



Fisheries

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Editorial

In this issue of the Fisheries Newsletter, readers will find reports on the activities carried out by the various sections of SPC's Marine Resources Division. Please note the item on the 15th meeting of the Standing Committee on Tuna and Billfish (Honolulu, Hawaii, 22 to 27 July 2002). The committee is designed to act as a forum where tuna scientists and tuna industry professionals can meet and address scientific issues on fishing data, research and stock assessment.

The Fisheries Training Section has recently produced a video: *Grow Seaweed, Grow Your Own Money*, the purpose of which is to promote seaweed culture by remote fishing communities. The film was made in Kiribati where the growing of *Eucheema* is already well developed, with an annual output of 1000 tonnes of dry product. There is market demand for this commodity and the production technology is known and reliable. Other countries could consider going into this type of aquaculture in the very near future. Enjoy this issue!

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*In Niue the Public Works workboat can be used
for maintaining FAD upper moorings.*

[Photo: Lindsay Chapman]



SPC ACTIVITIES

■ FISHERIES DEVELOPMENT SECTION

Certificate in Small Fishing Operations course – Papua New Guinea

Fisheries Development Officer William Sokimi conducted two courses in Kavieng, Papua New Guinea, with the National Fisheries College. The courses resulted in Certificates in Small Fishing Operations (SFO), being awarded to 27 participants. Six tutors were also trained, enabling them to implement this course in future. The SFO course targeted small-scale village fishermen who operate outboard-powered skiffs or banana boats, and work relatively close to the reef or coastline. The course combined classroom theory, and practical at-sea training in fishing methods and gear use.

Participants in the competency-based courses were assessed to gauge their understanding of the topics, and to measure their practical performance in gear rigging and vessel preparations, while fishing. The SFO course addressed three main subjects: safe boat operations, fishing operations, and seafood handling.

The three main topics relating to safe boat operations were: understanding health and safety requirements, operating a small craft, and operating and maintaining outboard motors. With respect to fishing operations, participants were coached

on: proper and effective work methods in the seafood industry; and preparing, deploying, retrieving and maintaining the hand-operated fishing gear used in ika-shibi fishing (these include squid jigging and light attraction methods, palu-ahi, vertical longline, 50 hooks horizontal longline, and deepwater bottom hand-reel fishing. Regarding seafood handling, participants were instructed in food handling and safety practices (including methods of preparing fish for the export market), and the importance of keeping the working area hygienic.



*Skiffs/banana boats used for at-sea training
[Photo: William Sokimi]*

*Course participants being trained in deep-water snapper fishing
[Photo: William Sokimi]*



Standing Committee on Tuna and Billfish – Hawaii

Fisheries Development Officer Steve Beverly attended the Standing Committee on Tuna and Billfish meeting in Honolulu, Hawaii, in June, as part of the Fisheries Technology Working Group. Steve presented a paper entitled, "State of the art longliner 2002", which showcased the New Caledonia long-

liner F/V *Yellowfin* (see *Fisheries Newsletter* #99). Steve reported that in the western and central Pacific Ocean the albacore component of the longline catch has increased significantly (both in volume and as a percentage of the overall longline catch), particularly below 10°S latitude. He stressed the need for both fish-

ermen and longline boats to be ready for this change, if they are to remain viable. Steve stated that longline vessels brought into the fishery should be adaptable, and that freezing at sea is a way to accommodate the increased albacore catch.



Longline fishing training – Cook Islands

In Cook Islands, Fisheries Development Officer William Sokimi focused on training potential crew for the country's developing and expanding domestic tuna longline fleet. The training was organised by the Ministry of Marine Resources, with funding from New Zealand.

The training aimed at increasing the number of local people crewing aboard tuna longline vessels, through teaching them skills. Many of the trainees were from the outer islands, where employment opportunities are very limited. Fisheries staff, as well as five crew from the longline vessel F/V *Mahr Leena*, also attended the training.

The four-week training combined classroom theory and practical at-sea exercises. Prior to the training, all participants

were required to attend basic first aid, basic firefighting, and sea survival classes.

Two at-sea training trips were made, but unfortunately only two sets were made on the first trip. The first set was conducted as a demonstration of line setting techniques and haul-back duties required of crew during longline fishing operations. Participants quickly adjusted to what was required of them.

The second set was made under more typical "commercial" conditions, but problems with the steering developed before the gear was hauled aboard. The crew tried to keep in contact with the gear during the several days it took to sort out the problem, but this was complicated because the gear continued to drift. Eventually the problem was

located, allowing the boat to manoeuvre and the gear to be hauled back.

Forty-one fish were landed from the first set; all but one shark was marketable. Twenty-six fish were boated from the second set, as some fish had to be discarded as a consequence of delays resulting from the mechanical breakdown. In total, 960 kg of export quality fish and 60 kg of saleable byproduct were discharged in Rarotonga for sale. The main species caught were mahi mahi, albacore tuna, wahoo and bigeye tuna.

Six sets were made on the second trip, and 2790 kg of export quality fish and 355 kg of byproduct were landed; mahi mahi, albacore tuna, wahoo and striped marlin were the main species caught. Moderate weather



Setting the gear
[Photo: William Sokimi]



Removing the hook from a mahi mahi
[Photo: William Sokimi]

allowed participants to get their sea legs and experience tuna longlining under typical conditions. Participants expressed gratitude at being given the opportunity to experience first hand the work involved in tuna longlining. It is pleasing to note that six participants gained employment on commercial tuna longliners at the completion of the workshop.

Fisheries Development Adviser Lindsay Chapman participated in a collaborative study in Niue on development options and

constraints for tuna longlining operations. Funded by the New Zealand government, a team of consultants including Ian Cartwright, of Thalassa Consulting, Brendon Pasisi, Niue Government Fisheries Adviser, and Ms Josie Tamate, Forum Fisheries Agency Project Economist, spent a week in Niue researching the issue and getting input from various stakeholders.

The study is examining a range of options, including small and medium-scale local development, joint venture operations,

foreign access, and reciprocal fishing arrangements with neighbouring states. The final report is expected to be presented to the governments of New Zealand and Niue in November or December 2002.



*Moderate weather conditions prevailed during the workshop
[Photo: William Sokimi]*

Update on the FAD research project

All 15 FADs deployed between Niue and Rarotonga and Aitutaki in Cook Islands were still on station after six months with none of the FAD designs showing any signs of deterioration. Servicing the FADs continues in Cook Islands on a regular basis, with the anodes needing

replacing on one of the wire cable FAD designs.

In Niue the mobile crane is working meaning the Public Works workboat can be used for maintaining FAD upper moorings. Five of the six FADs were serviced prior to or during

Lindsay's visit. Servicing included the replacement of aggregators.

In Niue, a sailor accidentally ran over a FAD, tangling the buoy system around the yacht's propeller. The sailor cut the buoy system to free it from the boat,

but was able to roughly tie the two ends together. The Niue Fisheries Department replaced the buoy system, the next day.

One area that needs improvement in all locations is the completion and returning of catch and effort logsheets. Fisheries

Departments in both countries are working hard on this, but it is very difficult without the co-operation of fishermen.



*Made-up aggregators
[Photo: Lindsay Chapman]*

■ COMMUNITY FISHERIES SECTION

I Qoliqoli Management Project

The “I Qoliqoli Management Project” in Fiji Islands began in September, following a trainers workshop for Fisheries Extension Officers.

The trained officers then served as trainers for their respective areas in the use of participatory learning tools for information gathering and needs assessment for resource management initiatives. Work in Fiji Islands has started



slowly as a result of ongoing management programmes.

These are priority work areas, and the new initiative has to be fit within the existing work schedule. Most of Fiji Islands’ established marine resource management projects involve practitioners working with communities on management in Fiji Locally Managed Marine Areas.



Country visit – French Polynesia

Aliti Vunisea, Community Fisheries Officer, undertook a visit to French Polynesia in association with the SPC Pacific Women’s Bureau, to assess both women’s participation in the fisheries sector, and resource management initiatives current-

ly in place. The joint visit was advantageous, and the role, status and problems facing women were clarified. Discussions were held with the Fisheries Department and the Environment Delegation, regarding the participation of women in the fish-

eries sector, and assessment of work relating to marine resource management at the community level.

It was obvious from initial discussions with female representatives (from both the govern-

ment and non-government sectors) that social problems were high on the agenda of issues relating to women, and that women's involvement in fisheries and other similar areas had yet to be recognised as important tools in addressing social issues. It was also apparent that in French Polynesia, the emphasis was on deep sea fish-

eries as opposed to lagoon fisheries; within coastal areas, the emphasis was more on the pearl industry.

Traditional communities have largely changed in most areas, with modern provincial structures in which the mayor replaces the traditional chiefly roles. Fishing in lagoon areas is

more common in outer islands, with some traditional fishing methods still practised.

Thanks are due to Roland Trolue, who was responsible for translation during meetings and discussions.



■ AQUACULTURE SECTION

Study tour of Cook Islands pearl industry

In September 2002 SPC organised an attachment with the Cook Islands Ministry of Marine Resources for Tevita Taumaipau, Pearl Oyster Project Officer from the Fiji Department of Fisheries. Tevita met with key government officials and business representatives in an attempt to gain an understanding of the Cooks' pearl industry, and paid a short visit to Manihiki atoll, which is the centre of pearl production in Cook Islands.

Initial meetings were held with Ian Bertram, Principal Director of the Ministry of Marine Resources, regarding the Manihiki Pearl Farming Plan, and with Temu Okotai, a pearl farmer in Manihiki, who owns a retail pearl outlet in Rarotonga.

Okotai expressed confidence in Fiji Islands' prospects for developing an industry, stressing that

management measures must be in place from the outset, as it would be very difficult to bring in these regulatory measures in the midst of industry development.

Visits were also made to Raymond Newnham, pearl farmer, pearl broker, and supplier of farming equipment; to Island Craft Limited, a company that markets jewellery, loose pearls, and handicraft items produced from pearl oyster shells; and to two Japanese pearl seeding technicians. A visit was also made to Manihiki to witness a pearl farm in operation.

Recommendations stemming from this trip include:

- Such trips be made regularly so as to keep up with changing production and marketing trends;

- Fisheries officers should be seconded to farms in Cook Islands to receive hands-on training and to familiarise themselves with technological trends and changes;

- Experts and officials from producing countries should be invited to Fiji Islands to give advice regarding development procedures and programs;

- Similar trips should be made to Tahiti, Australia and perhaps Indonesia, countries that are already mass producing pearls.

Thanks are due to Ben Ponia and Marie-Thérèse Bui for their assistance, and Ian Bertram and Temu Okotai for making the necessary arrangements in Cook Islands.



■ REEF FISHERIES OBSERVATORY

The DemEcoFish Project: Field Work in Fiji Islands

Field research carried out as part of the MacArthur Foundation-funded DemEcoFish project has moved to Fiji Islands after completion of six surveys in Tonga. To date, socioeconomic survey-

ing has been successfully completed in four Fijian village communities, including Muaivuso and Dromuna on Viti Levu, and Nukunuku and Nasaqalau on Lakemba, southern Lau Group.

As was done in Tonga, the Fiji Islands surveys gather relevant information on fishing grounds, fishing and seafood collection, consumption, and marketing of marine resources in each com-

munity. Methodological adjustments were made to survey methods developed in Tonga, to accommodate and respect Fijian traditional protocols.

A first comparison of data on frequency, quantity and diversity of marine resources caught and consumed from communities located in the southern Lau Islands and Viti Levu suggests that fishing pressure resulting from subsistence and small-scale commercial activities are higher in the communities located on Fiji's main island. Comparison between the communities on Viti Levu further suggests that fishing pressure is more severe in Dromuna village than in Muaivuso village, where people

have easier access to alternative income opportunities.

Marketing in the surveyed communities is via informal structures and networks, and varies according to distance, transport and general accessibility. In all cases studied so far, demand for fresh fish (and invertebrates) is greater than the supply. The selling price of fish varies considerably between village, regional and national market places.

The socioeconomic surveys were jointly conducted by the Community Fisheries Scientist from SPC's Reef Fisheries Observatory and staff members from the Fiji Department of Fisheries. Cooperation with a

staff member from the University of the South Pacific has recently started and will continue.

Information obtained during the surveys will assist in the preparation for ecological surveys of the fishing grounds used by each of the four Fijian communities.



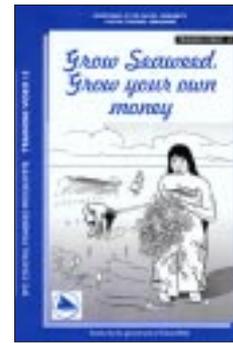
*The Fiji Islands surveys gathered relevant information on fishing, seafood collection and marketing of marine resources in each community
[Photos: Mecki Kronen]*

■ TRAINING SECTION

Seaweed video launched

The Fisheries Training Section has produced a new training video, *Grow Seaweed, Grow Your Own Money*. Using funds from a Taiwan/ROC-funded aquaculture project, the Section hired a video production company in Kiribati (Nei Tabera Ni Kai video unit) to produce a video on seaweed farming.

The video uses a humorous style to promote seaweed farming as a new cash crop for fishers and farmers in rural coastal areas. The new video is now available for distribution. It will complement a more technical video being produced by USP.



Training in tuna handling and grading, and seafood safety

In the absence of a dedicated Post-Harvest Fisheries Section, the SPC Coastal Fisheries Programme is committed to continue filling the region's training gaps in the key area of seafood quality and safety. Similar efforts are being made, in parallel, and often collaboratively, by the USP Marine Studies Programme.

During the third quarter of 2002, the Fisheries Training Section provided post-harvest training assistance to Samoa, Palau, the Cook Islands, Fiji and the Solomon Islands. Training covered tuna handling (Cook Islands), tuna grading (Samoa and Cook Islands) and seafood safety/HACCP (Fiji, Palau, Solomon Islands).

➤ In Samoa, the tuna grading workshop followed an initial training in December 2000 when Albert Petersen, a professional grader from Fiji, trained staff of local tuna export companies. High staff turnovers have resulted in the Samoa Fisheries Division requesting a second workshop, which was run by Section staff in July this year. The workshop was two-fold

with a classroom session on Monday 29 July followed by practical grading demos at the various companies. The lecture was attended by 24 trainees from the main seafood exporters in Samoa: Apia Export Fish Packers, Tradewinds Fish Co., CJ Exports, Albacorp Fish Co., Riverside Marine, as well as seven staff from the Samoa Fisheries Division. The follow-up on-site grading sessions were attended by approximately 35 additional persons.

➤ In the Cook Islands, three workshops were run back to back, in August. The first workshop targeted 12 outer islands trainees who had been brought down to Rarotonga by the Ministry of Marine Resources to take part in a month-long training programme on tuna longlining conducted by SPC Fisheries Development Officer William Sokimi. The tuna handling workshop was thus the first component of this training and was aimed at making these prospective crew members proficient in tuna handling skills. Apparently the

workshop had a positive impact on trainees, with William's later reporting of the trainees' excellent handling practices during longline trips. The second workshop included tuna grading as well as tuna handling. It was attended by 10 reps from existing and prospective fish export companies: Latitude 22 Fisheries Ltd, Taio Shipping, Cooper's, Brent Fisher's and Brett Porter's. Grading practicals at Latitude 22 followed the morning classroom session. A third workshop on tuna handling was attended by nine local fishers who were interested in targeting large tunas around FADS, using fish export companies to sell their catch on the lucrative overseas sashimi markets.

➤ A grant from Taiwan/ROC (USD 25,000) made possible the organisation of several in-country USFDA/HACCP courses. Palau was the first country to receive assistance in August through the visit by a seafood specialist from New Zealand (Francisco Blaha). The course, based on the US AFDO/

Seafood Alliance curriculum, was attended by six local seafood processors, four staff from the Department of Public Health and two staff from the Bureau of Marine Resources. The course in Fiji was jointly organised by the Training Section and USP's Marine Studies Programme. The

consultant hired by SPC (Cushla Hogarth from New Zealand) and Tony Chamberlain (USP) taught HACCP principles to 30 members of the local fishing industry and two staff from Fiji Fisheries Division. Lastly, in September, another seafood expert (Nigel Harris) travelled to the

Solomon Islands to run two HACCP courses, one in Honiara for 28 participants from the local industry and the other in Noro (Western Province) for 10 staff of the cannery owned by Soltai Fishing and Processing Co.



*Left and centre: Grading and packing H&G yellowfin and bigeye tuna at Apia Export Fish Packers (Samoa). Right: Cleaning albacore tuna before freezing at Tradewinds Fish Co. (Samoa)
[Photos: Michel Blanc]*

In brief

➤ Ian Cartwright, ex-FFA Deputy Director, now fisheries consultant based in Launceston, Tasmania, has completed the external review of the famous SPC/Nelson Polytechnic fisheries officers course which over the 1979–2002 period has trained close to 300 Pacific Island fisheries staff. Ian has had discussions with staff of the SPC Coastal Fisheries Programme at Noumea and the New Zealand School of Fisheries at Nelson. Several countries have been visited (Papua New Guinea, Solomon Islands, Fiji Islands, Tonga and Niue) and past trainees and fisheries administrations in other countries and territories have been consulted via questionnaires. The review report will be tabled at the Heads of Fisheries meeting early in 2003 and forwarded to course donors. SPC will develop a course outline for presentation at the 2003 HOF and, provided funding is secured, the new version of the Nelson course will be offered early in 2004.

➤ Training Section staff are finalising the development of new educational materials. The by-catch issues in pelagic longlining need to be tackled in a proactive manner and to that effect, it is important to start raising awareness and training longline vessel crew in the region. Early in 2003, a series of turtle by-catch materials will be released: some guidelines on how to release hooked turtles (posters, laminated cards and stickers) will be distributed to fisheries administrations and fishing companies in both English and

French speaking countries and territories. Later in 2003, the by-catch awareness workshop materials used in Hawaii will be adapted to the western and central Pacific tuna longline fishery and distributed to the region's fisheries training institutions.

- A training video on tuna loining will be available for distribution early in 2003. The footage for the video was filmed during a workshop in Fiji in 1999. Since then the number of loining operations, mainly for albacore tunas, has increased following the success of Tahitian companies. This video, which provides a step-by-step demonstration of the "hanging technique", should fill a training gap. It will be available in both French and English.
- A two-week organisational and financial management workshop will be run for the Palau Federation of Fishing Associations in February 2003. With funding from New Zealand and

SPC, an enterprise management specialist will travel to Koror to train PFFA Board members as well as managers of State cooperatives.

- In October, two instructors from the Solomon Islands School of Fisheries and Maritime Studies travelled to Noro, in the Western Province, to train 170 pole-and-line vessel crew in safety-at-sea. This massive training programme, sponsored by SPC, took almost a month to complete and combined on-board and classroom training. A second round is scheduled in December to train the remaining 200 crew from one of the largest fishing company in the Pacific. On completion of the training participants received a Basic Sea Safety certificate, which is mandatory under Solomon Islands legislation.



■ OCEANIC FISHERIES PROGRAMME

Fifteenth meeting of the Standing Committee on Tuna and Billfish

The fifteenth meeting of the Standing Committee on Tuna and Billfish (SCTB 15) was held from 22 to 27 July 2002 in Honolulu, Hawaii, hosted by the University of Hawai'i Pelagic Fisheries Research Program.

Attendees included participants from Australia, Canada, Cook Islands, Federated States of Micronesia, Fiji Islands, France, French Polynesia, Indonesia, Korea, Marshall Islands, New Caledonia, New Zealand, Niue, Northern Mariana Islands, Palau, Papua New Guinea, People's Republic of China, Philippines, Samoa, Solomon Islands, Taiwan/ROC, United States of America, Vanuatu, Vietnam, and Wallis and Futuna.

Representatives from various regional and international organisations also attended, including the Food and Agriculture Organization (FAO) of the United Nations, Inter-American Tropical Tuna Commission (IATTC), the Indian Ocean Tuna Commission (IOTC), and the Forum Fisheries Agency (FFA).

The Chairman and Group Coordinators for SCTB 15 were: SCTB Chairman: Mr Bernard Thoulag; Fishing Technology WG: Mr David Itano; Methods WG: Dr John Sibert; Statistics WG: Mr Tim Lawson; Albacore RG: Mr Régis Etaix-Bonnin; Bigeye RG: Dr Chi-Lu Sun; Skipjack RG: Dr Gary Sakagawa; Yellowfin RG: Dr Robert Campbell; Billfish and Bycatch RG: Mr Paul Dalzell.

The Chair of SCTB was scheduled for rotation after the two-year term of Mr Bernard Thoulag of Federated States of Micronesia. The meeting endorsed

the nomination of Dr Sung Kwon Soh (or his designate) of Korea for a new two-year term as SCTB chair. The meeting considered the timing and venue for SCTB 16, which will be hosted in Mooloolaba, Queensland, in July 2003 (exact dates to be advised).

There were eight individual working groups:

- Statistics Working Group (SWG)
- Fishing Technology Working Group (FTWG)
- Methods Working Group (MWG)
- Skipjack Research Group (SRG)
- Albacore Research Group (ARG)
- Yellowfin Research Group (YRG)
- Bigeye Research Group (BRG)
- Billfish and Bycatch Research Group (BBRG).

The initial overview of western and central Pacific Ocean (WCPO) tuna fisheries noted that the estimated total catch for 2001 for the four main tuna species was 1,914,000 mt, the second highest annual catch on record after 1998 (2,039,000 mt).

The 2001 WCPO catch of skipjack (1,206,000 mt) was slightly lower than in 2000 and well below the 1998 record catch (1,318,000 mt); as usual skipjack dominated the total catch. The WCPO yellowfin catch (476,000 mt representing 25% of the tuna

catch) was the highest since 1998 (494,000 mt), and continues to comprise 35–40% of the global yellowfin catch.

The bigeye (115,000 mt) and albacore (117,000 mt) catches each accounted for about 6% of the total and were similar to 2000 levels, but not as high as the record catches in 1999 for these species (116,000 mt and 148,000 mt, respectively). Reports on relevant activities of other organisations were received from IATTC, FAO and IOTC.

Statistics Working Group

The Statistics Working Group reviewed the status of data collection, compilation and dissemination, and the directives to the SWG that were made during SCTB 14. These directions concerned the compilation of data from Indonesia, the Philippines and Vietnam; methods to determine the extent of unreported catches in the WCPO, including trade statistics and catch certification schemes; discrepancies between bigeye species composition sampling by observers and port samplers for purse seiners; a workshop on standards for the design of national and regional observer programmes; the targeting of albacore by longliners; the compilation of vessel and gear attributes; and increasing the observer coverage of most fleets.

Directives to the SWG made during SCTB 15 include: several activities related to the development of standards for the design of national and regional observer programmes; the evaluation of the reliability of port sampling data and observer data; the examination of discrepan-

cies in the proportion of bigeye in “yellowfin plus bigeye” determined from purse-seine port sampling data and observer data; the development of a project to sample the species composition and length of fish caught in the domestic fisheries of Indonesia; and the documentation of procedures that are used by Indonesia and the Philippines for collecting data and estimating annual catches.

Methods Working Group

The Methods Working Group conducted research during the inter-sessional period to evaluate the performance of several stock assessment models. SPC’s Oceanic Fisheries Programme operational model was used to generate “simulated data” for analysis by MULTIFAN-CL, SCALIA, ASCALA, ADAPT, and age-structured and Fox production models. MULTIFAN-CL and some of the other complex models appear to estimate ratios of certain population parameters with acceptable accuracy.

Therefore, MWG participants were cautiously optimistic about the accuracy of MULTIFAN-CL biological reference point estimates, e.g. B/BMSY (relative biomass needed to produce MSY) and F/FMSY (relative fishing mortality to produce MSY). During the inter-sessional period prior to SCTB 16, MWG will continue the simulation work to evaluate model performance, focusing on the role of spatial structure and population movement in assessment results. Assessment models will also be tested with more realistic levels of variability in the simulated data. MWG will conduct an in-depth review of the MULTIFAN-CL yellowfin assessment for presentation to SCTB 16.

Fishing Technology Working Group

A preparatory meeting of the Fishing Technology Working Group was held prior to SCTB 15. Participants discussed 15 papers relating to: fleet reports; technical reference papers; technical data collection; the economic condition of surface fisheries; advances in vessel efficiency; anchored and drifting FAD technology and by-catch; regional purse-seine management initiatives, harvest capacity issues, regional bigeye tuna management issues and new entrants to the WCPO fishery. A detailed report of this meeting is appended to the final SCTB 15 report.

During the plenary session of FTWG, the report of the preparatory meeting was presented in addition to presentations on fishing strategies, vessel performance factors, current status and outlook for the US western Pacific purse-seine fleet, and technical advances in regional purse-seine and long-line technology.

Directives to the FTWG arising from discussion during SCTB 15 included work to: improve information useful to define and adjust for increasing efficiency in surface fisheries (particularly FAD-related issues); assist with observer training to recognise and document new fishing technologies; investigate the impact of new fishing technology on at-sea and port sampling programmes; and assist efforts to improve catch and effort data describing mixed bigeye/yellowfin landings.

Research Groups

The five Research Groups considered regional fishery developments, advances in research, stock assessment, and research coordination and planning for

skipjack, albacore, yellowfin, bigeye, billfish and by-catch. Summary statements on these matters are provided for each research group.

Several cross-cutting issues emerged from the Research Group discussions:

- (i) Stock assessments for skipjack, yellowfin and bigeye tunas continue to be hampered by the lack of adequate fisheries statistics (catch, effort, size and species composition) for some areas. In particular, data collection in the fisheries of Indonesia and Philippines needs to be strengthened.
- (ii) There is a need for improved observer coverage in order to sample the proportion of bigeye and yellowfin in purse-seine catches, estimate catch rates for non-target species, and collect size-composition data.
- (iii) Assessments for yellowfin and bigeye tuna indicate that both stocks are likely to be nearing full exploitation, in contrast to skipjack and South Pacific albacore stocks, which appear capable of sustaining current levels of exploitation. The catches and fishing mortality of juvenile yellowfin and bigeye have increased greatly over the past decade, due primarily to increased catches in Indonesia and the Philippines, and by the international purse-seine fishery. In respect to the purse-seine fishery, the rising use of drifting FADs has increased juvenile mortality of both species. SCTB 15 reiterated the recommendation of SCTB 14 that there be no further increase in fishing mortality in surface fisheries for these species in the WCPO.
- (iv) The Research Groups identified various research and fishery monitoring activities that

would lead to improved understanding of the stocks. Large-scale conventional tagging to provide better information on natural mortality, fishing mortality, movement and stock structure was seen as critical for all species. Also, archival and pop-up tagging of yellowfin, bigeye and albacore are needed to provide detailed information on vertical habitat utilisation used in CPUE standardisation studies. SCTB 15 therefore recommended that a small group be established to plan future tagging programmes and consider funding alternatives.

Albacore Research Group

The South Pacific albacore comprises a single stock. Catch in 2001 reached about 52,000 mt with a noticeable increase in fish caught by longliners from some Pacific Island countries and territories (PICTs). These vessels accounted for almost 50% of the total longline catch, which was estimated at 46,000 mt in 2001. Less than 15% of fish are taken east of 150°W, and most fishing occurs between 10°S and 50°S.

The total catch last year was the highest since the peak recorded in 1989 when drift net vessels fished in the region of the subtropical convergence zone (STCZ). The albacore surface fishery is now composed only of trollers, with a fishing season spanning from November to April around the STCZ and in New Zealand coastal waters.

Albacore CPUE of Taiwanese longliners operating in the

South Pacific showed a slight increase during the 1990s, except at the lowest latitudes where a drop was recorded in the most recent years. This appears to be related to changes in the fishing practices of this fleet towards targeting of bigeye and yellowfin, particularly in the waters north of French Polynesia. Changes in fishing practices of PICT longliners may also explain some recent trends in the albacore CPUE recorded in the EEZs of these countries. Some of these vessels are now fitted to target different species with flexibility.

CPUE for the New Zealand troll fleet has been relatively stable during the 1990s, showing some convergence in recent years with that of the USA troll fleet, which was previously higher and more variable.

The length-frequency data collected from longline and troll fleets indicate a single multiple-age class mode throughout the year with some overlap in the size composition of fish taken by both fisheries from January to March.

From the most recent stock assessment carried out with the MULTIFAN-CL model, biomass levels appear to reflect the variation of recruitment: the current biomass is about 85% of the estimated equilibrium unexploited biomass. The impact of the fisheries on total biomass is estimated to be low (reduction of less than 20% from the unexploited conditions).

However, there is a need to improve the assessment with

additional tagging data and more information on tag-reporting rates.

Better knowledge of the South Pacific albacore stock with respect to recruitment and biomass is expected from the use of a high resolution environmental and population dynamics simulation model originally developed for skipjack (SEPODYM model). With regard to albacore this model gives encouraging preliminary results but further refinement is required.

The MULTIFAN-CL model results indicate that current aggregate fishing mortality is less than FMSY (fishing mortality rate which, if applied constantly, would result in MSY, the maximum sustainable yield), and the adult biomass is greater than BMSY (biomass at MSY). The assessment could be improved by the following priority research and monitoring activities:

- (i) Strengthen the monitoring of catch, effort and size composition of albacore caught by PICT longline fleets;
- (ii) Obtain information on the fishing depth of longline gear targeting albacore;
- (iii) Conduct conventional tagging to improve estimates of natural mortality, fishing mortality and movements, and archival tagging to obtain information on albacore vertical habitat utilisation.

Skipjack Research Group

Skipjack tuna are the most important tuna resource in the WCPO, in terms of contribution by weight to the total catch. In the past decade, skipjack tuna catches have been approximately 1 million mt per year, contributing about 63% to the total tuna catch from the region. The 2001 catch was slightly more than 1.2



million mt, the second highest catch on record. The purse-seine fishery accounted for most of this catch (69%) with 24% from the pole-and-line fishery.

The CPUEs for purse seine are variable, with nominal CPUE for log and FAD sets showing an increasing trend (mainly due to increased efficiency of purse seiners), particularly in recent years. Nominal CPUEs for free-swimming school sets and for pole-and-line fisheries are essentially flat. A lack of trend was also seen in standardised pole-and-line CPUEs. Skipjack tuna are concentrated in tropical waters but expand seasonally into subtropical waters to the north and south. Their fast growth, early maturity, high fecundity, year round spawning, relatively short life span, high and variable recruitment, and few ages classes on which the fishery depends make this species unique among the main tuna species.

Ongoing fishery oceanography and environmental studies continue to improve understanding of the factors influencing availability and productivity of skipjack tuna in the WCPO. They suggest a positive impact of El Niño on skipjack tuna recruitment, particularly when followed by a La Niña event. The cause for these recruitment differences appears to be changes in the area of the spawning habitat with temperature and in forage availability. Modelling results predict lower skipjack tuna recruitment over the next two years, resulting from the 1998–2000 La Niña event. The biomass trend appears to be recruitment driven, with large variability and with the largest biomass levels estimated to be for the model period 1998 to 2000. Model results suggest that the WCPO skipjack tuna population in recent years is at an all-time high relative to the last 30 years.

Tag-based assessments from the early 1990s suggested low to moderate exploitation at catch levels slightly lower than those in recent years. Recent results from MULTIFAN-CL model analysis, which incorporates tagging and other information, were consistent with earlier assessments but indicated that fishing mortality had continued to increase from the 1970s and is now falling to some extent in recent years, probably due to economic factors. While fishing mortality has increased, the impact of fishing on the stock is estimated to be relatively slight throughout the time period.

The ratio of fishing mortality relative to FMSY is small (<0.20) and fishing mortality over the past 30 years has been significantly less than natural mortality. Similarly, estimates of recent spawning stock biomass (SSB) are considerably higher than the estimated level producing MSY ($SSB/SSB_{MSY} > 5.0$). The skipjack tuna stock appears to be healthy and capable of sustaining the current catch without adverse effect on stock condition.

Nevertheless, the Group noted that skipjack tuna do not appear to move rapidly over great distances and thus do not thoroughly mix over the entire region. Concentrated and sustained fishing effort in local areas could consequently result in local depletion.

In such areas, a further increase in fishing effort may not result in a proportionate increase in catches, but instead result in a decline in CPUE, and even in average size of skipjack tuna taken. The experience with the Atlantic skipjack tuna fisheries where this has occurred was noted.

Available information needs to be substantiated through advances in the basic biology, data collec-

tion and stock assessment of skipjack tuna, if management requirements for this economically and ecologically important species are to be met. Of particular importance is the need to estimate the magnitude and size composition of skipjack tuna caught in the domestic fisheries of the Philippines and Indonesia.

Bigeye Research Group

Bigeye tuna account for a relatively small proportion of the total tuna catch in the Pacific Ocean, but their economic value probably exceeds USD 1 billion annually. The preliminary estimate of Pacific-wide bigeye catch of bigeye for 2001 is 191,503 mt, slightly down on the record catch of the previous year (212,749 mt). In the WCPO, the 2001 catch was an estimated 115,392 mt, unchanged from 2000. The longline catch in the WCPO in 2001 increased to a record level (71,643 mt) while the purse-seine catch (24,133 mt) decreased by about 20% from the 2000 level.

During the meeting, preliminary catch estimates were presented for a rapidly developing longline fishery based in Vietnam, for which the catch in 2001 may consist of up to 70% bigeye tuna. Catches by other gears (pole-and-line and various gears in Indonesia and Philippines) remained largely unchanged from the levels reported in recent years. In the eastern Pacific Ocean (EPO), bigeye catch in 2001 was an estimated 76,110 mt, down considerably from the 2000 catch of 97,402 mt. This decrease was due to a drop in the purse-seine catch from the 2000 record level of 70,098 mt to 43,009 mt in 2001. The EPO longline catch of bigeye in 2001 was 33,101 mt, about a 20% increase over the previous year.

Considerable progress has been made in understanding bigeye



tuna vertical habitat utilisation and movements as the results of archival tagging experiments in various parts of the Pacific come in. Work conducted in the Coral Sea, around Hawaii, and in the eastern tropical Pacific suggests that bigeye vertical distribution varies across the Pacific and is likely to be related to differences in several oceanographic variables. This information will be of considerable value in the estimation of effective longline effort for bigeye using habitat models. Movement data thus far collected from archival tags suggest a degree of regional fidelity, although longer-term recaptures are required before strong inferences can be drawn regarding stock structure and mixing rates.

Several nominal and standardised CPUE time series were examined by the Group. Purse-seine CPUE trends for the main fleets generally reflect the extent to which associated sets, especially on drifting FADs (which have produced higher juvenile bigeye catches in recent years), have occurred in the fishery. Nominal CPUE for Japanese longliners fishing in the tropical WCPO has been fairly stable over a long period of time.

However, habitat-model standardised CPUE, which removes variability due to changes in targeting and some environmental variables, shows a declining trend. Two stock assessment models were presented for WCPO bigeye, one using the MULTIFAN-CL

method and the other using the ASCALA method. While some of the details of the respective model results differed substantially because of different assumptions and data analysed (e.g. absolute biomass levels and biomass trends differ appreciably in the two analyses), both indicate that recent fishing mortality rates, particularly in the tropical region where most catch occurs, are near or above commonly used overfishing reference points.

The MULTIFAN-CL analysis indicated somewhat lower impacts of fishing in the subtropical regions of the WCPO. On a WCPO-wide basis, the MULTIFAN-CL model estimated that fishing mortality rates and spawning biomass had not yet reached their respective MSY levels. The ASCALA model suggested that current levels of fishing mortality are likely to be beyond the FMSY reference point, although it was noted that some of the assumptions used in this analysis (particularly the assumption of constant catchability by the purse-seine fishery) are probably unrealistic.

However, both analyses agree that further increases in fishing mortality rates are unlikely to result in significant increases in long-term average yield with the current pattern of age-specific exploitation. Moreover, it is clear that the high juvenile fishing mortality generated by the fisheries in the Philippines and Indonesia, and by purse-seine

FAD and log sets in the WCPO, are limiting potential yields from the fishery and are likely impacting longline fishery performance in the tropical region.

The Group recognised that: 1) fishing mortality rates of adults are low and without a trend; 2) there are continuing uncertainties inherent in the assessments and, in particular, uncertainties associated with estimates of the juvenile bigeye catch; and 3) there is concern regarding increasing catches, with indications that current yields appear to be sustained only by recent periods of above average recruitment, and that fishing mortality rates of juveniles are high (relative to natural mortality) and increasing. For these reasons, the Group reiterated its recommendation that there be no further increase in the fishing mortality rate of juvenile bigeye tuna in the WCPO.

The Group noted that the following research and fishery monitoring activities should lead to improved stock assessment for bigeye tuna in the WCPO:

- (i) Improved catch, effort and size composition data from the Indonesian and Philippines fisheries, and from the rapidly developing Vietnamese fishery;
- (ii) Improved estimates of bigeye catch from the WCPO purse-seine fishery;
- (iii) Continued acquisition of data on bigeye tuna habitat (through archival and pop-up satellite archival tagging), and the incorporation of these data into habitat models to provide estimates of effective longline effort;
- (iv) Additional conventional tagging of bigeye to provide additional information on fishing and natural mortality, movements and other parameters.

Yellowfin Research Group

Yellowfin tuna catches represent the second largest component (21–28% since 1990) of the total annual catch of the four main target tuna species in the WCPO. For stock assessment purposes, yellowfin tuna are believed to constitute a single stock in the WCPO.

Yellowfin tuna catches in the WCPO first exceeded 200,000 mt in 1980. With the expansion of the purse-seine fishery during the 1980s catches doubled to 414,000 mt by 1992. Since that time yellowfin catches in the WCPO have varied between 326,000 and 494,000 mt, with the catches during the last five years being at historical high levels, averaging 464,000 mt. The catch during 2001 is currently estimated to be 475,000 mt, the second highest recorded. Purse-seine vessels harvested the majority of the yellowfin catch (45% by weight) during 2001, while longline and pole-and-line fisheries caught 17% and 3%, respectively and various other gears accounted for 34% (mostly in eastern Indonesia and the Philippines).

Nominal catch rates of yellowfin by purse-seine fleets are characterised by strong inter-annual variability believed to be associated with variation in environmental conditions associated with the El Niño Southern Oscillation cycle. Catch rates for most fleets indicate no clear trend over the available time series of data, despite the increased efficiencies associated with the use of drifting FADs. Nominal catch rates of yellowfin for the Japanese distant water longline fleet display a steady decline during the 1980s, increasing during the mid-1990s, dropping sharply to a historical low during 1999 before recovering somewhat during 2000. After

accounting for increased targeting of bigeye tunas since the mid-1970s, however, standardised catch rates for this fleet in most regions of the WCPO display large inter-annual variability and no overall long-term trend, but somewhat higher values between the mid-1970s through to the late 1990s.

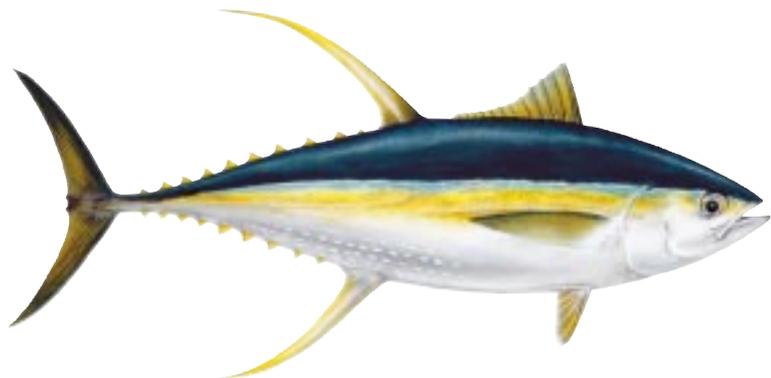
New research on the displacement patterns of tagged yellowfin, together with the results of research on juvenile recruitment patterns, indicate the possibility that short to medium (less than 1000 km) distance movements may be more characteristic of overall yellowfin movements than long distance migrations and large-scale mixing. While further work with archival tags is required to increase our understanding of movement patterns, the higher degree of regionalisation of yellowfin populations implied by these results increases the risk of localised depletions in areas where catch levels are too high relative to local yellowfin immigration rates.

New research on the trophic ecology of yellowfin associated with natural and man-made aggregation sites is improving the understanding of the ecological consequences of the increased used of FADs. To help standardise catch rates, however, further work is required in understanding habitat prefer-

ences, trophic dynamics and the influences of recent increases in fishing efficiencies (e.g. the increased used of drifting FADs).

Tag-based assessments from the early 1990s found exploitation levels of yellowfin tuna to be low to moderate; catch levels at that time were about 20–25% below those in recent years. More recent assessments of the yellowfin stock in the WCPO using the MULTIFAN-CL model indicate, however, that fishing mortality has increased significantly since that time, largely as a result of increase of catches in the purse-seine fisheries. The results from the latest assessment reaffirm these earlier findings, as well as the result from last year's assessment, which indicated that recent recruitment may have declined significantly. The reasons for this decline remain uncertain, though it does not appear to be related to a decline in spawning biomass due to fishing. It is possible that a shift to a lower productivity regime characterised by lower average recruitment has occurred. The recent declines in recruitment have produced a significant decline (of around one third) in overall stock biomass since 1997.

Biomass levels in 2000 and 2001 are estimated to be the lowest since the mid-1970s. The decline in biomass is most evident in the main catch regions of the



western equatorial Pacific, where current biomass is estimated to have declined by over 50% since the mid-1990s. For the WCPO as a whole, the current biomass is estimated to be around 35% less than it would have been in the absence of fishing.

Attempts to estimate an MSY for yellowfin continue to be hampered by uncertainty in the stock-recruitment relationship and the age-specific exploitation patterns, as well as other uncertainties in the stock assessment models. The possibility of two different productivity regimes also complicates the situation, because estimating the MSY level and associated spawning biomass ratio (the ratio of spawning biomass to that for the unfished stock) is dependent on overall stock productivity. Nevertheless, the assessment reviewed by SCTB 15 reaffirms the result of the previous assessment: that the yellowfin stock in the WCPO is presently not being overfished (i.e. $F/FMSY < 1$), nor is it in an overfished state ($SSB/SSBMSY > 1$).

However, the current trends in both ratios are towards their respective reference points, and if a shift to a lower productivity regime has occurred, it is believed that present catches may not be sustainable.

There is increasing evidence that the North Pacific Ocean is undergoing an environmental regime change and this is likely to have an effect on the productivity and distribution of tunas in the Pacific Ocean. Results of recent yellowfin tuna assessments in the WCPO suggest that the stock may be responding to this regime change, with lower recruitment than before.

The results are uncertain, however, because of assumptions used in the assessment models, and incomplete fisheries information available for the analy-

ses. Furthermore, due to the short time-series on which they are based, estimates of recruitment and cohort strength in the most recent years are the most poorly determined. As a result, additional years of data will be needed to confirm the present results, especially in terms of future stock productivity.

Nonetheless, if the stock is entering a regime of low recruitment, the current catch of 475,000 mt is significantly higher than the estimated MSY for a low recruitment regime ($\approx 290,000$ mt) and is not sustainable. In such an event, fishing mortality would need to be reduced, especially on juvenile yellowfin in the equatorial regions where the stock is believed to be nearly, if not already, fully exploited. If, however, recent estimates of low recruitment represent normal variability of a high recruitment regime, the current catch is estimated to be close to the estimated MSY for a high recruitment regime and appears to be sustainable.

While recognising continuing uncertainties associated with the present stock assessment, the Group reiterated the previous recommendation that there be no further increases in fishing mortality (particularly on juvenile yellowfin) in the WCPO. If future evidence supports a shift to a lower productivity regime, a decrease in fishing mortality is recommended.

Furthermore, the Group believes that this uncertainty and its impact on stock status advice highlights the need for the following immediate actions:

- (i) The condition of the yellowfin stock should be closely monitored over the next few years;
- (ii) Fishery data collections should be significantly improved, particularly for the fisheries with

a significant yellowfin tuna catch;

- (iii) Options for fishery management actions required for maintaining a healthy stock in a low recruitment regime should be evaluated, in order to be prepared should further analyses validate that the stock is in low recruitment regime;
- (iv) A greater understanding of changes in catchability is required in order to develop improved indices of stock abundance based on CPUE;
- v) Further development of stock assessment models, particularly MULTIFAN-CL, should be undertaken;
- (vi) The development of alternative recruitment indices, other than those provided by MULTIFAN-CL, should be developed; and
- (vii) Studies on the multi-species influences of the assessment should be carried out.

The Group also saw the need for additional large-scale and archival tagging to help validate the recent level of fishing mortality estimated from the assessment models, and to provide additional information on yellowfin movement, natural mortality and exploitation rates, all of which would support future stock assessment analyses.

Billfish and Bycatch Research Group

The Billfish and Bycatch Research Group (BBRG) has a more varied perspective than the single species research groups. Issues include non-targeted catches in pelagic fisheries, protected species interactions and the catch of billfish by commercial and recreational fisheries. SPC's Oceanic Fisheries

Programme (OFP) generates an annual estimate of commercial billfish catches, but currently not of recreational billfish catches. A system for reporting catches by recreational fishing clubs in the WCPO was established by OFP; ensuring that such data are collected and provided to OFP requires considerable work, and it has not been possible to adequately cover this activity (for most countries) over the past year.

During SCTB 15, the BBRG addressed turtle and other species by-catch in WCPO pelagic fisheries. The BBRG heard about a project's progress in assessing the global ecological impacts of longline fisheries on sea turtles, seabirds and sharks. The principal issues addressed in the study's first year were declining population trends of Atlantic sharks, mapping ocean features and bycatch, and estimating total black footed albatross longline-related mortality in the North Pacific. Work was currently under way on determining longline-related sea turtle mortality in the Pacific.

The goal of the study was to generate bounded estimates and determine relative threat of fisheries versus other sources of mortality. Discussions on this study noted the difficulty of obtaining the data needed to accomplish the study objectives, changes in the operational characteristics of longline fisheries over time, and the documentation of other sources of turtle

mortality in order to place longline related impacts in the correct context.

The results of a review by OFP of turtle by-catch in longline fisheries in the tropical WCPO from observer data were presented. There was little information on the type of fishery interactions with longliners (e.g. tangling or hooking). Depth was a major factor in interactions, with shallow longlines set at night catching an order of magnitude more turtles than deep sets made during the day. Olive Ridley and green turtles were the most frequently encountered turtles. An annual total of about 2000 turtle interactions with longlines within the tropical WCPO were estimated from observer data. The review listed recommendations for a variety of improvements including fishery observer coverage, species identification, collection of turtle biometrics, interaction descriptions, crew education and awareness.

BBRG heard about research to reduce longline-turtle interactions in the Hawaii-based swordfish fishery. Data collection from the first phase of experimental fishing for swordfish to test methods which may catch fewer turtles has been completed and the results were currently being analysed. The start of the second phase of this project to test direct mitigation measures such as blue-dyed bait and distance of hooks from the float was uncertain due to a

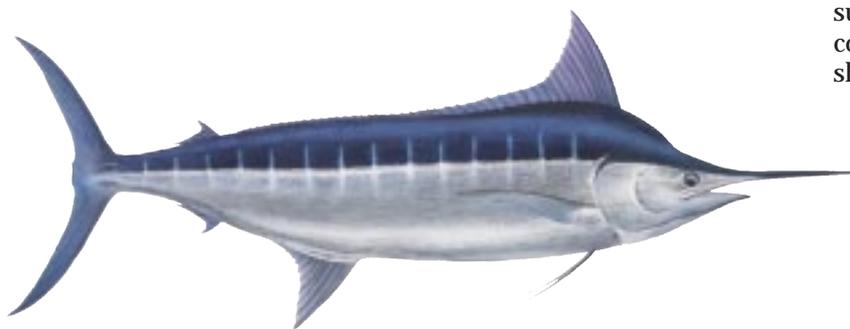
legal challenge to the fishing experiment by several conservation advocacy organisations. Research on the behaviour and physiology of turtles using captive animals was ongoing.

Results to date indicate that captive turtles are attracted to red-dyed bait, and not to blue bait. Also, turtle vision may be less acute under low light conditions than the fish targeted by longlining, and this may assist in the design of light sticks, which would attract fish but not turtles.

BBRG also heard how at-sea observer programmes can help turtle research by collecting information on the pelagic life phase of sea turtles, through tag deployment and collection of biological data and specimens for genetic research. Recent research on the use of pop-up satellite archival tagging (PSAT) of sea turtles was discussed to determine post-hooking survivorship of sea turtles. PSATs record hourly depth, temperature, and a daily geolocation.

The state-of-the-art tag provides somewhat questionable geolocation data, and is also difficult to attach to sea turtles, but PSATs are able to provide data even in the event of a mortality. PSATs have been deployed on hard shell turtles and tests were currently under way with a new method for attachment of PSATs to leatherback turtles. Results of tagging of turtles with ARGOS tags were reviewed and showed how turtles use oceanic features such as fronts and eddies. Data collected on diving behaviour showed the percentage of time turtles spend at various depth ranges.

The preliminary results of recent tagging of oceanic sharks were reviewed by the BBRG. This project involved attaching PSATs



to blue and other oceanic sharks, and collecting blood samples to determine key biochemical indicators for hooked and released sharks. PSATs record time spent at different depths by oceanic sharks. This information was augmented by data from longline fishing using time–depth recorders that indicate at the depth and time of day sharks were taken on longlines.

An update was given on ongoing research collecting basic biological information and life history data on opah (moonfish) and two monchong (pomfret) species. Updates were also given on the MULTIFAN-CL stock assessments of North Pacific swordfish and Pacific blue marlin. Problems associated with data inputs for both assessments were noted and discussed.

A report was given on a recently initiated food web study of the WCPO tuna ecosystem. The study's objective is to understand pelagic predator–prey relationships and to provide a model to assess environmental and fishing impacts on the ecosystem and tuna stocks. Diet and trophic level of different ecosystem components were established by examining stomach contents and by analysing the isotopic composition of muscle samples. Data from this study will be used in biodynamic ecosystem models.

Sequential changes in swordfish catch rates off eastern Australia were reviewed by BBRG. As fishing effort increased, fishing spread further offshore to maintain high catch rates. Similar scenarios were noted for many longline fisheries, where catch rates were initially high but then dropped off markedly. Australia's east coast fishery has been studied from its inception and provides an opportuni-

ty to investigate this phenomenon. Several hypotheses were explored, including the concept of resident sub-populations around seamounts, environmental changes and changes in the longline fleet composition over time.

BBRG was presented with the initial results of an age and growth study for juvenile swordfish in Taiwan using otolith microstructure. If the micro-increments observed in the sagittal otoliths were laid down on a daily basis, then juvenile swordfish reached a size of about 94 cm in their first year. Estimates of spawning dates, based on the otolith analysis, ranged from February to October.

BBRG made the following recommendations:

- (i) A strong focus on monitoring regional billfish catches, both in commercial pelagic fisheries and from recreational fisheries should be maintained.
- (ii) Efforts should be made to improve observer coverage in WCPO pelagic fisheries in order to obtain more reliable statistics on by-catch, and to permit risk analysis on by-catch species. Prior to implementation, the objectives for an observer program and the process by which these objectives can be met should be clearly identified. The risk assessment currently being conducted to set objectives for an observer program for Australia's east coast swordfish fishery may be a useful paradigm for this process.
- (iii) Participants should strengthen data collection on turtle interactions in pelagic fisheries in order to refine estimates of the interaction problem, due to concerns regarding the population status of Pacific

turtles. BBRG also recommends closer collaboration and liaison by participants with the appropriate government and regional agencies to ensure that turtle nesting sites are inventoried, and non-fishery related impacts on turtle populations are clearly identified and addressed, to place fishery impacts to turtle populations in context. Some of this broader analysis may be done by other organisations, but SCTB should remain informed of the issues and be able to evaluate information and analyses as they are used to set management policy. There are many protected-species issues emerging in the United States that can have a great impact on tuna fisheries, including the recent Pacific longline and gill net moratorium petition designed to protect leatherback turtles. The BBRG also notes that changes to existing fishery management statutes may be used to influence seafood exporters that ship to the USA to conform with various by-catch mitigation measures.

- (iv) BBRG recommends that a close watch be maintained on other by-catch issues as they arise, and in particular future developments under FAO IPOA on seabird–fishery interactions. Two meetings of note are the Second International Fishers Forum (Nov 2002) and the International Marine Turtle Technical Workshop (February 2003), which are both focused on turtle longline mitigation.



Oceanic Fisheries and Climate Change Project

In recent years, the annual world catch of the four main tropical tuna species (skipjack, yellowfin, bigeye and albacore) approached four million tonnes, with two thirds of the production coming from the Pacific Ocean. Skipjack are the most productive tuna species, and economic, rather than biological, factors limit increases in skipjack catch. This is illustrated by the 60% drop in skipjack prices between 1998 and 2000. This price drop was caused by exceptionally high catches following strong recruitment related to the powerful 1997–1998 El Niño event. Conversely, we can predict that the La Niña sequence of 1999–2001 has negatively affected the recruitment of skipjack, and should lead to lower biomass in 2002–2003.

Similar trends occur for yellowfin tuna (Fig. 1), which is second to skipjack by volume of capture. This species' longer lifespan produces lower-frequency fluctuation in the population biomass. The management implications were highlighted at SCTB 15.

The most recent population assessments of yellowfin tuna show that lower recruitment in recent years has produced a significant decline (of around one third) in overall stock biomass since 1997, suggesting a possible shift to a lower productivity regime. Biomass levels in 2000 and 2001 are estimated to be the lowest since the mid-1970s. If a shift to a lower productivity regime is confirmed, it is believed that present catches may not be sustainable.

Interestingly, this pattern seems to be reversed for the temperate albacore tuna, for which recruitment estimates prior to the mid-1970s are generally higher. Opposite trends in recruitment series of these species are apparently correlated with the last two different climate regimes of the Pacific Decadal Oscillation (PDO), and characterised by a high frequency of either La Niña or El Niño events (Fig. 1).

The last regime shift occurred in 1976 and there is increasing evidence that another regime shift may have occurred in late 1998. Given the very high global socioeconomic importance of tuna fisheries and their well-structured international trade, prediction of even simple overall trends of how climate variability impacts the pelagic ecosystem and tuna populations would be of major interest for resource management, with direct socio-economic consequences.

Predicting the effect of short- to long-term climate changes on the productivity and distribution of oceanic tuna stocks and fisheries will be the objective of the new multi-national Oceanic Fisheries and Climate Change Project (OFCCP GLOBEC).

Studies are being supported either through self-funded collaborations between scientists and research institutes or via external funding (see examples in boxes 1 and 2). The ultimate goal of the project is to conduct simulations with eco-system models that include the main tuna species, using an input data set predicted under a greenhouse warming induced climate change scenario as defined by the IPCC. Analyses of simulations based on retrospective series of oceanic and fishing data sets (i.e. hindcast simulations)

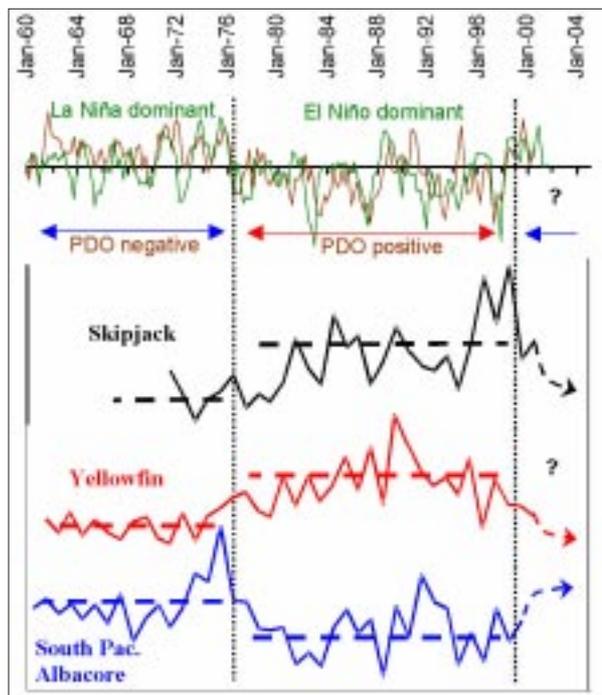


Figure 1: Fluctuation of the Southern Oscillation Index (SOI) and Pacific Decadal Oscillation (PDO), and annual recruitment of skipjack, yellowfin and South Pacific albacore tunas. There are apparent correlations between the recruitment of these species and the interannual ENSO and decadal PDO signals that suggest a possible new regime for the next coming years. The albacore series has been back-shifted by two years and the yellowfin and skipjack series by one year to account for the age of recruitment of these species

will serve to test the predictive capacity of the models, particularly at seasonal, inter-annual (ENSO-related) and decadal (PDO-related) time scales.

In addition, diverse studies are needed to improve the parameterisation (e.g. energy transfer from primary to secondary production), to improve the modelling of key processes (e.g. recruitment, movements and feeding), to validate the results of the simulations, and to investigate the socio-economic consequences of predicted changes. Four major components have been identified to achieve these objectives.

1 - Monitoring the upper trophic levels of the pelagic ecosystem

Existing and new instrumentation and technologies will be used for monitoring the upper trophic levels of the pelagic ecosystem. Observation will

combine both extensive studies at ocean basin scale and intensive studies in some sub-areas and key sites. Extensive studies aim at building ocean data sets for micro-nekton and large pelagic biomass. Intensive studies will focus on important processes and behaviour including movement, schooling and aggregation of tunas, prey-predator interaction and reproduction, composition and dynamics of micro-nekton. Each scale of observation corresponds to a modelling development: large-scale ecosystem models, population models and individual-based models.

2 - Food-web structure in pelagic ecosystems

For modelling the pelagic ecosystem, it is essential to identify the functional groups, how energy and matter flow through these groups and how they are affected by physical and biological

changes as well as by human activities (fisheries). Two kinds of analyses will be helpful in this task—a classical approach based on the study of stomach contents to establish the prey-predator interactions, and the more recent isotope-ratio approach, which appears to be a promising way of describing energy transfer through the food web. The success of this approach also relies on a multiplicity of studies in different regions of the ocean(s), over different periods of time, to establish an isotope-derived biogeography of the pelagic ecosystems.

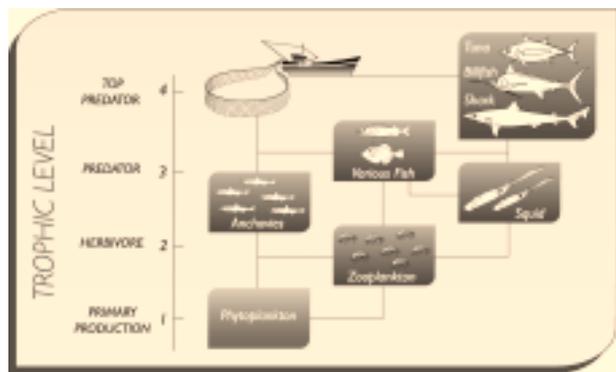
3 - Modelling from ocean basin to individual scale

Models have a pivotal role in the project and will provide a general framework to integrate studies at different time and space scales. A large range of models are represented in the

Box 1. Trophic structure and tuna movement in the cold tongue–warm pool pelagic ecosystem of the equatorial Pacific

This project proposes to test how regional variations in primary productivity relate to production of tunas in the cold tongue–warm pool system of the equatorial Pacific Ocean. The objectives are to define the trophic structure, to establish an isotope-derived biogeography and to characterise large-scale tuna movements in the ecosystems of the pelagic tropical Pacific.

An extensive sampling programme will be implemented on tuna fishing boats in the western, central and eastern Pacific to collect stomach, liver and muscle samples of tunas and by-catch species. Prey species, zooplankton and phytoplankton will also be collected. Predator–prey interactions will be quantified using stomach content analyses, while stable-isotope ratios will be used to assess the relative trophic positions of the ecosystems' functional groups. The Ecopath with Ecosim model will be used to represent the trophic flows among the ecosystem components.

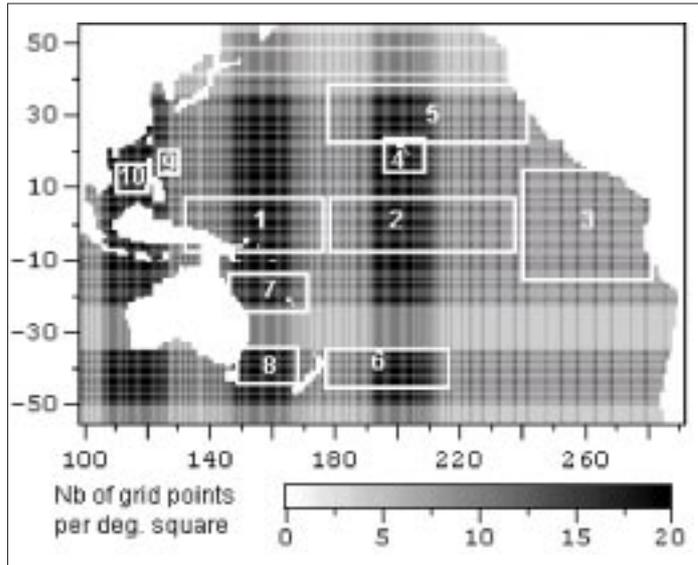


Carbon and nitrogen stable-isotope composition of the different component groups, from phytoplankton to tunas, will provide an isotope cartography of the Pacific pelagic ecosystems to characterise the trophic structures in different production regimes. This will help in parameterising the ecological energy transfer from primary production to tuna forage production in the spatial environmental population dynamics model SEPODYM. Food-web and isotope characterisation of body tissues with slow and fast turnover rates from different geographic areas in the Pacific will form the basis for testing the potential value of isotopes in studying tuna movements.

(Project carried out by V. Allain, R. Olson, F. Galvan Magana, B. Popp and B. Fry, and supported by the Pelagic Fisheries Research Program of the University of Hawai'i, USA.

Box 2: Mixed-resolution models for investigating individual to population spatial dynamics of large pelagics

The mixed-resolution modelling project proposes to develop or improve two classes of models: individual based models (IBMs) and advection diffusion reaction models (ADRM). Both approaches will be combined by using the same predicted environment to constrain tuna behaviour of individuals (IBMs) and population dynamics (ADRM).



Mixed-resolution grid used as an integrative framework for the different OFCCP case studies and projects associated with focus areas (1: warm pool, 2: cold tongue, 3: EPO, 4: Hawaii, 5: Chlorophyll Front Transition Zone, 6: Subtropical Convergence Zone, 7: Coral Sea, 8: Tasman Sea, 9: East Philippines-Luzon Sea, 10: South China Sea)

Predicted fields describing the ocean environment will be provided by a coupled physical-bio-geochemical ocean model developed at the Earth System Science Interdisciplinary Center (ESSIC), University of Maryland, USA. This model uses a stretched grid with greater resolution at one or multiple locations of the model domain. The vertically integrated micro-nekton (tuna prey) biomass distribution is modelled with the tuna (predators) population dynamics in a spatial environmental ADRM (SEPODYM) developed at the Oceanic Fisheries Programme, SPC, Noumea, New Caledonia. Predicted spatio-temporal distribution of physical and biological variables will be compared to satellite and in situ data at the scale of the Pacific basin and in several focus areas where the resolution will be enhanced. Movements of individual tunas predicted from IBMs will be compared to observations derived from electronic tagging and to density population movements generated by ADRMs. A two-year post-doctoral position will be open for IBMs development in the beginning of 2003.

Project carried out by Lehodey P., D. Kirby S., McClatchie, R., Murtugudde, L., Dagorn, K., Holland, J., Polovina and J. Sibert, and supported by the Pelagic Fisheries Research Program of the University of Hawai'i, USA

project, covering global to individual scales. At global or basin scales, predictions from different coupled physical-bio-geochemical models will be used to run ecosystem models of upper trophic levels, on which the economic and social analyses rely. One of the physical-bio-geochemical models will provide prediction at high resolution in several identified sub-regions where intensive process studies are conducted.

4 - Socio-economic impacts

Economic models developed for fisheries will use the outputs from spatial tuna population dynamics models, or will be directly coupled to such models, to investigate the impact of climate variability on the tuna fisheries and their socio-economic consequences. Issues that will need to be modelled include multi-fleet interactions

and the presence of fishing vessels from multiple political jurisdictions, as these imply different fishing costs resulting from differences in material and labour costs. The impacts of feasible management measures will be simulated.

For more information, please contact Dr Patrick Lehodey at PatrickL@spc.int



New tuna project to start in 2003

A new three-year project entitled "Trophic structure and tuna movement in the cold tongue-warm pool pelagic ecosystem of the equatorial Pacific" will begin

in early 2003. Funded by the University of Hawai'i Pelagic Fisheries Research Program, participants include Valerie Allain (SPC, New Caledonia), Robert

Olson (IATTC, La Jolla, USA), Felipe Galvan-Magaña (CICIMAR, Mexico), Brian Popp (University of Hawaii, USA) and Brian Fry (Louisiana State

University, USA). This collaboration between research scientists from several regions of the Pacific Ocean should allow testing of how regional variations in primary productivity relate to production of tunas in the equatorial Pacific Ocean.

Cold tongue–warm pool system

In the equatorial Pacific, cold water upwelling extends westward along the equator in a cold tongue of water from the coast of South America, eventually encountering a large pool of warmer water in the western Pacific (the cold tongue–warm pool system). The eastern cold tongue system is characterised by high levels of primary production, and the western warm pool by lower levels of primary production. The largest proportion of the tuna catch in the Pacific Ocean originates from the warm pool, even though paradoxically this is a region of low primary productivity. Tuna movement to upwelling zones at the fringe of the warm pool may be key in resolving this apparent discrepancy between algal and tuna productivity.

To test this hypothesis, the project proposes to define the trophic structure, to establish an isotope derived biogeography and to characterise large-scale tuna movements in the ecosystems of the pelagic tropical Pacific.

Trophic structure

Once the functional groups involved in the pelagic ecosystem are identified, the flow of energy and matter through these groups will be determined by two methods. Standard stomach content analysis will be used to quantify prey–predator interactions. Also, a more recent approach based on stable-isotope ratios will be used to assess trophic position of the different functional groups (^{15}N analysis) and to trace how different sources of primary production, related to upwelling and other environmental factors, are important in supporting these groups (^{13}C analysis).

The biodynamic modeling tool, Ecopath with Ecosim (EwE), will be used to represent the trophic flows among the ecosystem components in each region. Ecopath provides a framework for the construction of mass-balance models of ecosystems based on estimates of how abundant the resources are (biomass), the productivity or mortality rates of the resources, how they interact (diet compositions and food consumption rates), and how efficiently the resources are utilised in the ecosystem. Given the description of the ecosystem in Ecopath, Ecosim provides a tool to explore hypothesised changes in production by means of dynamic simulations.

Upwelling-related biogeography

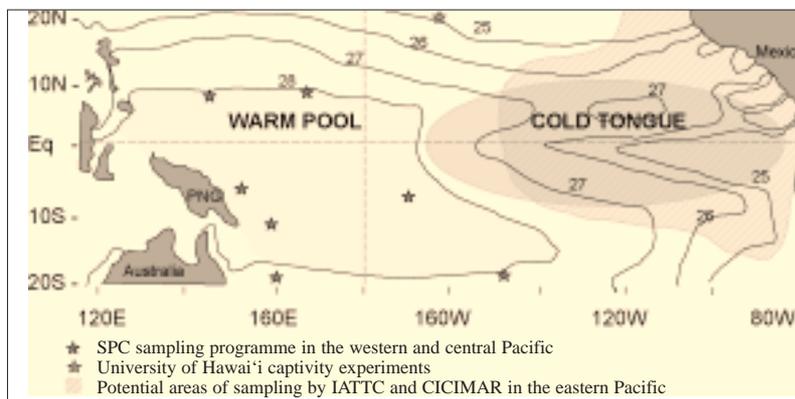
A biogeography of the major ecosystem linkages to the tunas and the carbon and nitrogen stable-isotope composition of the different components groups will be established. Through this isotope cartography, the trophic structures in different production regimes will be characterised, contrasting low-productivity zones (the warm pool) versus high productivity upwelling zones (the cold tongue).

The nitrogen isotopic composition of marine fauna is particularly sensitive to trophic level, whereas the carbon isotopic compositions of phytoplankton and consumers often reflect the algal sources of production, with high ^{13}C values associated with rapid growing diatoms characteristic of upwellings and blooms. The ^{15}N isotope values will be used to estimate the trophic level occupied by the tunas, other predators, their prey species, and the plankton. The ^{13}C values will be used to identify different sources of primary production. The combination of ^{15}N and ^{13}C will serve to map different regions of primary and secondary production in the Pacific Ocean.

Large-scale tuna movements related to upwelling regions

The biogeography of the food webs and isotope distinctions between different geographic areas in the Pacific will form the basis for identifying natural isotope tags useful for studying tuna movements. Isotope ratios of the fishes will serve as internal chemical tags that are characteristic of areas where they are living.

Discrepancy between the isotope ratio of a mobile predator



and the prey residing in the immediate area, after accounting for trophic-level enrichment, would imply that this predator is not a resident of the area where captured. A more refined view of tuna movements, one that estimates the number of days since diet switching and out migration from a feeding area, might be acquired by comparing tissues and compounds with different turnover rates, e.g. fast-turnover liver and slow-turnover muscle tissues.

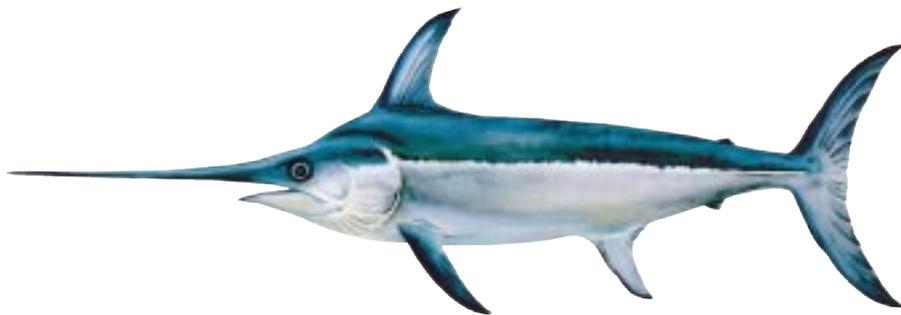
Sampling and analysis

Stomach, liver and muscle samples from target fishes (tunas) and by-catch species will be

sampled by observers on tuna fishing boats (purse-seine and longline) in the western, central and eastern Pacific Ocean. National observer programmes from the SPC area are involved in this sampling (PNG, FSM, Marshall Islands, Cook Islands, French Polynesia, Fiji Islands, Solomon Islands, New Caledonia, Kiribati, American Samoa) for the western and central Pacific. In the eastern Pacific, the sampling will be conducted by scientific observers of the Inter-American Tropical Tuna Commission (IATTC) from the ports of Manta, Ecuador and Mazatlán, Mexico.

The prey in the stomach samples will be identified and quan-

tified. Isotope analysis will be conducted on muscle, liver and lipids obtained from individual fish to determine overall trophic level and whether there is isotope equilibrium between these tissues. If there is equilibrium, and tissues reflect the isotope signature of the local prey after taking into account normal trophic-level enrichment, then the animals would be considered "resident". For other cases, movements between different regions would be inferred.



■ PACIFIC FISHERIES: THE FUTURE OF LONGLINE AND PURSE-SEINE FISHING IN THE PACIFIC

What do turtles, terrorism, cocaine, shrimps and the recent World Summit on Sustainable Development in Johannesburg have to do with fishing for tuna in the Pacific? They matter considerably if you are trying to forecast the future of US purse-seine and longline tuna fisheries in the Pacific.

The US purse-seine fleet has operated in the central and western Pacific since the early 1980s, based in American Samoa and supplying skipjack and yellowfin tuna to two canneries in Pago Pago. A treaty between the USA and the nations of the central and western tropical Pacific gives the US fleet unparalleled access to the 200 nm exclusive economic zones of these islands. The US fleet is therefore able to fish across a huge swath of the central and western Pacific, tracking areas of high tuna abundance, which can move progressively over thousands of miles. However, this fleet, once numbering as many as 60 vessels, declined steadily during the latter half of the 1990s, until there were only 31 vessels active in 2001.

A recent study of this fishery, published by the University of Hawai'i, noted that there was some uncertainty regarding the future of the US fleet in the region, with continued viability threatened by low or stagnant prices, high operating costs relative to other purse-seine fleets, reduced advantages for basing in American Samoa (see further below), and lack of generation-continuity, in the industry (i.e. sons following their fathers into what are largely family owned fishing concerns). However, it was noted that the US purse-seine fleet has overcome or adapted to many difficult situa-

tions over the past 20 years, and with low debt issues, US purse seiners will likely continue to remain active in the central and western Pacific fishery.

Fears that cheaper imported canned tuna from South America—allowed into the US duty free under the Andean Trade Preferences Act (ATPA)—would undercut the production from American Samoa have not been realised. ATPA originally went into effect in 1991. It grants special tariff treatment to the Andean countries of Bolivia, Peru, Colombia and Ecuador for many products and is designed to combat cocaine production in those countries.

However, the final version of the Act does not provide any duty-free access for canned tuna, but does give the US president authority to grant to Andean countries duty-free treatment for tuna packed in foil pouches, with the stipulation that the tuna must originate from Andean or US vessels.

US longline fisheries in the Pacific have experienced mixed fortunes. The size of the American Samoa-based fleet increased rapidly in 2001 through the entry of about 30 additional vessels. This fishery chiefly catches albacore for the two Pago Pago canneries. By contrast the Hawaii-based fleet, which historically targeted a mix of tunas and swordfish for fresh fish markets, was reduced in 2001 to about 100 vessels through a ban on swordfish fishing in the entire North Pacific by these vessels. Accordingly 20–25 Hawai'i-based swordfish-targeting longliners switched to operating out of southern California.

The swordfish ban resulted from litigation brought by several environmental advocacy organisations against the National Marine Fisheries Service and was based on the fact that swordfish longline fishing has higher numbers of interactions with endangered sea turtles than does tuna longlining.

These environmental organisations have attributed the decline in Pacific turtle populations to longline fishing, despite an increasing body of evidence pointing to far greater negative impacts from egg harvests, hunting of adults and loss of nesting beach habitat.

Nevertheless, a petition was recently circulated by these and other environmental advocacy organisations calling for a moratorium on longline fishing in the Pacific. This petition was presented to the second World Summit on Sustainable Development in Johannesburg.

The relatively small California-based swordfish longline fleet probably has the most limited lifespan. The Western Pacific Council's sibling organisation the Pacific Council has drafted a pelagic fishery management plan that would also prohibit swordfish longlining in the North Pacific by vessels under its jurisdiction. When the plan is implemented, this fleet will have no option but to cease fishing outright or switch to tuna longlining.

In addition, Pacific tuna fisheries are subject to changes in market forces and consumption patterns. In 2001 shrimp for the first time outpaced tuna as the most popular seafood in the US. Furthermore, demand for seafood as a whole fell between 2000

and 2001, partially as a result of market changes generated by the terrorist attack of September 11th and the economic recession that this accelerated. Other impacts of September 11th include increased difficulties in airfreighting fish, reductions in

the numbers of flights, and more stringent regulations governing airfreight.

For all of these reasons, the future of US Pacific purse-seine and longline fisheries is difficult to predict.

Source: Western Pacific Regional Fishery Management Council, 1164 Bishop St, Suite 1400, Honolulu, Hawaii 96813, USA
Tel: +1 808 5228220; Fax: +1 808 5228226;
website: www.wpcouncil.org



■ MEASURING THE EFFECTS OF MARINE RESERVES ON FISHERIES: THE DILEMMAS OF EXPERIMENTAL PROGRAMMES

In theory, no-take marine reserves hold benefits for nearby fisheries: the reserves allow target species to grow older and larger, produce more young, and ultimately replenish fished areas with larvae and/or adults. While evidence of benefits to fisheries has appeared in scientific literature, some researchers argue that most science on reserves has not involved sufficiently rigorous experimental design, including the use of control sites. As a result, they say, there is an urgent need for experimental programmes to clarify the fisheries benefits, and costs, for that matter, of marine reserves.

But conducting rigorous experiments on reserves brings an array of challenges that have hindered such research to this point. This month, *MPA News* interviewed several scientists about the fisheries benefits of reserves, why carefully controlled studies are rare, and how managers should communicate with stakeholders in light of the scientific uncertainty.

Do reserves have fisheries benefits?

The crux of the issue is whether the establishment of a marine reserve will have a negative or positive impact on a fishery and on those who depend on the fishery for their livelihood.

According to Ray Hilborn, a fisheries biologist at the Univer-

sity of Washington (USA), few studies have addressed that issue adequately.

"It is being argued that reserves will protect both biodiversity and increase fish yields," said Hilborn. "But the scientific data used to support these claims have internal biases. First, the protected areas used in the research were almost certainly selected for protection because of their higher productivity" — thus making comparisons with outside areas unfair — "and, second, the effort that was excluded from the protected areas would have been redirected to the unprotected areas." Together, these factors frustrate attempts to measure the effects of the closures. In short, says Hilborn, most studies have no rigorous control sites — that is, fished sites that are otherwise equivalent to closed areas — against which to evaluate reserves.

Although Hilborn sees value in reserves as scientific reference areas or as tools to protect biodiversity, he is skeptical of their usefulness in increasing catches. In part, he says, it is simply too difficult to create a closure that would boost more than one fish species at a time. "In theory, the size of a [reserve] needs to be finely tuned to the dispersal pattern of a species, and one size won't fit all," he said. And, he added, reserves do not solve the problems of enforcement or races for fish, the latter of which,

in his view, should be the top priority for managers to solve. "We should be embarking on an experimental program to determine whether MPAs have fisheries benefits or not," he said. "My gut feeling is that, for biodiversity reasons, we should probably go ahead and lock up a good portion of the sea, but not pretend like it'll benefit fishermen."

Wendy Craik, chair of the board of directors for the Australian Fisheries Management Authority and former executive director of the Great Barrier Reef Marine Park Authority, agrees on the need for well-designed studies of reserves. Most research programmes on the benefits of reserves, she says, are set up after the site has already been designated rather than as part of the site planning process. This hinders the selection of adequate control sites.

"MPAs have generally been put in place by environmental management agencies without necessarily a high degree of consultation with fisheries management agencies," said Craik. At the same time, she added, fisheries managers have been experimenting more with other management tools than with reserves. These events have conspired to make experimental programs on reserves rare.

Like Hilborn, Craik sees value for reserves as scientific reference areas and, probably, as pro-

tection for biodiversity. She believes there will eventually be empirical evidence of benefits from reserves to some — but not all — fisheries. Asked whether fisheries managers would be right to promise benefits to fishermen from reserves, she said, “I think managers should say that they are looking at marine reserves as options. Without empirical evidence to say that reserves would enhance fisheries, to say otherwise would be courageous.”

Challenges in evaluating reserve benefits

According to Trevor Ward, former programme manager for environmental research in the Division of Fisheries at Australia’s Commonwealth Scientific and Industrial Research Organisation (CSIRO), the benefits and costs of reserves from a fishing perspective are unclear. To a large extent, he says, convincing stakeholders of the potential of marine reserves still depends on theoretical or logical arguments based on researchers’ basic knowledge of marine ecology.

Ward co-authored *The Role of Marine Reserves as Fisheries Management Tools: A Review of Concepts, Evidence and International Experience*, which details the myriad challenges involved in evaluating reserve benefits to fisheries. They fall into three basic categories: methodological (including lack of control sites and time-series data); ecological (including the influences of predation and large-scale oceanographic or climatic events); and managerial (including lack of enforcement).

Coupled with the limited global history and experience with the use of MPAs, these challenges mean there are no well-tested approaches that can be used “off-the-shelf” by researchers

and managers to evaluate the benefits of reserves with confidence, according to the report. Speaking to *MPA News*, Ward said the lack of empirical evidence should not imply a failure of reserves to deliver benefits to fisheries.

“Fisheries enhancement should not be considered to mean only an increase in catch rates,” he said. “The responsible approach to this matter is to describe reserves to fishers as (given adequate design and management) potentially being able to make an important contribution to solving a number of key problems in the management of many fisheries.” Among these solutions, he said, were providing insurance against overfishing and helping to conserve species and habitats that would otherwise be affected negatively by fishing.

“Reserves will best fulfill their potential for supporting fisheries if they are adopted and incorporated into the toolkit of fishery managers in the same way as any other new opportunity to improve fisheries management: that is, systematically, progressively, and with constant vigilance and review, modification, and improvement,” said Ward.

He believes there will eventually be empirical evidence that properly designed reserves provide benefits for all fisheries. “The main arguments in favor of this lie in the role of reserves as insurance against environmental unpredictability and weaknesses in management systems,” said Ward. “This translates directly into long-term economic viability.”

Neville Barrett, a fisheries biologist at the Tasmanian Aquaculture and Fisheries Institute of the University of Tasmania (Australia), says reserves are

best viewed as fisheries management information tools — with the emphasis on information. “If the information that we are able to obtain on natural populations within an MPA is applied to a fishery with the capacity for flexible management, then clearly reserves can help to maximize yields,” he said. That is, by better understanding the potential size of a fish stock, managers may grow the population back toward a point of higher optimal yield, which would benefit fisheries in the long term.

Like Ward, Barrett believes there will eventually be empirical evidence of the benefits of well-designed reserves to all fisheries. In terms of promising benefits to fishermen, said Barrett, the argument for reserves may be most compelling in subsistence fisheries with no conventional management and severe overfishing. “In that case, reserves may be the only management option that is presently available,” he said.

This is not the case, he added, for large commercial fisheries in developed countries. “There is a reasonable argument that perhaps, in countries capable of doing so, fisheries and their impacts are best managed by appropriate conventional strategies such as input and output controls, gear restrictions, etc., and if provided with sufficient information these fisheries could be optimized without closed areas,” he said.

Case example of an experimental programme

A study on the fishery effects of reserves is under way in the northern Gulf of Mexico. In 2000, the US Gulf of Mexico Fishery Management Council designated two four-year closures encompassing potential

spawning aggregation sites for gag grouper, a commercially valuable stock threatened by overfishing. Researchers with the US National Marine Fisheries Service (NMFS), responsible for studying the no-take areas, selected a control (fished) site adjacent to one of the closures.

The year-round closures and the control are each roughly 10 nautical miles by 10 nautical miles along the 100-metre depth contour favored by grouper. By May 2003, researchers must report to the council their preliminary findings on the reserve effects; the council will decide then whether to reopen the closures to fishing in 2004 or continue them.

Andrew David, a biologist with NMFS, is studying the closures and control, and has had to confront many of the challenges inherent in reserve research. The greatest one, he says, has been enforcing the no-take regulations.

"Of the two closures, the closer one to land is 50 miles offshore," said David. "The only way to enforce it is with Coast Guard patrols." But vessel patrols in the area were infrequent; in addition, the Coast Guard in the past year reprioritised its activities in light of national security concerns, sending its vessels elsewhere. As a result of the lack of patrols, each time David and his team visited the closures, they saw violations taking place.

The situation is improving, though. Earlier this year the Coast Guard, following consultation with grouper researcher Chris Koenig of Florida State University (US), re-routed one of its airborne homeland-security patrols to fly over the closures each day on a randomly timed basis. The patrol is able to take geo-referenced photographs of violators, including the ves-

sels' permit numbers that often appear in large font on decks and roofs. "The violation rate has decreased significantly [in the latter portion of 2002] as word has spread that the daily overflights are occurring," said David. Despite the improved compliance, the research team still must determine how to account for the past illegal fishing in its study calculations, factoring in how many fish may have been removed by violators. "It's one of the sticky issues that we'll have to deal with in the report," said David. Another major challenge for the study is the short time period within which it must draw conclusions.

The closures and control have been in place only since 2000, and the research team will have just two full years of data to present to the council this coming May. "After only two years, it's hard to say how much of any effect is due to fishing or not fishing," said David. Add to this the fact that gag grouper do not reach sexual maturity for several years, making the real recruitment impacts of the closures somewhat unclear until 2010 or beyond. "We'll have a two-year data set to answer a decadal problem," he said. "The grouper lifecycle provides a good rationale for extending the closures to 10 years." That extension option will be one that the council will consider.

In selecting appropriate areas to serve as closures, the council considered up to 30 candidate locations. The main selection criterion was that the closures must incorporate known or suspected gag grouper spawning aggregation sites. (Fishermen viewed the two chosen sites as being somewhat depleted as productive fishing areas, which ensured fewer complaints during the site selection process, says David.) In choosing the

control, researchers picked a site near one of the closures so it could be sampled relatively easily, and would be subject to the same supply of juvenile fish and other environmental variables, such as storm events and upwellings.

Preliminary results from the study indicate more gag grouper are present in one closure than in the adjacent, open-to-fishing control site or other closed area. The latter closure has attracted red grouper instead — an unforeseen result, although David says a difference in bottom structure there is the most likely cause for the predominance of reds. He says it is too early to draw conclusions on whether any fisheries benefits have accrued from the closures.

Notably, the council has made no secret of where the control site is. This is despite the fact that such knowledge could, at least theoretically, lead fishermen to purposely skew the study results by not fishing in that control area. If the control site, for example, were found to have just as many fish as the closures, that would suggest the closures were having little effect. "They're fishing the control site, though," said David.

"I think the vast majority in the industry have an interest in perpetuating the stocks, and would like to see it remain a productive industry. Once they understand what we're doing in our research, they support it."

Source: *MPA News*, Vol. 4, No. 4, October 2002; www.mpanews.org



■ BIG ISLAND AQUACULTURE FARM TO RAISE OPAKAPAKA

A Big Island aquaculture farm hopes to commercially farm opakapaka (*Pristipomoides filamentosus*), one of Hawaii's most highly prized deepwater snapper, in offshore cages anchored to the ocean floor, which has never been done.

If successful, the company, Kona Blue Water Farms, could be the first to farm deepwater snappers in Hawaii, which include ehu, onaga and uku, and are considered among the best table fish locally.

This new bred of aquaculture builds upon what ancient Hawaiians started 1000 years ago when they built their first fish ponds, said John Corbin, manager of the state's aquaculture development programme run by the State Department of Agriculture.

"Hawaii has the oldest tradition of aquaculture in the United States by virtue of ancient Hawaiian fish ponds," Corbin said.

"The Hawaiians invented the fish pond. And the current generation of Hawaiians in companies based here are realising new technologies to expand the use of the ocean and take aquaculture offshore. It's basically with the same goals in mind: sustainability, successful food production and with no negative environmental impact."

Opakapaka and other deepwater snappers are a natural target for commercial aquaculture due to their high market value and the decline of the fishery in the main Hawaiian islands, said Kona Blue Water Farms Vice President Neil Sims. The company is a division of Black Pearls Inc.

The breakthrough in farming opakapaka came through the Hawaii Institute of Biology on Coconut Island in Kaneohe Bay, where researchers have been successful in getting opakapaka captured in the wild to reproduce.

"They sent us over some eggs to do some experiments with," Sims said. "We have 110 fingerlings that are about two months old now."

With opakapaka, as with other high market value fish that researchers have attempted to raise commercially, the problem is determining what they eat during the larval and fingerling stages, Sims said.

"Nobody knows what they eat when they first hatch," he said. "Now, they are taking pellet food and little bits of sardines and anchovies. There is still a lot more experimentation to do before it becomes commercially viable. It could take years. That's why we have 110 instead of 110,000."

Last year, researchers at the Hawaii Institute of Marine Biology were able to keep spawn of opakapaka alive only 41 days before they died, said Aaron Moriwake, research associate at the institute. This year they had better success.

"Right now, our fish are 87 days old and we have surpassed last year's effort," he said. "We were

able to get up through the critical stage of first feeding. We got them to feed on copepods in our bay. That was a milestone."

Much work remains before the project can be called a success, he said.

Opakapaka range throughout the Hawaiian Islands, said Mark Mitsuyasu, programme officer for the Western Pacific Fishery Management Council.

"In 2000, commercial fishermen landed 478,000 pounds of bottom fish worth USD 1.8 million around the main Hawaiian islands," Mitsuyasu said, adding that, in 1990, the figures were 645,000 pounds valued at USD 2.9 million (1 pound = 0.454 kg).

"The price per pound of these fish has gone down because a third of the market is supported by imports, which hold the price steady," he said. "If there is no fish on the market from local boats, they import it from places like Majuro (Marshall Islands), Tonga and Fiji."

The opakapaka fishery around the main Hawaiian islands has been hit hard, Mitsuyasu said.

"But the fishery in the Northwestern Hawaiian Islands remain healthy", Sims added.

"The State has now instituted new licensing requirements to bottom fish here and closed cer-



tain areas to bottom fishing,” he said.

Kona Blue Water Farms hopes it can fill the void by producing fish for the local market and helping to replenish the fishery, Sims said. Opakapaka’s commercial wholesale value is about USD 3.5 per pound, he said.

“This is the price for wild opakapaka,” he continued. “We think we can get more for farmed opakapaka.

But he doesn’t know what the company will be able to produce annually.

“We don’t have a business plan yet for opakapaka because we don’t know how fast they grow”, he said. “We are proposing to start with mahi mahi and, as we get other species developed in the hatchery and prove their market value and grow-out potential, we’ll substitute bottom fish for mahi mahi because of their higher commercial value.”

This is the future of aquaculture world-wide,” Corbin said. “Hawai’i is currently leading the nation in moving aquaculture offshore. There are certainly concerns, but it is not something everybody is going to do. It’s a very difficult and expensive process.”

Source: *Pacific Business News*,
20 September 2002;
Tel: +1 808 9558100;
www.pacific.bizjournals.com



AQUACULTURE ACTIVITIES IN MARSHALL ISLANDS, FEDERATED STATES OF MICRONESIA AND PALAU

In August 2002, Ben Ponia visited the Marshall Islands, the Federated States of Micronesia and Palau. During this trip he was able to visit some of the sites where aquaculture is being pursued and meet many of the names behind the scenes.

Marshall Islands

*Marshall Islands
Marine Resources
Authority (MIMRA)*

MIMRA is the government authority responsible for aquaculture; its director is Danny Wase. MIMRA operates a clam hatchery on Likiep Atoll managed by Junior DeBrum; there are plans to establish a second hatchery on Arno Atoll. Japanese aquaculture specialists have been asked to investigate the demise of a locally favorite rabbitfish (*Siganus* spp.) on Majuro, and suggest possible aquaculture remedies. James Uan, from Kiribati's Fisheries Division, is conducting seaweed farming trials on various atolls in the country.

*by Ben Ponia,
Aquaculture Adviser
SPC, Noumea,
New Caledonia*

*College of Marshall
Islands (CMI)*

CMI has been quite active in promoting aquaculture in the Marshall Islands and has found itself undertaking a considerable amount of aquaculture extension work. CMI marine programme director is Don Hess. The college aquaculture facilities are located at the Marshall Islands Science Station (MISS) in Arrak, about 50 km from the Majuro campus. The facilities have been renovated, and now include classrooms for teaching science courses, an algal culture laboratory, a basic science laboratory and an indoor hatchery with larval rearing tanks. Outside are circular concrete raceways for grow-out. The station is located close by the lagoon where nursery culture can be practiced.

Previously several MISS researchers were investigating sea cucumber aquaculture techniques but they have since left. The MISS hatchery now intends to direct its efforts towards blacklip pearl oysters instead. Manoj Nair (CMI aquaculture researcher) was recently hired to source funds and implement this programme.

*Black Pearls
of Micronesia (BPOM)*

Near the MISS station is the BPOM blacklip pearl hatchery, which had been dormant for some time. David Wise, the former hatchery manager, was called back from Australia to help resume operations. MIMRA staff assisted and collected a new batch of oyster brood stock from neighbouring atolls to start spawning operations. A pearl hatchery is considered to be critical to sustaining any further expansion of the pearl farming industry in the Marshall Islands. During my visit, there were discussions involving various aquaculture interest groups on the island (government and private sector) to see how to sustain the hatchery operation.

BPOM established one of the first commercial pearl farms on Majuro in the Marshall Islands.



*Raceways at the Marshall Islands College
aquaculture facilities
[Photo: Ben Ponia]*



*Black Pearls of Micronesia pearl hatchery
[Photo: Ben Ponia]*

Currently, a scaled-down version of the farm is run by Virgil Alfred who was one of the key Marshall Islanders involved in establishing pearl farming in the early 1990s.

Robert Reimers Enterprises (RRE)

The Wau Island Mariculture Farm, owned by RRE, specialises in marine ornamentals. The farm, managed by Rod Bourke, is based onshore and comprises a series of large concrete raceways. The operation focuses mainly on giant clams for the aquarium trade. There are about 10,000–20,000 clams of export size; the most common species is *Tridacna maxima* but other species include *T. squamosa* and *Hippopus hippopus*. The farm is interested in purchasing some *T. gigas* brood stock. The clams are airfreighted in shipments of about 800 clams to a buyer in the USA.



The Robert Reimers Enterprises owned mariculture farm (top). Giant clams destined for the ornamental aquarium trade (bottom)
[Photos: Ben Ponia]

Ornamental soft and hard corals, and reef fish are also being reared at Wau Farm. One of the reef fish is a clown fish which is endemic to the Marshall Islands and has three characteristic stripes (blue or pink depending on gender).

RRE has been involved in pearl farming for the past seven years, and has produced four pearl harvests with over 5000 pearls. The pearls are farmed at two locations, Arno Atoll and Jaluit Atoll, and there is a stock of 20,000 oysters at various sizes. RRE intends to expand its Marshall Islands venture and are looking for financial investors seeking a partnership.

RMI training workshop on integrated coastal management

My visit to the Marshall Islands coincided with a week-long workshop at CMI college on integrated coastal management run by the University of Rhode Island. The workshop theme included mariculture, and several people active in the sector were present, including Maria Haws, Director of the Pacific Aquaculture and Coastal Resources Centre at the University of Hawai'i at Hilo.

Also present was Simon Ellis, former aquaculture extension officer of the Centre for Tropical and Subtropical Aquaculture (CTSA), who is based in the Federated States of Micronesia. Both Maria and Simon have extensive experience among the US-affiliated islands and have many good ideas on development needs for the region.

Aquaculture aside, there was much attention during the workshop to the presentation by MIMRA staff members Terry Keju and Florence Edwards on their efforts (with the support of the SPC) to establish community based marine reserves at Mejatto Island.

Federated States of Micronesia

FSM National Aquaculture Center (NAC)

The NAC is based on Kosrae Island and includes a basic hatchery, laboratory, offices, gift shop and accommodation facilities. Most of the NAC hatchery operation is routine production of giant clams, predominately *T. derasa*. According to the manager, Mason Timothy, NAC normally achieves a settlement of 200,000 larvae per spawning. Outdoors, there are 32 five-ton concrete raceways stocked with about 30,000 juvenile clams between 8 months and 1.5 years old. The clams are distributed throughout FSM, mostly for restocking.

The two nursery sites for growing out the clams and holding broodstock are Walung and Utwa. The Walung site is located inshore, opposite Walung village. This nursery used to be accessible only through a small reef passage. It can now be reached by road, which is thought to account for considerable poaching of clams. To counteract the poaching an alternative nursery was established at Utwa on the ocean side of the island in about 70 feet of water.

The centre focuses on giant clams but also has the potential to diversify its operations. For example, Mason would like to investigate the culture of other species such as marine orna-



*FSM National Aquaculture Centre
[Photo: Ben Ponia]*

mentals. There is also a prospect to establish a demonstration and public awareness raceway (clams, ornamental fish, corals, etc.), which could generate donations from visitors and contribute towards operating expenses. Recently, the centre collaborated with the Kosrae State fisheries department to spawn a small batch of green snail bought from Tonga. The broodstock didn't release eggs and were returned to the wild for further conditioning.

*FSM Coastal Fisheries Consortium,
25 – 30 August 2002*

One of my main reasons for visiting FSM was to represent SPC at the 2nd FSM Coastal Fisheries Consortium held in Pohnpei island. This event was organised by Francis Itimai, Head of Fisheries Unit for the Department of Economic Affairs (DEA). The DEA office is the main focal point for aquaculture development in the country.

The FSM Fisheries Consortium brings together all of the FSM state fisheries representatives, a rare and valuable opportunity for coordination and collaboration among states. During the week that followed there was much discussion on the status of aquaculture projects among the different islands. For exam-

ple, in Pohnpei, recent activities include giant clam reseedling and staff training in the Philippines in mud crab farming.

In Chuuk there have been unsuccessful attempts to spawn pearl oyster and groupers, although a giant clam farm and sponge farm have been established. During the Fisheries Consortium meeting some of the states revealed that they have been rearing trochus juveniles for reseedling activities.

Pohnpei Agricultural Trade School (PATS)

PATS is a vocational training school with about 160 students at senior high-school level. The school has a marine programme with about seven senior students. The aquaculture facilities are part of the Marine and Environmental Research Institute Pohnpei (MERIP).

The set-up comprises a basic indoor hatchery and outdoor raceways, science laboratory and SCUBA shop. The aquaculture component focuses on marine ornamentals, sponges and pearl culture. The head of MERIP, Eileen Ellis, has a small cohort of hatchery-raised spat on which she is testing various

techniques for grow-out. The spat are being held on a single farm line in the lagoon. At another site, trials for sponge grow-out are also being conducted.

College of Micronesia (COM-FSM)

COM aquaculture activities are undertaken under the supervision of one of the college directors, Singeru Singeo.

In January 2001, Masahiro Ito, a pearl specialist with experience in Kiribati and Tonga, was hired by COM to set up a pearl hatchery. The site for the hatchery was a dilapidated storage shed at Nett Point in Pohnpei. By September 2001 the hatchery was constructed and had completed its first successful spat run. (This set-up was accomplished at a fraction of the cost compared to the often plush and ineffective hatcheries we normally see set up under aid programs.) Currently the pearl project has produced 10,000 two-inch-size spat and 30,000 one-and-half-inch-size spats. Assisting Masahiro are three Micronesian staff members from the college who are now capable in all aspects of operating the hatchery.

The project is establishing two lagoon nursery grow-out sites on Pohnpei. Two different types



*Pohnpei Agricultural School
[Photo: Ben Ponia]*



Palau

Marine Resources Bureau (MRB)

Marine Resources has recently been elevated to a bureau status within the Ministry of Resources and Development. The bureau remains under the directorship of Theo Isamu.



*The College of Micronesia low cost pearl hatchery (top). Micronesian staff who operate the hatchery (below)
[Photo: Ben Ponia]*

of environment have been chosen, a high island and an atoll. These spat will be the basis for small community farms on Pohnpei. There are also plans to extend the project to Yap and Chuuk.

Palau Mariculture and Demonstration Center (PMDC)

PMDC, managed by Obichang Orak, is part of the Marine Resources Bureau. Formerly, PMDC was known as the Micronesian Mariculture Demonstration Center. Pacific Islanders will recall the pioneering work of MMDC in giant clam culture. Many reefs throughout the region have been reseeded with PMDC clams.

Giant clam reseeded is an ongoing programme, with PMDC supplying spat to about eight states. Since 2001 there have been about 25,000 juvenile clams (*T. derasa*) seeded. The

programme involves a state trainee spending a month working at the clam hatchery and returning to his district with clams for reseeded.

The fish hatchery is raising groupers (*Epinephelus* spp.) and Napoleon wrasse (*Cheilinus* sp.) intended for the live reef fish food trade. Adult fish broodstock are held for conditioning indoors in large holding tanks. Some of the indoor tank space is also used to rehabilitate injured turtles that are brought in by the public.

Ngatpang State milkfish project

There has been a renewed interest in milkfish farming. Earlier in the year, the government submitted a proposal to FAO for a series of pilot trials in Palau. One of these is based at Ngatpang State on the north-western coast. SEAFDEC consultants from the Philippines have designed the hatchery and farm set-up. Construction will begin in early 2003.

Palau Community College (PCC)

According to Patrick Tellei, President of PCC, there are two



*Palau Mariculture and Demonstration Centre (left). Hatchery-reared Napoleon wrasse intended for the live reef fish food trade (right)
[Photos: Ben Ponia]*

main projects at the college that concern aquaculture. The first project aims to research the cultivation of hard corals for the aquarium trade. Comparative trials for both land-based and nursery-based culture are under way to see which technique is more cost-effective.

PCC is also establishing a prawn hatchery on Balbado Island at the college's agricultural research station site, a 25 hectare property. The aim of this project is to refine techniques for culturing indigenous giant

freshwater prawn (*Macrobrachium rosenbergii*). A sub-component of this project is to trial a low-cost feed that could significantly reduce production expenses.

Belau Aquaculture

Belau Aquaculture is the only company in Palau with an export permit for marine ornamentals. The owner, Jennifer Sugiyama, gave me a tour of the facilities and explained that the company exports a variety of reef fish, molluscs, echinoderms and coral species, almost exclu-

sively to the USA. Giant clams are purchased from the PMDC hatchery.

Belau Aquaculture is perfecting a unique trademark technique for culturing corals and live rock. The company has a keen awareness of conservation issues and an understanding of the niche for cultured products. It would be interested in participating in a regional accreditation scheme that recognises an ecologically sensitive approach.



PARTICIPATORY APPROACH TO MANAGEMENT INITIATIVES IN PACIFIC COMMUNITIES: THE USE OF PARTICIPATORY LEARNING ACTIVITIES (PLA) TOOLS

The Community Fisheries Section's community-based management work relies heavily on the use of participatory methods of information gathering, and involvement by local communities.

In most Pacific Island countries, many organisations, government agencies and individuals have implemented participatory approaches to development and management to ensure people's involvement. Participatory Learning Activities (PLA) are a necessary tool for information gathering at the community level, and focus on a "bottom up" approach to development, involving the active assessment of people's status and needs before project planning and implementation take place.

These participatory learning tools, which ensure a wider participation of people, allow for interactive learning and teaching and the collection of a wider range of views. Many Pacific Island cultures are characterised by gender, age and status restrictions and taboos, and the use of these tools provides a way of cutting through social and traditional restrictions.

This does not in any way question the importance of these traditions to the many Pacific cultures, but looks at ways of implementing modern, more friendly learning environments in existing traditional or community situations. After years of

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using such tools, practitioners are now at a point where the problems with PLAs can be identified and anticipated.

The unwritten rules of PLA

PLAs have no definite rule of application or use, and tools used differ depending on situations, and agencies, or the personnel facilitating the learning exercise. Points that must be remembered include:

- All activities should be modified or changed to suit the local situation and environment. The facilitators should be familiar with the local situation and should be ready to co-facilitate with locals if the need arises.
- Participatory learning is about learning on both sides (the facilitator and the learners).
- PLAs should be approached with a very open mind with respect to situations and events. There are no rigid rules, and when conducting these activities, there should be no preconceived ideas regarding situations, people or resource use mechanisms.

- PLA methods can be used on any subject, in any situation and in any work or study environment.

Why PLAs?

- The use of PLAs stem from the need to involve people. People in most cases are the owners and users of resources, thus they should make decisions concerning their welfare.
- PLAs consist of information gathering using a diverse range of activities and methods.
- PLAs cut through social and traditional barriers such as age, sex and status.
- PLAs allow women, youth and other stakeholders to participate in discussions and decision making.
- PLAs provide the opportunity for comparison of information through discussion groups, focal groups and various other activities.
- PLAs build the capacity of communities and expose the potential of the people involved.

The facilitator

In any situation where PLAs are used, the facilitator plays a very important role. Always remember the following:

- As a facilitator you are a colleague of the people.
- Know about the place and culture before you conduct any exercise or training. Always talk, dress and work at the people's level.
- Be interactive and friendly, but firm, and ready to listen.



Samoa 2002: Presentations by facilitator

- Be ready for differences, arguments, debates and for distractions. They are all part of the process.
- PLAs are fun only if you, as the facilitator, are fun to learn with. The process, tools and materials do not differ much; it is the facilitator that makes the difference.

The process

Always have introductory sessions. Introduce yourself and your team. Your team should have recorders and assistants to help out and take down notes. Participants should introduce themselves, their friends, etc. Hold ice-breaking exercises at the beginning of the session.

Materials for the workshop

Have all your materials ready in advance. Pens, writing boards, drawing materials, adhesive tapes, marker pens, etc. Check out existing facilities before the workshop begins. You will have made a reconnaissance visit to the community anyway, so should have a clear indication of what is available, and what the needs are. Materials should include all videos, overhead and electrical appliances and posters, books and whatever materials will be given out to participants.

The learning process

This process involves the facilitator talking to the people. It is an interactive process where participants can contribute and ask questions during the session. There is no right and wrong answer; you as the facilitator should decide how to handle questions. All issues raised, concerns, and information given should be recorded as they are given.

Participants as facilitators

The other interesting part of the whole process is where participants take over as facilitators and the facilitators join other participants. This should be a voluntary process.

Rules of the workshop

Rules, if any, are to be set by the participants. They may want to elect a time keeper, etc. They should also decide on what to do when the rules are broken. In Fiji Islands for example, a popular exercise is for participants to decide to refrain from kava drinking up to a certain time, when they are then allowed to

An example of an ice-breaking exercise

You can divide participants in pairs, and ask them to find out everything about one another before introducing their partners. In this manner, they have established contact and will introduce a person fully (Pacific people are usually hesitant about talking about themselves). Participants taking over the introductory sessions will help break the ice, and assist you to identify people's different strengths in the group.

mix their kava. Breaking a rule (such as being on time, for example), can result in people singing to the group, or performing some traditionally associated tasks.

Writing and recording of information

Whatever people say should be recorded as they say it.

Group work

This is a necessary tool of PLA, but composition of groups should always vary.

- Groups should vary when using different activities.
- Groups can be the elders, women, men, youth, young women, young men, etc. In

some instances these groupings can be mixed.

- In others people have to be in specially selected groups so that there is no traditional barrier that will stop people from contributing meaningfully. For example on leadership questions do not group the young and the elders or the women



Marshall Islands 2002: Group activities

with the leaders as discussions will be constrained.

- At the end of each group sessions, group findings are presented by a representative of the group. Always make sure that everyone takes a turn at presenting.
- Some people will tend to dominate discussions. Counteract this by making sure the others are also part of the discussions.
- Group work can create enjoyment and can also go overtime. Devise ways to keep time (e.g. a time keeper can be appointed).

Gender consideration

Always try to include women, young people and children in different groups. Women should try to do their own activity, such as drawing maps, and they should be encouraged to present the findings of a group. In Fiji women have increasingly participated in PLA exercises and there has been no unwillingness by male counterparts to work with them.

Activities that can be used

These are some of the major activities that can be used:

- **Resource mapping:** There are many variations of this activity. Maps that can show what the area was like 30 years before, and visionary maps may show what the people want their site areas to be like after 10 years of conservation effort. These can be then kept as comparison or reminder points for people during the entire management initiative. Mapping work is done in groups, with all materials for writ-

ing and drawing provided. Instructions should clearly state what is wanted. The groups then present their maps at the end.

- **Seasonal calendars:** These calendars can help identify the different species utilised or consumed by the community. This group exercise will also serve to highlight the interaction between terrestrial and marine resources. Calendars and maps shall be kept and photocopied in reduced size, so they can form part of the workshop reports.
- **Time line:** A time line of events is used to assist in trying to determine developments that have taken place in the community in the past. For example, a time line might focus on the past 30–40 years. People need to identify a certain

date as an indicator, against which all the other events taking place are measured. The identified event or activity may not relate at all to fisheries, but instead be a traditional or religious activity that people remember. For example, people may remember the opening of a new church as a reminder of an era when fish were plentiful, major events such as the political upheavals in Fiji, or the sinking of a boat may be used. All charts or time lines are taken into account, and the identified factors recorded as contributing to resource change in the area.

- **Species ranking:** After a group discussion or activity where people identify the most important species that they consume or sell, the 5 or 10 most important are taken and ranked. The

Important points to remember

- The tool used should be able to draw out the desired outcomes.
- People are at ease when doing the exercises, which facilitates information sharing.
- The tool chosen should be relevant, culturally acceptable and applicable.
- Timing is very important, so that all sectors of community can engage in the activities.
- Tools can enhance participation and also build participants' capacity.
- Ensure that people's potential is fully realised by ensuring maximum participation.
- All information, maps, charts and posters from group work or exercises should be recorded as they are given.
- All information should be translated into local languages at the end of the workshop, and sent back as a report to the community.

- exercise will focus on ranking methods and how to determine the most consumed species in the area.
- Development web: Other tools used include the development web, which focuses on development and its causes, benefits and advantages. The development web allows people to trace what development impacts are, whether they be positive or negative.
 - Problem solution tree: In this activity, people identify the main problem; through discussions, causes of the problem are discussed and root causes are isolated. The impacts and multiplier effects of problems are then also identified, by tracing what happens after various activities. This helps people see problems constructively, and by tracing causes and impacts they can put other community problems into perspective.
 - Development/ conservation exercises: This can be done in groups, with people discussing the positive and negative points of development and conservation, looking at impacts in detail.
 - There are many other tools that can be used, and many ways of implementing them.



Niue 1998: Group activities

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