

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. The responses (about 350) have been entered into a computerised database and the most common areas have been identified.

As part of the support offered to each SIG, the South Pacific Commission undertakes to circulate literature, technical materials, and correspondence relevant to the interests of group members on an occasional basis, mainly in this bulletin.

This first *Trochus Information Bulletin* will give group members an idea of the type of information we hope to include and provide a stock-take of currently available bibliographic information relevant to the interests of the group. An introductory list of SIG members is also given.

In return, we ask group members to keep us informed of their own work activities in the subject field, and send us single copies of any material or information that may be relevant to the interests of other members of the group, on topics such as:

- Research activities in biology and ecology;
- Fishing and marketing activities;
- Conferences, books and other publications; and
- Questions by members or information requests.

Thanks in advance.

Jean-Paul Gaudechoux
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Report on the SPC/SPRADP Workshop on Trochus Resource Assessment, Development and Management, 13 May – 2 June 1991

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Introduction

The topshell, *Trochus niloticus*, is native to countries of the Western Pacific, and has been introduced to many additional locations throughout the Pacific Islands. This shell is collected and exported for button-making and other uses, and provides an important source of income for rural and outer island dwellers in the region.

The Pacific Islands region is the most important trochus-producing area in the world. In 1986, the latest year for which complete figures are available, regional production was at least 2,166 tonnes. At present-day prices this would have a value to fishermen of around US\$ 26 million. Most of these earnings accrue to coastal communities whose alternative earning opportunities are frequently limited.

In recent years, the market value of trochus shell has increased markedly. As a result, the level of exploitation has also increased in many Pacific Island countries. There are fears in some locations that present levels of harvesting will not be sustainable and that serious resource depletion will occur if management regimes are not developed and instituted. This will result in undesirable consequences for those communities to which trochus harvesting is presently economically important.

The Twenty-Second SPC Regional Technical Meeting on Fisheries, held in Noumea in August 1990, discussed this issue in some depth. The meeting also discussed several related topics, including:

- factors determining regional and global variation in trochus quality, and therefore value;
- the merits of regional co-operation in the marketing of marine products, including trochus, as a means of increasing economic returns to Pacific Island countries from the resource;
- appropriate management approaches for trochus and other marine resources, including the use of hatchery-produced juveniles to replenish depleted natural populations.

As a result of these discussions, the meeting recommended that the South Pacific Commission take action to assist Pacific Island countries in maximising the returns they obtain from their trochus resources by promoting regional collaboration and information exchange in the development of effective exploitation, marketing and management systems. Given the interdisciplinary nature of the topic, the meeting also recommended that the Commission seek the active co-operation of other regional agencies, in particular the South Pacific Regional Aquaculture Develop-

ment Project and the Forum Fisheries Agency, in this work.

As part of its response to these recommendations, the Commission, through its Inshore Fisheries Research Project, organised a three-week Workshop on Trochus Resource Assessment, Development and Management.

The overall aims of the workshop were: to update participants on recent developments in trochus processing and marketing; to expose participants to current biological and aquacultural information relevant to trochus fishery resource assessment and management; to train selected participants in the conduct of field work aimed at providing assessment of the status of local trochus resources; in so doing, to develop a standard trochus survey methodology for use within the region, so as to allow direct comparison of survey data in the future; and to promote an exchange of trochus fishery management experiences in the region, in order to promote effective management of this important resource.

Venue and funding

The workshop lasted slightly more than three weeks, from Monday 13 May to Sunday 2 June 1991 inclusive. It was hosted by the Fisheries Department of the Government of Vanuatu and executed in collaboration with the FAO South Pacific Regional Aquaculture Development Project. Funding support was provided by the International Centre for Ocean Development (Canada), the UK Overseas Development Administration, the Commonwealth Secretariat, the Food and Agriculture Organisation of the United Nations, and the South Pacific Commission.

Workshop structure

The workshop was structured as three approximately one-week segments. All participants attended for the first week (13 - 18 May inclusive); selected participants stayed on for the second and third weeks (13-26 May inclusive, and 26 May - 2 June inclusive). Participants were not permitted to join the workshop part-way through.

Week 1 was aimed at a broad range of individuals involved in work on trochus, from those dealing with aspects of resource assessment and the provision of management advice, to those involved in decision-making at a senior level, or in product quality assessment, control or marketing. Parts of Week 1 were also relevant to individuals from the private sector.

Sessions during Week 1 consisted of lectures and discussion groups covering of aspects of trochus biology and life history, population dynamics, basic resource assessment methods, hatchery technology and juvenile propagation, resource management, shell processing and quality assessment, and marketing. Some attention was also given to the species *Tectus pyramis* and *Turbo marmoratus*, which occupy similar habitats and are traded in ways similar to *Trochus niloticus*. Site visits to commercial shell processing factories and to the government trochus hatchery were organised, and participants were able to observe trochus spawning and subsequent larval development.

Week 2 was aimed at individuals involved in survey and assessment work on trochus and other sessile marine invertebrate resources. Participants in Week 2 were required to have completed Week 1.

Week 2 consisted of two main elements:

- comparison of field survey methods for trochus, one of the aims being to develop a standardised survey methodology for use in future Pacific Island trochus surveys;
- an experiment to monitor intensively the short-term effects of a mass release of trochus juveniles in a selected location. Such experiments will be essential if we are to assess correctly the usefulness of the juvenile release programmes for fishery enhancement that are being considered in some parts of the region.

Week 3 provided an opportunity for participants to assist with an intensive field survey in Aneityum island, using the standardised methodology developed during Week 2. The survey formed part of Vanuatu Fisheries Department's national trochus assessment project and thus provided important support for trochus resource development in Vanuatu. Participants in Week three were required to have first completed Weeks 1 and 2.

Resource people and participants

Five people acted as resource persons for one week or more of the workshop. They were Garry Preston, South Pacific Commission, weeks 1-3; Warwick Nash, Tasmanian Sea Fisheries Department, weeks 1-3; Hideyuki Tanaka, Regional Aquaculture Development Programme, weeks 1-2; Kay Legras, South Pacific Commission, weeks 1-2; Seamus McElroy, Private, week 1. A further seven individuals acted as resource persons for short periods (one or two hours) in support of specific items on the workshop programme. They were

Serge Bordet, Private, Vanuatu; Robert Gillett, FAO/UNDP Regional Fishery Support Programme, Fiji; William Bour, ORSTOM (French Overseas Research Agency), New Caledonia; George Joe, Melanesian Shell Products Ltd, Vanuatu; Hirofumi Kubo, Okinawa Prefectural Fisheries Experimental Station, Japan; Masayoshi Murakoshi, Okinawa Prefectural Sea Farming Centre, Japan; Nory Ozaki, Kiyohara Co. Ltd., Japan.

The 37 participants from 16 countries who took part in various stages of the workshop were Kelvin Passfield, Patricia Ngamata Tuara (Cook Islands); Esaroma Ledua, Abdul Rahim, Apisai "Terminator" Sesewa, (Fiji); Ronald Cheneson (French Polynesia); Simpson Abraham, Flynn Curren, Donald David, Jerry Fagolimul, Joe Fanafal (Federated States of Micronesia); Temawa Taniera (Kiribati); Nena Kilma, Hilary Kobaia (Marshall Islands); Bernard "Ambassadeur" Fao (New Caledonia); Ken-ichi Kikutani, Steven Patris (Palau); Molean Chapau, Joshua Ako Kari, Kingsford Naniura (Papua New Guinea); Jon Leqata, John Mao, Eddie Oreihaka, Peter Ramohia (Solomon Islands); Suia Gaulofa (Tokelau); Tevita Finau Latu (Tonga); Nikolasi Apelinu (Tuvalu); Moses Amos, Albert Carlot, Felix Nguyen (Vanuatu); Henrietta "Bag of Beans" Winterstein (Western Samoa); Jim Gillespie, Erik Hunter, Karina Magro, Alex McCarthy, Jeremy Prince (Australia).

Week 1

Week 1 consisted of a large number of presentations and discussion sessions that fell within the following areas: status of Pacific Island trochus resources; Trochus trading and marketing; trochus biology and aquaculture; population and distribution characteristics of Trochus resource; potential Trochus management systems and enhancement methods; and a session on green snail (*Turbo marmoratus*). Each of these themes was treated more or less as a separate one-day "mini-workshop", moderated by a different resource person. The presentations and discussion sessions were extremely productive, and highly interactive, with all but a very few participants taking an active role in the interchange. The presence of numerous technical specialists, especially those from the shell industry and trade, led to a large body of otherwise inaccessible information being made available.

During the sessions, the following original papers were copied and distributed:

- Country statement - Queensland;
- Resource statement - Western Australia;
- Country Statement - Cook Islands;
- Status of trochus in Fiji;
- Situation de la ressource en Trocas en Polynésie Française;
- Country statement - Palau;
- Country statement - Papua New Guinea;
- Trochus assessment, development and management in Solomon Islands;
- Trochus resource in Tuvalu;
- History and present status of the trochus resource in Vanuatu;
- Trochus resource of Western Samoa;
- Country statement - Okinawa;
- Kiyohara Company outline/ Where trochus shell and shell button stand in Japan;
- Processing and trade of Melanesian Shell Products Ltd;
- Mass seed production and restocking of trochus in Okinawa;
- Methodology of trochus seed production in Vanuatu;
- Juvenile release in Palau;
- Updated table of Pacific trochus introductions;
- Studies on trochus ecology and its propagation in Micronesia (abridged translation);
- Remote sensing of trochus habitat on Tetemba reef, New Caledonia.

All the presentations and discussion sessions were recorded on audio tape for subsequent transcription. Unfortunately faulty sound recording equipment meant that recordings of some sessions are of poor quality and may be impossible to transcribe. Session transcriptions will be combined with the presented

papers in a workshop proceedings. It was originally planned to issue the proceedings early in 1992 but this has not been achieved. We hope nevertheless that they will be available before the end of the year.

Week 2

The 24 participants who stayed on for Week 2 relocated to Erakor Island, where accommodation and classroom facilities are conveniently located close to foot access to a fringing reef with a viable trochus population. This Week and Week 3 were more in the nature of a training course. Participants were given instruction in statistical procedures and survey design by the resource people, and were required to put this instruction into practice by carrying out survey work on the reef flat and analysing the results.

Because of heavy surf which made diving over the reef-edge dangerous, and general ease of access, survey work during the early part of the week focussed on benthic invertebrates other than trochus. This did not detract from the purpose of providing instruction in the basic principles of survey design and conduct. During the later part of the week, weather and tides allowed access over the reef and it was possible to target trochus specifically.

A juvenile release experiment was also carried out during this week. 2,000 juvenile trochus were tagged and released in 4 treatments at different places on the reef. Instantaneous monitoring was carried out on the following and subsequent days. (A further

check on the animals was carried out by one or two participants who had transit days in Port Vila after the end of Week 3. The Vanuatu Fisheries Department has been monitoring the site since the time of the release, and in August 1991 produced a progress report which is summarised as a separate article in this bulletin. Early survival rates were extremely encouraging, far better than anticipated or achieved in any other trochus release experiment, including the large programmes carried out in Japan. Vanuatu Fisheries Department now plans to carry out additional releases in order to obtain further improvements in survival rates.

Week 3

Week 3 involved 16 of the 24 Week 2 participants, who travelled to the island of Aneityum, in the south of the Vanuatu archipelago, to carry out survey work on the island's trochus population. This was a change in the original schedule, in which it was planned to carry out this field work on the island of Emae. The change was requested by the Vanuatu Fisheries Department, who needed management-related information in order to advise the island council on re-opening the fishery. Trochus and green snail harvesting had been banned for three years before the study team's visit and the situation thus presented an ideal opportunity both to assess the effects of the closure, and to provide useful advice to the island council.

The week was spent on board the chartered vessel *Coriolis*. Steaming to Aneityum took about 28 hours in each direction, in very rough weather. Most



Erakor Island



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.

participants were seasick and unable to function on the trip down, but by the end of the week some were sufficiently adapted to carry out data analysis and write-up of results on the return leg. After arrival at Aneityum, the *Coriolis* anchored in a sheltered location, and survey work was carried out using the vessel's two outboard-powered dive tenders.

Most survey work was carried out in the south of the island close to the centre of population and the main site of the fishery in previous years. At the end of the week, an afternoon stop was made on the northern side of the island to obtain comparative information from an unfished site, but continuing rough weather made survey work ineffective and these results were ultimately discounted in the final analysis.

Survey work consisted of the following activities: strip transects to estimate relative abundance; depletion experiments to estimate absolute abundance; mark-recapture experiments to refine the abundance estimates; and gathering of length-frequency information for use in the study of population demography and in virtual population analysis. All data gathering, recording, and interpretation were done by the participants, working in groups of four, under the supervision of the two resource people.

At the end of the week each group was required to use the data it had gathered, plus the information and experience presented during the first week, to draft a management plan for the Aneityum fishery. The plan was to be written in such a way that it could be presented and explained in a convincing way to the island council. Each group had access to the data gathered by the other three groups, but was asked to work independently.

The four management plans were compared and discussed in depth during a final session in Port Vila after the vessel returned. Although each has individual features, there is a consistency in approach which strongly suggests that workshop participants had effectively absorbed the information and techniques covered in the workshop. The merits and demerits of each plan were discussed, and based on this information the Vanuatu Fisheries Department has provided management advice to the island council, which has been accepted.

National workshop

After the main workshop, a smaller gathering of ten representatives from the various islands of Vanuatu was convened for two days by the participants from the Vanuatu Fisheries Department. This element was administered entirely by the Vanuatu Fisheries Department, and funded by ICOD.

The purpose of the national workshop was to advise island representatives on management of their own local trochus resources, based on information from the main workshop. The presentations were made in the local Bislama language by two of the ni-Vanuatu participants in the main workshop, and stimulated considerable interest and discussion. Island representatives were made aware of the likely biological and economic consequences of different approaches to managing this fishery. At

the same time, the Fisheries Department staff used the opportunity to gather up-to-date information on patterns of exploitation in different areas, and to discuss means of gathering additional research information through cooperation with local fishermen. The workshop was a valuable extension exercise which the Vanuatu Fisheries Department intends to repeat and capitalise on in the future.

Workshop documentation

Two documents will be produced as a result of the workshop:

—a report of proceedings, containing all papers tabled and edited transcriptions of the verbal presentations and discussion sessions. This report will essentially condense and disseminate the information presented during Week 1.

—a manual of survey techniques and statistical procedures for use in future survey work on benthic marine invertebrates. This manual is intended as follow-up support to participants, as well as providing a means of extending the training beyond the original participant group and a step towards standardising survey methodology.

Although preparation of both documents has been held up because of the pressure of other work commitments, both are now in an advanced state and are expected to appear before the end of 1992.

It is also expected that a formal scientific paper will be written on the results of the trochus juvenile release experiment, and submitted to the journal *Aquaculture* or another suitable publication vehicle. This work will be undertaken by Vanuatu Fisheries Department staff, with support from the FAO/UNDP Regional Aquaculture Development Programme.

Recommendations

The following recommendations were made during Week 1 of the workshop:

1. that the Commission 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;
2. that the Commission establish a new Special Interest Group (SIG) on shells and the shell trade, focussing especially on trochus;
3. that the Commission 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;

4. that the Commission encourage the adoption of standardised survey techniques for trochus and other benthic marine invertebrates in Pacific Island countries, so as to enable comparison of results by different workers and from different areas.

The recommendations were subsequently endorsed by the Twenty third SPC Regional Technical Meeting on Fisheries in August 1991, and approved by the South Pacific Conference in October 1991, so the Commission is committed to their implementation. The first recommendation will be dealt with within the framework of a broader project aimed at developing the use of RS/ GIS technology for marine resource assessment, which has just been approved by the SPC Committee of Representatives of Governments and Administrations.

The second is now being addressed, which is why you are able to read this bulletin. The third recommendation, for a detailed study of the Aitutaki trochus fishery, is just about to go ahead, and is the subject of a separate article in this bulletin. The fourth recommendation will be addressed principally through the publication of the manual of standardised survey techniques for trochus (and, by inference, for other marine invertebrates) that has already been mentioned above.

The enthusiasm of the participants was far beyond what was anticipated. During Week 1, there were numerous sessions in the evenings and on Saturday morning, and all were fully attended (more or less). Most individuals had a genuine strong desire to participate fully and to take home information that would be of direct application in their own situations, and this attitude greatly encouraged the free flow of information and the sharing of experience.

During Week 2, resource persons were surprised to discover that participants had been out on the reef in the middle of the night or before dawn, checking the released trochus juveniles and preparing early surveys so as to take full advantage of the tide. Many participants carried out additional transects on Sunday so as to ensure their data achieved the desired level of precision.

During Week 3, participants were expected to dive regularly at night, to work in surf or rough weather, and to carry out data analysis at other times. All these activities were carried out without complaint and with considerable enthusiasm (even by those individuals who managed to get themselves

dumped on the reef by the surf, losing diving gear and a fair bit of self-respect in the process), right until the last day. After an extremely rough 28-hour boat trip home, everyone was still keen to participate in the final discussion of the management plans, which began mid-Sunday afternoon and continued until 8 at night.

The workshop proved to be both an invaluable source of information on all aspects of the trochus resource, and an effective means of heightening

awareness of the factors influencing fishery management decisions on the part of the Pacific Island participants. In particular, the socio-economic aspects of management, and the requirements of the shell trade, were emphasised, so that any management decisions made are not by biological considerations alone. This approach ultimately resulted in participants developing considered management plans that were likely to make sense to rural people dependent on the fishery for their income.

Trochus reseedling experiment in Vanuatu

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In recent years the harvesting activity of trochus shells in Vanuatu has increased due to the steadily growing demand for the shell, whose market value has increased markedly. This has resulted in the establishment of three shell processing factories in Port Vila, thus increasing the level of exploitation of the resource throughout the island regions.

To determine whether re-seeding of depleted reefs with hatchery reared juveniles is a practical tool for management, an experiment on re-seeding of trochus was carried out in May 1991. This article is a summary of a progress report written in August 1991, about 3 months after the release was made. For further details, refer to Working Paper 26 from the Twenty-third SPC Regional Technical Meeting on Fisheries (August 1991).

Trochus were spawned at the Vanuatu Fisheries Department hatchery in Port-Vila during the first 3 months of 1990. A total of 1400 juvenile *T. niloticus* were tagged and released. Of these 1,000 had maximum basal shell diameter greater than 20 mm and 400 had basal shell diameter less than 20mm

The juvenile *T. niloticus* were segregated into 4 groups, with each group containing 350 juveniles with a separate tag colour (Group 1 – pink; Group 2 – white; Group 3 – green and Group 4 – blue tags). The juveniles in each group were individually marked in three different ways:

- a) small numbered polyethylene Hallprint tags attached to the shell with cyanocrylate glue;
- b) a drop of red-coloured cyanocrylate glue applied to the apex of the shell; and
- c) the number on the polyethylene tag was inscribed with pencil on the nacre inside the lip of the shell.

The juvenile Trochus were then measured (with Vernier callipers to the nearest 0.1 mm) and returned to a flowing seawater tank, where they were all left overnight before being transferred to the reef.

For convenience, a reef flat on the seaward side of Erakor Island, close to Port-Vila, was chosen as the release area. Before the experiment commenced, the village that owned the reef agreed to ban trochus fishing on it for a period of one year. All the release sites chosen were within the suitable habitat zone, so that comparison of survival rates could be done at different levels of protection from predators. The most suitable place for releasing the juveniles was a narrow band of coral rubble immediately shoreward of the elevated reef crest. The rubble was encrusted with coral and algae and the spaces between the rubble were considered the most appropriate size for small trochus to shelter.

The tagged juveniles were collected from the tanks at the Fisheries Department, taken in tanks of seawater to Erakor Island and placed in the shade at the top of the beach. Lumps of coral were placed in the tanks, and the juveniles were placed on the coral. These blocks with juveniles attached were later transferred to the sites selected for releases. They were placed at each of the four chosen sites and were provided with the following types of protection from the predators:

- Group 1: the coral blocks with the juveniles attached were covered with coral rocks (mainly plate *Acropora*) to shelter them from wave action and predation;
- Group 2: plastic mesh with 1 cm holes was placed over the blocks. The mesh was anchored in place with coral blocks placed around the edge while steel rods were hammered through the substrate to hold corners of the mesh firmly in place;