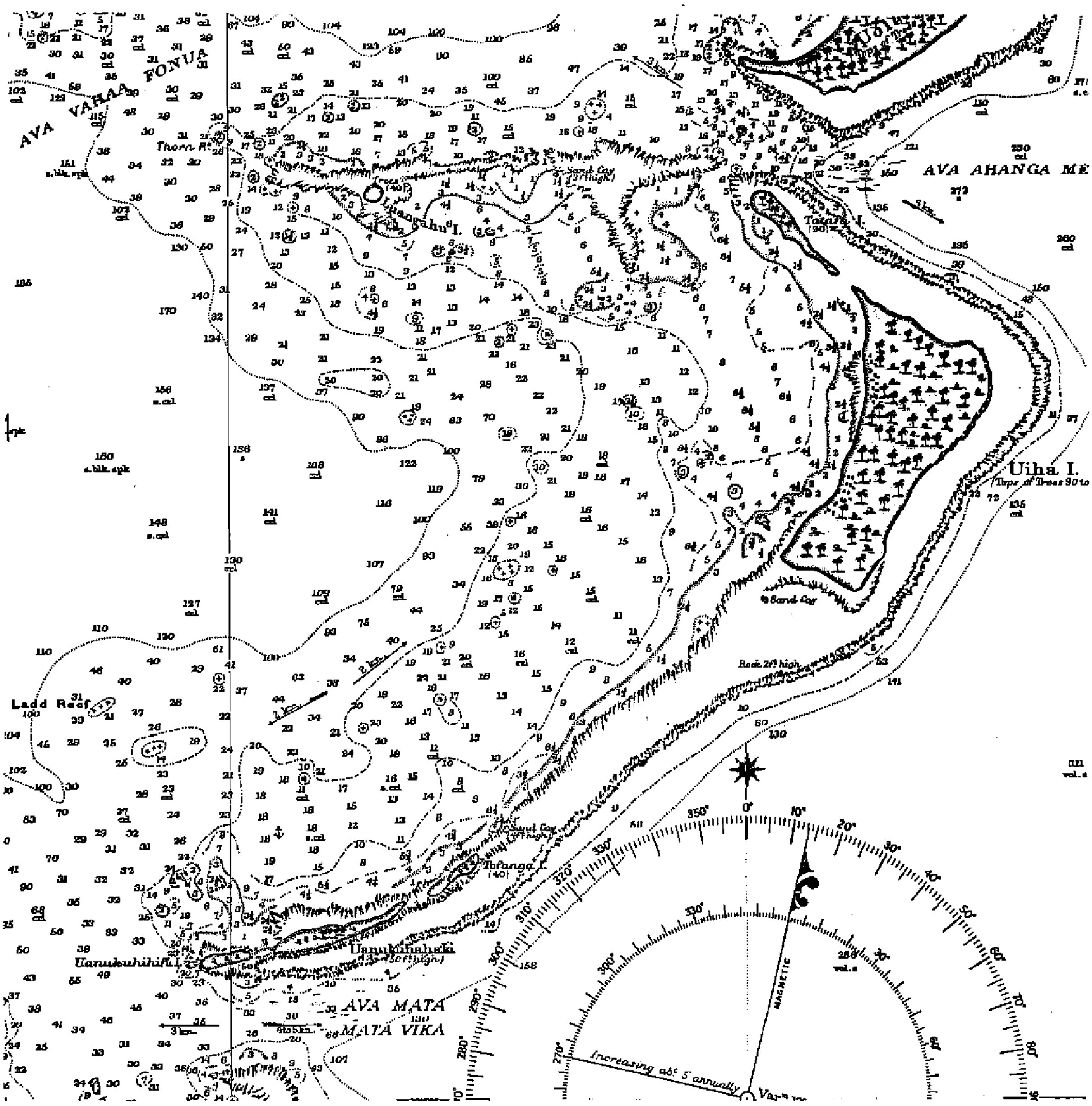


Figure 5: British Admiralty marine chart of Uiha island in Tonga's Ha'apai group

fishermen's ability to free-dive, effectively meant that the fishery would be confined to a maximum depth of about 30 m. Using the Admiralty charts, we therefore estimated the extent of the 30 m depth contour around each island and reef in the area, then used a planimeter to measure the area within each contour. This process was laborious, but allowed us to estimate commercial beche-de-mer abundance at about 1.01 million animals.

In November 1990 I found out that the Polynesian Remote Sensing Station (SPT) in Tahiti had a SPOT image that covered part of the Ha'apai area, including the island of Uiha as shown on the chart in Figure 5. I discussed with station director Dr Lionel Loubersac the possibility of using this data to repeat the work for the Uiha area that we had carried out manually, and comparing the results with our own. Our manual estimation had put the extent of the 30 m contour around Uiha, excluding the land and emergent reef surface, at 4,575 ha (1 ha = 100 x 100 m, or 10,000 m^2).

Dr Loubersac subsequently processed that part of the image covering Uiha to produce the bathymetric contour maps shown in Figure 6, and in doing so estimated the surface area within the contours by counting the pixels. Judging from the marine charts, the SPOT contours appear to cor-

Figure 6: (a) SPOT image of Uiha island and surrounding area, and (b) bathymetric contour map derived from it

respond roughly to the 10 m and 20 m isobaths, but this cannot be verified without some field-testing ('ground-truthing'). Light penetration in the frequencies used by SPOT is rarely good enough for bottom features much beyond this depth to be distinguished. Within the apparent contours, the estimated surface areas are: 0—10 m: 2,372 ha; 10—20 m: 1,394 ha; total (0—20 m): 3,766 ha.

The whole process took Dr Loubersac less than one afternoon and gave, I feel, much more accurate area estimates. SPT could probably estimate the areas of the other islands, in another afternoon's work — about a fifth of the time it took me to do it manually, and again with better results, as I was using estimated contours and an instrument, the planimeter, that is very sensitive to operator inaccuracy.

If I had known beforehand that SPOT imagery was available for even part of the area, I would have taken some printed outputs, of the type shown in Figure 6, with me. By measuring the depth accurately at known points on the printed image, we could have calibrated the depth contours more precisely than has been possible from the Admiralty charts, and refined the area estimates still further.

Other examples

There are several other examples from the region of digital image analysis being used in fisheries projects, or having an obvious interest to fisheries. In the early 1980s, workers in Papua New Guinea were using LANDSAT imagery to make area estimates for different types of reef around Kavieng. A pilot project for SPOT, also in the early 1980s, was to identify areas of coastal land suitable for prawn culture and other forms of aquaculture in New Caledonia. Dr Willy Bour's involvement in remote sensing began with his carrying out a project to estimate the area of trochus habitat on Tetembia reef in New Caledonia. Dr Pascale Joannot, of the Noumea aquarium, has recently been involved with Dr Bour in a similar project to use SPOT data to estimate the standing stock of corals of the family Favidae in the same area (these corals are commercially exploited in New Caledonia). LATICAL has also assisted Dr Pierre Thollot of ORSTOM by making an estimate of the extent of different types of mangrove in New Caledonia. Recently, as a public information exercise, the regional government of New Caledonia's Southern Province issued a poster of the SPOT composite image, shown in Figure 7, which illustrates the areas of existing marine reserves in the Territory.

A somewhat different application is demonstrated in Figure 8, which shows a false colour image produced by Dr Nicolas Baudry and his colleagues using data from a radar instrument carried on the SEASAT satellite. The instrument, which, unlike HRV, MSS, TM and others, is not passive but active (it generates its own signal), is able to measure the exact distance between the satellite itself and the sea surface. After processing to remove the effects of wave height, what remain are irregularities in the average height of the surface of the sea. These deviations from the average are caused by variations in the earth's gravitational field, and the variations are in turn associated with the presence of underwater features like seamounts. More detailed processing of the data from areas where gravitational anomalies have been detected permits the local bathymetry to be determined. Finally, the assignation of false colours to these areas makes the bathymetric features stand out: the deeper the red, the shallower the seamount.

A few features of Figure 8 are worth noting. The white contour lines shown in the figure are not derived from the satellite data, but are superimposed on the image from a world bathymetric map, maintained as a computerised database by the U.S. Defence Mapping Agency. This map essentially represents the total of what was previously known about the bathymetry of the area in question. At least a dozen seamounts or sea floor features that are not on the map are shown in the satellite image. The seamount shown on the map at 24.2°S, 201.2°E does not appear on the satellite image — i.e. it does not exist. In fact the seamount shown on the map is probably a seamount located two degrees further east, and the error in recording its position dates from the beginning of the century. The group of seamounts around 24°S, 212°E show several mapping inaccuracies. Modelling the bathymetry of these seamounts using the satellite data allows their positions to be corrected to within 5 km — better than the resolution of most of the mapping surveys used to compile the global bathymetric database — and their depths to be estimated to within 10 per cent of the true depth.

There is a clear application for this information in assessing, developing, and even finding, deep-bottom fishing stocks in some countries of the region. With the vastly improved radar data coverage that will become

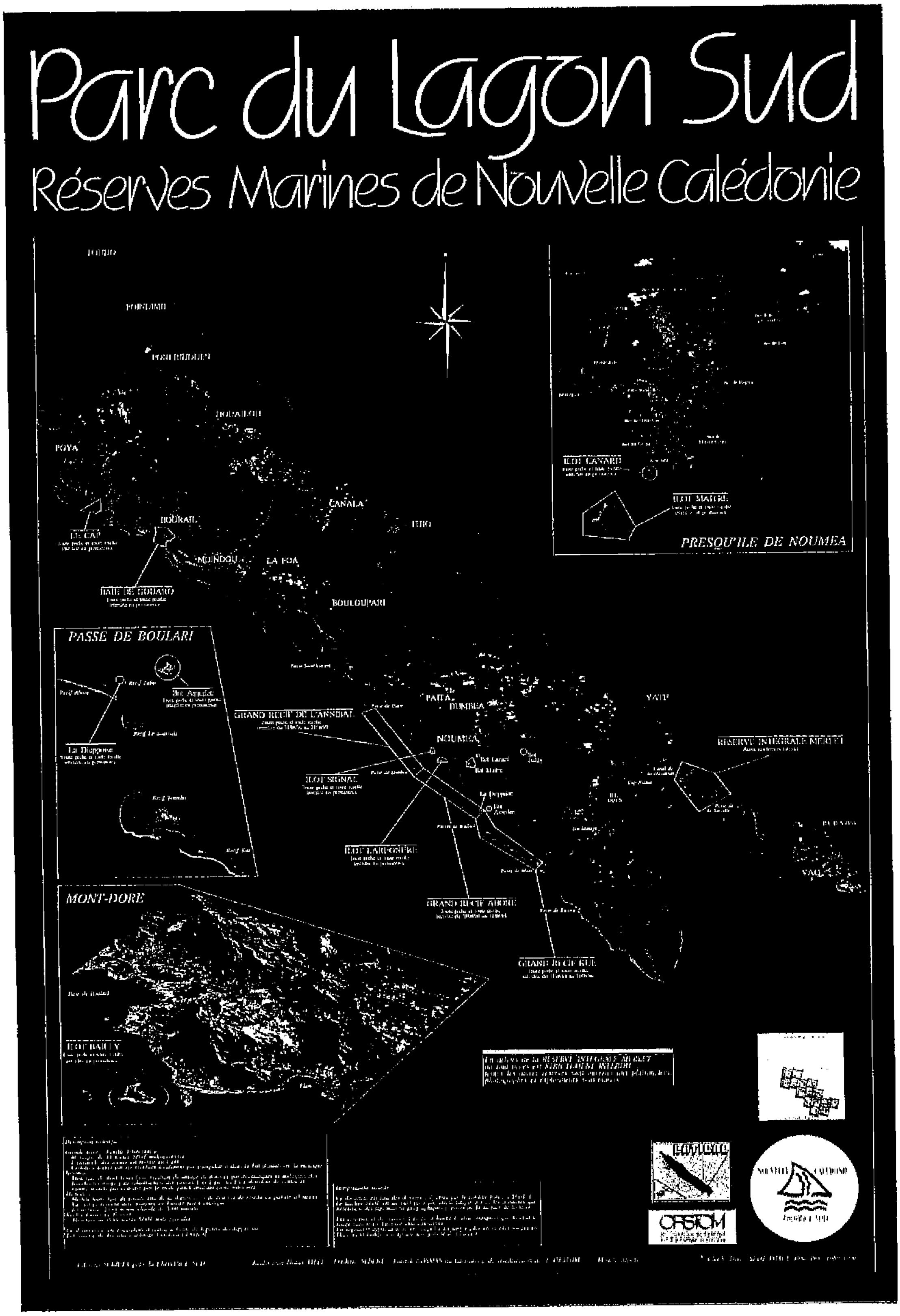


Figure 7: Poster publicising marine reserves in New Caledonia, composed of a mosaic of 26 SPOT images

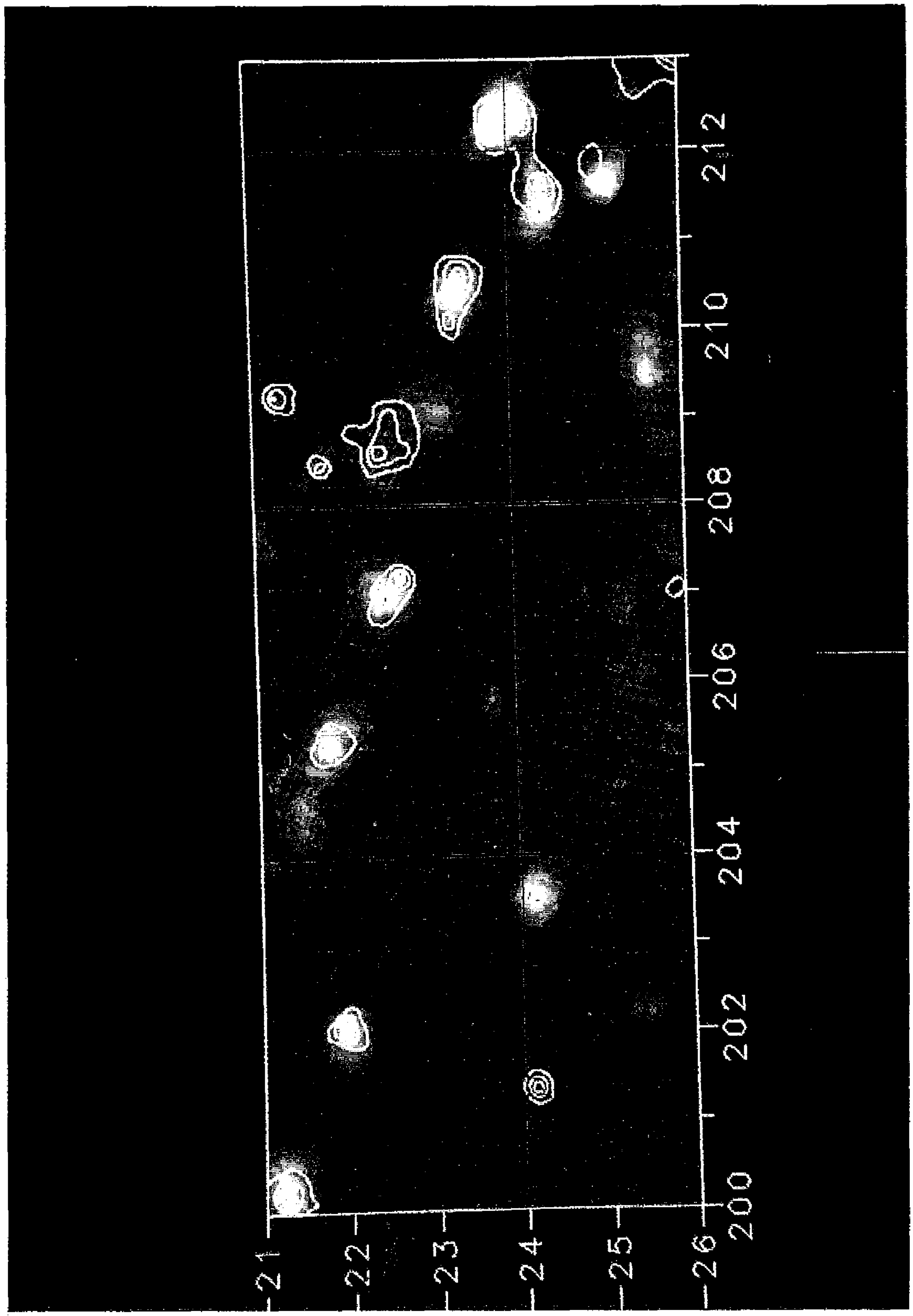


Figure 8: Seamounts in French Polynesia, mapped using radar satellite data
(Photo courtesy of Seafloor Imaging, Inc., Noumea, New Caledonia)

available from the ERS-1 and TOPEX/ POSEIDON satellites as of late 1991, satellite-based sea floor bathymetric modelling will be easier and more precise throughout the world's oceans.

Conclusions

People are often both impressed by the beautiful images produced by image analysis of remotely sensed data, and at the same time intimidated by the sophisticated technology involved. There is no doubt that the use of digital image technology requires costly equipment, costly data and even more costly training, and that in some cases, the production of pretty pictures from satellite data has been more aesthetically pleasing than practically useful. Hopefully, as people come to realise that remotely sensed data really are just data — with associated advantages and limitations like any other data set — the use of the associated technology will lose its mystique and start to conform more to real needs than to imaginary possibilities.

It should not be forgotten that simple visual interpretation of aerial photography is still probably the most useful form of remote sensing for the region's workers on inshore fisheries. There have been some innovative approaches to acquiring aerial photographs by fisheries workers.

The UNESCO book on coral reef research methods[2] describes a survey of coral reefs from above using an ordinary camera suspended from a small, helium-filled balloon anchored on the reef flat. In the Philippines, Dr John McManus used some of his research budget to buy a second-hand ultralight aircraft (cost: about US$5,000)[3]. He then fitted his pocket camera to the bottom of the plane and, in calm weather, overflew the areas he was interested in, taking pictures to make up a mosaic. In this way, in a short time and for the additional cost of a few litres of fuel and a roll of film, he was able to get a quick measure of the number of boats out fishing that he would never have been able to get by conventional surveillance on the ground. Most people, however, acquire their data by the more conventional method of buying it from the local lands department.

The use of digital technology allows more information to be extracted from an aerial photograph than can be seen with the naked eye. Drs David Hopley and Pauline Catt of James Cook University have for some time been using digitised infra-red aerial photographs taken from a low-flying light aircraft to monitor coral growth and development in Queensland[4]. In Scotland, Robert Wright was able to mount an ordinary home video camera (equipped with a 1/1000 second strobe shutter) under a light aircraft, and thereby take an airborne video sequence of a long stretch of beach that he was studying[5]. Afterwards, the video machine was hooked up to an IBM PC equipped with a graphics card and a video frame grabber, and the tape stopped when the desired part of the beach was in view. The frame grabber then converted the scene to a digital image amenable to computer-based image processing methods.

These examples illustrate that, as well as the conventional sources, there are many unconventional ways of obtaining remotely sensed data, often at low cost, and these are often limited only by imagination and perseverance. As the availability of remotely sensed information grows, and technical fishery people become more familiar with its potential applications, this kind of data is sure to be used more and more in the development and management of the region's marine resources.

2. Stoddart, D.R. and R.E. Johannes (eds) (1978). *Coral reefs: Research methods.* UNESCO monographs on oceanographic methodology No 5. United Nations Educational, Scientific and Cultural Organization, 7 Place de Fontenoy, 75007 Paris, France.

3. McManus, J. (1988). Pers. comm.

4. Hopley, D. and P. Catt (1988). Use of near infra-red aerial photography for monitoring ecological changes to coral reef flats on the Great Barrier Reef. *Proceedings of the 6th International Coral Reef Symposium, Townsville, Australia, August 1988.*

5. Wright, R. and T.A. Harris (1988).Change-detection in physically fragile coastal areas of Scotland by remote sensing. Paper presented at a conference on 'Remote sensing of the Coastal Zone', Gold Coast, Australia, September 1988.