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2 Executive summary

Aquaculture in the Pacific region ranges from highly commercial enterprises such as pearl culture to subsistence farming of fish and novel forms of aquaculture such as capture and grow-out of post-settlement fish larvae. The institutional capacity of Pacific island country (PIC) governments (in particular) to support the increasingly sophisticated needs of the aquaculture sector is often lacking; staff commonly lack the skills, experience or local resources to provide necessary technical support. These issues must be addressed for aquaculture in the region to reach its potential in a sustainable manner.

A previous ACIAR project (FIS/2001/75¹) pioneered a targeted, rapid and flexible response to these issues and successfully implemented fourteen 'mini-projects'. They led to significant capacity building and generated widespread support from the region and endorsement from the 5th SPC Heads of Fisheries Meeting in April 2006 for continuation.

This follow-on project, "*Developing aquaculture based livelihoods in the Pacific Islands region and tropical Australia*", was led by James Cook University (JCU), and partnered by the Secretariat of the Pacific Community (SPC), The WorldFish Center and the University of the South Pacific (USP). Involvement of JCU and USP provided study opportunities for Pacific islanders and thereby enhanced aquaculture technical skills available within the region and the professional capacity of PIC's. The project implemented mini-projects to address critical bottlenecks and opportunities for development of economically, socially and environmentally sustainable aquaculture in the Pacific Islands region, and to assist Indigenous aquaculture in tropical Australia. Mini-project concepts were sought through SPC and ACIAR channels, and through consultation with Aquaculture stakeholders within the region. Government-private sector partnerships were encouraged, as were mini-projects involving students from partner countries supported by the ACIAR-USP post-graduate scholarship scheme. Importantly, this project supported the SPC's Regional Aquaculture Strategy and supplemented the R&D activities of the SPC Aquaculture Action Plan.

Twenty-three mini-projects were conducted in seven PICs and another three focused on Australian Indigenous aquaculture initiatives. Two mini-projects involved multiple PICs. There was a focus on mini-projects with commodity-based research synergies (i.e. pearl oysters, sea cucumber) and project types (e.g. spat collection). However, the range of commodities and themes was broad and included culture of ornamental species, pearl oysters and pearls, freshwater fish and prawns, mud crab, sea cucumber and seaweed, in addition to support of aquaculture through improved business skills, feed production, culture system design and disease testing. Project staff also provided technical support for the ACIAR-WorldFish Center sea cucumber sea ranching project at Goulburn Island, Northern Territory (FIS/2003/059²), and supervisory support within the ACIAR-USP post-graduate scholarship scheme.

The project was well received by the PICs in which it operated and all PIC partners expressed their strong support for mini-projects. The benefits were seen to be immediate, in response to small but important emerging problems and opportunities. Among these were cross-cutting issues where mini-projects were able to add value to larger initiatives. The outputs of a number of mini-projects provided a foundation for development of large ACIAR projects, likely to have much broader regional impacts with key aquaculture commodities.

¹ FIS/2001/75: 'Sustainable aquaculture development in the Pacific Islands region and northern Australia'

² FIS/2003/059: 'Sea ranching and restocking of sandfish (*Holothuria scabra*) in Asia-Pacific'

3 Background

Aquaculture in the Pacific region is a diverse and expanding sector. Activities range from highly commercial enterprises such as pearl culture to subsistence farming of fish and novel forms of aquaculture such as capture and grow-out of post-settlement fish larvae. For aquaculture to reach its potential in a sustainable manner, institutional capacity to support and manage research within the Pacific must be enhanced.

The institutional capacity of Pacific Island country (PIC) governments (in particular) to support the increasingly sophisticated needs of the aquaculture sector is often lacking. Whilst many countries have facilities or basic resources (often established by aid projects), the staff commonly lack the skills, experience or local resources to provide necessary technical support. As a component of the previous ACIAR project (FIS/2001/75³) a total of fourteen 'mini-projects' successfully addressed these issues by adopting a targeted, flexible and rapid regional response.

The mini-project concept was novel in its approach of targeting specific bottlenecks and opportunities to regional aquaculture. They led to significant capacity building and generated widespread support from the region, including endorsement from the 5th Secretariat of the Pacific Community (SPC) Heads of Fisheries (HoF) Meeting in April 2006 for its continuation. The project review in November 2006 concluded that the mini-project concept had been successful and its results were 'impressive'. Its recommendation that a follow-on project to extend the mini-project concept be funded was supported by ACIAR and provided the basis for this project. This project provided a common pool of funds from which appropriate small projects in the region were commissioned to address critical bottlenecks and opportunities in aquaculture development.

The Australian Commissioned Agency, James Cook University (JCU), was partnered by the SPC as the representative of the Pacific Islands. The WorldFish Centre and the University of the South Pacific (USP) were collaborating partners. The overall aim of this project was to support economically, socially and environmentally sustainable aquaculture in the Pacific region, and to assist Indigenous aquaculture in tropical Australia. Importantly, the project supported the SPC's Regional Aquaculture Strategy and supplemented the R&D activities of the SPC Aquaculture Action Plan. The involvement of JCU and USP provided opportunities for Pacific islanders to further their studies in Aquaculture and thereby enhanced the base of technical skills available to the region and the professional capacity of PIC's.

The project was intended to deliver significant research and development support for the Pacific Aquaculture Strategy which is coordinated by the SPC. It provided a conduit to link on-going work in PICs with current or past ACIAR or WorldFish Center research projects, with PNG a particular focus in this respect. It further strengthened technical and academic exchanges between Australian and the Pacific Islands and the inclusion of JCU in the team facilitated this process. Much of the research undertaken through the project was also of relevance to Australia. The physical and social context to the development of Indigenous Australian aquaculture has much in common with the Pacific Islands, particularly with respect to initiatives involving small communities located in remote, tropical areas.

Dissemination of project outcomes was undertaken primarily using existing pathways available to the regional partner agencies, particularly those supported by SPC. These included existing technical and advisory services of the Pacific Aquaculture Program, technical meetings (including HoF meetings) the SPC Fisheries Newsletter and Information Bulletins. Outcomes were also more widely disseminated through the Network of Aquaculture Centres in Asia-Pacific (NACA) and via international conferences/forums.

³ FIS/2001/75: 'Sustainable aquaculture development in the Pacific Islands region and northern Australia'

4 Objectives

The overall aim of the project was to support economically, socially and environmentally sustainable aquaculture in the Pacific Islands region, and to assist Indigenous aquaculture in tropical Australia. The project supported the SPC's Regional Aquaculture Strategy and supplemented the R&D activities of the SPC Aquaculture Action Plan.

Specific objectives were:

1. Identify and implement targeted research activities and technology transfer in response to issues identified by Pacific Island Countries (PICs) where possible by drawing on results and expertise developed through completed and on-going ACIAR, WorldFish and other aquaculture projects;

- Identify suitable mini-projects that meet defined selection criteria
- Conduct mini-projects that address identified research gaps of regional significance;
- Transfer of appropriate aquaculture technology to target PICs
- Establish a framework for adoption and extension of mini-project outputs beyond the life of the project.

2. Increase institutional capacity amongst Pacific Island Countries (PICs) to support and manage research, particularly Papua New Guinea;

- Conduct mini-projects which enhance capacity for aquaculture research, development and extension in PICs with an emphasis on government institutions
- Involve multiple countries in mini-projects, as appropriate, to provide a basis for future collaborations and build stronger links between Pacific and Australian based agencies
- Improve access to information and facilitate mechanisms for information sharing in the Region
- Identify high quality upcoming PIC scientists and facilitate pursuit of scholarships and training opportunities where appropriate
- Contribute to the annual aquaculture technical forum in PNG.

3. Provide technical support for Indigenous Australian aquaculture ventures;

- Increase the capacity in aquaculture for Indigenous communities in tropical Australia by utilising Pacific experience in areas of common interest
- Technical support for the ACIAR-WorldFish Center sea cucumber (sandfish) sea ranching and reseeded project at Goulburn Island, NT.

5 Methodology

This project was a continuation of the mini-projects component developed under the ACIAR Project “*Sustainable Aquaculture Development in the Pacific Islands Region and Northern Australia*” (FIS/2001/075). It continued to use the rigorous system established for vetting and approving mini-projects and methodology developed during FIS/2001/075 for running mini-projects. Previous experience from that project allowed streamlining of methods which, in combination with transferring project administration to JCU, reduced transaction costs. The lessons learnt during the earlier project were used to modify the process for this project to increase the likelihood of successful mini-projects.

The project, through SPC and ACIAR channels and project staff interactions, consulted with Aquaculture stakeholders within the region (including government, private sector, community etc.) to seek project concepts. Proposals that included competent private sector enterprises were encouraged where appropriate, particularly where they provided partnership to government agencies. Opportunities were sought for research conducted by postgraduate students (i.e. from USP and/or JCU) in mini-projects conducted with private sector partners. With the establishment of the ACIAR-USP post-graduate scholarship scheme in 2007, there was increased emphasis to develop mini-projects with a student thesis in mind.

Appropriate project concepts were developed into proposals with assistance by the project team (Appendix 1). There was rigorous consultation with the relevant government agency during project development to ensure that mini-projects addressed government priorities. The in-country Project Leader was encouraged to take a strong role in the development of project proposals and worked closely with a member of the project team during this period. A specific project team member was allocated to assist in this process for each project concept, once approved by the team. Full project proposals were vetted by the project team according to agreed criteria and with the assistance of specialist advice when required. Approved projects were implemented after appropriate support had been sourced and put in place. Some projects required the inputs of a technical adviser from outside of the country. Expertise and experience gained from past and on-going ACIAR, WorldFish and other projects was used where possible.

5.1.1 Pathway for appraisal and implementation of mini-projects

The process for receiving, assessing and implementing mini-projects comprised the following steps:

1. Mini-project concepts were instigated from a variety of sources, including various commodity experts (within and outside the project team), the SPC Aquaculture section or the JCU project co-ordinator.
2. Preparation of a brief concept note on the proposed project, including basic what/where/who details as well as addressing the selection criteria (see below).
3. In-principle approval of the concept by all team members (representing the project partner agencies) before it can progress. Wherever possible mini-project concepts were vetted at face-to-face meetings (e.g. project leader meetings).
4. A number was assigned to the mini-project at this stage—a two letter, four number code as follows: M (for mini-project) S or L (small or large) ## (year) ## (sequential number), e.g. MS0701. The sequential number was used to track expenditure on each project for acquittal purposes.
5. Approved mini-project concepts were forwarded to the ACIAR Fisheries RPM for final approval and comment.

6. The full mini-project proposal was prepared by the proponent with assistance from project team members if needed.
7. The mini-project proposal was distributed to all team members for comment and then accepted or rejected by consensus. Proposals may be sent to a specialist for advice on technical feasibility. This process was discretionary.
8. Funds were disbursed from JCU to SPC in advance of expenditure using a formula agreed upon under a Memorandum of Understanding (MOU) which was drawn-up between the two organisations. In some cases, funds were disbursed from JCU to other implementers and appropriate arrangements between JCU and the organisation receiving the funds were made.
9. Proposals included a summary sheet of Objectives, Outputs and Payment schedules for MOUs and other administrative agreements.
10. The sign off for funds from JCU was carried out by the Project Leader (Southgate).
11. For mini-projects where SPC was responsible for funds' disbursement, an MOU between SPC and the PIC was signed and money released.

5.1.2 Assessment criteria for mini-projects

Mini-project proposals were vetted and assessed by project team members using the following criteria:

1. Should target an identified constraint to aquaculture and be of relevance to the SPC Regional Aquaculture Strategy and the SPC Aquaculture Action Plan 2006 with clear focus on ACIAR partner countries
2. Probability of success
3. Have widespread regional benefits
4. Have a high level of commitment by counterpart agency
5. Co-funding/contribution by counterpart agency
6. Technical feasibility
7. Extension and adoption strategies
8. Degree of engagement of private sector
9. Level and quality of project supervision in-country
10. Potential socio-economic outcomes
11. Potential environmental impacts
12. Strategic framework for aquaculture in-country
13. Potential for linkages between Australia and Pacific Islands
14. Instigates collaboration between PICs.

A mini-project application pro-forma, including guidelines and reporting requirements, was developed during FIS/2001/075 and used again in this project. It was based upon the SPC pro-forma for small projects because Pacific fisheries organisations and other institutions were familiar with this format. However, the form was modified to include a section relating to proposed adoption/extension mechanisms beyond the life of the project and consideration of potential environmental effects, particularly associated with species' introductions and translocations (see Appendix 1).

Mini-projects were tailored to meet these varying country requirements which may target the following areas: research, technology transfer and institutional capacity building. Within

tropical Australia, the project drew on experience from the Pacific islands region in areas of potential benefit to Indigenous communities.

5.1.3 Project management protocol

A project management protocol, based on experience gained during FIS/2001/075, was applied during this project. This involved assistance with mini-project development and proposal preparation, regular communication during mini-project operation to monitor progress, and assistance from team members with report writing and result dissemination.

All team members were involved with mini-project development and vetting and this ensured implementation of high quality mini-projects. On-going monitoring of mini-projects was undertaken via regular communication with in-country project supervisors; much of this was initiated by the SPC Aquaculture Officers and JCU project co-ordinator (Principal Research Officer, Cathy Hair). Any problems that arose were identified early on the basis of frequent contact, and were addressed in an appropriate manner. The project team assisted in data collation, report writing and dissemination to maximise mini-project outcomes. They further assisted with any subsequent development of mini-project outcomes (e.g. development into a larger project) where appropriate. The in-country Project Leader was encouraged to take a strong role in the data collection, collation and report writing through close association with a member or members of the Project Team who will assist in this process. Project outcomes were made available on the internet via the ACIAR web pages, the SPC Aquaculture portal and other relevant outlets with particular emphasis placed on reporting rigour.

6 Achievements against activities and outputs/milestones

Objective 1: Identify and implement targeted research activities and technology transfer in response to issues identified by Pacific Island Countries (PICs), where possible by drawing on results and expertise developed through completed and on-going ACIAR and WorldFish aquaculture projects.

no.	activity	outputs/ milestones	completion date	comments
1.1	Identify suitable projects that meet defined selection criteria.	Timely identification of constraints and opportunities.	31/12/2011	Seven face-to-face project team meetings were held to identify, discuss and vet mini-projects. Email, phone and Skype were also employed at various times to further discussion and collaboration. 36 suitable mini-project concepts were identified, although not all were undertaken.
1.2	Conduct mini-projects that address identified research gaps of regional significance.	Approximately 24 small and 3 large mini-projects. Rapid technical problem-solving activities to address specific bottlenecks and pursuit of potential opportunities.	31/12/2011	Twenty-six mini-projects (24 small and two large) were completed (Table 1 and Appendix 2).
1.3	Transfer of appropriate aquaculture technology to target PICs.	Enhanced technical skills and capacity for aquaculture production in PICs Enhanced productivity and profit from existing farming systems. Increased options for commercial aquaculture ventures (i.e. private sector). Diversification of aquaculture commodities. Increased food security within PICs.	31/12/2011	Fourteen mini-projects involved technology transfer. These were: MS0801 (clownfish culture), ML0801 (sandfish culture and sea ranching), MS0802 (rabbit fish cage farming), MS0803 (mabé pearl production), MS0804 & MS0903 (spat collection trials), MS0901 (Mozambique tilapia trials), MS0902 (live rock & coral culture), ML0901 (<i>M. lar</i> farming), MS1004 (Indigenous sponge farming), MS1005 (pen culture of mud crab), MS1006 (large-scale sandfish sea ranching), MS1008 (Indigenous live rock culture), MS1009 (village <i>Caulerpa</i> culture). Results were adopted by the private sector, e.g. Justin Hunter Pearls in Fiji and Tongan <i>Pteria penguin</i> farmers, Further, two mini-projects had a component which enhanced skills in commodity cross-cutting areas: training in business skills in MS0905 (PNG Credit Workshop); and training in aquafeed formulation software in MS1007 (Pacific aquafeed ingredient database).

1.4	Establish a framework for adoption and extension of mini-project outputs beyond the life of the project.	Mini-project proposals that incorporate appropriate adoption and extension strategies. Increased awareness in PICs of the planning requirements for appropriate adoption strategies.	31/12/2011	<p>PIC project partners were involved in and gained experience in planning of adoption strategies during proposal development. For example:</p> <ul style="list-style-type: none"> • ML0801 and MS1006 (sandfish culture and sea ranching mini-projects) developed a management framework for future extension of this activity and left Fiji Fisheries with facilities and trained government personnel. • MS0901 (Mozambique tilapia trials) and ML0901 (Culture and capture of <i>Macrobrachium lar</i>) were run as part of larger strategies developed by SPC. The proposals incorporated a framework for continuation through the inclusion of local fisheries, NGOs, communities and households. Specific expertise was established in-country in both studies. Essential infrastructure (e.g. a pilot-scale tilapia hatchery, <i>M. lar</i> ponds) was provided where required and appropriate. • MS1002 (Pearl oyster hatchery Tonga) provided oyster stock to the existing pearl industry and provided bridging research to ensure successful continuation of the follow-on ACIAR FIS/2009/057⁴. • MS1009 (Samoa <i>Caulerpa</i> culture) built on existing strengths and priorities of the Fisheries department and coastal communities. Necessary equipment and skills allowed research to continue beyond the life of the mini-project. <p>Outputs from ML0801 (Sandfish culture and sea ranching), MS0807 (Tonga <i>Pt penguin</i>), MS0903 (PNG spat collection), MS0906 (Goulburn Island sandfish sea ranching) and probably MS1009 (Samoa <i>Caulerpa</i> culture) provided the basis for larger ACIAR projects in the region (e.g. FIS/2010/017⁵, FIS/2010/054⁶, FIS/2003/059, FIS/2010/042⁷). Some also fed into follow-on research activities under the ACIAR-PARDI⁸ initiative and John Allwright fellowships (JAFs).</p> <p>Mini-project outcomes were disseminated at an international symposium on tropical sea cucumber mariculture.</p>
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PC = partner country, A = Australia

⁴ FIS/2009/057: 'Pearl industry development in the western Pacific'

⁵ FIS/2010/017: 'Building mariculture capacity in Papua New Guinea'

⁶ FIS/2010/054: 'Mariculture development in Papua New Guinea'

⁷ FIS/2010/042: 'Expansion and diversification of production and management systems for sea cucumbers in the Philippines and northern Australia'

⁸ PARDI/2010/004: 'Pacific Agri-business Research for Development Initiative'

Objective 2: Increase institutional capacity amongst Pacific Island Countries (PICs) to support and manage research, particularly Papua New Guinea.

no.	activity	outputs/ milestones	completion date	comments
2.1	Conduct mini-projects designed to enhance capacity for aquaculture research development and extension in PICs with an emphasis on government institutions.	<p>Improved research and administrative capacity in relevant PIC agencies.</p> <p>Increased level of scientific rigour and reporting in PICs</p> <p>Increased in-country and regional capacity resulting from use of experts from within the region.</p> <p>Raised profile of aquaculture research facilities in the Pacific.</p>	31/12/2011	<p>Most mini-projects were developed with PIC government input and had strong emphasis on increasing capacity of PIC government fisheries agencies (although not exclusively). NGOs and private sector are involved as stakeholders where appropriate, e.g. Bris Kanda in PNG, church agencies in Solomon Islands, ornamental fish exporters and pearl farmers in Tonga/ Fiji, potential live rock farmers in Western Australia.</p> <p>There was emphasis on supporting and strengthening the role of aquaculture research facilities in PNG (NFA, Nago Island Marine Research Facility), Vanuatu (Vanuatu Fisheries Department hatchery, Port Vila), Tonga (Sopu facility), Solomon Islands joint NGO-MFMR tilapia facility, Samoa (proposed government marine hatchery).</p>
2.2	Improve access to information and facilitate mechanisms for dissemination and sharing of information within the Region.	<p>Expansion of the SPC Aquaculture Portal to include mini-project activities, reports and publications</p> <p>Dissemination of mini-project results through regional workshops and conferences, SPC bulletins and ACIAR webpage.</p> <p>Greater awareness of regional aquaculture activities and improved access to information relating to them</p>	31/12/2011	<p>Project team members used their networks to facilitate information sharing and dissemination.</p> <p>Mini-project results have been shared amongst all interested groups. The SPC Fisheries Newsletter and information Bulletins (the Beche-de-mer and Pearl Oyster editions in particular) continue to be important outlets for project updates and results.</p> <p>The SPC Aquaculture portal now includes a link to ACIAR reports that have been prepared as part of FIS/2001/035 partnership with SPC. Project reports arising from this project will be uploaded to the site when they are finalised.</p> <p>A number of mini-projects had research synergies, e.g. clusters of commodity studies (i.e. pearl oysters, sea cucumber) and project types (e.g. spat collection), which foster sharing of information between projects in different PICs.</p> <p>An international symposium on culture of tropical sea cucumber facilitated by JCU (FIS/2010/035⁹) provided an opportunity for PICs to exchange information and access the latest research in this field.</p>

⁹ FIS/2010/035: 'Asia-Pacific Tropical Sea Cucumber Aquaculture Symposium'

2.3	Involve multiple countries in mini-projects.	Improved exchange of information and expertise between scientists and/or institutions in the Pacific and/or Australia. Provide a basis for future collaboration and regional networking. Stronger links between Pacific and Australian based agencies.	31/12/2011	Three mini-projects involved multiple PICs: (1) shrimp virus testing (MS0805) has collected tiger shrimp tissue from PNG, Solomon Islands and Palau; (2) improved <i>M. lar</i> farming (ML0901) which has components in Vanuatu and Fiji; and (3) Pacific feeds ingredient inventory (MS1007) involving PNG, Fiji, Samoa, Vanuatu and Solomon Islands. Synergy between similar mini-projects e.g. MS0804 (pearl oyster spat collection in Fiji) and MS0903 (in PNG). Two mini-projects forged stronger links and developed networks between Australia and the Pacific: MS1004 Indigenous aquaculture technology transfer for Sponge (Pohnpei to Torres Strait) and MS1008 Live Rock culture (Tonga to Western Australia).
2.4	Identify high quality upcoming PICs scientists and facilitate the pursuit of scholarships and training opportunities where appropriate	More PIC aquaculture scientists pursuing further training.	31/12/2011	Six mini-projects were run by students under the ACIAR-USP graduate student scholarship scheme: MS0801 (Fiji pearl oyster spat collection), MS0803 (mabé pearl), MS0806 (<i>M. lar</i> hatchery culture); MS0807 (Tonga <i>Pt. penguin</i> grow-out); ML0801 (Sandfish culture and sea ranching); ML0901 (improved <i>M. lar</i> farming). Funds were also released for a non-scholarship USP student mini-project MS1003 (Freshwater prawn settlement). Pranesh Kishore and Monal Lal (MS0803 and MS0806), were subsequently awarded JAFs to study for PhDs at JCU in 2011 and 2012, respectively. The PhD research of Salote Waiqaratu (former mini-project researcher, current UQ PhD JAF student) was supported by the provision of shrimp samples from three additional PICs (mini-project MS0805, virus testing of shrimp).
2.5	Contribute to an annual aquaculture technical forum in PNG	Facilitate development of aquaculture in PNG.	31/12/2011	PNG NFA formed a separate Aquaculture section within NFA in 2010, however, an annual technical forum was not a PNG priority and coordination was difficult. Ms Hair facilitated development of aquaculture in PNG through other ACIAR projects and supported NFA aquaculture managers and other staff where possible (e.g. hosting John Dillon Fellows and recipients of Crawford funding during Australian visits). She assisted in related ACIAR training activities (e.g. FIS/2009/027 ¹⁰).

PC = partner country, A = Australia

¹⁰ FIS/2009/027: 'Training in soil assessment and scientific writing for aquaculture officers in PNG'

Objective 3: Provide technical support for Indigenous Australian aquaculture ventures.

no.	activity	outputs/ milestones	completion date	comments
3.1	Identify and initiate suitable projects to promote Indigenous aquaculture in tropical Australia.	<p>Diversification of indigenous aquaculture activities through technology transfer – building on where applicable the experience of indigenous aquaculture in PICs.</p> <p>Solutions to identified research gaps / production constraints for Indigenous aquaculture activities.</p> <p>Increased linkages between stakeholder agencies in Australia and the Pacific involved in Indigenous aquaculture programs.</p>	31/12/2011	<p>Three mini-projects to support fledgling Indigenous aquaculture projects were carried out:</p> <ul style="list-style-type: none"> (1) MS0906 Development of ACIAR sandfish ranching project (Goulburn Island, NT); (2) MS1004 Indigenous aquaculture technology transfer for Sponge (Pohnpei to Torres Strait); and (3) MS1008 Indigenous aquaculture technology transfer for live rock culture (Tonga to Western Australia). <p>These mini-projects transferred experience and knowledge on these commodities from successful Pacific operations to Indigenous enterprises. In the case of the first project, NT participation in larger ACIAR initiatives in this area were secured (refer to Activity 3.2 below).</p>
3.2	Technical support for the ACIAR-WorldFish Center sea cucumber (sandfish) sea ranching project at Goulburn Island, NT.	<p>Successful trials in sandfish sea ranching in collaboration with WorldFish, DAFF, NLC and the Waruwi community of Goulburn Island.</p> <p>Baseline data for similar sea ranching and restocking activities in the Region.</p>	31/12/2011	<p>An ACIAR project variation to re-establish the Australian sea ranching node of the WorldFish-ACIAR project FIS/2003/059 was accepted: ACIAR funding was secured in late 2009.</p> <p>Throughout this project, Ms Hair provided support for the sea cucumber study. NT is also a partner in a follow-on ACIAR project (FIS/2010/042).</p>

PC = partner country, A = Australia

7 Key results and discussion

7.1 Mini-projects

Twenty-six mini-projects were approved by ACIAR and carried out by the project team—24 small mini-projects and two large mini-projects. A summary of these is presented in Table 1 and full mini-project reports are appended (Appendix 2).

Table 1. Completed mini-projects grouped by country. (MS=small, <\$25,000 and ML=large, \$25,000–\$50,000; middle two numbers indicate the year the project began, e.g. 08 = 2008; last two numbers indicate order, e.g. 01 = first project for a given year)

No.	Title / Country	Synopsis
Papua New Guinea		
MS0805	Feasibility of establishing specific pathogen free stocks of shrimp in the Pacific (see Appendix 2.1)	Determined the incidence of WSSV, IHNV, YHV, GAV, TSV, MBV and HPV in <i>Penaeus monodon</i> from PNG, Palau and Solomon Islands, and obtained new knowledge on their genetic diversity and population structure (multi-country).
MS0808	Assessment of Fly River herring for fish meal and as an aquafeed ingredient, PNG (see Appendix 2.2)	Developed optimum post-harvest handling methods, storage and processing methods for Fly River herring to ensure an acceptable and quality fresh fish and fishmeal product.
MS0903	Recruitment patterns of commercial molluscs and other species to spat collectors in PNG (see Appendix 2.3)	Determined the availability and seasonality of commercial species that recruit to surface and benthic spat collectors in New Ireland province PNG, providing a basis for follow-on ACIAR research at Nago Island (FIS/2010/017, FIS/2010/054).
MS0905	Improved access to credit and grant funding for PNG fish farmers, PNG (see Appendix 2.4)	Conducted a workshop to train fish farmers and extension officers on book-keeping and business aspects of freshwater aquaculture in order to improve access to credit for PNG fish farmers and educate credit providers (e.g. National Development Bank) on the economics of fish farming.
MS1001	Growth of rainbow trout (<i>Oncorhynchus mykiss</i>) on locally produced feed formulation in PNG Highlands ponds (see Appendix 2.5)	Compared the effectiveness of a rainbow trout diet produced in Goroka from local ingredients with a commercial trout pellet imported from Australia, concluding that the imported diet led to better growth but that the local diet was satisfactory and more accessible to Highland fish farmers.
MS1005	Pen culture trial of mud crab (<i>Scylla</i> sp.) in mangrove habitat, PNG (see Appendix 2.6)	Trained NFA, NGO and community members in pen and cage culture of undersized and lean mud crab, then ran trials to determine the feasibility of mud crab pen culture in PNG.
MS1007	Pacific islands aquaculture feed ingredients inventory (see Appendix 2.7)	Reviewed current knowledge about locally-available shrimp, prawn and fish aquafeed ingredients and analysed novel ingredients suitable for making farm feeds (multi-country).
Fiji Islands		
ML0801	Culture of juvenile sandfish for sea ranching trials in Fiji (see Appendix 2.8)	Investigated the potential for sea cucumber aquaculture and sea ranching in Fiji, through production trials at Hunter Pearl's blacklip pearl oyster hatchery and a ranching trial at Natuvu village near Savusavu, Vanua Levu.

MS0803	Improving <i>Pteria penguin</i> (winged pearl oyster) juvenile culture and mabé production techniques in the Fiji Islands (see Appendix 2.9)	Investigated the effects of culture depth, nucleus position, and implant age on the quality of mabé production for <i>Pteria penguin</i> in Fiji Islands.
MS0804	Recruitment patterns of pearl oysters to spat collectors in Savusavu Bay, Fiji, with emphasis on the blacklip pearl oyster (<i>Pinctada margaritifera</i>) (see Appendix 2.10)	Developed a reliable and efficient blacklip pearl oyster spat collection practice for Fiji that incorporated optimal targeting of spat, and constructed a useful pearl oyster spat identification key.
MS0806	Closing the life cycle of <i>Macrobrachium lar</i> , Fiji (see Appendix 2.10)	Closed the life cycle of the indigenous Pacific freshwater prawn, <i>Macrobrachium lar</i> , at USP marine studies hatchery in Suva.
MS1007	Pacific islands aquaculture feed ingredients inventory (see Appendix 2.7)	Reviewed current knowledge about locally-available shrimp, prawn and fish aquafeed ingredients and analysed novel ingredients suitable for making farm feeds (multi-country).
MS1003	Evaluation of different substrata to enhance freshwater prawn post-larvae production, Fiji (see Appendix 2.12)	Investigated the effects of using different substrates as a settlement substratum for freshwater prawn production at USP in Fiji, concluding that additional horizontal substrata improved survival but had no effect on growth.
MS1006	Large scale sandfish sea ranching trial, Fiji (see Appendix 2.13)	Trained fisheries staff at MAFF hatchery at Galoa in sandfish hatchery techniques, resulting in production of 5,000 juveniles. Release did not take place, however, due to mortality.
Vanuatu		
MS0801	Clown fish culture, Vanuatu (See Appendix 2.14)	Establishment of a hatchery system and trained Vanuatu aquaculture officers to culture the valuable ornamental clown fish, <i>Amphiprion melanopus</i> .
ML0901	Study of <i>Macrobrachium lar</i> capture and culture techniques in Vanuatu (see Appendix 2.15)	Studied the capture and culture of <i>M. lar</i> in Vanuatu, concluding that it is technically and economically feasible for low-tech, small-scale aquaculture.
MS1007	Pacific islands aquaculture feed ingredients inventory (see Appendix 2.7)	Reviewed current knowledge about locally-available shrimp, prawn and fish aquafeed ingredients and analysed novel ingredients suitable for making farm feeds (multi-country).
Tonga		
MS0807	Improved husbandry methods for the culture of juvenile winged pearl oysters (<i>Pteria penguin</i>) in Tonga (see Appendix 2.16)	Examined the effects of culture system, depth and site to develop an improved farming protocol for winged pearl oyster, <i>Pteria penguin</i> .
MS0902	Live rock and coral culture for the ornamental industry, Tonga (see Appendix 2.17)	Transferred production techniques and conducted grow-out trials to produce artificial live rocks and corals to augment the supply of marine ornamentals for export in Tonga.
MS1002	Support of pearl oyster (<i>Pteria penguin</i>) hatchery production in Tonga (see Appendix 2.18)	Enabled Tonga Fisheries aquaculture staff to produce winged pearl oyster (<i>Pteria penguin</i>) juveniles (approx. 35,000), which were distributed to Tongan pearl farmers to alleviate an oyster stock shortage and also supported research by the aquaculture division of MAFFF. This stabilised the industry and maintained momentum between successive ACIAR projects.

Solomon Islands		
MS0802	Rabbit fish culture and feed trials (capturing juvenile fish for food security), Solomon Islands (see Appendix 2.19)	Undertook basic farming trials of rabbit fish (<i>Siganus</i> spp.) using locally sourced diets to identify potential strategies to address food security in the Pacific.
MS0805	Feasibility of establishing specific pathogen free stocks of shrimp in the Pacific (see Appendix 2.1)	Determined the incidence of WSSV, IHHNV, YHV, GAV, TSV, MBV and HPV in <i>Penaeus monodon</i> from PNG, Palau and Solomon Islands, and obtained new knowledge on their genetic diversity and population structure.
MS0901	Mozambique tilapia grow-out trials, Solomon Islands (see Appendix 2.20)	Assessed the aquaculture potential of Mozambique tilapia in Solomon Islands, providing valuable information on future strategies for food security.
MS1007	Pacific islands aquaculture feed ingredients inventory (see Appendix 2.7)	Reviewed current knowledge about locally-available shrimp, prawn and fish aquafeed ingredients and analysed novel ingredients suitable for making farm feeds (multi-country).
Samoa		
MS1009	Village aquaculture of sea grapes (<i>Caulerpa</i> sp.) for domestic markets in Samoa (see Appendix 2.21)	Australian (JCU) tray grow-out methods were used to culture sea grape (<i>Caulerpa</i> spp.) in a village setting in Samoa, demonstrating that the local Upolo variety, <i>C. racemosa</i> grows well in clear water environments and has potential for community culture but requires more testing. Culture potential may also exist for the variety found on Savaii.
MS1010	New aquaculture facility options for Samoa (see Appendix 2.22)	Location, system requirements, design options and indicative costs for a new marine/freshwater hatchery in Samoa were reviewed by a hatchery systems expert.
MS1007	Pacific islands aquaculture feed ingredients inventory (see Appendix 2.7)	Reviewed current knowledge about locally-available shrimp, prawn and fish aquafeed ingredients and analysed novel ingredients suitable for making farm feeds (multi-country).
Kiribati		
MS0904	Survival and growth of hatchery produced white teatfish (<i>Holothuria fuscogilva</i>) juveniles in the wild, Kiribati (see Appendix 2.23)	Attempted to track the growth and survival of cultured white teatfish juveniles released in the wild, which was unsuccessful but provided valuable experience for future trial.
Australia		
MS0906	Development of sandfish sea ranching ACIAR project, Goulburn Island, Australia (Indigenous) (see Appendix 2.24)	Supported the development of a larger ACIAR project for a sandfish (<i>Holothuria scabra</i>) sea ranching project for the Waruwi community in Northern Territory.
MS1004	Transfer of Pacific experience to Indigenous Australian sustainable aquaculture: sponge culture, from FSM to Torres Strait, Queensland (see Appendix 2.25)	Enabled senior staff of the Indigenous Kailag Enterprises sponge farm (Yorke Island) to gain experience in sponge culture techniques, processing and marketing via exposure to an established industry in Pohnpei, FSM.
MS1008	Transfer of Pacific experience to Indigenous Australian sustainable aquaculture: live rock culture, from Tonga to Western Australia (see Appendix 2.26)	Facilitated the development of live rock culture enterprises in Indigenous Australian communities through a four-day course on production of artificial live rock, resulting in enhanced capacity and a successful licence application by an Aboriginal corporation.

Twenty-three mini-projects addressed constraints to and opportunities for aquaculture in seven PICs, and three mini-projects involved Australian Indigenous aquaculture initiatives. Table 2 shows the spread of mini-project effort by target country. Overall, Fiji received the highest amount of funding for mini-projects, due in part to the presence of the main USP campus in Suva and a corresponding higher number of student mini-projects done there. Papua New Guinea was the second largest recipient of funding, reflecting the fact that it is the largest PIC (in area and population) and the additional focus on supporting sustainable aquaculture and capacity building in that country.

Table 2. Target country, number and funding of all mini-projects.

Country	No. projects	Expenditure (AUD)
PNG	5	70,000
Fiji	6	80,500
Vanuatu	2	54,000
Tonga	3	61,500
Solomon Islands	2	34,500
Samoa	2	21,000
Kiribati	1	15,000
Multiple PICTs	2	46,500
Australia (Indigenous)	3	17,000
Total	26	400,000

7.2 Indigenous aquaculture support

In addition to conducting three mini-projects aimed at increasing capacity in aquaculture for Indigenous communities in tropical Australia (see Table 1 and Section 6, Objective 3), this project also provided technical support for Indigenous Australian aquaculture ventures. Ms Hair provided technical support for the ACIAR-WorldFish Center sandfish sea-ranching project at Goulburn Island, Northern Territory (FIS/2003/059) and will continue to do so for the follow-on ACIAR-JCU project (FIS/2010/042).

8 Impacts

Every mini-project had the *potential* to produce impacts in at least one of the categories listed: scientific, capacity or community (Table 3).

Table 3. Summary of potential impacts from all mini-projects.

Short mini-project title	Impact				
	Scientific	Capacity	Community economic	Community social	Community environmental
MS0801 Clown fish culture, Vanuatu		✓			✓
ML0801 Sandfish culture & ranching, Fiji	✓	✓	✓	✓	✓
MS0802 Rabbitfish cage culture, Sol. Is.		✓	✓		
MS0803 Mabé production, Fiji	✓	✓	✓	✓	
MS0804 Spat collection, Fiji	✓	✓	✓		
MS0805 Shrimp virus testing	✓	✓	✓		✓
MS0806 <i>Mac. lar</i> hatchery, Fiji	✓	✓	✓		✓
MS0807 <i>Pteria penguin</i> grow-out, Tonga	✓	✓	✓		
MS0808 Herring fishmeal, PNG	✓	✓	✓		
MS0901 Mozambique tilapia culture, Sol. Is.		✓	✓	✓	✓
ML0901 Improved <i>Mac. lar</i> farming, Vanuatu	✓	✓	✓	✓	✓
MS0902 Live rock & coral, Tonga		✓	✓		✓
MS0903 Spat collection, PNG		✓	✓		
MS0904 White teatfish juvenile release, Kiribati	✓	✓	✓		✓
MS0905 Credit Workshop, PNG		✓	✓	✓	
MS0906 Aust. Indigenous sandfish sea ranching		✓	✓	✓	
MS1001 Rainbow trout feed, PNG		✓	✓	✓	
MS1002 Winged pearl oyster hatchery, Tonga	✓	✓	✓	✓	
MS1003 Freshwater prawn settlement, Fiji		✓	✓		
MS1004 Sponge farming technology transfer (Indigenous)		✓	✓	✓	✓
MS1005 Pen culture of mudcrab (<i>Scylla</i> sp.), PNG		✓	✓	✓	✓
MS1006 Large-scale sandfish sea ranching, Fiji	✓	✓	✓	✓	
MS1007 PIC aquafeed ingredients inventory		✓	✓		✓
MS1008 Live rock culture training (Indigenous)		✓	✓	✓	✓
MS1009 <i>Caulerpa</i> culture, Samoa		✓	✓	✓	✓
MS1010 New mariculture facility options for Samoa		✓	✓		

It must be emphasised, however, that not all of these potential impacts translated to *actual* impacts—the short time-frame of most mini-projects and restricted funding were limits to achieving all possible impacts. For a number of mini-projects, the key impact was to identify if the methodology or approach investigated was worth pursuing in a follow-on project. Nonetheless, many mini-projects did have immediate and possible 5-years-time impacts, which are described in the following sections.

8.1 Scientific impacts – now and in 5 years

Significant scientific impacts were generated by 11 mini-projects (Table 3). In general, they were immediate impacts and there are unlikely to be any change in these in 5-years time. They are listed below.

- ML0801 'Culture of juvenile sandfish for sea ranching trials in Fiji' indicated that survival and growth of sandfish (*Holothuria scabra*) in the seagrass bed at Natuvu village compare favourably with results from other sea ranching trials (i.e. from New Caledonia and Philippines). These results constitute an important contribution to the small but growing body of knowledge on this topic. Furthermore, they have significant implications for the future of this technology in the Pacific, where there is intense interest in this commodity. Further, in the follow on mini-project MS1006 'Large scale sandfish sea ranching trial, Fiji' larvae were reared primarily using an off-the-shelf algal product, the first time this had been attempted.
- MS0803 'Potential for *Pteria penguin* (Röding, 1798) mabé pearl aquaculture by rural coastal communities in the Fiji Islands' research demonstrated how to produce high quality mabé pearls in Savusavu Bay through nuclei position, implant age (ideally 3 years), culture depth (best at relatively shallow depths of around 6 m compared to greater depths of 8 and 10 m), optimal stocking density (five oysters per panel net) and control of fouling. Mabé pearls from this species would be a new commodity in Fiji.
- MS0804 'Recruitment patterns of molluscs in Savusavu Bay, Fiji with emphasis on the blacklip pearl oyster, *Pinctada margaritifera*' found that deploying spat collectors a month before the peak recruitment months (April and December) would ensure high *P. margaritifera* spat settlement in Savusavu Bay and identified the best area for growth of spat. A valuable pearl oyster spat identification key was produced which will be used by researchers in this field. This key has been incorporated into a pearl culture manual being developed at JCU for the region.
- MS0805 'Feasibility of establishing specific pathogen free stocks of shrimp in the Pacific' involved three PICs: Palau, Papua New Guinea and Solomon Islands. The virus testing results are valuable in describing their shrimp virus status. However, the genetic aspect of the mini-project (elucidated by Salote Waqairatu, PhD student at CSIRO, Brisbane) also found that *P. monodon* sourced from the Solomon Islands is a unique population within the region. This suggests they are very divergent from the Australian and Thai *P. monodon* that the markers were originally designed from. The similarity of PNG shrimp to East Australian strains and Palau to South-East Asian strains may be due to past events in the evolution of the species or recent events such as the translocation of shrimp due to routine aquaculture practice.
- The successful production of post-larvae in MS0806 'Closing the life cycle of *Macrobrachium lar*' is a world first. *M. lar* postlarvae were produced at the USP marine aquaculture laboratory in 2009. This study identified the optimum salinity and temperature for larval rearing of *M. lar*. Constraints to the production of this species and priority areas for further research were highlighted. A valuable 'Staging Guide for the larvae of *Macrobrachium lar*' was developed by the author, to provide a rapid means of identifying live larval specimens during a culture run, without incorporating excessive anatomical detail. Two scientific papers will result from this work.

- In the first trials on juvenile grow-out of this species, MS0807 ‘Improved husbandry methods for the culture of juvenile winged pearl oyster, *Pteria penguin*, in Tonga’ determined survival and growth of *Pt. penguin* in different culture units, and the influence of depth and site. The type of culture unit had a significant effect on growth rate and survival of oysters and different culture units were found to be optimal for different sizes of oysters. The results allowed a standard culture protocol to be developed for pearl farmers in Tonga. Results of the growth trials showed that hatchery produced *Pt. penguin* required more than 2 years to reach a size suitable for half-pearl production (ca. 170 mm dorso-ventral shell height). The results will be published in international scientific journals.
- MS0808 ‘Post-harvest storage, preservation and handling techniques for Fly River herring (*Nematalosa* sp.) for fishmeal production’ describes the first study of the effects of time and storage on the degradation of Fly River herring, a tropical freshwater fish species. Researchers produced original data on a species of interest to PNG. The study suggests that fresh Fly River herring is fit as a direct fish feed or to be used as an ingredient in fish meal for up to four hours, regardless of whether or not it is iced. Iced fish is good up to 16 hours post harvest, but fish that had been left un-iced for eight hours should not be used for feeds beyond this time.
- ML0901 ‘Study of *Macrobrachium lar* capture and culture techniques in Vanuatu’ demonstrated that small-scale capture-based culture to produce the indigenous prawn, *M. lar*, in PICs for income generation is technically feasible. Although based on limited data collection so far, it appears that juveniles recruit to rivers throughout the year. *M. lar* can grow and survive in both pond and cage culture at rates comparable to those of the non-indigenous giant Malaysian freshwater prawn, *M. rosenbergii*.
- MS0904 ‘Growth and survival of hatchery produced white teatfish (*Holothuria fuscogilva*) juveniles in the wild’ in Kiribati. Unfortunately, due to severe weather events, there were no results on habitat preference, or survival and growth of released juveniles. However, the project reported the first ever observations of the behaviour of cultured juvenile white teatfish after release.
- Culture of winged pearl oysters under MS1002 ‘Support of pearl oyster (*Pteria penguin*) hatchery production in Tonga’, was done using Instant Algae® (micro-algae concentrate) as the sole food source for larvae. Results so far confirm the suitability of this product as a food for pearl oyster larvae greatly reducing the technical resources required for hatchery culture of pearl oysters. Given these potential benefits (which may also apply to hatchery culture of other invertebrates such as sea cucumbers and urchins) further research is justified to fine-tune and optimise methods for preparation, use and storage of this product. A scientific publication will be produced using the results of this study.

8.2 Capacity impacts – now and in 5 years

Every mini-project resulted in increased capacity – 14 of them involved focussed technology transfer for a variety of aquaculture commodities. Impacts were immediate in training and building capacity in Pacific Islands’ staff with skills that will be used now. Moreover, these capacity-building impacts go beyond the immediate needs of the project and have wider benefits for the country now and into the future (5-years time and beyond).

8.2.1 Technology transfer

The 14 mini-projects which transferred valuable skills in a specific technical area are listed below:

- MS0801 'Clown fish culture, Vanuatu'
- ML0801 'Culture of juvenile sandfish for sea ranching trials in Fiji'
- MS0802 'Rabbit fish culture and feed trials, Solomon Islands'
- MS0803 'Improving *Pteria penguin* (winged pearl oyster) juvenile culture and mabé production techniques in the Fiji Islands'
- MS0807 'Improved husbandry methods for the culture of juvenile winged pearl oyster, *Pteria penguin*, in Tonga'
- MS0901 'Mozambique tilapia grow-out trials, Solomon Islands'
- MS0902 'Live rock and coral culture for the ornamental industry, Tonga'
- MS0903 'Recruitment patterns of commercial molluscs and other species to spat collectors in PNG'
- MS1002 'Support of pearl oyster (*Pteria penguin*) hatchery production in Tonga'
- MS1004 'Transfer of Pacific experience to Indigenous Australian sustainable aquaculture: sponge culture, from FSM to Torres Strait, Queensland'
- MS1005 'Pen culture trial of mud crab (*Scylla* sp.) in mangrove habitat, PNG'
- MS1006 'Large scale sandfish sea ranching trial, Fiji'
- MS1008 'Transfer of Pacific experience to Indigenous Australian sustainable aquaculture: live rock culture, from Tonga to Western Australia'
- MS1009 'Village aquaculture of sea grapes (*Caulerpa* sp.) for domestic markets in Samoa'

8.2.2 Workshops

Targeted workshops were the primary objective of two mini-projects that were tailored to meet specific needs of the participants and conducted over several days, with training provided by specialists in the relevant fields.

- ML0905 'Improved access to credit and grant funding for PNG fish farmers'. This two-day workshop was attended by 30 participants comprising fish pond and cage farmers, government extension officers, teachers and bank officers. Sessions were presented by NFA aquaculture officers, small business trainers and bank officers.
- MS1008 'Transfer of Pacific experience to Indigenous Australian sustainable aquaculture: live rock culture, from Tonga to Western Australia'. This four-day workshop was attended by eight Indigenous participants from three north Australian groups, together with nine other trainers and observers. The workshop was designed and run by Mr Scott Mactier, the technical advisor who was an Australian Youth Ambassador in Tonga in association with FIS/2006/172¹¹.

In addition, formal and informal (ad-hoc) workshops were conducted within several mini-projects. For example:

¹¹ FIS/2006/172: 'Winged pearl oyster development in Tonga'

- ML0801 'Culture of juvenile sandfish for sea ranching trials in Fiji' and MS1006 'Large scale sandfish sea ranching trial, Fiji' provided training in sea cucumber hatchery production to government and private sector aquaculture technicians in Fiji.
- Dr Igor Pirozzi provided training to aquaculture technicians in Fiji, Solomon Islands, Samoa and Vanuatu in the use of Feed Formulation Software in MS1007 'Pacific islands aquaculture feed ingredients inventory'.
- Mr Jerome Genodepa trained PNG village members and aquaculture officers in skills needed for mud crab farming in MS1005 'Pen culture trial of mud crab (*Scylla* sp.) in mangrove habitat'.
- Project staff from ML0901 'Study of *Macrobrachium lar* capture and culture techniques in Vanuatu' participated in a 2-day workshop on freshwater prawn larval identification Noumea, New Caledonia.
- Professor Paul Southgate trained PNG NFA aquaculture staff in spat identification as part of MS0903 'Recruitment patterns of commercial molluscs and other species to spat collectors in PNG'.
- Tonga staff received training in hatchery techniques, experimental design and data collection as part of MS0807 'Improved husbandry methods for the culture of juvenile winged pearl oyster, *Pteria penguin*, in Tonga' and MS1002 'Support of pearl oyster (*Pteria penguin*) hatchery production in Tonga'.
- JCU researchers provided low-tech grow-out systems and trained government aquaculture officers in Samoa in methods to culture edible seaweed in MS1009 'Village aquaculture of sea grapes (*Caulerpa* sp.) for domestic markets in Samoa'.

8.2.3 Community capacity building

Community skills were enhanced through the following mini-projects:

- Community members, in particular the four wardens of Natuvu village, gained skills in release and monitoring of sea cucumbers in ML0801 'Culture of juvenile sandfish for sea ranching trials in Fiji'. In activities associated with the mini-project they also declared an MPA and increased capacity in management of their marine resources.
- Project research outcomes from ML0901 'Study of *Macrobrachium lar* capture and culture techniques in Vanuatu' were imparted through community-level training workshops run by northern office of the Vanuatu Fisheries Department (VFD) and there has been uptake of prawn farming techniques to a commercial level by a total of 16 farmers so far in Santo and Malekula. VFD, in collaboration with the AusAID TIVET project, will continue to run village-level workshops to demonstrate prawn juvenile collection and grow-out techniques. VFD, in conjunction with Vanuatu College of Agriculture, now has a prawn farming module for tertiary students.
- Research outcomes from MS0803 'Improving *Pteria penguin* (winged pearl oyster) juvenile culture and mabe production techniques in the Fiji Islands' has led to villagers recognising the value of *Pteria penguin* and starting to collect it now with the intent of growing it for mabé production. This will allow diversification and expansion of the pearl industry in Fiji, and increased income generating opportunities for coastal communities.
- Project leaders of MS0807 'Improved husbandry methods for the culture of juvenile winged pearl oyster, *Pteria penguin*, in Tonga' worked with members of the Tonga Pearl Growers Association to help improve farming techniques: local pearl farmers have modified their farming practices as a direct result of this study.
- Relatively inexperienced Solomon Island tilapia farmers gained valuable experience in tank and pond culture of a local tilapia in MS0901 'Mozambique tilapia grow-out trials'.

- A number of fish farmers from the PNG Highlands attended a workshop which was MS0905 'Improved access to credit and grant funding for PNG fish farmers'. The farmers learnt about record keeping, credit processes and increased their business acumen as a result of the workshop.
- Community members and NGOs in Port Moresby and Lae were trained in new aquaculture techniques in MS1005 'Pen culture trial of mud crab (*Scylla* sp.) in mangrove habitat, PNG'.

8.2.4 Indigenous community capacity building

Two sea rangers from the Goulburn Island Warruwi Community travelled to Cairns for 12 days from 5–16 December 2007, to take part in QLD Safe Diving strategy training. The training comprised an initial PADI recreational open water dive course followed by commercial training. It was designed to allow them to assist in future research activities relating to the sandfish sea ranching project at Goulburn Island. It has also provided them with basic training had they wished to participate in the commercial sea cucumber fishery in their sea country, although this has since proven to be unlikely to occur.

Other Indigenous capacity building impacts from this project included technology transfer and training provided within the following mini-projects:

- MS1004 'Transfer of Pacific experience to Indigenous Australian sustainable aquaculture: sponge culture, from FSM to Torres Strait, Queensland'.
- MS1008 'Transfer of Pacific experience to Indigenous Australian sustainable aquaculture: live rock culture, from Tonga to Western Australia'.

8.2.5 ACIAR-USP postgraduate scholarships and student capacity building

A number of mini-projects have supported research for Pacific islands university students (Table 4). Most of the USP students were part of the ACIAR-USP post-graduate scholarship scheme (PGSS) which was established in 2007 to provide tuition fees and research grant for post-graduate diploma (PGD) or Master of Science (MSc) degree, provided research topics were tied to an active ACIAR project. Chillion Panasasa was an exception, his PGD research was supported by mini-project funds without a scholarship. Two of the USP PGSS students subsequently received John Allright Fellowships (JAF) to JCU (Table 4).

Table 4. Summary of university students associated with mini-projects.

Mini-project short title, student and country	University	Degree status	Comments
ML0801 Sandfish culture & ranching, Fiji Laisiasa Cavakiqali (Fiji)	USP	MSc status extended (ACIAR-USP PGSS).	Thesis not submitted at end of 2011.
MS0803 Mabe production, Fiji Pranesh Kishore (Fiji)	USP	MSc awarded (ACIAR-USP PGSS).	Commenced JAF at JCU in 2011.
MS0804 Spat collection, Fiji Marilyn Vilisoni (Fiji)	USP	MSc awarded (ACIAR-USP PGSS).	Completed
MS0805 Shrimp virus testing Salote Waqairatu (Fiji)	University of Queensland / CSIRO	PhD (John Allwright Fellowship, JAF).	Thesis submitted in 2012.
MS0806 <i>Mac. lar</i> hatchery, Fiji Monal Lal (Fiji)	USP	MSc awarded (ACIAR-USP PGSS).	Commenced JAF at JCU in 2012.
MS0807 <i>Pteria penguin</i> grow-out, Martin Finau (Tonga)	USP	MSc extended (ACIAR-USP PGSS).	Suspended scholarship 2011 due to health.

ML0901 Improved <i>Macrobrachium</i> farming, Vanuatu Laura Williams (Fiji)	USP	MSc study ongoing (ACIAR-USP PGSS).	Should complete in late 2012.
MS1003 Freshwater prawn settlement, Fiji Chillion Panasasa (Solomon Islands)	USP	Post-graduate diploma awarded 2010 (ACIAR-USP PGSS).	Commenced ACIAR-USP PGSS MSc with WorldFish Center in 2011.

Shrimp samples from PNG, Solomon Islands and Palau obtained through MS0805 'Feasibility of establishing specific pathogen free stocks of shrimp in the Pacific' augmented Asian samples used for the PhD research by Salote Waqairatu¹². These PICs have not been included in previous genetic diversity studies of *Penaeus monodon* (black tiger shrimp) from the Indo-Pacific region. Hence, new knowledge was gained on the genetic diversity, population structure and evolutionary history of *P. monodon* from a wider geographic range. The samples also allowed her to investigate the genetic variation of monodon baculovirus and hepatopancreatic parvovirus that may be present in *P. monodon* from the Pacific region. The additional information from the mini-project samples has shed more light on the host-pathogen relationship. Importantly, it has also revealed genetic diversity and population structure of *P. monodon* in the Pacific—better understanding of these wild stocks assists in development of appropriate conservation strategies for increased aquaculture potential in the region.

8.2.6 Training activities

Training was carried out in many mini-projects (Table 5).

Table 5. Summary of training activities associated with mini-projects. Trainers were affiliated with JCU unless indicated otherwise.

Mini-project number/ Short title/Country	Type of training	Personnel trained	Trainer/s
MS0801 Clown fish culture, Vanuatu	<ul style="list-style-type: none"> • Hatchery training • System design 	Vanuatu VFD aquaculture officers.	Antoine Teitelbaum (SPC) Jonathan Moorhead
ML0801 and MS1006 Sandfish culture and ranching, Fiji	<ul style="list-style-type: none"> • Hatchery training • Juvenile release methods • Experimental design, data collection, data analysis • Student project (thesis writing) 	Fiji MAFF Aquaculture staff Labasa and Galoa. Private sector hatchery technicians. FSM Aquaculture technician ACIAR-USP MSc student (L. Cavakiqali). Natuvu community.	Cathy Hair
MS0802 Rabbitfish cage culture, Solomon Islands	<ul style="list-style-type: none"> • Fish husbandry • Aquafeed formulation 	Sol Is MFMR fisheries officers. WorldFish Center staff.	Antoine Teitelbaum (SPC)
MS0803 Mabé production, Fiji	<ul style="list-style-type: none"> • Experimental design, data collection, data analysis • Student project (thesis writing) • Mabe production 	ACIAR-USP MSc student (P. Kishore). J. Hunter Pearls staff	Paul Southgate Johnson Seeto (USP)

¹² Salote Waqairatu was lead researcher of the mini-project 'Confirmatory testing of the viral status of *Penaeus monodon* (Black Tiger shrimp) populations in the Fiji Islands' within FIS/2001/075.

MS0804 Spat collection, Fiji	<ul style="list-style-type: none"> • Experimental design, data collection, data analysis • Student project (thesis writing) 	ACIAR-USP MSc student (M. Vilisoni). J. Hunter Pearls staff	Paul Southgate Johnson Seeto (USP)
MS0806 <i>Macrobrachium lar</i> hatchery, Fiji	<ul style="list-style-type: none"> • Hatchery training • Experimental design, data collection, data analysis • Student project (thesis writing) 	ACIAR-USP MSc student (M. Lal).	Tomohiro Imamura (JICA).
MS0807 <i>Pteria penguin</i> grow-out, Tonga	<ul style="list-style-type: none"> • Experimental design, data collection, data analysis • Student project (thesis writing) 	ACIAR-USP MSc student (M. Finau). Tonga aquaculture officers. Scott Mactier (AYAD).	Paul Southgate
MS0901 Mozambique tilapia culture, Solomon Islands	<ul style="list-style-type: none"> • Experimental design, data collection • Fish husbandry • Aquafeed formulation 	Sol Is MRMD fisheries officers. Church NGO staff.	Tim Pickering (SPC)
ML0901 <i>Mac. lar</i> farming, Vanuatu	<ul style="list-style-type: none"> • Species ID • Hatchery training • Experimental design, data collection, data analysis • Aquafeed formulation • Student project (thesis writing) 	Vanuatu VFD aquaculture officers. ACIAR-USP MSc student (L. Williams).	Tim Pickering (SPC) Claire Marty (Province Nord, New Caledonia)
MS0902 Live rock and coral, Tonga	<ul style="list-style-type: none"> • Species ID • Coral propagation • Live rock base mixing and ocean culture 	Tonga aquaculture officers. Scott Mactier (AYAD). Export company employees (WSI). Community members.	Antoine Teitelbaum (SPC) Walt Smith Int. (private sector)
MS0903 Spat collection, Papua New Guinea	<ul style="list-style-type: none"> • Species ID • Collection and grow-out techniques 	PNG NFA aquaculture officers.	Paul Southgate Andrew Beer (private sector)
MS0904 White teatfish juvenile release, Kiribati	<ul style="list-style-type: none"> • Juvenile release • Monitoring/data collection 	Kiribati aquaculture officers.	Antoine Teitelbaum (SPC)
MS0905 Credit Workshop, Papua New Guinea	<ul style="list-style-type: none"> • Workshop – farming finance 	Highlands fish farmers, Fisheries extension officers, PNG National Development Bank officers.	NFA and EHP extension officers Cathy Hair
MS0906 Indigenous sandfish sea ranching, Australia	<ul style="list-style-type: none"> • Experimental design • Monitoring/data collection • Sandfish release techniques • Hatchery training 	Warruwi community members. TSPL hatchery staff. DAC hatchery staff. Project staff (Cathy Hair).	Dave Mills (WorldFish) Cathy Hair NDQ Duy (RIA3, Vietnam)
MS1001 Rainbow trout feed trial, Papua New Guinea	<ul style="list-style-type: none"> • Experimental design, data collection 	NFA/NDAL aquaculture officers. Highland's fish farmers. PNG students.	Cathy Hair Peter Graham (DEEDI) Wally Solato (PNG NDAL)
MS1002 Winged pearl oyster hatchery,	<ul style="list-style-type: none"> • Hatchery training • Post-larval and early 	Tonga aquaculture officers.	Paul Southgate Andrew Beer

Tonga	juvenile culture and maintenance	Scott Mactier (AYAD).	(private sector)
MS1003 Freshwater prawn settlement, Fiji	<ul style="list-style-type: none"> • Student project (thesis writing) • Hatchery training 	USP PGD student (Chillion Panasasa).	William Camargo (USP)
MS1004 Sponge Indigenous, QLD Australia	<ul style="list-style-type: none"> • Sponge farming techniques (broodstock collection, farming systems, processing, marketing) 	Indigenous participants from the Kailag Enterprises sponge farm, Torres Strait, Queensland	Pohnpei Sponge Farming Ass. Staff of MERIP (Marine and Environmental Research Institute of Pohnpei)
MS1005 Mud crab pen culture, PNG	<ul style="list-style-type: none"> • Species ID /crab condition • Collection and pen grow-out • Monitoring/data collection 	NFA aquaculture officers, Bris Kanda extension officers, PNG community members.	Jerome Genodepa
MS1006 Sandfish sea ranching, Fiji	<ul style="list-style-type: none"> • Hatchery production of sandfish 	Aquaculture staff at Fiji Fisheries hatchery, Galoa (Teari Kaure)	Cathy Hair
MS1007 Pacific aquafeed ingredient inventory	<ul style="list-style-type: none"> • Feed identification • Feed formulation (Winfeed software) 	Fisheries aquaculture officers in Solomon Islands, Vanuatu and Samoa	Igor Pirozzi
MS1008 Live rock Indigenous, Western Australia	<ul style="list-style-type: none"> • Live rock culture 	Indigenous participants from WA and NT, Australia	Scott Mactier Bart Penny (KimTAFE).
MS1009 <i>Caulerpa</i> culture, Samoa	<ul style="list-style-type: none"> • Low tech village sea grape culture 	Samoa Fisheries Division Aquaculture officers	Nicholas Paul Ian Tuart

8.3 Community impacts – now and in 5 years

All mini-projects had potential community impacts, generally more than one (Table 3). Below, the ‘actual’ measurable impacts are discussed, both immediate and what could reasonably be expected in 5-years time, based on the community situation at the conclusion of the mini-project.

8.3.1 Economic impacts

- ML0801 ‘Culture of juvenile sandfish for sea ranching trials in Fiji’ and MS1006 ‘Large scale sandfish sea ranching trial, Fiji’. had unexpected economic community impact through the harvest and sale of curryfish, a medium-value sea cucumber species, which were collected in late 2010 from the MPA that was created during the sea ranching mini-project. The beche-de-mer income funded a community hall (disaster evacuation centre), and contributed to the local school and church. Economic benefits from the MPA, coupled with sound management of sea cucumber resources, will continue to deliver community benefits into the future. Further, we predict that the success of rearing larvae with an off-the-shelf algal product will have important economic consequences for sea cucumber aquaculture in Pacific in the next 5 years.
- MS0803 ‘Potential for *Pteria penguin* (Röding, 1798) mabé pearl aquaculture by rural coastal communities in the Fiji Islands’ research demonstrated how to produce high quality mabé pearls in Savusavu. Although no data are available on cash returns, it has been reported that the results have been adopted by at least one pearl farmer who has now set up longlines of *Pt. penguin* culture and plans to produce mabé once the pearl

oysters have reached an appropriate size and will receive training from Pranesh Kishore who conducted the research. J. Hunter Pearls farm staff learnt mabé skills while Pranesh conducted the mini-project and they have since produced and marketed good quality mabé pearls. Economic benefits can be expected within 5 years.

- MS0804 'Recruitment patterns of molluscs in Savusavu Bay, Fiji with emphasis on the Blacklip pearl oyster, *Pinctada margaritifera*' results used by J. Hunter Pearls to target spat collection more accurately and reduce operating costs.
- Optimum techniques for rearing of juvenile winged pearl oysters, based on results from MS0807 'Improved husbandry methods for the culture of juvenile winged pearl oyster, *Pteria penguin*, in Tonga' have been adopted by farmers and *Pt penguin* seedstock provided to farmers. In the next 5 years, this will translate directly to economic benefits for pearl farmers through improved farm efficiency and increased pearl and pearl handicraft production, which will in turn support community income generation.
- MS0808 'Assessment of Fly River herring for fish meal and as an aquafeed ingredient, PNG'. Results from this mini-project have been put to commercial use in PNG in a barramundi cage farming trial being run by the PNG Sustainable Development Project (SDP). Although fishmeal is not being produced yet, the data on fish spoilage is guiding the protocols for use of fresh steamed herring in barramundi pellet diets. The maximum time limit for landing herring has been set to ensure that the herring is of acceptable standards for feed production. Also, fresh herring is being used as one of the feeding treatments. OTFRDP and WP are planning on commercialising tilapia farming around Tabubil and Kiunga and the mini-project results will be useful in any local diet that is developed. Fishmeal production is still being discussed as an option for the Western Province, and the mini-project study will be a valuable reference if that occurs.
- The results from ML0901 'Study of *Macrobrachium lar* capture and culture techniques in Vanuatu' indicate that both pond and cage *M. lar* production systems are financially and economically viable, whether marketing to Luganville or the more lucrative Port Vila. Vanuatu Fisheries is facilitating prawn transportation and marketing to support community farmers to access the Vila market for prawns. Improved methods translate directly to community through better techniques which save money and time and yield better results. Low-cost diets developed in the mini-project will assist with profitability for poor rural farmers.
- Although no fish farmers appear to have successfully obtained credit as a direct result of the training from MS0905 'Improved access to credit and grant funding for PNG fish farmers', a loan of K400,000 was given to establish a small-scale feed mill, in part because of the improved awareness of aquaculture in the banking sector. Senior NFA managers believe that applications are improving but that grant 'handouts' are negatively affecting the process. The workshop has definitely raised the profile of this issue and provided important information to the community. It is expected that in the next 5 years, the situation will continue to improve.
- MS1001 'Rainbow trout feed trial, PNG' has resulted in a number of economic impacts and created strong interest trout farming in the Highlands of PNG. The fish farmers who participated in the trial both sold fish worth several thousand kina at the conclusion of the trial and are convinced of the merit of the local feed formulation. The feed mini-mill referred to above will produce the locally formulated feed for rainbow trout in high altitude areas. The trial demonstrated that the local feed is cost-effective (compared to the imported feed), easier to source and produces a good tasting fish. One Mendhi farmer has already purchased 5 tonnes of the local trout feed and a number of smaller farmers have also purchased this feed. The trial has reinvigorated the industry. It is anticipated that in the next 5 years more farmers will diversify into rainbow trout farming

and a spin-off livelihood (feed production) will result from the increases in farming activities.

- Oysters produced in MS1002 'Support of pearl oyster (*Pteria penguin*) hatchery production in Tonga' were provided to the oyster industry to alleviate oyster stock shortage. An immediate impact of this regular supply of pearl oyster juveniles to pearl farmers in Tonga was to prevent industry collapse and increase interest from new farmers. Over the next 5 years, it is expected to grow the industry, creating livelihoods for farmers and guaranteeing a supply of mabé to locals involved in making pearl handicrafts. Hatchery production of *Pt. penguin* used Instant Algae® (micro-algae concentrate) as the sole food source for larvae. Results so far confirm the suitability of this product as a food for pearl oyster larvae, which in the next 5 years has the potential to substantially reduce hatchery establishment and running costs.
- MS1005 'Pen culture of mudcrab (*Scylla* spp.)'. One of the project trial pen sites in Central Province, PNG, stocked 239 crabs so late November 2011. Crabs are fed with trash fish provided free by a local exporter in return for the right to buy fattened crabs. There is potential for the development of this industry if premium prices are paid for fat crabs. Results of this first pen trial will indicate if there is profits to be made from the venture and if the community is keen to adopt it. Another economic impact is that it appears that crab sellers have re-priced their crabs based on their condition: the price of lean crabs has not decreased whilst fat crabs price has increased.
- The success of community-based seaweed culture in MS1009 'Village aquaculture of sea grapes (*Caulerpa* sp.) for domestic markets in Samoa' could contribute to a new village industry and income generation in Samoa. There are strong domestic markets for *Caulerpa* species in Samoa (at local markets and for hotel restaurants). A regular supply of this seaweed product from aquaculture could provide regular income for participating communities. Due to the minimal infrastructure required, low operating costs and fast growth rate of *Caulerpa*, economic returns could be expected within a year if this activity is adopted.

8.3.2 Social impacts

In terms of social impacts, mini-projects were most likely to have influence in the spheres of health (though provision of protein and increased food security), equity (increased capacity, education and financial independence) and culture (through enabling individuals and communities to exert more control over their marine and freshwater resources, and lifestyle)(see Table 3). Further, any initiative which can provide employment in villages and slow the immigration of (mostly) young people to towns and cities will accrue social benefits in the communities involved. Not surprisingly, most of these impacts were subtle and difficult to quantify. However, examples of mini-projects where social benefits were highlighted are summarised in Table 6.

Table 6. Summary of social impacts resulting from selected mini-projects.

Mini-project short title and country	Social impact	Description
ML0801 Sandfish culture and ranching, Fiji	Health Equity Culture	Natuvu village has a relatively small amount of arable land and the community is dependent on their marine resources for subsistence and cash needs. The traditional role of this community is to provide seafood to the Wailevu area chief. Therefore, increased productivity of their marine resources (brought about through this mini-project) contributes both to the health of their community, their cultural obligations and their social status.
MS0803 <i>Pteria penguin</i> mabé production, Fiji	Equity	The early adoption of <i>Pt penguin</i> mabé production in a community pearl farm indicates this activity may provide income generating opportunities for rural coastal communities in Fiji.

MS0807 <i>Pteria penguin</i> grow-out and MS1002 Winged pearl oyster hatchery, Tonga	Equity	Improved husbandry methods and regular supply of pearl oyster juveniles to pearl farmers through this mini-project has resulted in: (1) disengaged pearl farmers returning to the industry; (2) new farmers entering the industry; (3) interest in pearl farming in new areas (e.g. Tongatapu); and (4) an expanding and more pro-active Pearl Growers Association.
ML0901 Improved <i>Macrobrachium lar</i> farming, Vanuatu	Health	Most people living in remote villages in Vanuatu are living below the poverty line and the protein source (and associated health benefits) of catching and culturing this species are substantial. The project led to community-level training workshops and subsequent uptake of commercial prawn farming by 16 farmers.
MS0905 Credit Workshop, PNG	Equity	The mini-project resulted in curriculum materials for secondary schools, farmers and introductory aquaculture students.
MS0906 Indigenous sandfish sea ranching, Australia MS1004 Sponge Indigenous, QLD Australia MS1008 Live rock Indigenous, Western Australia	Equity Culture	Remote Indigenous communities in Australia are socially disadvantaged: development and employment opportunities are few, leading to pressure for increased involvement of communities in the fishing industry and management of local marine resources. Three mini-projects addressed these issues: (1) Sea ranching of sandfish suits the traditional extensive approach to resource use and many communities live adjacent to productive fishing habitats. If sandfish ranching proves to be viable, it may provide income and employment for community members; (2) The Kailag Enterprises sponge farm on Yorke Island (Torres Strait) is an Indigenous not-for-profit company aiming to develop local business and create jobs on the island. The mini-project helped to increase the chance of success of the enterprise through sending farm staff to learn from the Pacific sponge farming industry in FSM. (3) This live rock workshop was instrumental in enabling an Indigenous corporation in Western Australia to obtain a license to produce artificial live rock.
MS1009 <i>Caulerpa</i> culture, Samoa	Equity	Sea grape harvest and sale is traditionally the domain of women in Samoa. A <i>Caulerpa</i> tray culture industry is likely to benefit women in the local community.

8.3.3 Environmental impacts

- ML0801 'Culture of juvenile sandfish for sea ranching trials in Fiji'. The MPA was closed to fishing again after the curryfish harvest and sandfish remained protected. Observations suggest that sandfish populations have improved (increased size and abundance) since these measures were introduced. Sea cucumbers are known to have a beneficial ecological effect on the substratum through their feeding and burying habits. Spawning of hatchery-produced sandfish (inside the sea pens) was observed in November 2009 and March 2010, suggesting that the ranched sandfish were contributing to future stock biomass. Locals believe that other sea cucumber species have increased in number and size within the MPA.
- MS0806 'Closing the life cycle of *Macrobrachium lar*', Fiji and ML0901 'Improved *Macrobrachium lar* farming', Vanuatu have raised the profile of this endemic species and shown that it has strong potential as a culture species in PICs. Research under the latter mini-project suggests that collection of postlarvae from the wild is environmentally sustainable.
- Reducing the amount of live coral and rock that is taken from reefs as a result of MS0902 'Live rock and coral culture for the ornamental industry, Tonga' will have a positive environmental impact.
- Oysters produced in MS1002 'Support of pearl oyster (*Pteria penguin*) hatchery production in Tonga' were provided to local oyster farmers, reducing fishing pressure on wild stocks. Security of spat/juvenile *Pt. penguin* supply to local farms (from this mini-

project and training provided to Tonga Fisheries technicians to allow continued production) should allow wild stocks to mature, and recruitment from wild and cultured stocks to increase.

- Wild stocks of the edible seaweed, *Caulerpa racemosa*, have been overexploited in Samoa. Village culture of this species, developed through MS1009 'Village aquaculture of sea grapes (*Caulerpa* sp.) for domestic markets in Samoa' could help conserve wild sea grape stocks through combining fisheries management with aquaculture options. Improvements in post-harvest treatment of the product explored during the project (including removing water from the harvested biomass prior to packaging) could increase shelf-life and reduce waste, also reducing the pressure on the fishery resource.

8.4 Communication and dissemination activities

8.4.1 Conference presentations

'Growing hatchery produced sandfish *Holothuria scabra* in earthen ponds', by Cathy Hair, Natacha Agudo and Anjanette Johnston. Oral presentation by Cathy Hair at Australasian Aquaculture 2008 in Brisbane, Australia, May 2008.

'Hatchery production and restocking of sea cucumber *Holothuria scabra* in community managed *qoliqoli* (traditional fishing rights areas) in Fiji Islands', by Cathy Hair and Tim Pickering. Oral presentation by Cathy Hair at Australasian Aquaculture 2008 in Brisbane, Australia, May 2008.

'ACIAR Mini-project activities in the Pacific Islands Region and Tropical Australia'. Oral presentation by Cathy Hair, at the 6th Heads of Fisheries Meeting, SPC, Noumea, New Caledonia, February 2009.

'Hatchery production and sea ranching of sandfish in *qoliqoli* in Fiji Islands'. Oral presentation by Cathy Hair, at Inaugural Fiji Conservation Meeting, Studio 6, Suva, Fiji, August 2009.

'Mariculture and aquaculture livelihood options for the Pacific Islands region', by Cathy Hair and Paul Southgate. Oral presentation by Cathy Hair at the 5th GEF International Water Conference (Marine Workshop), in Cairns, Australia, October 2009.

'FIS/2006/138 Developing Aquaculture-based Livelihoods in the Pacific islands region and tropical Australia' poster by Helena Heaseman, presented at Australasian Aquaculture 2010, Hobart, Australia, May 2010.

'Sandfish (*Holothuria scabra*) production and sea ranching trial in Fiji', by Cathy Hair. Oral presentation by Cathy Hair at the ACIAR-SPC Asia-Pacific tropical sea cucumber aquaculture symposium, in Noumea, New Caledonia, February 2011.

'Mini-projects, an innovative approach to support sustainable aquaculture development in the Pacific islands and tropical Australia' by Cathy Hair, Ben Ponia and Paul Southgate. Oral presentation by Cathy Hair, Australasian Aquaculture 2012 in Melbourne, Australia, May 2012.

8.4.2 Popular articles

'Villagers back project', newspaper article by Alumeci Nakeke, Fiji Post On-line, 18 June 2009. Environment Feature, 3 pages.

'A Glimmer of Hope' newspaper article by Alumeci Nakeke, Fiji Sun Newspaper, Jan 26 2009, pp 8-9.

'Coral farm rejuvenated', article in Fish Tales, magazine of the Fishing Industry Association of Tonga, April 2009 issue, p 4.

'Kamaeuan te Kereboki (Breeding sea cucumbers)', article in Mamautari Newsletter, Kiribati, Vol 2, page 1, Jan 2010.

'Indigenous Knowledge Sharing' by Holly Reid, Page 25, Partners Magazine, Summer 2012.

8.4.3 Mini-project reports

The compilation of mini-project reports from FIS/2001/075 was prepared by Ms Marie-Ange Hnaujie (SPC aquaculture section). These were made available in individual PDF format on the SPC Aquaculture Portal in 2008:

(http://www.spc.int/aquaculture/index.php?option=com_docman&task=cat_view&gid=77&Itemid=3).

Upon finalisation, reports from this project will also be uploaded to the SPC Aquaculture portal.

9 Conclusions and recommendations

9.1 Conclusions

The mini-projects run within this project were a resounding success, expanding and enhancing experience gained from FIS/2001/075. Mini-projects were a novel and innovative approach for ACIAR, trialling the use of a pool of funds to support small projects ideas which were rapidly deployed to address bottlenecks and opportunities for a range of commodities and issues in ACIAR Pacific countries. Importantly, they were also used to pilot test ideas to gauge the chance of success before committing additional resources. Mini-projects also improved ACIAR engagement in Indigenous aquaculture development via mini-projects that drew on experience in Pacific commodities and systems with similarities to Australia's tropical north.

Overall, this project was well received by the PICs in which it operated and all PIC partners expressed their strong support for the mini-projects. The benefits were seen to be immediate and flexible in response to small but important emerging problems and opportunities. Among these were cross-cutting issues where mini-projects were able to add value to larger initiatives, enabling related ACIAR (and other) projects to overcome impediments to progress. Capacity building of researchers, technicians and extension officers is vital for research and management in all PICs. Although capacity building is an integral part of all ACIAR projects, it could be said that this project 'punched above its weight' in this arena due to the large number of mini-projects conducted, the wide range of commodities and issues addressed, and the many countries encompassed. The extensive Pacific and Australian Indigenous partnerships, project links and outcomes developed by the project are best illustrated diagrammatically (see Fig. 1).

Perhaps most importantly, a number of mini-projects provided proof of concept and a valuable foundation for developing larger ACIAR projects, likely to have much broader regional impacts with key aquaculture commodities such as pearl oysters, sea cucumbers, marine ornamentals, seaweeds and *Macrobrachium* species. These include FIS/2010/054, FIS/2010/096¹³, FIS/2009/057 and FIS/2010/057¹⁴. Furthermore, the 'mini-projects' model, pioneered by this project, has been adopted by larger ACIAR projects such as the Pacific Agribusiness Research through Development Initiative (PARDI), where many research projects, focused on a variety of commodities in a number of countries, are conducted within a single large ACIAR project.

9.2 Recommendations

In October 2010 the project was reviewed as part of a regular Project team meeting in Brisbane. This provided the sole reviewer (Warwick Nash, QLD Department of Fisheries and Forestry) with oversight of project activities and outputs, and an opportunity to interview all project partners. The report and recommendations from this review are pending.

¹³ FIS/2010/096: 'Removing bottlenecks for sea cucumber in PICs'

¹⁴ FIS/2010/057: 'Developing inland aquaculture in the Solomon Islands'

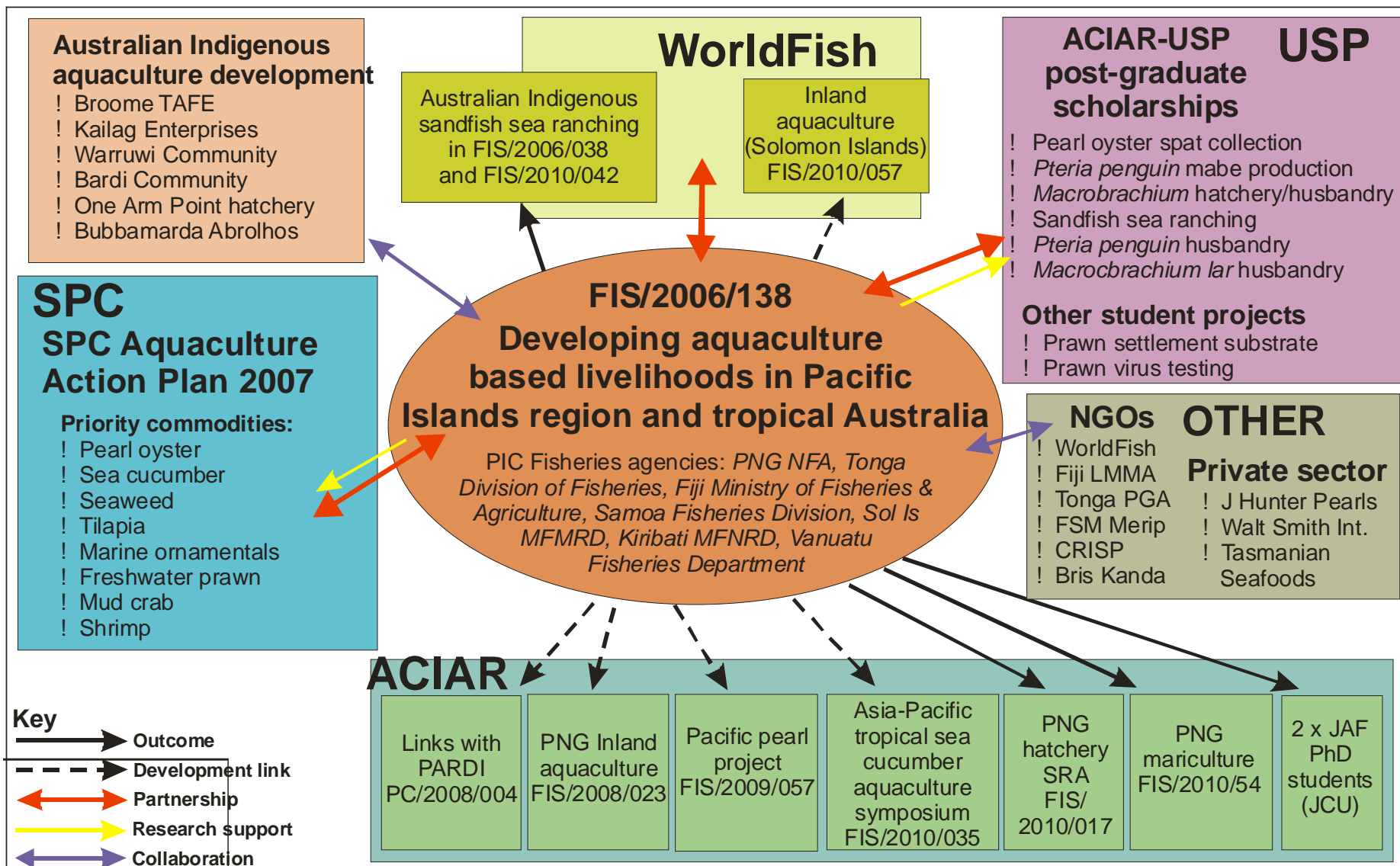


Figure 1. Pacific partnerships, project links and outcomes associated with ACIAR FIS/2006/138.

10 References

10.1 List of publications produced by project

10.1.1 Published papers and articles

- Finau, M., Ngaluafe, P., Kava, V., Mactier, S. and Southgate, P.C. (in prep.) Factors affecting growth and survival of the winged pearl oyster, *Pteria penguin*, during nursery and grow-out culture in Tonga.
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- Waiqaratu. S., et al. (in prep) Discriminatory power of a suite of DNA microsatellites in differentiating Black Tiger shrimp (*Penaeus monodon*) collected widely across its Indo-Pacific distribution range. Aquaculture Research
- Waiqaratu. S., et al. (in prep) Is there an evolutionary relationship between Black Tiger shrimp (*Penaeus monodon*) and two of its viral pathogens, PemoNPV and PmDNV?

10.1.2 Student theses


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- Lal. M. (2011). Spawning and larval rearing of the Monkey River prawn *Macrobrachium lar* (Fabricius, 1798) (Crustacea: Decapoda: Caridea: Palaemonidae) in the Fiji Islands. Master of Science in Marine Science Thesis, University of the South Pacific. Suva, Fiji Islands. 345 pp.
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Theses not yet submitted

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- Finau. M. Optimized culture methods (nursery and grow-out techniques) for hatchery-cultured winged pearl oyster (*Pteria penguin*; Roding, 1798) in Tonga. (not submitted at time of reporting).
- Waiqaratu. S. Genetic diversity of black tiger shrimp (*Penaeus monodon*) and two of its viral pathogens. University of Queensland PhD thesis. (Estimated completion mid 2012).
- Williams. L. Capture and culture of the Monkey River prawn, *Macrobrachium lar* Fabricius, 1798 (Crustacea: Decapoda: Caridea: Palaemonidae). (not submitted at time of reporting).

11 Appendixes

11.1 Appendix 1: Mini-project proposal pro-forma

<p>ACIAR Pacific Aquaculture Grant:</p> <p>Project Summary</p>		<p>SECRETARIAT OF THE PACIFIC COMMUNITY</p> <p>BP D5 98848, Noumea Cedex New Caledonia</p> <p>Tel: +687 26.20.00; Fax: +687 26.38.18; E-mail: spc@spc.int</p>
<p>Project Title:</p>	<p>Title</p>	
<p>Goal:</p>	<p>Overall goal.</p>	
<p>Objective(s):</p>	<p>The project will achieve these targets through the following objectives;</p> <ol style="list-style-type: none"> 1) Objective 1 2) Objective 2. 3) etc 	
<p>Project location:</p>	<p>Country (location within country if relevant)</p>	
<p>Project partner(s):</p>	<p>Committed partners</p>	
<p>Dates / duration:</p>	<p>Start/end dates, Duration</p>	
<p>Project description</p>	<p>Limit to logistics, methods, who, where, etc.</p>	
<p>Justification</p>	<p>Some lines on why this project is a priority, based on existing or previous experience in Pacific, elsewhere...</p>	
<p>Adoption and extension</p>	<p>How this project will be continued post-mini-project</p>	
<p>Funding sought:</p>	<p>Small, medium, large category (exact amount if known)</p>	

Project Title

1. Background:

Intro and background to project

2. Project Description

Outline of project methods, sites, experimental design, outcomes, extension and adoption, etc.

2. Budget

Table 1. Funds to be provided by ACIAR (AUD)

Activity	AUD\$ Cost
TOTAL	\$??

Table 2. Contributions from participating country (AUD)

Activity	AUD\$ Cost
TOTAL	\$??

4. Project Organisation and Management

Project manager: Name and contact details, including email address

Country manager: Name and contact details, including email address

Funds to be paid into the following bank account:
(insert bank details here)

11.2 Appendix 2: Full mini-project reports (grouped by country)

Please see separate PDF for the following mini-project reports

Papua New Guinea

Appendix 2.1

Feasibility of establishing specific pathogen free stocks of shrimp in the Pacific (MS0805)

Appendix 2.2

Assessment of Fly River herring for fish meal and as an aquafeed ingredient, PNG (MS0808)

Appendix 2.3

Recruitment patterns of commercial molluscs and other species to spat collectors in PNG (MS0903)

Appendix 2.4

Improved access to credit and grant funding for PNG fish farmers, PNG (MS0905)

Appendix 2.5

Growth of rainbow trout (*Oncorhynchus mykiss*) on locally produced feed formulation in PNG Highlands ponds (MS1001)

Appendix 2.6

Pen culture trial of mud crab (*Scylla* sp.) in mangrove habitat, PNG (MS1005)

Appendix 2.7

Pacific islands aquaculture feed ingredients inventory (MS1007)

Fiji Islands

Appendix 2.8

Culture of juvenile sandfish for sea ranching trials in Fiji (ML0801)

Appendix 2.9

Improving *Pteria penguin* (winged pearl oyster) juvenile culture and mabe production techniques in the Fiji Islands (MS0803)

Appendix 2.10

Recruitment patterns of pearl oysters to spat collectors in Savusavu Bay, Fiji, with emphasis on the Blacklip pearl oyster (*Pinctada margaritifera*) (MS0804)

Appendix 2.11

Closing the life cycle of *Macrobrachium lar*, Fiji (MS0806)

Appendix 2.12

Evaluation of different substrata to enhance freshwater prawn post-larvae production, Fiji (MS1003)

Appendix 2.13

Large scale sandfish sea ranching trial, Fiji (MS1006)

Vanuatu

Appendix 2.14

Clown fish culture, Vanuatu (MS0801)

Appendix 2.15

Study of *Macrobrachium lar* capture and culture techniques in Vanuatu (ML0901)

Tonga

Appendix 2.16

Improved husbandry methods for the culture of juvenile winged pearl oyster, *Pteria penguin*, Tonga (MS0807)

Appendix 2.17

Live rock and coral culture for the ornamental industry, Tonga (MS0902)

Appendix 2.18

Support of pearl oyster (*Pteria penguin*) hatchery production in Tonga (MS1002)

Solomon Islands

Appendix 2.19

Rabbit fish culture and feed trials (capturing juvenile fish for food security), Solomon Islands (MS0802)

Appendix 2.20

Mozambique tilapia grow-out trials, Solomon Islands (MS0901)

Samoa

Appendix 2.21

Village aquaculture of sea grapes (*Caulerpa* sp.) for domestic markets in Samoa (MS1009)

Appendix 2.22

New aquaculture facility options for Samoa (MS1010)

Kiribati

Appendix 2.23

Survival and growth of hatchery produced white teatfish (*Holothuria fuscogilva*) juveniles in the wild, Kiribati (MS0904)

Australia

Appendix 2.24

Development of sandfish sea ranching ACIAR project, Goulburn Island, Australia (MS0906)

Appendix 2.25

Transfer of Pacific experience to Indigenous Australian sustainable aquaculture: sponge culture, from FSM to Torres Strait, Queensland (MS1004)

Appendix 2.26

Transfer of Pacific experience to Indigenous Australian sustainable aquaculture: live rock culture, from Tonga to Western Australia (MS1008)