



Fisheries

Newsletter

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Editorial

Two important meetings were held during the first quarter of 2006. The fifth Heads of Fisheries (HOF) meeting took place at SPC's headquarters in Noumea, New Caledonia from 3 to 7 April. The yearly HOF meeting is the sole occasion that enables those in charge of managing fisheries in the Pacific Islands to gather and examine the issues and problems affecting fisheries and marine resources, share experiences with colleagues, and provide invaluable advice and guidance to SPC's Marine Resources Division. The outcomes of this meeting can be found in this newsletter from pages 2 to 7.

An SPC/Forum Fisheries Agency (FFA) workshop on Pacific Island regional deep-sea bottom trawling and high-seas biodiversity conservation was also held in Noumea from 29 to 30 March. Fisheries managers from SPC and FFA, together with specialists from intergovernmental and non-governmental agencies met informally to consider bottom trawling and protection of biodiversity in the high seas in the context of the 2005 Pacific Islands Forum and Pacific Community Conference. More information on the outcomes of this workshop can be found, annexed to the Heads of Fisheries report on agreed outcomes, at:

<http://www.spc.int/coastfish/Reports/HOF5/HOF5-outputs.pdf>

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■ FIFTH HEADS OF FISHERIES MEETING

The fifth Secretariat of the Pacific Community (SPC) Heads of Fisheries (HoF) meeting took place at SPC Headquarters in Noumea, from 3 to 7 April 2006. It was chaired on behalf of New Caledonia by Vincent Denamur, head of the Service de la Marine Marchande et des Pêches Maritimes.

HoF is a regional meeting of Pacific Island countries and territories that addresses the entire range of issues of interest to national and territorial fisheries services. As such, it plays a unique role in promoting dialogue and experience-sharing between island nations and territories, as well as guiding the work of SPC's fisheries programmes. It complements the role of the Forum Fisheries Committee and the Western and Central Pacific Fisheries Commission, whose primary emphasis is on tuna fisheries management, whereas HoF's focus includes aquaculture, coastal fisheries management and development, and living marine resource science. In addition, HoF is a broad-ranging and relatively informal venue for discussion that can include any issue of interest or significance to participants.

The following paragraphs summarize the points of agreement of SPC member country and territory fisheries heads on key meeting issues.

OUTPUT 1. Deepsea bottom trawling and high seas fisheries management: HoF discussed the options informal workshop on the subject held the previous week) in order to gain a better understanding of the issues involved and of the range of views available. HoF recognised that the issue of high seas bottom

trawling is important. The meeting asked SPC and FFA to continue to provide advice on these options, including possible suggested texts, merits, timeliness, costs and benefits, and geographic applicability in accordance with international agreements and decisions, to HoF, and to the Forum Fisheries Committee, as required over the forthcoming period leading up to the Forum leaders meeting.

OUTPUT 2. Coastal fisheries science: The PROCFish¹ and CoFish² Steering Committee met in Noumea on 1 April 2006 to review progress and to discuss the findings of the mid-term evaluation of the coastal component of the European Commission/SPC PROCFish project. Eleven Pacific-ACP³ and French OCT⁴ countries were present at the meeting, along with observers from several non-ACP countries, and SPC programme staff. Staff of the PROCFish-C team presented results of their work with regards to socioeconomics, finfish, invertebrates, and database development. These presentations were well received. Other presentations included a general overview of the programme and the work conducted so far, the recommendations of the mid-term evaluation, and the proposed workplan for 2006. The four main outcomes of the Steering Committee are:

(a) The Steering Committee strongly supported the finding in the mid-term evaluation to seek a no-cost extension of the programme to ensure it will fully meet its stated objective. With only 11 months remaining for the PROCFish-C and CoFish programme, there was insuffi-

cient time to complete necessary fieldwork, complete the data analysis and report writing, and to report the results back to each country. A no-cost extension for the programme was essential and there was available funding in the budget to support this.

(b) All members of the Steering Committee expressed concern that no country reports had been completed and submitted to countries, and this situation needed to change. Fisheries Departments could no longer justify to their governments the funding spent in support of PROCFish-C fieldwork activities, with no results or report to show. Countries needed their reports in a timely manner so they could use this information to help manage their inshore resources. The Steering Committee clearly stated that a strategy needed to be developed between PROCFish-C and countries to ensure reports, even at a site level in draft form, would be provided in a timely fashion.

(c) Capacity building within countries was also highlighted as an area the programme should focus on. Capacity in survey methodologies and data entry does occur, although data analysis and interpretation was highlighted as one area of capacity building that countries needed. The Cook Islands offered to host such a workshop, making sure that adequate computers would be available. A second area for capacity building was in using GIS and Map Info data. Countries needed the skills to present

¹ Pacific Regional Oceanic and Coastal Fisheries Project

² Extension of the PROCFish Project to the remaining Pacific ACP countries not covered in the initial phase of PROCFish

³ African, Caribbean and Pacific

⁴ Overseas countries and territories

information visually to senior decision makers and ministers, in order to convey different messages, especially in regard to inshore resources and local marine habitat. In-country capacity building in general was an overall concern for the countries and territories present at the meeting.

- (d) In reviewing the logical framework for the PROCFish-C programme, the Steering Committee supported the proposed changes made by the reviewer and presented in the mid-term programme evaluation.

OUTPUT 3. Oceanic fisheries science: The meeting noted the continued work of the oceanic component of PROCFish in fishery monitoring and ecosystem modelling and assessment. The Pacific Community expressed strong support for SciFish (Scientific Support for Oceanic Fisheries Management in the Western and Central Pacific Ocean), a project planned for continued European Community funding support that will continue several PROCFish-Oceanic activities. The meeting supported the directions the SciFish project design is taking, notably:

- (a) continued support for ACP and OCT members in fishery monitoring, with emphasis on operational support, training and coordination for national observer and port sampling programmes;
- (b) continued development of ecosystem models, which provide advice on the ecosystem approach to management of the region's tuna fisheries;
- (c) a major focus on regional tuna tagging, including both tropical tunas (skipjack, yellowfin and bigeye tuna) and South Pacific albacore tuna; and
- (d) the development of national capacity building associated with the above activities.

The meeting recommended the SciFish project to the EC for favourable funding consideration. The region looks forward to the project's early implementation.

OUTPUT 4. Southern albacore fisheries: the meeting directed that, in the development of new funding proposals, SPC should be careful to ensure that priority continue to be attached to the

investigation of stock status and prospects, and local development, of southern albacore fisheries. The meeting noted that, while the total quantity of southern albacore captured within the region as a whole is much less than that of the tropical tunas, many Pacific Island countries have significant investments in fisheries that depend on albacore. The meeting welcomed the FFA/SPC initiative to develop an albacore research plan, and requested that this item be added to the OFP work plan for 2006.

OUTPUT 5. Ecosystem approach to fisheries (EAF): Assisting SPC members with the implementation of the EAF by 2010, and concentrating on coastal fisheries and aquaculture, was endorsed as the main overall objective of the Coastal Fisheries Programme. The meeting emphasised that although the EAF is the way forward, the region should not lose sight of the need to achieve sustainable development of fisheries and aquaculture – that implementing the EAF is not an end in itself, but is only a tool to better achieve the main aim of sustainable development, including maximising value of fisheries production. The meeting endorsed



Participants at the Fifth Heads of Fisheries Meeting

the new Coastal Fisheries Programme Strategic Plan, noting that annual workplans should pay particular attention to the quantification of indicators so progress can be readily assessed.

The role of SPC's Oceanic Fisheries Programme in developing scientific information about oceanic fisheries ecosystems, for application by SPC member and regional oceanic fisheries management processes, was noted by HoF. The Oceanic Fisheries Programme Strategic Plan was endorsed as an appropriate framework for expediting this work.

OUTPUT 6. EAF methodology:

The meeting directed that SPC, in assisting members to apply the EAF to coastal fisheries and aquaculture, should use the EAF principles established by FAO. They should also build on the implementation framework being developed by FFA for application to oceanic fisheries by its member countries and territories, and not develop an independent framework for coastal fisheries. The meeting noted the importance of developing formal linkages between the Council of Regional Organisations in the Pacific (CROP) at the regional level, and between government departments and other relevant stakeholders at the national and local levels, for the application of the EAF.

OUTPUT 7. EAF implementation:

the meeting noted the importance of the "bottom-up" approach in the application of the EAF, in which all relevant stakeholders are consulted, both during the design of the system and in its operation. The meeting also noted the need for regular information on and communication with and between members during the application of the EAF.

OUTPUT 8. Regional aquatic bio-security proposal: The meeting drew attention to the problems of

transferring aquatic organisms, both imported to and exported by Pacific Islands. As well as being an environmental protection issue there are major economic implications, both in maximising the value of exports and minimising economically damaging diseases. Furthermore, aquatic bio-security is a necessary principle for applying the ecosystems approach to both fisheries and aquaculture. The issue was recognised as being complex, involving the jurisdiction of several government departments, as well as several regional agencies including the Pacific Regional Environment Programme (SPREP) and SPC (Land Resources Division). HoF agreed there was a definite gap to be filled, and an urgent need for a regional level of support in helping members to fill this gap. However, the meeting was concerned that the proposal by SPC for the establishment of a regional aquatic bio-security support unit should not duplicate the capabilities of other agencies, and that it would need to take into account all the necessary linkages and potential issues. HoF endorsed the SPC pre-proposal for regional aquatic bio-security. SPC was requested to seek its implementation noting the target is for full regional coverage by 2010.

OUTCOME 9. Enhancement of CFP skills base under new strategic plan:

HoF participants strongly believed that in order to effectively assist members in implementing the ecosystem approach to coastal fisheries and aquaculture it was necessary to expand the capacity of SPC's Coastal Fisheries Programme. HoF recommended that expertise be sought in project economics, mariculture, coastal legislation, and that existing project-based capacity in coastal fisheries resource and socioeconomic scientific assessment be consolidated on a more stable funding base. However, when new programme funding becomes available, the

priority is for new skills in economics, mariculture and legislation to be acquired.

OUTPUT 10. Linkages between sectors and fisheries ecosystem services:

HoF noted the need for a coastal ecosystem services study that would help countries to make decisions about different potential "trade-offs" in coastal fisheries ecosystem use. SPC was requested to expedite such a study if resources were available. The meeting also noted that the application of the EAF to coastal fisheries and aquaculture needs to include inland waters and mangroves, and that the application of the EAF to nearshore pelagic fisheries overlaps both SPC's coastal and oceanic work programmes.

OUTPUT 11. Regional fisheries meeting notice board:

HoF noted that it would be useful for SPC to compile and actively maintain a calendar of meetings that involve Pacific Island fisheries heads and fisheries departments. This calendar should be available on a public website, as well as a summary of the current year's events disseminated monthly by email to fisheries departments.

OUTPUT 12. Information-sharing:

Several countries mentioned the ongoing difficulty of obtaining information that is directly relevant to Pacific Island fisheries and aquaculture management and development. HoF strongly emphasised the need for SPC to increase and enhance its role as the pivotal point for sharing information between Pacific Islands on fisheries and aquaculture, particularly the sharing of Pacific Island successes and failures. The meeting also re-emphasised Output 24 of the previous (fourth) HoF, referring to the importance of the European Community proposed ACP-FISH2 project, and requested that SPC explore avenues for the inclusion of SPC member territories in the activities of the project,

which currently addresses only the needs of ACP countries.

OUTPUT 13. HoF meeting frequency: HoF expressed a preference for meeting in full session every two years in future, but that intermediate technical sessions, concentrating particularly on coastal fisheries issues, could be held during intermediate years, coincidental with any member country and territory input into project steering committees. Niue, as the next in line for the chair of HoF, made an offer, subject to Cabinet approval, for hosting the next full meeting.

OUTPUT 14. Spearfishing: HoF recommended that SPC develop targeted information products to assist fisheries managers in publicising the different spearfishery management issues in member countries and territories. The meeting noted that there was a

general consensus that the use of certain modern adaptations to the traditional equipment, particularly underwater breathing apparatuses and torches, should be targeted for prohibition, but that the region should not lose sight of the high potential selectivity of spearfishing and the fact that this is the one fishing method that requires the fisher to enter the fishes' habitat and have an understanding of the underwater environment.

OUTPUT 15. Economic component to national scientific reports on tuna fisheries: HoF noted that most of SPC's territory members do not have access to the economic fisheries development and planning advice that FFA provides to SPC/FFA member countries. A mechanism needs to be developed — through SPC/FFA collaboration involving more substantive observer participa-

tion in FFA processes, or by SPC alone — to make a full regional economic/scientific service available to all Pacific Islands, including non-FFA territories, for the planning and development of tuna fisheries." HoF requested that SPC discuss the issue with FFA in the first instance, and noted that it was mutually beneficial for all Pacific Islands, whether countries or territories, to work within a shared regional framework for the development of shared fisheries resources.

OUTPUT 16. CITES: HoF members requested that SPC, in recognition of the CITES regional workshop to be held in Australia in May 2006, quickly develop an information product for Pacific Island fisheries managers describing the practical implications of CITES Appendix 2 listing of humphead wrasse. Such an information product would keep HoF members informed about the potential listing of other Pacific Islands fishery species, including sea cucumbers, in future.

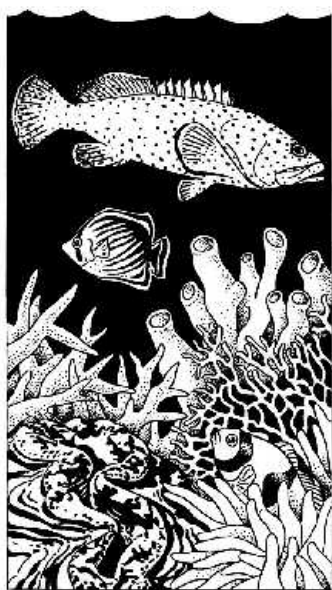
OUTPUT 17. General capacity building: It was proposed that one of the primary tasks of the SPC Director of Marine Resources would be, with the cooperation of national and territorial fisheries heads, to put together a comprehensive database of SPC member capacity, building on the informa-



The meeting was, as always, interesting and productive, covered a wide range of topics and provided important guidance for SPC's future work in fisheries



tion that will have already been collected for the Forum members. A questionnaire should also be circulated to provide some initial guidance. (*This is carried forward from the fourth HoF meeting [output #29] since it has not yet been achieved. SPC will need to develop the information from first principles since no information was available from the Pacific Plan process*). The meeting further recommended that, arising from this activity, a capacity-building planning exercise, setting out existing strengths in different countries, needs, and opportunities, and taking into account the findings of previous regional analyses, be carried out. Heads of Fisheries recognised that the problem of capacity is not simple and cannot usually be solved simply by providing more training – that personnel mobility and the capacity of small islands to absorb continuous training, were also factors, and that these should be taken into account by the Plan. The meeting suggested that this might usefully form the subject of an SPC workshop for senior fisheries staff.



OUTPUT 18. *Strategic Plan for Fisheries Management and Sustainable Coastal Fisheries in the Pacific Islands*: The meeting noted that this strategic plan was the first formal regional mechanism produced by the countries of the region for harmonisation of national policy on coastal fisheries management, particularly underlining the role of communities and the “bottom-up” approach – that it was a member-owned regional policy instrument and should not be confused with institutional work-programming documents like the SPC Coastal Fisheries Programme Strategic Plan. The meeting also noted that the regional plan does not cover the entire CFP work area, and that the time was ripe for review of the regional plan to take account of new institutional and policy developments and the need to coordinate and harmonise regional fisheries management activities at the coastal, oceanic and now ecosystem scales.

OUTPUT 19. *Regional collaboration on seaweed*: The meeting deliberated upon the SPC framework for regional collaboration to increase the level of mariculture of kappaphycus seaweed in the Pacific arising from a technical consultation with key stakeholders in the region. It was recognised that seaweed offers an alternative livelihood to fishing coastal resources, and in countries where it is being produced it is an important economic commodity at a local scale. However the price paid to seaweed farmers could motivate or deflate expectations. There is a need for strengthening marketing and processing opportunities utilising the regional collaboration outlined in the SPC framework.

OUTPUT 20. *Feed formulation*: Feed sourcing is a common bottleneck inhibiting the efficiency of the aquaculture sector. HoF urged SPC to coordinate regional

efforts to promote the adoption of local farm-made feeds and facilitate the development of cost-effective formulated feeds, making maximum use of locally available materials. (In view of the importance of the issue, and the need to make sure that it continues to be seen as a high priority by development agencies and partners, the meeting carried forward this Output 15 of the fourth HoF meeting.)

OUTPUT 21. *Pearl mariculture*: After reviewing the current status and trends of pearl mariculture, HoF discussed recommendations for regional collaboration by SPC and endorsed them in principle. It was noted that in the past, there were exchanges of expertise between countries, and the meeting encouraged the continuation of this spirit of goodwill in the region. There are critical training needs within the industry, which need to be addressed and the meeting aligned itself with the opportunities for increasing skill capacity as provided through institutions such as James Cook University in Australia, and donors such as the Australian Centre for International Agricultural Research (ACIAR). Farmers may also increase profitability by utilising advances in technology (e.g. triploid oysters), and HoF urged SPC to develop regional guidelines for the appropriate implementation of pearl mariculture technology.

OUTPUT 22. *Fisheries MPA brief*: HoF urged SPC to produce a briefing on the use of Marine Protected Areas for the achievement of fisheries ecosystem management goals, and in particular to implement Output 6 from the fourth HoF meeting, which was: The (fourth HoF) meeting requested SPC to coordinate a review of the effectiveness, in terms of fisheries management, of Marine Protected Areas with fisheries management objectives, for discussion at HoF and for the information of member countries

and territories. This review would also clarify the definition of the term "marine protected area".

OUTPUT 23. Safety at sea for small fishing boats: HoF noted the progress towards the fourth meeting of HoF (output #27)⁵ by various agencies, and welcomed the prospect of implementation of the technical cooperation project by FAO to assist countries in addressing this problem.

OUTPUT 24. HoF endorsed the "Fisheries Training Program" proposal, by the University of the South Pacific (USP), which was presented following recent discussion and development by USP and SPC. The proposal outlined a flexible and incremental learning programme for a certificate, diploma, and degree in sustainable fisheries. The proposed certificate in sustainable fisheries will replace the SPC/Nelson Marlborough Institute of Technology (NMIT) Fisheries Officer's certificate course in 2007 or 2008. In endorsing the propos-

al for further development and implementation, HoF asked that an appropriate balance between theoretical and practical components be achieved in course contents. HoF also commended the New Zealand School of Fisheries of NMIT for its long-term and valuable inputs into the capacity building of fisheries administrations, and requested that SPC maintain close links with NMIT at all levels of training, and to continue with the provision of short vocational training courses aimed at the fisheries private sector of Pacific Island countries and territories.

OUTPUT 25. The representative of the Queensland Department of Primary Industries and Fisheries (QDPI&F) provided an update on the status of the Sustainable Aquaculture Project funded by ACIAR, with key partner agencies being QDPI&F, the WorldFish Center and SPC. Particular emphasis was placed on describing the mini-project component coordinated by SPC, which has placed 14 small research and

development projects, worth AUD 184,000, within the Pacific region. The meeting noted that the Sustainable Aquaculture Project comes to an end in 2006 and that there is a possibility of ACIAR funding a second project, building on the mini-project concept. Representatives noted that the project had provided direct, practical assistance in aquaculture and, provided the availability of mini-project support is well publicised and opportunities continue to be equitably provided, strongly endorsed the value of a second-phase project.

OUTPUT 26. After a presentation on the application of aquaculture economics in the Pacific, and noting previous interventions from HoF calling for coastal fisheries economic assistance at the regional level, HoF was supportive of further work proposed by QDPI&F in conjunction with SPC. The meeting particularly requested that the Aquaculture Economic Decision Toolkit be updated with additional commodities.



■ FISHERIES DEVELOPMENT SECTION

Between 12 September and 7 December 2005, Fisheries Development Officer, William Sokimi 1) finalised a draft report on providing technical assistance on small-scale baitfishing trials, 2) gave a Commercial Fishing Operations 3 (CFO 3) course presentation at the Papua New Guinea (PNG) National Fisheries College, and 3) conducted fish aggregating device (FAD) experiments with the Asian Development Bank's Coastal Fisheries Management and Development Project (CFMDP) in Kavieng, PNG.

Preparations for practical module of the Pacific Islands Fisheries Officer's Course in Vanuatu

William spent a week in Luganville, Santo in Vanuatu working with the Vanuatu Maritime College's (VMC) Office Manager and Masterfisherman to make preparations for the practical fishing component of the

Fisheries Officers course to be conducted in Santo in June 2006 by SPC and the Nelson Marlborough Institute of Technology. Activities included surveying fishing vessels and assessing safety equipment and fishing gear to be used

during the course; making recommendations for necessary upgrades, replacements or acquisitions; and arranging for the deployment of a FAD at least a month before the students arrived in Santo.

⁵ Safety at sea for small fishing vessels: HoF reviewed and endorsed the outcomes of the recent FAO/SPC regional expert consultation on sea safety in small fishing vessels. While recognising that sea safety is most effectively pursued at the national and local level, Heads of Fisheries welcomed external assistance, provided that this was very clearly targeted at the practical implementation of national initiatives. The meeting urged SPC to approach FAO and IMO for potential assistance to member countries to facilitate sea-safety strategies and improvements in sea accident data recording and analysis. The meeting also recommended that SPC establish a Sea-Safety Special Interest Group bulletin and provide information to its members covering electronic location solutions to improve search and rescue operations.



Figure 1: FTV *Etelis* slipped and undergoing upgrading in preparation for the practical fishing trips in June.

VMC uses four vessels in the practical nautical and fishing components of its courses. The FTV *Euphrosyne II*, an 18-m full-structured timber vessel, is used for merchant seamanship and nautical training. The FTV *Etelis* (Fig. 1), a 10-m half-cabin marine plywood vessel, is used for small-scale commercial fisheries training. The FTV *Evolan*, a 10-m vessel, is also constructed from marine plywood, but with a cabin covering three-quarters of

its length. The absence of safety rails around the vessel's sides and aft end and the lack of space make it less than ideal for proper commercial fishing training, but it has a hydraulic system, and with a few modifications it will be used to demonstrate horizontal longline fishing. The FTV *Em Nao* is a 6-m, half-cabin marine plywood vessel constructed with funds provided by SPC's Fisheries Training Section several years ago.

Three of the fishing vessels require standard annual overhaul and slipping work to be carried out, as well as additional upgrading work in preparation for the practical fishing trips. The FTV *Etelis* was the main vessel used during the previous rural fishing courses, and more work needs to be done to prepare it for the upcoming fishing exercises, including replacement of the echo sounder transducer.

William and Nare Wolu, VMC's Masterfisherman, compiled a list of jobs to be carried out on the fishing vessels in preparation for the course, including slipping the FTV *Etelis*, installing of a line hauler (funded in part by SPC's Fisheries Training Section) on the FTV *Evolan*, and fitting and testing the engine on the FTV *Em Nao*.

VMC has the standard equipment for safely operating their vessels on fishing trips, although, the main components for constructing fishing gear for the different fishing methods are not in stock. A list of gear required for the course was compiled, and a survey was carried out to determine what was locally available, and the costs for purchasing them.



Institutional strengthening with the Tonga Fisheries Department

Coastal Fisheries Programme Manager, Lindsay Chapman, and consultant, Mike King, travelled to Tonga to participate in an institutional strengthening project with Fisheries Department staff. This work, which has been in operation for several years, is linked to longer-term assistance that is being provided through the Australian Government (AusAID). The AusAID project funded a three-day retreat for senior fisheries officers, and Lindsay and Mike attended.

The retreat provided all section heads with the opportunity to discuss their outputs, constraints, and possible solutions, with group discussions to refine the outputs. Some of the common issues raised included:

- lack of office space and no air-conditioning, making it very difficult to work on hot days;
- lack of computers with people needing to share;
- poor Internet access, especially during working hours;
- lack of communication internally and with stakeholders;
- the quality of data and the availability of analysis;
- lack of funding for operational activities, especially with the salary increases, with salaries now accounting for 91% of the total fisheries budget; and
- lack of skilled staff (63% of the 102 staff have no qualifications) and training opportunities for all staff.

Other issues discussed included the possible privatisation of commercial activities the Fisheries Department was involved in, especially those that were losing money. Staff had mixed feelings about this, as these activities had been in operation for a long time, and there were staffing issues as well.

The retreat was a good means for getting an idea of the Fisheries Department's work activities and the problems they face. The presentations were excellent and the discussions were frank and open. At the conclusion, the Secretary for Fisheries, Sione Vailala Matoto, thanked staff for their input and asked for continuing feedback to help him in doing his job.

Other activities in Tonga

Lindsay met with members of the local tuna and deep-water snapper fisheries to get an update on these activities. Apparently, tuna catches are slowly picking up. One boat was also fishing for swordfish during periods when the moon is full and doing quite well; they were hoping to export the swordfish to Australia, as there is a good market for it.

The deep-water snapper fishery has nearly 30 boats fishing. One company sent boats on 10-day fishing trips, with 3 to 4 days off before the next trip, in coordination with the weekly Thursday

flight to the US. The company hoped that each vessel would catch about a tonne of fish (of all species) during a 10-day trip. During the past year or so, the boats were catching many small fish (of target species). This was being discouraged, as the fish were worth less, were difficult to export, and the company had genuine concerns about harvesting sexually immature fish. The company had recently changed the hook size they used from 12/0 to 13/0 circle hooks, resulting in a reduction in the number of small fish being landed.



Regional seminar and workshop on implementing the STCW-F Convention

William Sokimi and Fisheries Training Adviser, Michel Blanc, travelled to Suva, Fiji to attend a regional seminar and workshop (20–24 March) on implementing the STCW-F Convention. The 1995 STCW-F Convention seminar is part of ongoing efforts of the International Maritime Organization (IMO), in collaboration with SPC's Regional Maritime Programme, to educate regional government maritime organisations, as well as relevant stakeholders, on the Convention's contents and implementation process. This was the eighth in a series of nine regional seminars and workshops, which is part of an initiative by the IMO Secretary General in response to Assembly resolution A.925 (22) (adopted on 29 November 2001). This response urges member governments to consider accepting the 1993 Torremolinos Protocol and the 1995 STCW-F Convention at the earliest opportunity, and to use these instruments as the foundation for encouraging the training and certification of personnel working on regional fishing vessels to ensure safe fishing operations and safe fishing vessels in

the region. [Note from ed.: More information on the STCW-F Convention and the Torremolinos Protocol is provided in Michel Blanc's feature article on p. 30]

The workshop was attended by 25 participants representing Australia and 13 Pacific Island countries, including Cook Islands, Federated States of Micronesia, Fiji, Kiribati, Marshall Islands, New Zealand, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu, and Vanuatu.

The main purpose of the IMO STCW-F workshop in Fiji was to enhance awareness of the STCW-F regulations and the 1993 Torremolinos Protocol/Convention in the Pacific Islands region. The workshop was conducted to encourage Pacific Islands Maritime Authorities to understand and consider the safety aspects for fishing vessels referred to in the 1995 STCW-F Convention and the 1993 Torremolinos Protocol and Torremolinos International Convention for the safety of fishing vessels. The main workshop conclusions and outcomes were:

- IMO representatives highlighted IMO's objective to gain worldwide support for the ratification and implementation of the 1995 STCW-F Convention with consideration of the 1993 Torremolinos Protocol and Torremolinos International Convention for the safety of fishing vessels. Only six states have ratified the STCW-F convention internationally. IMO requires 15 states to ratify the convention before it can enforce this internationally;
- Country representatives agreed that, from the standpoint of encouraging safety for fishing vessel personnel, the region could benefit from implementing the STCW-F Convention in the Pacific Islands. However, representatives needed to return to their home countries and consult with appropriate stakeholders before further action could be taken;
- Meeting representatives agreed that maritime authorities within the region should carry out in-country aware-

ness programmes to emphasize the safety aspects of the STCW-F Convention and its impact if it is implemented. SPC offered to work with regional maritime institutions to assist in this;

- IMO offered to provide technical assistance to countries that wished to ratify and

implement the Convention; IMO could also assist with identifying pathways for funds to facilitate the implementation of the STCW-F Convention; and

- IMO stated that it would give country representatives time to return home to brief stakeholders on the outcome of the

meeting and that IMO would follow up later to coordinate efforts made by the representatives, and liaise with individual countries on their progress.



Technical assistance to New Caledonia's longline companies

During February and March, Fisheries Development Officer, Steve Beverly, worked with Province Nord and Pêcheries de Nouvelle-Calédonie (PNC — see *Fisheries Newsletter* #99) in New Caledonia in training new longline skippers. Several fishing captains had been recruited from France to work on domestic longliners in New Caledonia, either for PNC or for another company, Navimon. The two companies have joined forces and now operate as a single fleet with 18 boats: nine fishing out of Noumea and nine out of Koumac, located to the north. One of the problems facing New Caledonia's domestic longline fishery is the lack of local captains with high seas and longline fishing experience. In France, there is a substantial workforce of experienced fishing captains, but very few with tuna longline fishing experience. Steve helped to fill the gaps in the new captains' experience by providing some short-term training in tuna longline techniques.

Steve accompanied some of the new captains on PNC's longline vessels on regular longline fishing trips to observe and work alongside them and to offer advice on fishing strategies and on-board fish handling. He then reported findings back to PNC's management and Province Nord. Earlier, a one-day workshop was held to introduce the new captains to the basics of longline fishing. In all, about 14 fishermen

attended, only five of whom were newly arrived captains from France. The workshop was a combination of lecture, video and practical hands-on gear fabrication. In addition, several publications were disseminated, including SPC's longline manual, a 1996 SPC report on Navimon, and turtle and shark ID booklets. Copies of sea surface temperature and altometric charts downloaded from the Internet were also handed out along with several useful web addresses. The original plan was to begin fishing with the new captains immediately after the brief workshop for one month, with a follow-up visit in six months. However, due to vessel breakdowns, only one fishing trip was made after the workshop.

The trip was on the F/V *Karaavha 4*, whose captain had experience in the swordfish fishery in the Indian Ocean (La Réunion and Madagascar). The boat travelled for one-and-a-half days to the southwest before the first set. Five sets were made around the line of banks (Argo, Kelso, and Nova Banks) that lie in the southwest quadrant of New Caledonia's EEZ. All of the sets had the same basic characteristics: 1500 hooks set in 35 hook baskets using California sardine, *Sardinops sagax*, for bait. The lines were set in the morning and hauled in the afternoon.

The catch of 90 fish weighed about 2260 kg, and consisted mostly of albacore (52%) and yel-

lowfin tuna (27%). The catch also included opah (10%), bigeye tuna (3%), and swordfish, marlin, mahi mahi and wahoo (8%). 7500 hooks were used in total. The catch per unit of effort (CPUE) was 1.2 fish/100 hooks and 30 kg/100 hooks, somewhat below average for New Caledonia.

Generally, all work during setting and hauling was carried out according to normal procedure, with one or two exceptions. No repair work was being done on branchlines during the haul. This is unusual. Normally there is an extra empty bin for coiling damaged branchlines. Gaffing, spiking, bleeding, gilling and gutting were all done properly on the F/V *Karaavha 4*. However, fish were left on the deck too long after processing, and should have been placed on ice within 10 to 20 minutes after landing. Also, fish were apparently not re-iced in the morning after initial chilling. The first icing (called pre-icing) chills the fish, and re-icing removes air pockets around the fish. This should be done the following morning after each haul (see *Fisheries Newsletter* # 79). The fish hold should be inspected regularly for water, air pockets, and exposed fish. Fish, however, were generally in good condition after unloading. Core temperatures of fish ranged from 0 to 1.5°C, which falls within an acceptable range.

The F/V *Karaavha 4* was not particularly suitable as a medium-

scale longliner. The main deficiencies were its limited range and fish hold capacity. This is true despite the fact that it had been stretched from 16 m to 19 m before it arrived in New Caledonia (as were eight other similar PNC boats). Longline trips on these boats are typically ten days with six days of fishing. Normally, it could take a medium-scale longliner as many as

four of five days to reach the fish. After finding good fishing grounds, a boat stays near the fish as long as possible. A boat with a longer range and larger fish hold can stay out for three weeks, enabling it to search for several days and then fish for a total of 10 to 12 days. The *Karaavha* boats cannot do this. Unless the crews are lucky and find large numbers of fish on the

first or second day of the trip, they will be forced to return to port without having adequate time to land a large catch. The *Karaavha* boats have limited capacity in any case, and can only store only about 6 mt of chilled fish. The fleet is also ageing and plagued with numerous breakdowns. It's clear the new French captains have a daunting job ahead of them.



Technical assistance provided to the Marshall Islands

Lindsay travelled to the Marshall Islands in late February and early March to assist the Marshall Islands Marine Resources Authority (MIMRA) in undertaking a survey and assessment of the rural fishing centres (fishbases) operated by MIMRA, to determine what is needed to restore these to full operation, and to examine the feasibility and sustainable operation of the centres. MIMRA requested that all eight fishbases be assessed, most of which are in the outer islands. Given the limited time, Lindsay was able to assess only three fishbases, the remaining fishbases would need to be assessed later in the year.

There are two types of fishbase operations (using solar energy to power chest freezers and diesel generators to power ice plants and freezers), plus two main marketing centres, Majuro and Ebeye. All of the fishbases and collection vessels were provided under Japanese aid over many years, and Japanese aid was also used for ongoing vessel maintenance and upgrading of fishbase facilities.

Arno and Ine fishbases

The Arno facility (Fig. 2) consists of one building housing an office with storage space, a 3-t cold store, a 1-t cold store, a 24-block

ice maker, a block ice crusher, a 25-KVA generator with diesel motor (in the engine room), two fresh water storage tanks, a toilet and shower area, an open area under cover for landing and sorting catch from fishermen, and a small wash area for rinsing fish. The manager explained that in 2000–2001 there were 40 to 50 fishermen supplying fish to the fishbase, with shipments of over 1000 lb (450 kg) of fresh fish sent to Majuro twice per week. Currently, there are about 15 fishermen supplying fish to the fishbase, with shipments of around 500 lb (225 kg) of fresh fish sent to Majuro twice per week. Fishermen are fishing 4 nights per week and land an average of 20 lb (9 kg) each of reef fish to the

fishbase, with the rest of the catch kept for home consumption. The manager mentioned that the size of fish was dropping and that the fishermen were travelling farther to catch fish. The manager also noted that the drop in fishermen supplying the fishbase was a result of the private sector taking the initiative, with some fishermen buying fish from other fishermen and taking them directly to Majuro for marketing.

The Ine sub-centre facility consists of one shelter/building housing an office with storage space, two 1-t cold stores, a block ice crusher, a 13-KVA generator with diesel motor (in the engine room), two fresh water storage tanks, a toilet and shower area,



Figure 2: The fishbase at Arno

an open area under cover for landing and sorting catch from fishermen, and a small wash area for rinsing fish. The Ine fishermen are mainly involved in spearfishing, but also did some gillnetting and hook-and-line fishing. There are currently 50 to 60 fishermen at Ine, with about 30 of these supplying the sub-centre. They fish two to four times per week, predominantly spearfishing at night with a torch. An average trip includes four to six hours in the water, but this might extend to the whole night on some occasions. On average, fishermen sell around 20 lb (9 kg) each to the fishbase, keeping the rest of the catch for home consumption. The catch consists almost entirely of reef fish. The Ine fishbase supplies 200 to 300 lb (90 to 135 kg), twice per week, to the Arno fishbase, and this is added to the Arno fish for transporting to Majuro. The Ine fishermen have a small diesel launch they use to transport the fish from Ine to Arno, and the ice from Arno to Ine.

The fishermen reported that fish are getting smaller in size, preferred species (unicorn fish, red snappers, rabbit fish and large goatfish) were harder to find, fishing trips were longer, and it was necessary to travel farther to

get good catches. This was partly because there were more fishermen, but also because the fish were becoming more scarce and smaller in size. To overcome the cost of travelling farther to fishing grounds, a boat would take more fishermen (usually eight or nine), with the costs of fuel, ice, and oil shared among all of the fishermen plus a separate share set aside for the boat.

Likiep fishbase

The Likiep fishbase was established in 1993, and consists of two buildings, each with a separate power source. The main building has a battery room (Fig. 3) with two banks of 16 heavy duty 12-volt batteries (each battery weighs 60 kg) to provide 110-volt AC power from DC current through an inverter. One bank of batteries provides power to two chest freezers (110 V), with the second bank supplying power to one chest freezer and lighting for the building. The batteries were all replaced in July 2005. A separate room houses the three chest freezers, plus there is an office with storeroom, an open storage area where the fuel drums are kept, an open area where the fish is weighed and iced in coolers, and a concrete water storage tank.

The second building is a smaller version of the first, with a battery room with 2 banks of 24 2-V batteries. These are used to provide lighting etc. for this building only, with an inverter used to produce 110 volts AC. These were the original batteries installed in 1997, and were working fine. The building also has several storage rooms and a large chiller room that was never completed as there is no chiller unit/refrigeration. The room was around 12 m³ capacity with 10 cm (4 in) insulated panels. Again, there was a separate concrete water tank attached to this building.

The power source for the buildings consists of large banks of solar panels mounted on the roof of each building (Fig. 4). The main building has two banks of 3-amp panels, each 14 panels long and 4 panels wide (56 panels in each bank). The smaller building has two banks of 3-amp solar panels, each 6 x 4 panels or 24 panels.

With this arrangement, ice is made in small trays in the chest freezers (Fig. 5) and sold to people in the village. Given that the collection vessel comes to Likiep every two to three months, most ice is used for domestic purposes rather than fishing, as there is no place to store fish in between collection vessel trips. Therefore, the fishbase had very little chance to make money, so some of the freezer space is rented out to villagers to store frozen goods.

According to local fishermen, the main fishing method used is handlining or bottomfishing in the lagoon for snappers and groupers. Next is trolling outside the reef for tunas and other pelagic species, although this is costly, given the price and availability of fuel. The other method being used is night spearfishing, and this appeared to



Figure 3: Banks of batteries in the battery room of the main building



be on the increase. Some fishermen said they did not like this method, as they felt it could quickly reduce fish populations in an area. Overall, the fishermen thought that fishing was acceptable; although it was better a few years ago, when there was a live reef fish operation working around the area.

Ebeye fishbase and marketing facility

Ebeye is one of two main marketing centres for the fishbase operations. The facility consists of a 1 t/day plate ice machine with a cold storage capacity room of 3 to 4 t. There is a large processing area and display cabinets for the fish, although most fish is sold direct from ice chests (Fig. 6).



The Ebeye fish market mainly purchases its fish from the fishbases in the outer islands, by running a fish collection vessel. The vessel travels to a fishbase, carrying ice and fuel for fishing operations, as well as passengers and cargo. The boat stays at the fishbase for one day. The manager of the fishbase sells the fuel and ice to local fishermen so they can fish while the boat is in port. The fishbase manager then purchases the fish using money (carried by the skipper) from that fishbase's bank account in Ebeye. Some local produce is also purchased by the fishbase manager. The boat is then loaded and the fish, produce, passengers and cargo transported back to Ebeye. The boat makes either one or two trips per month, depending on fish sales at Ebeye.



Figure 4: Solar panels on the roofs of the two fishbase buildings at Likiep

Figure 5: Making ice in the chest freezers at Likiep

Figure 6: Fish being sold from ice chests at Ebeye fish market

When the boat returns to the Ebeye fish market, the catch is unloaded and sold, with many people preferring specific species. This results in some fish being hard to sell, even at lower prices. Fish that are not sold after one week are generally cut into strips and processed into a salted and dried product (Fig. 7). The market also purchases fish locally on Ebeye, although this is usually fish that people transport on the inter-island cargo ship.

Preliminary assessment of the fishbases visited

The accounts were found to be incomplete with some inconsistencies between records of income and expenditure kept at different locations. The accounting during the time of fishing trips to Likiep was the main problem area, as the money from fuel sales was used for fish purchases and there were no receipts issued for the operations. This caused confusion as to which account was paying for what, and which account should be credited with income. Lindsay made suggestions on accounting practices, including keeping records for each account separately, and several simple spreadsheets were developed to record daily or monthly records for income and expenditure.

The Likiep fishbase has very few opportunities to make money, and the current schedule for the collection vessels is erratic. This needs to be formalised and regular trips made with adequate funding provided to purchase fish from local fishermen. Receipts need to be issued for each purchase or sale, so there is a paper trail and the financial side of the operation can be audited from time to time.

Spearfishing at night appeared to be the main fishing method used in most locations, with reports of declining catches close to the main villages. In some cases, the favoured species were harder to find and were getting smaller, indicating overfishing of species in some areas. This will need to be closely monitored, as any increase in the operation of the collection vessels may increase fishing effort and further deplete fish resources in these areas.



Figure 7: Salting and drying fish strips at Ebeye fish market

DEVFISH Project update

The Development of Tuna Fisheries in the Pacific-ACP States Project (DEVFISH), which is jointly implemented by the Forum Fisheries Agency (FFA) and SPC, continues to undertake the activities of its first-year work programme.

Country visits

Project staff Mike Batty and Jonathan Manieva continued their travel to Pacific-ACP countries during February, with visits to Fiji, PNG, Tuvalu and Vanuatu. As with earlier trips, the purpose was to:

- collect up-to-date information on the domestic tuna fishing industries in the four countries;
- review the economic and policy environment in which they operate in each country;
- review the status of fishing associations and mechanisms for consultation between government and the fishing industry; and
- identify constraints and possible areas for assistance under the project.

During the visit, several possible in-country projects were identified. Subject to receiving suitable requests from a consultative committee, the project is ready to provide technical assistance for:

- a feasibility study and action plan for the Madang Marine Industrial Park in PNG;
- an environmental impact assessment for the proposed



Figure 8: Processing of purse seine-caught tuna now provides almost 5000 jobs in PNG, mainly for women

China National Fishing Corporation (CNFC) and Vanuatu Government tuna packing and processing facility; and

- a workshop to establish and plan activities for a national fishers' association in Tuvalu.

As part of a broader regional study on the economic benefits of locally based purse-seine fisheries, it was confirmed that the economic contribution of onshore processing of purse seine-caught fish (Fig. 8) will be evaluated in PNG.

As in previous visits, a number of requests for information were received from industry and government officials, in most cases for reports and studies.

Country assistance

A consultant was engaged to assist Samoa with improving seafood safety and quality policies, programmes and practices, and with progressing Samoa's application to the European Union for exporting products to there. The consultant started a three-week assignment at the end of March. The project is liaising with the EU-funded "Strengthening Fisheries Products" programme to determine when assistance will become available to other countries in the region.

Fieldwork for an assessment of fish processing waste disposal options for the Soltai cannery and loining plant in Noro, Solomon Islands was also completed. The cannery has survived a long period of civil and economic disruption in Solomon Islands, but requires substantial investment. Assistance with the design and costing of a new refrigeration plant will also be provided.

The need for technical assistance to Tonga in the area of fishing port management was identified and assessed following country visits by project staff. Another planned project will trial new technology that enables better targeting of fish as an option to improve efficiency and reduce costs. The trial of a satellite fish finding system with the Tonga Exporter Fishing Association is envisaged for May and June 2006.

There is ongoing discussion with the Niue Island Fishermen's Association on their readiness to receive assistance for establishment of a headquarters.

Fishing associations representing artisanal fishermen on Savaii and Upolu in Samoa seem to be less active. Jonathan is communicating with interested parties in

Samoa regarding assistance to form a new association to represent alia fishers.

The first of the three sub-regional workshops is scheduled for April in Apia, Samoa. The project will bring together representatives of fishing industry/fishermen's associations, managers of leading tuna fishing companies, as well as government officials involved in tuna fisheries management and development from Samoa, Tonga, Cook Islands and Niue.

Association support

Fishing associations will form part of a consultative committee to provide industry input to the development of a national policy for development and management of the tuna industry. To date, 10 countries have been visited, with 7 of these having identifying needs in either setting up a tuna fishermen's association or support in capacity building and enhancement for the association.



Summary of tuna fishing associations in Papua New Guinea, Vanuatu, Fiji and Tuvalu

In Papua New Guinea, the Fishing Industry Association has been active in representing commercial fishing interests for 15 years. It is unique in the region in having two representatives on the board of the National Fisheries Authority, the government agency responsible for fisheries management and development at the national level. While the association has traditionally been represented by its long-serving chairman in both national and regional fora, it also employs an executive officer to follow up on day-to-day activities. A Tuna Management Advisory Committee was also established during the review of the Tuna Management Plan, which includes representatives of both the longline and purse-seine fisheries. Agreement was reached during the visit that this committee would serve as the channel for national requests to the DEVFISH Project.

In Fiji, divisions over the management of the tuna longline fishery

have resulted in two separate fishing associations. The Fiji Boat Owners Association (FBOA) represents long-established fishing companies, while the Fiji Offshore Fisheries Association (FOFA) represents many of the newer entrants who rely more on foreign-owned vessels. FOFA also aims to promote indigenous Fijian participation in the industry, although Fijian owner/skipper are also members of FBOA. The formal channel for consultation between government and industry is the National Offshore Council, although this has not been very active in recent years. The process of developing the current 2006–2010 Tuna Management Plan relied more on open meetings with stakeholders.

Vanuatu has two fishing associations: one representing small-scale commercial fishers, and the other representing sport fishing/charter boat owners. While Vanuatu's current Tuna Management Plan was developed by a

committee of government officials, these associations will be involved in future consultations.

In Tuvalu, an association of fishers on the main island of Funafuti has operated in the past, but currently seems to be inactive. There are plans to establish a national fishing association, which would be registered under Tuvalu's cooperatives legislation. Tuvalu's Tuna Management Plan has not been approved by the government. Since the plan's intended term was 2002–2006, it seems likely to expire before ever becoming effective.

The remainder of the Pacific-ACP countries are scheduled to be visited in June and July 2006.

Detailed updates and reports of the project can be viewed at:

www.ffa.int/DEVFISH



■ TRAINING SECTION

Development of new programmes in sustainable fisheries at the University of the South Pacific (USP)

New programmes in fisheries are being developed at USP in response to a regional demand for training in applied sustainable fisheries. The new programmes are collaborative (with SPC), interdisciplinary (fisheries science, social science), include a mix of theoretical and practical studies, are flexible in learning modes, allow either generalization or specialization, and facilitate professional development in fisheries in Pacific Island countries (PICs)

The proposed new programmes focus on issues such as fisheries sustainability and management in PICs, and integrates fisheries

sciences with socioeconomic studies and practical or applied studies with theoretical knowledge. The programmes will be offered as certificate (one year, equivalent to the SPC/Nelson Marlborough Institute of Technology [NMIT] Fisheries Officer course), diploma (two years, equivalent to USP's former Diploma of Tropical Fisheries), and degree (three years) in sustainable management. The first year will replace the existing SPC/NMIT course, and will be offered in collaboration with SPC (and NMIT if funds are available). The cross-crediting and incremental learning approach

facilitates professional development in fisheries departments in the region. Candidates with the SPC/NMIT Fisheries Officers certificate can progress directly to second year (diploma). USP's distance and flexible learning programmes enables all certificate and diploma courses to be undertaken in the major home countries. The wide choice of courses enables generalization or specialization in areas such as food technology, economics, extension, research, and/or policy and management.

In particular, the first year of studies provides basic under-

standing and core competencies, and integrates practical and theoretical subjects. It can be offered as the first of three years for the degree for continuing students, or as a stand-alone certificate suitable for fisheries assistants. It is designed to be generally equivalent to the SPC/NMIT Fisheries Officers certificate, the content of which, reviewed and

modified in 2003, is still relevant to the training needs of junior fisheries officers.

SPC will continue to offer a four-week course combining the observer programme and the practical fishing components of the SPC/NMIT Fisheries Officers course. This course will be held on a regular basis (annual or

biannual), at a national training institution. Attendance to the course will be restricted to staff of fisheries departments (graduates from USP certificate or diploma in sustainable fisheries as well as other fisheries officers requiring refresher training in those two areas).



■ AQUACULTURE SECTION

Aquaculture activities in Samoa

SPC's Aquaculture Officer, at the request of Samoa Fisheries Department, carried out a study to examine the possible relocation of their Toloa mollusc hatchery, and carried out demonstrations on tilapia hatchery operations, feed formulation and processing, tilapia harvesting, and live marketing activities. A workshop was also conducted to present results of the study as well as observations on field visits for new aquaculture developments.

Activities included meetings with Antonio Mulipola, Assistant Chief Executive Officer, Ministry of Agriculture Fisheries and Forests (MAFF) and other senior fisheries staff, about relocating the Toloa hatchery and aquaculture activities. Additional meetings about feed formulations and other aquaculture supplies for the development of aquaculture in Samoa were held with Michelle L. Macdonald, Marketing Manager Samoa Breweries LTD; Loise Moala, Manager, Farm Supplies Ltd; Mr Fililagi, Farm Superintendent, MAFF, Apia, Samoa; Pueata Pueata, Agriculture Store Corporation; and FAO aquaculture volunteers.

Relocation of Toloa hatchery

The relocation of the Fisheries Division's mollusc hatchery at Toloa is being pursued by Samoa Fisheries Department. This fol-

lows the government's decision to remove the hatchery from its current location because of renovation of and construction work on a tourist site nearby. Two possible sites were pre-determined by staff: Asau in Savaii and Taumaesina at Upolu.

Concerns were raised by the Assistant Chief Executive Officer that there is a need for the commercialization of aquaculture in Samoa and some action should be taken to improve hatcheries and grow-out activities. Some of the present activities had been affected by the Japanese International Cooperation Agency's activities in building a port and other facilities. There should be an output from aquaculture and at present this has not been realized to an expected level and a lot has to be carried out.

After much consideration, it seems Taumaesina is the better site for a multi-purpose mollusc hatchery. The advantages of the Taumesina site include:

1. plentiful, good quality seawater and access to freshwater. Asau does not have access to regular freshwater. Taumaesina also has a clean beach front, and good current and tidal flow, which will provide clean water for the hatchery. Asau's beach front water is turbid and would require good filtration

before it was suitable for hatchery use. This turbidity is caused by waves, runoff, and underground freshwater springs, the latter of which affects the water's salinity (salinity is 22 ppt at Asau and 35 ppt at Taumaesina). The seawater at Asau may also have high nutrient loads due to freshwater runoff.

2. adequate infrastructure such as roads, electricity, telecommunications, supplies, and freshwater.
3. close proximity to technical support from government or academic research centres. Alafua campus is in Apia.
4. a lack of domestic, industrial and agricultural pollution.
5. close proximity to Paolo Deep Marine Reserve, which may result in fewer conflicts of interests that may arise between communities and resource users.
6. ample area for ease of operation, and future expansion. Asau is situated on a slope with limited space for future expansion.
7. There is space and thus provision for sand filter tank, larval rearing tanks, live food production tanks, reservoir for

- emergency use, water pump, generator, aeration system and other hatchery equipment to be installed at Taumaesina at a lower cost compared to Asau where transport and other difficulties will arise and may cost more.
8. more available hatchery staff and general manpower.
 9. more opportunities for training, extension and information dissemination.
 10. more centrally located with access to domestic and international airlines and shipping routes.
 11. better access to centres for health management, disease diagnosis and treatment.
 12. close proximity to the University of the South Pacific's Alafua campus, the Pacific Regional Environment Programme, and international agencies such as the United Nations Food and Agriculture Organization.

A separate report is being compiled on the relocation of the Toloa hatchery. This will be in line with a report prepared by FAO Mariculture Officer, Alessandro Lovatelli, who is producing a document outlining how to set up a low-cost, multi-purpose hatchery. Another option is to build similar facilities at the present site (at Toloa) in Taumaesina.

Other activities

1. An examination of potential sites for tilapia and prawn farming on both Upolu and Savaii was conducted.
2. Information on general tilapia aquaculture, including SPC's manual on hatchery operation and tilapia grow-out was used during field work and distributed to Samoa Fisheries Department staff.
3. Demonstrations for simple feed formulation (developed feed for hatchery and grow-out) were carried out after visiting all feed outlets in Apia.
4. Tilapia hatchery operations, using the tank method, were demonstrated, including harvesting and transporting from Chanel College fishponds to the fisheries department office. Tilapia purging and live sales were demonstrated in the Apia market to the fisheries department staff.
5. Potential commercial freshwater prawn and tilapia farms were visited.
5. Locally available feeds (e.g. agricultural byproducts such as pawpaw and banana peels) will be used until commercial feeds are available.

Sideline activities

1. The Samoa Fisheries Department has approached FAO for assistance in purchasing a feed mill for making tilapia feed. Some information on machines is available from Malaysia. The site for the feed mill installation (Nafanua) was inspected, and it was found that the building needs renovation before the machines can be installed.
2. Nafanua is in an ideal location for a freshwater, multi-species hatchery, but the freshwater water supply from the nearby mountains should be tested.
3. A survey was conducted of the shops and outlets for stock feeds that could be used for fish feed formulations. Advised workshop participants to stop using copra meal from present source as it is not good quality.
4. There is a need to determine the cost of importing wheat bran from Flour Mills of Fiji (FMF). A product of FMF, Punjas Breakfast crackers, is sold in supermarkets. This is the only company producing wheat bran in Fiji, and arrangements could be made to import wheat bran in the same container as the biscuits.



■ MOTHER-OF-PEARL ON ICE: NEW CERAMICS MIGHT SERVE IN BONES AND MACHINES

Beneath the shimmer of an oyster's mother-of-pearl, an intricate microstructure bestows both strength and toughness on the natural ceramic. Now, scientists have come up with a way to replicate that structure in human-made substances.

The process exploits one of the most common transformations in nature, the freezing of water; so it's remarkably simple and potentially inexpensive and environmentally friendly, its developers say.

These researchers, at the Lawrence Berkeley (California) National Laboratory, have used their new approach to create an exceptionally rugged substance that may serve as a scaffold for new bone growth. The method also works well with non-biological materials, report Sylvain Deville and his colleagues in the January 27 issue of *Science*. Using it, the team has fabricated novel metal-ceramic composites that benefit from a seashell-like internal architecture.

Mollusks such as abalone and oysters create their iridescent armor, known as nacre, from brittle calcium carbonate micro-crys-

tals and pliant proteins arranged like bricks and mortar, respectively. Materials specialists have long envied the composite's resilience, which is superior to that of human-made ceramics.

Past efforts to artificially replicate the shells' architecture have typically stalled after a few microlayers or generated cruder laminations than those in the real stuff, says team member Eduardo Saiz. Using the new method, he, Deville, and Antoni P. Tomsia of the Lawrence Berkeley lab, and Ravi K. Nalla, now at Intel Corporation in Chandler, Arizona, fabricated centimeter-thick chunks of ceramic with internal layering almost as thin as that of natural nacre.

To make a micro-structured ceramic, Deville and his colleagues mixed water with finely ground ceramic powder and polymer binders. They then poured the blend into a chamber a few centimeters across. By carefully controlling subfreezing temperatures at the chamber's bottom and top, the researchers produced a temperature gradient that generated an ice structure sometimes observed in frozen seawater.

In that structure, sheets of microscopic hexagonal ice crystals formed vertically in the chamber. As those crystals grew, they forced the powder and binders to congregate between the pure-ice sheets. Freeze-drying removed the ice, and high-temperature sintering then solidified each ceramic-binder layer into a solid plate. Finally, the researchers selected a substance to play the role of nacre's protein and introduced it into the spaces between the ceramic plates.

To create bonelike composites, the researchers employed epoxy as the mortar between plates of hydroxyapatite, which is the predominant ceramic in bone and teeth. For non-biological materials, they bound alumina plates with a mortar containing an alloy of aluminum and silicon and, in some cases, titanium. Such composites may prove useful to many industries, including electronics, machining, and aerospace manufacturing.

Source: Science News Online, Week of 28 January 2006; vol. 169, no. 4
<http://www.sciencenews.org>



■ KIRIBATI DESIGNATES LARGE MPA, TO BE FUNDED BY ENDOWMENT

The Republic of Kiribati has designated one of the world's largest MPAs in a bid to guard against overfishing and climate change. The nearly uninhabited Phoenix Islands Protected Area (PIPA), encompassing 184,700 km² with eight atolls and two submerged reef systems, covers an area more than half the size of Germany. Located midway between Fiji and Hawai'i in the Central Pacific, the PIPA contains near-pristine coral ecosystems, with

more than 120 species of corals and hundreds of species of fish, including the world's highest population densities of Napoleon wrasse, according to scientists.

The protected area will be funded through an endowment being initiated with private funding from Conservation International, an NGO. The endowment will finance administration of the protected area and also compensate the Kiribati government for lost

revenue suffered from cancellation of fishing licenses to foreign fleets. Although a management plan for the site is not expected to be set for another year or so, it is anticipated that commercial inshore reef fishing, including by foreign vessels, will be banned in the PIPA.

Subsistence reef fishing by the fewer than 50 residents of the Phoenix Islands archipelago will be allowed to continue. The PIPA

also includes deep water, and it is unclear yet whether commercial fishing for offshore pelagics, like tuna, will be allowed. The endowment is projected to last in perpetuity, assuming management of the protected area is administered in good faith by the Kiribati government.

"If the coral and reefs are protected, then the fish will thrive and grow and bring us benefit," said Kiribati President Anote Tong, announcing the PIPA designation in March in conjunction with the Eighth Conference of the Parties to the Convention on Biological Diversity (CBD), held in Curitiba, Brazil. "In this way, all species of fish can be protected so none become depleted or extinct." The PIPA announcement was accompanied by commitments from other island nations at the CBD meeting to expand protection for their coastal waters.

The endowment

The geographic isolation of Kiribati and its Phoenix Islands archipelago (one of three island groups in the nation) has historically insulated the area from outside pressures. But foreign fleets have expressed growing interest in fishing there and the threat of climate change looms: a bleaching event occurred in the Phoenix Islands for the first time in 2003. "With recent advances in the fishing industry and impacts of global climate change, isolation can no longer be relied on to conserve these atolls," says Kiribati Environment Minister Martin Puta Tofinga.

To launch the development of a management plan and the endowment, the Kiribati government signed a memorandum of understanding with two organizations: Conservation International (CI) and the New England Aquarium. CI, through its Global Conservation Fund, is financing the initiation phase of the PIPA and is beginning capitalization of

the endowment, to be expanded with matching funds from private and public institutions. The size of the endowment will depend on the value of the fisheries to be closed, as well as projected PIPA administration costs; the final figure is being researched. The New England Aquarium, based in Boston, Massachusetts, USA, has conducted biological surveys in the Phoenix Islands since 2000, and was first to initiate talks with the Kiribati government regarding protection of the ecosystem. The aquarium will continue to provide research support for the PIPA and assist with developing its management plan.

Greg Stone, vice president of global marine programs for the New England Aquarium, says creating the PIPA is the only way to mitigate and protect reefs from climate change. "With climate change, there's not much you can do for reefs to mitigate on-the-ground impacts except for removing all other existing threats," he says. He adds that because of the healthy fish populations and lack of direct human impacts in the Phoenix Islands, the reefs there are recovering quickly from the 2003 bleaching event. In their excellent condition, he says, the Phoenix Islands are essentially a baseline reef — a control site. "They offer a valuable reference point for measuring the impact of climate change on reef systems there and elsewhere," he says.

The endowment will be similar to ones enacted by CI to protect South American rainforests. In an essay in the October 2005 issue of *MPA News*, CI personnel described the application of this tool — termed "conservation incentive agreements" — to MPAs through the provision of continuous, long-term financial incentives to conserve marine resources rather than exploit them for short-term gain ("Conservation Incentive Agreements As a Tool for Developing and Managing MPAs",

MPA News 7:4). The PIPA endowment will be overseen by a board of managers including CI, the government of Kiribati, and others.

Funding is contingent upon proper PIPA management by Kiribati. "If protection ever stops, the money goes away," says Stone. It is anticipated that other national governments will assist with management. New Zealand, for example, has indicated its willingness to provide flyovers by enforcement aircraft to guard against illegal activity in the Phoenix Islands.

The PIPA will help Kiribati meet international treaty obligations, including the Convention on Biological Diversity's protected area goal to create comprehensive, effectively managed, and ecologically representative systems of MPAs by 2012. The government is also considering pursuing listing of the Phoenix Islands as a UNESCO World Heritage site.

Depending on how one defines "marine protected area", the PIPA could be considered the world's third largest MPA, behind only the Great Barrier Reef Marine Park (Australia) and the Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve (USA). The list would exclude areas closed to certain fishing gear, some of which are several times larger.

The PIPA includes a 60-nm boundary around each of its atolls, which in most cases rise no more than 2 meters above sea level. The protected area comprises 5% of the entire EEZ of Kiribati, the largest atoll nation in the world. Kiribati includes two other, more-populated island groups in addition to the Phoenix Islands.

Source: *MPA News*, vol. 7, no. 9 (April 2006)
www.mpanews.org



■ OCEAN SURVEY REVEALS TINY CARNIVOROUS SPONGES, EERIE DEAD ZONE, AND MORE

Revelations by high-tech tracking devices about the coastal migrations of endangered fish and of large animals in the open Pacific Ocean top the highlights from the growing ranks of researchers conducting the global Census of Marine Life at its 2005 mid-point.

A Census project tagging thousands of endangered salmon to chart their individual travels, with profound implications for protection of threatened stocks, will expand its array of underwater monitors from British Columbia north along the continental shelf to Alaska and south to California. The system could spread worldwide to monitor traffic and tribulations of the many species that migrate along the shallow coastal highways.

Meanwhile, Census scientists increased by more than 50% from 2004, the number of reporting devices on the large animals that typically venture from the shallow shelves into the deep Pacific Ocean. Some 1800 open ocean animals of 21 species, including sharks, turtles, seals, sea lions, and seabirds carried Census tags during 2005. Some of the tags, resembling cellphones, call information into scientists via satellite each time the animal surfaces. A web-site (www.toppccensus.org) allows the public to follow some of these creatures in near real-time.

Tags show tuna are the marine jet set. A tagged bluefin tuna recorded its stunning trans-Pacific migration — three crossings in 600 days, a distance of 40,000 km, greater than Earth's circumference.

First Census of Marine Life at Mid-Point

Drawing comparisons to the Domesday Book that comprehensively surveyed England in 1066,

the Census has enrolled leading global experts in a 10-year scientific partnership, unprecedented in scale, to assess and explain the diversity, distribution and abundance of life in all oceans, a baseline against which future change may be measured.

They are assembling in one place for the first time most of what we know about marine life, and marking what is unknown and may yet be unknowable. They are reconstructing the history of ocean life since fishing became important, censusing the present state, and using the past and present to forecast future marine lives. They are satisfying basic human curiosity about what lives beneath the waves as well as generating insights useful for better managing and preserving ocean resources.

The 10-year project began in 2000 with about 250 collaborators, and an almost seven-fold increase has taken place in the five years since then. Some 1700 experts from 73 nations are today working to produce the First Census by 2010. In November 2005, some 150 leaders of all components of the Census met in Frankfurt to review progress and harmonize their efforts to cover all habitats and species by 2010.

The Census reached maturation in project breadth in 2005 with 17 initiatives, four of them new this year. Expeditions to previously unexplored regions rose from 8 in 2004 to 14 in 2005, with many more planned through 2010. The years 2006-2008 will see the most intense field work; the results will be analyzed and integrated in 2009-2010.

The research spans species from microbes to whales, from nearshore to mid-ocean, from the world's deepest mud in the abyssal

plains to the foamy and sparkling surface, from hot seafloor vents to the ice oceans at both poles. Areas of exploration include the submerged edges of continents, seamounts dotting the ocean's floor, and coral reefs.

Using new approaches and technologies, including supersensitive visual and acoustic devices, Census researchers can sample life in all ocean realms and identify specimens quickly through genetic science and digital image libraries.

"Immense scale challenges the Census," says Dr Victor A. Gallardo of Chile, Vice-Chair of the Census Scientific Steering Committee. "The deep-sea floor is an area of 300 million square kilometers, of which the area sampled to date is equal to a few football fields. The number of seamounts (underwater mountains rising at least 1000 meters from the ocean floor, often extinct volcanoes that failed to grow tall enough to become islands) is estimated at between 30,000 and 100,000, of which a few hundred have been biologically sampled, less than 50 of them sampled well. Representative sampling on a global scale is the key for an effective census".

Discoveries and highlights, 2005: Fish with chips

Marine animals carrying computer chips that report their locations show that fish and many other species use well-defined ocean zones.

The POST (Pacific Ocean Shelf Tracking) project has revealed the Pacific migration routes of young wild salmon from US and Canadian rivers. Because many salmon die in the ocean, knowing their usual travels along marine highways has far-reaching implications worldwide for authorities

who determine when fisheries should be open or closed to conserve endangered stocks.

The salmon are implanted with almond-sized electronic tags scanned by devices on the ocean floor when they pass over, like an electronic tag on a car passing through a highway tollbooth (see animation at: http://www.postcoml.org/videos/how_it_works.htm). The data reveal the movement and survival of each tagged fish as it migrates within the system and the distribution of all the tagged fish.

The current array of monitors stretches more than 1550 km, from Washington State, through British Columbia to north of the Alaskan panhandle. By 2010, the Census of Marine Life (CoML) team aims to cover the entire western North American coast, with a goal to replicate the network on continental shelves worldwide. Continental shelves average about 80 km (50 mi) wide, and the edge of the shelf occurs at an average depth of about 200 m (660 ft), where it falls steeply into the deep sea. Salmon and many other marine animals travel extensively along shelves.

The number of fish tagged almost tripled in 2005 with some 2700 salmon from 19 US and Canadian stocks in 16 river systems, up from 1050 fish tagged from 14 stocks in 8 river systems in 2004. The monitor performed nearly flawlessly, revealing substantial differences in the paths, speed, distribution and survival of species and stocks within species, both wild and from hatcheries.

Among other benefits, the work will provide clues about how fish behaviour would change should ocean waters warm.

Says POST lead scientist, David Welch: "New developments in the technology mean that we will be able to monitor individual fish with tags that will last 10–20 years. For salmon, this means we

will also be able to monitor the return migration of adults, providing information that could help better protect endangered stocks".

Science suggests smart fishing

"The dream of abundant and sustainable stocks of commercial fish is now one step closer, thanks to this Census of Marine Life program. The new data reveal for the first time those zones of the ocean where we have the highest leverage for conservation and thus smarter fishing," said D. James Baker, President of the Academy of Natural Sciences of Philadelphia and former long-time chief of the US National Oceanic and Atmospheric Administration, responsible for management of marine fisheries.

Why did the fish cross the ocean?

The Tagging of Pacific Pelagics (TOPP) project, meanwhile, found many salmon sharks (*Lamna ditropis*) from Alaska share with humans an attraction to warmer winter destinations and frequently migrate to destinations like Hawaii. Growing to more than 300 kilograms (660 pounds), the salmon sharks can attain speeds of more than 50 kilometers (30 miles) per hour. The project's shark team also recorded an unprecedented 305-day track of a white shark that completed a full migratory cycle from coastal waters to off-shore and back again.

TOPP's state-of-the-art tags have also allowed marine turtle researchers to determine how much energy a leatherback sea turtle burns at sea. Says TOPP researcher Bryan Wallace: "Imagine that the turtles are cars. These measurements allow us to know their ratings for miles per gallon on the road, not just idling in traffic. And with the help of habitat data the turtles are col-

lecting, TOPP research may just help make travelling a bit safer for this highly endangered species".

Discoveries and highlights, 2005: Diversity

Carnivorous sponges and other new species in Southern Oceans: Unexpected biodiversity greeted scientists on two expeditions to the abyssal plains and basins of the South Atlantic and Southern Oceans. Although those seas are low in biomass, they are rich in variety, and scientists say 50% to 90% of specimens collected from the two expeditions are new to science. The southern deep abyss may hold reservoirs of genetic diversity and evolutionary novelties. Among the most intriguing creatures were tiny carnivorous sponges, about 5 mm (0.2 in) in diameter, which engulf other organisms with their "mouths" (sponges typically feed by filtering small particles from the water). Three of four carnivorous sponge species found in the Southern Ocean abyss had never been seen before. Sponges with calcium skeletons living much deeper than expected also created surprise. Also found: minute unicellular animals (called "xenophyophore") using sediment grains to construct delicate shells that resemble soccer balls.

Novelties Still in North Atlantic: Exploring the northern Mid-Atlantic Ridge, beneath the most-traveled ocean surface on Earth, researchers documented several new and rare species, including strange varieties of deep-sea fish, two possibly new species of squid and, at the ocean floor, at least four new species of sea cucumbers. They also found almost one-quarter of demersal (deep swimming) fish species identified were new to the study area, reflecting how much there is yet to learn about the distribution and abundance of species known already.

DNA identifiers for 800 fish: DNA barcodes, a standardized segment of the genome, can rapidly and accurately identify species. The Census now has a library of barcodes for almost 800 fish species, and another 1000 species will be added by mid-2006. Researcher Bronwyn Innes (Tasmania, Australia) barcoded eight tuna species and used the barcodes to identify tuna carcasses on longliners in the Indian Ocean. Some misidentifications were revealed, including instances of endangered Southern Bluefin being misidentified as yellowfin or big-eye tuna.

Microbe database: Marine microbes are the tiniest of ocean species but constitute 90% of the ocean's biomass and cycle 98% of the carbon and nitrogen. To census microbes, CoML in 2005 launched an array of online resources that allows researchers to exploit molecular, environmental, geospatial, and taxonomic information, "MicroBIS". MicroBIS allows researchers to cross-check the identity of collected microbes against known species.

Discoveries and highlights, 2005: Distribution

Unexpected presences in Arctic: Census explorers in the Arctic Ocean's frigid Canada Basin discovered many creatures never seen there before, including several species of squid and the area's first known octopus.

First Atlantic hydrothermal vent south of equator: An international team of researchers, towing remotely operated vehicles to explore the southern Mid-Atlantic Ridge, found the first known hydrothermal vents south of the equator in the Atlantic. They sampled animals adapted to life in these extreme vent environments, where water, super-heated to 350°C in the Earth's crust, flows from "black smokers" on the deep ocean floor. Comparison of the specimens collected with those

found on hydrothermal vents previously discovered north of the equator provides clues to the mysterious deep currents that may disperse them.

Whales follow undersea ridges: Tagging of baleen whales show they use the mid-ocean ridge as a feeding area and north-south migration route in the North Atlantic.

Expansion of nearshore coverage: In a cooperative effort to catalog biodiversity in the nearshore environment, scientists and volunteers are now working at 80 official Census sites around the world, encompassing more than three-quarters of the world's coastlines.

Discoveries and highlights, 2005: Abundance

Dead zone around tsunami epicenter: On the first scientific expedition to the epicenter of the December 2004 tsunami, deadliest in recorded history, Census biologists found little or no effect on deep-sea fauna except at one site off Sumatra roughly 4000 m (2.5 miles) deep, where five months after the disaster there was no evidence of large animals during an 11-hour dive. The absence of biological life at the site was "unprecedented in 25 years of deep-sea sampling".

Scientists coordinating data from surface ships from small airplanes documented in 2005 major fluctuations in the abundance of feeding whales, pelagic fish, and plankton in the Gulf of Maine.

Reconstruction of North Sea marine life back to Middle Ages: Creatively mining historical data from such sources as salt tax records, Census researchers have revealed drastic declines in populations of whales, seals, birds, large fish, and oysters during the past 500 years in the Wadden Sea, part of the North Sea bordering

Denmark, Germany, and the Netherlands. The area once teeming with large animals would be unrecognizable to the early civilizations that lived there, characterized today by quiet mud flats. Ocean historians also documented that recent conservation efforts such as hunting bans and habitat protection have benefited seals as well as some birds.

Global demography of tuna and billfish since 1950: Using records of fish hooked on longlines in open oceans, researchers found the abundance and species diversity of large pelagic fish declined rapidly over the past 50 years. Global concentrations of such key predators such as tuna, marlin, and swordfish decreased dramatically worldwide. The research also uncovered four regions where high diversity persists, off the east coasts of the US, Australia, and Sri Lanka; south of Hawaii; and in the southeastern Pacific.

Discoveries and highlights, 2005: Synthesis

North Pacific Pilot Inventory: To test the feasibility of the global Census, a team of CoML experts in the North Pacific Science Organization (aka. PICES) prepared the pilot Census "Marine Life in the North Pacific: The Known, Unknown, and Unknowable". The report surveys bacterio-plankton, phytoplankton, zooplankton, unexploited fishes and invertebrates, commercially important fishes and invertebrates, seabirds, marine mammals, and turtles. While everything cannot be known in detail because of the vastness of the system and rapid fluctuations of some populations, the North Pacific report encouragingly points the way toward the 2010 Census.

OBIS inventory grows

Perhaps the foremost legacy of the inaugural Census will be the geographical information system

it is creating for all data about marine life where the species of the specimen and the place it was observed are reliably recorded.

A USD 9.5 million meta-database, the Ocean Bio-geographical Information System (OBIS), now links 60 databases containing 8.4 million taxonomic records (species, date, latitude, longitude, and depth found), an

increase of 62% from 5.2 million records last year.

OBIS today contains more than 40,000 of an estimated 230,000 marine species described in science literature so far (which may only represent only one-tenth of all marine species in existence).

Of the 40,000 species of all types inventoried, 78 are marine fish

newly added in the first 11 months of 2005, an average of 6.5 species added monthly. The total number of marine fish species in the database is now 15,717.

Source: www.sciencedaily.com (6 January 2006)

Adapted from a news release issued by Census of Marine Life/Census of Marine Life, January 2006)



■ THE REPRODUCTION OF BLUEFIN TUNA IN CAPTIVITY: PROMISING FIRST RESULTS

Last summer, eggs from captive bluefin tuna were successfully fertilised in vitro in Spain. This step towards the reproduction of bluefin tuna in captivity could have important consequences on the future development of aquaculture. The research was conducted under the EU-financed Reproduction of the Bluefin Tuna in Captivity (REPRO-DOTT) project by a team of Spanish, French, Maltese, Greek, Italian, German and Israeli researchers.

Bluefin tuna farming is a huge challenge for the years to come. The success of this fish on markets worldwide, particularly in Japan and America, has increased its commercial value (see Fishing in Europe No 23, September 2004, pp. 10–11).

Bluefin tuna farming in the Mediterranean is currently based on fattening the fish in “floating cages”. The animals are sometimes caught at a considerable distance from the fattening zone and are brought to the “farm” in specially designed cages towed by a slow-moving boat. The tuna are fattened on sardines and anchovies and placed on the

market when their flesh has reached optimal quality capable of satisfying the very specific expectations of gourmets, notably the Japanese.

This type of business is expanding in the Mediterranean because it is very profitable. But this commercial success created the risk of overexploitation of stocks, particularly in the Mediterranean where part of the population migrates every summer to spawn. Alarmed over this situation, the ICCAT¹, GFCM² and the European Union have adopted rules for the strict management of bluefin tuna, aimed in particular at regulating the fattening activity (caging declaration, sampling procedure, list of authorised farms, monitoring of quantities caged and marketing). Each contracting party has put in place measures such as inspections to reduce catches of juveniles. In 2006, the ICCAT Scientific Committee will assess the bluefin tuna stock and the ICCAT will study the effectiveness of management measures in place.

Absence of reproduction in captivity

If bluefin tuna reproduced in captivity, domestication and farming could provide a solution by meeting market demand while minimising pressure on wild stocks. Unfortunately, since the first cages were put into use in 1996, there has been no spontaneous reproduction of captive individuals in the Mediterranean.

That is why a large-scale research project aimed at improving understanding of the reproductive cycle of captive bluefin tuna was launched by a consortium of eight marine research institutes³, of which seven from the Mediterranean area. The REPRO-DOTT project is financed by the European Commission in the amount of EUR 1.5 million under the Fifth Framework Programme for scientific research. It began in 2003 and will expire at the end of 2005. There is obviously great interest in the project because it is expected to help meet continually rising market demand and ease pressure on a stock that is in danger for the moment.

¹ International Commission for the Conservation of Atlantic Tunas — the regional fisheries organization responsible for the management of tunas and related species in the Atlantic Ocean and adjacent seas, including the Mediterranean.

² General Fisheries Commission for the Mediterranean — the regional fisheries organization responsible for the management of fisheries in the Mediterranean and the Black Sea.

³ Instituto español de Oceanografía, Universidad de Cadiz, Institut français de Recherche pour l'Exploration de la Mer, Institute of Marine Biology of Crete, Israel Oceanographic and Limnological Research, Malta Centre for Fisheries Sciences, Università degli Studi di Bari and Universität Heinrich-Heine Düsseldorf.

Three years of research

The scientific consortium worked closely with the tuna fattening companies based in the region of Cartagena, Spain, where this activity began to develop at the end of the 1990s. The research was carried out on their captive specimens, because the consortium opted to conduct its research under the "normal" conditions of fattening in cages, rather than under laboratory conditions.

The first two years of research conducted under the REPRO-DOTT project were spent trying to improve knowledge of the reproductive cycle of bluefin tuna, based on observations and analysis of tissue samples from the reproductive organs. The research thus helped improve biological knowledge, particularly on the species' maturation cycle.

It is important to realise that fertilization does not take place in the female's body, but from the contact of sperm and eggs in the marine environment. To simplify, the female releases her eggs, which the male then fertilizes by releasing his sperm.

During the third year, the scientists developed and tested means of controlling the reproductive cycle (i.e. of artificially provoking ovulation in the females and the production of sperm by the males). They used a method of hormonal induction of spawning. This consists in using hormonal implants, in other words, substances that are inoculated into the organism to stimulate ovulation and trigger the production of sperm. An implant developed by the consortium ended up attaining the desired result. Ovocytes were collected in the cages and fertilized in vitro. The first viable bluefin tuna larvae were born shortly afterwards.

A view from the Pacific

In the Pacific region, Japanese researchers working on the reproduction of southern bluefin tuna have adopted a different tactic than that of their European counterparts. Indeed, they have opted for control of all environmental conditions, enclosing the tuna in large pens and letting them spend years getting accustomed to their captive environment, which provides optimal conditions of water quality and temperature.

Their method has produced results: in June 2002, researchers from Kinki University in Osaka completed the first full reproductive cycle, obtaining eggs from individuals born in captivity. The major constraint of such a method is its unforeseen ability in terms of the date of obtaining eggs.

A long way to go

This result does not, however, mean that bluefin tuna farming is just around the corner. Numerous scientific and technical hurdles still have to be cleared. First, it has to be shown that this experiment can be reproduced with other individuals in other conditions. The different parameters of the experiment will then have to be analysed and translated into a reliable protocol capable of being transposed to other circumstances.

The REPRO-DOTT project ceases with the production of fertilized eggs, moreover. The subsequent stages, including the very delicate stage of hatchery, still have to be studied in other research projects. At this point, there is a need to discover ways and techniques for increasing the number of eggs that hatch, to ensure regular production of larvae with acceptable survival rates, and to provide the best support for their growth, and for the growth of fry, etc.

Handle with care

A major problem still has to be solved: how to handle these very big animals – an adult weighs from 180 to 400 kg – which paradoxically are very fragile. Simply

taking a bluefin tuna out of the water provokes a traumatism that kills it within hours. In the course of the project, many individuals died after being captured and immobilised in preparation for inoculation with the hormonal implants. So the scientists had to invent a method for injecting the implants at a distance, using an underwater shotgun.

This extreme fragility has always been attributed to the stress of captivity. The scientists believe there may be other factors, however. The complete domestication of bluefin tuna will involve increased handling: the introduction of implants, transfers of fry, isolation of breeding stock, care, tissue sampling, etc. So it will be important to understand how this traumatism is fatal to individuals of the species and to come up with means and techniques for remedying the problem.

Source: Fisheries and Aquaculture in Europe, No. 27, December 2005
http://www.europa.eu.int/comm/fisheries/policy_en.htm



■ MEETING ANNOUNCEMENT

An international forum on coral reef ecosystem biodiversity is being co-organised by the French Research Institute for Development (IRD) and the Secretariat of the Pacific Community (SPC) under the auspices of France, the New Caledonia Government and Provinces. The forum will take place at the IRD Noumea Centre in Noumea, New Caledonia, from 30 October to 3 November 2006.

Although comparable with humid forests, the specific richness of coral reefs remains poorly characterized, and numerous interactions between species that live in coral reef habitats are still unknown. The spatio-temporal variability of reef formations is under-investigated, although it is essential in the association

between biodiversity and climate change.

These issues are particularly important in New Caledonia, which has one of the largest barrier reefs in the world, and is known as one of the world's biodiversity hotspots. New Caledonia's barrier reef is also a candidate for the UNESCO World Heritage Sites in 2007. However, facing strong pressure from the development of human activities, in particular openpit mining, New Caledonia needs preservation programmes for its coral reef ecosystem.

The Coral Reef Ecosystems Biodiversity (BIODEC) forum is part of the national and international research strategy on biodi-

versity. It aims to bring together key international and national experts in order to review current scientific knowledge in the field of coral diversity, identify academic research priority areas, and prioritize applications for sustainable development.

For further information about the programme and conference sessions, see: www.ird.nc/biodec, or contact the Scientific Committee: Claude Payri, biodiv@noumea.ird.nc, or the Organizing Committee: Mina Vilayleck, infocom@noumea.ird.nc



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FISH FOR TODAY AND TOMORROW: COMMUNITY-BASED FISHERIES DEVELOPMENT AND MANAGEMENT ENSURES LONG-TERM SUSTAINABILITY

Nearshore fisheries are critically important to Pacific Island people, both for food security and income, but expanding populations and environmental degradation are placing increasing pressure on these fisheries.

And while Pacific Island governments use regulations to manage nearshore fisheries resources, these regulations are rarely successful for a variety of reasons. Problems include the difficulty of enforcing national regulations in subsistence fisheries, which involve large numbers of fishers, the great variety of species that are targeted, the myriad fishing methods employed in nearshore waters, and the (often) small individual catches. In addition, most Pacific Island fisheries agencies are under-staffed and have very limited budgets, making research, management and enforcement difficult for many.

Government enforcement of fisheries regulations is particularly difficult in a country such as Papua New Guinea (PNG), which has extensive coastlines, numerous island groups, and many isolated coastal communities with different languages and vastly differing cultural practices. Enforcement is further complicated by the fact that coastal communities often operate under their own traditional governing structure, and may resent what they consider to be government interference.

Kim Des Rochers¹

Enabling a community to take some form of control over the management of its reefs and mangroves is essential for the successful management and long-term sustainability of these resources. The Coastal Fisheries Management and Development Project (CFMDP), through its community-based management component, is building community capacity to manage reefs and mangroves within three coastal provinces in PNG.

The CFMDP is a 3.5-year project that promotes the sustainable exploitation of marine resources in PNG's coastal waters; the main goals of the project include improving management of inshore fisheries resources in PNG, and assisting in alleviating poverty through sustainable marine resource use. The project, which is funded by the PNG government through a concessionary loan by the Asian Development Bank, is being implemented by Gillett, Preston and Associates, Inc., through the PNG National Fisheries Authority (NFA).

NFA is in the process of devolving some of its authoritative powers to provincial and local level governments around coastal PNG. This is being done because NFA recognizes that it is impossible for them to effectively

manage the country's inshore fisheries resources from the capital in Port Moresby.

Community-based resource management in PNG

Conservation and sustainable management of fisheries resources can be difficult to achieve at a community level because marine resource conservation measures and the need to earn a cash income are often viewed by fishers as incompatible. The solution lies in education and awareness, and the CFMDP is working with local PNG-based NGOs to raise awareness about fisheries and marine resource-related issues. By working with NGOs, the project is maximizing the long-term sustainability of its community-based management work, which should continue long after the project comes to a close in 2007.

The CFMDP has enlisted the support of Ailan Awareness, an environmental NGO, to help educate and raise awareness in rural coastal communities in New Ireland Province about the importance of community-based resource management. Ailan Awareness regularly visits remote coastal communities, performing marine environmental awareness shows using music, dance, videos and distributing information materials developed by the project.

The CFMDP also holds training workshops for provincial fisheries officers, relevant NGOs, and people from the private fisheries sector. The training aims to enable provincial fisheries and other resource people to effectively initiate and support community-based management (CBM) activities, both now and after the project ends. CFMDP training workshops are in two parts. Participants are first educated

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Alleviating poverty through community-based management

One of the main functions of the CFMDP is to alleviate poverty. This is being addressed, in part, through the project's infrastructure work (e.g. small wharves, jetties, and fish processing plants), which makes it possible for fishermen to get their fish catches to markets. But to ensure that fishermen do not overfish — now that they have a ready way to earn cash from their catch — CFMDP has instituted a community-based management aspect to the project, whose work includes educating fishermen and women about how to take care of their resources, so that resources can be sustainably harvested for generations to come. In addition, it's impossible for PNG's National Fisheries Authority, or even provincial fisheries offices, to manage resources in the more remote parts of PNG (provincial fisheries departments in PNG are typically understaffed and lack operating budgets). So it is only obvious and natural for communities to take responsibility for their resources, looking after them in a way that their grandchildren and their grandchildren will always have fish.

about various coastal ecosystems (e.g. reefs, mangroves, and estuaries), their biological and ecological function, and how they are inter-related. Participants also learn what management of fisheries and marine resources entails, and why it's necessary and important. This part of the training emphasizes the necessary techniques and skills required to prepare and present information (such as fisheries biology and management techniques) at the village level.

The second part of the workshop focuses on training participants in the CBM process, and covers how to launch an awareness-raising campaign in village communities, how to engage villagers in discussions about marine resource issues in their community, and how to help communities develop and draft their own set of rules and regulations governing the marine resources they depend on.

Some fishing communities possess detailed knowledge about the marine environment that is based on experience. This knowledge can contribute towards more enlightened, effective, and equitable remedies and solutions for managing reefs and mangroves, and provides a basis on which communities can be

encouraged and motivated to manage their own marine resources.

Village fisheries management plans

When working with communities, Ailan Awareness invites community members to contact the CFMDP office if they want assistance with or advice on managing their resources and developing rules and regulations specific to their communities' reefs and coastal areas, but makes it clear that it is up to the communities to seek out CFMDP's help. This ensures that the project works only with communities that are serious about and committed to managing their fisheries resources.

When the CFMDP office receives requests for assistance in developing a CBM strategy, Ailan Awareness and a CFMDP staff member pay a visit to that community to talk with villagers about the CBM process. They help identify various marine resource issues in the community, and work with the community to devise a list of solutions to address these issues. This problem-solution list forms the basis of a village fisheries management plan (FMP). The list of fisheries and marine resource con-

cerns in any given village's FMP might include the following: dynamite fishing, anchor damage to reefs, driving fish into gill nets, harvesting female lobsters and crabs with eggs, and dumping rubbish into the sea.

One of the main points that CFMDP drives home, both to its workshop participants and to communities, is the importance of community ownership of FMPs. If everyone in the community isn't onboard or in agreement with the actions and penalties within their FMP, then community-based management doesn't stand a chance of actually working.

Fines and penalties

A resource issue mentioned in just about every community is the use of Derris, a plant found throughout much of the Pacific, and which is used to stun fish to make them easier to catch. An active ingredient in Derris is rotenone, a pesticide that also harms other marine animals, not just the fish that are being targeted. Solutions to problems such as this most often take the form of fines. For example, one community has decided to place a ban against cutting mangrove trees within a certain distance from the shoreline. If someone is caught and found guilty, that person must pay a fine within two weeks of the offence. In most instances, the community elects a committee to enforce the rules it draws up.

Once an initial FMP has been drafted, it is taken back to the community for final approval. This part of the CBM process is necessary so that communities feel the FMP belongs to them and that everyone is in agreement about what should be contained within it.

The question has arisen whether it is possible for communities to actually enforce the penalties set forth in their own FMP, because just about everyone is related to

one another. In response to this, the CFMDP's Coastal Fisheries Advisor, Peter Watt, gave the example of a community that had drafted its own FMP, and where a village magistrate recently heard a case involving fishermen driving fish into their gill nets. This particular community's FMP stated that such an action was punishable. The magistrate found the fishermen guilty, and ordered their fishing nets to be confiscated. Watt explained that one of the things CFMDP tries to instill in communities is a sense of ownership in their resources and their FMP. "If they have that, then there's a chance that community members will put pressure on one another to adhere to it," he said.

What will give the village FMPs some "bite" is the soon-to-be

enacted revised PNG Fisheries Management Act, which acknowledges FMPs as actual laws. Because of the new Act, the FMPs are not just a wish list of solutions to resource problems, they are, in fact, gazetted and drafted into the national law.

To date, seven communities in New Ireland Province have developed their own FMPs, and more communities are in the process of doing so. Although the CFMDP has moved into the other target provinces, the CBM process continues in New Ireland and requests for help are directed solely to Ailan Awareness and the cadre of participants that have been trained by the CFMDP for this purpose.

What's next?

One of the goals of the CFMDP is to reduce fish catches of the more heavily fished species. To this end, the project is developing alternative income-generating projects for fishermen. As an example, the project is rigging and deploying fish aggregating devices (FADs) to move fishing pressure offshore to less targeted fish species. Ailan Awareness is assisting in this endeavour by giving a workshop to interested community members on how the FADs are made and work. This will hopefully give community members a better appreciation for these and encourage them to look after and maintain them.



TOOLS FOR IMPROVED FISHING VESSEL SAFETY: THE TORREMOLINOS PROTOCOL AND THE STCW-F CONVENTION

It is a well-known fact that fishing is one of the most dangerous occupations in the world. The following statistics from the International Labour Organization (ILO), the International Maritime Organization (IMO) and the Food and Agriculture Organization of the United Nations (FAO) clearly demonstrate the extent of the safety problem in the global fishing industry.

- Each year there is an average of 24,000 fatalities and 24 million non-fatal accidents (non-fatal injuries are grossly under-reported according to the ILO).
- While fishing represents less than 1% of occupations worldwide, 7% of all worker fatalities occur in the fishing industry.
- The fishing fatality rate is estimated at 80 deaths/100,000 individuals per annum, which is 79 times higher than the overall occupational fatality rate.

The community nature of much of the world's fishing activities, and the potentially devastating impact that high injury and fatality rates can have on fishing communities, is demonstrated by another set of statistics.

- In 1995, the total world fishing fleet (of all types) was about 3.8 million vessels.
- About 15 million people are employed aboard fishing vessels and about 98% of these people work on vessels less than 24 m in length.

Michel Blanc
Nearshore Fisheries Development
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- Most of the world's fishing fleet comprises boats that operate in artisanal fisheries.

According to the IMO, 80% of accidents are caused by human error and most of these errors can at some point be attributed to management deficiencies that create pre-conditions for accidents. Personnel must be effectively managed to ensure that they have appropriate training and that they work in accordance with relevant labour laws and agreed on conditions. The procedures, methods and systems used on fishing vessels must be properly managed to ensure that they work effectively and efficiently and produce the required outcomes. Finally, the mechanical components involved (hull, machinery, fishing gear, etc.) must also be managed to ensure that they are properly maintained and perform in accordance with their designed capacity.

The solutions for improving fishing vessel safety are thus straightforward: seaworthy vessels, well-trained and competent crews, and safety-oriented management.

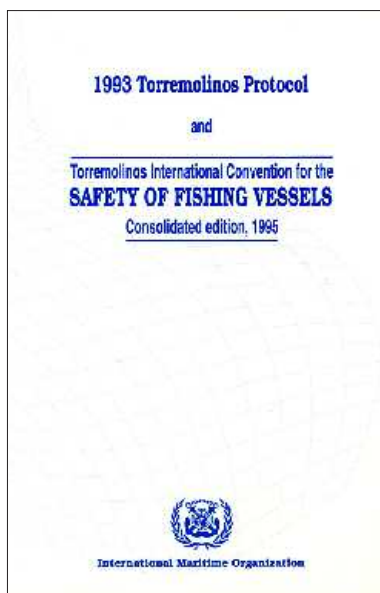
Seaworthy boats are of critical importance, but it is necessary to have standards for their design and construction, as well as for the vessel equipment and outfitting. Along with these standards there must also be standards for

maintenance and inspection; in other words, a regulatory system designed to oversee the fundamentals of safe operations. The standards must be universally adopted and this requires some sort of international binding agreement. The Torremolinos Convention and its 1993 Protocol provide the necessary framework.

Just as important as the standards for the vessels, there must be standards for the crew, their training, qualifications and work methods. Because fishing is an industry that operates in open seas, interacts with other maritime industries, and is global in operation, it is also important that common crew training standards be used, particularly when it comes to qualification and certification. Those standards must be universally adopted and recognised and the only way to do this is through the framework of an international convention. This is the purpose of the Convention on Standards of Training, Certification and Watch-keeping for Fishing Vessel Personnel, 1995 (STCW-F Convention).

The 1977 Torremolinos Convention and its 1993 Protocol

The safety of fishing vessels has been a matter of concern to IMO since it came into existence. In 1977, the first ever international conference on the safety of fishing vessels was held in Torremolinos, Spain. The conference adopted the Torremolinos Convention (1977), which established a safety regime for fishing vessels of more than 24 metres. The Convention looked at construction standards and some safety related equipment for fishing vessels in a similar way that the Safety of Life at Sea (SOLAS) Convention does for cargo and passenger vessels. Found too stringent by the major fishing nations, however, the Convention was never ratified.



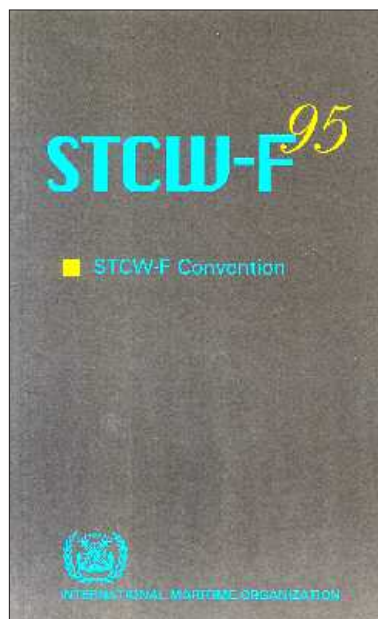
In 1993, a Protocol to the Convention was adopted (Torremolinos Protocol). The Protocol updates and amends the 1977 Convention taking into account technological evolution and the need to take a pragmatic approach to encourage ratification of the Convention. The safety provisions of the Protocol cover construction, stability, machineries, fire protection, protection of crew, life saving equipment, emergency procedures, radio communications, navigation equipment, vessel certification and port state control. Some of the provisions are restricted to fishing vessels of more than 45 m. To date, six states have ratified the Protocol (15 are required for its entry into force).

The 1995 STCW-F Convention

The STCW-F Convention complements the Torremolinos Protocol by setting the regulatory framework for the training and certification of fishing vessel personnel. STCW-F is the “sister” Convention to the 1978 STCW Convention (training and certification of seafarers), as amended in 1995, with similar provisions.

The STCW-F Convention addresses the training and certification standards for skippers and watchkeepers on fishing vessels

of more than 24 m, for engineers on vessels producing more than 750kW, and for crew in charge of radio communications. It also requires basic (pre-sea) safety training for all fishing vessel personnel. The Convention embraces the concept of competency-based training. It does not deal with manning levels. Six states have so far ratified the STCW-F Convention (15 are required).

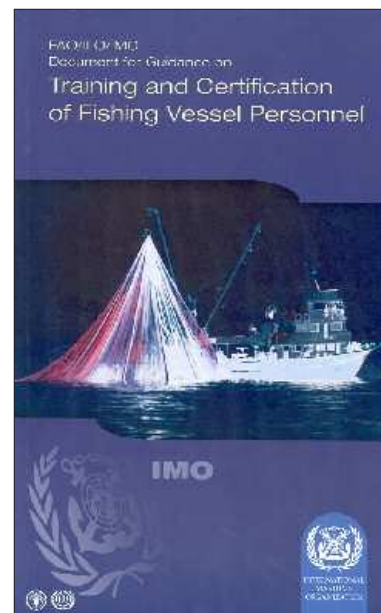


Document for Guidance on Training and Certification of Fishing Vessel Personnel

First published in 1985, and thoroughly revised in 2001, the Document combines the conventions and recommendations adopted by ILO and IMO with the wide practical experience of FAO in the field of fishermen's training.

The Document is aligned with the provisions of the STCW-F Convention. It provides guidance to set the framework for a training system for fishing vessel personnel appropriate to the size and nature of the fishery (all sizes of fishing vessels are covered). The Document addresses issues such as the methods of training and assessment (competency-based training is promoted), the content and duration of training

programmes, the competences to be assessed, and the required experience and qualification for tutors. There is a strong emphasis on sustainability (FAO Code of Conduct), fatigue management, and the active involvement of all parties in training development.



The above instruments were promoted at a regional seminar in late March, in Suva, Fiji, as part of an initiative from the IMO to urge member governments to consider accepting the 1993 Torremolinos Protocol and the 1995 STCW-F Convention. This was the eighth in a series of nine regional seminars run by Milhar Fuazudeen (IMO Technical Officer) and David Harrod (Maritime Safety Consultant). Participants included 10 maritime administrators, 8 training providers, 3 fisheries administrators and 2 fishing operators as well as staff from both SPC maritime and SPC fisheries programmes.

With regards to the likely impacts of Torremolinos and STCW-F on Pacific Islands, several important points were made at the seminar.

- The Pacific Islands region is well ahead of other regions in that it already has training and

certification standards for fishing vessel personnel: a common certification structure for trading and fishing vessels was developed by SPC's Regional Maritime Programme in the mid-1990s through a consultation process involving heads of marine departments and training institutions. It is monitored on an ongoing basis through a sub-committee of the Pacific Islands Maritime Association (PacMa) (latest version is available from SPC's Regional Maritime Programme).

- Training institutions in the region are already familiar with the concept of competency-based training, and a number of model training programmes for fishing vessel personnel are available and being used throughout the region (e.g. SPC's safety certificate and SPC/Pacific Island Qualified Fishing Deckhand certificate). The pre-sea induction training system used in Papua New Guinea for new vessel crew is also relevant as it is aligned with the requirements of STCW-F for basic pre-sea safety training for all fishing vessel personnel.
- While the Protocol and Convention apply to large fishing vessels (i.e. > 24 m),

which are very few in Pacific Island countries (PICs), the application of these instruments is flexible. It is possible for national laws to extend the applicability of Torremolinos and STCW-F to smaller classes of vessels.

- National administrations and the regional fishing industry need to be aware of and familiar with the provisions of these international instruments and to prepare for their entry into force. The current status of requirements and standards in the region means that the effective implementation of the Protocol and Convention would not be too difficult.
- Due to the current limited number of missing signatories, PICs, by ratifying the instruments, may drive their entry into force.
- SPC's Regional Maritime and Fisheries Programmes can underpin a regional mechanism and be the focal agencies in assisting countries with the implementation of the Protocol and Convention.

SPC shares the opinion of the IMO that implementing the 1993 Torremolinos Protocol and the 1995 STCW-F Convention will significantly improve the safety record of the fishing industry

and contribute to the prevention of loss of lives onboard fishing vessels.

Obviously, the introduction of relevant standards for vessel safety and crew training can only provide a safer working environment, improved safety, wider employment options, and sustainability of livelihood to fishing vessel personnel. However, the change will have a cost, not only for fishing vessel operators (upgrading of safety systems), but also for training institutions (wider application of competency-based training and assessment) and maritime administrations (certification and surveys). These cost implications need to be considered and carefully assessed: SPC and the Forum Fisheries Agency (FFA), through the European Union-funded DEVFISH project, will soon undertake a regional study on this issue, the results of which will be widely distributed to fisheries and maritime stakeholders.

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SEAMOUNTS AND PELAGIC FISHERIES INTERACTIONS UNDER STUDY

In October 2005, SPC's Oceanic Fisheries Programme, in collaboration with the Forum Fisheries Agency (FFA), started a five-year endeavor called the Pacific Islands Oceanic Fisheries Management Project (OFM project). The OFM project is funded by the Global Environment Facility (GEF), and the Scientific Assessment and Monitoring Enhancement Component of the project (including ecosystem analysis) is implemented by SPC.

One of the objectives of the OFM project is to obtain an enhanced understanding of the ecology of seamounts, in particular their influence on the aggregation and movement of pelagic fish species, and also the impact of fisheries on seamount ecosystems.

To organise this specific activity, a seamount research planning workshop, gathering 14 seamount and benthic and pelagic fisheries experts, took place at SPC headquarters in Noumea on 20 and 21 March 2006.

The objective of this workshop was to review existing knowledge about seamounts in the Pacific in relation to pelagic fisheries, and plan activities within the timeframe of the OFM project to gather more information on the ecology of seamounts and pelagic fisheries.

The workshop began with participants' presentations of work conducted around seamounts in

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the Pacific and future projects under development. Afterwards, many topics relating to seamounts and pelagic fisheries were discussed, and some of these are summarized below.

What is a seamount?

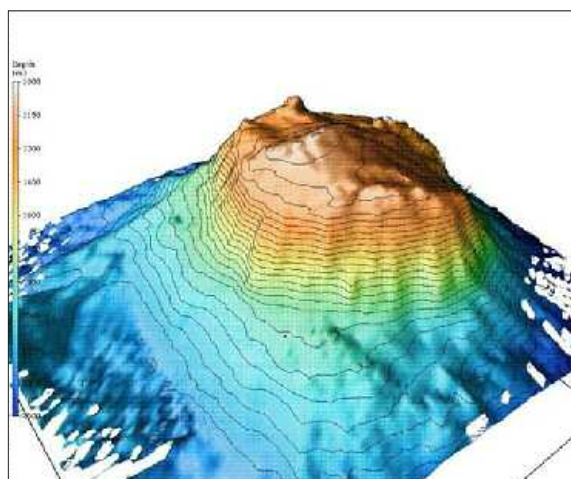
A seamount is generally defined as an isolated underwater mountain that rises more than 1000 m above the seafloor. However, workshop participants agreed

that an operational definition of seamounts, and one that is particularly relevant to pelagic fisheries, should include underwater features less than 1000 m above the sea floor, and having different geologic features such as terraces, ridges, banks, plateaux, and shelves.

Only those seamounts that extend up into the euphotic zone¹ and the lower level of the deep scattering layer (DSL)² will have an influence on pelagic fish species.

How many seamounts are in the Pacific Ocean?

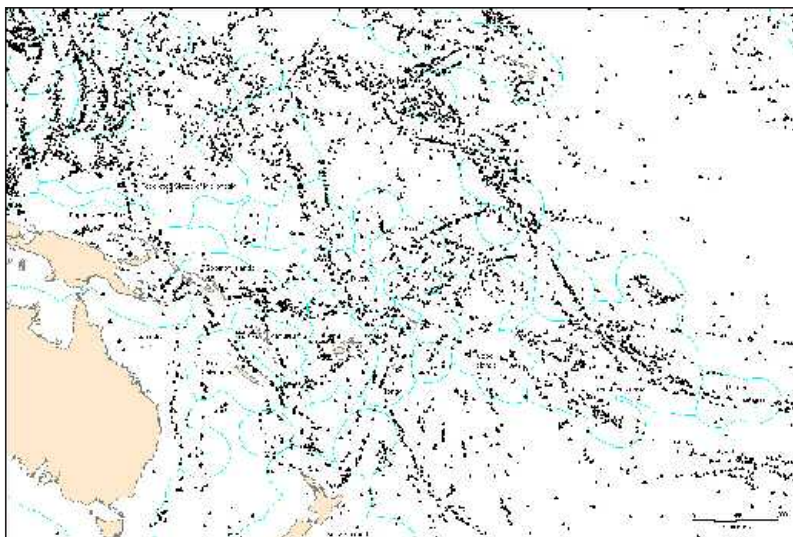
The number of potential seamounts in the Pacific Ocean could be 30,000, although less than 1000 have been properly identified and less than 150 have been explored. There is a critical need to gather accurate, fine-scaled bathymetric data to properly identify the seamounts. Bathymetric data on the location of seamounts comes from two



Three dimensional diagram of the Bear Seamount in the Atlantic Ocean whose summit reaches about 1000 m depth (source: National Oceanic and Atmospheric Administration: http://www.oceanexplorer.noaa.gov/explorations/deepesto1/logs/sep13/media/bear_seamount.html)

¹ Sea surface waters where enough light penetrates for photosynthesis to occur (i.e. down to about 80 meters or more). The depth of the euphotic zone varies with the water's extinction coefficient, angle of incidence of sunlight, length of day, and cloudiness. (FishBase Glossary).

² A horizontal zone of living organisms, usually schools of fish, occurring below the surface in many ocean areas. The zone derives its name from the layer of water scatters or reflects sound waves, causing echoes in depth sounders. The DSL tends to rise towards the surface at night, and to descend during daytime. (Encyclopedia Britannica; FishBase Glossary).



Position of potential seamounts based on analysis of 2-minute gridded global relief (ETOPO2) satellite data.

Data from Kitchingman A. and Lai S 2004. Inferences on potential seamount locations from mid-resolution bathymetric data. *Fisheries Centre Research Reports*. 12(5):7–12.

major sources: ship-derived data and satellite-derived data.

Ship-derived data are generally very detailed and are of high resolution, but these data only cover small oceanographic areas. These kinds of data allows for locating seamounts, but can also provide very detailed topographic maps of seamounts. Satellite-derived data provide the potential location of seamounts, offering complete coverage of an ocean. Resolution depends on the dataset used, but no detailed topographic information on seamounts is available. Considerable work is still required to obtain an accurate and precise list of seamounts in the Pacific Ocean.

What is the influence of seamounts on pelagic species and fisheries?

Fishermen are well aware that seamounts attract pelagic fish;

Capricorn Seamount in Tonga, for example, is a particularly productive fishing area.

A commonly stated hypothesis to explain the aggregation of pelagic fish around seamounts is the unique water circulation around seamounts, and the existence of enhanced phytoplankton production³, which in turn supports a rich ecosystem. Large numbers of small fish, crustaceans, and squids feeding on large quantities of phytoplankton and zooplankton will attract pelagic fish such as tuna. However, the enhanced production hypothesis has not been observed in many explored seamounts. A new idea is that the DSL is trapped by seamounts and will act as the feeding source, thus attracting predatory species.

Seamounts probably have different roles for different life-history

stages of some species (e.g. spawning grounds, feeding grounds, nursery areas). Because fish aggregate around seamounts, they became a target for fishermen. Two examples of fisheries that have developed around seamounts include the tuna fishery around Capricorn Seamount in Tonga, and Cross Seamount in Hawaii. Already some dramatic depletion of resident fish populations around seamounts has been observed (e.g. the swordfish fishery around Britannia Seamount in Australia).

Do pelagic fisheries have an impact on seamounts?

Seamounts are very fragile and specific ecosystems mainly unknown but characterized by a very particular fauna. Each time a new seamount is explored, a high percentage of the species collected are new to science, and the fauna often show a high degree of endemism⁴. Hence, seamounts constitute ecosystems of very special interest for conservation and it is important to evaluate the impact of human activities on them in order to prevent destruction and damage to these poorly known and unexplored features.

Heavy bottom trawling fishing gear dragged on the top or on the slopes of seamounts can cause significant damages to seamount fauna. However, some pelagic fisheries (e.g. purse seine, longline) are operated from the surface, and if the lines hang above the seamount (i.e. they do not touch it), it is suspected that pelagic fisheries in surface waters are unlikely to impact the fauna living directly below on the seamounts. But, removing large

³ A flora of freely floating, often minute organisms that drift with water currents. Like vegetation, phytoplankton uses carbon dioxide, releases oxygen, and converts minerals to a form that animals can use when feeding on phytoplankton. Phytoplankton constitute the base of the food chain, and are consumed by zooplankton that are in turn consumed by small fish that constitute the food of larger fish. (*Encyclopedia Britannica*).

⁴ A species whose distribution is confined to a given area is said to be endemic to that area. For example, some particular species of sponges or crabs are only found on a specific seamount, therefore, they are said to be endemic to this seamount and not found anywhere else.

quantities of pelagic predators could cause disequilibrium of the ecosystem around seamounts.

The general lack of knowledge about seamount ecosystems (location, and geological, biological, oceanographical characteristics) shows the importance of implementing studies on their ecology to acquire a better understanding of their potential impact on pelagic fisheries and vice versa.

Analysing existing data

The OFM project's first task will be to obtain an accurate list of seamounts. This will be done by reanalysing the Kitchingman and Lai dataset to remove any false identification of seamounts and to identify submarine banks relevant to fisheries.

This dataset of seamounts will be examined in reference to fisheries catch and effort data provided by SPC member countries and distant water fishing nations, and compiled by SPC's Oceanic Fisheries Programme. In addition,

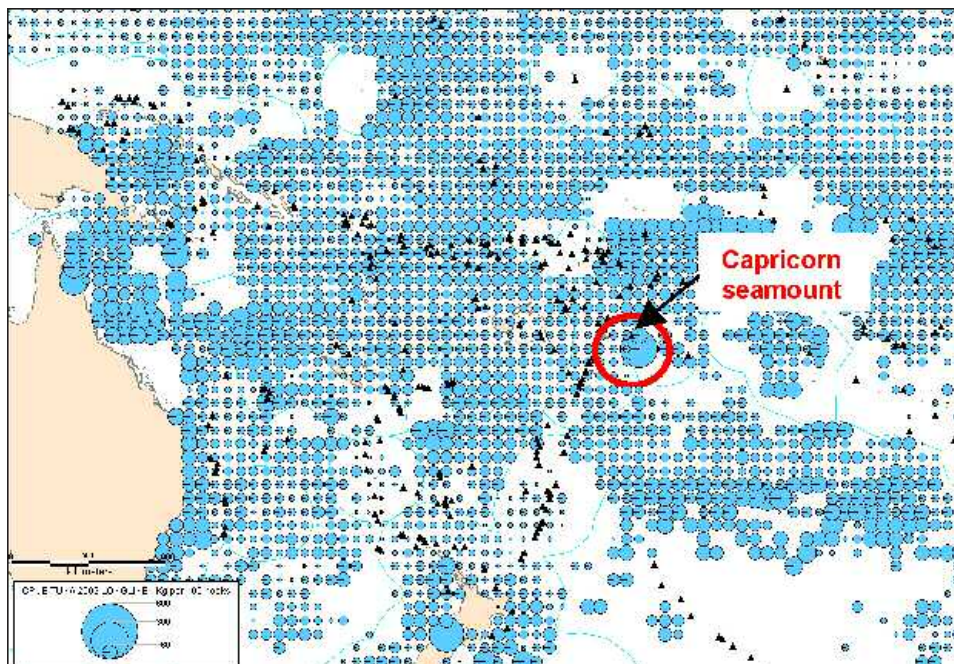
there are data from onboard observers for a small percentage of the fleet. These data are on a much finer scale and include bycatch species composition. The OFM project will try to determine if there is any apparent connection between fisheries data (catch per unit of effort, species composition, size of fish caught) and seamount presence/absence or other characteristics. Datasets from previous large-scale tagging programmes will also be reanalysed to investigate whether there is any obvious site fidelity for fish tagged in the vicinity of seamounts.

Acquiring new data

In addition to analysing existing data, new field work will be undertaken during the OFM project to enhance our understanding of seamount ecosystems in relation to pelagic fisheries. Several sampling cruises are already planned for the first part of the project.

The Papua New Guinea (PNG) tagging project will focus on the Bismarck Sea/Solomon Seas and adjacent areas, and will visit some seamounts. This is the first phase of a larger regional tuna tagging project, and one of the objectives is to tag tunas around seamounts to investigate the behaviour of fish and their site fidelity. Biological sampling, particularly of stomach contents, will be carried out during the tagging cruises to gain a better understanding of the trophic impact of seamounts on the fish.

The Seamount Planning Workshop allowed experts to share their views on the ecology of seamounts and to plan research efforts for the coming years. Another meeting will be organised in two to three years' time to review the work undertaken thus far, and future studies to be undertaken.



Catch per unit of effort (CPUE in kg per 100 hooks) of the longline tuna catch in 2002 per 1 degree square. Black triangles represent potential seamounts whose summits are between 50 and 1000 m depth. In the circle is shown the high catches around Capricorn Seamount.

Data from SPC's Oceanic Fisheries Programme.

GIANT CLAM FISHING ON THE ISLAND OF TUBUAI, AUSTRAL ISLANDS, FRENCH POLYNESIA: BETWEEN LOCAL PORTRAYALS, ECONOMIC NECESSITY AND ECOLOGICAL REALITIES

INTRODUCTION

Located south of the Tropic of Capricorn some 670 km south-west of Tahiti, Tubuai is part of the Austral Islands group. Tubuai is a high island located between the islands of Rapa in the south-east and Raivavae in the north-west. It is volcanic in origin and has a land area of only 45 km². In contrast, the lagoon, which is enclosed by a coral reef, has an area of 88 km². Fishers collect *Tridacna maxima*, a bivalve mollusc known locally as *pahua*, from the lagoon. This edible giant clam, which is found throughout much of the Pacific² is strictly protected and is listed in Appendix II of the CITES agreement³. Only Pacific Islanders still have the right to collect giant clams and in French Polynesia, regulations permit the harvest of specimens of more than 12 cm in size.

Although giant clams have been widely harvested in most island groups of French Polynesia, particularly in the Society Islands, *T. maxima* is still abundant in the eastern Tuamotu Islands and Austral Islands where significant-sized populations remain (Gilbert 2005). Nevertheless, the recent decline in stocks in a few Tuamotu island groups and in the Austral Islands is a cause of concern for the Ministry of Marine Affairs. This article is a

Sébastien Larrue¹

follow-up to three fact-finding trips to the island of Tubuai where giant clams have become a significant source of income for a small segment of the population.

In addition to discussing the harvest of giant clams, the trade channels used, and income generated, this article provides another example of the "gap" between local views, economic reasoning and scientific claims regarding resources — a gap that makes it difficult to agree on a common approach to the management of the clams.

STATUS OF GIANT CLAM HARVESTS ON TUBUAI

The issue of *T. maxima* harvests on Tubuai is complex; it is difficult to determine who exactly collects giant clams, how often they do so, and in what quantities. However, it is well known, at least on Tubuai, that many people harvest them. In addition, according to inhabitants, the *pahua* belong to everyone and breed in large numbers, from the beach out to the reef. Some believe that the *pahua* can even move about on the sandy bottom, rather like the migration of rock lobsters in the Caribbean.

On Tubuai, giant clams are regularly harvested by the general population for subsistence purposes (Chabouis 1965). Of the island's 1979 inhabitants, 323 people, often heads of families, hold professional farmer/fisher cards, which are required by the government. Nevertheless, certain families fish more than others and are recognised as "good" giant clam fishers. About 10 families of fishers are more heavily involved in collecting *pahua*. Almost all giant clam fishers are located in the township of Mahu in the southern part of the island (Fig. 1)

EFFICIENT ARTISANAL FISHING TECHNIQUE

All fishers basically use the same technique to collect *pahua*. They travel by boat to the middle of the lagoon, out to the coral heads or to the reef, and insert the end of a t-shaped metal bar, about 60 to 70 cm long, between the two halves of the giant clam's shell. They then rapidly lever the bar to detach the clam from its coral base. Some fishers use what they call a "hook" to detach the clams. This tool, which is similar to a gaff, is a flat metal pole about 60 cm long, one end of which is curved back. The hook is sometimes attached to the end of a two-metre pole, enabling fishers to detach clams from the surface down to depths of two metres. According to some reports, the hook has the advantage of pulling the *pahua* off the rocky base without damaging it (Larrue 2005). The hook is derived from a traditional sickle-shaped wooden tool that made it possible to remove giant clams from corals without damaging them.

Normally, the clam meat is supposed to be extracted onboard the vessel and cleaned in the

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² The geographical distribution of *Tridacna maxima* covers the western tropical Pacific, the Red Sea and the coasts of East Africa (Rosewater 1965).

³ Washington Convention – Convention on International Trade in Endangered Species.

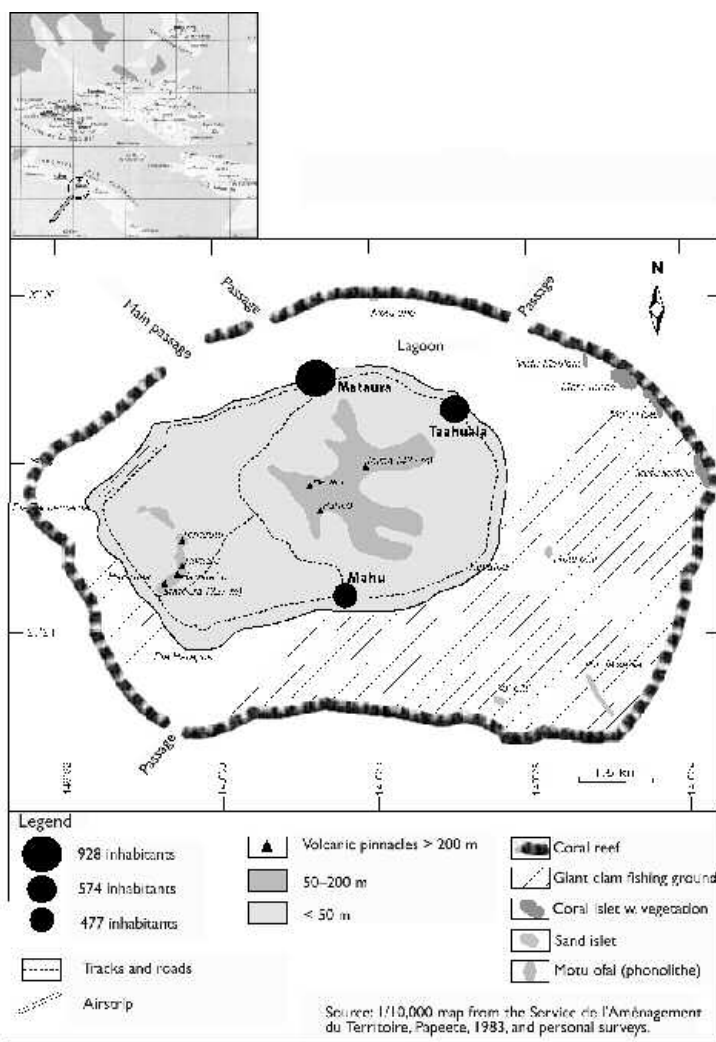


Figure 1: Tubuai and its lagoon, showing the giant clam fishing areas.



Figure 2. A touque of giant clams (*Tridacna maxima*). These clams (>19 cm long) were collected from Haraimea. A touque is the local unit for giant clam sales, and represents 20 kg of pahua meat (i.e. 100 to 140 giant clams).

lagoon before being piled into a makeshift container, locally called a *touque* (Fig. 2). The *touque* is the basic unit for giant clam fishing and represents about 20 kg of meat. *Touques* are made from old paint cans or plastic buckets. A *touque* can hold between 100 and 140 giant clams (i.e. around 5 to 7 *pahua* per kilogram of meat, a quantity that obviously varies depending on the size of the clam).

Clam fishers' yields are based on the number of *touques* filled per hour. This number varies depending on the fishing site (abundance of the clams, accessibility, swell, water depth), the size of the clams harvested (12 cm or more), and how experienced the person is at harvesting clams. These parameters therefore modify fishing yields considerably. In fact, depending on these variables, filling a *touque* with giant clams takes between one and two hours of fishing time. According to our surveys, on average it takes an experienced fisher 90 minutes to fill a *touque*. This time includes both collecting the clams and cleaning them before packing them in the buckets.

Today, this artisanal fishery seems to be gaining in popularity, and this has implications for conserving the resource, especially as the income earned through giant clam fishing is relatively substantial.

QUANTITIES HARVESTED AND PAHUA FISHERY INCOME

As far back as people can remember, giant clams have been harvested on Tubuai, which implies that *T. maxima* has formed part of the normal diet in the Austral Islands for many years. Nevertheless, while people did fish for giant clams in the past, this was done mostly to meet local food needs. Today, however, although many people continue to eat *pahua* on Tubuai, except for Seventh-Day Adventists who

consider giant clams to be *tabu* (prohibited), the clams have become a significant and even vital source of income for many fishers.

According to estimates, fishers on Tubuai harvest 1940 *touques* of clams per year (i.e. 40.64 tonnes of meat representing about 243,840 giant clams)⁴, with an overall economic value on Tubuai of some XPF 19,400,000⁵. In addition to this quantity, giant clams are occasionally harvested by the local community for food and by a few "unregistered" *pahua* fishers. Except in rare instances, no fisher works alone; rather they fish in groups of two to seven people, often from the same family. Giant clams can be harvested all year round on the island of Tubuai, but the price of a *touque* varies (between XPF 8000 and 10,000) depending on three factors:

1. Geography: in Mahu, a *touque* generally sells for XPF 8000, while it can reach as much as XPF 10,000 around Haramea.
2. Climate: the state of the lagoon (e.g. heavy swell and low temperatures) affects fishing trips and can result in price increases. During the Southern Hemisphere winter, the price of a *touque* is about XPF 10,000 all around the island.
3. Economy: according to a few fishers, the price of a *touque* also varies depending on fishers' needs for ready cash. The same fisher might sell a *touque* for XPF 8000 at the beginning of the month and for XPF 10,000 at the end of the month if he needs money. Similarly, the frequency of fishing trips also depends a great deal on how much fishers feel they need money. We noted, as we will explain in

further detail below, that fishers are not "in a rat race for income" but fish on an "as needed" basis (i.e. they do not go fishing if they feel that they still have enough money).

Not all fishers are at the same economic level. In fact, depending on the person, the number of *touques* collected each month varies from 1 to 45, bringing in monthly incomes of between XPF 16,000 and 360,000, respectively. All the fishers interviewed work to fill orders, some of which are placed on a regular basis whereas others are changeable or occasional. This situation reflects the existence of several commercial channels for *pahua* on Tubuai.

In addition to these regular fishers, there are also associations and religious groups that carry out large-scale, one-off harvests for specific events. This is particularly the case for the Mormon community, which every year in April, sends about 27 *touques* to Tahiti to finance travel costs for their young people. Some local people said that in April 2005, the association *Ia tauturu ia na* shipped out nearly one tonne of giant clams harvested in one day by 11 people.

A preliminary study carried out on Tubuai by the Fisheries Department indicated that giant clam resources would be endangered by harvests of more than four tonnes of meat annually (Gilbert, op.cit.). Therefore, even if there were errors in the models used to set that threshold, the difference between the maximum quantity recommended to ensure the sustainability of this resource and the quantities actually collected locally (i.e. more than 10 times greater than the replacement threshold) is such that there can be no doubt that the giant clams are currently being overexploited.

Only a few fishers, who at present have little involvement in obtaining income from *pahua*, have reported that the number of giant clams is declining everywhere around the island and has been for the past five or six years (i.e. since commercial channels have increased).

WILL INCREASING COMMERCIAL CHANNELS KILL THIS PRIZED RESOURCE?

On Tubuai there are two major channels, or origins, for the giant clam fishery: 1) fishers fill orders from Tubuai's "non-fisher" population, and 2) fishers respond directly to requests from Tahiti. It is also possible for certain fishers to use a hybrid system (i.e. one based on a combination of both local demand and orders from Tahiti). There are also additional minor channels.

Origin of demand for giant clams

The first channel consists of orders from people on Tubuai who order one to four *touques* of *pahua* from certain families. When the fisher has enough orders, he goes fishing. Payment is made directly by local customers to fishers, with no middleman involved. This is probably the most visible channel. Questions then arise about where local orders end up: Why do people on Tubuai order giant clams? Do they eat them themselves, sell them, or send them as gifts to family on Tahiti or Rurutu?

In fact, people on Tubuai who order clams from fishers say that they do so to send them to relatives on Tahiti. This case often involves "gifts" for festive occasions, but certain families buy *pahua* from relatives who are still living on Tubuai. Whatever the situation, this process is based

⁴ Estimate based on an average of 120 giant clams/*touque*.

⁵ Pacific franc; XPF100 is equal to EUR 0.840 and USD 1.09

more on a form of "the exchange of friendly services" than on commerce. Nevertheless, there may be cases where this system of family solidarity should be verified as some people place orders with fishers every month, supposedly to "send to their relatives".

We consider that there are two possibilities: either their relatives on Tahiti eat practically nothing but *pahua*, or they resell these giant clams to hotels and restaurants. Alternatively, the shipments are not based on aspects of kinship at all but rather are direct responses to orders from hotels and agro-food industries on Tahiti. Within this first channel then, there are people on Tubuai who act as "middlemen" (i.e. they place orders with fishers and resell the giant clams to contacts in Tahiti: restaurants, food vans, major hotels, exporters, supermarkets, etc.).

The second channel consists of fishers working directly on orders for people in Tahiti. This channel is less visible and is extremely difficult to obtain reliable information on. In principle, the fishers involved ship the orders to Tahiti but do not leave Tubuai. In a very few instances, fishers such as those who live on Mataura, supply *pahua* to the few snack bars on the island.

According to island elders, in the past people harvested *pahua* to sell on Tubuai. At the time, this simply involved sales for local consumption by people on the island, often during festive occasions. People harvested about three *touques* of giant clams per day and sold the *pahua* for XPF 100/kg, which was very little income for work they considered tedious. Fishers today are satisfied to see a *touque* sell for XPF 8000–10,000. Obviously the current situation bears no relationship to the time described by

the elders when there was no commercial channel worthy of the name on Tubuai.

One of the first "official" commercial giant clam operations on Tubuai was linked to the initiative of a *popaa*⁶, who in 1990 sent giant clams to Tahiti on a regular basis. A middleman there received the *pahua* and supplied hotels, restaurants and supermarkets on Tahiti. The clams were packaged to meet the health standards required for large retail stores. The quantities of *T. maxima* sent equalled about 500–600 kg of meat per month. At the time, the fishers who worked for the restaurant owner each harvested 50 kg of meat in four or five hours of fishing. This was apparently the maximum yield and so the people who fished had the reputation of being good giant clam fishers. Today, that person no longer conducts this business, but others have taken over the work.

On Tubuai there are only two ways of shipping goods: by boat or by plane. The plane makes an average of four return trips a week. Giant clams are shipped by air for urgent but costly orders. The cost of air freight is high: XPF 6000 to send one *touque* (20 kg) of giant clams from Tubuai to Tahiti. People who say that they are sending their giant clams to relatives often do so by plane. However, this is quite expensive for a family shipment when the local cost of the *touque* is added in, XPF 16,000 for one *touque* shipped to Tahiti.

Given the prohibitive cost of air freight, a large proportion of exports appear to be carried by boat except when shipments are urgent. Although the boat makes only two return trips a month, the low shipping costs compensate for the inconvenience. When shipped by boat, the giant clams are packaged in flour sacks that

hold about two *touques*. The cost of shipping one sack is XPF 1000, which is one-twelfth the air freight cost. An employee in charge of registering all items loaded onto the ship *Tuhaa pae*, estimated that slightly more than 40 *touques* of *pahua* are shipped each month from Tubuai to Tahiti, which equals about 800 kg/month. According to our informant, Raivavae exports much more, about 2000 kg/month. However, we think this is an underestimate, since a single Tubuai family specialising in giant clams harvests an average of 45 *touques*/month, which equals 900 kg of meat. Given this information, the Tahiti Fisheries Department is trying to clarify the situation by obtaining better estimates and — with the support of local authorities — has set up controls for this purpose through the Rural Development Service on Tubuai.

A sensitive local situation

It is not always easy to obtain information about giant clam fishing on Tubuai because it is something of a "secret fishery" that islanders do not discuss readily with "outsiders". In fact, there are no written records on the giant clam fishery and the Mayor's Office has no information or reports on it. Giant clams account for significant financial revenues for fishers, and are even an essential source of income for some. Only a few fishers dared to respond to the embarrassing question — Is income from *pahua* vital for your family or is it just extra income? — by admitting that this income was essential for their households. People are afraid to say that *pahua* can generate increased levels of income out of fear that the Territorial Government will want to tax it.

Given this setting, the information we did obtain tended to show that the issue of possibly

⁶ Local name for people from metropolitan France.

managing giant clams is a source of conflict. In addition to work by the Fisheries Department, local authorities (the Mayor's Office, Municipal Council and Council of Elders) have for several years been discussing the possible implementation of a *rahui*⁷ on giant clams. On the island, the authorities are aware that the *pahua* is subject to commercial-level operations. However, it was at the specific initiative of the Tahiti Fisheries Department that discussions about this matter recently resumed. In short, the Mayor's Council, assisted by the island's "wise men", is divided on this matter.

According to a few members of the Council, a *rahui* must be put in place to ensure the survival of the giant clams, but much hard work still needs to be done to convince everyone of this. According to several reports, managing *pahua* stocks by means of a *rahui* is vital to conserve these resources. However, many islanders believe that there are never-ending supplies of *pahua*.

It is particularly noteworthy that, contrary to expectations, the old people, fishers or members of the elders, are for the most part against the *rahui* although they are supposed to be the guardians of tradition and resources. A few elders stated that there has never been a *rahui* on giant clams on Tubuai and they do not understand why there should be one now. In general, *pahua* fishers between the ages of 30 and 45 do not seem to be particularly opposed to a *rahui*. Many are fathers with children but, more importantly, they are better informed than the old people about a possible decline in the

resource. These adults seem to be more concerned with the future of *pahua* for their children. However, this is not the case with the elders, who seem to want to profit as much as possible from the resource without really worrying about the future. While some people do not want to hear anything about a *rahui* on giant clams, they would like a *rahui* to be put on the price: No less than XPF 20,000 per *touque*.

Half of the Mayor's Council is still in favour of a *rahui*, while the other half is against it. Given this conflict, the role of the elders must not be underestimated. In invoking the fact that no *rahui* on giant clams exists in oral traditions, it is apparent that the effect of their opinions is to swing the situation in favour of uncontrolled fishing.

LOCAL CONCEPTS ABOUT THE PAHUA FISHERY ON TUBUAI

Faced with apparently increasing commercial exploitation, we felt that it was important to find out whether the people of Tubuai attributed any symbolic importance to giant clams that could be used to limit harvests.

The sociocultural position of giant clams

The giant clam is apparently a food that people are most likely to eat during festive occasions. It is very commonly eaten at weddings, during a *ma'a*⁸ or during the *heiva*⁹. According to fishers, it is much less commonly eaten during regular meals "because collecting *pahua* is a lot of work". In contrast to Raivavae, which has a few legends about giant clams (Lherbier 1944), Tubuai

has none, and the bivalve itself is not subject to any prohibitions¹⁰. According to elders, *pahua* have never held any kind of symbolic meaning on the island, unless it has been forgotten. Apart from the ban on bringing the shells back to land, they do not know of any specific prohibitions relating to *pahua*. However, the giant clam is known locally as *te metua vahine o te miti* (the mother of the sea), which reveals that it was traditionally considered important within the rest of the ecosystem. And, and in former times, priests used giant clam shells for religious rituals on the *marae*¹¹, again indicating the giant clams' significance (Audran 1926).

What is perhaps more interesting is that during a *rahui*, the prohibited area was delineated by necklaces of giant clam shells attached to the trees at the boundary of the *tabu* zone. These areas were monitored by people called *toohitu*, "guardians of the sea". During the *rahui* on giant clams, the sea was divided up, and each part had a name. However, the elders can no longer recall the names. When the *rahui* was removed, people would go out fishing together, which would ease tensions between families. Traditionally, giant clams were harvested with pointed sticks made from the wood of the *aito* (*Casuarina*) root, and the meat was removed with bamboo "blades" (Gilbert, op. cit.).

Apart from this sketchy and largely irrelevant information, we were not able to gain any other information on the sociocultural position of giant clams on Tubuai. This suggests that it would be difficult today to base a *rahui* on any kind of symbolism in an effort to protect the

⁷ *Rahui* is the traditional system for managing lagoon resources. Sites were closed to fishing for a set time or a ban on harvesting specific species was imposed until such time as the ban was removed by the Council of Elders or wise men.

⁸ *Ma'a* refers to a traditional Tahitian meal with food steamed underground in a traditional oven, but also to a social or family gathering.

⁹ *Heiva*, which used to be called *tiurai*, is a long period of festivity during July.

¹⁰ Except for Seventh-Day Adventists who do not eat it.

¹¹ *Marae* are religious edifices and traditional sacred sites. They usually consist of different levels of raised platforms built from stone, on which diverse ceremonies were practiced.

resource by referring to tradition. On Tubuai, the only symbolism that giant clams currently seem to have can be summed up in terms of financial value.

Is the *pahua* endangered on Tubuai? Fishers' responses

People are increasingly attracted to the income generated by *pahua* fishing. The islanders consider that the giant clams belong to everyone, and individuals are free to harvest as much as they like, as long as "they're not afraid to get their feet wet going out to get them".

When first asked about their purpose in fishing for *pahua*, many fishers responded "to send to relatives in Tahiti". People may not respond truthfully either because they are afraid of being taxed on this fishery or because the authorities on Tahiti might put restrictions on the collection of giant clams. At present, fishers are suspicious of territorial authorities and of what is being said about the decline of giant clam stocks. Fishers also challenge certain scientific information that was poorly understood during meetings with the Fisheries Department. For example, they do not agree that a period of five years is needed for giant clams to reach their "adult stage". Fishers think that clams reach this adult stage in two to three years. However, there is some confusion in their minds between the adult stage, which — from an ecological point of view — corresponds to sexual maturity, and the legal fishing size of 12 cm. In fact, fishers believe that the adult stage corresponds to the authorised size for collecting giant clams.

Almost all fishers interviewed had been harvesting giant clams for 15 to 20 years and sometimes longer. They said that they had not noticed any decline in stocks, with some saying that there were now more giant clams than

before. According to the Rural Development Service Officer on Tubuai, "There are giant clams everywhere around the island, except between the airstrip and the pass". This informant also said that the shellfish is recolonising areas it had disappeared from between Mataura and the first motus (islets) in Mahu.

In fact, fishers do not believe that stocks are declining as scientists claim. In addition to the reasons mentioned above, they think that collecting giant clams is not harmful to the renewal of the resource for two main reasons. The first is based on a cultural argument or recourse to tradition — which is oral and therefore difficult to verify — that claims people have harvested giant clams for many generations without destroying the stocks.

The second is linked to practices. In the past, custom dictated that giant clam shells were never brought back to land (except for specific uses related to religious rituals). They had to be thrown back into the lagoon they had

been taken from. This *tabu* had two bases: 1) to avoid cluttering the beaches with piles of shells that could cause injury, and 2) to allow "reproduction of the shells". This practice is still in effect and the Tahiti Fisheries Department encourages fishers to follow it.

Many fishers think that the shells come back to life in the lagoon. Some fishers said that they had noticed that after six months, the shells that they had thrown back into the lagoon "came back to life", allowing renewal of the giant clams. In this regard, some "newly arrived" fishers who did not respect this *tabu* were strongly criticised by the community for bringing giant clam shells back to the land. Since then, everyone has been expected to respect the prohibition and are persuaded that they are promoting giant clam reproduction when they leave the shells in the lagoon. Nevertheless, as can be seen in Figure 3, not everyone is following the prohibition. According to one fisher on Tubuai who was still living on Tahiti in 1950, there were as many giant clams between Paea and



Figure 3: Opening giant clams with a knife on the beach. Theoretically it is "prohibited" by custom to open *pahua* on the beach and to leave the shells there. This ban has also been issued by the Tahiti Fisheries Department, which advocates throwing the empty shells back into the lagoon to facilitate settlement of juvenile giant clams.

Papearii as there are on Tubuai. If there are not many giant clams on Tahiti now "this is indeed because people brought the shells back to land".

Secondly, fishers think that cleaning the giant clams in the lagoon "releases" and scatters the shellfish's eggs, which then develop into new specimens. As with the miraculous "resurrection" of the shells, this is not the case. According to the Fisheries Department, at most this process might stimulate and speed up reproduction in nearby giant clams by releasing pheromones that act as sexual stimuli. In no case do the eggs thus released develop to term.

Given the current state of affairs, therefore, fishers do not see the point of setting up protection zones for giant clams since they do not believe that their fishing habits are a threat to the resource. Their opinion is supported by the fact that there are still significant numbers of the shellfish in nearly every part of the lagoon. However, although they feel that giant clam stocks are not actually endangered, opinions seem to be divided. Some fishers have noticed that the number of giant clams has declined all around the island. Based on what they have observed, the few fishers willing to admit this are not against the idea of an updated and well-adapted *rahui*. For the moment, they are in the minority. However, it is important to note that this group consists of fishers who are not dependent on income earned from giant clams, which allows them a certain measure of detachment. This is not the case for fishers who are more heavily involved in sharing the proceeds from the sale of giant clams.

Tabu zones

Given the situation described, we tried to find out if certain ancient beliefs linked to the French Polynesian concept of *tabu* and sacred sites still exist, particularly regarding possible forms of traditional management of giant clam stocks.

However, traditional customs, including those relating to the sacredness of sites and fishing practices, seem to have disappeared from Tubuai. Even the *marae* are no longer given any special attention and are generally overgrown by vegetation and treated with indifference¹². For example, in Haramea, a 1.2-m phonolite still standing on the ground, and locally called "the ringing rock", was once used to call people together, but to the best of our knowledge, no one remembers its precise history. According to legend, the island lost its navel, which was carried off to Maiao¹³ by the bird guardian who was disappointed in the behaviour of man. No one remembers the exact reasons behind this disappearance and it is rare to find a person who can still tell the entire history of Motu Ofai, the only phonolithic volcanic island in the lagoon.

In practice, the local communities fish all around the island, except in those spots where the geomorphology of the lagoon is not suitable for harvesting giant clams. When they want to collect giant clams, fishers from Mataura go by boat in the direction of Haramea or the first *motus*, Mautaro and Toéna, 6 km offshore from Mataura. This entails fuel costs and probably explains why there are very few *pahua* fishers in Mataura. In Tamatoa/Mahu, people go directly out from where they live and fish in

front of their houses a few hundred metres into the lagoon and all the way out to the reef. In Haramea, the fishers we encountered said that they also went across from their homes to the lagoon and out to the reef. Many said that they had been harvesting giant clams for 20 to 30 years and had not noticed any decline in the *pahua* stock.

It appears that fishing areas are no longer prohibited to permit renewal of resources. The community has no recollection of the last time a *rahui* was used on Tubuai. Furthermore, some elders themselves say that these bans never involved giant clams. Nevertheless, according to a few reports, the *motu pahua* are the result of long-term dumping of giant clam shells by the elders. According to these reports, it was traditionally forbidden to get rid of the shells elsewhere in the lagoon. The gradual build-up is supposed to be the origin of the *motu*¹⁴. Today it is difficult to clarify matters: is this a simple myth that has become part of the collective memory or is it the surviving traces of historically based facts?

In terms of traditional lagoon resource management, the old practices have been "forgotten". The islanders know that the *rahui* system was used on Tubuai, but very few people know exactly when the system was abandoned. Thus, there are no longer any areas temporarily closed to *Tridacna maxima* harvest, either in fact or in the memory of oral tradition.

CONCLUSION

There is little awareness of a possible decline in *pahua* and many fishers seem to be convinced that this resource is inexhaustible, or

¹² Except by a few people who are trying to maintain the island's cultural heritage.

¹³ A high island in the Society group.

¹⁴ This version appears rather far fetched to us and we think that it is more likely that this pile of shells is the result of the lagoon's own natural selection or hydrodynamic segregation processes.

at least that is the impression they gave. However, we did note that near the village of Mahu — in the very area where the largest number of giant clam fishers can be found — some 120 to 140 *pahua* are needed, on average, to fill a touque. On the Haramea side, 90 to 100 giant clams are enough to fill one. Although large giant clams continue to be harvested near Haramea, it does seem that the fishers in Mahu are now harvesting large *pahua* from younger generations. In addition, several fishers admitted that they had to go into increasingly deeper waters to find large giant clams.

Certainly there are still large numbers of *Tridacna maxima* on Tubuai, but if the commercial sector continues its uncontrolled growth, we believe the situation could quickly become critical. A few indigenous people share this opinion and tend to favour putting a *rahui* in place. According to them, giant clams will go the same way as *remu* seaweed¹⁵ if no

bans are implemented. But most importantly, vestiges of oral tradition seem to be used by certain elders as a shield to protect their economic interests. In fact, many of them are directly involved in obtaining revenue from the giant clam fishery. The existing gap between the local portrayal of the situation, economic reasoning, and scientific claims makes joint management of giant clam resources very difficult. In addition, this fishery is vital for numerous families on Tubuai, whose standard of living is one of the lowest in French Polynesia.

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¹⁵ This type of seaweed was harvested in large quantities by the community and sold with no control measures. Today it has almost disappeared.

