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Editorial

The original intent of the *Traditional Marine Resource Management and Knowledge Bulletin*, which was first launched in 1992, was that it would serve as a hub for the collection, discussion and dissemination of information on traditional marine resource management systems and the traditional ecological knowledge (TEK) on which these systems are based. Kenneth Ruddle was the originating editor of the bulletin and the main driver of its existence over the last 30 years (except for issues 37 and 38 where Philippa Cohen was a guest co-editor alongside Kenneth).

Kenneth was an outstanding choice as editor because he was a pioneer along with other distinguished persons – such as Tomoya Akimichi, John Cordell, Robert Johannes, Bernard Nietschmann, Richard Pollnac, Nicholas Polunin and Robert Pomeroy – researching and advocating for the recognition of both TEK and what has since become known as customary marine tenureship. These two terms have inspired other researchers in the fields of anthropology and marine biology, including myself, Shankar Aswani, Joshua Cinner, Philippa Cohen, Simon Foale and Edvard Hviding, and many others.

In issue 7 (September 1996), Kenneth made impassioned pleas for authors to use the *Traditional Marine Resource Management and Knowledge Bulletin* to share their research and experiences. But it was not until three years later, in issue 11 (September 1999), that the bulletin received all its articles unsolicited. Issues 15 (July 2003) and 16 (December 2004) were the only other issues where the bulletin received all its contributions unsolicited, without Kenneth having to put a call out to peers and colleagues to contribute their research findings.

Last year, I was asked by SPC to be the guest editor for the *Traditional Marine Resource Management and Knowledge Bulletin*, which had been inactive for three years as Kenneth became occupied with several other issues that required his attention and in April this year, Kenneth sadly passed away (you can see an eulogy for Kenneth by his friends Daniel Pauly and Anthony Davis at the following link: https://link.springer.com/article/10.1007/s40152-023-00334-0). To facilitate submissions, I sent emails to all Pacific Island countries and territories' fisheries agencies, and to everyone I knew working in non-governmental conservation organisations, and to many friends, peers and colleagues working in various academic institutions. All to no avail. Another attempt resulted in the five papers that make up this final issue of the bulletin.

Kenneth had also reported on this problem in the past, and which has continued to plague the bulletin. Many of us are all too familiar with the adage of "publish or perish". Publication metrics (e.g. ORCHID, Scopus, Google Scholar, Microsoft Academic, even Research Gate) are a measure of academic productivity and

are important for individual careers. They are also a significant part of the funding award process. Authors from academic institutions, therefore, are reluctant to publish their findings in non-peer reviewed and less formal publications.

During the 30-year lifespan of the *Traditional Marine Resource Management and Knowledge Bulletin*, nearly 150 articles have been published on TEK, customary marine tenure, community-based fisheries management, research methodologies, data collection, and other related issues. Of these, 63% were from Melanesia (Papua New Guinea, Solomon Islands, Vanuatu and Fiji), showing a strong bias towards TEK, partly due to the fact that many people residing in this region still live largely subsistence lifestyles.

Given the predominance of articles from Melanesia, it seems fitting, that for this final issue of the *Traditional Marine Resource Management and Knowledge Bulletin*, four articles are from Solomon Islands and one from Papua New Guinea.

In the first article, staff from the Solomon Islands' Ministry of Fisheries and Marine Resources – in collaboration with the Overseas Fisheries Cooperation Foundation – detail the results of a pilot project that started in 2010, and involved the hatchery production of juvenile peanutfish (*Stichopus horrens*) to be released into wild habitats under co-management arrangements. The authors report on the issues and challenges that were faced while implementing this project, and highlighted the "modern" realities of community-based fisheries management with community dependency and demands. The authors provide recommendations to enhance such co-management arrangements in the future.

The second article focuses on the management and protection of fish spawning aggregations (FSAs) in Solomon Islands. To help understand FSAs, the authors collected TEK from 102 fishers residing around Munda, and Roviana and Marovo lagoons in the Western Province. This information was used to inform community-based fisheries management of the identified FSAs, and provide recommendations for adapting current government regulations for managing FSAs. By using TEK, information regarding the spawning of important grouper species pointed to regional variations in spawning times among individual species, specifically groupers, and identified areas for concern regarding the current nationwide seasonal ban.

The third article moves us from the coastal fringe onto land and into ponds for farming tilapia in Solomon Islands' Malaita Province. It highlights the issues with providing extension services to tilapia farmers, and reports on key lessons learned from this project. Technology and e-platforms for communication and data collection are increasingly becoming the new TEK. The development of a tilapia app was seen as a vital breakthrough in disseminating relevant information to tilapia farmers for extension purposes, and this resulted in greater sharing of technology, increased farmer motivation, and stronger awareness of the need to integrate health and safety as positive impacts.

The fourth article from the Solomon Islands, involves a team of researchers from Solomon Islands National University, James Cook University (Australia), Solomon Island Ministries of Health and Medical Services, and Justice and Legal Affairs, who conducted an investigation of livelihood options with communities of the Sirubai Voko Tribal Association in southeast Vella La Vella in Western Province. Using a diagnostic workshop, four generic strategies were formulated from the communities' strengths, weaknesses, opportunities and threats. The diagnostic analysis was followed by an assessment of six livelihood options to realise their suitability for supplementing the community's resource management initiatives.

The fifth and final article highlights not only the highly biodiverse marine environment of Papua New Guinea's Milne Bay Province, but also reports on the ongoing efforts that have been made to establish local marine management areas. In 2017, a local system of customary marine management called *gwala* (in the Bwanabwana language) was promoted for its integral and historical cultural value, rather than the previous focus by an international NGO on Western notions of science and conservation. The use of *gwala* provides communities with a familiar method to manage their marine resources and associated environments for food and livelihood security, resulting in localised recovery of declining marine resources.

While two of the papers in this final issue of the bulletin have highlighted that while "traditional ecological knowledge" has its place, ecological knowledge that increasingly utilises multi-media technology is becoming increasingly important. Unfortunately, however, the *Traditional Marine Resource Management and Knowledge Bulletin* is unable to follow this new trajectory. To ensure there is still an option for highlighting continuing research and work in this field, SPC has created the web portal "Echoes of Oceania" (https://cbfm.spc.int/), which can be used to share information and research.

In addition, the SPC *Fisheries Newsletter* remains open to publishing articles relating to fisheries and aquaculture, including those on TEK, and I urge you to use it if you have articles you would like to see published. The SPC *Fisheries Newsletter* has a wide readership across the Pacific Islands region and is easily accessible (where many formal journal articles are not).

For my last words, I'd like to say "*vale*" to the *Traditional Marine Resources Knowledge and Management Bulletin*, and to Kenneth Ruddle, I would like to express how important his considerable efforts over the last 30 years in managing this bulletin have been.

Jeff Kinch

Lessons for government-led community trials for improved sea cucumber management outcomes

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Introduction

Sea cucumbers are an important fishery resource with high export value to Asian markets, mainly China (Rahman and Yusoff 2017; Purcell et al. 2018 Kinch et al. 2008). In Solomon Islands, the fishery has the potential to be a multi-million-dollar industry (Pakoa et al. 2014). The fishery has long provided an important source of income for rural communities and foreign exchange revenue in the form of export duty for the country. In 2021, high-value species (e.g. white teatfish, sandfish and peanutfish) were sold for between SBD[3] 300 and 600 per kilogram/dry weight by sea cucumber fishers (Ministry of Fisheries and Marine Resources 2021a).

Increasing market demand, overexploitation and inadequate fisheries management have, however, led natural stocks sea cucumbers to dramatically decline (Zacarías-Soto et al. 2013; Domínguez-Godino et al. 2014; Pakoa et al. 2014). Recognising this, the Solomon Islands government placed the first moratorium on sea cucumber harvests and export in 2005 (Nash and Ramofafia 2006), with the aim of allowing the fishery to revive. Because of the intense commercial interest in the fishery, the Ministry of Fisheries and Marine Resources (MFMR) has come under pressure to re-open the fishery several times since then (Pakoa et al. 2014) and it has become the norm to manage the fishery by regular openings and closures. The fishery has not revived under this regime as evidenced by undersized beche-de-mer (dried form of sea cucumbers) sold to Chinese businesses (Ministry of Fisheries and Marine Resources 2018a), and by Pakoa et al. (2014) who described the Solomon Islands sea cucumber fishery as being on the verge of collapse.

In Solomon Islands, sea cucumber management has been governed by the sea cucumber management regulations 2015 (Ministry of Fisheries and Marine Resources 2014) and were identified by the Solomon Islands government in the National Aquaculture Development Plan 2019–2023 as one of the top three priority commodities for development. Although a draft document exists, MFMR has yet to develop a comprehensive policy with strategies to guide the development of the sea cucumber fishery, and to provide a conducive environment that enables the sustainable use of this important fisheries resource. In the absence of an overarching policy, the sea cucumber fisheries have continued to be managed using the precautionary approach by enforcing open and closed seasons.

Sea cucumber research in Solomon Islands began in the early 1990s when researchers at the International Centre for Living Aquatic Resources Management undertook research on the viability of producing sea cucumbers (*Holothuria scabra, H. fuscogilva* and *Actinopyga mauritiana*) in a hatchery for stock enhancement (Battaglene 1999; Battaglene and Bell 1999). In recent decades, concerns about overexploitation has led to ongoing initiatives to promote ranching and restocking programmes as an income-generating activity and a means to rejuvenate wild stocks (Jimmy et al. 2011). Sea cucumber aquaculture in the Pacific Islands region is growing, with the establishment of various hatcheries and restocking programmes in various countries, including Solomon Islands (Jimmy et al. 2011). The focus of most hatcheries is mass production for restocking to replenish depleted stocks (SPC 2009; Jimmy et al. 2011). Species of interest include sandfish, white teatfish (*Holothuria fuscogilva*), peanutfish (*Stichopus horrens*), blackfish (*Actinopyga miliaris*) and surf redfish (*Actinopyga mauritiana*) (Jimmy et al. 2011).

In 2010, the Solomon Islands government – through MFMR and the Overseas Fisheries Cooperation Foundation (OFCF) of Japan – cooperatively started a pilot project for the management of sea cucumbers in Solomon Islands, which included hatchery productions of juvenile sea cucumbers to be released to the wild habitats. This joint government–community livelihood project is focused on peanutfish (*Stichopus horrens*), because of this species' availability for research purpose and high market value.

The project has focused on two main components: 1) the mass production of juveniles in a hatchery at MFMR for restocking depleted wild stocks, which involves broodstock collection by community members (monitors) from project sites, hatchery juvenile production, juvenile husbandry, and restocking (Fig. 1); and 2) researching juvenile recruitment patterns by involving communities to set up collectors along the breeding ground in order to collect juveniles. The project has had three phases over a 12-year period:

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[3] SBD 1.00 = USD 0.12 (as of 31 August 2023)
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- **Phase 1** – Preparation, which includes infrastructure, identifying a community project site, biology, hatchery staff training and breeding trials.

- **Phase 2** – Practice, which involves improving juvenile production and their wild release, and expanding the number of project sites.

- **Phase 3** – Continuation of practice through the transfer of expertise and techniques from OFCF experts to MFMR counterparts, and conducting trials on the collection of juveniles from the wild as a basis for community-based resource management.

The focus on community trials throughout all phases has required project staff (MFMR and OFCF) to engage with selected communities. While agreements have been reached and activities undertaken, over that time, there have been many issues related to the community-based activities, which have caused delays and setbacks to project outcomes. Now in Phase 3 of the project, we reflect on the outcomes to date with respect to the community trials. We identify issues that the project has experienced with community-based activities, and by reviewing project documentation, reflect on how these could be mitigated or avoided in the future. We identify lessons and provide recommendations for similar projects in the context of improved co-management for Solomon Islands sea cucumber fisheries.

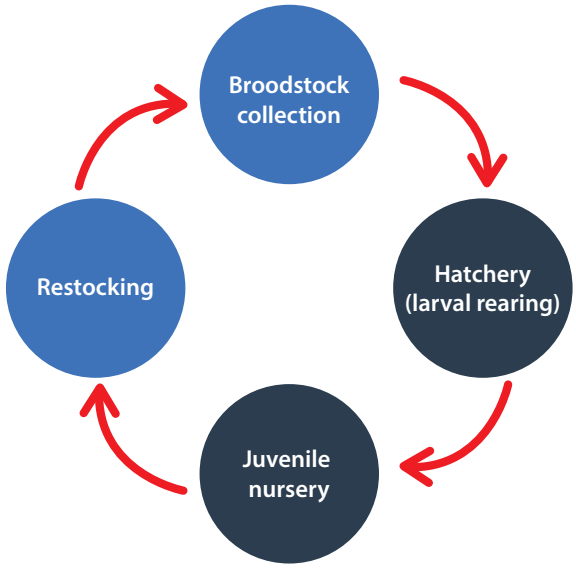

Figure 1. Cycle of sea cucumber project (hatchery component) involves four stages; black-coloured stages were carried out by project staff (MFMR and OFCF) and blue ones were carried out by community project partners.

Methodology

The authors of this paper are either MFMR or OFCF officers who are actively engaged in project activities. Information collated for this paper was summarised from trip reports, minutes from consultation meetings and memorandum of understanding (MOU) discussions, project reports, and informal interviews with community members.

The documents were reviewed to identify the issues that had been experienced, and these were summarised under themes. We also listed some of the apparent root causes of the issues that were identified and their impact on project implementation. Finally, we identified opportunities for mitigation or avoidance in the future.

Community project partners

To identify which communities were interested in being community project partners, criteria were based on the availability of peanutfish stock at that time (2010), a suitable environment for sea ranching hatchery-produced juveniles, and the proximity of the site to the hatchery in Honiara. No information was collected on socioeconomic aspects of the project sites.

The sites were the Hatare sea cucumber association in Marau, east of Guadalcanal Province, and the Nagotano sea cucumber association in Buena Vista, Ngella, Central Province (Fig. 2).

Hatare sea cucumber association in Marau Sound is made up of three sub-tribes: the chiefly, priestly and warrior tribes. The association has a hierarchy structure whereby the chiefs are depicted as having power over committee members and monitors (Fig. 3). However, all decisions regarding the project, in terms of who can attend the consultation meetings, MOU discussions and selection of monitor members, were made by the committee.

Marau Sound is a well-known tourist destination with basic infrastructure such as an airstrip, wharf, schools, police, fisheries centre, market, mini-clinic and resort. Over the years, numerous livelihood projects in the field of fisheries, including the conservation, management and rehabilitation of coral reef resources through the creation of marine protected areas (MPAs) and appropriate mariculture initiatives (Tabo et al. 2004) have been carried out there. There have also been agricultural projects such as one on integrated crop management (including pest and soil management) for farms. Finally, there has been a livelihood economic development project by World Vision, marine resource governance by Foundation of the Peoples of the South Pacific (Schwarz et al. 2013), not to mention the provision of fish aggregation devices (FADs) and a new market.

The Nagotano sea cucumber association has a similar structure (Fig. 3). Chiefs of the three sub-tribes were appointed as head of the Nagotano sea cucumber project. Their structure, however, allowed for four working groups, selected according to the four zones within their community. Each of the groups consists of all households within each zone,

Figure 2. Sea cucumber peanutfish (*Stichopus horrens*) project sites.

including men, women and youth. These groups take turns monitoring juvenile sea cucumbers that have been released, and collecting data. There have been fewer development project opportunities at Buena Vista compared to Marau, although the region is a tourist destination for diving and for visitors from Honiara (Flysolomons 2022; Pinca et al. 2009).

To promote co-management, MOUs were developed between MFMR and each community. Initially MOUs were for one year only, but this was found to be too short and was increased to three years. The MOUs outlined how broodstock should be collected from the customary waters of the relevant tribes in the two areas, and stated that restocking from the hatchery would be done at the same location as where the broodstock were collected. The MOUs outlined how the project partners (MFMR and OFCF) would provide some livelihood assistance to the communities, including FADs, training and materials for tilapia farming, and fishing equipment. Monitors were paid for 15 days a month at SBD 100 per day for site security and data collection from re-stocked sites through a separate contract arrangement. Monitors were paid directly by MFMR through special interest group finance processes, in Marau payments were made directly to individual monitors, and in Gela a lump sum payment (at the same rate) was paid to the committee who oversaw the validation of datasheets and funds disbursement to the individual monitors (Fig. 3).

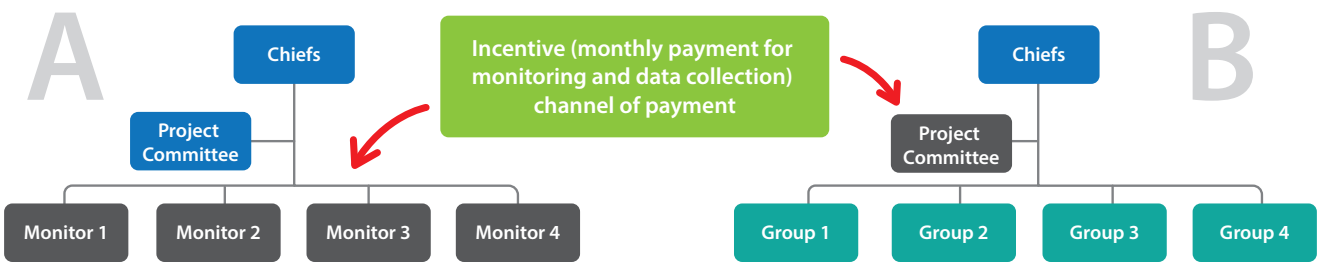

Figure 3. Hatare (A) and (B) Nagotano sea cucumber association structures and the channel of payment for monitoring and data collection.

Findings

Social issues

We identified three major issues we experienced and, which, impacted the project at different levels (Fig. 4): 1) demand for more project benefits from the community partners, 2) internal community disputes, and 3) delay of cash payments.

Demand for more benefits

Over 12 years, the project signed six MOUs for Hatare: four MOUs for a one-year duration and two MOUs for a three-year duration. Two MOUs, each three years in duration, have been implemented for Nagotano. The project partners showed genuine commitments at the start but over time, this commitment decreased. One issue identified was that community members started noticing that certain individuals appeared to be having control over the entire project for their own gain.

MFMR delivered on the FADs, tilapia training and fishing equipment (although with the latter, there were some delays with items that needed to be purchased from overseas), and the government invested SBD 400,000 each year under its development budget for the operation of the project. Furthermore, OFCF-Japan has contributed 12 years of technical and material support. Nevertheless, at each consecutive MOU signing, there were demands for ever- increasing financial and material support to go to the communities. In addition, when the sea cucumber fishery was opened by the government in 2021 (Ministry of Fisheries and Marine Resources 2021b), both project sites demanded assistance from MFMR on top of their 15 days of monitoring payments, to help them look after (provide security from poaching) the project site. Demands have largely been met by MFMR and OFCF, despite the demands realistically being beyond the scope of what was able to be provided in a sustainable manner.

Internal community disputes

Conflict among the different tribes at the project sites was identified as an issue negatively impacting the project's success. This was a bigger issue at one of the community sites than the other. Disagreements and disputes among individuals in one community, on one occasion resulted in officers from MFMR and OFCF being refused access to the project site and turned back by a disputing party. This resulted in halting the project in terms of access for broodstock collection, data collection and research. Similarly, during one MOU signing, a heated debate between the tribes resulted in postponing the MOU signing. It took more than a year to solve the issue and sign the MOU.

In Hatare in 2021, one of the three tribes separated from the other two tribes for the purpose of dealing with the project. The two groups drew a boundary to delimit two distinct maritime zones for the purposes of the project. Now two separate MOUs for the Hatare site are being sought by the two groups.

Delay of cash payments

The opportunity cost for the monitors of fulfilling their role was recognised by a means of monthly payment directly to their individual bank accounts in Hatare (Fig. 3A). It was not always possible, however, for MFMR to make the payments on time due to delays in processing payments through the

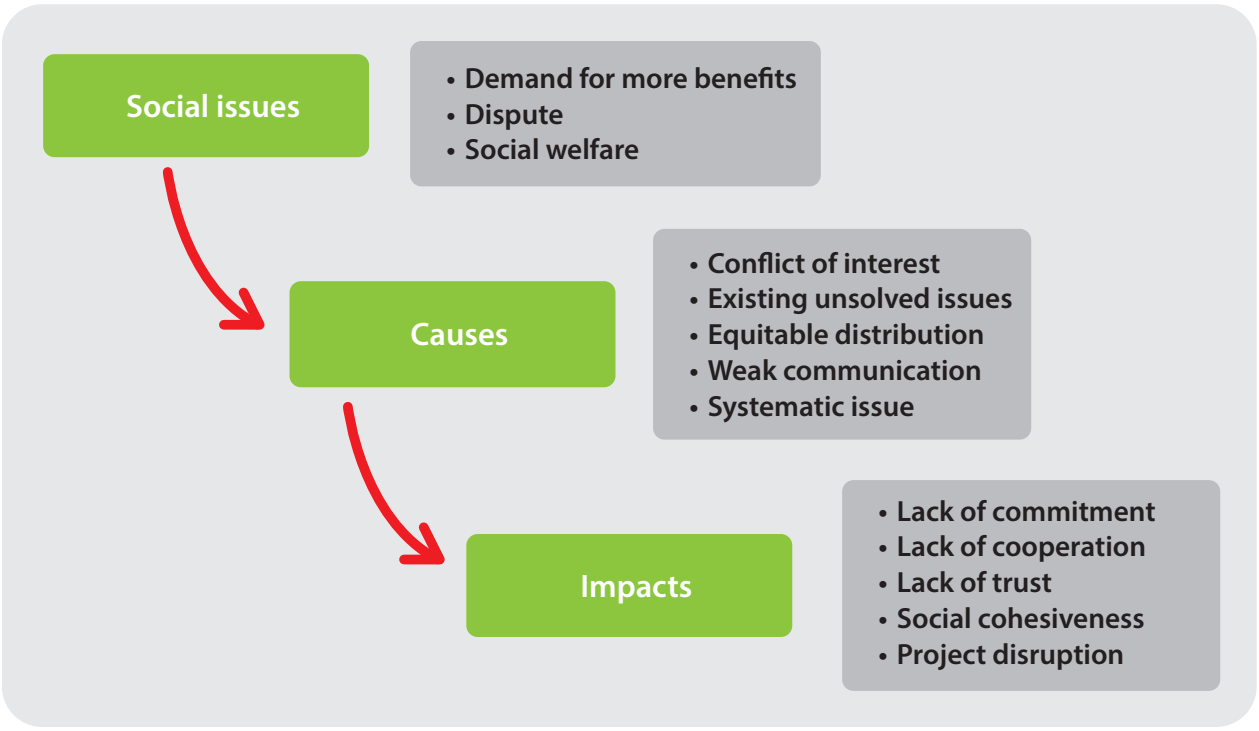

Figure 4. Social issues identified for Hatare and Nagotano sea cucumber project sites.

Ministry of Finance and Treasury. The challenge of meeting personal and family obligations for the monitors was high. At times, delays of their payments forced officers to feel that they needed to lend money from their own pockets when monitors approached them to borrow money from the OFCF office in Honiara. This caused considerable inconvenience because the officer then required repayment from the monitors, who were understandably reluctant to repay in a timely manner themselves.

This is not the case for the working groups in Nagotano, where monthly payments were made to the committee as a lump sum, and the treasurer was then responsible for disbursement (Fig. 3B). The committee also seemed to be more willing and able to accept any delays in payment from the government.

Root causes

We found that there were some root causes in the community, and in the partnership between the government and the community, that were likely exacerbating these issues.

Conflicts of interest were observed to be a factor leading to demands for more benefits. There were reports from community members of instances where payments intended for the community – such as goodwill payments and access fees – were used by certain individuals for their own benefit instead of giving it to the community. Similarly, individuals controlled project assets (e.g. boats and diving gear) that, according to the MOU, were for project use and not for personal use.

Unsolved issues among the project tribes also contributed to the social issues affecting the project. In Marau there is an ongoing dispute regarding the land and benefits from the domestic airstrip. This airstrip is controlled by one of the three tribes, and therefore the benefits were unfairly distributed. This particular dispute spilled over to the project in that it led to two of the three tribes having total control over the sea cucumber project in terms of benefits. This resulted in the disolution of the sea cucumber project committee.

Inequitable distribution in terms of unequal workforce representation and benefit sharing was identified as an issue in meetings and interviews. Men and women expressed dissatisfaction with outcomes, and the women who were interviewed expressed some particular concerns, including the inequality of labour and benefits provided by the project, committee decisions were biased and unfair, and women had seen no tangible benefits reaching the people apart from the stock's improvement (peanutfish abundance). Suspicions were also expressed about the way in which goodwill or access fees were used and whether they even reached the community.

Interviews at both project sites revealed that *communication and awareness* was lacking between the government and the communities as well as the project committee and the community. Women particularly noted that they had lost track of the project's progress and were unaware of what was going on, on the ground. From the government's perspective, all information was channelled through the established community structures, and there was an expectation that the information would be shared. It became apparent, however, that information did not go beyond the project committee.

Lastly*, the institutional issue on the part of the government partner* of delays in payments and handover of materials impacted the welfare of the project's partners, and complaints were commonly raised in project meetings. The government's payment processes through the Ministry of Finance and Treasury contributed to the delay of payments, and some materials and equipment had to be purchased overseas by the local supplier, sometimes taking months. The persistent challenge of the constraints imposed by government cash flow issues and processing of transactions – that at times dragged out payments for months – affected the morale of all concerned, project officers and community members alike.

Discussion

The identified social issues generated additional costs to the project, prevented progress, and made cooperation between stakeholders difficult; factors that have been identified elsewhere that result in ineffectiveness (Beuret et al. 2019).

The types of issues and causes identified for this joint government–community livelihood project are not new to the small-scale fisheries and coastal livelihoods sector, where such issues have impacted on stakeholder commitment (Haapasaari et al. 2007), cooperation (Almany et al. 2015) and trust. Social issues are a big part of any fishery because management of the fishery cannot be separated from the people (Hair et al. 2020).

Safeguarding coastal fisheries in the Pacific is critical for the security of people's food, sources of income and livelihoods, and sustaining the natural environment (Veitayaki 2021). This has resulted in the establishment of various fisheries livelihood projects in Small Island Development States, although the management and sustainability of these projects are often challenging. Much of the literature reveals that, in general, factors such as climate change (Neena 2021), market forces (Chuenpagdee et al. 2019), socioeconomic conditions (Kronen et al. 2010), social, and cultural norms (Charles 1994; Boyd and Charles 2006; Connelly 2007), governance (Eriksson et al. 2012; Fabinyi and Barclay 2022) and recently COVID-19 have all impacted the outcomes of livelihood projects. Projects that come with few alternatives for fishers to earn money (Barclay et al. 2019) often result in people showing less commitment to the project.-

This project explicitly set out to have a resource management and livelihood component, offering FADs, seaweed culture and tilapia farming as opportunities for income generation as well as cash payments for opportunity costs for monitors. However, cooperation and trust became a challenge where there were significant conflicts of interest, unequal labour force representation from each tribe (with only one tribe

dominating the work force), and unequal distribution of project benefits among the tribes, which exacerbated existing tensions, such as an unresolved land rights case. Where there were no such unresolved local issues and there was trust in the leadership, cooperation was noticeably higher.

A co-management modality has the potential to improve service delivery for MFMR and is consistent with approaches to community-based resource management (Ministry of Fisheries and Marine Resources 2021c), the national fisheries policy (Ministry of Fisheries and Marine Resources 2019) and the national development plan (Ministry of Development Planning and Aid Coordination 2016) as well as the Aquaculture Development Strategy (Ministry of Fisheries and Marine Resources 2018b). For this to be an effective strategy, however, it is important to learn lessons and adapt approaches moving forward. We unpack some of the areas where we recommend that further attention be paid for such government–community partnerships, and the following recommendations are suggested.

- Prior to agreeing to MOUs, undertake inclusive consultations to develop an understanding of the social and economic challenges and opportunities that could impact on the contribution of the intended community partner, and to develop a mutual understanding of the project's scope.

- Design and implement a staged awareness programme for all members of the community. Awareness should not be a onetime event, but should be periodic and ongoing and needs to be facilitated between the government and the (different groups within) communities as well as between the project committee and community members.

- The role of the government, its functions and timeframes or payment methods must be clearly explained to the project partners and risks identified to avoid frustrations.

- More appropriate arrangements for disbursing funds within the government's finance regulations should be explored to better accommodate a particular project's needs.

- Potential risks to the use of project assets should be identified with different social groups in the community prior to developing agreements to ensure the arrangements mitigate identified risks and are understood, agreed on, and identified across all parties prior to assets being allocated.

- Develop longer-duration MOUs. Three years is more reasonable than one year because of the time, effort and negotiations required.

- Manage expectations with the community when goods are to be purchased outside of the country. The speed of delivery will be outside the control of MFMR because it depends on the payment system and other payment logistics.

- MFMR should develop a policy around payments for community co-management in order to avoid unnecessary claims and increases in MOU demands. Projects can be viewed as an opportunity to take advantage of, or to make, money.

These recommendations are consistent with previous recommendations (e.g. Hviding 1993) made with regard to giant clam mariculture in Solomon Islands, in that greater attention should be paid to social and cultural parameters, and for their improved integration (alongside with biological and technical aspects) into village trial activities. The recommendations are also consistent with emerging approaches within MFMR, where more attention is being paid to gender and socially inclusive approaches to community engagement (e.g. Barclay et al. 2021). Improved understanding, recognition and capacity in developing community agreements will also help MFMR to nurture and guide its partners in development (MFMR 2019) for more effective community partnerships. Identifying the socioeconomic issues (Kronen et al. 2011), and the processes and relationships that are formed between them is the key to sustainability (Urquhart et al. 2014) and are important to the success of government-supported fisheries projects. Understanding and addressing these issues can help improve holistic management (Purdy et al. 2017). We hope that by highlighting our own experience we can share lessons and recommendations that will contribute to the ongoing improved implementation of such projects.

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References

Almany G.R., Hamilton R.J., Matawai M. and Kichawen P. 2015. Local benefits of community-based management: Using small managed areas to rebuild and sustain some coastal fisheries. SPC Traditional Marine Resource Management and Knowledge Information Bulletin 35:3–17. https://purl.org/spc/digilib/doc/wrtdt

Barclay K., Fabinyi M., Kinch J. and Foale S. 2019. Governability of high-value fisheries in low-income contexts: a case study of the sea cucumber fishery in Papua New Guinea. Human Ecology 47:381–396. https://link.springer.com/content/pdf/10.1007/s10745-019-00078-8.pdf

Barclay K., Mangubhai S., Leduc B., Donato-Hunt C., Makhoul N., Kinch J. and Kalsuak J. (eds). 2021. Pacific handbook for gender equity and social inclusion in coastal fisheries and aquaculture. Noumea, New Caledonia: Pacific Community. 202 p. https://purl.org/spc/digilib/doc/mav7c

Battaglene S.C. 1999. Culture of tropical sea cucumbers for the purposes of stock restoration and enhancement. NAGA, The ICLARM Quarterly 22(4):4–11.

Battaglene S.C. and Bell J.D. 1999. Potential of the tropical Indo-Pacific sea cucumber, Holothuria scabra, for stock enhancement. p. 478–490. In: Howell B.R., Moskness E. and Svasand T. (eds). Stock enhancement and sea ranching. Bergen, Norway: Blackwell Science, Oxford.

Beuret J.E., Cadoret A., Pothin K., Barnay A., Le Bihan O. and Sevin Allouet M. 2019. Understanding and valuing conflicts in marine protected areas: The best way to develop innovations? Aquatic Conservation 29(S2):212–222. https://doi.org/10.1002/aqc.3070

Boyd H. and Charles A. 2006. Creating community-based indicators to monitor sustainability of local fisheries. Ocean and Coastal Management 49:237–258.

Charles A.T. 1994. Towards sustainability: The fishery experience. Ecological Economics 11(3):201–211.

Chuenpagdee R., Salas S. and Barragán-Paladines M.J. 2019. Big questions about sustainability and viability in small-scale fisheries. p. 3–13. In: Chuenpagdee R., Salas S. and Barragán-Paladines M.J. Viability and sustainability of small-scale fisheries in Latin America and the Caribbean. Center for Maritime Research, MARE Series #19. New York, New York: Springer International Publishing.

Connelly S. 2007. Mapping sustainable development as a contested concept. Local Environment 12:259–278.

Domínguez-Godino J.A., Slater M.J., Hannon C. and González-W.M. 2015. A new species for sea cucumber ranching and aquaculture: Breeding and rearing of Holothuria arguinensis. Aquaculture 438:122–128. https://doi.org/10.1016/j.aquaculture.2015.01.004.

Eriksson H., Robinson G., Slater M.J. and Troell M. 2012. Sea cucumber aquaculture in the Western Indian Ocean: Challenges for sustainable livelihood and stock improvement. Ambio 41(2):109–121. https://doi.org/10.1007/s13280-011-0195-8

Fabinyi M. and Barclay K. 2022. Asia-Pacific fishing livelihoods. Cham, Switzerland: Palgrave Macmillan. https://doi.org/10.1007/978-3-030-79591-7

Flysolomons. 2022. Tulagi, Central Province. Solomon Airlines. https://www.flysolomons.com/about-us/contact-us

Haapasaari P., Michielsens C., Karjalainen T., Reinikainen K. and Kuikka S. 2007. Management measures and fishers' commitment to sustainable exploitation: A case study of Atlantic salmon fisheries in the Baltic Sea. ICES Journal of Marine Science. 64: https://doi.org/10.1093/icesjms/fsm002

Hair C., Foal, S., Daniels N., Minimulu P., Aini J. and Southgate P.C. 2020. Social and economic challenges to community-based sea cucumber mariculture development in New Ireland province, Papua New Guinea. Marine Policy 117. https://doi.org/10.1016/j.marpol.2020.103940

Hviding E. 1993. The rural context of giant clam mariculture in Solomon Islands: An anthropological study. Manila, Philippines: International Center for Living Aquatic Resources Management.

Jimmy R., Pickering T. and Hair C. 2011. Overview of aquaculture and stocking research in the Western Pacific region. Asia/Pacific tropical sea cucumber symposium, 15–17 February 2011, Noumea, New Caledonia.

Kinch J., Purcell S., Uthicke S. and Friedman K. 2008. Population status, fisheries, and trade of sea cucumbers in the Western Central Pacific. p. 7–55. In: Toral-Granda V., Lovatelli A. and Vasconcellos M. Sea cucumbers. A global review of fisheries and trade. FAO Fisheries and Aquaculture Technical Paper No. 516. Rome, Italy: Food and Agriculture Organization of the United Nations.

Kronen M., Vunisea A., Magron F. and McArdle B. 2010. Socio-economic drivers and indicators for artisanal coastal fisheries in Pacific Island countries and territories and their use for fisheries management strategies. Marine Policy 34. https://www.sciencedirect.com/science/article/pii/S0308597X10000655

Kronen M., Pinca S., Magron F., McArdle B., Vunisea A., Vigliola L., Kulbicki M. and Andréfouët S. 2011. Socio-economic and fishery indicators to identify and monitor artisanal finfishing pressure in Pacific Island countries and territories. Ocean and Coastal Management 55(2):63–73.

Ministry of Development Planning and Aid Coordination. 2016. National Development Strategy 2016 to 2035. Improving the social and economic livelihoods of all Solomon Islanders. Honiara, Solomon Islands: Ministry of Development Planning and Aid Coordination.

Ministry of Fisheries and Marine Resources. 2014. Fisheries (beche-de-mer) (amendment) regulations 2014. Honiara, Solomon Islands: Solomon Islands Government.

Ministry of Fisheries and Marine Resources. 2018a. Sea cucumber price listing. Unpublished raw data. MFMR, Solomon Islands.

Ministry of Fisheries and Marine Resources. 2018b. Solomon Islands national aquaculture management and development plan 2018–2023. Honiara, Solomon Islands: Ministry of Fisheries and Marine Resources.

Ministry of Fisheries and Marine Resources. 2019. Solomon Islands national fisheries policy 2019–2029. A policy for conservation, management, development and sustainable use of fisheries and aquatic resources of Solomon Islands. Honiara, Solomon Islands: Ministry of Fisheries and Marine Resources.

Ministry of Fisheries and Marine Resources. 2021a. Sea cucumber price listing. Unpublished raw data. Honiara, Solomon Islands: Ministry of Fisheries and Marine Resources.

Ministry of Fisheries and Marine Resources. 2021b. Sea cucumber minimum harvest, purchase and export sizes. Accessed online at https://www.fisheries.gov.sb/announcements/notifications/88-sea-cucumber-minimum-harvest-purchase-and-export-sizes

Ministry of Fisheries and Marine Resources 2021c. Solomon Islands community based coastal and marine resource management strategy 2021–2025. Honiara, Solomon Islands: Ministry of Fisheries and Marine Resources.

Nash W. and Ramofafia C. 2006. Recent developments with the sea cucumber fishery in Solomon Islands. SPC Beche-de-mer Information Bulletin 23:3–4. https://purl.org/spc/digilib/doc/sqgz4

Neena B. 2021. Why Pacific Island nations, like the Federated States of Micronesia, need climate change finance for food security now. Pacific Environews, 2 July 2021.

Pakoa K., Masu R., Teri J., Leqata J., Tua P., Fisk D. and Bertram I. 2014. Solomon Islands sea cucumber resource status and recommendations for management. Noumea, New Caledonia: Secretariat of the Pacific community. 60 p. https://purl.org/spc/digilib/doc/skzww

Pinca S., Vunisea A., Lasi F., Friedman K.J., Kronen M., Awira R., Boblin P., Tardy E., Chapman L.B. and Magron F. 2009. Solomon Islands country report: Profiles and results from survey work at Nggela, Marau, Rarumana and Chubikopi (June to September 2006 and December 2006). Pacific Regional Oceanic and Coastal Fisheries Development Programme (PROCFish/C/CoFish). Noumea, New Caledonia: Secretariat of the Pacific Community. 409 p. http://purl.org/spc/digilib/doc/drvft

Purcell S.W., Williamson D.H. and Ngaluafe P. 2018. Chinese market prices of beche-de-mer: Implications for fisheries and aquaculture. Marine Policy 91:58–65.

Purdy D.H., Hadley D.J., Kenter J.O. and Kinch J. 2017. Sea cucumber moratorium and livelihood diversity in Papua New Guinea. Coastal Management 45(2):161–177. https://doi.org/10.1080/08920753.2017.1278147

Rahman M.A. and Yusoff F. 2017. Sea cucumber fisheries: Market potential, trade, utilization and challenges for expanding the production in the South-East Asia. International Journal of Advances in Chemical Engineering, and Biological Sciences 4(1):26–30.

Schwarz A.M., Andrew N., Govan H., Harohau D. and Oeta J. 2013. Solomon Islands Malaita Hub Scoping Report. CGIAR Research Program on Aquatic Agricultural Systems. Penang, Malaysia Project Report: AAS-2013-18.

SPC (Secretariat of the Pacific Community). 2009. Use of hatcheries to increase production of sea cucumbers. Background Paper 4, Sixth SPC Heads of Fisheries Meeting, February 2009, Secretariat of the Pacific Community. https://purl.org/spc/digilib/doc/72qqb

Tabo S., Tafea H., Leqata J. and Kinch J. 2004. Community workshops in the Marau Sound, Guadalcanal, Solomon Islands. Suva, Fiji: Marine Aquarium Council and Foundations of the Peoples of the South Pacific. 15 p.

Urquhart J., Acott T.G., Symes D. and Zhao M. 2014. Introduction: Social issues in sustainable fisheries management. p. 1–20. In: Urquhart J., Acott T.G., Symes D. and Zhao M. (eds). Social issues in sustainable fisheries management. Dordrecht, Netherlands: Springer Netherlands.

Veitayaki J. 2021. Saving coastal fisheries in the Pacific: Food, livelihoods and community security. Australian Pacific Security College. Accessed online at https://pacificsecurity.net/saving-coastal-fisheries-in-the-pacific-food-livelihoods-and-community-security/

Zacarías-Soto M., Olvera-Novoa M.A., Pensamiento-Villarauz S. and Sanchez-Tapia I. 2013. Spawning and larval development of the four-sided sea cucumber, *Isostichopus badionotus* (Selenka 1867), under controlled conditions. Journal of World Aquaculture Society 44(5):694–705.

Identifying management options and effectiveness in Solomon Islands fisheries using traditional ecological knowledge

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Keywords:
fish spawning aggregations, Marovo Lagoon, Roviana Lagoon, community-based fisheries management, locally managed marine areas

Abstract

While most fish spawning aggregations are targeted by fishers in Solomon Islands, very little is still known about spawning aggregation locations and the timing of aggregations for different species. We collected traditional ecological knowledge from 102 fishers residing around Munda, as well as the Roviana and Marovo Lagoons in Western Province to inform community-based management of fish spawning aggregations, and to provide recommendations for adapting current government regulations for the management of aggregating grouper species. Fishers identified 31 separate fishing locations and 26 possible aggregation areas, validating findings from earlier surveys while also highlighting new areas for verification and management. Collated traditional environmental knowledge, integrated with spawning information derived from past studies, pointed to regional variations in spawning times among individual species, specifically groupers, that lessens the effectiveness of the current nationwide seasonal ban and suggests that finer-scale management is warranted at the site level.

Introduction

For many coral reef fishes, reproductive life history includes the formation of fish spawning aggregations (FSAs) that are typically characterised as seasonal events that occur ephemerally within one to several months of the year, depending on the species. At the population level, FSAs represent the sole means of replenishing populations, many through self-recruitment (Jones et al. 1999). At the ecosystem scale, FSAs serve as biological hotspots that provide food and nutrients to marine organisms across a wide trophic spectrum (Nemeth 2012). FSAs are often multi-species and may comprise thousands of individuals, thus representing substantial increases in biomass and nutrient flow. During these events, FSAs attract not only fishers, but also a wide variety of organisms, ranging from planktivores, detritivores, egg-eating fish and invertebrates, and marine megafauna, including manta rays, whale sharks and requiem sharks (Mourier et al. 2016; Rhodes et al. 2019). Thus, their loss can have substantial impacts not only to fisheries, but also to ecosystem dynamics and function.

In the western Pacific, multi-species FSAs form at spatially and temporally predictable sites that attract fishers because of the high catch rates and fish volumes they can obtain over brief periods of time. The timing and location of FSAs is common knowledge among fishers who traditionally depend on them for subsistence and, more recently, small-scale commercial purposes (Hamilton and Kama 2004; Hamilton et al. 2012; Rhodes et al. 2019). Continuing human population growth and an expanding cash economy have, however, intensified FSA fishing, placing FSAs under increasing threat. Indeed, an expanding number of FSA-forming species are now listed among the IUCN Red List's higher threat categories.[4]

To adequately protect these important events and the marine resources dependent on them, resource managers and conservationists worldwide are calling for FSAs to be incorporated into fisheries management (Erisman et al. 2015). Among the most commonly used management methods are area protection, and harvest and sales bans. However, both require information on the spatial and temporal nature of these events, as well as finding the appropriate mechanisms and means for effective monitoring and enforcement.

In Solomon Islands, fishing has heavily impacted FSAs, with density decreases recorded for FSAs near population centres and extirpation where FSA fishing is intense (Hamilton and Kama 2004; Hughes et al. 2020). The Solomon Islands Ministry of Fisheries and Marine Resources (MFMR) developed specific regulations protecting FSAs published in the Solomon Islands Gazette (Fisheries Management [Prohibited Activities and Amendments] Regulations 2018), with a harvest and sales ban from October to January. The regulations also include size limits on key FSA-forming species of groupers and on two other FSA-forming species, green bumphead parrotfish (*Bolbometopon muricatum*) and humphead wrasse (*Cheilinus undulatus*), the latter listed under the Convention on International Trade in Endangered

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Species of Wild Flora and Fauna (Gillett 2010). Yet, across Solomon Islands, scientific and anecdotal evidence have identified a broad range of spawning seasonality, with FSA-based reproduction occurring in all months of the year for three confirmed locations in Western Province where there are some monitoring data (Hamilton et al. 2012; Hughes et al. 2020). Furthermore, almost nothing is known of their composition or status, and little is known about other potential FSA sites.

Our study was designed to address these knowledge gaps by combining a comprehensive review of published records of the timing of FSAs for key targeted species in Western Province, Solomon Islands, with local knowledge collected from fisher interviews. This information is being used to inform local site-based community management of FSAs, as well as to provide recommendations for modifications to the current broad seasonal ban.

Methods

Study area

We focused on filling in information gaps on FSAs from Western Province, Solomon Islands, from the published literature and by collecting traditional ecological knowledge (TEK) from local fishers. Solomon Islands is an island nation of over 600,000 people spread across eight degrees of latitude (5°–13°S) and 14 degrees of longitude (155°–169°E). Located within the Coral Triangle, Solomon Islands boasts some of the highest biodiversity on the planet, with 1019 species of coral reef fishes and 494 species of corals, many of them endemic (Green et al. 2006). These ecosystems form the basis of the fisheries that Solomon Islanders rely on for food and economic security. Solomon Islanders' fish consumption is high, ranging from 30 to 40 kg per person, with 64% of of all fish taken by subsistence fishing, and 90% of all animal-sourced nutrition derived from fish products (Bell et al. 2009). This level of consumption is projected to be unsustainable without effective management and conservation of marine resources.

In Marovo and Roviana lagoons in Western Province, numerous FSA sites are known and nearly all known sites are fished for subsistence and commercial purposes, including domestic export to the capital, Honiara (Brewer et al. 2009; Hamilton et al. 2011). Only one FSA (Uepi) is actively monitored and enforced in Marovo Lagoon, while the species composition, seasonal occurrence and (spawning) population status are unknown for all but two locations in Roviana Lagoon, Shark Point and Njari (Hamilton et al. 2012; Hughes et al. 2020).

TEK Interviews

In May 2019, fisher interviews were carried out in Munda, Western Province, and around Roviana and Marovo lagoons in January 2021. Interviews were conducted using a combination of structured surveys and informal talks with key informants, with a focus on guiding future fisheries management within the region and at the community level (as community-based fisheries management, CBFM), and developing locally managed marine areas (LMMAs). In Munda, 29 surveys were carried out in 16 villages, while 34 interviews across 8 villages were conducted in Roviana Lagoon and 39 interviews across 11 villages around Marovo Lagoon. Surveys focused on obtaining information relevant to identifying location, use and impacts to fish populations in general, and more specifically, the timing and location of FSAs. Surveys also provided information on gear use, target species, and site visitation, with a view to deriving information that would confirm prior findings of FSA sites and times collected through earlier interviews (i.e. Johannes and Lam 1999; Hamilton and Kama 2004; Hamilton et al. 2012). All but a few of the interviews were with patriarch fishers who each had, on average, more than 30 years of fishing experience. Interviewees were asked to provide information on perceived declines in catch and views toward management effectiveness and management options, including but not limited to area and seasonal closures around perceived spawning times. We received ethics approval from the Wildlife Conservation Society (WCS)'s Internal Review Board to conduct this research.

Results and discussion

TEK shared through fisher interviews provided valuable information that has increased our understanding of Solomon Island fisheries and fish life histories in Western Province. Interviewees provided information and suggestions for improving management and LMMA development, particularly by identifying previously unknown spawning sites and verifying sites identified through earlier interviews.

Most fishing trips are reportedly carried out by dugout canoes, with exclusive use of motorised boats comprising only 3% of use in Marovo. Use of canoe and motorised boats varied between 10% (Munda) and 41% (Marovo) across sites (Fig. 1a). As is typical of most tropical Pacific countries and territories (e.g. Dalzell et al. 1996), catch methods varied, with various handline techniques the most common method, followed by spearfishing, including both daytime and nighttime spearfishing. Net fishing and trolling were found to be relatively uncommon (Fig. 1b).

Fishers identified 31 separate fishing locations and 26 possible aggregation areas. Results also validated findings from earlier surveys of FSA locations and times using both underwater visual census and fisher knowledge (Table 1). While a few of these sites have been explored and confirmed by previous researchers as spawning sites, most have been unexplored and represent avenues for new research and possible management. Many of the fish species named as aggregation-forming species have not been investigated, although they occur within families known to aggregate when they spawn (Table 1). The derived information is being actively used by Wildlife Conservation Society staff to conduct in-water verification and monitoring of newly recorded FSAs. An evaluation of these sites may not only confirm additional spawning sites, but can also act to provide baseline information on the impacts of fishing on fish stocks and guide future management development.

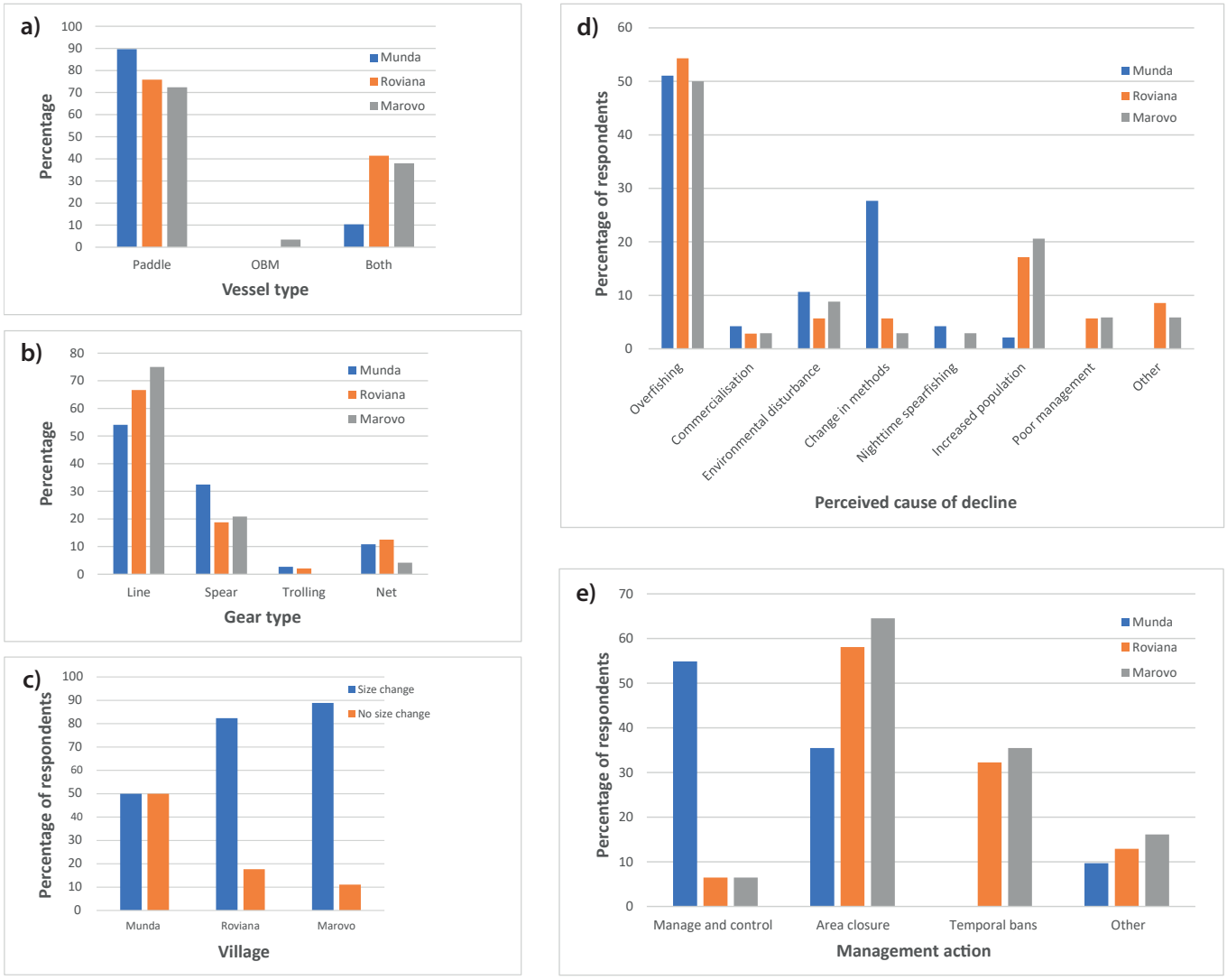

Figure 1. a) Vessel type used across sites, where "paddle" is paddled outrigger canoes and "OBM" is outboard motors; **b)** Reported use of most common fishing gear; **c)** Percentage of respondents who perceive changes in sizes of aggregating species over time; **d)** Perceived cause; **e)** Management action.

Table 1. Species-specific spawning seasonality for fishes identified through current and prior studies in the Solomon Islands. Site names have been coded to maintain confidentiality. Several of the listed species are known to form spawning aggregations (e.g. two-spot red snapper, *Lutjanus bohar*; brown-marbled grouper, *Epinephelus fuscoguttatus*), while others have yet to be confirmed as aggregation-forming species (e.g. three-spot grouper, *Epinephelus trimaculatus*). Direct evidence is confirmation from underwater visual census surveys, while indirect evidence is based on fisher knowledge.

Species	Location	Seasonality	Evidence	Reference(s)
Epinephilidae				
Epinephelus polyphekadion	Western Province A	February–June	Indirect	Johannes and Lam 1999
	Western Province B	October–January	Indirect	Johannes and Lam 1999
	Isabel Province E	June–July	Indirect	Johannes and Kile 2001
	Western Province C	February–March	Direct	Hamilton et al. 2012
	Western Province D	March–August	Direct	Hughes et al. 2020
	Solomon Islands (unspecified)	October–January	Indirect	Hamilton 2003
E. fuscoguttatus	Western Province A	February–June	Indirect	Johannes and Lam 1999
	Western Province B	October–January	Indirect	Johannes and Lam 1999
	Isabel Province E	June–July	Indirect	Johannes and Kile 2001
	Western Province C	November–March	Direct	Hamilton et al. 2012
	Western Province D	January–August	Direct	Hughes et al. 2020
	Solomon Islands (unspecified, multiple)	October–January	Indirect	Hamilton and Kama 2004
	Western Province B	November–January	Indirect	Roviana Fisher Surveys 2021
E. ongus	Solomon Islands (unspecified)	November–January	Indirect	Hamilton and Kama 2004
	Western Province B	November–July	Indirect	Roviana Fisher Surveys 2021
E. spilotoceps	Solomon Islands (unspecified, multiple)	June	Indirect	Hamilton 2003
E. trimaculatus	Solomon Islands (unspecified, multiple)	June	Indirect	Hamilton 2003
E. melanostigma	Western Province B	n/a	Indirect	Munda Fisher Surveys 2019
E. coeruleopunctatus	Western Province B	November–December	Indirect	Roviana Fisher Surveys 2021
Plectropomus areolatus	Western Province A	February–June	Indirect	Johannes and Lam 1999
	Western Province B	October–January	Indirect	Johannes and Lam 1999
	Isabel Province E	June–July	Indirect	Johannes and Kile 2001
	Western Province C	Monthly	Direct	Hamilton et al. 2012
	Western Province D	Monthly	Direct	Hughes et al. 2020
	Solomon Islands (unspecified, multiple)	October–January	Indirect	Hamilton and Kama 2004
	Western Province B	Monthly	Indirect	Roviana Fisher Surveys 2021
P. leopardus	Western Province B	n/a	Indirect	Munda Fisher Surveys 2019

Lethrinidae				
Lethrinus erythropterus	Solomon Islands (unspecified)	March–May, October	Indirect	Hamilton 2005
	Western Province B	n/a	Indirect	Munda Fisher Surveys 2021
L. ornatus	Western Province B	Monthly	Indirect	Munda Fisher Surveys 2019
	Western Province B	Monthly	Indirect	Roviana Fisher Surveys 2021
	Western Province B	September – January	Indirect	Roviana Fisher Surveys 2021
L. obsoletus	Western Province B	Monthly	Indirect	Munda Fisher Surveys 2019
	Western Province B	n/a	Indirect	Roviana Fisher Surveys 2021
L. harak	Western Province B	Monthly	Indirect	Munda Fisher Surveys 2019
L. atkinsoni	Western Province B	Monthly	Indirect	Munda Fisher Surveys 2019
Lutjanidae				
Aphareus rutilans	Western Province B	n/a	Indirect	Munda Fisher Surveys 2019
Lutjanus rivulatus	Western Province A	February – May, September–December	Indirect	Johannes and Hviding 2000
	Solomon Islands (unspecified)	January – March, October–December	Indirect	Hamilton 2003
L. bohar	Western Province A	June–July	Indirect	Johannes and Hviding 2000
	Solomon Islands (unspecified)	Monhtly	Indirect	Hamilton 2003
	Western Province B	n/a	Indirect	Munda Fisher Surveys 2019
L. gibbus	Solomon Islands (unspecified)	Monthly	Indirect	Hamilton 2003
	Western Province B	n/a	Indirect	Munda Fisher Surveys 2019
L. argentimaculatus	Western Province B	n/a	Indirect	Munda Fisher Surveys 2019
L. adetii	Western Province B	n/a	Indirect	Munda Fisher Surveys 2019
L. carponotatus	Western Province B	n/a	Indirect	Munda Fisher Surveys 2019
L. vitta	Solomon Islands (unspecified)	n/a	Indirect	Hamilton 2003
Symphorichthys spilurus	Western Province A	August–January	Indirect	Johannes and Hviding 2000
	Western Province B	October–December	Indirect	Roviana Fisher Surveys 2021

Perceived declines in catches were the most commonly identified impact from FSA fishing, as mentioned by around two-thirds of fishers, which was more pronounced than in other studies in Solomon Islands (e.g. Ensor et al. 2018). Size change was mentioned by 50% or more of interviewees, with nearly 90% of Marovo fishers mentioning reduced sizes of fish (Fig. 1c). Perceived cause of decline varied widely, but overfishing associated with changing methodology and fisher population increase was most notable among all sites (Fig. 1d). Although only sometimes specifically mentioned, nighttime spearfishing was raised as a cause of decline, which has been documented in other studies (e.g. Rhodes et al. 2019). Among management options listed, area closures received the most positive response, with temporal controls that include seasonal closures during spawning times specifically mentioned by Marovo and Roviana fishers (Fig. 1e). Only two respondents failed to suggest a management option. Information derived from fisher interviews and past studies (Johannes and Lam 1999; Johannes and Hviding 2000; Johannes and Kile 2001; Hamilton 2003; Hamilton and Kama 2004; Hamilton 2005; Hamilton et al. 2012; Hughes et al. 2020) identified regional variations in spawning times among individual species, specifically groupers, that lessen the effectiveness of the current nationwide seasonal ban (Fig. 2) and support the need for finer-scale management at the site level.

Fisher interviews also identified key target species (Table 2), with 91 individual species mentioned. For all species, snappers (Lutjanidae) were the most mentioned (n = 131 mentions), emperors the second most commonly mentioned (n = 105), while trevallies (Carangidae) were mentioned 64 times and groupers (Epinephelidae) were mentioned 63 times (Table 3).

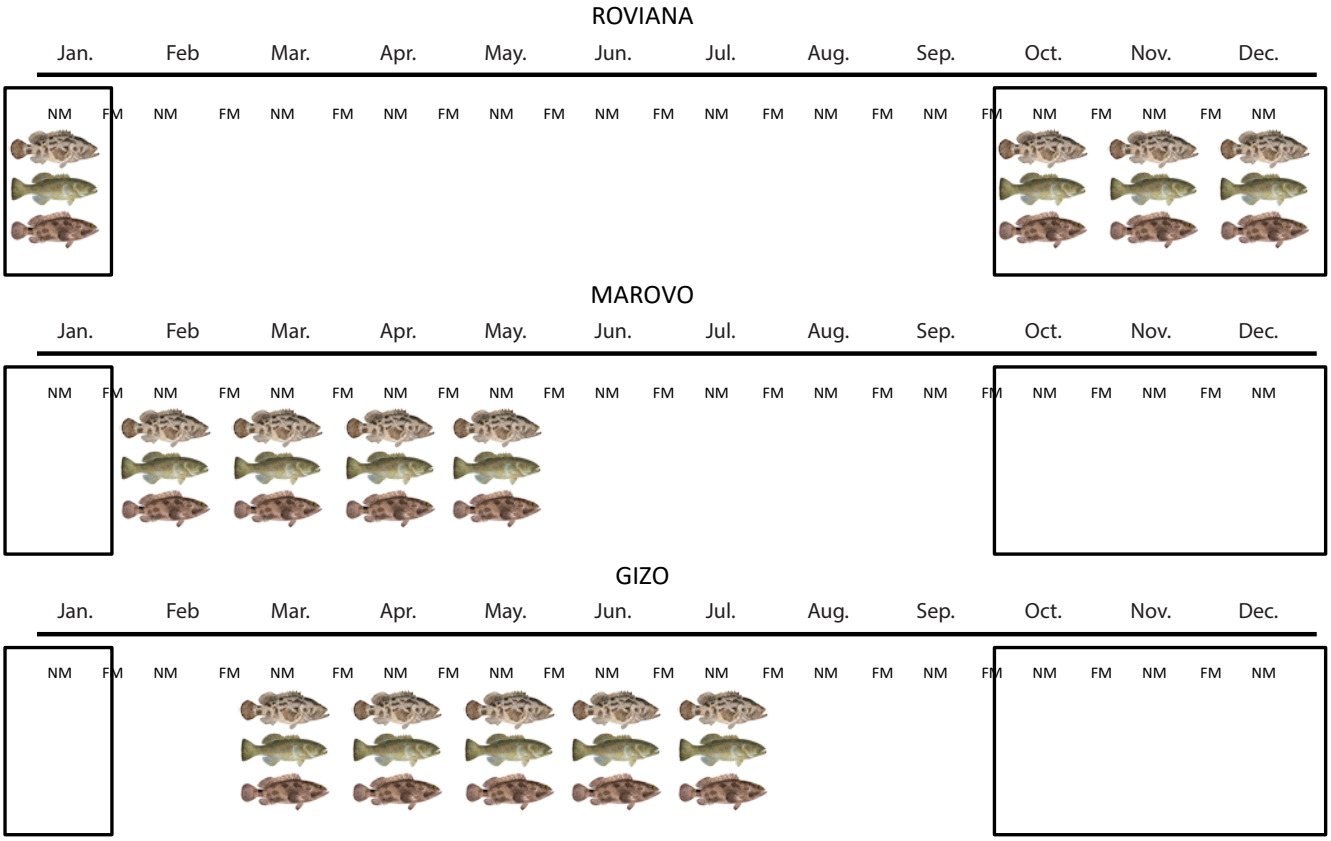

Figure 2. Calendar representation of the timing of spawning for three grouper species. From top to bottom (for each locale) are brown-marbled grouper (*Epinephelus fuscoguttatus*), squaretail coralgrouper (*Plectropomus areolatus*) and camouflage grouper (*Epinephelus polyphekadion*) taken from traditional ecological knowledge (TEK) surveys. These three species are known to aggregate and spawn during variable seasons within Solomon Islands. For these species, aggregations form and persist in the days leading up to new moon phases (NM) during the months indicated in each location. Boxes represent months of the current national sales ban.

Table 2. The 20 target species most mentioned in fisher interviews. Lethrinids (emperors) and lutjanids (snappers) dominate the list of target species.

Common name	Scientific name	Family	Mentions
Longface emperor	*Lethrinus olivaceus*	Lethrinidae	33
Humpback red snapper	*Lutjanus gibbus*	Lutjanidae	29
Two-spotted red snapper	*Lutjanus bohar*	Lutjanidae	22
Spanish mackerel	*Scomberomorus commerson*	Scombridae	18
Mangrove red snapper	*Lutjanus argentimaculatus*	Lutjanidae	13
Rusty jobfish	*Aphareus furca*	Lutjanidae	12
Giant trevally	*Caranx ignobilis*	Carangidae	10
Longfin emperor	*Letrinus erythropterus*	Lethrinidae	8
Blackfin barracuda	*Sphyraena qenie*	Sphyraenidae	8
Thumbprint emperor	*Lethrinus harak*	Lethrinidae	7
Orange-striped emperor	*Lethrinus obsoletus*	Lethrinidae	7
Five-lined snapper	*Lutjanus quinquelineatus*	Lutjanidae	7
Yellowmargin triggerfish	*Pseudobalistes flavimarginatus*	Balistidae	7
Bluefin trevally	*Caranx melampygus*	Carangidae	6
Three-striped whiptail	*Pentopodus trivittatus*	Nemipteridae	6
Striped monocle bream	*Scolopsis lineata*	Nemipteridae	6
Great barracuda	*Sphyraena barracuda*	Sphyraenidae	6
Lined surgeonfish	*Acanthurus lineatus*	Acanthuridae	5
Rainbow runner	*Elagatis bipinnulata*	Carangidae	5
Brown-marbled grouper	*Epinephelus fuscoguttatus*	Epinephelidae	5

Table 3. Number of times that individual species were mentioned in fisher interviews by fish family. Lutjanids and lethrinids dominated the list, while the order of mentions generally reflects fisher preference in marketed catch.

Family	Mentions
Lutjanidae	131
Lethrinidae	105
Carangidae	64
Epinephelidae	63
Scombridae	34
Balistidae	30
Sphyraenidae	25
Acanthuridae	19
Scaridae	14
Nemipteridae	12
Haemulidae	7
Caesonidae	6
Mullidae	6
Holocentridae	4
Pomacentridae	3
Siganidae	3
Labridae	2
Mugilidae	2
Priacanthidae	2
Gerreidae	1
Terapontidae	1

Based on the information derived from these interviews, Wildlife Conservation Society (WCS) is developing a list of recommendations for the Solomon Islands MFMR to enhance the current ban on FSA fishing. WCS is also working closely with local community leaders and fishers to enhance awareness about the impacts to key commercial fish populations from FSA targeting and for the development of resource management plans and LMMAs. In addition to awareness presentations and community-level discussions, WCS has also developed a series of awareness posters and playing cards to expand passive efforts to raise awareness. The aim of these activities is to protect and prolong Solomon Islanders' economic and food security for this and future generations.

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References

Bell J.D., Kronen M., Vunisea A., Nash W.J., Keeble G., Demmke, Pontifex S. and Andréfouët S. 2009. Planning for the use of food security in the Pacific. Marine Policy 33:64–76.

Brewer T.D., Cinner J.E., Green A. and Pandolfi J.M. 2009. Thresholds and multiple scale interaction of environment, resource use, and market proximity on reef fishery resources in the Solomon Islands. Biological Conservation 142:1797–1807.

Dalzell P., Adams T.J.H. and Polunin N.V.C. 1996. Coastal fisheries in the Pacific Islands. Oceanography and Marine Biology: An Annual Review 34:395–531.

Ensor J.E., Abernethy K.E., Hoddy E.T., Aswani S., Albert S., Vaccaro I., Benedict J.J. and Beare D.J. 2017. Variation in perception of environmental change in nine Solomon Island communities: implications for securing fairness in community-based adaptation. Regional Environmental Change 18:1131–1143.

Erisman B., Heyman W., Kobara S., Ezer T., Pittman S., Aburto-Oropeza O. and Nemeth R.S. 2015. Fish spawning aggregations: where well-placed management actions can yield big benefits for fisheries and conservation. Fish and Fisheries 18:128–144.

Gillett R. 2010. Monitoring and management of the humphead wrasse, Cheilinus undulatus. FAO Fisheries and Aquaculture Circular. No. 1048. Rome, Italy: Food and Agriculture Organization of the United Nations.

Green A., Lokani P., Atu W., Ramohia P., Thomas P. and Almany J. (eds). 2006. Solomon Islands Marine Assessment Technical Report. The Nature Conservancy Pacific Island Countries Report No. 1/06. https://www.conservationgateway.org/Documents/SolomonIslandsMarineAssessmentReport-Full.pdf.

Hamilton R.J. 2003. A report on the current status of exploited reef fish aggregations in the Solomon Islands and Papua New Guinea Choiseul, Ysabel, Bougainville and Manus Provinces. Western Pacific Fisher Survey Series. A report to the Society for the Conservation of Reef Fish Aggregations. 52 p.

Hamilton R.J. 2005. Indigenous ecological knowledge (IEK) of the aggregating and noctural spawning behaviour of the longfin emperor, Lethrinus erythropterus. SPC Traditional Marine Resource Management and Knowledge Information Bulletin 18:9-17. https://purl.org/spc/digilib/doc/hosdd

Hamilton R.J. and Kama W. 2004. Spawning aggregations of coral reef fish in Roviana Lagoon, Western Province, Solomon Islands: Local knowledge fish survey report. (Unrestricted Access Version). Report prepared for the Pacific Islands Countries Coastal Marine Program, The Nature Conservancy. TNC Pacific Island Countries Report No. 5/04. https://www.conservationgateway.org/Documents/SPAGS%20local%20knowledge%20Roviana%20%20Hamilton%20-public-%20Aug04.pdf.

Hamilton R.J., Potuku T. and Montambault J.R. 2011. Community-based conservation results in the recovery of reef fish spawning aggregations in the Coral Triangle. Biological Conservation 144(6):1850–1858.

Hamilton R.J., Giningele M., Aswani S. and Ecochard J.L. 2012. Fishing in the dark – local knowledge, night spearfishing and spawning aggregations in the Western Solomon Islands. Biological Conservation 145:246–257.

Hughes A.T., Hamilton R.J., Choat J.H. and Rhodes K.L. 2020. Declining grouper spawning aggregations in Western Province, Solomon Islands signal the need for a modified management approach. PLoS ONE 15(3):e0230485. https://doi.org/10.1371/journal.pone.0230485

Johannes R.E. and Lam M. 1999. The life reef food fish trade in the Solomon Islands. SPC Live Reef Fish Information Bulletin 5:8–15. https://purl.org/spc/digilib/doc/y2yrp

Johannes R.E. and Hviding E. 2000. Traditional knowledge possessed by the fishers of Marovo Lagoon, Solomon Islands, concerning fish aggregating behaviour. SPC Traditional Marine Resource Management and Knowledge Information Bulletin 12:22–29. https://purl.org/spc/digilib/doc/arbh3

Johannes R.E. and Kile N. 2001. Protecting spawning aggregations, a potential target of the live reef food fish trade in Ysabel and Wagina Islands, Solomon Islands. SPC Live Reef Fish Information Bulletin 8:5–9. https://purl.org/spc/digilib/doc/uzd44

Jones G.P., Milicich M.J., Emslie M.J. and Lunow C. 1999. Self-recruitment in a coral reef population. Nature 402:802–804.

Mourier J., Maynard J., Parravicini V., Ballesta L., Clua E., Domeier M.L. and Planes S. 2016. Extreme inverted trophic pyramid of reef sharks supported by spawning groupers. Current Biology 26:1–6.

Nemeth R.S. 2012. Ecosystem aspects of species that aggregate to spawn. p. 21–56. In: Sadovy de Mitcheson Y. and Colin P.L. (eds). Reef fish spawning aggregations: Biology, research and management. Dortrecht, Netherlands: Springer.

Rhodes K.L., Baremore I. and Graham R.T. 2019. Grouper spawning aggregations affect activity space of grey reef sharks, Carcharhinus amblyrhynchos, in Pohnpei, Micronesia. PLoS ONE 14(8):e0221589. https://doi.org/10.1371/journal.pone.0221589

Rhodes K.L., Tua P., Sulu R., Pitakaka P., Kekete P., Uti M., Funu F. and Masu R. 2019. Gear-based characterization of the Gizo, Solomon Islands, inshore finfish fishery. Regional Studies in Marine Science 32:100807. https://doi.org/10.1016/j.rsma.2019.100807

A snapshot of a partnership to drive tilapia farming in Malaita Province, Solomon Islands

Billy Meu

Introduction

Brief history of tilapia development in Solomon Islands

Solomon Islands, like many other Pacific Island countries, has exerted pressure on its coastal fisheries, resulting in overfishing and degradation of fishing grounds, which is evident in parts of Solomon Islands. Reef fish provide an important source of protein and livelihood for many coastal and inland communities (Cleasby et al. 2014). To supplement this, the Solomon Islands government has prioritised aquaculture development in its development aspirations, given its potential for supporting rural livelihoods.

The Ministry of Fisheries and Marine Resources (MFMR) is the government agency mandated by the Fisheries Management Act 2015 to develop and manage fisheries and aquatic resources in Solomon Islands. In 2008, MFMR developed an Aquaculture Development Plan 2009–2014 to guide the redevelopment of aquaculture in a post-conflict Solomon Islands. Given the plan's high prioritisation of tilapia dubbed the "aquatic chicken" (Pickering 2009), a Solomon Islands National Tilapia Aquaculture Action Plan 2010–2015 was also developed. Both have now been superseded by the Solomon Islands National Aquaculture Management and Development Plan 2018–2023. This policy framework has provided a structured pathway for sustainable tilapia aquaculture in Solomon Islands.

Since the 2000s MFMR has worked with farmers and other institutions (e.g. the Pacific Community and WorldFish) to pilot the small-scale aquaculture of *Oreochromis mossambicus* (Mozambique tilapia), a non-native freshwater species that has been present in Solomon Islands since the 1950s (MFMR 2018). Focused on two of the largest and most populated island provinces of Malaita and Guadalcanal, pilot sites have targeted food security and income generation (Cleasby et al. 2014). This local research showed that Mozambique tilapia was not viable for intense aquaculture due to its slow growth, fast reproduction (early sex maturation), and lack of genetic variation due to a high degree of inbreeding (Pickering 2009; Lloyd 2011; MFMR 2018). Based on this information and look-and-learn trips to Fiji, Papua New Guinea and Timor Leste (Pickering and Schwarz 2018), MFMR sought to import an improved strain of Nile tilapia for aquaculture. Nile tilapia is widely distributed and farmed in neighbouring countries such as Fiji, Papua New Guinea and Vanuatu (Pickering 2009). Because of the growing interest for Nile tilapia farming in Solomon Islands, MFMR embarked on a plan to import a more viable strain of tilapia, suitable for aquaculture in Solomon Islands (Lloyd 2011; MFMR 2018), and approval for the importation of Nile tilapia was secured in August 2017.

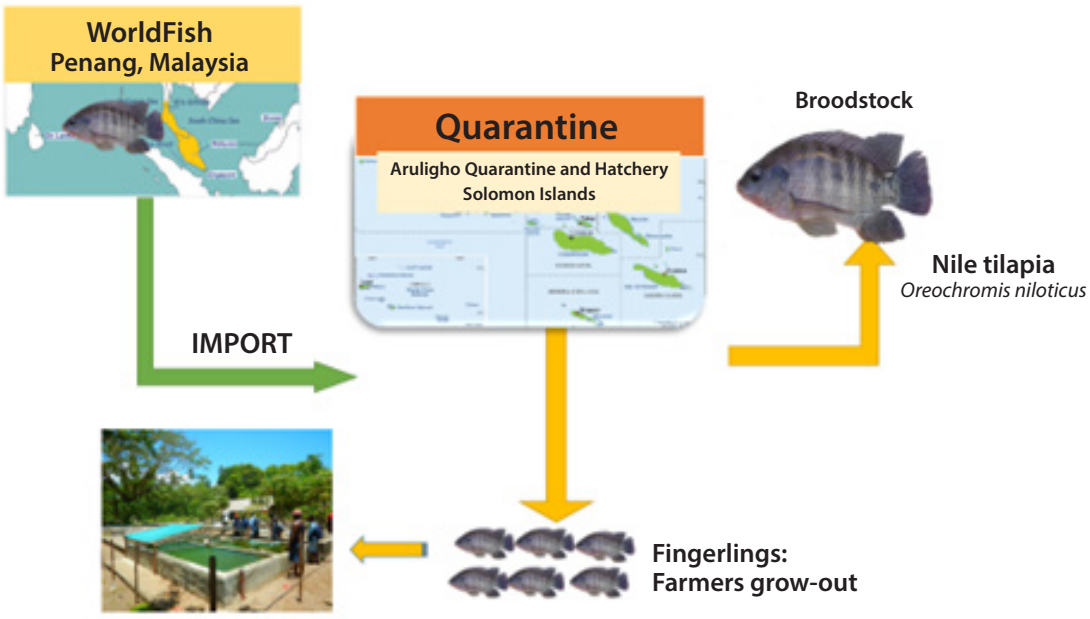

Figure 1. MFMR's tentative importation plan for GIFT tilapia.

Current tilapia development in Solomon Islands.

The tilapia development focus, in line with Solomon Islands Aquaculture Development and Management Plan (2018–2023), was to: establish the necessary infrastructure; improve technological know-how; and import high quality tilapia fries for farming in Solomon Islands. MFMR anticipated the importation of GIFT (genetically improved for farming) tilapia (MFMR 2018) and with the support of partners, including the Pacific Community, a GIFT Importation Plan and other necessary policy documents were developed.

In accordance with Solomon Islands' quarantine and environmental legal requirements, a set of steps will be followed before the fish enter the country (Fig. 1). The necessary infrastructure development and capacity building have been prioritised by special interest groups and supported by donor partners, including the New Zealand Ministry of Foreign Affairs and Trade, the government of Japan, and others since 2017 in accordance with the Solomon Islands Aquaculture Development and Management Plan 2018–2023. A functioning national hatchery is under construction and expected to be completed by the end of 2023.

It is expected that high quality fries will be imported, bred in the national hatchery and quarantine facility. Then, fingerlings (seedlings) will be distributed to well-established farmers in rural communities (Figs. 1 and 2).

Preparing farmers

With the decisions and commitments made to the process of importing an improved strain of tilapia, a parallel workstream is aimed at preparing well-established Mozambique tilapia farmers to become early adopters for the new strain. MFMR has continued to work with farmers in communities in Malaita and Guadalcanal as a mechanism to upskill farmers in preparation for Nile tilapia and for locally relevant approaches to farmers support to be developed. As such, MFMR has collaborated with partners such as WorldFish, the Pacific Commnity, and most recently the Solomon Islands Association of Vocational Rural Training Center (SIAVRTC) and the Waikato Institute of Technology (WINTEC) to capacitate farmers and developed workable tools required for the nationwide rollout of Nile tilapia.

From 2017 to 2020, MFMR partnered with SIAVRTC under an MFAT-funded project that worked with 26 farmers and three Rural Training Centers (RTCs) in Malaita Province to upskill tilapia farmers. The project was called Upim Tilapia Project.

This article focuses on the experiences learned during the three years of the project to describe how a partnership between different government agents, donors, educational institutions and farmers helped to improve information and resource dissemination to tilapia farmers in rural Malaita, Solomon Islands.

Materials and methods

The project, which involved SIAVRTC, WINTEC and MFMR, aimed to promote tilapia farming education in rural areas of Malaita Province. Given the limited opportunities to disperse information to remote locations, the project approach was to develop a mobile phone app that could work offline, containing basic technical information required to start and manage a small-scale tilapia farm in Solomon Islands. Information was gathered over a three-year period by working with 26 farmers and 3 RTCs (Ngaligagara, Afutara and APSD) in Malaita Province (Fig. 3). Activities under this project included workshops, field trips and site visits conducted by project field officers and MFMR representativs.

The farmers who were part of this project were selected based on their prior engagement with MFMR and their enthusiasm for farming tilapia. The farmers were divided into four groups according to their geographical proximity, so that they could reach each other on foot. The project supported these farmers with farming materials, capacity building through workshops, and the development of a Tilapia Info Mobile App (Tilapia App).

Farmer visits were conducted monthly by two project officers to monitor progress and submit reports to other members of the project partnership team.

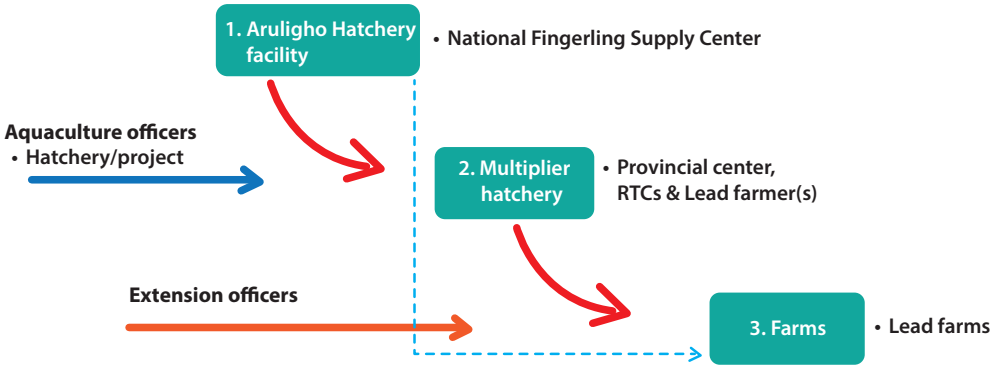

Figure 2. Tentative GIFT grow-out plan.

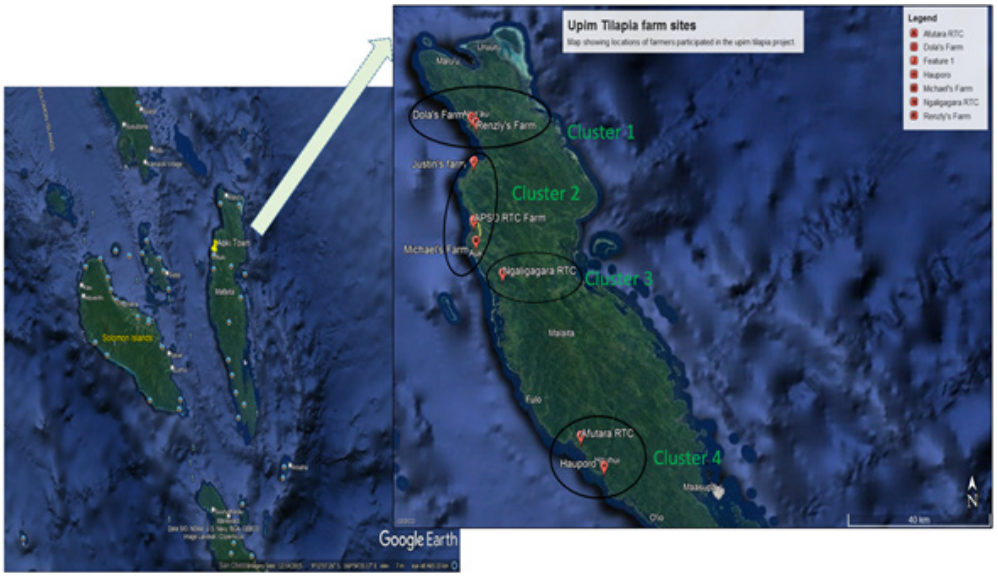

Figure 3. Study area in Malaita located within four constituencies: Lau/Baelelea, West Kwara'ae, Central Kwara'ae, Auki Langalanga and West Areare (not shown on the map).

Results and discussion

Development through a participatory approach.

During the initial planning stage of any project, the right choice of partners or stakeholders is fundamental to project success.[1] In 2017, WINTEC was engaged by MFAT to work with SIAVRTC in order to develop educational materials for aquaculture education at the RTCs.[2] Because MFMR was the mandated government agency with the necessary technical expertise, and an annual development programme aiming to promote a sustainable aquaculture in Solomon Islands, the project team collaborated with MFMR to identify the tilapia farmers who would be the participants in the project.

The farmers were grouped into four cluster groups, a technique described by (Harohau et al. 2016) based on their geographic area as summarised in Table 1.

A similar approach was observed in Timor Leste during a look-and-learn trip in 2018 at Gleno, Ermera municipality (Pickering and Schwarz 2018; New Zealand Ministry of Foreign Affairs and Trade 2018).

One focal person was appointed for each cluster group to liaise with project team members on all matters relating to project implementation. A cluster leader was selected based on his/her willingness to accept the position and their capability to take up a leadership role.

Table 1. Summary of cluster characteristics.

Cluster characteristics			
Cluster 1	**Cluster 2**	**Cluster 3**	**Cluster 4**
• Good community support and engagement • Fish as pet and only harvest fish to share as seedlings • Ponds water fed from ground water • Excellent gender balance	• Farmers sparsely spread • Some ponds located far from home • Big or numerous smaller ponds • Used for family consumption	• Located in Auki township • Less land available • Small size ponds located next to owner's house • Regular partial harvesting	• North of Auki • Entrepreneurial • Selling tilapia • Income invested into small-scale business activities • Supportive of new farmers

[1] http://eq4pm.typepad.com/eq4pm/2006/04/applied_eq_49_r.html
[2] https://www.wintec.ac.nz/about-wintec/news/article/2018/03/04/aquaculture-the-answer-to-an-island's-food-shortage

It was observed that a small group or cluster of five to ten farmers was easy to manage and promoted good farmer participation and coordination. For example, in cluster 1 (see Fig. 3) there were five farmers from two neighbouring communities and because of their small number, it was observed that cluster coordinator had a small job to visit farms, organise group meetings and group work to support individual farmers. Notably, the leader of cluster 1 was a former Provincial Assembly Member of the Malaita Provincial Government who had good leadership skills and knowledge. This observation is consistent with the recommendation by Harohau et al. (2016) where a cluster group leader with an existing leadership role and a good educational background could contribute to effective management of a cluster group. Thus, this technique was proven during this project implementation to be a useful tool fostering a farmer-led approach that promotes active farmer participation.

According to a farmer interview with Renzly (leader of cluster 1), a tilapia farmer at Sisifiu Village in Northwest Malaita, smaller groups of farmers meant they felt confident to exchange innovative ideas and technology that would support farm improvement with limited resources. There was also physical evidence of this. Figures 5 and 6 show Renzly's tilapia earthen pond improvement works before and after being trained and supported by the project.

Figure 4. Project participants during the final workshop held in Auki, Malaita Province. Each farmer participant was awarded a certificate of participation at the end of the project.

Figure 5. Farm before project.

Figure 6. Farm during and after project.

Causes and impacts of project on tilapia farming.

Feedback on project activities from participants and the wider communities had been received during stakeholder activities, field trips and monitoring visits. Positive impacts on tilapia farming were recorded due to four key underlying factors (Fig. 7).

Efficient delivery of farming resources

Efficient delivery of resources such as hardware materials, small financial support and networking among and across cluster groups was evidenced by the physical status of the farms. For example, procurement of materials had previously been delayed due to slow government payment processes and logistics due to islands being widespread. The project funding helped considerably towards the effective delivery of project support to farmers.

Development of mobile app for tilapia farming

The second factor affecting farming success was the efficient transfer of technical know-how on tilapia farming through the development of the offline mobile app. This app could be shared through SHAREit and installed on any android device. Information on this app was simplified to suit farmers' education levels and the Solomon Islands context. To fast-track socialisation of this offline app, the project provided android handsets to all core participants (about 30) and this incentive was highly welcomed by the farmers. Participants are able to transfer the technology to more than 14,000 interested individuals in their communities. The RTC network recorded the highest rate of sharing and distribution of the app.

Project partners

Identifying the right stakeholders was crucial for successful project implementation. In this project, the WINTEC team consisted of expat specialists in various technical fields, while SIAVRTC was the academic platform for wider and effective dissemination of information and technical training. MFMR is the technical government agency responsible for aquaculture development in Solomon Islands. Similarly, without the hard-working farmers and the enthusiasm they had for tilapia farming, this project would not have been successfully accomplished. As noted in Harohau et. al. (2020): "all the prospective farmers have been selected based on their ongoing engagement in tilapia farming under the MFMR".

Effective monitoring and evaluation

Finally, project progress cannot be measured without the effective monitoring and evaluation work conducted by field officers based in Auki, Malaita Province. Monitoring visits were conducted quarterly and information gathered was shared across to all stakeholders and key findings discussed during the annual stakeholder workshop (see Fig. 8).

Figure 8. Stakeholders' workshop conducted in Auki, Malaita Province in 2019.

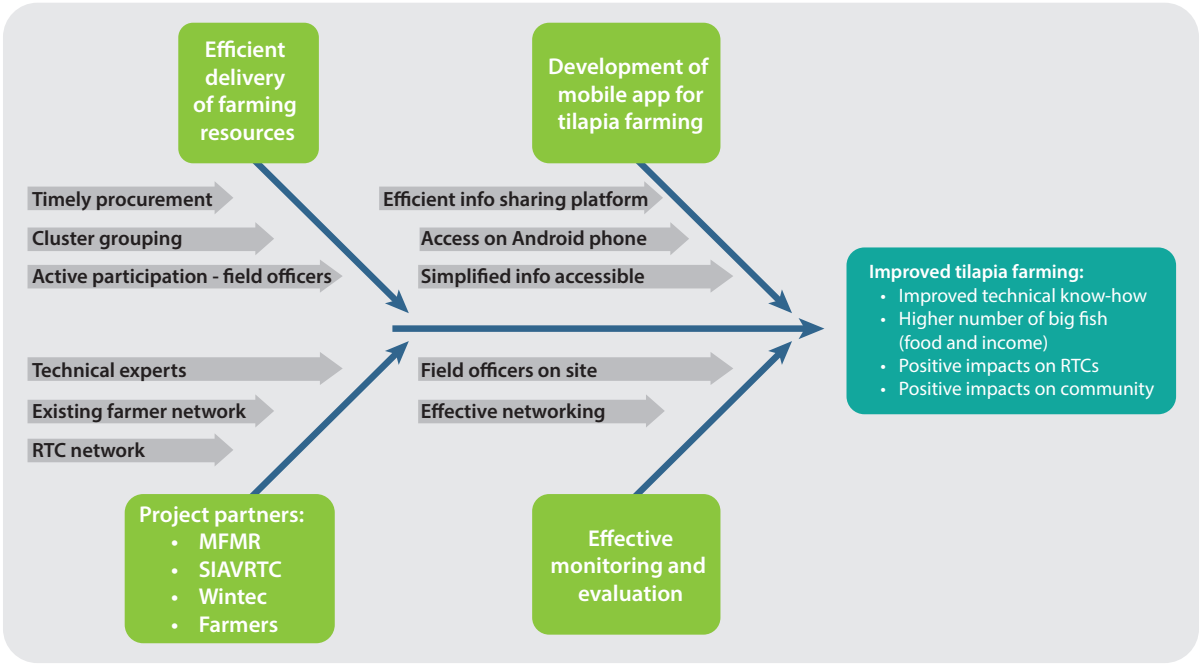

Figure 7. Cause and effect diagram of project Upim Tilapia.

Improved tilapia farming

Four main outcome areas were identified that contributed to improved tilapia farming (Fig. 7).

Outcome 1: Improved technical skills and knowledge

- Pond design, structure and management (Figs. 5, 6 and 9).
- Technical information available in a simplified form to farmers in the remote areas through an offline tilapia farming mobile app.
- Improved capabilities and capacities at RTCs.

Outcome 2. Improved food security and income generation opportunities

- 71% of participants used farmed tilapia for household consumption.
- 43% of farmers sold their fish to earn extra income to support their family.
- 1% of the farmers integrated tilapia farming with local eco-tourism.

Figure 9. Pond greening is an important skill learned by participants.

Outcome 3. Increased capabilities at RTCs

- Increased tutor capability to deliver aquaculture education.
- Tilapia app distribution through SIAVRTC.
- Innovative feed mixes developed using local ingredients.
- Three RTCs constructed fishponds facilities during the project.

A farmer's story 1:

A farmer who lives at Auki Township could not let the problems of space and water shortage bar him from pursuing his dream of becoming a tilapia farmer. Through this project, he was assisted with the design of a rain-fed system pond using local construction plastics as a pond liner to avoid water leakage. The pond was constructed in 2018 and is still in use today (Fig. 10).

Figure 10. Picture depicting two different pond designs for a rainwater-fed system in Auki.

A farmer's story 2:

In 2019, Mr Dola Roboliu, from Madalua Village, was charging a farm entry fee of SBD 5 per individual and SBD 10 per family (i.e. parents + kids) for visiting his site and/or fishing for their own fish, which was paid separately. He estimated that he can collect up to SBD 1000 per week during holiday months on access fees alone. Mr Dola happily said that he also sold some of his fish for SBD 2–5 per fish, depending on size. In December 2019, he conducted partial harvesting of one of his fishponds (10 m x 9 m x 1 m depth) and sold 300 fish, earning SBD 600 within two hours of tilapia live sales at the farm site.

Figure 11. Dola Roboliu's tilapia farm at Madalua Village, northwest Malaita, Solomon Islands.

Outcome 4. Wider community impacts

- A focus on ensuring both men and women participated in project activities that they were interested in.
- Networking and relationship building through cluster connections.
- 35 new farms set-up.
- Increased health and safety knowledge included in the app.
- Huge interests in tilapia farming from other institutions.

Moreover, the sustainability of tilapia aquaculture to contribute to fish supply and demand in Solomon Islands requires that serious investment be committed to this sector. Phillip et al. (2011) reported that a sustainable fish aquaculture production required serious investments into improving fish yields, building skills and organisational arrangements, access to finance and market access. So, in the future, to ensure sustainable GIFT tilapia production will require bringing complementary skills, technologies and investments via partnerships and involving both the public and private sectors.

A farmer's story 3:

A female farmer and teacher at Ngaligagara RTC demonstrated the feed mix she prepares through a simple processing method. For example, drying and pounding cassava tubers into powder, coconut meal, dried beans, coconut oil, etc… and mixing them together to achieve at least a 15–20% crude protein content. This feed yields comparatively good results in terms of growth rates. She found there were many big fish in her pond after a 4–6 month grow-out period. The technical know-how of feed and feeding is provided to farmers by technical officers from MFMR.

Figure 12. Participants demonstrate local feed mix preparation.

Issues and challenges

Several issues and challenges were faced during the project's implementation. The challenges are categorised into technical issues, equipment support, and community issues. Some of these were addressed as the project proceeded through additional information being added to the app (e.g. health and safety information), while others will inform the approach taken to the Nile tilapia farmer rollout.

Type of issue	Descriptions
1. Technical issues	Water loss and shortage in some locations, particularly peri-urban areas. Low quality Mozambique tilapia fingerlings.
2. Absence of essential aquaculture infrastructure and equipment locally	Unavailability of local supplies of appropriate and high-quality equipment and supplementary feed. Lack of national hatchery to produce quality fingerlings.
3. Community issues affecting tilapia farming	Theft of fish. Dispute over viable farming sites. Health and safety risks – including drowning risks for children in poorly constructed ponds.

Conclusion

Key lessons learned during the project's implementation include the value of using technology to engage more youth participants. The development of the tilapia app was seen as a vital breakthrough in the technological innovation to disseminate relevant information to tilapia farmers.

Farmer cluster groups enhanced networking, effective resource sharing, and peace building between communities and are now a proven workable approach for MFMR to adopt when rolling out Nile tilapia in Solomon Islands. We observed sharing of technology, farmer motivation and a stronger awareness of the need to integrate health and safety as positive impacts. Also, through this project, overall farm production in terms of the number of bigger fish, feeding and feed, and pond design were improved.

For a sustainable tilapia aquaculture programme to contribute to Solomon Islands' fish supply requires ongoing serious investment be committed to this sector. This was also highlighted by Phillips et al. (2011) who noted that sustainable fish aquaculture production required investments into improving fish yields, building skills and organisational arrangements, access to finance, and market access. Successful and sustainable aquaculture of Nile tilapia will require bringing complementary skills, technologies and investments via partnerships involving both the public and private sectors.

MFMR aims to continue to collaborate and seek further partnership arrangements to support farmers in terms of capacity building and trying out localised, innovative ideas to suit the Solomon Islands context in preparation for the Nile tilapia grow-out programme.

Acknowledgements

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References

Cleasby N., Schwarz A.-M., Phillips M., Paul C., Pant J., Oeta J., Pickering T., Meloty A., Laumani M. and Kori M. 2014. The socio-economic context for improving food security through land based aquaculture in Solomon Islands: a peri-urban case study. Marine Policy 45:89–97. http://dx.doi.org/10.1016/j.marpol.2013.11.015.

Harohau D., Sulu J.R., Phillip M., Sukulu M., Pickering T. and Schwarz A.M. 2016. Improving household tilapia (Oreochromis mossambicus) aquaculture through participatory action research. Aquaculture 465 (2016):272–286. http://dx.doi.org/10.1016/j.aquaculture.2016.09.024

Harohau D., Blythe J., Sheaves. and Diedrich A. 2020. Limits of tilapia aquaculture for rural livelihoods in Solomon Islands. Sustainability 12:4592. http://doi.org.10.3390/su12114592

Lloyd L. 2011. Risk assessment for the importation of genetically improved farmed tilapia (GIFT), Oreochromis niloticus, to the Solomon Islands for aquaculture. Honiara, Solomon Islands: Ministry of Fisheries and Marine Resources.

Ministry of Fisheries and Marine Resources. 2018. Solomon Islands National Aquaculture Management and Development Plan 2018–2023. Honiara, Solomon Islands: Ministry of Fisheries and Marine Resources.

New Zealand Ministry of Foreign Affairs and Trade. 2018. Evaluation report: Aquaculture development in Timor Leste-Job No.: 690525. Prepared by AECOM Australia, Adelaide.

Phillip M., Schwarz A.M. and Pickering T. 2011. Aquaculture and food security in Solomon Islands. SPC Fisheries Newsletter 134:17–18. https://purl.org/spc/digilib/doc/7tav3

Pickering T. 2009. Tilapia fish farming in the Pacific – A responsible way forward. SPC Fisheries Newsletter 130:24–26. https://purl.org/spc/digilib/doc/j956a

Pickering T. and Schwarz A.M. 2018. Solomon Islands and Timor Leste exchange knowledge in tilapia aquaculture. SPC Fisheries Newsletter 155:17–18. https://purl.org/spc/digilib/doc/g5ij7

Supplementing conservation with appropriate livelihood activities: A case study of Vella La Vella, Solomon Islands

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Keywords:
Community-based organisation, conservation, diagnostic analysis, supplementary livelihood options, sustainability

Abstract

Community-based resource management (CBRM) has been widely used for inshore fisheries in the Pacific Islands region. In Solomon Islands, CBRM is recognised as a strategy to enhance food security, adapt to climate change, and conserve threatened species. Yet even with its national recognition, rural communities are still faced with economic and social challenges while trying to manage their resources. As such, it is vital that while communities are engaged in resource management, they are also involve in sustainable supplementary livelihood activities that will sustain their living. From a diagnostic workshop conducted at Pusiju Village in Southeast Vella La Vella in Western Solomon Islands, four generic strategies were formulated from the community's strengths, weaknesses, opportunities and threats. The diagnostic analysis was followed by assessment of six livelihood options to realise their suitability for supplementing the community's forest conservation initiative. From the assessment, it was evident that the four strategies form the basis for implementation of livelihood options identified during the workshop. Thus, despite variation of requirements and/or resources to make the livelihood options successful, the main goal is that these requirements will enable the livelihood options to continue into the future without failing.

Introduction

Throughout the Pacific Islands region, coastal communities are experiencing dwindling supplies of natural resources, which is being exacerbated by both direct and indirect anthropogenic effects. In Solomon Islands, population growth, changing climatic conditions, and unsustainable developments such as logging, agricultural activities, and human settlements among other factors pose a direct threat to both terrestrial and marine resources. Coupled with the challenges of limited access to financial resources, markets, political instability, global economic downturn, and the recent COVID-19 pandemic, these hurdles create a huge challenge to the health and livelihood of rural communities. According to a survey conducted in 2012–2013 (Solomon Islands National Statistics Office and World Bank 2017), 12.7% of the country's population live below the basic-needs poverty line. This, however, varies according to province, and depends on the population size and poverty rate.

Successive governments have developed centralised state control or top-down coastal protection and management approaches that are merely politicised, and most often do not meet the requirements of rural communities. Consequently, rural communities often have minimal engagement and support from the central government, which also contributes to a number of failed projects in the past. Many commercial fish stocks, and terrestrial flora and fauna, continue to dwindle in the islands while management policies are collecting dust on office shelves.

In most Pacific Island countries, top-down resource management efforts and livelihood-related approaches are too costly, both financially and in terms of scarce human resources, to be of much practical value for broad-scale national application (Ram-Bidesi et al. 2011). Incompatibility of inherited government systems with the social and geographical realities of some independent Pacific Island countries is also an issue (Govan et al. 2009). For Solomon Islands in particular, the diversity of cultures and remoteness of islands increase the difficulty of developing a generic top-down approach that can be applicable for all rural communities in the country.

A move from a top-down to a locally based management approach that is more adaptive would be more suitable for rural Solomon Islands communities. While the emphasis is for the management to be driven by communities, most often communities collaborate with partner organisations and/or government representatives for technical support. This approach corroborates a study by Wheeler and Root-Bernstein (2020) that emphasised co-management that leads to informed decision-making when indigenous and traditional knowledge are combined with science in the process. Currently in the Pacific Islands region, CBRM tends to dominate inshore fisheries management strategies. Specifically, for Solomon Islands, CBRM is recognised as a strategy that improves food security, adapts to climate change, and conserves threatened species by facilitating rural participation and enabling local people to make their own plans for managing resources (Sukulu et al. 2016). With the recent ecosystem approach to fisheries management, CBRM now extends from ridges to

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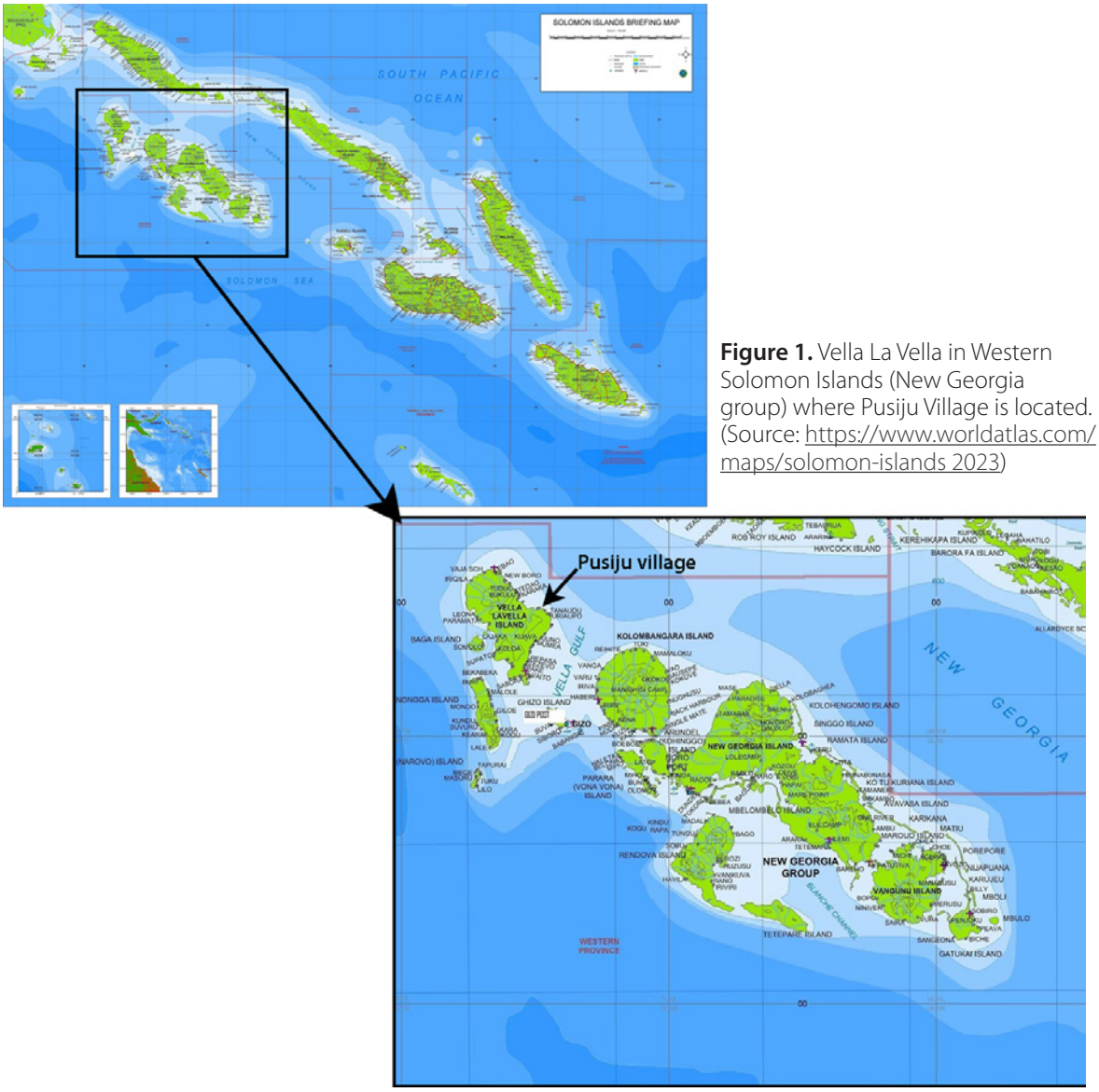

Figure 1. Vella La Vella in Western Solomon Islands (New Georgia group) where Pusiju Village is located. (Source: https://www.worldatlas.com/maps/solomon-islands 2023)

reefs where it builds on customary land and marine tenure, traditional ecological knowledge, and existing leadership structures to maintain resources. Nevertheless, even with this more holistic approach, communities are still faced with economic challenges with regard to increasing population, food insecurity, higher food prices, loss of foreign currency from imports, changes in culture due to influences from intermarriage, and pressure from destructive development that seduces people with high incentives.

Some partner organisations advocate that communities should be incentivised with alternative livelihoods to effectively manage their resources, although the sustainability of such an approach will depend entirely on the affiliation of the partner organisation to the project (Govan et al. 2009; O'Garra 2007). Therefore, unless community-driven sustainable supplementary livelihood options are in place, exploitation and dwindling resources will continue due to limited economic activities available for communities. As articulated by Blythe et al. (2014), Collins et al. (2009), Finkbeiner (2015), Hanh and Boonstra (2018), and Mills et al. (2017), sustainable livelihood options can improve living standards of rural households and empower their ability to face uncertainties. It is, therefore, important that while communities are actively engaged in resource management, they should also participate in sustainable supplementary livelihood activities that would help improve their wellbeing.

In this article, we present an investigation of how livelihood options are assessed in a four-day interactive workshop with Sirubai Voko Tribal Association (SVTA) communities using participatory diagnostic tools. SVTA is a community-based organiastion in southeast Vella La Vella in Western Solomon Islands (Fig. 1).

It is one of the few CBOs that firmly stands against unsustainable development such as logging to effectively conserve its rainforest. To date, the rain forest has been under protection for almost a decade with no human disturbance. In the analysis process, helpful and harmful factors in the communities were identified using a strengths, weaknesses, opportunities

and threats (SWOT) analysis followed by an assessment of six existing livelihood options using the Supplementary Livelihood Options for Pacific Island Communities (SLOPIC) tool. We draw on this investigation to explore how supplementary livelihood options could be supported by identifying what makes a livelihood option worth undertaking or rejecting (O'Garra 2007). This simple process can be replicated to other contemporary Pacific Island communities that are also challenged with the pressures of resource degradation, climate change and limited options to sustain livelihoods.

Methodology

SWOT analysis

The exercise was conducted by three groups (men, women and youth) to identify factors that are helpful and/or harmful to the communities of Pusiju and Valapata. This was done following the SWOT analysis protocol described by (Sarsby 2012). Information from the SWOT analysis was then used to develop the following action strategies: growth strategies, internal development strategies, external development strategies, and survival strategies. These generic strategies should be established before the two communities plan to seriously engage in supplementary livelihood activities. This tool was used purposely to help reduce communities' chances of failure by recognising what is lacking, and then eliminating the hazards that would otherwise cause harm to their livelihoods and wellbeing.

Pairwise ranking

Following the initial analysis above, the three groups ranked the threats from the SWOT to help facilitate the development of action strategies. Here we used the pairwise ranking tool described by Govan et al. (2008) to compare threats in pairs to choose which is the most critical. The most critical threats were identified by each group to help us match and convert the harmful factors from the SWOT into helpful factors. Thus, the pairwise ranking will help to direct where SVTA management should focus their efforts and time to prevent the threats identified from undermining their progress.

SLOPIC

Eleven livelihood options were identified but only six were assessed during the workshop due to time constraints. The assessment was conducted following the protocol described by (Govan et al. 2008). Basically, the SLOPIC tool is used to assess supplementary livelihood options that are appropriate and sustainable for communities. While it is seen as a guide towards success, the critical perception advocated in this tool is building on what the community has, and less so about depending on external sources. According to O'Garra (2007), most projects that are ongoing without relying on subsidies are those that have involved baseline studies and continuous monitoring all throughout. As highlighted by Govan (2011) in the SLOPIC guide, this tool is used to assist community members choose different livelihood options, most of which may be existing options, and assessing these options to see how promising they are for communities. A promising livelihood option is one that continues into the future, coping with changes and disasters, and without losing the things that make the livelihood possible.

Livelihood options

The assessment for sustainability of supplementary livelihood options was conducted by analysing the following resources: natural resources, equipment, people and skills, market and transport, finances, and support and information.

Figure 2. Participants during the diagnosis workshop at Pusiju Village, Vella La Vella.
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Results

SWOT analysis and pairwise ranking

We chose to analyse only the most critical threats and common opportunities, weaknesses and strengths. Outlined in Figure 3 are the generic strategies formulated from the diagnostic exercise.

SLOPIC exercise

Six livelihood options were identified in the SLOPIC exercise, and include betel nut, canteen, banana, piggery, kava and fishing. Figure 4 shows some important resources that the livelihood options being assessed will require in order to succeed. Most of the needs identified from the assessment are also covered under the four generic strategies shown in Figure 3.

Figure 3. Four generic strategies formulated from the diagnostic exercise.

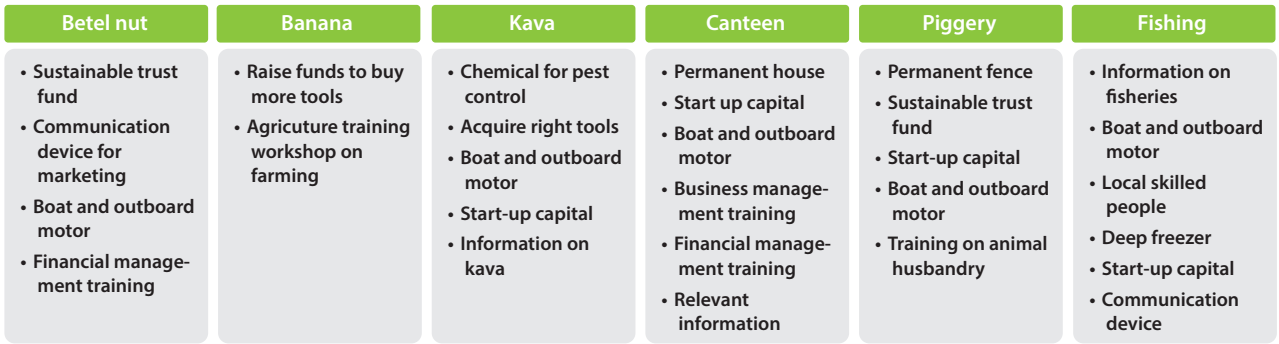

Figure 4. Resources identified during the assessment that will make the livelihood options more successful.

Discussion

The SWOT analysis indicated a number of helpful factors that, in principle, form the basis of the success of SVTA and previous community projects implemented by the communities of Pusiji and Valapata. Cooperation and/or oneness, good leadership, information sharing, and consultation (among other factors) were found to be the key strengths of the two communities. This may be because every individual in Pusiju and Valapata are closely related through common ancestry and inheritance. A study by Ross et al. (2019) corroborated with these findings by highlighting that community participation and collaboration is an important element in supporting management and sustainability in many communities in the Asia-Pacific region.

On the contrary, community weaknesses that were discovered during the exercise included issues of weak leadership, lack of communication, lack of education, and laziness. These issues usually lead to poor management that often affect the demand for a desired resource and weaken the cohesiveness of a community (Singleton 2000). Such situations may pose challenges to management in rural Solomon Islands communities, yet the associated weaknesses can be converted into strengths to expedite the development of internal factors that will help the community to progress. As highlighted in the internal development strategies in Figure 3, when these weaknesses are converted into strengths, a number of new opportunities will open up for the community to improve (Sarsby 2012). Moreover, the communities can move forward with internal developments by capitalising on the concept of "social capital" as proposed by Malherbe et al. (2020). Social capital in this context basically involves the norms and networks that allow people to work together towards common goals. The key attributes of social capital are oneness and/or social cohesion and good leadership, which in the case of SVTA, are key strengths. Thus, according to Gutiérrez et al. (2011) and Jupiter et al. (2017) these attributes, coupled with effective implementation and community ownership of the process, will determine success in resource management.

In rural communities, deliberation on opportunities is sometimes overrated and often raises expectations. Nonetheless, opportunities can be successfully matched with existing strengths to develop growth strategies that promote progress in the community. In fact, growth will only happen when the community does more on what it is good at, and invests on those factors that enhance its capability (Sarsby 2012). Given the technical capacity of SVTA to lead development initiatives, it is auspicious that enthusiastic individuals especially youths in both When our team visited the communities of Pusiju and Valapata, it was obvious that SVTA was investing more in education and sports, which are crucial for their progress. Social activities such as sports help to promote strong cohesiveness by increasing self-esteem, community identity, and unity that can advance other developments in the community (Skinner et al. 2008).

When rating the threats identified from the SWOT analysis (using a pairwise ranking tool), land disputes, high illiteracy rates, poor leadership, and poor management stood out as the most critical threats that SVTA management must prevent at all costs. Land is a very important natural resource that all livelihood options will depend on to operate (Govan 2009). In Solomon Islands, land is a tribal inheritance. Descent-based land ownership, however, has hindered quite a number of development projects in the past when disagreements arose from unfair distribution of livelihood assets (Hviding 1993). To prevent land disputes, SVTA must be proactive to establish cordial working relationships with sister tribes as indicated in the survival strategies in Figure 3. Correspondingly, rural communities such as Pusiju and Valapata will move away from threats to poor leadership and poor management when their leaders are empowered with the appropriate capacity (Warner 2000).

Besides the SWOT analysis above, quite several requirements were identified from the assessment of livelihood options using the SLOPIC tool (Fig. 4). The most common requirements highlighted were: sea transport, farming and fishing equipment and tools, communication, relevant information, capacity building, and establishment of a sustainable trust fund. While the latter is paramount for the sustainability of the other requirements, information and capacity building are equally important to ensure that technical knowledge and skills are available in the community (Warner 2000).

Although it is important to specify the resources required for each livelihood option, this also depends entirely on the personal judgment of whoever is doing the assessment. Despite minor variations in the assessment process, the important prerequisite for sustainability is that communities build on what they have instead of depending entirely on external sources. Apparently, some of the requirements must be acquired elsewhere outside of the community, although the generic strategies in Figure 3 should offer a useful guide to focus only on what is more appropriate for the community. Thus, livelihood options that are community-led, and build on community innovations are very likely to be successful.

For the case of SVTA, assessing the sustainable supplementary livelihood options is very important as communities had already been bombarded twice in the past 10 years to give in to logging. Hence, in order to progress further, SVTA must capitalise on its key strengths that corroborate with Albert et al. (2010) who also emphasised that community support and leadership are key factors for success in resource management. Specifically, from the assessment, betel nut, banana and kava will not require much financial resources to start although they will require some funds for transport and marketing. Unlike the first three options, canteen, piggery and fishing will require some initial capital to start and operate. According to the community group assessing banana as a livelihood option, banana is very sustainable because there are two types: the one that is quickly harvested (*meqora naka*) is quite suitable for larger households, and the other, which

takes longer to before it can be harvested (*qole naka*) is farmed mainly for food security. Unlike banana, betel nut and kava are long-term economic activities that normally take more than three years to be harvested, although comparatively, the financial benefit of kava is far better than all the other economic activities. Piggery and canteen will succeed when the requirements highlighted in Figure 4 are met. Moreover, fishing is a sustainable livelihood option that can continue as part of the day-to-day activities of the community. Fishing is not only done for income generation, but also contributes to food security, which is essential for future generations.

Regardless of the different costs incurred for each livelihood option, the important goal is sustainability. As indicated by O'Garra (2007), the key indicator of success is that the livelihood activity is able to persist long after subsidies and/or external funding is utilised. Although the assessment of livelihood options to identify the most appropriate option is vital, it is also important to diversify options as a form of self-insurance so that when one option fails, the community still has other options (Haider et al. 2018). All in all, the requirements highlighted above are important for the success and sustainability of these different livelihood options.

Conclusions

A management scheme that combines traditional and indigenous knowledge with modern-day science is very likely to succeed. This is possible for contemporary communities in the Pacific Islands region because such an approach will reflect local knowledge, and will help communities make plans that build essentially on what they have. From the study, it was obvious that despite the weaknesses identified during the diagnostic workshop, the development strategies formulated from the strengths and opportunities will help SVTA management and member communities to overcome their weaknesses and progress. The most crucial strategies that may leverage sustainability in any conservation programme in Pacific Island countries include: capacity building to enhance quality leadership and technical skills within the communities; collaboration and networking; and sustainable supplementary livelihood options. Implementation of these strategies will promote social cohesiveness, growth, development and effective management of natural resources. Despite threats such as land disputes, high illiteracy rates, poor leadership, and poor organisational management with regard to resource management, we have seen that contemporary community-based organisations such as SVTA can build on their most important strengths, and utilise every possible opportunity to move away from these threats. In addition, identifying the most appropriate supplementary livelihood options that are fitting for the communities is also crucial. Thus, despite any cost that can be incurred to start and/or operate the livelihood options, the important objective is that the options that are chosen are realistic and sustainable.

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References

Albert J., Schwarz A. and Hawes I. 2010. Creating rural livelihoods in Solomon Islands through an environmentally friendly trade of marine ornamentals for the aquarium trade: Lessons learned. Honiara, Solomon Islands, WorldFish Center.

Blythe J.L., Murray G. and Flaherty M. 2014. Strengthening threatened communities through adaptation: Insights from coastal Mozambique. Ecology and Society 19(2):6.

Collins D., Morduch J., Rutherford S. and Ruthven O. 2009. Portfolios of the poor: How the world's poor live on $2 a day: Princeton, New Jersey: Princeton University Press.

Finkbeiner E.M. 2015. The role of diversification in dynamic small-scale fisheries: Lessons from Baja California Sur, Mexico. Global Environmental Change 32:139–152.

Govan H. 2011. How can we support communities to build on what they have for a better life? Supplementary livelihoods in the Pacific. Suva, Fiji: Foundations for the Peoples of the South Pacific.

Govan H., Aalbersberg W., Tawake A. and Parks J.E. 2008. Locally-Managed Marine Areas. A guide fo practitioners. Suva, Fiji: Locally-Managed Marine Area Network.

Govan H., Tawake A., Tabunakawai K., Jenkins A., Lasgorceix A., Schwarz A. and Notere D. 2009. Status and potential of locally-managed marine areas in the South Pacific: Meeting nature conservation and sustainable livelihood targets through wide-spread implementation of LMMAs Study Report. Suva, Fiji: SPREP/WWF/WorldFish-Reefbase/CRISP.

Gutiérrez N.L., Hilborn R. and Defeo O. 2011. Leadership, social capital and incentives promote successful fisheries. Nature 470(7334):386–389.

Haider L.J., Boonstra W.J., Peterson G.D. and Schlüter M. 2018. Traps and sustainable development in rural areas: a review. World Development 101:311–321.

Hanh T.T.H. and Boonstra W.J. 2018. Can income diversification resolve social-ecological traps in small-scale fisheries and aquaculture in the global south? A case study of response diversity in the Tam Giang lagoon, central Vietnam. Ecology and Society 23(3):16.

Hviding E. 1993. Indigenous essentialism? 'Simplifying' customary land ownership in New Georgia, Solomon Islands. Journal of the Humanities and Social Sciences of Southeast Asia 149(4):802–824.

Jupiter S.D., Epstein G., Ban N.C., Mangubhai S., Fox M. and Cox M. 2017. A social-ecological systems approach to assessing conservation and fisheries outcomes in Fijian locally managed marine areas. Society and Natural Resources 30(9):1096–1111.

Malherbe W., Sauer W. and Aswani S. 2020. Social capital reduces vulnerability in rural coastal communities of Solomon Islands. Ocean and Coastal Management 191:105186.

Mills D.J., Tilley A., Pereira M., Hellebrandt D., Fernandes A.P. and Cohen P.J. 2017. Livelihood diversity and dynamism in Timor-Leste – Insights for coastal resource governance and livelihood development. Marine Policy 82:206–215.

O'Garra T. 2007. Supplementary livelihood options for Pacific Island communities: A review of experiences. Suva, Fiji: Foundation of the Peoples of the South Pacific International.

Ram-Bidesi V., Lal P.N. and Conner N. 2011. Economics of coastal zone management in the Pacific. IUCN and Suva, Gland, Fiji: IUCN, xiv, 88.

Ross H., Adhuri D.S., Abdurrahim A.Y. and Phelan A. 2019. Opportunities in community-government cooperation to maintain marine ecosystem services in the Asia-Pacific and Oceania. Ecosystem Services 38:100969.

Sarsby A. 2012. A useful guide to SWOT analysis. Nottingham, England: Pansophix Online.

Singleton S. 2000. Co-operation or capture? The paradox of co-management and community participation in natural resource management and environmental policy-making. Environmental Politics 9(2):1–21.

Skinner J., Zakus D.H. and Cowell J. 2008. Development through sport: Building social capital in disadvantaged communities. Sport Management Review 11(3):253–275.

Solomon Islands National Statistics Office and World Bank. 2017. Solomon Islands Poverty Maps Based on the 2012/13 Household Income and Expenditure Survey: Technical Report. Honiara, Solomon Islands: World Bank Group.

Sukulu M., Orirana G., Oduagalo D., Waleilia B., Sulu R., Schwarz A.-M. and Eriksson H. 2016. Management over ownership: Modern community cooperation in Langalanga Lagoon, Solomon Islands. SPC Traditional Marine Resource Management and Knowledge Information Bulletin 37:13–21. https://purl.org/spc/digilib/doc/iwimr

Warner M. 2000. Conflict management in community-based natural resource projects: experiences from Fiji and Papua New Guinea. Working Paper 135. London, UK: Overseas Development Institute. https://odi.org/documents/2834/2738.pdf

Wheeler H. C. and Root-Bernstein M. 2020. Informing decision-making with indigenous and local knowledge and science. Journal of Applied Ecology 57(9). https://doi.org/10.1111/1365-2664.13734

Gwala, a form of marine customary closure in the Bwanabwana area of Milne Bay Province, Papua New Guinea

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Keywords:
gwala, *tambu*, Milne Bay Province, Papua New Guinea, marine management

Abstract

The highly biodiverse marine environment of Milne Bay Province in Papua New Guinea supports approximately 280,000 people and their livelihoods. Beginning in 2000, efforts have been made to establish Local Marine Management Areas across Milne Bay Province. It was not until 2017 however, when a local *tambu* system of customary marine management called *gwala* (in the Bwanabwana language) was acknowledged for the value and opportunity that this experiential community-driven approach offered. Several coastal and island communities across the Bwanabwana area have promoted *gwala* for food and livelihood security, and localised recovery of declining marine resources. With the continued promotion of *gwala,* management decisions about the placement of *gwala* and associated rules were recorded on smartphones. This was done to document *gwala* within and by the community so as to be utilised as needed in its oversight and compliance.

Background

Milne Bay Province (MBP) in Papua New Guinea (PNG) consists of the easternmost tip of the island of New Guinea and associated islands in the Coral and Solomon Seas. The mountainous mainland and nearby islands exhibit high levels of species endemism over a relatively small land area of 15,000 km2 (Kraus 2021). The marine environment contains 30% of PNG's reef systems with an estimated 5355 km2 of reefs and shoals that are less than 20 metres deep (Skewes et al. 2002, 2011). These reef associations are species rich, with 430 reef species (Fenner 2003) and more than 1300 reef fishes (Gerry Allen, pers. comm., 2019) and 643 molluscs (Wells and Kinch 2003). These coastal areas and islands were settled mainly by Austronesian peoples (with the exception of Rossel Island) (Shaw 2019; Chynoweth et al. 2020). These mostly rural and remote coastal and island communities predominantly rely on subsistence agriculture and artisanal fisheries for their livelihoods. The main source of cash income for these communities is the exploitation of commercially valuable marine resources, most notably, sea cucumbers for the production of beche-de-mer (Barclay et al. 2019; Kinch 2020) and shark fins (Vieira et al. 2017) and shells such as trochus and blacklip pearl shell.

Customary marine management

Customary marine management practices of closure over natural resources are found across many communities of the Indo-Pacific region (Vierros et al. 2010). Referred to as a *tambu* in PNG, it is known across some of the main language groupings of MBP as *gwala, tawakaus, hivi* and *doi.*

The early practice of customary marine management and associated closures by coastal and island communities along the southern New Guinea coast from Mailu (in the now Central Province) to Suau was known as *gora* (Abel 1902), and from Logea Island along the north coast to Cape Vogel and Dobu Islands (Malinowski 2022), as well as the Engineer Group of Islands (Seligman 1910) extending to the Trobriand Group of Islands (Malinowski 1922).

Traditionally, on Dobu Island in the D'Entrecasteaux Group of Islands, upon the death of a man of importance in any of the hamlets, the whole community underwent a *gwala,* a *tambu* on harvesting betelnut and coconuts in preparation of the required mortuary rites (Malinowski 1922). Kinch (2020) records that across island communities of the Louisiade Archipelago, it was common practice to declare a portion of reef closed when someone of importance dies. The sign of this closure was to tie coconut leaves across the limbs of a Y-shaped branch or young tree and then placed on a section of reef, signalling to the community that this area was now closed (Seligman 1910). The length of such a closure varied, according to the importance of the man who had died, as well as other logistical circumstances (Malinowski 1922).

With the advent of both Christianity and greater dependence on the cash economy, the practice of *gwala* has declined.

The re-emergence of gwala

In 1997, Marida Ganisi placed a *gwala* on Wialoki Island after the death of her uncle. Marine resource abundance around Wialoki Island was poor due to previous over-

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exploitation of commercially valuable marine resources. Marida had seen her forefathers practice *gwala* and now as the head of a matrilineal family she reintroduced *gwala*. The original *gwala* involved a ban on trochus harvesting for six months. When the *gwala* was lifted, fishers from the nearby Kwaraiawa Island community came and collected all the marine resources they could find. This led Marida to reintroduce another *gwala* in 1999, this time banning the harvest of all commercially valuable marine resources across an area of over 53% of the total reef–lagoon system of Wialoki and adjoining islet. This *gwala* remains in place and has become a refugia and giant clam gardens have been established (see Kinch 2002, 2008 for other parts of MBP). The resultant spill-over from this *gwala* into adjacent areas that are open for fishing and gleaning has been sufficient to sustain the harvesting of marine resources for Wialoki Islanders for both food and trade.

During the Global Environment Facility's Milne Bay Community-based Coastal and Marine Conservation Project (CBC&MCP) that ran from 2002 to 2006, community development workers employed by Conservation International (CI) visited Wialoki Island. Working closely with Marida and the community, CI staff supported *gwala* as part of their requirements to establish Locally Managed Marine Areas (LMMAs). Due to a range of issues with management, the CBC&MCP was closed (Baines et al. 2006; Dowie 2008; Balboa 2013). In the lead up to the closing of the CBC&MCP, CI tried to develop a Conservation Incentive Agreement, essentially "cargo for conservation" process in an attempt to entice the Wialoki Island community to establish a LMMA (Conservation International 2006; Kinch 2020). Reflecting on the closure of the CBC&MCP , the then CI Country Director claimed that "money had killed conservation". As a result of the CBC&MCP termination, Marida decided that it was her responsibility to ensure the continued custodianship of the *gwala* customary closure that she had initiated.

In the case of Wialoki Island and later Anagusa Island, the purpose of the *gwala* was primarily for food security and rehabilitating stocks of commercially valuable marine resources.

Having seen the loss of reef health as well as the depletion of commercially valuable marine resources, a ward member on Anagusa Island asked community elders about reintroducing *gwala*. Community discussions ensued and community members provided their support following a vote, with everyone shouting: "we go for *gwala*" (Elama Peter in the video *Gwala Rising*, 2018). The area to be closed was then discussed by the community and agreed upon. One factor that was considered in the area selected was that it had previously had large shoals of scads (*katukatule, Selar* spp.) and they wanted to provide an area for their recovery. The boundary of the *gwala* closed area was clearly defined with visible natural features that served as markers, and rules were agreed upon by community consensus along with the length of time of the closure. The ward member, a formally elected representative within the local level government recognised

Figure 1. Placing a marker for the *gwala* in the lagoon on Anagusa Island, closing this and the fringing reef from fishing, 2017. Still image taken from video 'Gwala Rising' 2018, by Stephani Gordon, © Conservation International,

Figure 2. Placement of *gwala* at Ole Island 2018. The mark was dressed with *bagi* and *mwali* shells, conch shells, and betelnut. Still image taken from smartphone video record of gwala closure by Noel Wangunu, ©ECA.

these decisions and rules in the local language as "customary law". The customary mark of *gwala,* a forked branch with coconut and coconuts leaves was then placed on the reef, and to provide another level of authority, the church pastor also blessed the *gwala.*

Where there is community participation, a common understanding and commitment towards a common action, the implementation and potential of shared benefits from a *gwala* is more likely to succeed. Local infringements can be heard by the local village court, which under the Village Courts Act 1989 can hear matters in relation to land (reef is also defined as reef in this Act), on the right by custom of its use, or prohibition of use. In incidences of poaching commercially valuable marine resources, village court decisions in relation to customary practices such a *gwala* can be presented to a higher court; customary law being recognised as a source of underlying law in PNG within the Underlying Law Act 2000.

With a need for cash, a secondary value of the *gwala* has been achieved at Anagusa Island by opening the gwala closure in which fishers can dive for trochus. This is permitted, following community agreement that allows collection for a few hours, within which around 1000 shells are collected. Trochus is ideal for a well-managed sustainable take, with the saleable pieces coming from a base diameter of 8–12 cm. The lower limit allows spawning and recruitment of stock and the upper limit is set due to these shells being of no commercial value due to the shell being attacked by borer worms (Nash 1993). In this way new cohorts and reproductive shells remain in the *gwala.* In Vanuatu, for example, the primary reason for establishing some customary marine areas was as a management approach for trochus as a cash income. Through the 1990s the Fisheries Department, Environment Unit, and Vanuatu Cultural Centre supported these traditionally derived contemporary *tambus* through a programme of cooperative management (Hickey 2006). Within the sheltered lagoon of the Anagusa Island. seaweed farms were established and harvested, however with loss of market these were disbanded.

Other communities in MBP are now also placing *gwala* over areas of their marine tenure. These have been supported by varying levels of influence, either initiated internally, through the church or government, or with support from non-governmental organisations.

For example, Ole Island is a small island within the Kula Ring of MBP, a network of customary traders on islands who exchange valuable *bagi* shell necklaces for *mwali* armlet along with other items (Irwin et al. 2019). At Ole Island, 78% of the reef area is now under a *gwala*, with an emphasis of protecting high-value *kula* exchange items. Again, the church pastor has given his blessing while, the ward member has recognised this act, and the Milne Bay Provincial Environment Officer was invited to witness the placement of the *gwala*.

In the Brumer Islands, 37% of the reef area is now under a *gwala.* At the dedication for this *gwala,* a church minister linked the custom of *gwala* to the scriptures of Ecclesiastes 3:1 and 2a[2] and Genesis 2:15,[3] and sprinkled "holy" sea water into the sea when declaring the *gwala* closure. Another

[2] There is a time for everything, and a season for every activity under the heavens: a time to be born and a time to die, a time to plant and a time to uproot.
[3] The Lord God took the man and put him in the Garden of Eden to work it and take care of it.

Figure 3. United Church minister and community at the blessing of the gwala on Bonarua Island in the Brumer Group, 2021. Still image taken from smartphone video record of gwala closure by David Mitchell, ©ECA.

church pastor prayed over the *gwala*. In this instance, the branch that identified the *gwala* was decorated with giant clam shells to signify the marine nature of the closure.

In mid-2016, before CI finally exited PNG, a local NGO, Eco Custodian Advocates, was formed and a short film on the *gwala* system of maraine closures, called *Gwala Rising* (2018), was produced, which included part of Marida's story. This film combined personal stories from different perspectives within the communities in their application of a *gwala*. More importantly, the film documented the process of establishing a *gwala* by the community at Anagusa Island. This *gwala* has been maintained to the present. The message within *Gwala Rising* is also a call-to-action, making it an ideal introduction for other communities to consider reintroducing *gwala* in their own marine territories. When projected onto a white sheet in villages or watched on smartphones, community members are able to relate to these stories, and discussions can be generated about taking action to implement a *gwala*.

In one instance, this led in 2020 to a ward member from Simbumbum Islet using a smartphone to record a video of his community's declared rules, and the placement of a *doi* (their name for *gwala*).

The use of smartphones allows the dynamics of customary, written law and religious beliefs to be recorded, and provides a storable medium apart from human memory. Apart from being a record of *gwala* for communities, it can also be used within village courts, as well as being presented to government agencies and higher courts. More importantly, when the implementation of a *gwala* is recorded within the community, in the language and context of where it is implemented, the rights over this intellectual property remains within the community.

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References

Abel C. 1902. Savage life in New Guinea: The Papuan in many moods. London England: London Missionary Society.

Baines G., Duguman J. and Johnston P. 2006. Milne Bay Community-based Marine and Coastal and Marine Conservation Project, Project Number PNG/01/G31 Terminal Evaluation of Phase 1, July 2006

Balboa C. 2013. How successful transnational non-governmental organizations set themselves up for failure on the ground. World Development 54:273–287.

Barclay K., Fabinyi M., Kinch J. and Foale S. 2019. Governability of high-value fisheries in low-income contexts: A case study of the sea cucumber fishery in Papua New Guinea. Human Ecology 47:381–396. https://doi.org/10.1007/s10745-019-00078-8

Chynoweth M., Summerhayes G.R., Ford A. and Negishi Y. 2020. Lapita on Wari Island: What's the problem. Asian Perspectives 59(1):100–116.

Conservation International. 2006. Community Conservation Incentive Agreement, Between: Conservation International and The Kisakisa Wialoki sub clan and the Magisubu Nataule sub-clan, Skelton Island branch. Conservation International, Papua New Guinea Country Program, Alotau.

Dowie M. 2008. Wrong path to conservation in Papua New Guinea: Dangling cargo to win local support, Western enviros have instead aroused ire in Papua New Guinea. The Nation. September 29, 2008 issue.

Fenner D. 2003. Corals of Milne Bay Province Papua New Guinea, Chapter 1:20–26 in Allen G., Kinch J.P., McKenna S. and Seeto P. (eds). 2003. A rapid marine biodiversity assessment of Milne Bay Province, Papua New Guinea Survey 2 (2000), RAP Bulletin of Biological Assessment 29, Conservation International.

Gwala Rising. 2018. Vimeo https://vimeocom/251872301; You Tube https://www.youtube.com/watch?v=AfANgYbcGP4

Hickey F.R. 2006. Traditional marine resource management in Vanuatu: Acknowledging, supporting and strengthening indigenous management systems. SPC Traditional Marine Resource Management and Knowledge Information Bulletin 20:11–23. https://purl.org/spc/digilib/doc/h7iso

Irwin G., Shaw B. and McAlister A. 2019. The origins of the Kula Ring: Archaeological and maritime perspectives from the southern Massim and Mailu areas of Papua New Guinea. Archaeology in Oceania 54:1–16.

Kinch, J. 2002. Giant clams: Their status and trade in the Milne Bay Province, Papua New Guinea. Traffic Bulletin 19(2):67–75.

Kinch J. 2008. From prehistoric to present: Giant clam (Tridacnidae) use in Papua New Guinea. In: Antczak A. and Caprini R. (eds). Early Human Impact on Megamolluscs. British Archaeological Reports International Series 1865:179–188.

Kinch J. 2020. Changing lives and livelihoods: Culture, capitalism and contestation over marine resources in island Melanesia, A thesis submitted for the Degree of Doctor of Philosophy, School of Archaeology and Anthropology Research School of Humanities and the Arts. Australian National University, Canberra.

Kraus F. 2021. A herpetofauna with dramatic endemism signals an overlooked biodiversity hotspot. Biodiversity and Conservation. https://doi.org/10.1007/s10531-021-02242-3

Malinowski B. 1922. Argonauts of the Western Pacific: An account of native enterprise and adventure in the Archipelagos of Melanesian New Guinea. New York, New York: George Routledge and Sons, Ltd.

Nash W.J. 1993. Trochus. Chapter 14. In: Wright A. and Hill L. (eds). Nearshore marine resources of the South Pacific. p. 451–495. Institute of Pacific Studies, Suva; Forum Fisheries Agency, Honiara; International Centre for Ocean Development, Canada.

Seligman C.G. 1910. The Melanesians of British New Guinea. Cambridge, United Kingdom: Cambridge University Press.

Shaw B. 2019. Archaeology of the Massim Islands Region, Papua New Guinea in C. Smith (ed). Encyclopedia of Global Archaeology. https://doi.org/10.1007/978-3-319-51726-1_3444-1

Skewes T., Kinch J., Polon P., Dennis D., Seeto P., Taranto T., Lokani P., Wassenberg T., Koutsoukos A. and Sarke J. 2002. Research for sustainable use of beche-de-mer resources in Milne Bay Province, Papua New Guinea. Cleveland Australia: CSIRO Division of Marine Research Final Report.

Skewes T., Lyne V., Butler J., Mitchell D., Poloczanska E., Williams K., Brewer D., McLeod I., Rochester W., Sun C. and Long B. 2011. Melanesian coastal and marine ecosystem assets: Assessment framework and Milne Bay case study. CSIRO Final Report to the CSIRO AusAID Alliance.

Vieira S.; Kinch J.; Yaman L. and White W. 2017. Shark fishing in the Louisiade Archipelago, Papua New Guinea: Socio-economic characteristics and government policy options. Ocean and Coastal Management 137:43–56.

Vierros M., Tawake A., Hickey F., Tiraa A. and Noa R. 2010. Traditional marine management areas of the Pacific in the context of national and international law and policy. Darwin, Australia: United Nations University Traditional Knowledge Initiative.

Wells F.E. and Kinch J.P. 2003. Molluscs of Milne Bay Province Papua New Guinea,–Chapter 3:39–45. In Allen G., Kinch J.P., McKenna S. and Seeto P. (eds). A rapid marine biodiversity assessment of Milne Bay Province, Papua New Guinea Survey 2 (2000), RAP Bulletin of Biological Assessment 29, Conservation International.

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