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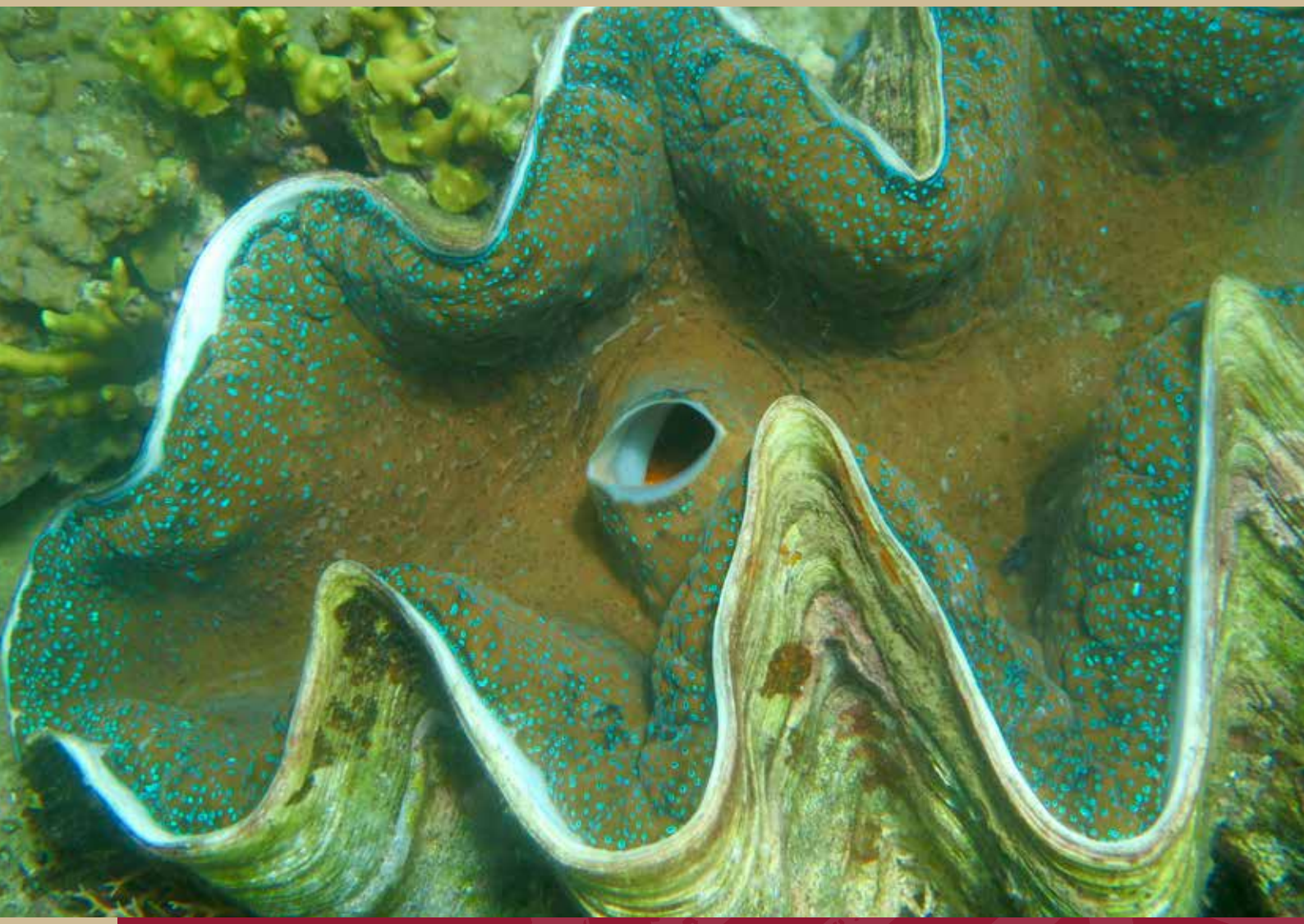

Impact assessment of giant clam research in the Indo-Pacific region

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Davila, F., Sloan T., Milne M., and van Kerkhoff L., 2017. Impact assessment of giant clam research in the Indo-Pacific region. ACIAR Impact Assessment Series Report No. 94. Australian Centre for International Agricultural Research: Canberra. 79 pp.

ACIAR Impact Assessment Series –
ISSN 1832-1879 (print)
ISSN 1839-6097 (online)
ISBN 978 1 86320 058 5 (print)

Editing: Biotext
Cover photo: Giant Clam, ACIAR

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October 2017

Abbreviations

ACIAR
Australian Centre for International Agricultural Research

CITES
Convention on International Trade in Endangered Species of Wild Fauna and Flora

FAO
Food and Agriculture Organization of the United Nations

HINP
Hundred Islands National Park

ICLARM
International Center for Living Aquatic Resources Management

LGU
local government unit

MPA
marine protected area

MSI
Marine Science Institute, University of the Philippines

PNG
Papua New Guinea

PhD
Doctor of Philosophy

R&D
research and development

RAPID
research and policy development

SUML
Silliman University Marine Laboratory

Acknowledgments

This report would not have been possible without the high levels of interest from the multiple interviewees who participated, often more than once. Anne Moorhead provided extensive insights, encouragement and discussions throughout the impact assessment. Special acknowledgments to Cletus Oengpepa; Johann Bell; Chris Barlow; Mai Algacan; Edgardo Gomez; Colette Wabnitz; Ian Bertram; Richard Braley; Robert Jimmy; Jeff Kinch; Paul Southgate; Antoine Teitelbaum; Thane Militz; Angel Alcala; Cecilia Conaco; Patrick Cabaitan; Hilconida Calumpong; the Philippine Council for Agriculture; Aquatic and Natural Resources Research and Development; the Philippines Department of Environment and Natural Resources; and the Ministry of Fisheries and Ministry of Environment in Solomon Islands.

Foreword

Giant clam culture was the subject of one of the first major fisheries projects commissioned by ACIAR after its founding in 1982. The decision to embark on this research in the Indo-Pacific was based on the dual needs of restocking declining populating and researching culture techniques. For a 25-year period, ACIAR invested $4 million throughout the region to improve knowledge and conservation of giant clams. In the Philippines there was a pressing need to restock and conserve giant clams given overharvesting and the ongoing destruction of coral reefs. Since the original investments, ACIAR maintained a 25-year connection with giant clam research across the Indo-Pacific, focusing on the environmental, economic, and social dimensions of giant clam mariculture.

This impact assessment of giant clam research in the Indo-Pacific region is thus a valuable historical compendium of the ACIAR-sponsored work undertaken over those 25 years. The authors have drawn together a wide-ranging evaluation of the work from biological, ecological and socioeconomic perspectives. There is no doubt that the work has led to the establishment of a vast body of knowledge about giant clam biology, markets, and culturing techniques that has contributed to ongoing efforts to conserve the species and continued research capacity in the Indo-Pacific. The evidenced case study from the Philippines shows the contributions ACIAR made towards supporting the development of a long-term mariculture expertise in the country and high environmental awareness. In the Solomon Islands, the impact assessment demonstrated the high scientific value of the project, but revealed the complex nature of long-term technology adoption in dynamic development and economic contexts.

The cost-benefit analyses in this report have revealed the difficulties of putting a dollar value on activities that initially targeted conservation and building a coastal village industries. The economic viability of such industries were significantly constrained by policy and political changes over time in the Philippines, Solomon Islands, and international giant clam markets. A Philippines ban on international giant clam sales from 1995 diminished opportunities for any financial gain for growers, and socio-political events in the Solomon Islands reduced the chances for sustained adoption of technologies. The limited nature of the giant clam market, notably in the aquarium trade, also presented long-term limitation for scaling giant clam activities.

Despite these economic constraints, ACIAR's first major fisheries investment projects have left a lasting legacy in the Indo-Pacific region. The authors report on the quality of science outputs and build-up of a capacity that is now able to respond and adapt to new conservation objectives, and to undertake research on other marine species with potential for economic gain. A positive but unintended benefit has emerged through the fast-growing ecotourism industry in the Philippines, with giant clam culture and population restoration proving a tourist drawcard in multiple regions.

ACIAR's recent move to widen the study of impact to include the more qualitative and non-quantifiable components of research impact, such as social and policy change, capacity building and knowledge system change has enabled a far more holistic picture of the worth of this large group of projects over time. The authors conclude by proposing holistic 'lessons for ACIAR' that affirm the value of diversifying impact assessment methods and approaches.

In their recommendations for project leaders and program managers the authors touch on to shortcomings that have been recognised and in many cases addressed as ACIAR's programs have grown and changed with the times. The story of ACIAR's giant clam research could therefore be seen to parallel the Centre's own 35-year journey.

Andrew Campbell
ACIAR Chief Executive Officer

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Executive summary

From 1982 to 1997, the Australian Centre for International Agricultural Research (ACIAR) invested in four research projects on giant clams and their potential contribution to sustainable livelihoods. Total financial support was approximately A$3.5–4 million, distributed across eight countries. The projects had multiple objectives targeting scientific knowledge, environmental conservation and livelihood improvements. This impact assessment relates to projects FIS/1982/032, its extension FIS/1987/033, the economics project EFS/1988/023 and the Solomon Islands–specific project FIS/1995/042. These projects focused on restocking activities, hatchery technique development, documentation of giant clam biology, assessment of possible markets, and development of grow-out techniques for coastal villages.

ACIAR's giant clam investments formed part of a regional program of work exploring the biophysical and economic aspects of the species. Between 1980 and 2010, a range of giant clam research projects were funded by aid and research agencies in Organisation for Economic Co-operation and Development (OECD) economies, including ACIAR (Gomez and Mingoa-Licuanan 2006; Neo et al. 2017). OECD-funded research focused on ecology (Copland and Lucas 1988; Munro 1993a; Othman et al. 2010), economics and market opportunities (Tisdell 1991, 1993), and breeding of giant clam juveniles in hatcheries (Bell et al. 1995; Bell 1999), with the aim of re-establishing depleted giant clam populations through restocking (Teitelbaum and Friedman 2008).

Giant clams have important ecological roles, and farming of giant clams can have positive socioeconomic impacts. There are 10 giant clam species, all of which are part of family Tridacnidae (Othman et al. 2010). The latest species was identified in 2008 by Richter et al. (2008). Giant clams have the unique characteristic of being self-feeding through a symbiotic relationship with algae that reside in the mantle, which photosynthesise to convert sunlight into nutrients for the clam (Munro 1993a; Cacho and Hean 2002). Giant clams are self-reproducing—sperm is produced first, shortly followed by eggs (Munro 1993a). Giant clams are sold for human consumption, and shells for carving and decor, and for the aquarium trade, with a relatively low but consistent demand (Cacho and Hean 2002; Teitelbaum and Friedman 2008). Economic activities and environmental changes have continued to threaten the species, which remain listed as endangered under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). CITES prevents sale in the international market of wild-harvested giant clams.

Objectives and methods of the impact assessment

This impact assessment determines the extent to which giant clam research and restocking investments contributed to long-term knowledge exchange, conservation efforts, and economic opportunities for partner countries.

The specific objectives for social, environmental and economic impacts are to:

- assess the extent to which technical knowledge products from projects have led to increased awareness of giant clam rearing, market opportunities and conservation
- determine how knowledge produced during the project has influenced longer-term conservation initiatives and economic opportunities, and increased capacity in partner countries
- document how giant clam investments achieved different levels of impact depending on the different developmental contexts in which the investments took place.

The impact assessment focuses on regional impact across the Indo-Pacific region, with detailed studies in the Philippines and Solomon Islands. We tracked publications and interviewed regional experts involved in the ACIAR projects or familiar with giant clams. For the Philippines and Solomon Islands chapters, the report presents field data from interviews with key informants

involved in giant clam research, industry and conservation. The fieldwork allowed the team to collect any available data on giant clam restocking, requests and economics for the country. Fieldwork included visits to hatcheries, marine protected areas, universities and ecotourism sites that use giant clams sourced from ACIAR project partners.

We interviewed 32 people (8 via phone,[1],11 in the Philippines, 13 in Solomon Islands). Interviews lasted 25–90 minutes and were annotated, and recorded where consent was given. They were thematically analysed following ACIAR guidelines. The quantitative data presented in the report include citation metrics to document scientific knowledge flow, student graduate output from partner universities, available restocking data for the Philippines and price of giant clams in international markets.

Impact assessment framework

Data were analysed using ACIAR's impact assessment guidelines and impact pathway approach, to capture the flows of benefits and costs to different users over time (Davis et al. 2008). The impact pathway guidelines offered a general benefit–cost framework for analysis of the case studies.

We complemented the benefit–cost impact pathway with ACIAR's knowledge systems and RAPID (research and policy in development) framework (Davila et al. 2016) to capture the impacts related to knowledge transfer and relationship building, as well as to contextualise impacts in relation to broader social factors. This qualitative framework guides the analysis of how technical scientific knowledge was absorbed and enacted by different users depending on its salience, credibility and legitimacy; whether and how relationships between research and practice were fostered through boundary organisations or individuals; and the macrodevelopment and context of each case study country. It enables systematic analysis of knowledge-based processes, including ongoing research programs, technical skills and technologies; analysis of relationships and networks facilitated by the projects; and a systematic approach to understanding contextual factors that affected the impact of the investments over the long term.

1 Phone interviews conducted with stakeholders in Australia, Canada, Cook Islands, Fiji, Papua New Guinea and Samoa

The use of both ACIAR frameworks draws on qualitative and quantitative data to generate a more holistic understanding of impacts relating to giant clam research, commercial developments and conservation.

Impacts in the Indo-Pacific region

Regionally, ACIAR supported the production of highly salient and credible knowledge on giant clam biology and culture techniques. This knowledge continues to be used in the Indo-Pacific region for educational, research and conservation purposes. The capacity of local researchers at the time was high, and ACIAR supported activities that helped individuals and research institutions continue to expand their experience in giant clams.

Although capacity of core researchers and institutions remained high after the projects, there were mixed results for the transfer of knowledge to economic activities. Similar findings related to environmental impacts for the region overall: the number of active giant clam hatcheries and conservation programs is currently higher than before the projects. However, the lack of documented change and monitoring data on giant clam populations makes actual environmental impacts unclear. Overall, social and community benefits were also unclear.

Economic impacts were more limited as a result of the constrained nature of the giant clam market. The limited demand for giant clams in aquarium markets, coupled with the difficulty of transporting live specimens, limited buyers in the region and legal restrictions, limited the extent to which giant clams could become a common income source for coastal communities. Viewed from a traditional economic assessment framework, the giant clam projects did not have any major economic benefits to communities, as the technology adoption was not sustained.

Impacts in the Philippines

The intended impacts of ACIAR investments on Philippines knowledge, capacity and conservation were high, and are demonstrated by the high number of ongoing activities in the Philippines. The projects also had the unintended long-term impact of assisting ecotourism activities.

Knowledge produced during the project was highly salient to the Philippines context, as some giant clam species such as *Tridacna gigas* were near extinct. Restocking was critically needed to balance populations. At present, numerous restocking efforts have been conducted throughout the country, and academic literature reports between 10,000 and 20,000 *T. gigas* individuals restocked over 20 years. Despite these reports, our team found that the historical data on restocked giant clams were inconsistent among researchers, making an adequate assessment of environmental contributions difficult. For example, although many people spoke about restocking activities, there was no significant monitoring, largely for financial reasons. Stock levels are conditional on patrolling and community enforcement, and this varies widely throughout the country.

Capacity was already high at the time of the investments, with two highly trained institutions working on the projects. Since project completion, the team members involved in the Philippines project have continued to become global leaders in marine protected area development and research, mariculture techniques, and giant clam conservation and biological research. These highly skilled individuals and institutions have continue to train the next generation of marine researchers and to produce high-quality knowledge in academic publications.

Economic impacts and technology transfer to communities were hindered by contextual policy changes in the country. A ban on international giant clam sales was put in place in 1995, neutralising economic opportunities from giant clam sales. Farmers were not beneficiaries from ACIAR knowledge and technologies, despite this being an identified intended impact of the projects. The policy context in the Philippines meant that businesses and farmers had little incentive to apply research to develop a giant clam industry.

However, through time, a new, unintended impact emerged. As the research centres continued to produce giant clams for research and conservation purposes, an ecotourism industry developed. This impact assessment reports on two ecotourism case studies—one public and one private—that have used giant clams sourced from ACIAR partners to develop their activities. Such activities require training of village and business leaders to ensure that giant clams are managed adequately and that correct information is provided to tourists. These activities have generated incomes for local communities and have seen an increasing number of tourists. Similar stories exist in the Indo-Pacific region, where giant clams are iconic species and tourists are willing to pay to see them.

Impacts in Solomon Islands

The funds provided to Solomon Islands for giant clam grow-out research were relatively small; however, some positive social, capacity and knowledge impacts were achieved. Economic and environmental impacts were not sustained.

The **social and capacity impacts** were small; this is not surprising, given the small nature of the investments. Only 26 farmers were involved in the grow-out stages, with varying levels of interest. The most successful ones were able to transfer skills to other sectors, such as sea cucumber farming or bookkeeping jobs, after the clam industry closed in the country. The local staff involved in the project developed advanced research and giant clam rearing skills, which they continued to use for a range of other employment opportunities after the project. **Environmental** outcomes were not part of the original project objectives. Farmers were expected to restock reefs with 5–10% of clams from their farms; however, this was not monitored.

The relatively small amount of funds provided by ACIAR to Solomon Islands for giant clam research delivered a series of immediate high-quality **knowledge and economic impacts**. The scientific publications produced during the project provided rigorous evidence on how giant clams can be grown in villages and sold to international markets. These methods remain highly salient for countries that actively farm giant clams. The techniques developed, and the data recorded on survival rates and environmental conditions that enable giant clam production continue to be of relevance to users throughout the Indo-Pacific region.

The local context, however, meant that sustained adoption of knowledge and technologies did not occur. The policy and political changes in the early 2000s made the continuation of giant clam production unviable throughout the country. Furthermore, the income generated from giant clams was always going to be additional income for farmers, rather than a sole provider of livelihoods. With the closing of hatcheries, farmers in the country have been unable to source adequate clam seeds to use the cages and materials provided during the project. Some farmers have been able to transfer the skills to other commodities, such as sea cucumbers and oyster pearls, or to other sectors, such as banking.

Overall impact

Overall, the impact of the projects on knowledge and capacity in mariculture techniques and giant clam biology was high. As the first major fisheries investments for ACIAR, the giant clam projects have left a legacy in the Indo-Pacific region, and the technical knowledge is well known. The changing market context of the commodity has meant that sustained adoption of technology and marketing has not occurred. However, the quality of the science and the capacity built is now able to respond and adapt to new conservation objectives, and marine-based research or commodities that might emerge. For example, as research and market interest in sea cucumbers and pearl oysters have grown, those skilled in giant clam mariculture can transfer techniques and experience, and diversify their opportunities. As ecotourism continues to grow in some countries, especially as giant clams become part of the activities, there continues to be a place for the credible and salient information that ACIAR produced over a period of 25 years.

From the perspective of traditional economic assessment frameworks, it is likely that there have been zero or negative economic returns on ACIAR investments. The lack of a growing market, and the policy and political contexts of partner countries have prevented a stable supply of giant clams. However, this does not mean that the projects did not have wider sustained impacts, including impacts on adoption of knowledge. The narratives provided across three chapters in this report show that ACIAR produced highly salient and credible knowledge during the investments, and supported the development of key institutions and individuals in partner countries. The knowledge generated throughout the investments continues to be used, and remains a foundational base for giant clam biology and mariculture.

Lessons for ACIAR

The story of giant clam investments presents a number of examples of the complexities of achieving social, economic and environmental impacts from complex programs in varied contexts. The projects provide a good example of the complexities of conducting and delivering high-quality technical and scientific outputs, and transferring them to socioeconomic and environmental systems for ongoing use and eventual impact. This report concludes with general lessons for impact assessments, project leaders and program managers.

Impact assessments will continue to grow in complexity, given the multiple possible impacts ACIAR can have and seeks to measure. ACIAR has demonstrated an ability to conduct rigorous benefit–cost impact assessments using a coherent framework. More recently, ACIAR has shown interest in capturing the more qualitative and non-quantifiable components of research impact, such as social and policy change, capacity built, and knowledge system change. We endorse the diversification of impact assessment methods and approaches, given the changing nature of development and research institutions, and suggest that flexible methods and frameworks continue to be used as required for assessment of selected case studies.

For project leaders designing and conducting projects funded by ACIAR, we recommend three things. First, we propose focusing on networks and boundary organisations as long-lasting elements of projects. Second, we suggest recognising the crucial role of building monitoring and data storage systems in institutions, to facilitate future reviews and impact assessments. Finally, we suggest that focusing on gender-diverse knowledge systems is crucial to diversify the approaches and knowledge generated during projects, and contributes to wider developmental needs of partner countries.

For program managers, we recommend that focusing on private industry as strategic partners can be beneficial for delivering long-term economic impacts. The growing role that the private sector plays in rural areas can provide ACIAR with strategic opportunities to enhance market access and technology adoption. A further recommendation is to continue the active partnership with, and capacity building of, local champions, who demonstrate passion, intellect and commitment to continued contribution to partner countries. Finally, we recommend that program managers learn from ACIAR's strong record of delivering agriculture and mariculture projects. For this, processes of systematising reflection processes between past, current and future program managers can provide opportunities for greater institutional learning.

1. Introduction

Since its inception, the Australian Centre for International Agricultural Research (ACIAR) has become a leader in partnership-based research in the Indo-Pacific region. From 1982 to 1997, ACIAR invested in four projects targeting research on giant clams as a potential contribution to sustainable livelihoods. Total contributions were approximately A$3.5–4 million,[2] and involved eight countries. The projects had multiple objectives targeting scientific knowledge, environmental conservation efforts and livelihood improvements. The broad nature of the giant clam investments offers an opportunity to explore the impact of these investments on social, environmental and economic systems.

The major 1980s giant clam projects 'acted as a catalyst for development of mariculture in the Pacific, and for its diversification in the Philippines' (Hammond et al. 1992). However, the original project's economic benefits were not immediately realised. This was partially due to a lack of clear understanding of what the market for giant clams looked like at the time. To mitigate this, ACIAR invested in project EFS/1988/023, and delivered a series of reports and publications proposing the costs and potential benefits of a giant clam industry in Australia and partner countries (Tisdell 1993). With this economic understanding, the next project (FIS/1995/042) focused on helping farmers grow and distribute giant clams for the seafood and aquarium markets, and focused specifically on Solomon Islands. During this project, 26 farmers from 14 villages were realising profits of up to A$1,467 per year from giant clams sold to the aquarium market (Hart and Bell 1997). The end-of-project report for FIS/1995/042 noted that the grow-out trials in Solomon Islands developed skills, capacity and technical knowledge on producing giant clams for the aquarium trade, and set a platform to explore a possible sashimi market (Hart and Bell 1997).

This impact assessment is being conducted 35 years after the first ACIAR giant clam investments started and 20 years after the final giant clam projected concluded. Such an extended time frame has enabled the impact assessment team to examine how giant clam knowledge generated throughout the ACIAR project has been absorbed and used, and has affected different social, environmental and economic domains within partner countries.

The impact assessment builds on an existing internal review for all giant clam–funded projects. It integrates primary interview data with interdisciplinary literature on the current social, economic and ecological context of giant clam mariculture in the Indo-Pacific region.

1.1 Definitions

Our report uses a number of terms from the impact assessment and development literature. For this assessment, 'inputs' were defined as the research investments (cash and in-kind) made by ACIAR and collaborating organisations to implement and support the activities necessary to produce the research 'outputs' or deliverables. Following the impact pathway framework, 'outcomes' were defined as the adoption of the project outputs by next and final users that resulted in changes in capacity, knowledge, practice, policy or behaviour required to achieve the intended or unintended impacts (i.e. the desired changes in economic, environmental and/or social conditions beyond the life of the project) (Palis et al. 2013). Here we draw from Davis et al. (2008) and Davila et al. (2016) to clarify what each term means for clarity of reading and analysis:

- **economic impacts**—changes in market conditions as a consequence of ACIAR's investment
- **social impacts**—the benefits (or costs) experienced by beneficiaries as a result of ACIAR-funded activities, either directly or via institutional changes such as public policy
- **environmental impacts**—changes in the state of natural resources as a consequence of ACIAR's investment

2 Some review documents claim higher investments. Our analysis leads us to estimate investments at A$3.5–4 million.

- **knowledge system**—the network of actors connected by social relationships (formal or informal) that dynamically combine knowing, doing and learning to bring about specific actions for sustainable development
- **developmental factors**—the context-specific factors that enable or constrain uptake of technologies and knowledge flows (e.g. policies, political changes, social and gender relations, governance).

1.2 Objectives and approach of the impact assessment

The aim of the impact assessment is to determine the extent to which giant clam research and restocking investments contributed to long-term knowledge exchange, conservation efforts and economic opportunities for partner countries.

The specific subobjectives for social, environmental and economic impacts are to:

- assess the extent to which technical knowledge products from projects have led to increased awareness of giant clam rearing, market opportunities and conservation
- determine how knowledge produced during the project has influenced longer-term conservation initiatives and economic opportunities, and increased capacity in partner countries.
- document how giant clam investments achieved different levels of impact depending on the different developmental contexts in which the investments took place.

ACIAR invested in giant clam activities in eight countries, including Australia. To capture the impact of these activities on long-term knowledge uptake, and economic, social and environmental impacts, we took a case study approach to the impact assessment. We conducted two field trips to different countries. The first was Solomon Islands, which was the recipient of the standalone project FIS/1995/042. This was one of the last giant clams projects that ACIAR invested in. The area was geographically accessible and had numerous key informants still familiar with the project. We then travelled to the Philippines to determine the long-term impact of activities there after they concluded in the early 1990s. The Philippines was selected as a case study because it has ongoing giant clam activities decades after ACIAR investments, allowing the impact assessment to draw links between past investments and current use of knowledge. Finally, we conducted Skype and telephone interviews with regional stakeholders from the Indo-Pacific region who had previously worked with giant clams, or are currently involved in marine trade, conservation or policy work. The document review, field trips and discussions with multisectoral stakeholders allowed our team to collate a range of data that provide a more holistic understanding of the intended and unintended impacts of ACIAR's investments than a single method alone would achieve.

To analyse the data for the study, we drew on ACIAR's impact assessment guidelines and impact pathway approach to capture the flows of benefits and costs to different users over time (Davis et al. 2008). The impact pathway guidelines offered a general benefit–cost framework for analysis of the case studies, whereas the knowledge system and RAPID (research and policy in developement) framework (Davila et al. 2016) provide an analytical way of exploring how networks and knowledge affect development and policy in specific contexts.

For most impact assessments of ACIAR projects, a benefit–cost framework has been used to estimate the market cost and benefits that can be attributed to the initial investment. These impact evaluations of research and development (R&D) have largely focused on agricultural systems. Appraisal and valuation of environmental and ecosystem impacts of R&D have been less common. In the case of ACIAR's investment in giant clam research in the Philippines, the outcomes were predominantly environmental and hence would require estimations of non-market benefits such as biodiversity, recreation, and marine ecosystem existence and health. Capturing these estimations would have required extending traditional benefit–cost frameworks and estimating values within a 'willingness to pay' (WTP) conception of economic welfare analysis (Pearce and White 2012). These evaluations were beyond the scope of this study. To overcome this limitation, the team explored the general recreational benefits to requesters of giant clams and captured the extent to which giant clams are used for non-market purposes in the Philippines.

From a number of database searches, including the Environmental Valuation Reference Inventory, and the Economy and Environment Program for Southeast Asia database, we identified two non-market valuation studies undertaken to estimate the value of coastal natural resources in the Philippines (White et al. 2000; Samonte-Tan et al. 2007) and two studies that estimated recreationists' WTP to visit marine protected areas (MPAs) in the Philippines (Arin and Kramer 2002; Tongson and Dygico 2004). However, these studies did not provide estimates of the visitors' WTP to see giant

clams specifically, and so were not suitable for a 'benefit transfer' assessment for this evaluation. For Solomon Islands, there were unexpected contextual changes in the country, which we captured using ACIAR's knowledge systems and RAPID framework (Davila et al. 2016). We present secondary data on the profits from giant clam production; however, the lack of sustained market and technology adoption also created challenges for a full cost–benefit analysis.

Despite these challenges to economic analysis, the giant clam history in the Indo–Pacific region presents multiple non-market, capacity-building, knowledge uptake and conservation benefits. We complemented the benefit–cost impact pathway with ACIAR's knowledge systems and RAPID framework (Davila et al. 2016) to capture these broader impacts. This qualitative framework guides the analysis of how technical scientific knowledge was absorbed and acted on by different users, depending on the macrodevelopmental and context of each case study country. It enables systematic analysis of knowledge-based processes, including ongoing research programs, technical skills and technologies; analysis of relationships and networks facilitated by the projects; and a systematic approach to understanding contextual factors that affected the impact of the investments over the long term.

The use of both ACIAR frameworks draws on qualitative and quantitative data to generate a more holistic understanding of impacts relating to giant clam research, commercial developments and conservation. We undertook an impact pathway analysis for the Philippines to better understand the linkages between the initial research outputs, outcomes and longer-term impacts. This allowed us to identify the multiple users and the intended and, more importantly, unintended benefits that flowed from the ACIAR investment in giant clam research in the Philippines. We collected data on giant clam requests to the two public hatcheries at the Silliman University Marine Laboratory (SUML) and the Marine Science Institute of the University of the Philippines (MSI). This provided us with the number of clams requested over time, the sector of the requesters (e.g. government, resort owner) and the purpose of their request for giant clams (e.g. conservation, ecotourism). Using these data, we identified two of the larger user categories—local government units and resorts—and selected a case study restocking site from each of these. For Solomon Islands, we mapped the project outputs and users following interviews and document analysis. The lack of an active giant clam market in Solomon Islands meant that a full benefit–cost study was not possible, and adoption of technologies was non-existent. As a result, the analysis focused on the salience, credibility and legitimacy of the knowledge products generated, and the contextual factors that enabled or hindered long-term use of capacity built and knowledge produced.

1.2.1 Fieldwork and data analysis

Our team carried out field trips to Solomon Islands and the Philippines to collect data from key informants involved in giant clam research, industry and conservation.

Qualitative, semistructured interviews were conducted to examine key informants' narratives of research impact, following the interview guides in Appendixes 1 and 2. These narratives provided insights into participants' perceptions of intended and unintended impact and benefit from the ACIAR projects, and identified a range of contextual factors that were regarded by participants as relevant to understanding the consequences of the projects over the long term. We interviewed 32 people (8 over the phone,[3] 11 in the Philippines, 13 in the Solomon Islands). Interviews lasted 25–90 minutes, and were recorded and annotated. They were then thematically analysed using ACIAR impact assessment frameworks to identify common themes and assessments of the impact of ACIAR investments. The interviews identified factors that were unlikely to be captured in cost–benefit analysis.

The team also collected any available data on giant clam restocking, requests and economics for the country. Fieldwork included visits to hatcheries, MPAs, universities and ecotourism sites that use giant clams sourced from ACIAR partners. The quantitative data presented in the report include citation metrics to document scientific knowledge flow, student graduate output from partner universities, available restocking data for the Philippines, and price of giant clams in international markets. Table 1 provides an overview of data collected for each major chapter in this report.

1.2.2 Data availability for cost–benefit analysis

A number of data sources were used for this impact assessment. As noted above, the lack of data specific to giant clams, as well as inconsistencies in the data that were available, meant that there was very little that could meaningfully inform a comprehensive cost–benefit analysis. Table 2 summarises the status of the data we sought, identified and examined in gauging the feasibility of a full cost–benefit analysis.

3 Phone interviews conducted with stakeholders in Australia, Canada, Cook Islands, Fiji, Papua New Guinea and Samoa

Table 1: Sources of information for each chapter

Chapter and project	Data sources
Chapter 2: Regional context of giant clam activities FIS/1982/032, FIS/1987/033, EFS/1988/023, FIS/1995/042	Peer-reviewed literature, grey literature, phone interviews with regional experts (*n* = 8)
Chapter 3: Philippines case study FIS/1982/032, FIS/1987/033	Field-based interviews (*n* = 11), grey and peer-reviewed literature, quantitative data on publications, student flows
Chapter 4: Solomon Islands case study EFS/1988/023, FIS/1995/042	Field-based interviews (*n* =13), phone interviews, grey and peer-reviewed literature, quantitative data on publications

Table 2: Type of data required, and availability for the Philippines and Solomon Islands

Data type	Availability
Giant clam data	
Number of clams requested and deployed from public hatcheries	Summary data obtained from Silliman University Marine Laboratory Summary data obtained from MSI and published literature, but inconsistencies between sources Data obtained verbally from Solomon Islands
Number of clams requested and deployed from private hatcheries	Disaggregated survey data for the Philippines of one private hatchery (Mies et al. 2017)
Survival rates	No current data Survey data available from 1990s, but published literature shows survival rates will depend on actual natural and human impacts, raising problems in using experimental survival rates to estimate numbers in the wild Publications from Solomon Islands projects document survival rates in grow-out trials (Foyle et al. 1997; Hart et al. 1998)
Current numbers in the wild	No current national or site-based data
Cost data	**Availability**
ACIAR investment in giant clam research and development in the Philippines	Available from ACIAR project documents
Costs of producing clams in hatchery and nursery	Actual costs of production not available from MSI hatchery Only 'recovery costs' available
Costs of transporting clams to restocking sites	Limited (depends on mode of transport—e.g. air, road) Data exist for Solomon Islands at time of investments (Bell et al. 1996)
Cost of protecting clams in MPAs	Available on local case study basis

Table 2: Type of data required, and availability for the Philippines and Solomon Islands (continued)

Benefit data	Availability
Prices of imported clams to United States	Available on websites
Quantity of clams 'traded' internationally	CITES data. These quantities are not sales of giant clams, since clam exports are banned in the Philippines
Quantity of clams traded domestically	Disaggregated survey data for the Philippines provided by Mies et al. (2017)
Benefits of MPAs and ecotourism to local communities	Difficult to estimate and attribute to specific activities
Subsistence benefits of clams to coastal communities	Unclear, as giant clams are often produced for sales, not subsistence. Average profits for Solomon Islands documented (Hart and Bell 1997)
Value of endangered clam species	Not available—database search undertaken
Environmental values associated with clams	Not available—database search undertaken
Willingness to pay estimates to visit clams	Not available. Economic values of MPAs and tourism in the Philippines are available, but not specifically to visit giant clams
Number of tourists going on clam-related boat tours	Case study basis only
Revenues from boat tours	Case study basis only
Defining the 'without project' scenario (counterfactual)	Defined by academics involved in ACIAR projects
Defining the 'with project' scenario	Defined by academics involved in ACIAR projects

ACIAR = Australian Centre for International Agricultural Research; CITES = Convention on International Trade in Endangered Species of Wild Fauna and Flora; MPA = marine protected area; MSI = Marine Science Institute, University of the Philippines

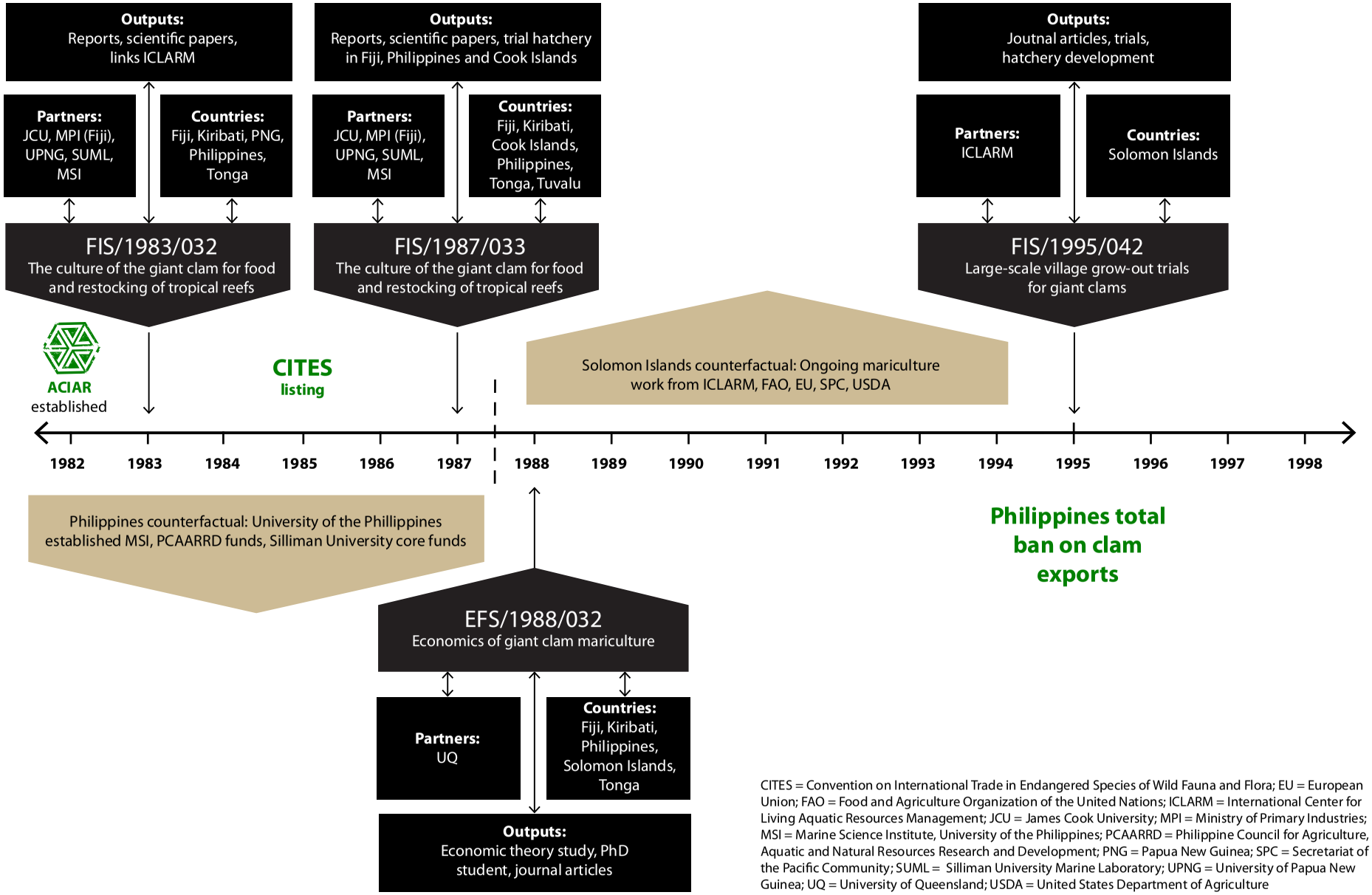
1.3 Project summaries

Table 3 summarises the key ACIAR projects that invested in giant clams in the Indo-Pacific region. Summaries were obtained from the ACIAR website or project reviews (Baker et al. 1987; Hammond et al. 1992; Tisdell 1993; Kearney and Hundloe 1998). Figure 1 shows a time line of ACIAR investments in giant clam projects.

Table 3: Summary of ACIAR investment in giant clams in the Indo-Pacific region

Project number	Title	Objectives	Associated reviews and materials
FIS/1983/032	The culture of the giant clam for food and restocking of tropical reefs	▪ Assess tridacnid stocks at various localities in Fiji, Papua New Guinea and the Philippines, using standardised field assessment procedures ▪ Study natural growth rate of tridacnids and the influence of environmental factors, especially those related to latitude, such as water temperature, sunlight intensity and tides ▪ Investigate the reproductive biology of tridacnids, including gametogenic and spawning cycles, and spawning chemistry ▪ Identify the specific ecological requirements of larvae and juvenile clams in natural environments, and the experimental extent of protection necessary for juveniles and adults ▪ Apply the results obtained in the above research to establish hatchery and rearing techniques for optimum growth and survival in large-scale culture of the tridacnid species of greatest commercial importance	▪ Large monograph synthesising all giant clam research (Copland and Lucas 1988) ▪ Project review (Baker et al. 1987) ▪
FIS/1987/033	The culture of the giant clam for food and restocking of tropical reefs (extension)	▪ Undertake farming trials for ocean-nursery and grow-out culture of giant clams with coastal fishing villages ▪ Develop management strategies to assist Pacific island countries with stock assessments, management, training and mariculture technology ▪ Undertake further studies of the environmental factors and culture conditions that optimise growth and survival of giant clams ▪ Obtain production data and costs for giant clam culture for use in economic analyses and marketing trials ▪ Investigate the genetics of giant clams with regard to geographic variation and the selection of optimal culture traits ▪ Determine the normal microflora and pathogenic organisms in field and cultured clams, and the pathology of diseased clams ▪ Produce a manual on giant clam stock assessment and mariculture methods	▪ Three large manuals: Braley (1992), Norton and Jones (1992) and Calumpong (1992) ▪ Contributions to International Center for Living Aquatic Resources Management conference proceedings (Munro 1993b) ▪ Project review documents (Hammond et al. 1992) ▪ Academic publications
EFS/1988/023	Economics of giant clam mariculture	▪ Develop market prospects for giant clams ▪ Investigate the production economics and supply factors involved in giant clam mariculture ▪ Investigate marine property rights as these affect the economies of giant clam mariculture ▪ Investigate the possible value of giant clam mariculture in development in less developed countries in the Indo-Pacific region, especially South Pacific countries	▪ 21 publications on the economics of clams ▪ 1 PhD thesis ▪ Monographs in 1992 and 1994 (Tisdell 1992; Tisdell et al. 1994) ▪ Project completion report (Tisdell 1993)
FIS/1995/042	Large-scale village grow-out trials for giant clams	▪ Collect growth data from large-scale grow-out trials across villages in Solomon Islands ▪ Analyse data and prepare manuscripts for publication	▪ 11 publications associated with the project ▪ Project termination report (Hart and Bell 1997)

Figure 1: ACIAR giant clam investments time line



CITES = Convention on International Trade in Endangered Species of Wild Fauna and Flora; EU = European Union; FAO = Food and Agriculture Organization of the United Nations; ICLARM = International Center for Living Aquatic Resources Management; JCU = James Cook University; MPI = Ministry of Primary Industries; MSI = Marine Science Institute, University of the Philippines; PCAARRD = Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development; PNG = Papua New Guinea; SPC = Secretariat of the Pacific Community; SUML = Silliman University Marine Laboratory; UPNG = University of Papua New Guinea; UQ = University of Queensland; USDA = United States Department of Agriculture

1.4 Research investments

Tables 4–8 present budget data of total investments for all ACIAR-funded giant clam projects. These budgets are based on internal documents provided by ACIAR.

Table 4: Budget for FIS/1982/032

ACIAR spending	To 30 June 1984	1984–85	1985–86	1986–87	Total
ACIAR to Australia	$48,932	$153,034	$173,414	$112,890	$488,270
ACIAR to partners	$33,459	$116,931	$122,871	$74,714	$347,975
Total	**$82,391**	**$269,965**	**$296,285**	**$187,604**	**$836,245**

Table 5: Budget breakdown for FIS/1982/032

Organisation or country	To 30 June 1984	1984–85	1985–86	1986–87	Total
JCU	$48,932	$153,034	$173,414	$112,890	$488,270
PNG	$8,125	$31,400	$30,700	$19,475	$89,700
Fiji	$13,311	$30,276	$32,051	$21,924	$97,562
SUML Philippines	$12,023	$24,855	$29,720	$14,815	$81,413
MSI Philippines	$0	$30,400	$30,400	$18,500	$79,300
Total	**$82,391**	**$269,965**	**$296,285**	**$187,604**	**$836,245**

JCU = James Cook University; PNG = Papua New Guinea; MSI = Marine Science Institute; SUML = Silliman University Marine Laboratory

Table 6: Budget for FIS/1987/033

Organisation or country	1 Feb – 30 June 1989	1989–90	1990–91	1991 – Jan 1992	Total
JCU	$81,950	$202,212	$195,542	$103,814	$583,518
Country program	$27,340	$122,916	$125,639	$61,827	$275,895
AIMS	$0	$62,120	$51,720	$24,336	$138,176
OVL	$0	$58,740	$47,700	$25,685	$132,125
Fiji	$28,507	$70,784	$50,746	$25,339	$175,376
Cook Islands	$0	$24,100	$21,200	$5,400	$50,700
Kiribati	$3,700	$17,600	$28,546	$9,090	$58,936
Tonga	$52,800	$12,900	$12,000	$5,400	$83,100
Tuvalu	$0	$4,300	$11,856	$0	$16,156
MSI Philippines	$15,001	$64,734	$49,934	$19,358	$149,027
SUML Philippines	$15,636	$43,683	$35,693	$15,744	$110,756
Total	**$224,934**	**$684,089**	**$630,576**	**$295,993**	**$1,835,592**

AIMS = Australian Institute of Marine Science; JCU = James Cook University; MSI = Marine Science Institute; OVL = Oonoonba Veterinary Laboratory; SUML = Silliman University Marine Laboratory

Table 7: Budget for partner contributions to FIS/1987/032

Organisation or country	1 Feb – 30 Jun 1989	1989–90	1990–91	1991 – Jan 92	Total
Cook Islands	$0	$62,000	$62,000	$36,170	$160,170
Fiji	$0	$5,000	$12,000	$12,000	$29,000
Kiribati	$6,235	$20,595	$16,922	$10,082	$53,834
MSI Philippines	$15,834	$40,400	$40,400	$23,566	$120,200
SUML Philippines	$2,708	$6,500	$6,500	$3,792	$19,500
Tonga	$12,208	$30,901	$31,850	$19,192	$94,151
Tuvalu	$0	$0	$0	$0	$0
JCU	$82,294	$177,841	$166,071	$78,408	$504,614
AIMS	$0	$21,800	$21,800	$4,417	$48,017
OVL	$44,000	$48,400	$26,620	$119,020	$238,040
Total	**$163,279**	**$413,437**	**$384,163**	**$306,647**	**$1,267,526**

AIMS = Australian Institute of Marine Science; JCU = James Cook University; OVL = Oonoonba Veterinary Laboratory; MSI = Marine Science Institute; SUML = Silliman University Marine Laboratory

Table 8: Budget for EFS/1988/023 and FIS/1995/042

Year	Project	Budget
1988–92	EFS/1988/023	$225,000
1995–96	FIS/1995/042	$50,368
1996–97	FIS/1995/042	$41,150—remaining $2,245 spent on diving equipment
Total	**FIS/1995/042, EFS/1988/023**	**$316,518**

1.5 Context of giant clams

This section presents the ecological and socioeconomic context of giant clams. We use a range of academic and grey literature from different disciplines to highlight the relevance of giant clams during and after ACIAR projects. We include insights from the regional experts consulted for this impact assessment, particularly in assessing the current context.

1.5.1 Ecological context

Giant clams are the largest bivalves found in marine environments. They are characterised by their large size, shell structure and colourful mantles. They can be found between east Africa and the central Pacific; the largest concentration of different species is in the Indo-Pacific region (Othman et al. 2010; Van Wynsberge et al. 2016). There are 10 established members of the giant clam family Tridacnidae (Othman et al. 2010). The latest species was identified in 2008 by Richter et al. (2008). Giant clams have the unique characteristic of being self-feeding through a symbiotic relationship with algae that reside in the mantle, which photosynthesise to convert sunlight into nutrients for the clam (Munro 1993a; Cacho and Hean 2002). Giant clams are self-reproducing—sperm is produced first, shortly followed by eggs (Munro 1993a).

Density of giant clams remains low in many countries in the Indo-Pacific region. This is largely attributed to increasing fishing pressure and habitat destruction (Teitelbaum and Friedman 2008; Othman et al. 2010; Neo et al. 2017). Giant clams have traditionally been exploited by local fishers for meat consumption, both for subsistence and for selling at local markets (Othman et al. 2010). Giant clams are used for their shells, feasting, and 'clam gardens' in front of village beaches to highlight family property boundaries (Hviding 1993, 1998).

Although giant clam species were initially identified in 1758, limited research into the ecology of, and market demand for, giant clams took place before the 1980s. The rapid depletion of giant clams and near extinction of the species led to a surge in giant clam research. Munro (1993a) states that, in the 1980s, three major realisations led to an 'enormous upsurge' in giant clam research: clams could be artificially propagated; growth rates of larger species were relatively rapid and could meet market expectations; and their self-feeding nature made them an attractive animal for aquaculture.

Between 1980 and 2010, multiple giant clam research projects were funded by the aid and research agencies of economies in the Organisation for Economic Co-operation and Development, including ACIAR (Gomez and Mingoa-Licuanan 2006; Neo et al. 2017). This original research focused on ecology (Copland and Lucas 1988; Munro 1993a; Othman et al. 2010), economics and market opportunities (Tisdell 1991, 1993), and breeding of giant clam juveniles in hatcheries (Bell et al. 1995; Bell 1999). Most projects had the aim of re-establishing depleted giant clam populations through restocking (Teitelbaum and Friedman 2008).

The ecological decline of the species provided a platform for restocking research projects. Restocking programs centred around two activities: protecting and aggregating remaining wild adults to facilitate spawning, and breeding and releasing hatchery-reared clams (Teitelbaum and Friedman 2008). In the 1970s and 1980s, 22 countries were involved in giant clam restocking (Teitelbaum and Friedman 2008), with three common goals embedded across the range of restocking projects in the Indo-Pacific region:

- reinforcing giant clam stocks that had been overfished in the Indo-Pacific region
- reintroducing clam species in places where they had been extinguished
- improving aquaculture technology and early grow-out systems to assist restocking projects.

The technical skills developed throughout the Indo-Pacific region have created an ongoing understanding of, and interest in, the social, economic and environmental value of giant clams, including the transfer of particular techniques and approaches between projects. To determine the impact of ACIAR-specific activities, it is important to understand the economic and market context of giant clams as a commodity.

1.5.2 Socioeconomic context

International market demand is consistent for clam products—notably adductor muscle for human consumption and smaller species for the aquarium trade (Cacho and Hean 2002; Teitelbaum and Friedman 2008). However, the emphasis placed on these different markets has changed over time. The different pressures on clam populations, along with severe reduction in species in the 1980s, led to the 1985 listing of giant clams under Annex II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). CITES prevents the sale in the international market of wild-caught giant clams. They are also listed as vulnerable under the International Union for Conservation of Nature Red List of Threatened Species (Neo et al. 2017).

Although recent publications have disagreed about the number of active hatcheries, there were approximately 34 functioning giant clam hatcheries in 25 countries in 2016 (Heslinga 2013; Neo et al. 2017). Many of these countries are in the Indo-Pacific region. Table 9 provides an overview of the current status of giant clam research and industry in 19 countries in the Indo-Pacific region, some of which received ACIAR funding.

Mies et al. (2017) documented the trends and challenges in giant clam mariculture using the CITES database, primary request data and discussions with 20 giant clam farm managers. The findings show that the main giant clam–producing countries were the Federated States of Micronesia, Palau, the Philippines and Vanuatu. These four countries accounted for 60% of global giant clam production. Of the total 126,130 units of Tridacnidae giant clams recorded as produced in 2015, it is unclear what proportion made it to the market because individual country data is hard to come by or non-existent (Mies et al. 2017).

Since the 1980s, there has been a shift in the drivers for production of giant clams. During the 1980s, including ACIAR projects FIS/1982/032 and FIS/1987/033, the focus was on producing giant clams for local consumption (Mies et al. 2017), conservation and restocking (Copland and Lucas 1988; Gomez and Mingoa-Licuanan 2006), and the food markets in South-East Asia (Tisdell 1993). Although, at the time, there was considered to be great potential for giant clams in the seafood market, for both local and export consumption, economic studies commissioned by ACIAR in the early 1990s demonstrated that the production of giant clams for the meat market was unlikely to be economically viable, as a result of limited demand (Tisdell 1991, 1993).

Table 9: Overview of current giant clam research and industry in the Indo-Pacific region

Country	ACIAR project number	Status of giant clam industry	Details	Species produced (Mies et al. 2017)	Reported production (in units) (Mies et al. 2017)
Australia	FIS/1982/032 FIS/1987/033	Active	There are two active hatcheries in Western Australia (Mies et al. 2017). The current hatcheries are not connected to the ACIAR projects FIS/1982/032 or FIS/1987/033. The hatchery previously at Orpheus Island is no longer active. Sources: Mies et al. (2017), interviews	*Tridacna crocea* *T. maxima* *T. squamosa* *T. derasa*	14,600
Cook Islands	FIS/1987/033	Active (ecotourism)	There is one active hatchery in the Cook Islands (Mies et al. 2017). Hatchery activities have taken place in the country since the early 1900s. The hatchery is privately run, with production focused on *T. derasa* and *T. gigas*, and also serves as an ecotourism operation in Aitutaki Lagoon (Heslinga 2013). Giant clams are part of the Cook Islands 2012–2016 Development Plan, and Heslinga (2013) reported that there were plans to restore the indigenous *T. maxima* to Aitutaki Lagoon. A recent natural disaster stopped cultivation of giant clams for the aquarium trade, and current clam production focuses on restocking for tourists visiting Aitutaki Lagoon. Sources: Heslinga (2013), Mies et al. (2017), Neo et al. (2017), interviews	*T. maxima* *T. derasa*	5,000
Federated States of Micronesia	No relevant ACIAR projects	Active (export, conservation)	There are two active hatcheries in the Federated States of Micronesia. They are located at the National Aquaculture Center in Kosrae and in Pohnpei, and are used for the aquarium trade and for conservation. The Federated States of Micronesia is one of the main producers of giant clams (Mies et al. 2017). Main exports are to the United States and Germany. Sources: Mies et al. (2017), Neo et al. (2017)	*T. crocea* *T. maxima* *T. squamosa* *T. derasa*	16,700
Fiji	FIS/1982/032 FIS/1987/033 EFS/1988/023 FIS/2015/028	Not active (under reconstruction)	At the time of writing, there was no active hatchery in Fiji. The previous hatchery was the Makogai Hatchery. The Makogai Hatchery was destroyed in 2016 during Cyclone Winston. The Fiji Government is currently investing funds to re-establish a hatchery. Sources: Mies et al. (2017), Moorhead (unpublished), interviews	None	Not available
French Polynesia	No relevant ACIAR projects	Active (export)	Whereas Mies et al. (2017) did not report any hatchery activities in French Polynesia, Heslinga (2013) noted that there is one active hatchery, which exports to the United States through the Pacific East Aquaculture company. Source: Heslinga (2013)	Not available	Not available

Table 9: Overview of current giant clam research and industry in the Indo-Pacific region (continued)

Country	ACIAR project number	Status of giant clam industry	Details	Species produced (Mies et al. 2017)	Reported production (in units) (Mies et al. 2017)
Indonesia	No relevant ACIAR project	Active (export, restocking)	There is one active hatchery in Indonesia (Mies et al. 2017). It is based in Bali and produces clams for both export and restocking. Source: Mies et al. (2017)	*T. crocea* *T. maxima* *T. squamosa* *T. derasa*	2,000
Kiribati	FIS/1987/033	Active (export)	There are two active hatcheries in Kiribati (Mies et al. 2017). One of these was established in 2001 in Tarawa and is producing for the aquarium trade. Sources: Bueno and Pongthanapanich (2014), Mies et al. (2017)	*T. maxima*	11,000
Malaysia	No relevant ACIAR project	Active for conservation	There is one active hatchery in Malaysia (Mies et al. 2017). It is run through the Marine Environmental Research Centre, and serves both conservation and ecotourism activities (Heslinga 2013). Sources: Heslinga (2013), Mies et al. (2017)	*T. crocea* *T. maxima* *T. squamosa* *T. derasa* *T. gigas*	7,500
Marshall Islands	No relevant ACIAR project	Active	There is at least one active hatchery in the Marshall Islands. Whereas Mies et al. (2017) contends there is one, Neo et al. (2017) suggest that several are established. The hatchery is privately operated. Giant clam produced is targeted for export to the United States (Heslinga 2013). Sources: Heslinga (2013), Mies et al. (2017), Neo et al. (2017)	*T. maxima* *T. squamosa* *T. derasa*	12,000
Palau	No relevant ACIAR project	Active (export, conservation)	There are at least two active hatcheries in Palau (Mies et al. 2017). Palau is the basis of one of the longest-standing operations of mass clam production (Mies et al. 2017; Moorhead, unpublished). Palau is also one of the main producers of giant clams (Mies et al. 2017), although this production can be variable (Moorhead, unpublished). Since the early 1980s, Palau MDC (formerly the Micronesian Mariculture Demonstration Center) has been active in giant clam research and production in the Pacific region, and has assisted many other countries with their own clam production (Moorhead, unpublished). Sources: Heslinga (2013), Mies et al. (2017), Neo et al. (2017), interviews	*T. crocea* *T. maxima* *T. squamosa* *T. derasa*	15,000
Papua New Guinea	EFS/1982/032 FIS/2010/054	Active (research)	Neither Mies et al. (2017) nor Moorhead (unpublished) noted any giant clam–related hatchery or industry. However, a current ACIAR project, FIS/2010/054, does have a giant clam component for research rather than commercial purposes. Source: interviews	Not available	Not available

Table 9: Overview of current giant clam research and industry in the Indo-Pacific region (continued)

Country	ACIAR project number	Status of giant clam industry	Details	Species produced (Mies et al. 2017)	Reported production (in units) (Mies et al. 2017)
The Philippines	FIS/1982/032 FIS/1987/033	Active (conservation)	There are at least two active hatcheries in the Philippines (Mies et al. 2017). The longest-functioning hatchery is at the Bolinao Marine Laboratory, University of the Philippines. This site was established in the mid-1980s during ACIAR projects FIS/1983/032 and FIS/1987/033. The team has been mass-producing giant clams at the laboratory for national stock enhancement for more than 25 years. Another hatchery is the Semirara Marine Hatchery Laboratory in Western Visayas, which won an ASEAN Energy Award in 2015 for conservation efforts in Semirara Island. As of 2012, Heslinga (2013) observed that there were two other hatcheries. These were the privately operated Cebu Mariculture Demonstration Center and the multipurpose Giant Clam Sanctuary in North Davao. The latter is a community-based ecotourism project managed by the AdeCor United Fisherfolk Organization in partnership with the Igacos Local Government Unit. In addition to these hatcheries, there are current sanctuaries and marine reserves that are known for their healthy giant clam populations, including at the Hundred Islands National Park in Pangasinan and Anvaya Cove in Bataan. Sources: Heslinga (2013), Mies et al. (2017), interviews	*T. crocea* *T. maxima* *T. squamosa* *T. derasa* *T. gigas*	17,300
Samoa	EFS/1988/023	Active (conservation)	Hatcheries for giant clam production have been functioning intermittently since the 1980s in Samoa. Whereas Mies et al. (2017) did not identify an active hatchery in Samoa, Moorhead (unpublished) observed that there has been an active hatchery in Samoa since 2014. The current focus is on community use and conservation. Source: Moorhead (unpublished)	Not available	Not available
Singapore	No relevant ACIAR project	Unclear (likely active)	In 2012, a hatchery was active to start and support a restocking program. A Filipino assistant from Bolinao was involved in the project (Heslinga 2013). Source: Heslinga (2013)	Not available	Not available
Solomon Islands	EFS/1988/023 FIS/1995/042	Not active	During ACIAR project FIS/1995/042, there was an active hatchery in Solomon Islands, and Heslinga (2013) notes that much of the work undertaken was successful. However, the hatchery closed during the tensions. Although it was briefly reactivated with an injection of donor funding between 2005 and 2010, it again became inactive once funding was withdrawn. Sources: Heslinga (2013), van der Ploeg et al. (2016)	None	Not available

Table 9: Overview of current giant clam research and industry in the Indo-Pacific region (continued)

Country	ACIAR project number	Status of giant clam industry	Details	Species produced (Mies et al. 2017)	Reported production (in units) (Mies et al. 2017)
Thailand	No relevant ACIAR project	Active (conservation)	Neither Mies et al. (2017) nor Moorhead (unpublished) note any giant clam–related hatchery or industry. However, there is a conservation-focused hatchery in Phuket at the Phuket Marine Biological Center (Heslinga 2013). Source: Heslinga (2013)	Not available	Not available
Tonga	FIS/1987/033 EFS/1988/023	Active (export, conservation)	There is one active hatchery in Tonga (Mies et al. 2017). The hatchery was established in the late 1990s for production for the aquarium trade and restocking (Neo et al. 2017) Sources: Mies et al. (2017), Neo et al. (2017)	*T. maxima* *T. squamosa*	4,030
Tuvalu	FIS/1987/033 EFS/1988/023	Unclear (likely inactive)	Unknown	Not available	Not available
Vanuatu	EFS/1988/023	Active	There is one active hatchery in Vanuatu (Mies et al. 2017). Neo et al. (2017) note that the hatchery is active, activities have but declined in recent years. Sources: Mies et al. (2017), Neo et al. (2017)	*T. crocea* *T. maxima* *T. squamosa*	21,000

Although food export markets could be developed, the more immediate and consistent demand was from the aquarium trade (Shang et al. 1991; Cacho and Hean 2002).

During the early 1990s, the aquarium market was opening up to a range of aquatic species, with a trend away from fish-only private aquariums towards systems that kept a greater diversity of reef species, including giant clams (Mies et al. 2017). In production terms, this led away from an emphasis on *Tridacna gigas and T. derasa* towards smaller and brighter species, such as *T. maxima* and *T. crocea* (Mies et al. 2017). The aquarium trade provided producers with a shorter time frame for their return on investments—it usually takes 18–24 months before giant clams can be sold to the aquarium trade, compared with much longer periods for the larger species (Bell et al. 1997a, b)

Limited data are available on the total global production of giant clams dating back to the 1980s (Wabnitz et al. 2003). This data gap presents difficulties for estimating the overall economic and environmental contribution of giant clam activities.

Despite this gap, ongoing giant clam research allows a number of observations to be made about the current industry and market for giant clams in the Indo-Pacific region.

Multiple interviewees from research, regional organisations and industry noted that there is a growing emphasis on the production of giant clams, with one reflecting 'that giant clams are coming back into vogue'. As Table 9 shows, there is still engagement and interest in giant clams from Indo-Pacific countries. Drivers for this interest include restocking and conservation, local food consumption and community use, and the aquarium trade (Mies et al. 2017; Neo et al. 2017). Although not capturing all active hatcheries, Mies et al. (2017) found that current giant clam aquaculture is largely operated by private companies that aim to sell to the international aquarium market. This is followed by government-supported hatcheries. Limited operations are supported by not-for-profit organisations. The study suggested that, despite a long history of knowledge and techniques, production remains relatively low, and a decline in collaborations between government, private and university sectors has stagnated the giant clam industry.

Although potential continues for cultivating giant clams for food export, particularly in South-East Asia, interviewees emphasised that this was unlikely to be economically feasible. The current export market remains focused on smaller, brighter and faster-growing species for the aquarium trade. The current international markets for clams are in the United States and Europe, with growing interest from other developed countries such as Australia and the growing middle class in China. However, interviewees noted that the giant clam aquarium market is a 'niche market' that has clear limits on the scope of its production potential, echoing insights from other researchers (Bell et al. 1997b; Wabnitz 2003 et al.).

A challenge for many Pacific island countries is the costs associated with accessing international markets. Transportation costs can be significant within specific countries and across the Pacific region, with hatcheries in remote and isolated locations (Mies et al. 2017). One researcher based in Papua New Guinea (PNG) observed that the internal transport costs for live giant clams within PNG were nearly as much as for international transfer to the United States. Such logistical costs can significantly reduce the ability to compete with areas that have direct passage to the United States. Similarly, Mies et al. (2017) noted that distance from markets was one of the reasons hatcheries in Solomon Islands shut down. Although these costs do not preclude relatively isolated locations, such as in Kiribati, from trading internationally, they are a limiting factor.

Another challenging aspect of the aquarium market is the demand for specific colours and species. One researcher noted that certain Indo-Pacific countries are able to provide the right colours and aesthetics, even if it is in low volumes. In contrast, although the Philippines has high clam seed production at its hatcheries, it does not produce the optimal species to provide high supply for the aquarium market.

The most significant limitation on export markets for giant clams is in relation to demands and scalability of markets. The demand for giant clams, as with other aquarium species, is increasing; however, there is not the market to sustain giant clam industries across the Pacific region at a larger scale. As observed by one researcher, 'there is only a certain amount of market absorption that is possible … and the market is already saturated'. The challenge is that the market is easily flooded because of relatively limited demand. If producers were able to increase production markedly, this would potential lower the price. Mies et al. (2017) observed that the giant clam market would be unlikely to function profitably with high volumes of production at lower prices. This has implications for the likelihood of establishing broader-scale commercial enterprises in the Indo-Pacific region, and limits large-scale livelihood benefits as a direct result of the international aquarium trade.

Interviewees noted that the multiple giant clam activities could provide potential long-term benefits. Participants highlighted that there are multiple demands and opportunities for giant clams that go beyond the international aquarium trade—for example, the benefits reaped from ecotourism activities, as well as other community and conservation benefits noted above. A number of participants observed that these different uses of giant clams are also not mutually exclusive. For example, as one researcher reflected, 'giant clams are an important component of aquarium fisheries in the Pacific. They are simple to do, communities can grow them out and, if you have market access, they can be sold on. If not, you can put them on the reef for other benefits, like conservation, dive tourism, the manufacture of handicrafts, and food'. The multiple uses of giant clams mean that, even without market access, they will not go to waste. This makes giant clams valuable for more than economic purposes, as they provide a range of environmental and aesthetic values that can be used for multiple purposes.

1.6 Report structure

The report contains three major data chapters, and one discussion chapter. In Chapter 2 we use grey and academic literature, and interviews with regional researchers and practitioners involved in giant clam activities in the Indo-Pacific region to provide a current context of giant clam research and industry activities. In Chapters 3 and 4, we present quantitative and qualitative data on the impacts of ACIAR activities in the Philippines and Solomon Islands. Each chapter focuses on knowledge systems, environmental impacts, socioeconomic impacts and tourism activities. In Chapter 5, we synthesise the information from all three data chapters and present, in Chapter 6, a series of major program lessons and institutional lessons for future ACIAR projects that seek to achieve linked environmental, social and economic objectives.

2. Regional context of giant clam activities

This chapter provides a regional assessment of giant clam–related investments in the Indo-Pacific region. It draws on a combination of document review and interviews with key informants. The following sections present the research impacts on knowledge, capacity building, socioeconomics, environment and recreation.

2.1 Regional research activities

Since the 1980s, donors, regional bodies and governments have shown significant interest in giant clam research in the Indo-Pacific region. There have been a number of drivers for the culture of giant clams, including commercial interests, ecological restoration and local food consumption. These drivers have changed over time and vary between countries.

This section focuses on the contributions that the Australian Centre for International Agricultural Research (ACIAR) has made to the Indo-Pacific region. Although interviewees were, overall, confident about their recall of ACIAR research activities, some noted that the time that has lapsed since the original projects meant they did not always recall which specific donor or organisation was responsible. For example, one participant noted the good work that ACIAR had undertaken in Palau; however, ACIAR was not involved in giant clam–related work in Palau, and the participant was probably referring to Palau MDC (formerly the Micronesian Mariculture Demonstration Center). Another participant noted that ACIAR had made valuable contributions in Samoa in relation to the community fisheries program, which was funded by the Australian Aid program at the time (AusAID), not ACIAR.

Although interviewees were confident with their assessment that, overall, ACIAR's contributions had led to positive impacts (as outlined below), the overlap of the ACIAR projects with that of other organisations should be acknowledged to avoid attributing impacts to projects funded by other agencies.

2.2 Knowledge and capacity impacts

ACIAR projects FIS/1982/032 and FIS/1987/033 made significant progress in providing a better understanding of giant clam biology, as well as the culturing of giant clams and associated husbandry techniques. As one researcher noted, 'prior to the research investments of the 1980s, there was very little known about giant clams. Greater knowledge on the culture and biology of giant clams was the project's lasting legacy'. For example, Braley's (1985) finding during the ACIAR projects that serotonin could be used as a hormone stimulant to induce giant clam spawning was a significant step away from destructive approaches to giant clam spawning, such as through giant clam gonad extraction (Mies et al. 2017).

Knowledge outputs in a development research context should be credible (of high academic standard), salient (relevant to policy and practice decision-making) and legitimate (fair and respectful of non-academic partners and end users) (Cash et al. 2003; Clark et al. 2016)—these factors are important in assessing the long-term impact of a research investment (Davila et al. 2016). There was a clear consensus among interviewees that the lasting legacy and impact of ACIAR's investments were related to the extensive scientific and economic knowledge about gian clams.

2.2.1 Publications and application of knowledge

The ACIAR research investments produced a large volume of high-quality research outputs related to giant clams (see Figures 2–4). The credibility of the research outputs is demonstrated by the number of peer-reviewed publications that emerged from the projects and authors, and the associated citation counts. At the time of production, the ACIAR research outputs filled a gap in the academic literature in relation to a sound understanding of biology and culturing techniques for giant clams. The ongoing credibility of the ACIAR project-related research is highlighted by citation

counts in the period since its original publication. This reflects both the peer-reviewed journal articles, and other manuals on the culture and biology of giant clams (Baker et al. 1987; Munro 1993a).[4] As noted by a young researcher, the impact of the research was 'Phenomenal! You can't do clam research today without referencing the original publications. If you put them through Google Scholar they would be the most highly cited giant clam articles in aquaculture. From a research and aquaculture view, it is foundational'. The publications emerging from ACIAR partner countries are documented further in Chapters 3 and 4 of this report.

Along with academic publications, one of the major technical outputs from ACIAR's giant clam research investments between 1983 and 1992 was the guides and manuals on the taxonomy of the Tridacnidae and extensive documentation on rearing technologies. These manuals were essential in supporting the increased culture of giant clams in the Indo-Pacific region. During the 1980s, the research and support products were considered salient and legitimate because they provided clear and practical guidance for the culture of giant clams, and involved local partners actively throughout their development. These documents, combined with capacity development and training, supported the establishment of hatcheries and culture of giant clams across the Pacific region (see Table 9 in Chapter 1).

As a testament to the relevance of the initial ACIAR investments, the original techniques and three manuals are still used today in fishery offices and hatcheries. Multiple interviewees noted that the guides were still being used within the region far beyond the end of the specific projects, including in countries not involved in the ACIAR projects. Reflecting on their time with a regional support organisation, one participant noted that the ACIAR guides 'were the sort of bible. Pretty much every hatchery has them and they guide their work. In my efforts, I definitely referenced them along the way and we tried to make sure that the fisheries departments either had a hard copy or access to one'. One researcher noted that 'the technical outputs of the project have been enduring. They are still found within different fisheries offices and hatcheries, and have been used over time. Regionally, their impact has been significant'.

The uptake, application and adaptation of the knowledge outputs are another enduring impact of ACIAR's investments. As noted above, in the 1990s, there was a shift away from a focus on producing giant clams for food markets towards the aquarium trade. The implication was a shift in the species of giant clams that were produced. Interviewees reflected that the technical knowledge from the original projects was successfully transferred to the production of new species. As one senior official noted, the 'knowledge around giant clams rearing and the capacity that had been developed allowed for hatcheries to shift from meat-focused species to aquarium ones as well as diversify aquaculture commodities such as trochus, pearl oysters, sea cucumber, amongst others'. The basic skills in animal husbandry from the giant clam projects were noted as being transferable to other commodities.

The knowledge developed through the ACIAR investments has been important in enabling development of commercial activities related to giant clams on a regional basis. As discussed in Chapters 3 and 4, on a project basis, there was not strong engagement with the private sector or other potential commercial partners. However, this has not prevented the emergence of private sector investors in giant clam rearing, with Mies et al. (2017) noting that most giant clam hatcheries are operated by private sector organisations.

Although the knowledge outputs from the initial ACIAR projects have been adapted and applied to different species, interviewees noted that the knowledge developed in the 1980s does not serve all current needs. The original projects focused on species valued for their potential food production, and the same research into species biology has not been conducted with giant clams of greater value to the aquarium trade. Although certain rearing techniques were directly transferable, such as the use of serotonin for inducing giant clam spawning, and research into energetics and giant clam feeding, there are knowledge gaps in areas relevant to the aquarium trade. For example, there is minimal understanding of techniques to culture giant clams to promote different colours, which would be of great benefit for targeting aquarium markets. Similarly, there is less knowledge of some species for which a greater market share could be developed. One researcher noted this in relation to *T. crocea*, which is considered the hardest species to produce, but questioned whether this was just a result of negligible research into the rearing of the species.

4 Also see Braley (1985); Copland and Lucas (1988); Gomez and Alcala (1988); Juinio et al. (1989); Braley (1992); Calumpong (1992); Norton and Jones (1992).

Figure 2: Types of publications produced during all ACIAR-funded giant clam projects

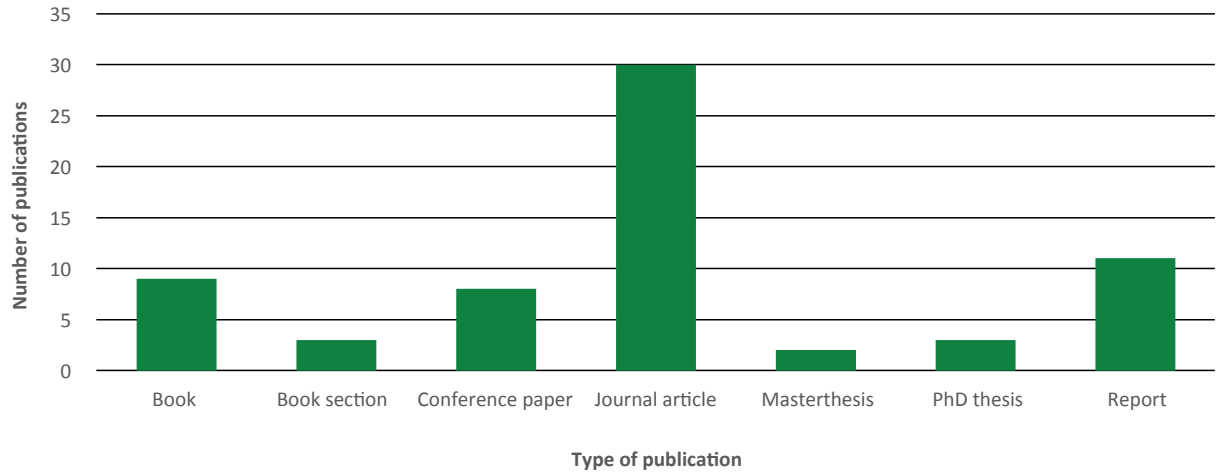


Figure 3: Number of publications for all ACIAR-funded giant clam projects, 1986–2017

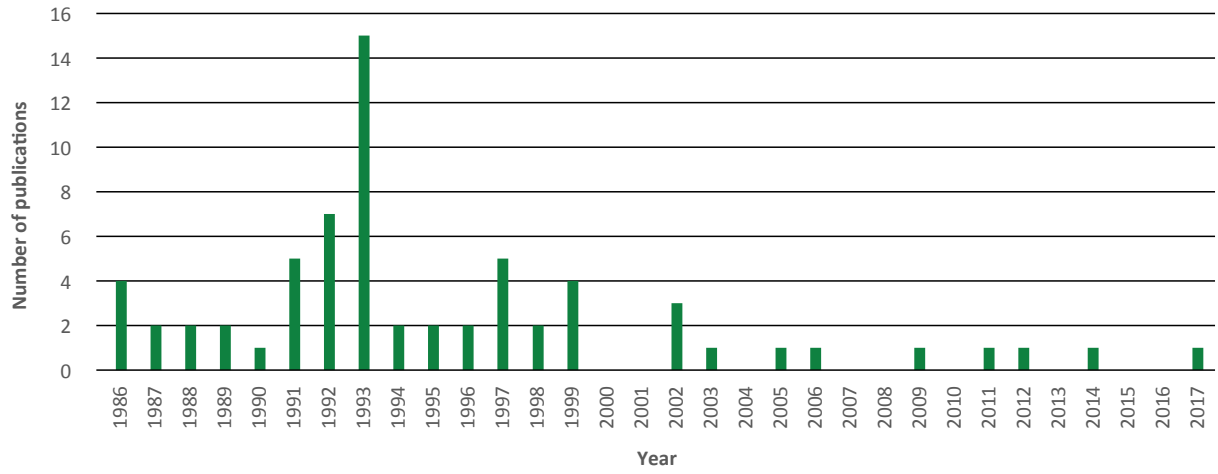
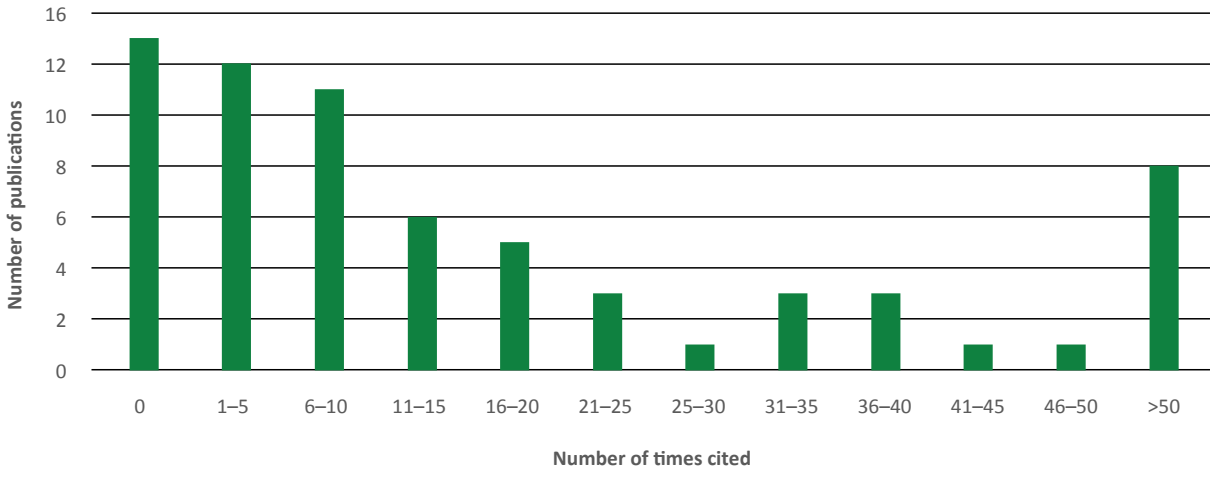


Figure 4: Number of citations for all ACIAR-funded giant clam project publications



2.2.2 Capacity development

The long-term impacts of ACIAR's research investments on capacity development have been variable. Interviewees identified clear, long-term benefits from ACIAR research projects for certain researchers. A number of senior researchers interviewed noted that their engagement with the ACIAR projects had held them in good stead for their ensuing work and careers. One interviewee noted that their engagement as a PhD student in the original projects had provided a strong foundation for launching a successful career in academia. A number of researchers from the Philippines also built on the expertise and academic profile they developed during projects FIS/1982/032 and FIS/1987/033, and rose to senior academic and national government roles (discussed in more detail in Chapter 3).

A number of other individuals involved in ACIAR-funded projects were able to use the skills and expertise they developed in other contexts. One particular success story was identified in Solomon Islands. Through their engagement in ACIAR's work, one individual developed a strong understanding of husbandry and rearing techniques. Since the end of the ACIAR projects, they have applied these skills to conduct training and act as a consultant in the region, and are still considered a regional expert on giant clams. More details of the local capacity in Solomon Islands are provided in Chapter 4.

Interviewees noted that a broad range of current and former fisheries officers are likely to have benefited from ACIAR research investments. As one private sector participant reflected, 'indirectly, ACIAR has been responsible for training a lot of people in hatcheries. While they now know how to do clams, they can also work with other commodities. There is a whole bunch of capabilities and facilities that were developed for giant clams and are now applied to different species'. This highlights that there are likely flow-on effects for the region as a result of the training, capacity development and infrastructure investments of the ACIAR projects.

While there were clear instances of individual capacity development, interviewees noted some potential shortfalls in the impact that the projects had on broader capacity building within partner country institutions. One participant noted that research projects generally had a greater emphasis on international research staff and that 'there is not enough effort put into capacity development', whereas another reflected that the high staff turnover presented a core challenge to local institutions' ability to build ongoing capacity. This was a challenge in institutions with and without international donor funding or project engagement. It reflects that the effectiveness and long-term impact of capacity building are also dependent on the local institutions involved, as well as the economic context that generates high demand for people with skills. While this is a broader issue to be aware of, the interviewees noted that the ACIAR giant clam–related projects did achieve positive capacity development outcomes at individual and institutional levels, as discussed above and further reflected in the vignettes in Sections 3.3 and 3.6.

Interview participants also raised the broader need to design and implement research projects so that capacity is transferred on a sustainable basis, rather than building dependency on donor inputs. A senior official who was previously involved in ACIAR projects at both hatchery and operational levels reflected, 'At a general level, six to eight years for a hatchery or nursery project is a long time for transferring capacity and assisting a community. While other projects might take longer, you should be pulling out a lot earlier if you want to be transferring capacity. Within that time frame, the recipient country should also take more leadership in driving development'. There is a clear challenge here for research partners, such as ACIAR, to balance the need to invest adequate time in building relations, skills and a portfolio of experience with local partners, while also ensuring that responsibilities, ownership and leadership opportunities are being taken up by those local partners. Although it is beyond the scope of this assessment to comment further on this issue, it should be an area of further consideration for ACIAR.

2.3 Socioeconomic impacts

Although there were clear impacts of the technical knowledge produced from the ACIAR research investments, the long-term socioeconomic impacts were less evident. This is not unexpected, given that the original project objectives in the 1980s (projects FIS/1982/032 and FIS/1987/033) were largely scientific in their focus, with a shift to livelihoods and economic viability through project EFS/1988/023. A number of interviewees noted that the socioeconomic impacts risked being overstated, and hence require critical examination. Discussion with interviewees regarding socioeconomic impacts revolved around three key areas: community benefits, commercial benefits, and the degree of realism in achieving livelihood benefits from giant clam production. Further details on the different socioeconomic impacts are provided in Chapter 3 and 4.

2.3.1 Community and commercial benefits

Interviewees noted that the long-term benefits for communities from ACIAR research investments were unclear. The original ACIAR projects did not have a strong focus on communities during the design phase and, as a result, presented learning opportunities for how projects could better integrate community needs. One senior researcher noted, 'The original ACIAR giant clams project was the first of its type in fisheries. It forced us to learn how to engage with different countries, engage with different communities, and align with local livelihood needs. It really made us engage with that social side'. The same participant observed that the lessons learned from the original ACIAR projects, as well as those in Solomon Islands, had been transferred to other projects, including current work in Papua New Guinea (PNG). This observation reiterates the contention that the original projects focused on technical research outputs, rather than community benefits.

A number of outcomes of the original ACIAR projects led to the feeling that there could be wider community benefits. The success of community grow-outs in Solomon Islands was identified as a potential model that could be upscaled, and the technical outputs produced techniques that could be easily replicated. For example, one senior researcher and trainer reflected, 'It was a very successful project. It showed that with quite simple techniques you can produce quite reasonable numbers. It is easy for people to do. If people get lazy and don't clean them for a week then the clams seem to be able to handle it'. However, the potential community and livelihood benefits were largely noted as not having been achieved. As another senior researcher reflected, 'Overall, the commercial and community benefits of the ACIAR investments were not as successful as the technical. More broadly, [ACIAR] needed to think of other beneficiaries at the design phase'.

The long-term commercial impacts of the original ACIAR projects were also identified as being variable. At one level, the giant clam commercial industry and the aquarium trade draw explicitly from the techniques identified in the original projects. As one researcher reflected, 'The original ACIAR projects were hugely impactful. You can't farm giant clam, through spawning, larval rearing, nursery culture, and growout without them. Do the outputs touch on all aspects of industry? No, because they were focused on food production. But from industry, you can't culture a giant clam without relying on the early research'. However, as noted above, the commercial uptake of giant clam rearing has been despite a lack on emphasis on private sector stakeholders during the actual ACIAR projects.

Interviewees noted that there was an issue in the Pacific region with 'romanticising' the giant clam industry as a way to improve commercial and livelihood outcomes for coastal communities in the Pacific. Although many donors and governments continued to promote giant clams as an option for livelihood improvement because they were easy to rear, they ignored the realities of the current aquarium market, as well as the different priorities that are placed on giant clam production. As one participant reflected, 'Everyone is talking about the aquarium market like it is going to save the day, but it is not like that, it is pretty competitive'.

Interviewees raised concerns that there was not a balanced reflection on the potential for both commercial and livelihood benefits from giant clam production. This was noted as a point of reflection on both past impact and future potential benefits from giant clams. The production of giant clams in a country or through a particular hatchery does not itself ensure livelihood impacts. The means by which the commodity is bred and grown out has implications. A hatchery operation can be a successful commercial enterprise while also having very limited engagement with the surrounding communities. For example, one participant noted that, in Palau, grow-out occurs in a laboratory. This has very different implications for local benefits compared with community and farmer grow-outs, as trialled in Solomon Islands. Anecdotes also emerged from interviews where attempts to engage the community did not work. For example, from their experience in the Cook Islands, one participant reflected, 'We tried to introduce local community clam culture. They were keen for two or three months but there was not real interest in culturing clams. This is probably because there are enough alternative forms of employment, such as tourism, to not make it worthwhile'.

This highlights that many of the socioeconomic benefits have been on an individual level, rather than for the whole community: 'There have been some benefits for people; however, not sure that this is clear on the larger scale' (researcher). As distilled by another researcher:

> *In relation to the impact of giant clam farming on livelihood improvements for people, that is inconclusive. Studies in the 80s and 90s showed that benefits can occur, but no one has done a study which looks at whether current industry is providing benefits to local people. It has to provide some benefits indirectly, to some extent, even if it is just an expatriate exporter employing local people, paying business*

taxes, sourcing production and shipping materials locally, and/or engaging local companies to transport their product along supply chains. Through those avenues, there are benefits to the local countries and communities, but the extent of these benefits to the local communities needs to be further assessed.

In assessing the regional socioeconomic impact of ACIAR research investments, consideration needs to be given to the primary objective of hatchery operations. The production of giant clams can serve multiple objectives, including conservation, commercial benefits and food. These objectives can compete: an approach that emphasises commercial engagement in the aquarium market does not necessarily produce community-level livelihood benefits, and there can be clear competition between aquarium trade and conservation objectives. Interviewees contended that there needs to be a clearer perspective on what the priority objective for clam production might be. Building on this, there also needs to be consideration of who should be involved to ensure that the activity endures beyond a particular donor's support. As observed by multiple participants, at a regional level due consideration has not been given to the financial sustainability of giant clam research investments, and how multiple stakeholders can participate in activities in a sustained way.

While there were variable assessments of the ongoing socioeconomic impacts and community benefit derived from the ACIAR projects, participants reiterated that, at a base level, the initial knowledge generated has been influential in driving demand for giant clams in the region. An adviser from a regional organisation summarised:

The ongoing interest from the region in giant clams goes back to the research from ACIAR. It set the baseline, the methodology and the practices that have since been used. For now, we have basically modified things here or there, but in terms of the original know-how and original knowledge, that came from the original work ACIAR invested in. The investment in the region, farming and private sector uptake is a testament to the previous research undertaken by ACIAR.

2.4 Environmental and recreational impacts

The long-term environmental impacts of ACIAR research investments in giant clams are variable. The techniques developed have allowed the broader establishment of hatcheries and culture of clams. This has contributed to broader-scale restocking efforts and giant clam production for conservation purposes, with one participant noting that ACIAR's research investments have 'ultimately contributed to preventing the species going extinct'.

Participants noted that restocking efforts had, at a regional level, been largely positive. However, lack of ongoing ecological monitoring of restocking efforts means that there is no way to identify how successful these efforts have been. Similarly, lack of ongoing monitoring of hatcheries and restocking efforts has meant that limited reliable data are available on the long-term success of efforts to support the growth of giant clams across the Pacific region. This restricts the ability to identify lessons learned from investments and apply them to other contexts. Although species extinction has been avoided so far, multiple interviewees noted that the species were still vulnerable. Participants noted that giant clams are still on the International Union for Conservation of Nature Red List of Threatened Species and, with growing interest in giant clams, the challenges of poaching are increasing, rather than diminishing.

One researcher suggested that an indirect benefit of the ACIAR work had been generating broader interest and engagement of countries in taking ownership and caring for coastal resources: 'A lot of countries started establishing marine reserves and special management areas with giant clams put there as a livelihood option for local communities'. However, the broader interview participant base was less positive in relation to this point. A number of interviewees observed that projects designed for restocking and conservation have not considered financial sustainability of research investments. For example, one researcher reflected, 'on the conservation side, it is important to keep reproducing and restocking as they are still going extinct—this is important even if there was not a monetary value attached to it'. While noting that the objective for research investments did not always need to be commercial, a number of participants said that it was critical to factor into the design of projects how a restocking activity might be sustained beyond the support of a particular donor. This was noted as an issue within the original ACIAR investments, as well as a comment on the broader research project design—that is, investment might be successful in promoting ecological restoration, but is reliant on donor support.

These tensions, and lack of current knowledge on the success of restocking activities, were well summarised in a reflection from a senior fisheries official:

> *When we are doing any work in aquaculture or mariculture restocking, there should be a cost–benefit analysis to see if we should go down this route in the first place, as opposed to other management practices. In the region, people say aquaculture for restocking depleted stocks is important and an alternative, but does it work? People can't point me to evidence where it has succeeded for a species that we've worked on—for example, clams, trochus, oysters or coral. The question is when do we pull out of an activity? For me, aquaculture is mainly a commercial enterprise, although there is scope for small-scale farming for food security in some countries. You put a lot of money into it promoting private sector development and it should be for commercial output reasons, otherwise you just build a dependency on donors. We need to be conscious when we use this technology or donor funds to prop up inadequate or inappropriate management of wild stocks or the ecosystem, because if stocks are well managed, there is no need for restocking projects.*

The emergence of recreational benefits from ACIAR investments was largely unclear. A number of interviewees noted the potential for restocked, healthy reefs and the creation of clam gardens to provide co-benefits to communities, particularly in relation to ecotourism.

Interviewees identified a number of examples where ecotourism activities and associated community benefits had emerged; however, these were largely on an anecdotal scale. Interviewees noted that they were aware of ecotourism activities at a community level occurring in at least PNG, Fiji and Samoa. In PNG, this was a result of locals taking visitors diving to see clam gardens. In Fiji and Samoa, tourists were taken to see giant clams as part of healthy reef systems. For Samoa, these activities were identified as occurring within community-managed areas, with the benefits being reinvested into the community.

Other commercial ecotourism activities were noted but not reported on a large scale by interviewees. For example, in the Cook Islands, current clam production occurs with the sole focus of restocking for tourism. Previously, it was also focused on aquarium production, but this has now ceased in the wake of a recent natural disaster. Overall, the assumption that environmental and conservation benefits would lead into ecotourism benefits only emerged at an anecdotal level.

2.5 Summary of regional impacts

This chapter presented a regional overview of how ACIAR's giant clam investments contributed to knowledge, capacity built and environmental conservation awareness, along with the market challenges of using giant clams for improving livelihoods. The data on total giant clam publication metrics based on ACIAR-funded research and interview data from participants show that ACIAR supported the production of highly salient and credible knowledge on giant clam biology and culture techniques. This knowledge continues to be used in the Indo-Pacific region for educational, research and conservation purposes. The capacity of local researchers at the time was high, and ACIAR supported activities that helped individuals and research institutions continue expanding their experience in giant clams. The limited demand for giant clams in the aquarium markets, coupled with the difficulty of transporting live specimens and limited buyers in the region, meant that it was difficult for giant clams to become a common income source for coastal communities. Viewed from a traditional economic assessment framework, the giant clam projects did not provide any major economic benefits to communities, becuase the technology adoption was not sustained within those communities. In the next two chapters, we present narratives from the Philippines and Solomon Islands to show the non-economic benefits of ACIAR giant clam investments.

3. Philippines case study

This chapter presents findings from a field trip to the Philippines, and document reviews from grey and academic literature. The chapter covers the Philippines components of projects FIS/1982/032 and FIS/1987/033. At the time of Australian Centre for International Agricultural Research (ACIAR) investments, both Philippine university partners contributed A$140,000. Ongoing contributors after ACIAR project completion include the Pew Charitable Trusts (approximately A$200,000 over three years for a range of marine activities), National Geographic (approximately A$40,000), the Philippines Commission on Higher Education (approximately A$260,000) and other national government agencies.

3.1 Country context

This chapter presents qualitative and quantitative data on giant clam activities in the Philippines. The qualitative data in this section are based on interviews conducted in the field and over the phone. Qualitative data were thematically coded using the three impact assessment objectives in Section 1.2, and the general coding terms based on the ACIAR impact assessment frameworks documented in Section 1.2 (Davis et al. 2008; Davila et al. 2016).[5] Data collected are presented within each section to present the evidence for the impact of ACIAR activities. Noteworthy case studies are highlighted in 'vignettes' throughout the chapter.

Giant clam research in the Philippines was virtually non-existent before ACIAR investments (Gomez and Alcala 1988). Original efforts started in the early 1980s between ACIAR and the International Center for Living Aquatic Resources Management, with a focus on rearing and restocking (Gomez and Mingoa-Licuanan 2006). The main Philippines partners were the Marine Science Institute (MSI) of the University of the Philippines, and the Silliman University Marine Laboratory (SUML).

5 Coding terms included impact, outcomes, technology adoption, capacity, knowledge, boundary organisation, legitimacy, salience, credibility, policy and politics.

In the early 1980s, *Tridacna maxima* and *T. crocea* were abundant; *T. squamosa* and *Hippopus hippopus* were abundant in certain localities; and *T. gigas*, *T. derasa* and *T. porcellanus* were rare. ACIAR funds facilitated the sourcing of bloodstock for *T. gigas*, *T. derasa* and *T. porcellanus* from Palau, Solomon Islands and Australia. Once ACIAR funds ended, further funding supported ongoing giant clam work, including funding from the International Development Research Centre; the Pew Charitable Trusts; National Geographic; and the Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development.

ACIAR reviewed Philippines activities in 1987 and 1992 (Baker et al. 1987; Hammond et al. 1992). The reviews spoke favourably of the 'amount and level of training gained during the project' (Hammond et al. 1992), and the 'very significant analysis of the Tridacnidae clams over a vast area' (Baker et al. 1987). The reviews also noted the critical needs for the technical and scientific research to transfer outside university walls, for closer collaborations with the Bureau of Fisheries and Aquatic Resources (BFAR), and for hatcheries to become commercial and provide a consistent number of clams to meet market demand at the time (Hammond et al. 1992). Although the original objectives were largely scientific and technical in nature, Objective 1 of project FIS/1987/032 aimed to pilot growing techniques with communities. This was partially achieved but not sustained, largely because of a national government policy shift in 1995, which placed an international export ban on giant clam activities (Wabnitz 2003 et al.). The policy change meant that the technologies, capacity and networks built through ACIAR were no longer suitable for farming and export, and thus new activities had to be developed.

There are currently multiple hatcheries, and giant clam–related private and public activities in the Philippines (Table 10). The ability for Philippines public, private and academic sectors to be adaptive and innovative as a response to a changing policy context is the major story related in this chapter.

The chapter begins with the impact pathway for the Philippines. We then present narratives of the four major impacts attributable to ACIAR investments. The first finding is the high impact that investments had on long-term knowledge in the country. Knowledge produced during and after the project continued to be salient and credible, as evidenced by the active scientific literature, students graduated, and ongoing activities conducted by the MSI and the SUML. The adoption of technology and knowledge has had long-lasting legacies, despite changes in trade contexts in the country. Key leaders in the country have allowed giant clam research and conservation activities to continue, despite a limiting economic context.

The second finding was the relatively low impact on livelihoods and communities during the project, largely due to low community engagement, and wider interactions with private businesses, non-government organisations and policymakers. Here, we critique the lack of coherent links and boundary organisations through time that could have allowed changes in the trade context and facilitated greater economic engagement with communities interested in giant clams.

The third finding has a different focus on community impacts, and is largely centred on the environmental impacts of ACIAR-funded programs. The Philippines now has an extensive marine protected area (MPA) system, some of which is home to restocked giant clam populations. Many community and private initiatives also use giant clams for environmental purposes.

Finally, we discuss the unintended impacts by highlighting the links between ACIAR investments and current ecotourism operations in the Philippines.

3.2 Philippines impact pathway

Figure 5 shows the impact pathway for ACIAR projects in the Philippines.

Outputs

Knowledge outputs included stock assessments of wild tridacnid populations in the Philippines, which were undertaken between 1984 and1986 by the MSI and the SUML. The focus species were *T. derasa* and *T. gigas,* because of their near-extinct status in the Philippines.[6] A number of baseline information studies on the status of giant clams in the Philippines were undertaken, and some academic publications were produced (Gomez and Alcala 1988; Hammond et al. 1992; Gomez and Mingoa-Licuanan 2006). Technology outputs included hatchery development, notably at the MSI. Capacity outputs included training of researchers and general skills in the region on giant clam rearing techniques.

Next users

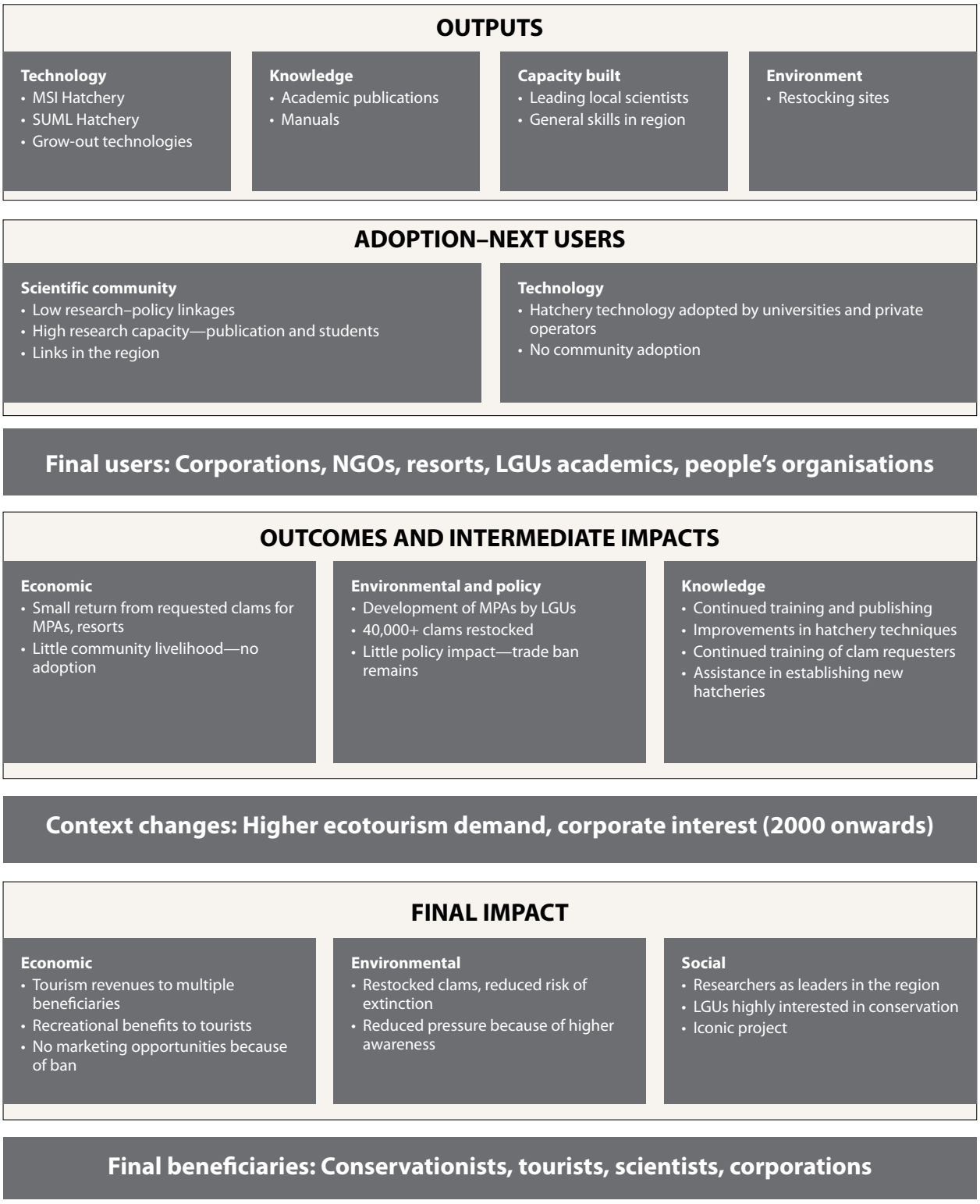
Farmers were the intended end users of the knowledge produced during project FIS/1987/033. These intended users, however, were not adequately engaged throughout the research process, and the market context of giant clams in the Philippines meant that farmers had no incentives to take on the technologies. As a result, these users did not take up technologies or knowledge in a sustained way.

6 Giant clams remain listed under the International Union for Conservation of Nature Red List of Threatened Species.

Table 10: Giant clam hatcheries and tourism uses in the Philippines

Hatcheries active as of 2017, based on Heslinga (2013) and field interviews
Bolinao Marine Laboratory, University of the Philippines
Cebu Mariculture Demonstration Center—the newest giant clam project, privately operated by a Belgian–Filipino non-government organisation
Taklobo Tours and Davao del Norte State College hatchery
Semirara Marine Hatchery Laboratory, Western Visayas
Silliman University Marine Laboratory multipurpose laboratory
Marine and ecosystem-focused giant clam areas in the Philippines
Hundred Islands National Park in Pangasinan, Giant Clam Garden of Asia
Giant Clam Sanctuary in North Davao—Taklobo Tours
Anvaya Cove in Bataan, which has a community-led clam seeding conservation area
Apo Reef
Pico Sands Resort in Nasugbu

Figure 5: Impact pathway for FIS/1982/032 and FIS/1987/033 in the Philippines



LGU = local government unit; MPA = marine protected area; NGO = non-government organisation

■

A new set of unintended next users emerged, who continue to use giant clam knowledge and skills. These were the universities and local government units (LGUs), which continue to use giant clams for research, conservation and tourism purposes. This difference in next users is explained in relation to project outcomes below.

Intended outcomes—next users

The giant clam projects were designed to include farming trials with coastal fishing villages to restock natural sites and subsequently improve the local livelihoods of coastal communities. In most of the countries involved in the second phase, including the Philippines, this objective was not met (Hammond et al. 1992). This meant that technology adoption by farmers and fishers was not high. There was also a lack of involvement and transfer to appropriate government agencies, which was needed for the development phase to succeed, and there were concerns that the potential longer-term livelihood benefits may not be realised for local fisher communities (Hammond et al. 1992). Overall, the transfer to other users, including research to policy linkages, was low.

In the Philippines, the two ACIAR partners took different pathways. The SUML took more of a livelihoods approach and, as the ACIAR project design intended, worked with coastal communities to develop and trial hatchery and nursery technologies. The MSI undertook more of a restocking program, developing methods to culture clams in its hatchery and providing them directly to requesters without pursuing the community engagement component. The MSI did not receive International Development Research Centre funding to undertake grow-out trials until after the ACIAR project (Gomez and Mingoa-Licuanan 2006).

Actual outcomes—next users

Despite the lack of transfer of hatchery and nursery technologies to coastal communities, the MSI and SUML hatcheries began culturing giant clams during the ACIAR projects period to restore depleted populations of giant clams. This giant clam rearing meant that both partners generated a supply of clams for other users. After the ACIAR project, both universities started dispatching clams to private and public sector users for predominantly conservation purposes. More recently, some requesters such as private resorts have begun conserving clams in MPAs and have made them part of their ecotourism activities. Figures 6–8, and Tables 11 and 12 present the giant clam request data from different users.

At least 81,500 giant clams have been dispatched from MSI and SUML hatcheries since the ACIAR giant clam projects began. During the ACIAR projects, the giant clams were dispatched to people's organisations,[7] and private and public sector requesters for predominantly conservation and research purposes. Almost 60% of the clams requested from the SUML went to people's organisations, highlighting the livelihoods approach taken by the SUML in developing hatchery and nursery technologies with coastal communities. Unfortunately, following the ACIAR projects, there was limited external funding to pursue trials with communities, and the number of clams requested by people's organisations decreased to almost zero (see Table 12). The public hatchery at the SUML is currently not actively producing giant clams, because of funding constraints. However, the hatchery facilities are instead used for other research projects and education purposes.

7 People's organisations in the Philippines are common. They are non-government entities that allow individuals interested in a particular issue to organise themselves for a range of activities (e.g. commercial, religious, environmental, social, education)

Table 11: Type of requesters

Requesters	Purpose
People's organisations (coastal communities)	During project: subsistence and trade After project: conservation and ecotourism activities
National, provincial and local government bodies	Restocking marine protected areas, marine sanctuaries and national parks for conservation and ecotourism activities
Tour operators and resorts	Conservation and ecotourism activities
Private sector, largely corporate social responsibility	Conservation, culturing and ecotourism activities
Academic institutions	Further research

Figure 6: Number of clams requested from the Marine Science Institute by requester type, 1994–2017

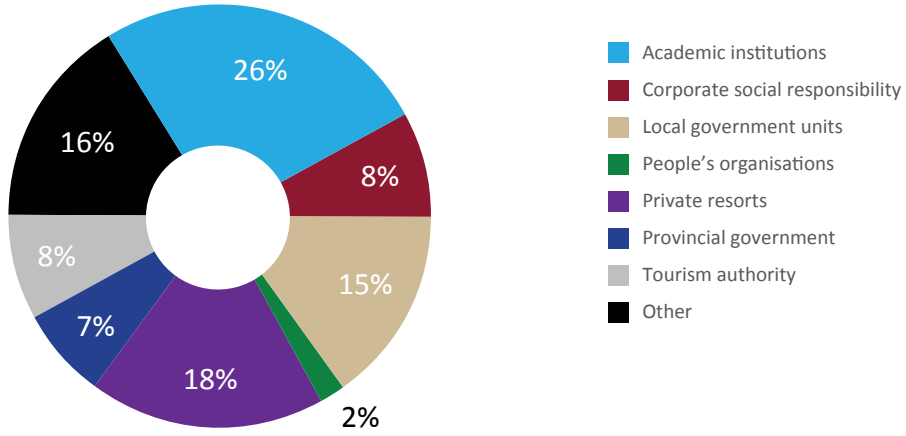


Figure 7: Number of clams requested from the Silliman University Marine Laboratory, 1985–92

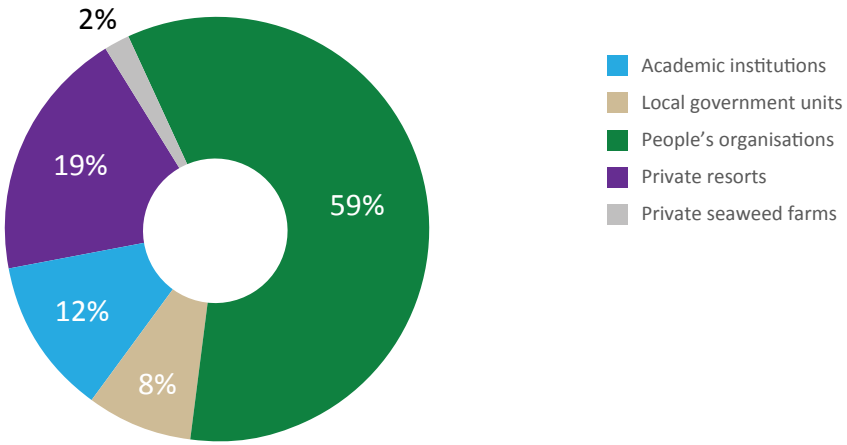


Figure 8: Number of clams requested from the Silliman University Marine Laboratory, 1993–2009

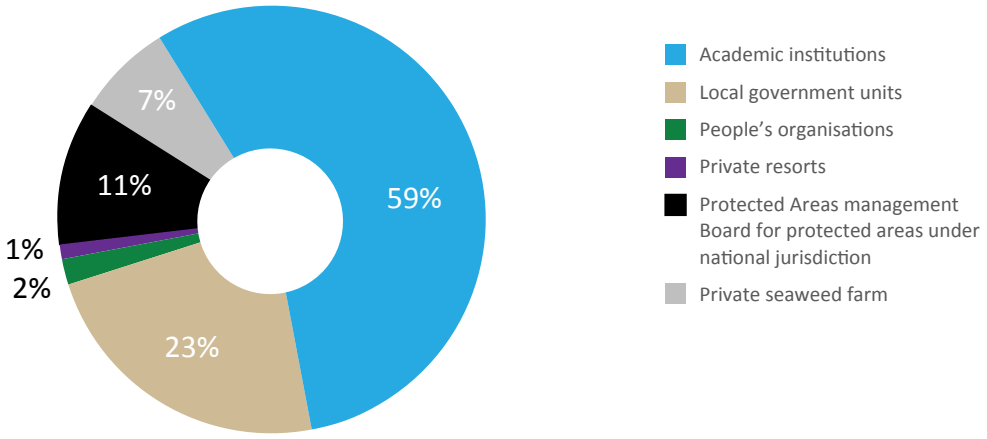


Table 12: Giant clam requests to the Marine Science Institute and the Silliman University Marine Laboratory, by user type

User type	MSI post-project (1994–2017)		SUML during project (1985–92), 26 sites		SUML post-project (1993–2009), 12 sites	
	% of clams requested	Number of clams	% of clams requested	Number of clams	% of clams requested	Number of clams
People's organisations	1.4	648	59.3	12,267	1.8	270
Protected Areas Management Board	na	na	na	na	11.6	1,740
LGUs	15.1	6,963	7.8	1,614	23.6	3,540
Academic institutions	26.4	12,105	11.8	2,441	55.6	8,340
Private resorts	18.25	8,367	18.8	3,889	0.7	105
Private seaweed farm	na	na	2.3	476	6.7	1,005
Tourism authority	8.3	3,824	na	na	na	na
CSR	7.6	3,527	na	na	na	na
Provincial government	6.7	3,099	na	na	na	na
Other	15.9	7,314	na	na	na	na
Total	**99.65**	**45,847**	**100**	**20,687**	**100**	**15,000**

CSR = crorporate social responsibility ; LGU = local government unit; MSI = Marine Science Institute; na = not applicable; SUML = Silliman University Marine Laboratory

Sources: Calumpong and Solis-Duran (1994), field data

3.3 Knowledge and capacity impacts

The project objectives for FIS/1983/032 and FIS/1987/033 were largely centred on generating credible, rigorous and salient giant clam knowledge. Chapter 2 presented the extensive publication impact of knowledge generated across all ACIAR projects. In the Philippines, the development of skills in using hatchery technologies, developing scientific methods for giant clam rearing and restocking, and writing conference and scientific papers has had sustained impacts on knowledge, training and dissemination.

The quality of the research and the high awareness were discussed as positive impacts of investments. One researcher noted that 'the research was definitely very good—at the time there were no mariculture techniques, and the life cycle, history, spawning, raising larvae, all of that was new at the time. The manuals on rearing were new and novel'. A local government official also noted the high awareness of giant clam activities, saying that 'the lab trains the policy and officials on taking care of the clams. The communities also learn from UP [University of the Philippines] about the awareness of giant clam conservation, people know that they have to be protected'.

The role of researchers in providing training was also perceived as a long-term impact. The role of partner universities in disseminating and building knowledge and capacity throughout the Philippines was recognised. A local government official noted that 'MSI has been crucial for capacity building, training, and awareness of the giant clams'. A researcher also noted that 'UP and Silliman are the only universities—they offer lots of marine training. The students are throughout the country, for example in the Davao hatchery.

The capacity built during the ACIAR project was very high'. Other researchers complemented this, saying that 'the Bolinao Lab is also responsible for building the capacity of field officers responsible for restocking the giant clams. The link with MSI is strong'. Finally, a private sector representative noted that 'three of our people went to Bolinao for training on giant clams, and now they work in the marine protected areas in this area'. Another policy official noted that overall 'there is generally high awareness—we involve officials, police, communities a lot in our work'.

The academic literature is an indicator of the ongoing research and scientific capacity present in the Philippines. This is evidenced by the numerous publications produced since 1985 in a range of marine sciences, and an increasing number of masters level and PhD graduates graduating from the MSI (see Figures 9–11). The synthesis paper by Gomez and Mingoa-Licuanan (2006) continues to be a 'baseline' paper that captures the social and ecological challenges and contributions of restocking activities. Ongoing giant clam research remains active in the Philippines (Lebata-Ramos et al. 2010; Lizano and Santos 2014; Cabaitan and Conaco 2017), and a researcher noted that 'the next stage of research is to track where our clams have gone through genetic studies'.

Both institutions involved in the Philippines produced high-quality scientific publications and continued work on giant clams after completion of the ACIAR projects.

Figure 9: Total publications from the Marine Science Institute, 1985–2017

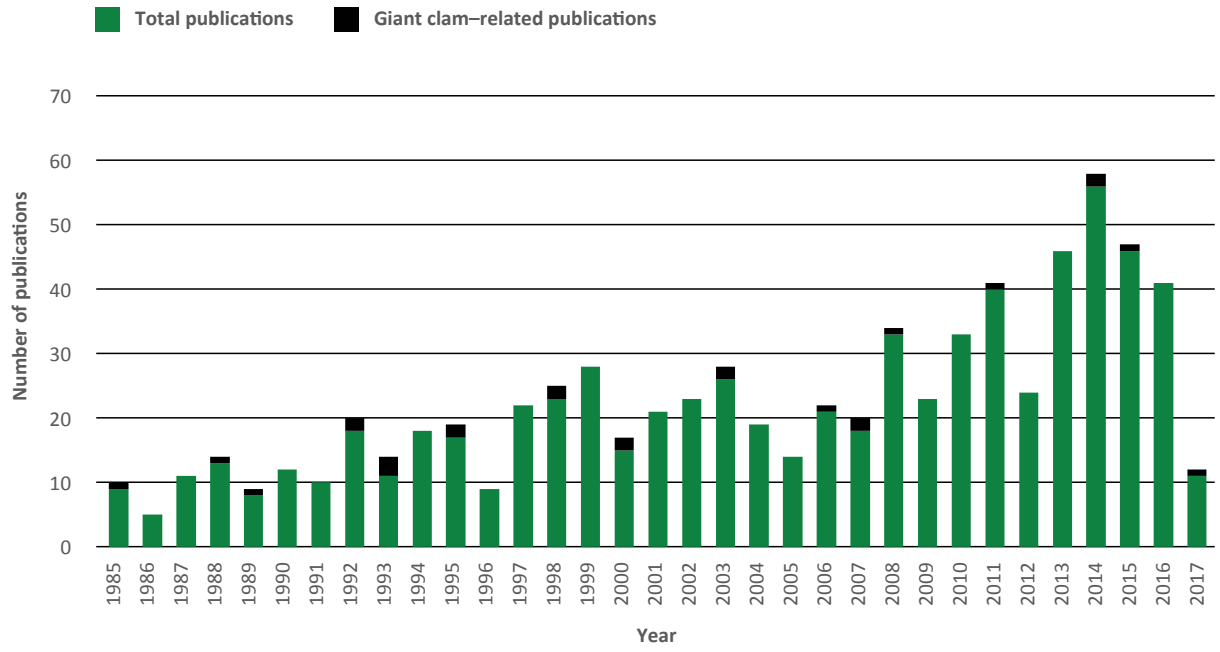


Figure 10: Number of students graduated from the Marine Science Institute, 1985–2017

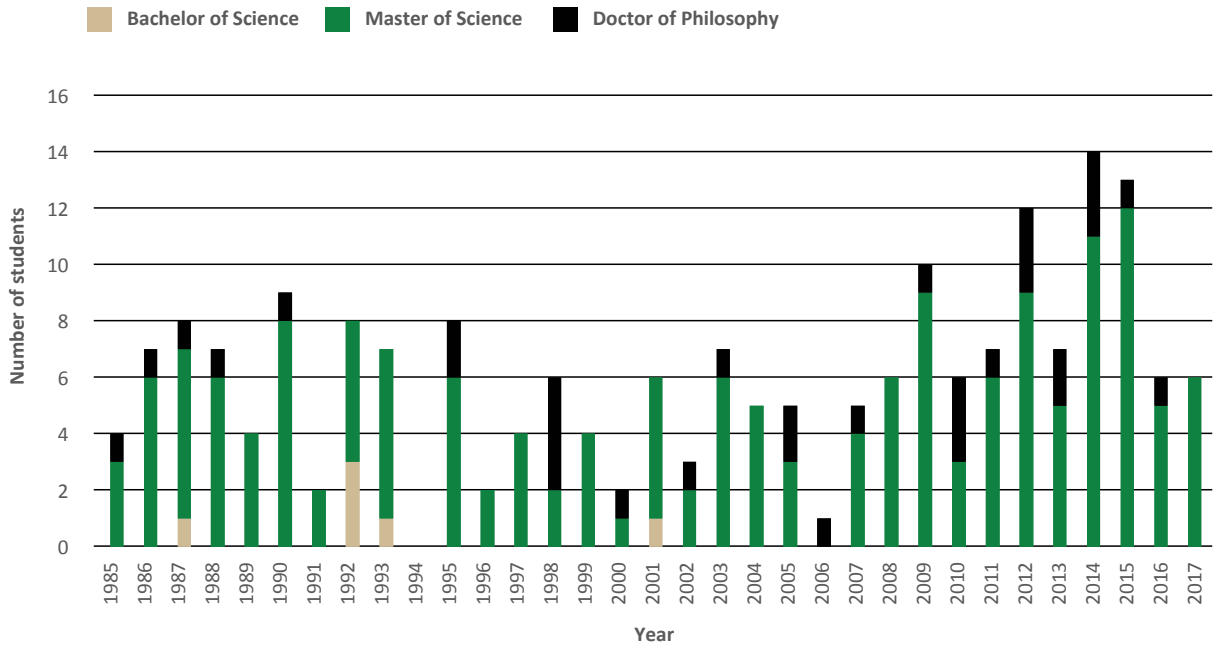
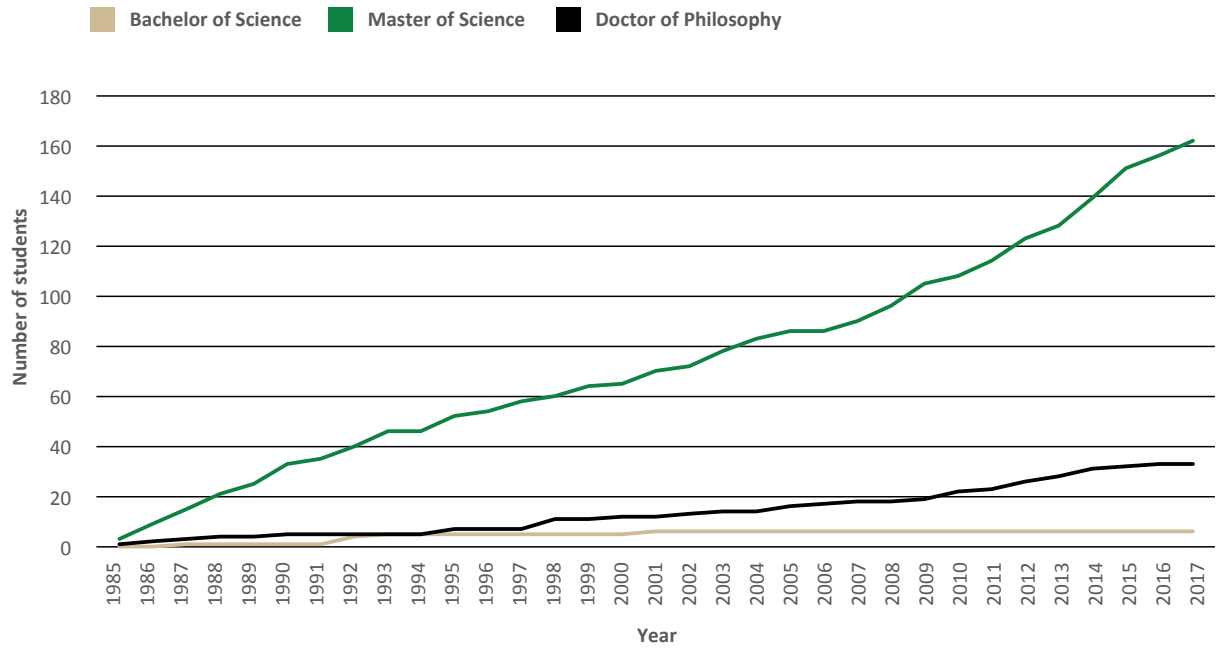


Figure 11: Cumulative number of students graduating from the Marine Science Institute, 1985–2017



3.3.1 Vignette: The Marine Science Institute and the Silliman University Marine Laboratory

The MSI was set up by leading researcher Professor Edgardo (Ed) Gomez, who played an instrumental role in the research and restocking activities during and after the ACIAR projects (see Box 1). The institute was originally funded by the University of the Philippines, and established on an original area of 5 hectares in Bolinao. The laboratory was built in the early 1980s, and original researchers from the ACIAR projects contributed to its design.

The MSI has been a major contributor to ongoing giant clam research, training and restocking activities since ACIAR funding ended. Interviews with researchers, policymakers and resort operators in the Philippines highlighted that the MSI was a highly respected and credible institution for giant clam work in the Philippines.

A senior researcher indicated that the 'ACIAR funding allowed the university to create the first seawater system—before ACIAR funding there was no hatchery running. ACIAR helped us get going'. The MSI was responsible for obtaining broodstock for locally extinct giant clams from as many places as possible, including hatcheries in Solomon Islands and Australia. At the time of investment, *T. gigas* was nearly extinct in the Philippines, but according to a researcher they are now 'highly present in the Philippine marine ecosystem'. This statement is supported by the ongoing publications generated by the MSI (Gomez and Mingoa-Licuanan 2006; Cabaitan and Conaco 2017). (See Figures 12–14).

Figure 12: Types of giant clam publications produced from the Philippines, 1986–2017

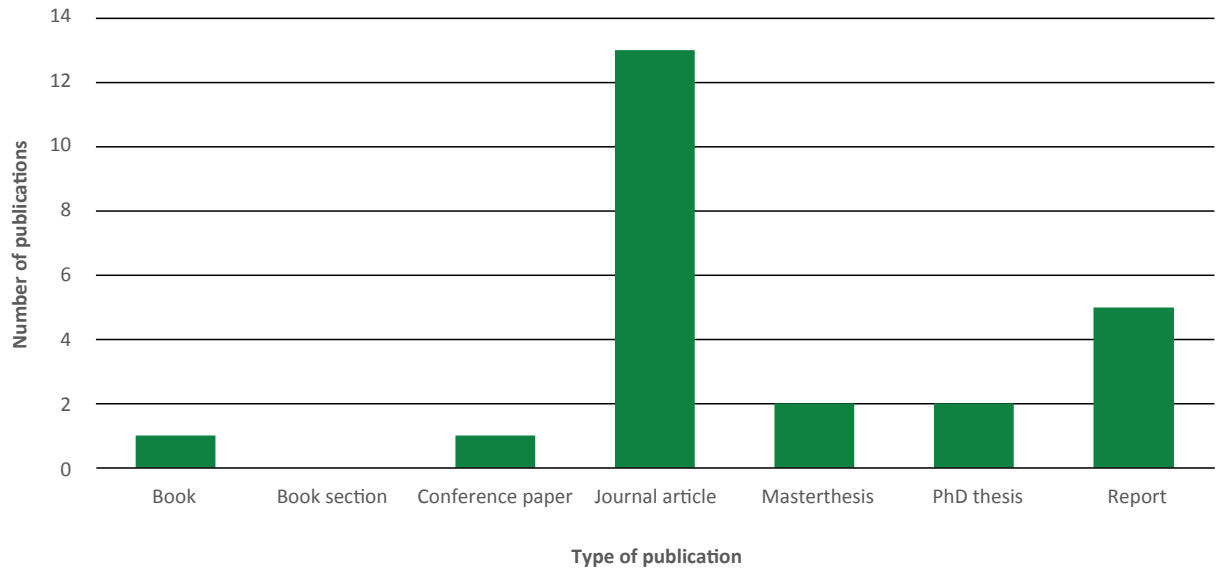


Figure 13: Number of giant clam publications for the Philippines, 1986–2017

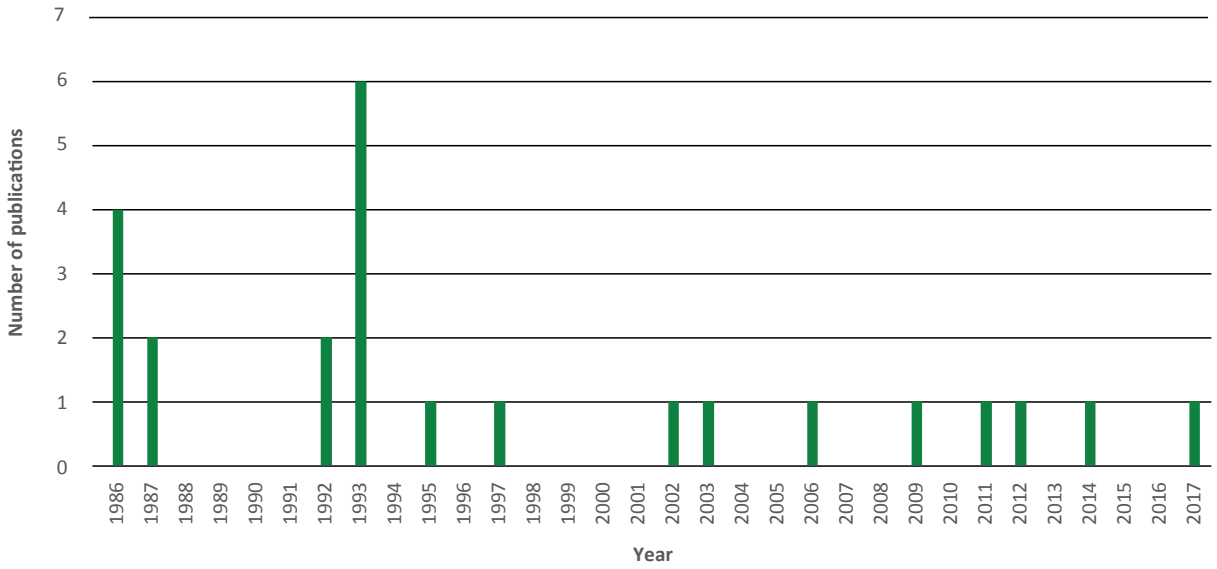
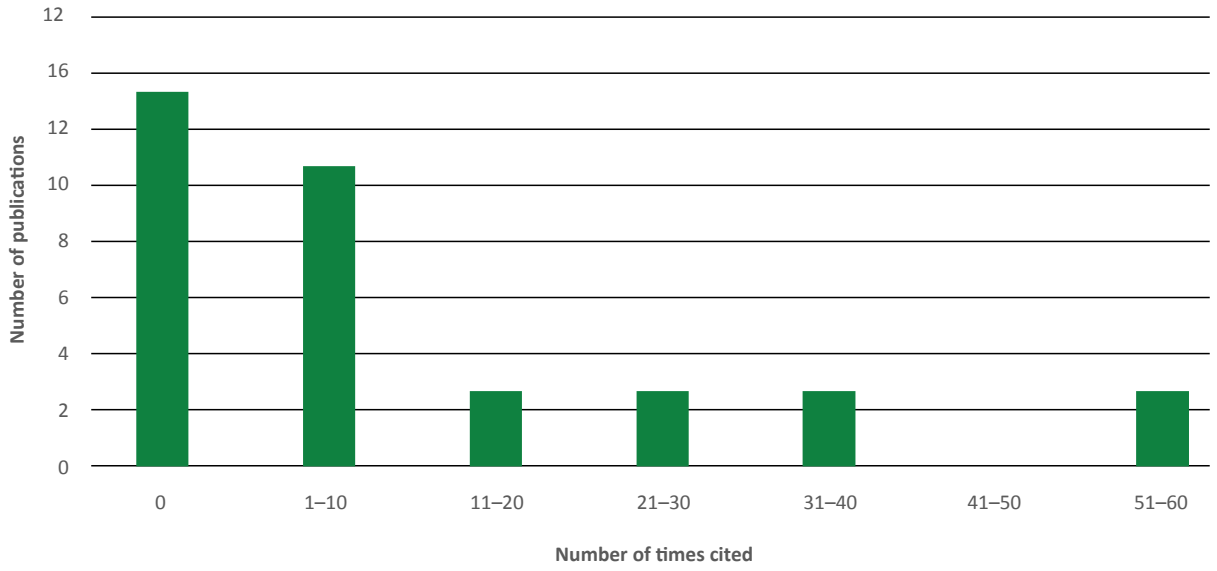


Figure 14: Number of citations of Philippines giant clam publications, 1986–2017



Box 1: Profile of Professor Edgardo Gomez

Professor Ed Gomez was the founding director of the Marine Science Institute (MSI), and saw the development of the infrastructure, research profile and outreach activities of the institute. With a vision of collegiality and learning, the MSI was established to expand the knowledge base of the Philippines marine ecosystem. The Australian Centre for International Agricultural Research projects started in the early days of the MSI, allowing Professor Gomez to develop a research focus on giant clams during the 1980s. Throughout the 1980s and early 1990s, Professor Gomez led the team of researchers involved in surveying the Philippines seas for giant clam populations, and began restocking efforts for near-extinct species. Through his leadership, Professor Gomez was able to source species of *Tridacna gigas and T. derasa* from the Indo-Pacific region for restocking efforts in the Philippines. Professor Gomez was a key player in developing the restocking efforts of the Hundred Islands National Park, which continue to have long-term ecotourism benefits for the local communities in the region. He has extensive knowledge of giant clam biology and conservation efforts in the Philippines and the Indo-Pacific region, and has contributed to numerous publications and research reports on marine conservation and biology. He continues to pursue giant clam conservation activities, most recently through helping to establish a hatchery on Semirara Island. In 2014, Professor Gomez was named a National Scientist of the Philippines.

Since ACIAR funding ended, the MSI has been responsible for training and engaging users who request giant clams in the Philippines. It is the only place where giant clam culture can be undertaken in the Philippines. Users requesting giant clams all need to undertake training at the MSI before acquiring the clams. The MSI has also been highly successful in producing salient and credible knowledge on giant clam and other marine species since ACIAR funding ended. The capacity of the MSI is extremely high, with the institute seeing an increasing number of Masters and PhD students graduating over time. A researcher noted that 'the MSI has been one of the most productive institutions in the Philippines in terms of research output and grant acquisition'. New-generation researchers have developed skills and capacity through working at the MSI, and subsequent funding from international funders has allowed them to continue doing giant clam work.

At present, the MSI facilities are being used by other ACIAR-funded fisheries projects on sea cucumbers and corals. The institute has grown over time, with more tanks, accommodation, and laboratory and teaching facilities available. Overall, the ACIAR funds partially supported the establishment of the MSI and provided a platform to develop a legacy of giant clam activities in the Philippines. The narratives show that ACIAR's original investments made a clear contribution to ongoing clam work.

Siliman University Marine Laboratory

As noted in the previous section, the story for the SUML is slightly different. Similar to the MSI, the SUML focused heavily on marine resources research and conservation. The SUML was already established before ACIAR investments, and the then director worked on the giant clam projects as one of the last activities before moving on to government roles. The focus of the SUML shifted after the ACIAR projects to working with communities to govern MPAs (Alcala 1998; Alcala and Russ 2006). The SUML has played a critical role through time in providing ongoing assistance to communities interested in marine conservation, and continues to be a training hub for these activities in the southern Philippines.

Professor Hilconida Calumpong leads a range of marine science activities in the SUML, continuing the legacy of the centre as an MPA and community engagement leader. Assisted by Professor Calumpong (see Box 2), the MSI and the SUML have supported a generation of female researchers, who continue to lead Philippines marine science and manage laboratories. A number of senior roles have been held by female staff involved in the ACIAR projects or mentored by past ACIAR staff. Senior roles continue to be held by female academics—this is testament to the ability of both institutions to create opportunities for knowledge systems in which both men and women can excel.

Overall, ACIAR supported the two institutions in expanding their skills and infrastructure in giant clam mariculture. The two universities took different trajectories after project completion, with the MSI focusing on research and restocking, and the SUML focusing on community engagement and MPAs. These ongoing activities have led to long-term knowledge production within research bodies in the Philippines.

Box 2: Profile of Professor Hilconida P. Calumpong

Dr Hilconida P. Calumpong is currently a Professor of Biology at Silliman University, and directs the Institute of Environmental and Marine Sciences. She led the development of the three manuals produced during Australian Centre for International Agricultural Research (ACIAR) project FIS/1987/033 (Calumpong 1992). Dr Calumpong is a member of the Apo Island Protected Landscape and Seascape Management Board, the Technical Committee for Marine Science of the Philippine Commission on Higher Education, and the United Nations Group of Experts of the Regular Process for Global Reporting and Assessment of the State of the Marine Environment, including Socioeconomic Aspects.

Dr Calumpong's involvement with the giant clam project started in 1990. Her focus was on developing technology for the ocean culture of giant clams. She has conducted several studies on substrate suitability, optimum size at deployment, and growth rates in different habitats and ocean conditions, among others. In addition, she has looked at various management schemes, such as polyculture with farmed seaweeds, clams in protected areas, and local government versus private management. Dr Calumpong continued the project after ACIAR funds ended, and an additional 15 sites were restocked after the projects.

Dr Calumpong has been involved with clam production, and expanded and improved the giant clam hatchery and nursery at Silliman. Working with graduate students and project staff, she has explored increasing survival and production in the hatchery and nursery using different sources of zooxanthellae, various feeds for the larvae and even cross-fertilisation. She has also surveyed giant clam populations in the Philippines, the South China Sea (Spratly Islands) and Savu Sea (Indonesia).

However, although the knowledge created was salient and credible, the overarching knowledge system for giant clams remains fragmented in the Philippines. A range of contextual factors have meant that the links between research and policy have not delivered long-lasting economic impacts to communities and return on investment for ACIAR activities. In the next section, we explore the weak links with policy by focusing on the low impact on livelihoods and communities, and the policy barriers that prevented giant clams from reaching the market, which posed major limitations for economic impact of ACIAR investments.

3.4 Socioeconomic impacts

The first objective of project FIS/1987/032 was to conduct farming trials for ocean-nursery and grow-out culture of giant clams with coastal fishing villages. Overall, the success in meeting this objective was low. The review report indicated that the MSI had a strong conservation focus, and did not conduct farming trials at the village level or seek to facilitate commercial ventures (Hammond et al. 1992). The same review noted that the SUML had a more user-oriented approach, and supplied seed clams to tour operators and potential farmers. It also delivered training to all clam recipients on giant clam culture techniques. Despite the efforts, the 1992 review recommended that more attention should be given to farming trials to produce useful economic data on the potential benefits of clam production (Hammond et al. 1992)

This impact assessment confirms the findings from the 1992 review. Despite an increase in giant clam activities and new hatcheries opening in the Philippines, there was little effort to conduct grow-out trials with farmers. Interviewees noted the different ways of engaging with communities. One researcher noted that 'we did some work with them, but this did not lead to long-term uptake'. Another researcher noted that 'the focus for us was conservation, so we focused on training them on giant clam knowledge and setting up marine protected areas'.

For the Philippines, a notable story is the fact that demand for giant clams domestically continued to increase from multiple users, despite a major policy shift in 1995. This came in the form of a total ban on giant clam sales for seafood and the aquarium trade, both domestically and internationally. A key informant noted that the motivation for this ban was the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). This is confirmed by the Philippines Government Fisheries Administrative Order 208 of 2001, which states that it is unlawful to collect giant clams, and Sections 11 and 97 of the Philippines Fisheries Code of 1998. A researcher said that 'during the ACIAR project, we started working with communities to develop livelihoods, but the ban in 1995 came in and we stopped all livelihood opportunities'. Here we describe the international ban on giant clams as an unexpected contextual factor that limited the opportunities for long-term economic impacts.

3.4.1 Contextual change: the export ban

Before ACIAR investments, the Philippines was exporting wild clams, both live and shells, to the United States and Europe. Between 1993 and 1996, the Philippines harvested on average 60,000 *T. squamosa* per year for export (Cheshire 2008). The ACIAR giant clam projects were designed to replenish clam stocks, with the long-term goal of developing a market for cultured clams in the Asia–Pacific region.

ACIAR provided critical economic knowledge through funding project EFS/1988/023, and identifying the potential for further growth and development of the aquarium and live seafood markets for cultured giant clams from the Asia–Pacific region (Tisdell 1992, 1993; Tisdell et al. 1994). However, in 1995, the Philippines national government regulatory agency, the Bureau of Fisheries and Aquatic Resources, placed a CITES ban on the harvesting of all wild giant clam species to protect them (Gomez and Mingoa-Licuanan 2006). Section 97 of the Philippines Fisheries Code of 1998 states that it is 'unlawful to fish or take rare, threatened or endangered species as listed in the CITES and as determined by the Department'. Importantly, whereas the context for the ban was the international agreement that addressed export, the domestic legislation covered harvesting in total, affecting both domestic and international markets. This led to a significant drop in trade activity for all species of giant clams. The number of CITES entries for the export of giant clams fell from 805 before the ban to only 149 after the ban (Table 13). Of the post-ban entries, only 11 were considered legal trades of cultivated clams, suggesting that the export trade is close to non-existent.

Table 13: Export of giant clams from the Philippines

Species of *Tridacna*	Number of clams, pre-ban (before 1995)	Number of clams, post-ban (after 1995)	Years
T. squamosa	310	49	1985–2015
T. gigas	197	35	1983–2014
T. crocea	179	38	1985–2011
T. maxima	95	20	1985–2015
T. derasa	24	7	1985–2008
Total	**805**	**149**	**1985–2015**

Note: Philippines figures are based on permits issued, not actual trade (Wabnitz et al. 2003). Source: CITES database

Since the ban, farming of giant clams has not been a viable livelihood option, because trade is illegal and no market exists for the commodity. This contextual factor led both universities to refocus their activities. A researcher noted that 'regulation prohibiting the production for trade of giant clams also forced MSI to just focus on its restocking activities'. It is unclear whether grow-out and community engagement would have occurred if the ban had not been implemented. Confirming the 1992 review findings, a researcher noted that 'no large-scale culture of clams for food eventuated—only piloting took place. Clam production for food didn't take off because of their protected CITES status, and the fact that they are slow growing meant partner farmers were too impatient'. Some participants still believe that there could be livelihood opportunities if the ban was lifted. One policy official stated that, 'if the ban is lifted, then communities can benefit from the clams'. This, however, would require serious industry engagement, as discussed by regional experts in Chapter 2. A researcher noted that 'the current focus should be in lobbying to change the trade ban—it would open up an entire new market for producers'. It is difficult to determine whether the ban will change in the future and open up opportunities for a giant clam market, and little organised lobbying was evident.

Table 14: Production of clams, Philippines hatcheries, 2015

Use	Government	Private
Restocking (9,150)	4,575	4,575
Aquarium trade (21,350)	0	21,350
Total	**4,575**	**25,925**

There is a common belief in the Philippines that the ban is also on the domestic market, making it illegal to trade in giant clams in the Philippines. According to a researcher, some clams are 'eaten in local restaurants and sold to aquariums in Manila but the market is believed to be very small'. In contrast, Mies et al. (2017) report that the Philippines was a major producer of giant clams in 2015, with 30,500 giant clams produced that year. The data from that project suggest that there is a booming domestic aquarium market. The authors reported that, from their interviews with two hatcheries in the Philippines, 21,350 clams (70%) were produced and sold in the domestic aquarium trade in 2015, and the remaining 9,150 (30%) were used for restocking purposes. These figures could not be verified and seem unusually high, given the lack of evidence of production from our fieldwork. It was reported that three private hatcheries exist in Cebu, Semirara Island and North Davao, but we were unable to access their current production outputs. However, the growth in hatcheries in recent years indicates that there may be a potential opportunity for selling non-wild clams domestically, depending on the extent to which the ban applies to non-wild clams grown in hatcheries. Table 15 shows how government and the private sector use giant clams, and assumes the government is not formally involved in supplying the aquarium market domestically.

Table 15: Annual revenues and costs associated with giant clams at HINP. Based on LGU field data.

Revenues	Price/person (AUD)	Quantity	Total (AUD)
Average boat revenues/year	5.50	176,000	968,000
Aquarium trade (21,350)	1	176,000	176,000
Total annual revenues	n.a	n.a	1,444,000
Annual cost of care takers	**2,000**	**2**	**4,000**

The qualitative narratives on the history of giant clam activities led our team to identify weak research–policy linkages. Previous ACIAR impact assessments highlight the critical role played by organisations that bring together industry, research and government officials in creating a multistakeholder knowledge system (Davila et al. 2016). Despite high interest in giant clam research in the Philippines, the interviews revealed limited opportunities for technical research to inform policy developments. No coherent boundary organisation was present in the Philippines that linked different stakeholders. Much of the scientific work continued despite low expectations for a market opening up. The lack of boundary organisations may also contribute to the lack of coherent lobbying to lift the trade ban, as there is no representative body through which to focus and direct an argument for policy change.

Interestingly, more recent links between LGUs and the MSI have indicated that the links with government are growing. One researcher noted the example of the Provincial Government of Bohol, which recently purchased 100 giant clams from the Bolinao laboratory with the view of repopulating the island. Other LGUs in the Pangasinan area have worked with the MSI to acquire clams for tourism purposes (see Section 3.6). The links with business seemed relatively strong in the Philippines, given that the ban required other users to use the giant clams from the MSI hatchery. This is consistent with findings from Mies et al. (2017), who say that the Philippines, along with Indonesia and the Federated States of Micronesia, is one of three places where industry actively engages with university; the remaining 17 out of 20 farms surveyed in that study indicated low links with researchers. These businesses are almost exclusively tourism operators, (discussed in Section 3.5). A major example of other private users of giant clams is Semirara Corporation, a mining company that has set up a hatchery and restocking activities as part of its corporate social responsibility activities.

3.5 Environmental impacts

As an agency investing in agriculture and fisheries research, it is critical for ACIAR to study the impact of activities on natural resource outcomes. A major objective of projects FIS/1982/032 and FIS/1987/033 was to conduct restocking activities throughout partner countries. In the Philippines, restocking activities were conducted during and after the projects (Gomez and Alcala 1988; Hammond et al. 1992; Gomez and Mingoa-Licuanan 2006; Lebata-Ramos et al. 2010; Cabaitan and Conaco 2017). In a review of restocking activities, Bell (1999) highlighted that the Philippines has had the most comprehensive restocking program. The long-term impacts of conservation activities are difficult to quantify—as one national government official noted, 'there is little recorded restocking data'. Cabaitan and Conaco (2017) suggest that restocking efforts since 1995 have allowed natural spawning of giant clams, and the overall increased presence of *T. gigas* in the Philippines is a result of restocking. Here, we present the status of partner hatcheries, data on restocking activities, and the MPA context in which giant clams continue to be used in the Philippines.

3.5.1 MSI and SUML restocking efforts

Field surveys in the 1980s found that the three largest species—*T. gigas, T. derasa* and *Hippopus porcellanus*—were becoming endangered in the Philippines (Juinio et al. 1989). A researcher involved in restocking said that 'without ACIAR funding at the time we can assume that the giant clam numbers, especially of endangered species *T. gigas*, *T. derasa* and *H. porcellanus*, would have declined rapidly to ecological extinction'. The number of sites restocked since ACIAR project completion have been partially dependent on external donor funding to the public hatcheries and the demand by requesters for restocking sites. The MSI is still producing giant clams for restocking purposes, but the SUML has not dispatched any clams since 2009. A researcher informed us that the MSI continues to be partially run by core university funds, while another researcher indicated that the SUML hatchery is a multipurpose facility used for student research and training purposes.

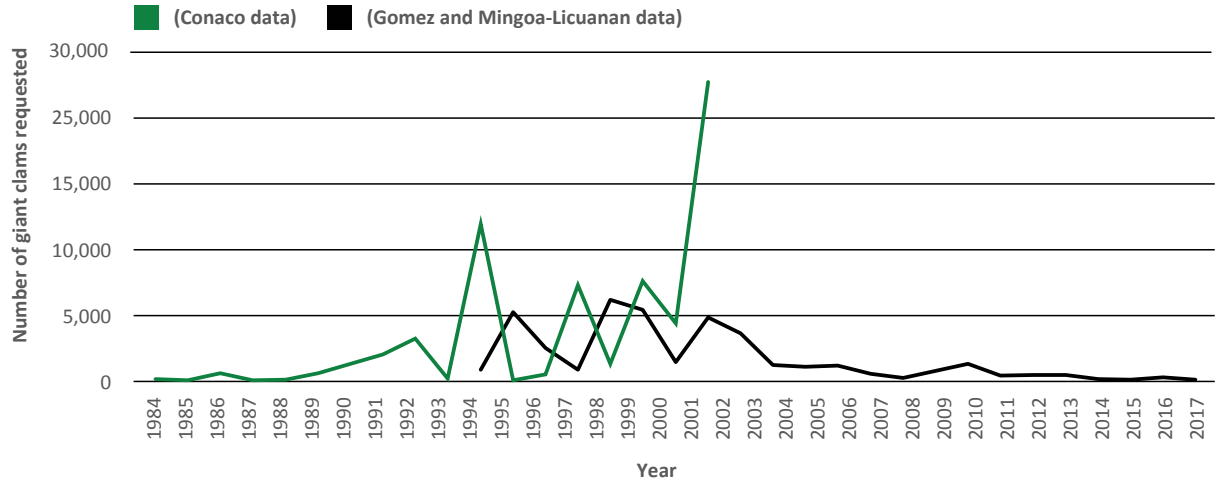
Restocking at the MSI began in 1984 (Gomez and Alcala 1988; Gomez and Mingoa-Licuanan 2006). Recipients or stewards (a person designated to monitor the giant clam ocean nursery) were advised and/or trained in monitoring survival and growth of the restocked clams. Initially, there was widespread mortality of released clams, largely due to poaching and illegal fishing (Gomez and Mingoa-Licuanan 2006). This problem was eventually overcome by teaming up with individuals and groups who protected giant clams transplanted into areas under their control. MPAs were also identified as suitable sites for restocking giant clams (Gomez and Mingoa-Licuanan 2006).

During the ACIAR period, a number of seed clams were produced, and small number of *T. gigas* derived from imported reared cohorts were used for restocking.

Since 1994, nearly 75% of the giant clams deployed from the MSI have been *T. gigas*, 85% of which have been requested by non-academic and government users. Academics and LGUs have requested at least 40% of the other giant clam species. By 2005, Gomez and Mingoa-Licuanan (2006) reported that more than 40 sites throughout the Philippines had received cultured giant clams from the MSI. We obtained two sets of data on the number of clams deployed by the MSI for restocking. Regrettably, given the large discrepancies between the datasets, we were unable to combine them to calculate the total number of giant clams deployed since the ACIAR projects began. Figure 15 shows the two datasets on the number of clams restocked in the Philippines.

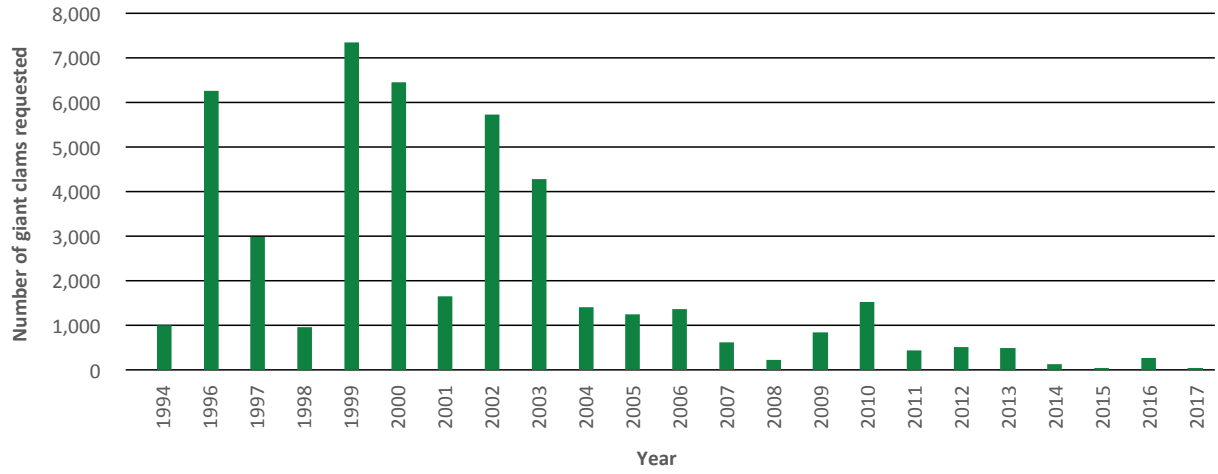
Data acquired in the field (Figure 16) show that numbers of requests for giant clams at the MSI have been small in the past 10 years, averaging seven requests per year and 500 clams on average deployed annually for restocking. A researcher noted that 'the demand for clams for restocking purposes is well below the number of clams that MSI are producing. The MSI produces about 5,000 clams that are placed in the ocean nursery each year'.

Figure 15: Number of giant clams requested from the Marine Science Institute, showing dataset differences, 1984–2017



Sources: Field data from the Marine Science Institute compiled by Cecilia Conaco, Gomez and Mingoa-Licuanan (2006)

Figure 16: Number of clams requested from the Marine Science Institute, 1994–2017



Source: Field data from Cecilia Conaco

3.5.2 Monitoring challenges

Increased production and restocking of giant clams in natural sites is likely to have reduced the risk of extinction of giant clams in the Philippines. Unfortunately, there are no national monitoring or recent stock surveys to confirm whether numbers of giant clams have changed in the Philippines since restocking activities began under the ACIAR projects. According to the Philippines Department of Environment and Natural Resources, the LGUs are now responsible for monitoring giant clam numbers in their MPA sites, but the department does not seem to have a national monitoring system to collect and aggregate these data. Monitoring activities associated with both the universities' restocking sites declined significantly in the mid-1990s when foreign funding for restocking activities also fell. Of the sites restocked by the SUML during and after the ACIAR projects, reportedly just over half the sites are now monitored, but no monitoring data were available, and none of our interviewees could directly confirm who was conducting the monitoring or what the outcomes were. The MSI does not undertake any monitoring activities of its restocking sites, despite continuing to produce about 5,000 clams a year in its offshore nursery.

3.5.3 Marine protected areas

A contextual factor that influences the conservation of giant clams in the Philippines is the strong focus on MPAs and marine ecosystems. Given that giant clams cannot be legally exported, they have had to be put to other uses. A government official noted that 'giant clams are an indicator of ecosystem health—it is generally good to have them there'. Another business representative attributed the presence of giant clams to the creation of MPAs, saying that 'we got clams from the MSI, and after a long time of working with communities, we formalised the creation of three MPAs'. The MPAs grew from approximately 50 in 1990 to more than 1,200 in 2012 (Weeks et al. 2010; Horigue et al. 2012). Despite the rapid growth, only 0.5% of Philippines protected areas are in coastal municipal waters, and between 2.7% and 3.4% are in coral reefs, which is inadequate to achieve long-term conservation objectives (Weeks et al. 2010). Despite these challenges for conservation impact of ACIAR projects, the fact that many MPAs are managed and governed by communities has led to increased awareness of conservation of marine resources (Alcala 1998; Alcala and Russ 2006). Professor Angel Alcala, a senior National Scientist of the Philippines, offered a brief vignette of his experience working with ACIAR and subsequent MPA work (see Box 3).

Box 3: Profile of Professor Angel Alcala

Professor Angel Alcala was involved in the original Australian Centre for International Agricultural Research giant clam projects as the Director of the Silliman University Marine Laboratory (SUML). Professor Alcala has developed facilities and worked with SUML staff to improve giant clam culturing techniques. The SUML team produced publications and a training program on giant clams. Much of the training was extended to local communities, with the vision that one day they would farm giant clams as a livelihood opportunity. However, socioeconomic benefits were not the only motivation behind Professor Alcala's work. A strong focus was given to establish marine protected areas (MPAs) in the Visayas region, where giant clams were introduced and protected. Establishment of MPAs has meant that local communities have participated in the governance and management of marine areas for conservation purposes.

Working on the ACIAR-funded project was Professor Alcala's final role at the SUML before he moved to the Department of Environment and Natural Resources as Secretary in the early 1990s. In this policy role, Professor Alcala was able to expand the MPA network throughout the Philippines and knowledge of marine conservation. Following this role, he became Chairman of the Philippines Commission on Higher Education. In 2014, he was named a National Scientist of the Philippines for his contributions to marine biology and conservation knowledge in the Philippines.

Although the socioeconomic objective of community engagement from the ACIAR projects was not fully achieved and long-term impacts were not sustained, the giant clams have provided stimulus for current community-related activities. Extensive work has documented the critical role that local communities play in MPA management (Horigue et al. 2012), as they are more exposed to the marine environment and can act more quickly than national-level government (Alcala 1998). Although the MPAs are not only about giant clam conservation, the restocking of clams appears to have provided a focal point for communities to engage with protection. A researcher noted that 'people love protecting biodiversity, and SUML helped set up the MPA concept, and the giant clam project helped us focus this conservation'. Another researcher noted that 'municipalities were interested in conservation, and SUML provided the giant clams to pursue reef and conservation protection'. The same researcher also

noted the contribution that ACIAR made to awareness and training, highlighting that 'community partners trained on how to spawn and take care of clams in ocean culturing'. A government official noted that 'the LGUs throughout the country continue to request giant clams from the MSI—largely for altruistic or conservation purposes'.

These narratives and the literature evidence suggest that there is ongoing context-specific interest in marine conservation stimulated by clams as an iconic and desired species. Poaching of giant clams remains an ongoing issue in the Philippines, but the establishment of MPAs and community engagement have allowed higher levels of awareness. We spoke to a leading scientist who stated that 'before the [ACIAR] project, there was no organised effort by people or universities to conserve the giant clams. Now we have four hatcheries and a lot more awareness of giant clams and marine conservation'. This reflection indicates the legacy impacts of ACIAR investments on technical knowledge and broader social awareness of giant clams.

Other conservation activities have benefited from the MSI hatchery. For example, the Semirara hatchery has a technical expert trained in giant clam culture. The Department of Environment and Natural Resources continues to be part of the international Coral Triangle Initiative, which has a broad interest in marine conservation and sees giant clams as an indicator of ecosystem wellbeing. Resorts and ecotourism operators, discussed in Section 3.6, also continue to request giant clams from the MSI.

3.6 Recreational impacts

The Philippines is known as a top-quality destination for international tourists seeking to enjoy marine areas. Given that giant clams cannot be sold in markets for seafood and aquarium purposes, a new set of users has emerged in the Philippines: people who wish to use giant clams for tourism purposes, bringing potential economic benefits from giant clam activities. Users requesting clams from the MSI include LGUs, people's organisations, international non-government organisations and private businesses.

In the Philippines, a growing number of public and private bodies have begun requesting giant clams, predominantly *T. gigas*, from the public hatcheries, and placing them into their MPAs for conservation purposes and ecotourism activities. Between 1996 and 2016, 22 resorts requested giant clams from the MSI. Snorkelling and boat tours to see giant clams have become a popular tourist activity, generating additional tour revenues and park fees for the requesters. Some tours are specifically focused on seeing the giant clams (e.g. Taklobo Tours in Davao, Pico Sands Cove Tours in Batangas); others visit a number of attractions, including the giant clams, such as in the Hundred Islands National Park (HINP). Here we present two vignettes of how a public and a private tour operation are benefiting from giant clam knowledge and resources that originated from ACIAR-funded knowledge and technologies.

To identify the costs and benefits associated with giant clam restocking activities, we selected two case study restocking sites: HINP, a government-run MPA, and Pico Sands Resort, a privately run MPA. For the case studies, we have reported the revenues generated by the boat tours. However, incorporating these figures into a benefit–cost framework is difficult. We were unable to estimate the number of people who went on the cove tour to see clams and the number who would have gone on the tour regardless of seeing clams. We also know that visitors do not come on their holiday solely to see clams, and hence cannot attribute profiles to just the clams. The benefits of the tour would therefore be classified as derived demand—the demand for a service, such as a tour, which is a consequence of the demand for something else, such as a holiday.

3.6.1 Vignette: Hundred Islands National Park

HINP is the oldest MPA in the Philippines, managed by the national government between 1940 and 2005 (Horigue et al. 2012). The change in governance after 2005 to the local government provided an adequate context to maximise the presence of giant clams in the park. During and after the ACIAR project, because of its proximity to the MSI hatchery, HINP was the recipient of more than 10,000 clams for restocking purposes (Gomez and Alcala 1988; Cabaitan and Conaco 2017), as an effort to mitigate the impacts of illegal fishing. In 2002, a further 10,000 clams were placed in the park. After 2.5 years, at least 75% of the clams remained in the park, with losses occurring predominantly among the juvenile size classes. Only 2% of subadults and 1% of brood stock were lost. Mortalities were attributed to typhoons, fouling, crowding, predation and poaching (Gomez and Mingoa-Licuanan 2006).

The change of governance in 2005 allowed development of new infrastructure and management of the park. The total number of visitors grew from 63,000 in 2005 to 450,000 in 2016[8] (Figure 17). The creation of the park has

8 Data obtained from the Alaminos City Local Government Unit

had multiple community benefits, as documented by a government official: 'There has been more income, especially for fisher men, the financing of motor boats has helped the communities, the general sales have helped market holders, and the infrastructure and snorkel hire businesses have benefited'.

Although giant clams are only one of the many attractions of HINP, they continue to be a drawcard for snorkelling and 'helmet diving' activities. A local government representative said that 'one of the first programs in 2005 was rehabilitation, and we got in touch with MSI to help us in the area. There is less communication with MSI now, as the engagement happened in the early days'. Overall, an official responsible for ecotourism noted that 'the MSI has been crucial for capacity building, training, and awareness of the giant clams'.

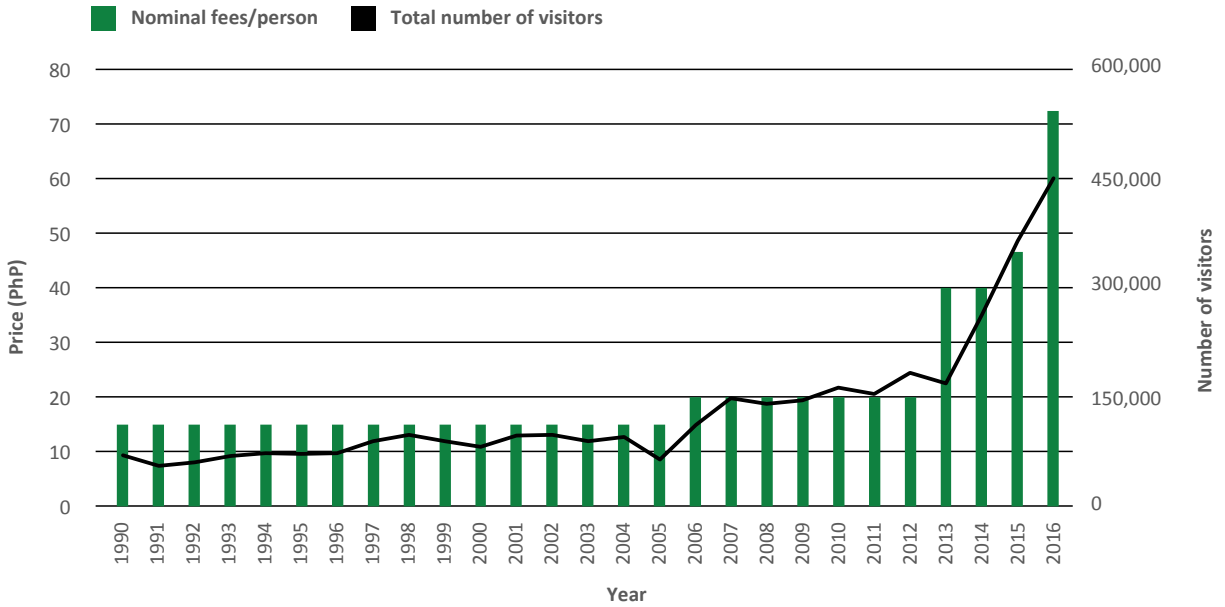
HINP brings multiple benefits to communities. Boat tours and visits to the coral garden, where the giant clams live, are a main attraction. During the past 27 years, the number of people visiting the national park has increased more than threefold, which has increased the revenues to the 900 local boat tour operators. The LGU has also increased its revenues as a result of rising visitor numbers and increased park and environmental fees. There are also benefits to the local tourism industry from the increased number of people visiting the park. However, as mentioned above, we cannot attribute all the local revenue benefits to the restocking of the giant clams, since clams are only one of the attractions of the boat tours.[9]

The interviews narrated the mutually beneficial role that both exclusive conservation zoning and ecotourism play for ecosystem stability. A government official reported that 'both ecotourism and conservation approaches are needed to improve the environment'. This was echoed by other government officials, who saw both the economic opportunities from ecotourism and the fragile ecosystems that bring the economic benefits. A similar perspective was held by a business representative from the Pico del Loro resort, which also offers activities that stem from the provision of MSI giant clams.

There was no financial cost to the government in placing the 10,000 clams in the park. The giant clams were provided as a 'donation' from the MSI, as a type of insurance scheme in case something happened to the stock at Bolinao. The only cost to the LGU in conserving the giant clams is the employment of park rangers to patrol the national park and reduce the risk of poaching of marine animals. Two to four park rangers are paid about A$5 to patrol the main islands each night.

9 As noted in Section 1.2, to estimate the benefits to visitors from seeing the clams in HINP, we would need to know what visitors are willing to pay to see exclusively the giant clams. We can assume that, because of their iconic status, the placement of giant clams in HINP is likely to have attracted visitors, but we are unable to confidently estimate the recreational value of having giant clams in the park.

Figure 17: Number of visitors and fee changes in Hundred Islands National Park



A number of interviewees claimed that the patrolling has reduced poaching by 100%, and there were no reports from the Alaminos and Bolinao LGUs of any people being caught. Calumpong et al. (2002) also suggest that community management of MPAs, where local fisherman become the guards, eliminated the threat of clam poaching. Table 16 presents the annual average revenues and costs directly related to the existence of clams at HINP. The revenues are considerably higher than the costs of protecting the clams.

3.6.2 Vignette: Pico Sands Resort

SM, the company that owns Pico Sands Resort, obtained 175 *T. gigas* from the MSI in 2007, and placed them in three coves near the resort for conservation purposes and sustainable development. The initial investment in obtaining the giant clams from the MSI was about A$17,500. According to a manager, the transport costs were negligible because the clams were 'transported by personal car in styrofoam containers'. The cost of protecting giant clams in MPAs is often the hiring of local fishermen to patrol the MPAs, particularly at night, to ensure that the clams are not poached. At Pico Sands, the caretaker is paid PhP12,000 (~A$325) per month to protect the MPAs from poachers and is a reformed dynamite fisher. The 30 clams that were placed at a nearby resort were all poached because it was believed that there was no caretaker. This view is supported by others who believe 'resolute guarding by local teams has been the key to preventing poaching in the face of strong incentives to take clams to overcome poverty, lack of food, poor fish catches, and even enhancement of private tourist developments' (Gomez and Mingoa-Licuanan 2006).

A manager at the resort indicated that the 'giant clam activities are an ecotourism partnership with WWF'. The coves were declared MPAs in 2009 after extensive negotiations with local communities. Ninety-five giant clams remain in the coves, as recent experience of intense storms and silt run—off killed non-cove based clams. One of the main tourist attractions is the daily boat tours to the privately managed MPA to snorkel with giant clams. The resort runs six 1-hour clam tours a day; according to one of the resort receptionists, this is 'one of the most popular tours'. The resort ran 561 cove boat trips in 2015 and 628 in 2016. The average number of people per boat is five, and we have assumed that they all hired snorkelling gear and life jackets. Although we could not obtain all the costs from the boat tours, the figures show that revenues generated from boat tours are high and profits to the resort are likely to be considerable, given the low cost in monitoring. Table 17 lists the annual revenues and costs associated with giant clams at Pico Sands.

Table 16: Annual revenues and costs associated with giant clams at Hundred Islands National Park

Revenue	Price/person (A$)	Quantity	Total (A$)
Average boat revenue	5.50	176,000	968,000
Average park fee revenue	1	176,000	176,000
Total revenue	**na**	**na**	**1,144,000**
Annual cost of caretakers	2,000	2	4,000

na = not applicable
Source: Based on local government unit field data

Table 17: Annual revenues and costs associated with giant clams at Pico Sands

Revenues	Price (AUD)	Quantity	Total (A$)
Average resort boat trips/year	165	595	98,175
Snorkelling gear hire	15	2,975	44,625
Total revenue	***180***	***3,570***	***142,800***
Wages to caretaker of MPA	3,900	1	4,000
Wages to boat operators	5,460	3	16,380
Total costs	***9,460***	***4***	***20,380***
Net revenues			**122,420**

Source: Pico Sands Resort, personal communication, 2017.

3.7 Summary of impact for the Philippines

The Philippines component of projects FIS/1982/032 and FIS/1987/033 had a number of intended long-term impacts, as well as unintended positive impacts. The projects also faced challenges in achieving long-term impacts in the socioeconomic and restocking components. Here we summarise the capacity, economic, environmental, social and scientific impacts of FIS/1982/032 and FIS/1987/033 in the Philippines.

The capacity and social impacts of the projects were high. The narratives and evidence provided throughout this chapter show that ACIAR investments stimulated changes in the knowledge system in the Philippines, and work on giant clams and marine science continues to this day. Before ACIAR investments, the MSI was starting, and the projects supported the initial giant clam projects and infrastructure for the centre. The ongoing ability to produce high-quality research in giant clams and other marine commodities, and the increasing number of students graduating from ACIAR partners show ongoing use of skills and knowledge. To date, policy impacts have been low. We contend that this is due to a general lack of incentives for scientists to participate in lobbying or change the existing policies on giant clam exports. The lack of clear boundary organisations that facilitate knowledge exchanges between policy, research, business and communities has prevented the knowledge system from adapting to new needs and potential markets for giant clams. Significantly higher awareness of giant clam conservation has occurred in the Philippines, with private corporations now using giant clams for corporate social responsibility and tourism activities.

The economic impacts could not be quantified, given the lack of a legal market and inconsistent production data. A major driver in neutral economic impacts has been the ongoing policy banning export of giant clams, both wild and hatchery produced. This has prevented communities from developing the skills to grow out giant clam seed in coastal villages. It has also disincentivised the scientific community from extending knowledge and technologies to communities. However, the unintended impact on the tourism industry has brought economic benefits to selected communities, businesses and the hatcheries. LGUs continue to request giant clams for restocking, and this brings financial returns to the MSI. The tourism industry discussed in this chapter shows that there has been increased use of giant clams for snorkelling and scuba-diving tours in different parts of the country.

The environmental impacts were discussed by some interviewees as being high, largely attributed to the perceived increased number of giant clams, especially *T. gigas*, in the country. This is also reported in the literature (Gomez and Mingoa-Licuanan 2006; Cabaitan and Conaco 2017; Neo et al. 2017). Despite these reports, our team found that the historical data on restocked giant clams were inconsistent among researchers, making an adequate assessment of environmental contributions difficult. For example, although many people spoke about restocking activities, it was evident that monitoring did not occur, largely for financial reasons. Stock levels are conditional on patrolling and community enforcement, and this varies widely throughout the country. Despite this lack of consistent monitoring, in general, the Philippines is perceived to have improved giant clam populations, and the giant clam activities hold an iconic place in the recent history of marine conservation and research in the country.

For the scientific impacts, the MSI continues to be a leader in marine research, and the SUML works with communities to guide the management of MPAs in the Philippines. This ongoing flow of scientific knowledge remains highly credible and salient to the Philippines, and attracts sources of funding and new students pursuing marine conservation activities. The publication metrics show that Philippines giant clam publications are cited in the literature, and there has been a consistent publication output from the MSI. Before ACIAR's investments, no research had been done on giant clams. ACIAR supported national surveys on the status of giant clam species; scientific publications on giant clam culture, including growth rates; and the establishment of collaborative research activities with other institutions and individuals. This contributed to the clear community of practice of giant clams in the Philippines, which continues to actively train and develop awareness of giant clam conservation.

Overall, the Philippines has continued to use giant clam knowledge and technologies that originated as part of the ACIAR projects. This sustained use of giant clam knowledge has allowed requesters of giant clams to develop high awareness of giant clam biology and conservation, with the aim of delivering high-quality activities to end users not factored into the original ACIAR project: tourists.

4. Solomon Islands case study

This chapter presents findings from document review and interviews with key informants involved in, or familiar with, the Solomon Islands project FIS/1995/042. This project had a modest investment of A$93,763, and focused on giant clam grow-out trials across different villages. Australian Centre for International Agricultural Research (ACIAR) funds targeted 26 farmers across 14 villages for 2 years. The project funds were used by the International Center for Living Aquatic Resources Management (ICLARM) to pay staff and acquire equipment to facilitate the grow-out experiments. This project coincided with the 1994–97 ICLARM (now WorldFish) project that also focused on grow-out trials, funded by ICLARM core funds[10] and the European Union's STABEX program (approximately A$54,000). The Food and Agriculture Organization of the United Nations (FAO) and the Secretariat of the Pacific Community also had active funds supporting giant clam activities at the same time.

4.1 Country context

Solomon Islands offered potential for giant clam research for a number of reasons. Poaching and overharvesting of clams were prevalent in the country at the time of the ACIAR studies. Govan (1988, cited in Govan et al. 1988) notes that, in 1987, a visit to the Marovo Lagoon where trial clam fishing took place showed that stocks were largely depleted. Between 1982 and 1987, four Taiwanese fishing boats were caught illegally fishing and storing giant clams in remote reefs off Solomon Islands. The larger boats were carrying more than 1 tonne of clam adductor muscle, which was estimated to come from 10,000 clams largely from Solomon Islands (Govan et al. 1988). Although no formal ecological surveys exist, verbal accounts indicate that giant clam populations were rapidly declining in Solomon Islands (Govan 1993; Richards et al. 1994). The Solomon Islands Government also had explicit interest in 1986 to develop an aquaculture centre as a strategy for livelihood improvement and conservation (Govan et al. 1988).

A focus on conservation issues and rearing techniques for giant clams in the early 1990s provided the context to pursue new research. Tisdell's (1991, 1992, 1993) economic research revealed that, although there was a potential meat market, the long grow-out period of 7 years made giant clams unviable for villages in the Pacific region. However, the aquarium market, which consistently demands clams that are approximately 1 year old at relatively high prices, provided a potential livelihood diversification (Bell et al. 1997).

ICLARM established a Coastal Aquaculture Centre in 1986 in Solomon Islands, which led to the initial work in hatchery rearing techniques and village grow-out trials. These trials were conducted by Govan et al. (1988), Govan (1993) and Bell et al. (1997b). This initial ICLARM work, partially funded by the International Centre for Ocean Development (Bell et al. 1997b), concluded in 1992. In 1995, Gervis (cited in Bell et al. 1995) and Naegel (1995) developed a model for maximising productivity from village farms. The model relied on ICLARM as the centralised hatchery to sell seed to farmers, small-scale village farmers to grow the seed to market size, a distributor who would purchase seeds and sell to the exporter, and an exporter to supply the international market.

In Solomon Islands, the supply chain was organised as follows:

- Component A—ICLARM Coastal Aquaculture Centre as the centralised hatchery, selling seeds at SBD$1 per seed to farmers
- Component B—25–30 small farmers to rear clams to market size
- Component C—ICLARM as the distributors
- Component D—Aquarium Arts (based in Honiara) as the international exporter.

10 Approximately A$750,000 per year to run the centre. Sourced from <www.fao.org/docs/eims/upload/206309/3_1_cases.PDF>

In 1995, ACIAR maximised the existing knowledge of giant clam conservation and rearing, and the established hatchery, to investigate the economic potential identified by Tisdell (1991, 1992, 1993). ACIAR provided approximately A$94,000 in project FIS/1995/042, with the majority going to ICLARM in Solomon Islands. The scientific outputs from the project demonstrated that two giant clam species—*T. ridacna gigas* and *T. squamosa*—could be grown profitably for the aquarium trade (Bell et al. 1997b; Foyle et al. 1997). Other outputs were training of village farmers in Solomon Islands on clam rearing, bookkeeping, basic infrastructure maintenance, and clam ecology and behaviour (Bell et al. 1995; Hart and Bell 1997).

The farming system used in project FIS/1995/042 involved rearing the giant clams in raised sea cages until they were large enough to withstand environmental stress and predation. The major costs of production were clam seed, labour and time (Cacho and Hean 2002). Cacho and Hean (2002) state that the project trials sought to identify the best environmental conditions and techniques to farm giant clams at the village level. By the late 1990s, ICLARM was providing seed clams to up to 50 villages in Solomon Islands. The farmers produced clams for the aquarium and seafood markets. ACIAR's project objectives were met by project completion in 1997 through identifying optimal species for the aquarium trade and preparing manuscripts for scientific publication (Hart and Bell 1997; Kearney and Hundloe 1998). The aspirations for long-term socioeconomic benefits from the grow-out trials were effectively ended by the political instability in the country. Without any funds for subsidising the hatchery, and the limited number of producers, the giant clam industry rapidly ended in Solomon Islands.

This chapter captures some of the high-level scientific and knowledge impacts of project FIS/1995/042, and the challenges of sustaining a viable giant clam industry for the country.

4.2 Impact pathway

The review by Kearney and Hundloe (1998) analyses the extent to which project outputs from FIS/1995/042 were delivered by the research team, and the adoption of technologies. This review took place before the political unrest in the country and captured initial impact as the project was concluding. The review team indicated that both objectives were achieved. The first objective, focused on collecting data from grow-out trials, was fully achieved; the review noted that there was 'impressive information on the relative growth rates of the three most important species'. The second objective, focused on preparing manuscripts for publication, was also achieved. At the time of the review in 1998, six journal articles and conference papers had been finalised. The review indicated that adequate linkages with other researchers in the aquaculture industry were maintained, scientific rigour was high, and training and dissemination of knowledge to end users were actively carried out. The environmental potential of the findings was stated as being strong, as adequate management of clam farms could lead to re-establishment of clam populations. The impact pathway map is presented in Figure 18.

Outputs

Technology outputs included the provision of cages of 200 seed clams to 26 farmers in 14 villages. Knowledge outputs were high during the project: manuals and training offered to farmers on giant clam culture and growth, including survival rates and environmental variables affecting giant clam growth, were all documented. At the time of project completion, six publications had been published or submitted.

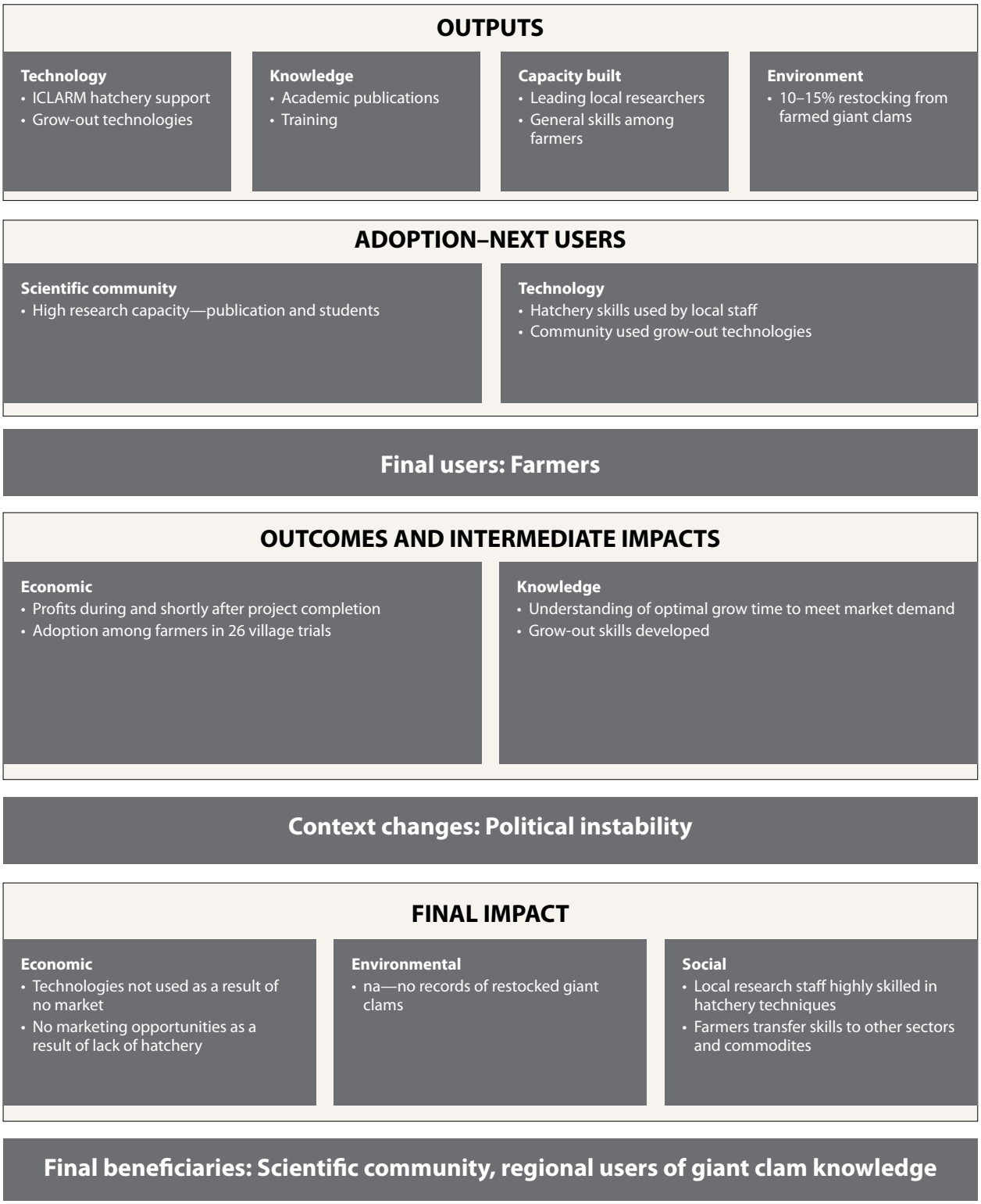
Next users

The immediate next users were two main groups: the scientific community, and the local technicians and farmers. The scientific community, made up of a mix of local and international staff, immediately used the hatchery and grow-out techniques to continue research in mariculture. Rearing technologies are transferable to other marine commodities, such as sea cucumbers and corals. The skills learned during the giant clam projects continue to be used in other countries and with other commodities. The local laboratory technicians also used these skills to work on subsequent projects funded by non-Australian donors. The 26 farmers throughout the country used the technologies and skills provided for the duration of the project. Sustained adoption of these technologies, however, was hampered by political unrest and the small size of the giant clam market. This is explored qualitatively in Section 4.3.

Outcomes

Giant clams were sold to international aquarium markets, and farmers had the potential of making A$1,467 per year profit from giant clam production. This additional income was substantial, given the relatively low cost of producing giant clams (1 day's work and clam seed). The skills learned, such as bookkeeping, shipping produce and linking with distributors, were transferable to subsequent projects

Figure 18: Impact pathway for project FIS/1995/042 in Solomon Islands



ICLARM = International Center for Living Aquatic Resources Management; na = not applicable

■

on sea cucumbers. Active links were developed between village communities and government organisations; however, these did not lead to subsidies or support services from government to maintain the hatchery operations in the long term.

Long-term impacts

The sustained impacts have been on the knowledge generated, and the capacity and skills of key individuals in Solomon Islands. The ability of the 26 farmers involved in grow-out trials to maintain their production came to a halt when hatchery operations ceased in the early 2000s. Although some giant clam activities continued out of Nusatupe in the Western Province, there was no active buyer. The impact on sustained knowledge for a core group of local communities and project leaders was high—the skills were transferred to other projects, and some used the knowledge to work internationally. A subsequent New Zealand Aid project in 2005 allowed some farmers to reconnect with giant clam production, and one of the farmers was able to secure funds from the FAO to set up a village-based hatchery.

There is no evidence of negative or positive environmental impacts. It is unclear whether the 10% restocking from giant clam grow-outs occurred, and, if it did, what the survival rates were.

Economic impacts are non-existent, given the lack of an active giant clam market in the country.

4.3 Knowledge and capacity impacts

The Solomon Islands researchers and farmers had been exposed to giant clam knowledge before investments from project FIS/1995/042. A private consultant in Solomon Islands indicated that 'much of the work started in 1991, which focused on giant clam participatory research in Guadalcanal'. Govan's (1993) work was conducted in collaboration with the ICLARM coastal aquaculture centre established in 1986. Much of this early work is also documented by Hart and Bell (1997). When project FIS/1995/042 started, farmers needed 'skills and knowledge to successfully grow clams so they could sell them'. Immediately after project completion, the project review found that farmers learned useful skills, such as keeping accounts and inventories, shipping produce to distributors, and skills that were transferable to other aquaculture commodities (Hart and Bell 1997).

Researchers noted the coherent knowledge flows within ACIAR itself, and pointed towards institutional learning: 'The work of John Munro set up the backbone of the giant clam research in the Solomon Islands. The ecological realisation that giant clams were self-feeding and required little farmer cost made them an attractive development investment. The economic evaluation of the giant clam work poured cold water over the idea that clams were a good investment'. The learning from all previous ACIAR projects allowed the team for project FIS/1995/042 to design a targeted project that built on the scientific and economic learnings of previous projects.

This knowledge was used by the research team to focus efforts on growing clams to optimal size in the shortest possible time. These experiments, conducted in the Aruligo hatchery 25 kilometres from Honiara and village farms throughout the country (Objective 1), provided much of the scientific knowledge that led to the scientific publications from the project (Objective 2; for example, see Bell et al. 1995, 1997a, b; Hart et al. 1998, 1999). Interviewees reflected that, although the objectives were achieved, the outputs were very targeted and scientific, without larger development outcomes immediately clear. These views were consistent with the final project report, which notes that, even though farmers had income at the time, there was still potential for new markets, and there was ongoing international competition (Hart and Bell 1997).

4.3.1 Knowledge salience

At the time of investment, it was clear that there was still a perceived opportunity to develop the giant clam market, despite the critical analysis provided by Tisdell (1991). The project proposed to generate knowledge that was salient at the time. Farmers needed ways of growing giant clams quickly and in a cost-effective manner. The aquarium market demanded a relatively low but consistent amount of giant clams, offering economic opportunities for farmers. Furthermore, the 1985 listing of clams under the Convention on International Trade in Endangered Species of Wild Fauna and Flora indicated that export of clams would need to come from hatchery-sourced juveniles to reduce impact on wild stocks.

Reflecting on the focus given to giant clams by ACIAR, a key informant noted that 'rural people have shown a lot of interest in aquaculture, but the reality is that the small-scale nature of markets may only contribute a small income. For some coastal people agriculture may be a more profitable option'. A local Western Province

resident indicated that 'the clams help was very good for the community. They received them, they grew them, sold them. This helped the village around the area. The poor villages depend on the sea, so the production of clams was beneficial. Caring for the clams was very important for people—they were attached to the animal'.

The salience of research at the time was twofold. The first was the scientific gap in identifying the optimal conditions for growing clams quickly for the aquarium market. This is documented throughout the scientific publications from the Solomon Islands project (Bell et al. 1995, 1997a, b). The second relates to the non-market value of clams to local coastal communities. The interview showed that communities valued the additional income opportunities offered from giant clam farming. The marginalised nature of coastal communities made giant clam activities salient for them as a possible way of increasing incomes.

Local communities are aware of the ecological conditions required to preserve giant clams. The strong cultural association Solomon Islanders place on clam gardens (Hviding 1993) and the interest in locally managed protected areas indicate that the knowledge produced by ICLARM remains present in the Western Province region. The story of how heavy rains affected clam populations in a community-managed marine protected area illustrates these links between traditional values and scientific knowledge:

> *After the 2007 tsunami, the community came together to manage the area with conservation in mind, because we shared ideals on the value of conservation. We manage 38.6 hectares, 6 of which are sometimes accessible for fishing. We choose to manage our own area because we believe in balancing economics and conservation. The community is very keen on conserving the clams, especially as we cannot sell it. However the 2014 heavy rains of 3 months killed all of our clam populations. We know that fresh water kills them—and the mix of our fresh river flow and rain killed the clams.*

A clear, long-lasting impact on capacity has been the knowledge and legacy held by local expert Cletus Oengpepa, who continues to be a regional leader and source of knowledge for giant clam work in the Indo-Pacific region (Box 4). Cletus was instrumental in project FIS/1995/042, and his drive and passion to continue giant clam research and conservation efforts are an example of the long-lasting impacts of ACIAR investments on individuals.

Box 4: Profile of Cletus Oengpepa

When we spoke to regional experts about Solomon Islands, one name kept coming up: Cletus Oengpepa. Cletus was a local research champion during and after Australian Centre for International Agricultural Research (ACIAR) projects. Cletus held multiple roles as a local leader in mariculture, including as research station manager at the Nusatupe WorldFish station. Cletus has provided mentoring and skill development for farmers and WorldFish staff for more than two decades, and continues to advise regional developments on giant clam and other marine conservation and production efforts. Cletus played a critical role in the late 1990s when the Honiara hatchery was taken over by rebels, and facilitated the transfer of broodstock to the Western Province. Cletus pursued a Masters in Aquaculture through Deakin University with the support of ACIAR. He continues to be fondly remembered by researchers and ACIAR staff as a caring, committed and intellectually driven individual who has devoted his life to supporting marine conservation, research and market development for Solomon Islands.

4.3.2 Knowledge credibility and legitimacy

Project FIS/1995/042 produced a number of quality publications in a short time, which continue to be cited. Figures 19–21 track publications from FIS/1995/042. They indicate the different types, quantity and citation counts of giant clam publications produced since 1982 from ACIAR projects included in this report.

Although the knowledge was credible, its uptake in different sectors was challenging. This comes down to low mediation, translation and communication of knowledge—the technical expertise existed, but there was no coherent or comprehensive way for it to adequately transfer into government sectors. For example, one key informant noted, 'In the past there has been a mismatch between the speed of research outputs and the uptake of policy—different priorities have sometimes meant there has been a disconnect between agencies'. A key informant from a farmers group emphasised how the high-quality knowledge benefited farmers: 'Farmers are capable and skilled people—especially those involved in projects. They used their skills from ACIAR to work in the New Zealand and EU subsequent projects'.

Figure 19: Type of giant clam publications produced during project FIS/1995/042

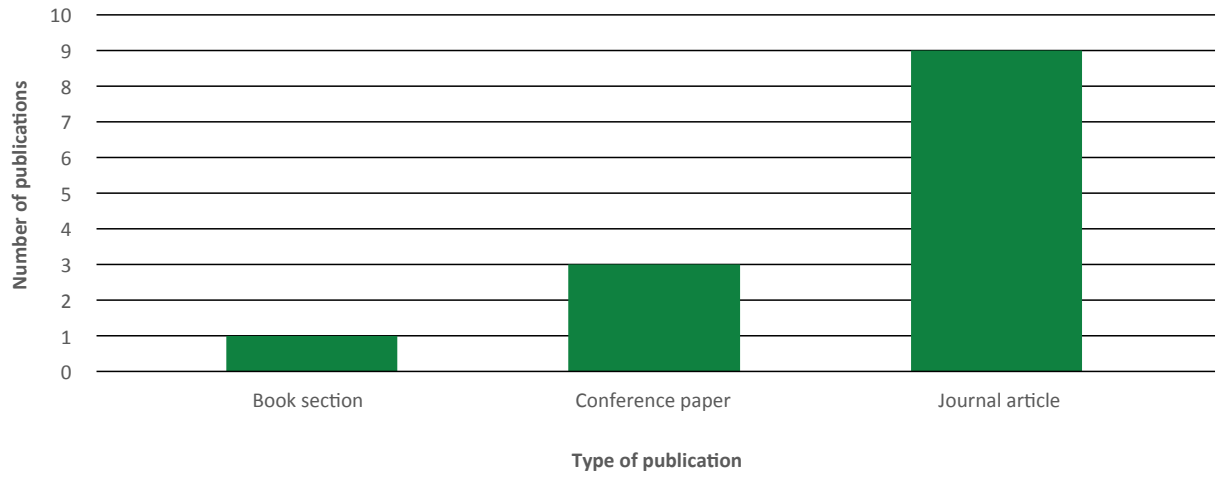


Figure 20: Number of giant clam publications from project FIS/1995/042, 1994–2002

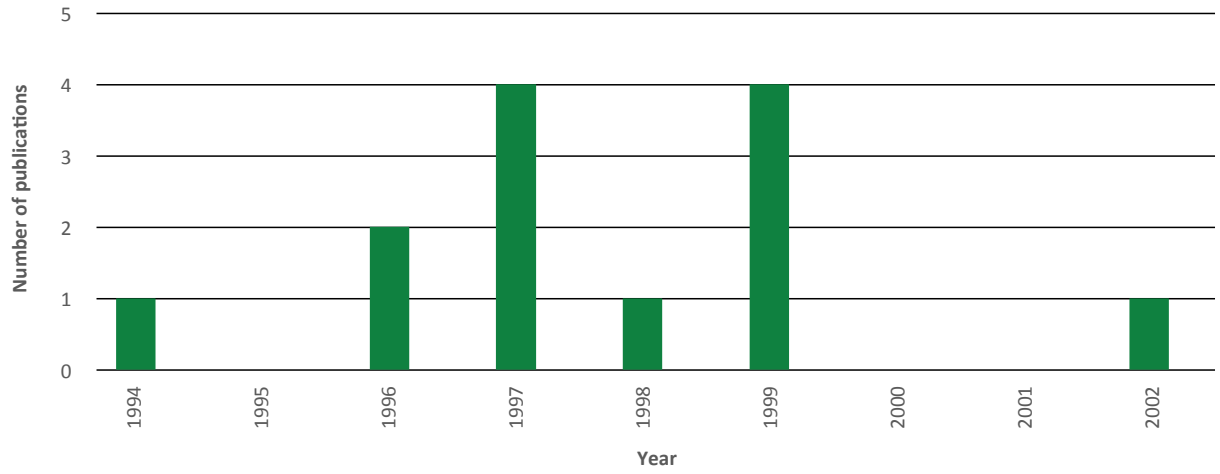
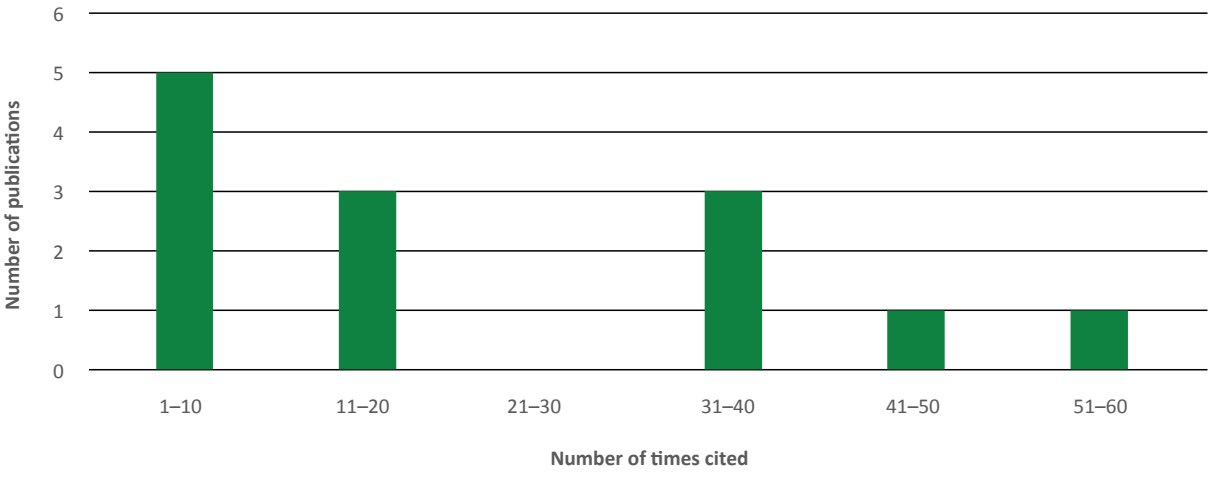


Figure 21: Number of citations for publications from project FIS/1995/042



Knowledge legitimacy relates to the extent to which projects adequately included different stakeholders' needs and insights into the knowledge creation process. Documentation by Hviding (1993, 1998) indicates that giant clams play a strong cultural role in Solomon Islands. The extent to which this knowledge formed part of the project design and conduct is unclear, indicating that knowledge legitimacy was low.

These ideas align with findings from a recent CGIAR project on research for development in Solomon Islands, which noted the critical changes that have taken place that can enhance legitimacy of knowledge. A key informant noted that 'an important lesson is that research needs to be embedded in the development processes if it is to have a meaningful impact'.

These insights indicate that, at the time of investments, giant clam work was very much focused on producing high-quality salient and credible research outputs, but did not fully integrate this science into the development context of the country. Communities were beneficiaries during the project, but were not active participants in generating knowledge and sustaining the long-term knowledge generated by the project. This is no one's fault per se; rather it was the nature of scientific research at the time. Local partners and researchers were actively involved in the project and transferred knowledge to communities.

The changing role of research in and for developmental outcomes is now more widely acknowledged (Douthwaite et al. 2017), and future giant clam technical research would need to align with this new paradigm. The critical insights provided by van der Ploeg et al. (2016) show that the changing nature of research for development requires much more meaningful integration of different knowledge types into research design and conduct.

4.3.3 Knowledge exchanges

The knowledge system in the 2000s was largely linear and based on the giant clam value chain. Farmers received technical training from ICLARM extension officers. These extension officers obtained their knowledge from ICLARM project leaders. Farmers would then provide the commodity at a set price to ICLARM, which would sell it to the international market via the exporting business Aquarium Arts, based in Honiara.

A government official noted that knowledge exchange between non-government organisations, government and researchers is positive, but dependent on funding: 'There used to be a very strong network for all the NGOs called the Solomon Islands Local Management Network. But the coordinator left due to lack of funds, so it is not ongoing anymore. The network was good—there was learning exchange, data sharing, lots of activities. It was also a chance of link with other country agencies. Learning exchange is a major benefit'. Another stakeholder noted, 'We do the best with the knowledge we have at the time. Now I would use all the knowledge we have about the clams and use it to educate people in how to best manage their natural resources. All the knowledge from the time now feeds into curriculum development, advice on community-based natural resource management. That is no small thing'.

4.4 Context: sociopolitical changes

Project FIS/1995/042 had a strong focus on supporting the hatchery operations in Honiara. Funds were used to maintain and staff the facility. The centre provided the juvenile clams for farmers to grow out in the village trials, and the clams would then come back to the centre for selling in the international aquarium market. The hatchery is the backbone of the giant clam industry for legal international exports. Throughout the duration of the project, the hatchery operated on fuel to pump sea water into the tanks for up to 3 months. This expensive operation was possible as long as ACIAR funding was available. Some participants noted that the idea was for the Solomon Islands Government to take up the hatchery after ACIAR funds expired.

The political unrest in Solomon Islands in the early 2000s put an abrupt end to hatchery operations, and this had implications for a sustained source of seed for farmers. This unpredicted event saw the dismantling of the hatchery and, in essence, the end of the giant clam industry in the country. As one participant noted, 'The hatchery was attacked by the rebels. It was impossible to protect the facility. Everything got moved to the Western Province to continue the project'. Another participant narrated, 'There were 10,000 clams in the Honiara site. When the political unrest hit, 50% of them were taken by the team on a fast boat and we moved them to a resort and released them into the wild. The other 50% remained in the hatchery and the rebels ate them. We hired two 40-foot containers to store the clams in a secure facility and collected as many materials as possible during the tensions'.

Hatchery production was re-established in Nusatupe, in the Western Province. The challenging institutional instability in the country over the tensions meant that mariculture and aquaculture were not a priority for

development agencies. In 2005, New Zealand funded a similar project with ICLARM to provide some livelihood opportunities to farmers after the tensions. The equipment and staff from the Nusatupe site were involved in the New Zealand project. At present, the Nusatupe site remains idle. The cost of pumping water makes it prohibitive for ICLARM and local government agencies. The lack of an operational hatchery has made giant clam farming in Solomon Islands impossible. Despite these technical and financial limitations, skills, interest and valuing of giant clams remain lively in the country. Participant observation during the trip at the Nusatupe WorldFish station also highlighted the commitment and interest of extension officers to work with farmers on ways of managing marine resources and improving their livelihoods.

4.5 Summary of impact for Solomon Islands

The funds provided to Solomon Islands for giant clam grow-out research were relatively small; however, some positive social, capacity and knowledge impacts were achieved. Economic impacts were not sustained. The social and capacity impacts were small; this is not surprising, given the small nature of the investments. Only 26 farmers were involved in the grow-out stages, with varying levels of interest. The most successful ones were able to transfer skills to other sectors, such as sea cucumber farming or bookkeeping jobs, after the clam industry closed in the country. The local staff involved in the project developed advanced research and giant clam rearing skills, which they continued to use for a range of other employment opportunities after the project. Environmental impacts were not achieved, as there is no clear evidence of the extent to which farmers restocked reefs with 5–10% of the clams they produced. Restocking activities were never the core objectives of the project.

The relatively small amount of funds provided by ACIAR to Solomon Islands for giant clam research delivered immediate high-quality knowledge and economic impacts. The scientific publications produced during the project provided rigorous evidence on how giant clams can be grown in villages and sold to international markets. These methods remain highly salient for countries that actively farm giant clams. The techniques developed and data recorded on survival rates and environmental conditions that enable giant clam production continue to be of relevance to users throughout the Indo-Pacific region.

The local context, however, meant that sustained adoption of knowledge and technologies did not occur. The policy and political changes in the early 2000s made the continuation of giant clam production unviable throughout the country. Furthermore, the income generated from giant clams was always going to be additional income for farmers, rather than a sole provider of livelihoods. With the closing of hatcheries, farmers in the country have been unable to source adequate clam seeds so that they can use the cages and materials provided during the project. Some farmers have been able to transfer the skills to other commodities, such as sea cucumbers and oyster pearls, or to other sectors, such as banking.

5. Overall impact of giant clam investments

In this chapter, we synthesise the data and discussion points presented in Chapters 2–4 to provide an overall assessment of the impact of giant clam activities. The giant clam projects provided an appropriate case study to document how Australian Centre for International Agricultural Research (ACIAR) investments can have unintended and non-economic benefits when the context of the research changes. We presented a range of data from databases, grey and peer-reviewed literature, and field and phone-based interviews. This chapter first provides a summary of how the data contribute to impact assessment objectives, and then provides a summary of the data analysed in line with the knowledge systems and RAPID (research and policy in development) framework.

5.1 Increased awareness of giant clam rearing, market opportunities and conservation

Before ACIAR's investment, the only other major giant clam research project was in Palau. The declining giant clam populations throughout the Indo-Pacific region provided the stimulus to develop more detailed understanding of the biology, growing technologies, markets and restocking activities in the region. ACIAR made a significant contribution to expanding scientific knowledge of giant clams during the 1980s and early 1990s. Chapter 2 documents how regional experts perceive the credibility and salience of ACIAR-supported knowledge, with multiple interviewees discussing the important role that technical articles and manuals played in giant clam knowledge. In the Philippines and Solomon Islands, despite the different impacts of the projects, giant clams have been labelled 'iconic', and both projects have contributed to a cultural legacy in these countries. In the Philippines, participants reported that awareness of giant clam conservation increased as the Marine Science Institute (MSI) and the Silliman University Marine Laboratory produced publications and engaged communities. This is verified by a mix of training, growth in university departments, publications, and engagement with private and community groups, indicating that people in the Philippines have become more aware of the value of protecting giant clams. This protection has come largely though the creation of locally managed marine protected areas and ecotourism activities throughout the country.

The market opportunities were not sustained after project completion. This impact assessment found that projects FIS/1982/032 and FIS/1987/033 were largely conservation and science oriented, confirming the review findings from Hammond et al. (1992). The research team did not manage to extend the knowledge to local communities, the intended end users of the knowledge and technologies. It is difficult to determine the potential economic impact to communities if technologies had been adopted, given that the policy context of the Philippines continues to ban giant clams. The economic knowledge produced during project EFS/1988/023 provided an adequate platform for the next grow-out project in Solomon Islands (FIS/1995/042). Understanding of the potential demand in the seafood and aquarium markets informed the design of the study, which focused on developing techniques for farmers to grow giant clams in villages. These technologies were adopted in the short term, but sustained impact did not occur (see Section 5.2).

5.2 Long-term conservation initiatives, economic opportunities, and increased capacity in partner countries

Sustained uptake of the village-based grow-out trials did not occur in Solomon Islands, hindering long-term economic opportunities. The project team delivered a series of training activities and materials for farmers across 14 villages to grow giant clams for the aquarium market. However, the escalation of political tensions in the country saw the abrupt closure of the Honiara hatchery, making seed inaccessible to farmers. Without

seed, farmers were unable to continue the production of giant clams. Coupled with displacement, insecurity and lack of buyers at the time, the giant clam industry stopped for approximately 5 years in the country. Although it was revived in 2005 through a New Zealand Aid project, at present there are no giant clam activities in Solomon Islands. For the Philippines, economic opportunities came in the form of the unintended development of a tourism industry. Private resorts and local government units continue to request small numbers of clams from the MSI, creating economic opportunities for multiple groups. Giant clam–based tourism activities have also been documented in other parts of the Indo-Pacific region (Moorhead, unpublished data).

Despite the lack of long-term economic benefits in Solomon Islands, capacity and skills developed in local staff were high. Capturing the benefits of capacity built are complex—economic return frameworks fail to capture the wide benefits that investments bring to individuals and institutions (Mullen et al. 2016). The narratives collected in the field for this impact assessment show how local staff continue to use the technical skills in other marine commodities, such as sea cucumbers and corals. Staff also continue to engage with relevant government ministries and other giant clam–related consulting projects throughout the region. In the Philippines, research capacity continues to be very high—for example, demonstrated through the high research output of the MSI.

It is difficult to determine the contribution of restocking of giant clam populations in the region. The lack of data and documented monitoring activities in the Philippines made a detailed environmental assessment difficult. Despite the lack of data, anecdotal and academic publications indicate an overall increase in numbers of giant clams, especially *Tridacna gigas*, in the Philippines. Given the near-extinct status of the species before ACIAR projects, the sustained populations of this species demonstrate an impressive conservation achievement by Philippines staff, and ACIAR projects played a role in this achievement.

5.3 Levels of impact based on developmental contexts in which investments took place

The knowledge systems and RAPID framework developed by ACIAR document how different country contexts will influence the extent to which research and knowledge produced can have long-term social, environmental and economic impacts (Davila et al. 2016). In the Philippines, the policy context meant that livelihood opportunities could not be directly developed from ACIAR-supported knowledge and technologies. The high capacity and knowledge in the country, however, meant that research bodies continued to acquire funding for giant clam research and conservation efforts. As ecotourism demand developed in the country, the potential of giant clams as a possible tourist attraction in marine areas emerged. At present, there is a relatively low but consistent demand for young giant clams from ACIAR-funded hatcheries to support marine areas and tourism opportunities.

In Solomon Islands, the political context played a major role in the sustained uptake of technologies and knowledge. Without stable policies and institutions during the political tensions, there were no opportunities for the hatcheries to continue their operations. This prevented the small number of trained farmers from obtaining seed for ongoing production, hence halting all giant clam production in the country. Since the tensions stabilised, there has been no uptake of giant clam activities, suggesting that the economic opportunity was not sufficient for local communities to demand the revitalisation of the industry. The skills of key individuals continue to be used in other commodities, and some farmers have used skills to acquire employment in non-mariculture sectors.

5.4 Overall impact

The aim of the impact assessment was to determine the extent to which giant clam research and restocking investments contributed to long-term knowledge exchange, conservation efforts and economic opportunities for partner countries. The reality of the giant clam market contexts meant that measuring return on investments was an unrealistic way of capturing the much wider impacts of ACIAR investments on giant clam knowledge and partner capacity. For this impact assessment, we drew from Davis et al. (2008) to document the impact pathways, and the intended and unintended outcomes. The lack of available markets for giant clams in both the Philippines and Solomon Islands allowed the impact assessment to focus on the qualitative knowledge flows, capacity built, networks and policy impacts that ACIAR projects can have. To do this, the analysis centred on knowledge systems and research–policy linkages (Davila et al. 2016). This framework guided the analysis of qualitative data to document the wider sustained impacts of knowledge and capacity in partner countries. We present in Table 18 the summary of relevant themes under the ACIAR frameworks used and the impact assessment objectives.

From a traditional economic assessment framework, it is likely that there have been zero or negative economic returns on ACIAR investments. The lack of a growing market, and the policy and political contexts of partner countries have prevented a stable supply of giant clams. This, however, does not mean that the projects did not have wider sustained impacts, including adoption of knowledge. The narratives provided across three chapters in this report show the highly salient and credible knowledge that ACIAR produced during the time of investments, and how ACIAR supported the development of key institutions and individuals in partner countries. The knowledge generated throughout the investments continues to be used, and remains a foundational base for giant clam biology and mariculture.

Overall, the impact of the projects on knowledge and capacity in mariculture techniques and giant clam biology was a major contribution. As the first major fisheries investments for ACIAR, the giant clam projects have a legacy in the Indo-Pacific region, and the technical knowledge is well known. The changing market context of the commodity has meant that sustained adoption of technology and marketing has not occurred. However, the quality of the science and the capacity built are now able to respond and adapt to new conservation objectives, marine-based research or commodities that might emerge. For example, as research and market interest have grown into sea cucumbers and pearl oysters, those skilled in giant clam mariculture can transfer techniques and experience, and diversify their opportunities. As ecotourism continues to grow in some countries, especially as giant clams become part of the activities, there continues to be a place for the credible and salient information that ACIAR produced over a period of 25 years.

Table 18: Giant clam impact assessment summary analysed under ACIAR guidelines, and knowledge systems and RAPID framework

Objective/framework themes	**Knowledge systems and RAPID**			**Guidelines for impact assessment**
	Evolving, dynamic systems; quality and characteristics of evidence	**Relationships and linkages, communication**	**Political context, external drivers**	**Inputs; outputs; end and final users; impacts on social, environmental and economic factors**
Assess the extent to which technical knowledge products from projects have led to increased awareness of giant clam rearing, market opportunities and conservation	▪ High awareness of giant clam conservation, especially in the Philippines, where activities continue today ▪ Selected group of farmers, government and research experts in other Indo-Pacific countries ▪ High-quality research publications and manuals, which are still in use	▪ Small community of practice on giant clam mariculture and research, many still collaborating ▪ At time of investment, frequent forums and knowledge exchange activities for researchers ▪ Weak boundary organisations facilitating policy changes to support farmers or sell giant clams internationally	▪ Policy context in the Philippines prevented giant clams from being sold internationally. No incentives for researchers to extend technologies to farmers ▪ Political context of Solomon Islands prevented the hatchery from continuing operations, preventing farmers from accessing seeds ▪ Regional activities continue, and ecotourism activities have developed in some Indo-Pacific countries	▪ Technical outputs highly relevant to the scientific community ▪ Farmers, especially in Solomon Islands, benefited from grow-out technologies for the duration of the project ▪ Environmental benefits in some countries, such as the Philippines, where restocking of near-extinct species brought back populations ▪ Social benefits remain in the skilled institutional and individual partners involved in the projects

Table 18: Giant clam impact assessment summary analysed under ACIAR guidelines, and knowledge systems and RAPID framework (continued)

Objective/framework themes	Knowledge systems and RAPID			Guidelines for impact assessment
Determine how knowledge produced during the project has influenced longer-term conservation initiatives and economic opportunities, and increased capacity in partner countries	▪ In the Philippines, the partner research centres continue to be the source of knowledge for conservation and ecotourism activities, creating a mix of conservation and economic benefits ▪ Capacity high throughout the region among those involved in projects. Individuals have pursued further careers in mariculture and marine policy after ACIAR investments	▪ No organised bodies that bring together giant clam knowledge ▪ The Coral Triangle Initiative has emerged as a multidonor-funded activity, which many interviewees mentioned as a way for giant clam experts to contribute their insights	▪ No clear policy changes stemming from giant clam research have emerged ▪ The Philippines is in a position where increased links between research and policy could lead to changes in the interpretation of CITES	▪ Capacity enabled in some countries. In the Philippines, capacity was already high, and funds supported the development of research centres ▪ Ecotourism activities and knowledge have flowed between countries, with the Philippines leading a range of ecotourism operations
Document how giant clam investments achieved different levels of impact depending on the different developmental contexts in which the investments took place	▪ Overall knowledge produced was highly salient and credible. Research continues to be cited and is well known in the region	▪ Mariculture experts have used the skills and continue to work in sea cucumbers, oyster pearls, etc	▪ Small production in the Indo-Pacific region and a limited market mean that upscaling of the giant clam industry has not been possible ▪ Tourism has emerged as an economic activity in several countries, bringing benefits and using skills	▪ Grow-out technology adoption in the Solomon Islands did not occur after the project—context played a major role ▪ End users in the Philippines are now tourism operators and tourists

ACIAR = Australian Centre for International Agricultural Research; CITES = Convention on International Trade in Endangered Species of Wild Fauna and Flora

6. Lessons for research for development

The story of giant clam investments presents a number of examples of the complexities of achieving social, economic and environmental impacts from complex programs in varied contexts. The projects provide a good example of the complexities of delivering high-quality technical and scientific outputs, and transferring them to socioeconomic and environmental systems for ongoing use and eventual impact.

In this chapter, we draw from the lessons and experiences from the giant clam impact assessment to propose a series of project, program and impact assessment lessons for the Australian Centre for International Agricultural Research (ACIAR).

6.1 Lessons for project leaders

Research for development is rapidly changing in light of complex transparency, accountability and global development needs (van der Ploeg et al. 2016; Douthwaite et al. 2017). Developed country researchers working in developing and emerging economies have an ethical responsibility to actively work in a manner that suits the needs and context of their developing country partners. The adaptability of projects and the ability for technologies to suit the needs of local institutions will be critical for ongoing sustained uptake of knowledge and research outputs (Blythe et al. 2017).

The project leaders for the giant clam projects had the complex task of guiding scientific studies across different countries. This is no easy task—patience, perseverance, willingness to fail and learn, and critical thinking are central to delivering research objectives. The giant clam projects during the 1980s were guided by core teams in Australia and partner countries that were able to deliver high-quality outputs. These technical outputs continue to be core to those currently working with giant clams—for example, Neo et al. (2017) and Cabaitan and Conaco (2017). The projects, however, did not establish a series of strategic institutions and monitoring structures that may have enhanced the long-term impact of knowledge.

It is worth reflecting that, despite high-quality ongoing scientific research into giant clams in the Philippines, a policy barrier prevents the commodity from being sold and commercialised. The main reason for this seems to be the listing of giant clams under Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora. However, this listing allows trade in a regulated way. This impact assessment found that there was no coherent and ongoing opportunity for knowledge exchange, to allow researchers and policymakers to update each other on giant clam status or activities, and possibly change the current nature of the export ban. The absence of these types of networks meant that there was no clear network of people interested in giant clams beyond research. To function as a knowledge system, a network would require sustained exchanges of knowledge between research, policy, industry, civil society and the general public. Extensive work on these boundary organisations shows the ability of formal and informal networks to influence change and have developmental impact (Cash et al. 2003; Clark et al. 2016). Examples of these types of networks have been proven to continue independently after ACIAR investments end, and enable ongoing knowledge exchange between end users (Davila et al. 2016). Therefore, when designing complex projects with multiple social, economic and environmental objectives, we recommend that project leaders examine the possibility of creating networks and organisations that are able to bring together relevant actors beyond researchers to sustain the use of knowledge after project completion.

Another challenge for this impact assessment was the clear absence of coherent, consistent ecological data on giant clam restocking efforts. The projects were initiated more than 35 years ago, and it is understandable that early records may have been misplaced or lost through time. However, with more than 20 years of conservation efforts, the Philippines had an overall lack of consistent and coherent ecological monitoring data. Although monitoring can be regarded as a costly and time-consuming exercise without immediate benefits,

it is in the interest of leaders focusing on conservation outcomes to build the skills and systems required to produce baseline and ongoing data so that changes can be tracked through time. We recommend that, when working with partners, ACIAR develops guidelines and institutional arrangements for documenting data directly linked to the project objectives. This can form part of formal monitoring and evaluation activities conducted during projects, with emphasis on supporting local capacity to continue monitoring in a cost-effective way. The sustained upkeep of data would help impact assessment leaders in the future track the impacts of the project. Maintaining data can also help create an evidence base for advocacy and supporting proposals for policy change—for example, trade restrictions based on endangered species.

Finally, we note that, at the time of investments, the projects were highly unbalanced in terms of female research leaders. Despite this, the Philippines was able to mentor, and currently employs, highly successful female scientists in research and community extension work. Given the important role that women play in community leadership throughout the Indo-Pacific region, we recommend that future projects design gender-diverse knowledge systems that include female project leaders and partners to enhance project diversity. Given the current focus of ACIAR and the Australian aid program, gender will continue to be built into Australian-led initiatives. However, this may not be a requirement in some partner countries, and therefore enabling gender-diverse knowledge in projects will need to be facilitated from the outset.

6.2 Lessons for program managers

Program managers for sustainable research investments in agricultural systems will be required to align technical agriculture research with wider policy, social, environmental and economic changes (Thompson and Scoones 2009). This complex task requires an understanding of content matter, knowledge management and integration, and policy and political contexts, and an ability to project the future impact of current research activities. The giant clam lessons present insights for future projects that have multiple social, economic and environmental objectives.

Chapter 2 presented a range of narratives from the Indo-Pacific region that indicated the challenges for the giant clam industry to become profitable and sustained by different countries. Indeed, despite extensive research and knowledge on giant clams, there continues to be a relatively low supply of clams. Demand, at least for aquarium markets, is limited, and few efforts have been made to generate a seafood or shell market. A core message from the regional experts was that private industry was not adequately engaged during the ACIAR project, but is now the major funders of hatcheries. An example of this was in the Philippines, where a private company has set up one of the country's largest hatcheries in Semirara. In Solomon Islands, all giant clam seeds were subsidised by project funds, and there was little role for government or industry in the process. These experiences stem from low focus on the private sector as a partner in the giant clam industry. Future research that seeks to promote livelihoods should carefully consider the role of local and regional industries in facilitating the sustained use of knowledge generated through research investments. The boundary organisations discussed in Section 6.1 can act as catalysts of knowledge exchange between sectors. Importantly, they can also offer opportunities for groups with different interests and levels of power over decision-making to begin deliberating on marketing specific commodities. These types of industry partnerships align with current Australian aid objectives and may attract opportunities for multistakeholder research. As such, we recommend that program managers explore how strategic industry partners can form part of research design, conduct and uptake, to deliver sustained economic and market impacts.

For ACIAR, local champions in partner countries who drive the projects and continue the legacy after investments cease are critical. The vignettes presented in Chapters 3 show how local leaders continued to work on giant clam conservation, research and policy after ACIAR concluded its projects. For the Philippines, a major impact was on skills and knowledge that continued to grow after the project. For Solomon Islands, despite the dormant industry, local knowledge prevails, and the skills are being used in the region for both giant clams and other commodities. This type of partnership with local champions is critical for sustainable development and for successful agricultural research (Douthwaite et al. 2017). We recommend that future programs continue to target core local champions who can deliver on project objectives, and can lead the ongoing use of ACIAR-generated knowledge and technologies after project completion.

Positively, ACIAR demonstrated institutional learning throughout the 15-year period of giant clam research. The learnings from project FIS/1982/032 clearly informed the objectives and selection of hatchery sites for project FIS/1987/033. The projects delivered high-

quality outputs and coherently built on learnings. The reflection that little market knowledge existed allowed ACIAR to fund project EFS/1988/023, and the final report for the project indicates that there was ongoing communication with the scientists working in other ACIAR giant clam projects (Tisdell 1993). The final project, FIS/1995/042, was able to link the scientific and economic insights from previous projects to design a targeted grow-out and livelihood-focused project. Although the project did not lead to sustained uptake of technologies, the findings provided a series of manuals and knowledge that can be transferred to other countries interested in giant clam mariculture. The overall giant clam program demonstrated strong institutional learning for ACIAR, and allowed the projects to contribute a coherent and valuable knowledge legacy.

We recommend that existing institutional learning processes, such as reviews and adoption studies, continue to inform new projects to plan for unintended positive and negative impacts. The impact assessment series can continue to provide insights on how past projects dealt with unexpected changes in social and environmental systems. Long-term impact assessments such as the one in this report can contribute to a broader understanding beyond the more immediate lessons from specific projects, by placing outcomes in their wider sociopolitical context and the evolution of impacts through time.

6.3 Lessons for impact assessments

The giant clam projects had objectives that span social, economic and environmental domains. The original projects focused on knowledge and conservation; as the projects evolved, visions of creating livelihood opportunities were built into them. The diversity of objectives presents an example of how impact assessments for agricultural research require flexible and adaptable frameworks and methods that are suitable to the context and type of project.

The study in the Philippines showed that different valuation methods, such as benefit transfer, could provide a way of measuring the environmental contributions of ACIAR research, when appropriate data are available. Giant clams are a unique commodity that allows multiple types of uses and values, not solely commercial. Other marine commodities may offer different types of values, indicating that future impact assessments will require a range of methods that align with general frameworks to capture multiple benefits and impacts. As ACIAR impact assessment guidelines evolve to suit more complex projects, the frameworks and methods available for impact assessment will need to be adaptable and flexible so that they are salient to the context in which ACIAR invests funds.

The giant clam projects also demonstrated that pathways to impact will be different for different objectives, especially as ACIAR projects evolve and increase in complexity. The sudden contextual change in Philippines policy meant that the livelihood objective was not achieved, and the pathway to adoption did not exist. The pathway to the unintended ecotourism benefits, however, was quite different. It did not rely on hatchery technologies, but rather on training and knowledge of giant clams. We recommend that future impact assessment guidelines offer flexible frameworks and methods that can capture the different pathways to intended and unintended impacts.

Appendix 1:
Philippines interview guide

Impact assessment objectives

The aim of the impact assessment is to determine the extent to which giant clam research and restocking investments contributed to long-term knowledge exchange, conservation efforts, and economic opportunities for partner countries.

The specific subobjectives for social, environmental and economic impacts are:

1. to assess the extent to which technical knowledge products from projects have led to increased awareness of giant clam rearing, market opportunities and conservation
2. to determine how knowledge produced during the project has influenced longer-term conservation initiatives and economic opportunities, and increased capacity in partner countries
3. to document how giant clam investments achieved different levels of impact depending on the different developmental contexts in which the investments took place.

The impact assessment will aim to capture the long-term desired impacts of ACIAR investments—social, environmental and economic. The impact assessment will use the Philippines and Solomon Islands as case studies to illustrate how different developmental contexts lead to different impacts of ACIAR investments.

The social focus will be on the extent to which ACIAR produced high-quality knowledge and facilitated knowledge exchanges between industry, research and government. This will also address long-term capacity built through training leading academics and students in giant clam research, as well as knowledge networks and ongoing research activities. Consideration of community impacts includes village community engagement, impacts for women and youth, and intended or unintended consequences from project outcomes. We will assess the extent to which ACIAR investments contributed to long-term community-based activities and sustained use of skills learned during the project.

The environmental focus will be on the role that ACIAR knowledge played in motivating stakeholders to develop conservation and marine protected areas, either legally recognised or community-based ones. Here we will also focus on the co-benefits of ecotourism and conservation, and investigate whether ACIAR investments supported current activities.

The economic analysis will depend on data availability. There is currently some international trade in giant clams but, in the case of the Philippines, there is only a domestic market. We will attempt to estimate trade and ecotourism benefits to local stakeholders from ACIAR investments in giant clam research. Beyond the Philippines, the small nature of the giant clam export sector means that exact figures are often not released by private traders, and farm-gate price is often inaccessible. We will explore ways of linking cost and benefits of ecotourism activities to local stakeholders and examine village-level trading where they can be tracked back to initial ACIAR investments.

Where possible, economic returns stemming from tourism and conservation activities in the Philippines will be assessed using a case study approach. The specific data collection focus and analysis for social, economic and environmental benefits will be subject to an inception meeting and writing guide, to be developed for ACIAR before fieldwork to the Philippines.

Qualitative and quantitative methods for this impact assessment will include:

- publication tracking of the impact of manuals, reports and academic material to determine the long-term use of technical material produced by the report
- semistructured interviews to capture stories, narratives and vignettes of key contributions ACIAR investments made to long-term developmental outcomes
- quantitative analysis of possible ecotourism and conservation outcomes from ACIAR investments.

Interview structure

The interviews will have five major sections: participant profile; current state of clams industry/activity and their involvement; project context and history; project impact on knowledge and policy; and project impact on economic, social and environmental development.

The sequence of questions will allow interviewees to start by discussing the current state of the industry, then their involvement in the project and the contextual issues that influenced project implementation. The interviews will then proceed to deeper questions on the quality of research investments, relevant policy impacts and organisational links, the relevance to end users, adoption of outputs, possible economic impacts, unintended outcomes, and overall perceived impact of ACIAR investments across social, economic and environmental domains.

The interviews are structured around the themes and steps indicated in IAS92 (pages 33 and 52).

Themes to be cognisant of

Knowledge systems:

- Legitimacy, salience, credibility
- Research knowledge influencing conservation and other policies
- Links between government, universities, business
- Boundary organisations, how they function, their legitimacy
- Formal rules, incentives, etc. that influence knowledge flows
- 'Vignette' case studies of knowledge transfer

RAPID:

- Contextual drivers that influence giant clam research impact on policy, knowledge, conservation
- External factors—e.g. global trade, climate change, latest research
- Evidence—quality of evidence/knowledge used to carry out giant clam development activities

Economics

- Intermediate vs end users—who benefits from the giant clam activities
- How do they benefit—altruistic, economic, knowledge?
- University student flows—outflow of students, papers, PhDs graduated, etc.; link to the prestige of the institution in the Philippines

Participant profile and any possible numeric data

- What organisation do you work for, how long have you been there?
- Please tell us how your organisation works with aquaculture and the marine sector
  - Prompt: policy links, boundary organisations, use of up-to-date research, engagement with universities.
- How many people in your organisation used to or currently work with giant clams?
- What other agencies work with giant clams or mariculture in the area?
  - Prompt: briefly explain how these agencies work with giant clams and what drives this work.
- What is the main purpose of your organisation? If conservation, try to capture:
  - number of glams restocked since 1990
  - total costs of restocking
  - total benefit of restocking—number of clams surviving in wild, restocked numbers, number of tourists.

Current state of clams industry/business/activity

- How would you describe the current clam activity In the Philippines?
  - Is there a domestic trade, is this legal or illegal, who benefits from this trade?
  - Ecological restoration, harvesting—explain the benefits of conservation activities.
  - Ecotourism activities.
  - Corporate social responsibility? (Semirara Mining and SM company)

There has been a giant clam ban since 1995. What drove this ban, and if this ban did not exist, do you think the Philippines would benefit? Please explain.

- How much interest is there today about giant clams? Prompt: Bohol, private corporations, WWF work on giant clams
  - Village level?
  - Provincial level?
  - National level?
  - Regional bodies? (SPC?)
  - Donors/international interests?

- What motivates agencies to work in giant clam conservation?
  - Explain the extent to which different government agencies work/invest on giant clam conservation or research.
- Are people investing time or money into the further development of clams for harvest?
- Have there been any significant changes recently that have influenced the way people think about clams and their economic potential?
  - Access to markets?
  - Growing international demand? From where?
  - Changing ecological conditions (making it easier or harder to farm them)?
- Have there been any significant changes recently that have influenced the way people think about clams and their conservation potential?
- What are the main challenges the clam industry/clam conservation faces today?
- What are the main opportunities that industry/conservation faces today?

Research to policy questions (RAPID)

Context—in the past

- Who was involved in giant clams investments at the time of investments? Try to capture the counterfactual.
  - Name agencies, number of farmers, type of skills needed.
  - For the Philippines, discuss who else was funding the MSI and helped giant clam research take off in the 1990s.
- What were some of the drivers that led to interests in giant clams? (time frame—20 years ago? Now?)
  - Prompt: ask about environmental concerns, demand for meat products.
  - Prompt: what led to the interest – why were YOU interested?
- Did farmers wish to increase into giant clams at the time (before the 1995 ban)? What were other sources of incomes/livelihoods for these farmers and what was the expected impact of giant clams on these farmers?
- How has the demand for clam products changed through time? Note hypothetical of no 1995 ban.
- What was the conservation/environmental concern at the time of investments? Were there other efforts to improve giant clam populations?
  - Are 'clam gardens' relevant in the Philippines and, if so, who values them and who 'makes' them? Are there negative impacts of clam gardens (e.g. taking them from the reef)?
- What is the nature of the relationships between researchers and mariculture policies/government officials/clam suppliers?
  - What are the links/networks like?
- Where do farmers/industry get the latest knowledge/information/skills about mariculture skills and markets?
  - Prompt: focus on extension officers—where do extension officers get the knowledge? Do they used past knowledge?
  - Prompt: discuss the role of NGOs and the private sector—both are active in the Philippines and have activities related to giant clams.

Context—present

- Are there people from the original projects still involved in giant clam production? Why/why not?
  - Prompt: In the Philippines answer likely YES—discuss what has motivated and supported their willingness to continue working with giant clams.
- What happened to knowledge about giant clams following the projects?
- What happened to interest about giant clams following the projects?
  - Note 1995 ban and the implications of this.
- Are there any mariculture policies today that support giant clam production?
  - Discuss Bohol and other provincial government support for giant clam activities.
- What is the current structure of the giant clam value chain?
  - How many seed distributors, buyers, farmers Try to capture current value chain context—discuss in context of domestic trade, if any.
- Has production/knowledge about giant clams remained the same or improved after ACIAR investments finished?
  - Why/why not/provide examples.
- Has there been any connection between the research projects and current marine protected areas in the Philippines? How? Who has been responsible for these?
  - Prompt: did ACIAR clam research influence development of marine protected areas?

- Prompt: discuss Hundred Islands National Park and other related activities.

Knowledge systems questions

- What was the state of knowledge of giant clam mariculture before ACIAR investments? (Early 1980s?)
  - Prompt: what agencies were involved at the time in giant clams work? (counterfactual)
  - Prompt: were there other motivators besides ACIAR in pursuing giant clam activities? Why were giant clams seen as a good commodity/ species of interest?
- Did farmers want to learn about giant clam farming? What motivated them to farm giant clams?
- Did industry want to learn about giant clam farming?
- In general, what do you think have been some of the major contributions of ACIAR research outputs in the Philippines?
- UPLB and SULM were main partners—can you comment on the extent to which capacity was built through ACIAR giant clam investments?
  - What was the nature of this capacity built, and is it still there (research, growing techniques, technical skills)?
  - Try to capture student flows, papers generated, etc.
- A lot of research was conducted by ACIAR and Philippines partners. Was this research on restocking and harvesting important at the time? Why/why not?
- Why type of knowledge did farmers need at the time to improve their livelihoods?
- What type of knowledge do farmers need to improve their livelihoods?
- Can you comment on the nature of the relationships between people involved in the ACIAR project?
  - Were there any organisations that linked farmers, researchers, policymakers and development agencies? Are there any now?
- Did ACIAR research and grow-out trials information influence policy into giant clams or marine protected areas? Why/why not??
- Have political developments/changes/unrest impacted giant clam activities in the Philippines?
- Are the knowledge/skills/infrastructure/techniques developed through ACIAR investments still in use?
  - By who? Why not? Has the knowledge led to other things?
  - Prompt: Discuss MSI and Silliman use of infrastructure for other purposes.
- Who else is involved in giant clam farming and research at the moment? Or similar commodities, such as pearls or sea cucumbers?

Appendix 2:
Solomon Islands interview guide

Participant profile and any possible numeric data

- What organisation do you work for, how long have you been there?
- Please tell us how your organisation works with aquaculture and the marine sector
  - Prompt: policy links, boundary organisations, use of up-to-date research, engagement with universities.
- How many people in your organisation used to or currently work with giant clams?
- What other agencies work with giant clams or mariculture in the area
- Does your organisation actively work with clam farmers? Do you have access to numerical data on:
  - number of households farming clams
  - total costs of production
  - output from clam farming
  - quantity and value of exports

Current state of clams industry/business/activity

- How would you describe the current clam activity?
  - commercial, noncommercial
  - local subsistence, international food markets
  - ecological restoration, harvesting
  - active management, passive
- How much interest is there today about giant clams?
  - Village level?
  - Provincial level?
  - National level?
  - Regional bodies? (SPC?)
  - Donors/international interests?
- Are these interests the same or different?
- What is driving these (same or different) interests?
- Are people investing time or money into the further development of clams for harvest?
- Have there been any significant changes recently that have influenced the way people think about clams and their economic potential?
  - Access to markets?
  - Growing international demand? From where?
  - Changing ecological conditions (making it easier or harder to farm them)?
- What are the main challenges the clam industry faces today?
- What are the main opportunities that industry faces today?

Research to policy questions (RAPID)

Context—in the past

- Who was involved in giant clams investments at the time of investments? Try to capture counterfactual.
  - Name agencies, number of farmers, type of skills needed.
- What were some of the drivers that led to interests in giant clams (time frame—20 years ago? Now?)
  - Prompt: ask about environmental concerns, demand for meat products.
  - Prompt: what led to the interest—why were you interested?
- Did farmers wish to increase into giant clams? What were other sources of incomes/livelihoods for these farmers?
- How has the demand for clam products changed through time?
- What was the conservation/environmental concern at the time of investments? Were there other efforts to improve giant clam populations?
- What knowledge do farmers currently have access to?
  - Prompt: extension officers, education, access to services—who is providing them with knowledge?

- What is the role of local customs and governance systems in conserving clams?
  - Prompt: mention clam gardens.
- What is the nature of the relationships between farmers and mariculture policies/government officials/clam suppliers? What are the links/networks like?
- Where do farmers get the latest knowledge/information/skills about mariculture skills and markets?
  - Prompt: focus on extension officers—where do extension officers get the knowledge? Do they used past knowledge?

Context—present

- Are there people from the original projects still involved in giant clam production? Why/why not?
- What happened to knowledge about giant clams following the projects?
- What happened to interest about giant clams following the projects?
- Are there any mariculture policies today that support giant clam production?
- What is the current structure of the giant clam value chain?
  - How many seed distributors, buyers, farmers, etc. (capture current value chain context)?
- Has production/knowledge about giant clams remained the same or improved after ACIAR investments finished?
  - Why/why not/provide examples.
- Has there been any connection between the research projects and current marine protected areas in Solomon Islands? How? Who has been responsible for these?
  - Prompt: did ACIAR clam research influence development of marine protected areas?

Knowledge systems questions

- What was the state of knowledge of giant clam mariculture before ACIAR investments? (Early 1980s?)
  - Prompt: what agencies were involved at the time in giant clam work?
- Did farmers want to learn about giant clam farming? What motivated them to farm giant clams?
- In general, what do you think have been some of the major contributions of ACIAR research outputs in Solomon Islands?
- WorldFish (ICLARM) was a major partner at the time—can you comment on the extent to which capacity was built through ACIAR giant clam investments?
  - What was the nature of this capacity built, and is it still there (research, growing techniques, technical skills)?
- A lot of research was conducted by ACIAR and ICLARM—was this research on restocking and harvesting important at the time? Why/why not?
- What type of knowledge did farmers need at the time to improve their livelihoods?
- What type of knowledge do farmers need to improve their livelihoods?
- Can you comment on the nature of the relationships between people involved in the ACIAR project?
  - Were there any organisations that linked farmers, researchers, policymakers and development agencies? Are there any now?
- Did ACIAR research and grow-out trials information influence policy into giant clams/marine protected areas? Why/why not??
- What was the impact of the political unrest in the 2000s on giant clam farming?
- Are the knowledge/skills/infrastructure/techniques developed through ACIAR investments still in use?
  - By who? Why not? Has the knowledge led to other things?
- Who else is involved in giant clam farming and research at the moment? Or similar commodities, such as pearls or sea cucumbers?

Economic questions

It may be enough to identify categories of benefits rather the collecting numerical data. In saying that, time series data on the quantity and value of giant clam exports for Solomon Islands from the 1990s to about 2017 would be useful in looking at trends and estimating sector impacts.

- Do you have any recollection of the number of farmers that were involved in the trials?
  - Are they still involved? Why/why not?
- We understand that the 1995 investments had 26 village trials—is this correct? Please provide an overview of how the trials were conducted.
- What was the profile of those farmers selected, and are there any available data on how long they were involved in the project?

Fill out the following table based on participant responses.

Category	1980s–1990s Number of farmers	2017 Number of farmers
Farmers in original project **AND** still farming		
Farmers in original project **BUT** not farming		
Farmers since 1995, **BUT** not part of ACIAR investments		
New clam farmers post-ACIAR investments		
Total clam output to market (tonnes and $)		
Total clam output for conservation purposes		
Active number of clam farmers in Solomon Islands		

- What percentage of the villages were selling commercially, as opposed to collecting for household consumption?
- How many villages involved in one of the original trials are still farming clams today?
- How many villages are farming clams in Solomon Islands in 2017?
  - Prompt: if not farming clams, what are they farming now and why?
- Are there farmers that have started farming clams after the political issues in the 2000s?
  - Any perspectives on what motivated them to farm clams/where did they get the knowledge from?

Closing remarks

- Who else should we talk to in Honiara/elsewhere in Solomon Islands/over the phone in the Pacific?
- Are there regional organisations/businesses we should talk to?
- Do you know of other countries doing giant clam production that has some connection with ACIAR investments?
- What do you think are the most important things an impact assessment of the giant clams program should look at?

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IMPACT ASSESSMENT SERIES

No.	Author(s) and year of publication	Title	ACIAR project numbers
1	Centre for International Economics 1998.	Control of Newcastle disease in village chickens	AS1/1983/034, AS1/1987/017 and AS1/1993/222
2	George P.S. 1998.	Increased efficiency of straw utilisation by cattle and buffalo	AS1/1982/003, AS2/1986/001 and AS2/1988/017
3	Centre for International Economics 1998.	Establishment of a protected area in Vanuatu	ANRE/1990/020
4	Watson A.S. 1998.	Raw wool production and marketing in China	ADP/1988/011
5	Collins D.J. and Collins B.A. 1998.	Fruit fly in Malaysia and Thailand 1985–1993	CS2/1983/043 and CS2/1989/019
6	Ryan J.G. 1998.	Pigeonpea improvement	CS1/1982/001 and CS1/1985/067
7	Centre for International Economics 1998.	Reducing fish losses due to epizootic ulcerative syndrome—an ex ante evaluation	FIS/1991/030
8	McKenney D.W. 1998.	Australian tree species selection in China	FST/1984/057 and FST/1988/048
9	ACIL Consulting 1998.	Sulfur test KCL–40 and growth of the Australian canola industry	PN/1983/028 and PN/1988/004
10	AACM International 1998.	Conservation tillage and controlled traffic	LWR2/1992/009
11	Chudleigh P. 1998.	Postharvest R&D concerning tropical fruits	PHT/1983/056 and PHT/1988/044
12	Waterhouse D., Dillon B. and Vincent D. 1999.	Biological control of the banana skipper in Papua New Guinea	CS2/1988/002-C
13	Chudleigh P. 1999.	Breeding and quality analysis of rapeseed	CS1/1984/069 and CS1/1988/039
14	McLeod R., Isvilanonda S. and Wattanutchariya S. 1999.	Improved drying of high moisture grains	PHT/1983/008, PHT/1986/008 and PHT/1990/008
15	Chudleigh P. 1999.	UseandmanagementofgrainprotectantsinChina andAustralia	PHT/1990/035
16	McLeod R. 2001.	Control of footrot in small ruminants of Nepal	AS2/1991/017 and AS2/1996/021
17	Tisdell C. and Wilson C. 2001.	Breeding and feeding pigs in Australia and Vietnam	AS2/1994/023
18	Vincent D. and Quirke D. 2002.	Controlling *Phalaris minor* in the Indian rice–wheat belt	CS1/1996/013
19	Pearce D. 2002.	Measuring the poverty impact of ACIAR projects— a broad framework	
20	Warner R. and Bauer M. 2002.	*Mama Lus Frut* scheme: an assessment of poverty reduction	ASEM/1999/084
21	McLeod R. 2003.	Improved methods in diagnosis, epidemiology, and information management of foot-and-mouth disease in Southeast Asia	AS1/1983/067, AS1/1988/035, AS1/1992/004 and AS1/1994/038
22	Bauer M., Pearce D. and Vincent D. 2003.	Saving a staple crop: impact of biological control of the banana skipper on poverty reduction in Papua New Guinea	CS2/1988/002-C
23	McLeod R. 2003.	Improved methods for the diagnosis and control of bluetongue in small ruminants in Asia and the epidemiology and control of bovine ephemeral fever in China	AS1/1984/055, AS2/1990/011 and AS2/1993/001

No.	Author(s) and year of publication	Title	ACIAR project numbers
24	Palis F.G., Sumalde Z.M. and Hossain M. 2004.	Assessment of the rodent control projects in Vietnam funded by ACIAR and AusAID: adoption and impact	AS1/1998/036
25	Brennan J.P. and Quade K.J. 2004.	Genetics of and breeding for rust resistance in wheat in India and Pakistan	CS1/1983/037 and CS1/1988/014
26	Mullen J.D. 2004.	Impact assessment of ACIAR-funded projects on grain-market reform in China	ADP/1997/021 and ANRE1/1992/028
27	van Bueren M. 2004.	Acacia hybrids in Vietnam	FST/1986/030
28	Harris D. 2004.	Water and nitrogen management in wheat–maize production on the North China Plain	LWR1/1996/164
29	Lindner R. 2004.	Impact assessment of research on the biology and management of coconut crabs on Vanuatu	FIS/1983/081
30	van Bueren M. 2004.	Eucalypt tree improvement in China	FST/1984/057, FST/1987/036, FST/1988/048, FST/1990/044, FST/1994/025, FST/1996/125 and FST/1997/077
31	Pearce D. 2005.	Review of ACIAR's research on agricultural policy	
32	Tingsong Jiang and Pearce D. 2005.	Shelf-life extension of leafy vegetables—evaluating the impacts	PHT/1994/016
33	Vere D. 2005.	Research into conservation tillage for dryland cropping in Australia and China	LWR2/1992/009 and LWR2/1996/143
34	Pearce D. 2005.	Identifying the sex pheromone of the sugarcane borer moth	CS2/1991/680
35	Raitzer D.A. and Lindner R. 2005.	Review of the returns to ACIAR's bilateral R&D investments	
36	Lindner R. 2005.	Impacts of mud crab hatchery technology in Vietnam	FIS/1992/017 and FIS/1999/076
37	McLeod R. 2005.	Management of fruit flies in the Pacific	CS2/1989/020, CS2/1994/003, CS2/1994/115 and CS2/1996/225
38	ACIAR 2006.	Future directions for ACIAR's animal health research	
39	Pearce D., Monck M., Chadwick K. and Corbishley J. 2006.	Benefits to Australia from ACIAR-funded research	AS2/1990/028, AS2/1994/017, AS2/1994/018, AS2/1999/060, CS1/1990/012, CS1/1994/968, FST/1993/016 and PHT/1990/051
40	Corbishley J. and Pearce D. 2006.	Zero tillage for weed control in India: the contribution to poverty alleviation	CS1/1996/013
41	ACIAR 2006.	ACIAR and public funding of R&D. Submission to Productivity Commission study on public support for science and innovation	
42	Pearce D. and Monck M. 2006.	Benefits to Australia of selected CABI products	
43	Harris D.N. 2006.	Water management in public irrigation schemes in Vietnam	LWR1/1998/034 and LWR2/1994/004
44	Gordon J. and Chadwick K. 2007.	Impact assessment of capacity building and training: assessment framework and two case studies	CS1/1982/001, CS1/1985/067, LWR2/1994/004 and LWR2/1998/034

No.	Author(s) and year of publication	Title	ACIAR project numbers
45	Turnbull J.W. 2007.	Development of sustainable forestry plantations in China: a review	
46	Monck M. and Pearce D. 2007.	Mite pests of honey bees in the Asia–Pacific region	AS2/1990/028, AS2/1994/017, AS2/1994/018 and AS2/1999/060
47	Fisher H. and Gordon J. 2007.	Improved Australian tree species for Vietnam	FST/1993/118 and FST/1998/096
48	Longmore C., Gordon J. and Bantilan M.C. 2007.	Assessment of capacity building: overcoming production constraints to sorghum in rainfed environments in India and Australia	CS1/1994/968
49	Fisher H. and Gordon J. 2007.	Minimising impacts of fungal disease of eucalypts in South-East Asia	FST/1994/041
50	Monck M. and Pearce D. 2007.	Improved trade in mangoes from the Philippines, Thailand and Australia	CS1/1990/012 and PHT/1990/051
51	Corbishley J. and Pearce D. 2007.	Growing trees on salt-affected land	FST/1993/016
52	Fisher H. and Gordon J. 2008.	Breeding and feeding pigs in Vietnam: assessment of capacity building and an update on impacts	AS2/1994/023
53	Monck M. and Pearce D. 2008.	The impact of increasing efficiency and productivity of ruminants in India by the use of protected-nutrient technology	AH/1997/115
54	Monck M. and Pearce D. 2008.	Impact of improved management of white grubs in peanut-cropping systems in India	CS2/1994/050
55	Martin G. 2008.	ACIAR fisheries projects in Indonesia: review and impact assessment	FIS/1997/022, FIS/1997/125, FIS/2000/061, FIS/2001/079, FIS/2002/074, FIS/2002/076, FIS/2005/169 and FIS/2006/144
56	Lindner B. and McLeod P. 2008.	A review and impact assessment of ACIAR's fruit-fly research partnerships—1984–2007	CP/1997/079, CP/2001/027, CP/2002/086, CP/2007/002, CP/2007/187, CS2/1983/043, CS2/1989/019, CS2/1989/020,CS2/1994/003, CS2/1994/115,CS2/1996/225, CS2/1997/101,CS2/1998/005, CS2/2003/036,PHT/1990/051, PHT/1993/87 and PHT/1994/133
57	Montes N.D., Zapata Jr N.R., Alo A.M.P. and Mullen J.D. 2008.	Management of internal parasites in goats in the Philippines	AS1/1997/133
58	Davis J., Gordon J., Pearce D. and Templeton D. 2008.	Guidelines for assessing the impacts of ACIAR's research activities	
59	Chupungco A., Dumayas E. and Mullen J. 2008.	Two-stage grain drying in the Philippines	PHT/1983/008, PHT/1986/008 and PHT/1990/008
60	Centre for International Economics 2009.	ACIAR Database for Impact Assessments (ADIA): an outline of the database structure and a guide to its operation	
61	Fisher H. and Pearce D. 2009.	Salinity reduction in tannery effluents in India and Australia	AS1/2001/005

No.	Author(s) and year of publication	Title	ACIAR project numbers
62	Francisco S.R., Mangabat M.C., Mataia A.B., Acda M.A., Kagaoan C.V., Laguna J.P., Ramos M., Garabiag K.A., Paguia F.L. and Mullen J.D. 2009.	Integrated management of insect pests of stored grain in the Philippines	PHT/1983/009, PHT/1983/011, PHT/1986/009 and PHT/1990/009
63	Harding M., Tingsong Jiang and Pearce D. 2009.	Analysis of ACIAR's returns on investment: appropriateness, efficiency and effectiveness	
64	Mullen J.D. 2010.	Reform of domestic grain markets in China: a reassessment of the contribution of ACIAR-funded economic policy research	ADP/1997/021 and ANRE1/1992/028
65	Martin G. 2010.	ACIAR investment in research on forages in Indonesia	AS2/2000/103, AS2/2000/124, AS2/2001/125, LPS/2004/005, SMAR/2006/061 and SMAR/2006/096
66	Harris D.N. 2010.	Extending low-cost fish farming in Thailand: an ACIAR–World Vision collaborative program	PLIA/2000/165
67	Fisher H. 2010.	The biology, socioeconomics and management of the barramundi fishery in Papua New Guinea's Western Province	FIS/1998/024
68	McClintock A. and Griffith G. 2010.	Benefit–cost meta-analysis of investment in the International Agricultural Research Centres	
69	Pearce D. 2010.	Lessons learned from past ACIAR impact assessments, adoption studies and experience	
70	Harris D.N. 2011.	Extending low-chill fruit in northern Thailand: an ACIAR–World Vision collaborative project	PLIA/2000/165
71	Lindner R. 2011.	The economic impact in Indonesia and Australia from ACIAR's investment in plantation forestry research, 1987–2009	FST/1986/013, FST/1990/043, FST/1993/118, FST/1995/110, FST/1995/124, FST/1996/182, FST/1997/035, FST/1998/096, FST/2000/122, FST/2000/123, FST/2003/048 and FST/2004/058
72	Lindner R. 2011.	Frameworks for assessing policy research and ACIAR's investment in policy-oriented projects in Indonesia	ADP/1994/049, ADP/2000/100, ADP/2000/126, AGB/2000/072, AGB/2004/028, ANRE1/1990/038, ANRE1/1993/023, ANRE1/1993/705, EFS/1983/062 and EFS/1988/022
73	Fisher H. 2011.	Forestry in Papua New Guinea: a review of ACIAR's program	FST/1994/033, FST/1995/123, FST/1998/118, FST/2002/010, FST/2004/050, FST/2004/055, FST/2004/061, FST/2006/048, FST/2006/088, FST/2006/120, FST/2007/078 and FST/2009/012
74	Brennan J.P. and Malabayabas A. 2011.	International Rice Research Institute's contribution to rice varietal yield improvement in South-East Asia	
75	Harris D.N. 2011.	Extending rice crop yield improvements in Lao PDR: an ACIAR–World Vision collaborative project	CIM/1999/048, CS1/1995/100 and PLIA/2000/165
76	Grewal B., Grunfeld H. and Sheehan P. 2011.	The contribution of agricultural growth to poverty reduction	

No.	Author(s) and year of publication	Title	ACIAR project numbers
77	Saunders C., Davis L. and Pearce D. 2012.	Rice–wheat cropping systems in India and Australia, and development of the 'Happy Seeder'	LWR/2000/089, LWR/2006/132 and CSE/2006/124
78	Carpenter D. and McGillivray M. 2012	A methodology for assessing the poverty-reducing impacts of Australia's international agricultural research	
79	Dugdale A., Sadleir C., Tennant-Wood R. and Turner M. 2012	Developing and testing a tool for measuring capacity building	
80	Fisher H., Sar L. and Winzenried C. 2012	Oil palm pathways: an analysis of ACIAR's oil palm projects in Papua New Guinea	ASEM/1999/084, ASEM/2002/014, ASEM/2006/127, CP/1996/091, CP/2007/098, PC/2004/064, PC/2006/063
81	Pearce D. and White L. 2012	Including natural resource management and environmental impacts within impact assessment studies: methodological issues	
82	Fisher H. and Hohnen L. 2012	ACIAR's activities in Africa: a review	AS1/1983/003, AS1/1995/040, AS1/1995/111, AS1/1996/096, AS1/1998/010, AS2/1990/047, AS2/1991/018, AS2/1993/724, AS2/1996/014, AS2/1999/063, AS2/1996/090, AS2/1996/149, AS2/1996/203, AS2/1997/098, CP/1994/126, CS2/1990/007, EFS/1983/026, FST/1983/020, FST/1983/031, FST/1983/057, FST/1988/008, FST/1988/009, FST/1991/026, FST/1995/107, FST/1996/124, FST/1996/206, FST/2003/002, IAP/1996/181, LPS/1999/036, LPS/2002/081, LPS/2004/022, LPS/2008/013, LWR/2011/015, LWR1/1994/046, LWR2/1987/035, LWR2/1996/049, LWR2/1996/163, LWRS/1996/215, LWR2/1997/038, SMCN/1999/003, SMCN/1999/004, SMCN/2000/173, SMCN/2001/028
83	Palis F.G., Sumalde Z.M., Torres C.S., Contreras A.P. and Datar F.A. 2013	Impact pathway analysis of ACIAR's investment in rodent control in Vietnam, Lao PDR and Cambodia	ADP/2000/007, ADP/2003/060, ADP/2004/016, AS1/1994/020, AS1/1996/079, AS1/1998/036, CARD 2000/024, PLIA/2000/165
84	Mayne J. and Stern E. 2013	Impact evaluation of natural resource management research programs: a broader view	
85	Jilani A., Pearce D. and Bailo F. 2013	ACIAR wheat and maize projects in Afghanistan	SMCN/2002/028, CIM/2004/002 and CIM/2007/065
86	Lindner B., McLeod P. and Mullen J. 2013	Returns to ACIAR's investment in bilateral agricultural research	
87	Fisher H. 2014	Newcastle disease control in Africa	AS1/1995/040, AS1/1996/096
88	Clarke M. 2015	ACIAR-funded crop–livestock projects, Tibet Autonomous Region, People's Republic of China	LPS/2002/104, CIM/2002/093, LPS/2005/018, LPS/2005/129, LPS/2006/119, LPS/2008/048, LPS/2010/028, C2012/228, C2013/017

No.	Author(s) and year of publication	Title	ACIAR project numbers
89	Pearce D. 2016	Sustaining cocoa production: impact evaluation of cocoa projects in Indonesia and Papua New Guinea	SMAR/2005/074, HORT/2010/011, ASEM/2003/015, ASEM/2006/127, PC/2006/114
90	Pearce D. 2016	Impact of private sector involvement in ACIAR projects: a framework and cocoa case studies	PC/2006/114, ASEM/2006/127, SMAR/2005/074, HORT/2010/011
91	Brown P. R., Nidumolu U. B., Kuehne G., Llewellyn R., Mungai O., Brown B. and Ouzman J. 2016	Development of the public release version of Smallholder ADOPT for developing countries	
92	Davila F., Sloan T. and van Kerkhoff L. 2016	Knowledge systems and RAPID framework for impact assessments	CP/1997/017
93	Mullen, J.D., de Meyer, J., Gray, D. and Morris, G. 2016.	Recognising the contribution of capacity building in ACIAR bilateral projects: Case studies from three IAS reports.	FST/1986/030, FST/1993/118, FST/1998/096, FIS/2005/114
94	Davila F., Sloan T., Milne M., and van Kerkhoff L., 2017	Impact assessment of giant clam research in the Indo-Pacific region	FIS/1982/032, FIS/1987/033, EFS/1988/023, FIS/1995/042

Impact assessment of giant clam research in the Indo–Pacific region

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