The use of local resource knowledge and customary fisheries management to assist marine management in the Fiji Islands using Maumi, Fiji, as a case study.

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Attestation of Authorship

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by any other person (except where explicitly defined in the acknowledgements), nor material which to a substantial extent has been submitted for the award of any other degree or diploma of a university or other institution of higher learning.

Signed (student) 

Date 05/08/2013

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Abstract

Traditional and community-based marine resource management practices can enhance the effectiveness of contemporary environmental management models. These traditional management practices, which are based on knowledge of natural and cultural systems in specific areas, provide useful lessons from which contemporary resource managers can learn about the experiences of others. Fisheries management in traditional communities is well integrated into society and people are regarded as integral parts of the ecology of the coastal zone and, therefore, the fishery.

A descriptive analysis of the interactions between human perceptions of the Maumi village people and the ecological condition of the Maumi Estuary and Namata River is provided in this thesis. The aims of this study were a) to conduct a review of existing marine management in Fiji using both academic and informally published transcripts and reports (grey literature); b) to describe local knowledge of marine habitats, customary fishing grounds and significant fish species distribution and abundance in the Namata River and Maumi Estuary; and c) to validate local knowledge through opportunistic in situ sampling with customary fishers. Fulfilling these aims will address the question of whether combined ethnological and ecological information should be used to aid traditional fisheries management in Fiji. In order to achieve these objectives several methods and techniques were used. A broad literature review was conducted, gathering information from academic databases and libraries, government departments, non-governmental organisations and other sources of grey literature in order to evaluate the current marine management practices in Fiji. Over a period of one month, interviews were carried out in Maumi Village in order to collect baseline data to provide information on resource use and related spatial and temporal variations, in and around the Maumi Estuary and Namata river mouth. Following the interviews, a group

workshop was held to gauge the perceptions of current resource management and to discuss future goals and desires for marine protection and managers. Finally, an opportunistic field study with a local customary fisher was performed to assess catch rates in the area using three different traditional fishing methods. These data were then compared to that collected from the interviews to gauge the accuracy of the local people's perceptions of their catch rates.

This study showed that local ecological knowledge (LEK) can serve a significant role in creating more socially sustainable and robust marine management plans, especially in data-poor regions such as Fiji. When used in partnership with ecological information, LEK can form a strong foundation for the development of adaptable and sustainable protected areas in Fiji. By acknowledging the perspectives of the local people and associated stakeholders in marine management initiatives, we exhibit a greater understanding for the way in which worldviews and beliefs influence our interaction with natural resources and the environment. In doing so, such information can be used to adapt management concepts to apply to local and regional spaces, encouraging greater effectiveness and local support. Further information is also needed to enlighten the relationship between social perspectives, actions, ecological status and outcomes.

Coastal communities, including Maumi Village, in Fiji depend heavily on their natural resources. Community-based protected area initiatives aid in developing management programs that protect resources for the future. With further research of surrounding settlements a management plan for the Namata River and Maumi Estuary catchment could more effectively protect the local resources for future generations.

Chapter 1: Introduction

1.1 Global and regional marine management trends

Both globally and throughout the South Pacific there has been a marked decline in the oceans ability to provide vital ecosystems services (Ruddle, 1998; United Nations Environmental Program (UNEP), 2011). Managing such a decline and the issues associated with it, require a shift from marine science towards solution driven research and from sector-based management to ecosystem-based management (EBM). EBM is an integrated approach to marine management that encompasses all elements of a given ecosystem (Day, Fernades, Lewis, & Innes, 2003; Day & Roff, 2000). When we are managing the ocean's resources and processes through EBM, the goal is to manage processes at various scales, which are place specific (Crowder & Elliott, 2008). These include the social, cultural, political and economic processes and issues that overlay the biophysical area, (Slocombe, 1998). This encourages the integration of natural and social sciences needed to attain ecosystem-based solutions.

The common sector-based governance approach to marine management has, in the past, suffered from fragmentation and spatial and temporal mismatches in various areas. However, the initiation of EBM has developed clear guidelines and strategies to enhance and combine the effective elements of more conservative approaches. Marine spatial planning (MSP) is one of these elements (Day, Fernades, Lewis, & Innes, 2003; Slocombe, 1998). MSP has been adopted with the goal of creating a more promising and strategically viable avenue for implementation of EBM (Crowder & Elliott, 2008; Douvere, 2008; Agardy, 1993). Instead of agencies managing individual activities across a range of areas, MSP allows several main agencies to govern all human activities within one ecological or sociological area. This would enable the management

of delimited areas, breaking down the boundaries between individual processes, as this is vital to attaining ecosystem-based solutions.

One of the key elements of MSP is the mapping of human uses and the biophysical habitats associated with the marine environment (Day & Roff, 2000; Gilliland & Laffoley, 2008; Agardy, 1993). In doing so, unique assemblages such as shellfish beds, fish breeding grounds and mangrove forests can be identified (Douvere, 2008). Simultaneously, human uses and the political boundaries associated with the area can be mapped, providing a socio-economic overlay (Day & Roff, 2000). Such investigations could map oil and gas development, shipping and fishing practices (Aswani & Lauer, 2006). In addition, the mapping of jurisdictional boundaries offers information on areas already governed by other organisations or governmental agencies (Douvere, 2008). Combining all this information would provide a broad overview of an area's suitability for place-based marine management, therefore fulfilling the aim of managing human activities in order to maintain ecosystem function, resilience to environmental change and provide sustainable ecosystems services.

1.2 Geographic context and ecological significance of the Fiji Islands

The Fiji Islands is a country rich in natural resources and biological diversity. Comprised of 332 islands, the Fiji Island marine eco-region is distributed between the latitudes of 177-178^{0} and longitudes 15-23^{O}S (Asian Development Bank, 2005). The islands cover a total land area of 18,500km^{2} and lie between the Tonga-Kermadec and New Hebrides convergent zones (World Wildlife Fund (WWF), 2003a). The Lau Basin to the east and the Fiji basin to the west complete Fiji's boundary. The exclusive economic zone (EEZ) of Fiji covers an area of 1.3 million km^{2} (Asian Development Bank, 2005). Within the EEZ, Fiji's largely volcanic islands are exposed to predominant south-easterly swells throughout the year, with the exception of July and December,

when there is an easterly dominant swell. Lagoons and estuaries experience strong tidal currents three hours prior to and post low and high tides, with the amount of water entering lagoons and passages dependent on tidal heights, (Vuki, Zann, Naqasima & Vuki, 2000; Vuki, Naqasima, & Vave, 2000).

The Fiji Islands are of particular ecological significance as they are an area that displays a wide range of marine habitats (Tawake & Tabunakawai, 2009; Techera & Troniak, 2009). The uplifted, shallow platform, on which the Fiji Islands were formed, is created by the convergence of several oceanic plates, surrounded on all sides by deep oceanic waters. The platform provides shallow warm waters for the rich growth of marine life (Techera & Troniak, 2009). These conditions encourage the medium to high levels of marine diversity, which characterise Fijian waters. This diversity includes estuaries, mangroves, wetlands, sea grass, macro-algal assemblages, protected and exposed soft shores, lagoons and coral reefs. Fiji is within the top 10 countries or geographical locations, with globally significant coral systems, is home to the world's third longest barrier reef system and forms part of the world's richest fishing ground for tuna (*Katsuwonus pelamis*, *Thunnus albacares*, *Thunnus obesus*, *Thunnus alalunga*), accounting for 15% of the catch in the region (National Tuna Management Plan – Managed by the Ministry of Fisheries and Forests, 2002), (Anon, 2002).

Coastal communities have traditionally relied on marine resources food and income, (Gillett & FAO, 2010). Fisheries have been, and continue to be a significant source of sustenance and economic growth, accounting for 1.5% GDP, (World Wildlife Fund (WWF), 2003b, Government of Fiji, 2006).

The management of inshore marine fisheries requires detailed knowledge of the marine environment. Such knowledge includes information on spawning cycles of fish and the

effect of lunar changes (Drew, 2005). This information and much more was shown by Johannes (1980) to be contained in the oral traditions of fishing people. As younger generations become more urbanised and less connected to traditional practices, there is a need to record the information stored in the memories of native populations (Aswani & Lauer, 2006; Drew, 2005; Sabetian, 2002a,b).

The use and protection of marine resources is a complex and ever-changing process. This process is often a product of the diversity of stakeholder groups and political and legislative requirements. If we are to establish effective management plans it is vital that reliable information is collected to ensure a sustainable solution to resource management issues. In Fiji this process is undertaken by a collaboration of stakeholder groups including NGOs, local communities, government and regional agencies, academic institutions and private businesses to inform the development of sustainable and ecologically productive marine protected areas (MPA).

1.3 Thesis aims

The study pursued three aims, described below, which if met, will address the question, "Can combined ethnological and ecological information be used to aid traditional fisheries management in Fiji?" The study sites for this research are the Maumi Village and Estuary and the adjoining Namata River, which are situated north east of Nausori, on the island of Viti Levu, Fiji, and are governed by several locally designated fishing grounds (qoliqoli), connected to several surrounding villages. Maumi Estuary is also the location of several collaborative research projects with Fiji National University, the local Maumi people and the Fiji Locally Managed Marine Areas (FLMMA) network. Similar research has been conducted in the Solomon Islands by Shankar Aswani, Richard Hamilton and Armagan Sabetian, (Aswani & Hamilton, 2004; Sabetian, 2002a, b), who studied traditional ecological knowledge and its implications in marine and

fisheries management practice.

The 1970s spawned an increased scientific interest in local or traditional knowledge relating to the marine environment. Inquiries into natural resource ownership, sea tenure systems, taxonomic and fisheries systems were developed. The resulting literature represents a combination of research in the fields of anthropology and marine biology (Johannes, 1977, 1978, 1981, 1982; Akimichi, 1978; Ruttley, 1987; Hviding, 1988, 1989; Ruddle, 1993, 1994; Aswani, 1997, 1998; Foale, 1997; Hamilton & Walter 1999).

In contemporary marine management practice it is now accepted that ethnological, ecological and other forms of local knowledge are vital to the success and sustainability of marine management initiatives. In Fiji, ethnographic techniques commonly used in the gathering of knowledge data include social surveys and participant observations, as well as formal and semi-structured interviews, for both qualitative and analyses (Polunin 1984; Ruddle, Hviding & Johannes, 1992; Johannes & Hviding, 1989; Pollnac et al., 2001; Johannes, 2002; Sabetian, 2002a; Aswani and Hamilton 2004; Christie and White, 1997; Clark and Murdoch, 1997). Hamilton and Walter have declared that such skills are often "difficult, time consuming and well beyond the professional training of most fisheries scientists, resource planners, and project managers" (Hamilton & Walter, 1999, p.13).

The completion of this project may determine the adaptability of similar practices to the Maumi Village people and the Maumi Estuary and Namata River. In order to investigate whether combined ethnological and ecological information can be used to aid traditional fisheries management in Fiji, I established the following research aims:

1) Conduct a review of existing inshore marine management in order to explore the perception of indigenous Fijians and resource use of the local waterways in Fiji, by way of gathering and comparing both academic and grey literature addressing marine management and resource use in Fiji and the South Pacific (GL'99 Conference, 1999).
2) Describe local knowledge of marine habitats, customary fishing grounds, significant fish species distributions and abundance in the Namata River and Maumi Estuary. This analysis will involve the investigation of temporal and spatial resource use patterns, management perceptions and desires of the Maumi village people. A focus group and semi-structured interviews including mapping exercises will provide the resource use data and aid in the future spatial marine planning in the study area.
3) Assess local knowledge with the use of in situ sampling, including biophysical data and Catch Per Unit Effort (CPUE) data through the catch collected in an opportunistic field survey of Maumi Estuary and the adjoining Namata River.

These objectives were met by employing the research methods presented in Chapter Three. Chapter Two (Aim 1) provides a review of Fijian marine management practices. Chapter Four describes the study sites used, in order to provide the geographical context for the results contained in Chapter Five. Chapter Five (Aims 2 & 3) presents the results of a focus group conducted in the local village to unearth historical, current and potential management practices that govern the local waterways. This Chapter also addresses two semi-structured interviews conducted simultaneously to gather demographic information, information regarding use of the waterways, and temporal and spatial trends in the catching of marine animals. Chapter Five also presents the results of an in situ opportunistic fishing survey of local marine

animal catch that was conducted with customary fishers to validate information gathered in the semi-structured interviews. Fishing in Maumi village is undertaken in a variety of ways, for a variety of species (including crustaceans). The principal techniques of interest are line fishing, netting, crabbing, gleaning. For the purpose of this study fishing is defined as catching fish with a single nylon fishing line, hook and bait, netting is placing a net in a set place for several hours to claim those fish and crustaceans caught in the outgoing tide, crabbing is capturing crabs in wire cages and gleaning is collecting marine organisms by hand (usually crustaceans).

This research was supported by Fiji Locally Managed Marine Areas (FLMMA), Fiji National University (FNU) and Auckland University of Technology (AUT). The geographic area studied was selected after the recommendation of FLMMA with the aim of providing a greater insight into a current area of interest for FLAMMA, FNU and the local Maumi village people.

Chapter 2: Understanding existing marine management and resource use in Fiji

This chapter includes a background review of Fijian marine management, resource use issues, and customary management. The review describes contemporary marine management and inshore fisheries in the Fiji Islands, using a mix of peer reviewed academic and grey literature.

2.1 Marine Management in Fiji

Since the early 1900s there has been growing interest in the management of marine resources in the Fiji Islands (Lees & Siwatibau, 2007). This included the increased acknowledgement that western biological and economic management models are not effective in the case of tropical inshore multi-species fisheries (Aswani, 1999; Jupiter & Egli, 2011). Long standing issues, regarding the enforcement and compliance of government-driven fisheries regulations, have initiated the assessment of community-based management schemes or customary marine tenure as possible vehicles for locally adapted fisheries management schemes (Hviding & Ruddle, 1991; Veitayaki, 1998; Muehlig-Hofmann et al., 2006).

As with most Pacific Islanders, the indigenous Fijian people are maritime people, depending on the ocean and waterways for economic sustenance and food. There is a culture of fishing threaded throughout the Fijian people, which are displayed in the passing down of fishing traditions to the younger generations and the way in which skilled fishers are highly regarded (Veitayaki, undated). In coastal areas, fish and marine life serve as a staple part of the diet and hold important cultural significance, which still influences the way people use these resources today (Veitayaki, 1998; undated; Hooper, 2000; DeMers & Kahui, 2012). However, many coastal populations

no longer believe in the supernatural ideas of their ancestors nor adhere to all traditions, yet they remain aware of them and will commonly reference their practical uses (Muehlig-Hofmann et al., 2006).

Many Fijians rely on inshore and offshore fisheries for their primary income and sustenance (WWF, 2003a; Gillett & FAO, 2010). Over the past decades there has been significant pressure placed on fisheries leading to declines in fish stocks (Teh, et al., 2009; Gillett & FAO, 2010; Jupiter & Egli, 2011). This reality combined with rising trade prices has led to decreases in subsistence catches from 1996 to 2002 (Hviding & Ruddle; 1991, Jupiter & Egli, 2011). Meanwhile the percentage of catches sold is increasing. Catch per unit effort (CPUE) totals from recent surveys of village catches, from locations across Fiji, suggest that greater than 70% of catch is being sold (Institute of Applied Science (IAS), 2009). Over a century of bêche-de-mer (Sea Cucumber) harvesting has resulted in a notable depletion of stocks in southern Viti Levu and Bua Province of Vanua Levu (Teh et al., 2009).

Fijian society traditionally views the physical, biological and human elements of the environment as linked together in a complex web of relationships called '*vanua*' (Baines, 1984). This is viewed is shared by the people of Maumi Village and is a concept is more closely related to the contemporary ecosystem view of the natural environment. These traditional views are often seen as polar to traditional western approaches that have been labeled as normative (Lightfoot & Burchell, 2005), techno centric (Gladwin, Kennelly, & Krause, 1995) anthropocentric (Campbell & Loy, 1996; Gladwin et al., 1995), or ecocentric (Gorobets, 2006) and economically and politically biased. Fijians traditionally have not seen the land as a commodity in the capitalist sense. The expression '*na qau vanua' vanua*' – not <u>my</u> land but 'the land to which I

belong, of which I am an integral part: the land that is part of me and feeds me' (Roth, 1953/1973) demonstrates this mindset. Land is seen as a more holistic concept, which encapsulates all that is natural, including human populations. The land is a representation of the spiritual and is traditionally very sacred, (Ewins, 1998).

The holistic environment represented by *vanua,* has not always been considered a priority by external development consultants or government when project planning or managing. The lack of acknowledgement of *vanua* by recent Fijian governments has been a significant issue influencing environmental management initiatives (Kellert et al., 2000; Tuivavalagi, 2002). The government has struggled to find a balance between the pressures of the 'modern' nation state to develop economically and politically and the values of communality and ties to the land. Doing so would encourage the implementation of holistic environmental and conservation policies and initiatives. Finding the balance between desires for further modernisation and maintaining the core elements of the *vanua* is an issue that effects not only government but local Fijian villages and communities. Cultural hybridisation of core *vanua* values, cash-based economies, entrepreneurial demands, democratic decision-making, governing bodies and religion could offer a balance and encourage sustainable development.

Contemporary perceptions relating to the significance of traditional fishing practices and beliefs have emphasised the importance of maintaining, and understanding traditional resource use. Resource usage was traditionally based on empirical knowledge of local, cultural and natural systems (Veitayaki, 2000; Aswani & Hamilton, 2004; Aswani & Lauer, 2006; Ban, Jones, & Vincent, 2009). These resource practices are rapidly changing today, but some fundamental elements of traditional resource use structures still remain (Muehlig-Hofmann et al., 2006). Johannes (1980) demonstrated, in his work in Palau how traditional knowledge can be combined with

western science to develop a more sustainable management framework. This combined approach can work in a variety of industries and contexts. This theory still features today in conservation measures throughout Fiji, as demonstrated by the foundation and growth of Fiji Locally Managed Marine Areas (FLMMA) in community-based marine management programmes, driven by the union of traditional and contemporary environmental management practices (Jupiter et al., 2011).

The failure of traditional inshore marine management throughout much of the Fiji Islands has driven a collaboration of stakeholders to form a network called, Fiji Locally Managed Marine Areas (FLMMA). The goal of FLMMA is to establish a cohesive network of Marine Protected Areas where contemporary conservation initiatives are combined with traditional management systems (Dudley, 2008; Polunin, 1984). An Locally Managed Marine Area (LMMA) differs from what is commonly known as a Marine Protected Area (MPA) in that LMMAs are characterised by local ownership, use and/or control, and in some areas follows the traditional tenure and management practices of the region, whereas MPAs in the formal sense are typically designated via a top-down approach with little if any local input. Communities typically set aside at least part of an LMMA as a no-take reserve (oftentimes referred to as an MPA, but with a different meaning than the formal definition above) or impose certain gear, species, or seasonal restrictions to allow habitat and resources to recover from fishing pressure, or to sustain or increase fish catch.

In addition to this network, there are 410 traditional fishing grounds called *qoliqoli* that have been established by the local communities to also promote local management of fisheries resources. Of these 410 *qoliqoli*, seventy are regarded as over exploited and 250 are fully developed, whereby the local *qoliqoli* is fished to the replenishment

threshold (Jupiter & Egli, 2011; Hand et al., 2005).

These ‘‘hybrid’’ institutions have utilised customary governance structures, such as village councils, to allocate catch quotas in individually transferable quota (ITQ) systems (Adams, 1998); used traditional ecological knowledge to locate and temporarily restrict fishing in spawning aggregation sites of commercially valuable species (Graham & Idechong, 1998; Drew, 2005); mapped vulnerable benthic habitats for integration into conservation plans (Aswani & Lauer, 2006a) adaptively experimented with gear restrictions (Adams, 1998; Cooke et al., 2000; McClanahan & Cinner, in press); implemented temporary closures to manage stocks (Ruttan, 1998; Thornburn, 2001; Hickey & Johannes, 2002); and established community owned and managed MPAs.

There has been relatively little documented research conducted in Fijian marine ecosystems. However, surveys conducted by World Wildlife Fund (WWF) and World Conservation Society (WCS) have evaluated the biological value of several areas, such as Kubulau in 2005 and Cakaulevu in the last few years (Wildlife Conservation Society (WCS), 2012a; Jupiter et al., 2010c). Further research conducted has revealed a much greater level of biodiversity than previously predicted and the South Pacific marine eco-region, along with South Pacific Islands forests is recognised by the WWF on the Global 200 as two of the Earth’s most biologically valuable regions, that need to be conserved (WWF, 2003a).

In a study conducted by WWF, 13 areas of ecological, cultural or economic significance were identified by participants, with one of these being the Rewa and Tailevu Mudflats situated north of Suva, which includes the study site of this research (WWF, 2003b).

2.2 Legislative framework for protected area management

The current deficit of legal guidance due to the lack of a coherent framework has led to challenges, including the failure of existing legal means to establish and maintain long-term management structures for co-managed conservation areas (Ministry of National Planning, 2010; Vukikomoala, et al. 2012; Techera & Troniak, 2009). Consultations held by the Fiji Department of Environment are currently being conducted in order to improve the situation (Clarke & Gillespie, 2009; Department of Environment, Fiji, 2012) Despite Fiji having no formalised protected area legislation, there are several systems in place that attempt to provide site-based conservation of natural and cultural resources (Clarke & Gillespie, 2009; Techera & Troniak, 2009; Department of Environment, Fiji, 2012)

The current legislative mechanisms of relevance to indigenous Fijian communities include the Native Lands Act (CAP 133), the Native Lands Trust Act (CAP 134) and the Fisheries Act (1991) (Clarke & Gillespie, 2009; Troniak, Techera & Govan et al., 2009). The Native Lands Act allows for the continued occupation of the 'native lands' differentiated into terrestrial land and coastal marine areas. Such land falls under the ownership of neither the Crown, nor freehold title. Freehold title is the same as fee simple; it can be bought and sold freely and owned forever. Approximately 9% of land in Fiji is freehold and much of it is situated in the North and on the island of Vanua Levu, (UNEP, 2004). Recognition of traditional communal ownership provides a legal gateway for the community-driven conservation of natural resources (Clarke & Gillespie, 2009). Any communal decisions made, that are in accordance with traditional customs, are binding for both *mataqali* (native land owners) and involved third parties. Lands under this customary land tenure system are defined by the principle of communal ownership of a land parcel that has already been topographically surveyed,

charted on Native Land Commission (NLC) Maps, and registered in the Register of Native Lands (RNL). Under this system land and communal landowners are registered, with no individual titles being issued. Ownership of land is vested in the *mataqali* or tribal group as registered in the RNL. Individual membership of the land owning *mataqali* or tribal group is recorded in the *Vola ni Kawa Bula* (VKB). Despite this arrangement, whereby customary owners are able to assert their ownership interest in their traditional lands, the Fijian government still maintains final control over such land, granting user rights to customary owners (Troniak, et al., 2009).

According to the Native Lands Act (CAP 134), all native lands in Fiji are under the governance of the Native Land Trust Board (NLTB). The NLTB is responsible for the management and administration of land on behalf of the traditional owners (Clarke & Gillespie, 2009; Troniak, et al., 2009; Asian Development Bank, 2005; Department of Lands and Surveys, date unknown). As the NLTB holds administrative rights to the land, the board must grant permission if any land is to be transferred, charged or encumbered. Such land can only be sold, granted or transferred to the crown. Conservation agreements, including those administered by the National Trust for Fiji, are also at the discretion of the NLTB (Clarke & Gillespie, 2009, Department of Lands and Surveys, Date unknown).

The laws relating to marine resources in Fiji are written in Chapters 158, 158A and 149 of the Laws of Fiji. The legislative framework, put in place by the colonial government in 1941 to safeguard the rights of indigenous Fijians reflects traditional fishing and coastal use practices (Asian Development Bank, 2005; Weeks, Bucol & Alcala, 2010). Chapter 158, the Fisheries Act (1991), recognises the Fijian people's customary right to fish in traditional fishing grounds *(qoliqoli)*. It allows the owners of customary fishing rights to advise the District Commissioner and Fisheries Division which commercial

fishermen shall be allowed to fish in their area and to impose restrictions on commercial fishermen (Asian Development Bank, 2005; Clarke & Jupiter, 2010; Department of Lands and Surveys, date unknown). The coastal and foreshore water resources are shared under dual ownership, wherein the state owns the land beneath the sea and the Fijian clans own the right to fish for subsistence purposes in their respective traditional fishing-grounds (*qoliqoli*) (Department of Lands and Surveys, date unknown). In the past, the *qoliqoli* system functioned effectively in providing for equitable sharing and sustainable management of near shore resources (Asian Development Bank, 2005; Muehlig-Hoffmann, 2008). Integrating this traditional system of near shore land and water use rights with more modern ownership practices is a major challenge facing Fijian government agencies (Weeks et al., 2010; Clarke & Jupiter, 2010).

The Fisheries Act (1991) has established provisions enforcing the need for community consent in regards to commercial or subsistence fishing ventures that occur within local fishing grounds (*qoliqoli*). This enables the involvement of communities in coastal marine management initiatives. Section 13 of the Fisheries Act requires commercial and non-commercial harvesters to gain permission from customary *qoliqoli* owners to operate in their *qoliqoli*, providing an opening though which customary law acts as a vessel for the governance of coastal marine areas (Troniak, et al., 2009). Even though the Fisheries Act allows customary owners to assume control over their *qoliqoli,* the establishment of conservation initiatives such as Marine Protected Areas by the LMMA is still reliant on government endorsement. As a result, there have been many challenges associated with community enforcement of customary and national fisheries law (Clarke & Gillespie, 2009). This represents a conflict between “”top-down” and “bottom-up” governance structures in the management of inshore marine resources (Muehlig-Hoffmann, 2008).

Land owning clans known as *mataquali* hold communal customary title to 86% of Fiji's land, as recorded by the Native Lands Trust Board (Troniak, et al., 2009). Traditional leaders play a significant role in the designation and decision-making around land use and use of the associated resources. This centuries-old, traditional, decision-making process is governed by customary and traditional ecological knowledge (TEK) (Clarke & Jupiter, 2010). The Forestry Act guides the creation of forest and nature reserves and the Environment Management Act (1995) governs environmental assessments of development activities that threaten protected areas. These two policies play a guiding role in the conservation management of coastal areas (Troniak, et al., 2009; Weeks, et al., 2010; Clarke & Jupiter, 2010; Muehlig-Hoffmann, 2008).

Coastal areas are not only affected by government policies, but also by commercial practices and access to modern, more efficient, fishing techniques. The influx of modern fishing methods, increasing coastal populations and anthropogenic threats to the natural environment - threatening ecological systems and fish stocks - have made the development of several government-driven ecological goals all the more vital (Tawake & Tabunakawai, 2009). Following the issuing of the Barbados Plan of Action in Mauritius in 2005, the Fijian Government committed to effectively managing and financing at least 30% of Fiji's inshore marine areas (Jupiter et al., 2010a; Muehlig-Hoffmann, 2008). In light of this commitment, the Fijian government committed to creating one ecological network formed by 30% of its inshore and offshore marine areas, with a management and financial plan to ensure its sustainability, driven by the Departments of Environment and Fisheries (Veitayaki et al. 2003, World Conservation Society (WCS), 2012a,b). In order for this goal to be reached, traditional fishing

conservation methods will need to be evaluated and changes made to find a balance between local and national purpose.

Fiji's traditional *tabu* approach to fishing mimics a boom-bust trend, whereby limitations are placed on natural resources until that resource is replenished (McClanahan, Marnane, Cinner, & Kiene, 2006; Seaweb, date unknown; WCS, 2012a). Given the advances in technology, a growing population and a degrading natural environment, this method of management is no longer sufficient. In order for conservation methods to be established, which are both socially and culturally appropriate and effective, there is a genuine need for a management approach, which combines the *tabu* community method with modern conservation approaches (WCS, 2012a).

2.2.1 Lack of legislation for protected area management

The lack of effective legislation for managing protected areas prevents the involvement of resource owners in the process of identification, establishment and management of such areas. The current framework offers little opportunity for the temporal modification of regulations or the involvement of resource users in a consultative capacity, leading to inflexible and ineffective policies, (Clarke & Gillespie, 2009; Lindsay, 1998). There is an urgent need to develop legislation that marries community-based management with government agencies and civil society organisations, involving all stakeholders. The means to distribute the economic benefits of environmental management equally, must be trialed, in order to avoid conflict and increase long-term effectiveness, (Kellert, Mehta, Ebbin, & Lichtenfeld, 2000; Warner, 2000).

So that Fiji's resources can be effectively and sustainably managed, a governance model, that integrates resource rights and traditional practices, and shares the responsibility for planning, implementation and management duties needs to be

developed, joining communities and government to utilize the strengths of each body, (Aswani, 2005; Cinner, Marnane, & McClanahan, 2005; McClanahan et al., 2006; Reti, 1993). The importance of local communities in natural resource management must be acknowledged in national level laws and institutions (Lindsay, 1998; Lynch, 1998).

2.3 Marine Protected Areas

Global recognition of the decline in coastal fisheries stocks and marine biodiversity has fuelled a movement to increase the area of ocean under protection. The creation of marine protected areas (MPAs) is acknowledged to increase recruitment and migration of adult fish populations owing to increasing abundance and biomass of targeted species (World Bank, 2000). Such results rely heavily on effective compliance and enforcement in addition to favourable size and placement of MPAs in the network. Permanent no-take areas are well known to show the most effective results, in relation to those only partially protected or periodically harvested MPAs (World Bank, 2000; Salm, Clark & Siirila, 2000; Preston, 1997). The success of MPA networks has been linked to such factors as levels of ecological interaction and habitat diversity, which have been shown to be far more effective at increasing abundance and size of target species, than small individual reserves, (Roberts et al., 2003; World Bank, 2000; Lockwood, Worboys, & Kothari, 2006).

2.3.1 Fiji Locally Managed Marine Areas

Before 1989, Fiji had very little conservation fisheries legislation and therefore, in an attempt to remedy this, surveys and mapping of the nation's *qoliqoli* were undertaken. In the following decade, the Fiji Fisheries Division attempted to establish and re-establish several Locally Managed Marine Areas (LMMAs), a form of MPA, with the goal of minimizing the deterioration of inshore fisheries. More recently, in response to growing environmental awareness, there has been a rapid uptake of marine resource

management initiatives throughout the South Pacific. Five hundred communities and 15 independent countries and territories are involved in similar environmental initiatives, with Fiji representing 90% of the regions surface area that is under local marine management (Govan, et al., 2009). These LMMAs utilise a national level approach that combines customary tenure, traditional knowledge, governance and local awareness.

Temporary closure is the most frequently used management tool used in LMMAs. The local community is the driving force behind such a plan, as they assign the location, size and management regime for their closed area. Each area averages around 0.2-3.3km^2 in the Cook Islands, Fiji, Papua New Guinea, Samoa, Solomon Islands and Tonga (World Bank, 2000; Salm, et al. 2000; Preston, 1997). Closed areas are often placed within view of governing villages and often fall within the area of customary tenure of the village. This limits overlapping, minimising governance issues and increases the effectiveness of management. In theory, such closures of small areas aim to maximise fish catch. However, there could be a threshold whereby edge effects outweigh the potential benefits of such closures (Jupiter & Egli, 2011; Jupiter, et al., 2010b; Klein, Steinback, Scholz, & Possingham, 2008; Aswani & Hamilton, 2004). Fishing outside a marine reserve reduces numbers of species like snapper inside the edge of the reserve. This phenomenon is called the "edge effect". In larger marine reserves the "edge effect" is a much smaller proportion of the total area. Marine reserves must also be placed in areas of the greatest benefit to economy and ecology, i.e. in an area that will maximise fisheries production. This is contradicted by many traditional closures that are placed on fringing reef flats and back-reef lagoons, where fish biomass is often low, (Aswani & Hamilton 2004).

Many LMMAs in Fiji have shown encouraging growth in fish life and marine flora, resulting in greater food security, following the implementation of a community-based protected area (Jupiter & Egli, 2011). Those sites of community-based management

initiatives have been sources of the highest recorded biomass and coral reef fish numbers compared to anywhere else in the Pacific (Jupiter, et al., 2010c). Despite the many success stories from the FLMMA network and other community-based management projects, there have been areas that have struggled to reach management goals. The marine reserves that have been developed by Kubulau District in Bua (Namena Marine Reserve) and Toyota Island in Lau (Daveta Tabu) have been great successes in sustaining fish biomass and a new ecosystem-based management has recently been launched in Wainunu District, with the aid of the World Conservation Society (Wildlife Conservation Society (WCS), 2012b; Jupiter, et al., 2010b). The remoteness and physical inaccessibility as well as steep reef slopes, strong currents, large areas under management and long-term respect for fishing taboos can be credited with the success of management initiatives at these sites.

Some sites have not been as successful and therefore have not reaped the benefits of conservation management in their region. Kia Island in Macuata District is host to the Cakaulevu Tabu area and this initiative has not held out against growing economic opportunities. Middlemen working on behalf of seafood export companies have established businesses in the area and this has become a source of reliable income for many of the local fishers (World Wildlife Fund (WWF), 2003a; Jupiter & Egli, 2011). The community-managed protected area has been intensively harvested following a fundraiser. After four weeks of intensive fishing 45% of reef biomass had been removed. After one year of recovery the same reef system had only 83% of the original biomass (Jupiter & Egli, 2011). Education promoting valuable marine practices is a significant part of community management initiatives and is an important way of strengthening MPA effectiveness (Jupiter, et al., 2010b).

The LMMA model is supported by the organisation called Fiji Locally Marine Managed Area (FLMMA), which aims to preserve and protect marine resources through

sustainable techniques and involvement of local resource owners (World Bank, 2000; Jupiter & Egli, 2011; United Nations Development Programme (UNEP) 2012). This model is built on partnership between multiple stakeholders and is coordinated by the Fisheries Department. After its formation in 2000, the FLMMA model was used as an example on an international scale, at such meetings as the Pacific Biodiversity Roundtable and the South Pacific Region Environmental Programme. It has also gained recognition throughout Fiji from both communities and policy-makers, and has won several international awards for its innovative approach (Clarke & Gillespie, 2009). This is a tribute to the success of FLMMA, as a management model that integrates local, regional and national stakeholders, and international NGOs, to sustainably manage local fisheries and associated resources.

Despite the progress of FLMMA, the very high dependency on coastal resources in Fiji often greatly inhibits conservation actions, as fishers and resource owners are reluctant to sacrifice economic gain for environmental stability. Action is often only taken in light of significant ecological declines and perceived threats to their livelihood.

2.4 Resource use issues

Fiji's fisheries development has followed a global movement of expansion fueled by technological innovation and inadequate regulation. Over the past 150 years this rapid global development has contributed to degrading environments, negative social impacts and cultural changes, with Fiji being no exception (World Bank, 2000; United Nations Development Programme, 2012; Adams, 1998). Fiji has experienced some successes as a result of their efforts to mitigate the impacts of fisheries; however these management plans have largely failed to reign in Fiji's fisheries challenges (Aswani & Hamilton, 2004; Jupiter & Egli, 2011).

Artisanal and subsistence fishing sectors have always depended on inshore estuaries, lagoons and reefs to sustain their catch (Department of Fisheries, 2005a). In 1993 there were approximately 2,000 registered artisanal vessels used for full or part-time fishing or harvesting in Fiji (Cavuilati, 1993). Fishing methods varied significantly from traditional methods such as spears and fish fences to hook and line fisheries (Zann, 1981). In the province of Macuata, on the island of Vanua Levu, the use of spear community fish drives was employed and size limits were enforced as a conservation measure (Fong, 1994). Women often contributed significantly more to the overall catch than men, by using nets more often (Zann, 1981). The use of the marine and estuarine environments in Fiji is dominated by the fisheries sector at both an artisanal and commercial level. These activities can be viewed in two categories, offshore fisheries and inshore fisheries.

2.5 Offshore fisheries in Fiji

Over fishing is increasing in the offshore waters of Fiji. As fish stocks in other oceans, such as the North Atlantic and the North and Eastern Pacific have been heavily depleted, the focus has shifted to less exploited areas, including the Indian Ocean and Western Central Pacific Ocean (WCPO), (FAO 2010). In 2008, sixty percent of the global recorded catch of the yellowfin (*Thunnus albacares*), bigeye (*Thunnus obesus)*, albacore (*Thunnus alalunga*) and skipjack (*Katsuwonus pelamis*) were caught in the Western Central Pacific Ocean (FAO, 2008). Yellowfin, bigeye and albacore are either fully or over exploited in the Fijian waters and skipjack is heavily threatened due to the shared nature if its niche with the yellowfin, (FAO, 2008). Tuna are severely overfished and the tuna fishery has been at risk of total collapse in recent times (FAO, 2008).

Tuna stock levels in the WCPO have been seen as a prominent issue in the last decade. There has been pressure from Pacific nations to make changes that would benefit the

countries that share the migratory grounds of tuna stocks. Distant water fishing nations (DWFN) are described by Pauly and colleagues (1998) as nations that support and pursue commercial fishing outside the waters surrounding their own territories, and presently best defined as those fishing outside their own exclusive economic zones (EEZs).

Distant Water Fishing Nations are seen to profit more from the Pacific regions offshore fisheries than the small Pacific Island nations that host them, (Munro, 1989). Many small Pacific Island nations permitted fishing arrangements with foreign countries to boost their economic and political development (Gillett & Cartwright, 2010). Pacific Island nations have strived for greater fisheries benefits, often leading to the enforcement of licensing fees imposed upon foreign vessels fishing within the host nations Exclusive Economic Zone (EEZ). These fees have often remained low owing to the dominance of foreign fishing countries, leading to an approximate gain of 4% gross revenue (FAO, 2010). However, Pacific Island countries have often leveraged against these low fees to stimulate collaborative ventures or increase foreign aid (Veitayaki, 1995).

An inability of these nations to take a united stance or effectively coordinate fishing operations, has greatly limited the sustainability of tuna fisheries in the region. After the formation of the EEZs in 1979, many Pacific Island states joined the Forum Fisheries Agency (FFA), with the purpose having a governing body to coordinate policy and aid negotiation between DWFN's (Gillett & Cartwright, 2010). The role of the FFA was misinterpreted. It was operating to serve purely in a facilitation capacity, addressing management decisions made by island states, which were adverse to releasing rights to their fisheries. In order to manage tuna fisheries on a regional scale the Western and Central Pacific Fisheries Commission (WCPFC) was established, serving a similar role

to other Atlantic-based organisations such as the Inter-American Tropical Tuna Commission and the International Commission for the Conservation of Atlantic Tunas (ICCAT). However, efforts to ensure the long-term sustainability of fisheries operations were relatively unsuccessful. As in the case of WCPFC, management decisions were not reached (FAO, 2010).

Adding to such regional and international governance, the Tuna Management Plan was launched in 2002, setting catch and long-line operation limits within the Fijian EEZ. This plan established licensing criteria and reporting and monitoring standards for fishing activities (Department of Fisheries, 2007). The success of this plan has followed the relative course of other arrangements such as FFA, the WCPFC and Atlantic initiatives. Such initiatives provide a focal point for fisheries issues, but fail to reinforce such initiatives with political commitment and often lack the capacity on a national scale to coordinate and enforce decisions, leading to similar degrees of over-exploitation and overcapacity to those witnessed in open access circumstances (FAO, 2010).

On top of governance and overcapacity issues the WCPO is swamped with illegal fishing. The extent of this catch by illegal fishing operations and pirate vessels is of course unreported and unknown. Approximately ten percent of tuna catch could be illegal and unregulated (DeMers & Kahui, 2012). International law views fishing as a freedom of the high seas and has attempted to create legally binding agreements associated with such activities. Success has been the exception, demonstrated by the UNCLOS agreement, requiring states to collaboratively manage fisheries migrating between EEZs and nearby high seas areas. Driftnet fishing was banned throughout the Pacific Islands' EEZs in 1989 and small pockets of the high seas in the area. Tuna fishing is completely banned in two high seas areas. There is continued movement and

pressure to close large areas of EEZ and high seas pockets to all tuna fishing in an attempt to save the depleted fish stocks.

2.6 Inshore fisheries in Fiji

Marine resources have served as a staple in the Fijian diet, culture and economy throughout its human history (World Resources Institute, 2005). Until recently these resources have been limited by technology and low population density and, more recently, the late and slow development of Fiji compared to more temperate countries (Hooper, 2000). The nature of fishing and the motivation to fish have dramatically shifted due to the development and societal changes of Fiji. The issues associated with inshore fishing in Fiji are comparable to those experienced in other countries where common property marine resources, which were traditionally governed at a local level are developing according to modern demands (Cavuilati, 1993; Hooper, 2000; Veitayaki, 2000, 2003). Relatively more primitive technologies in combination with a detailed knowledge of local fishing habitats played a huge role in ensuring the sustainability of Fiji's fisheries (Veitayaki, 1995). In recent years urbanisation and the commercialisation of the fisheries industry have led to the detriment of ecological and economic sustainability (University of the South Pacific, 2004). The destabilisation of traditional management structures resulted in the transformation of restricted coastal areas into open access zones. This transition marked the historical conflict between polar approaches to the ownership and management of marine resources, as 'open access' traditions imported from Britain during the colonial era were administered in Fiji (Lam, 1998).

The fundamental causes of over-exploitation in the fisheries industry can be reflected in a combination of Hardin's Tragedy of the Commons and Gordon's (1954) writing on open access fisheries (Gordon, 1954; Hardin, 1968; Hardin & Baden, 1977). Scarce

resources and unrestricted access result in inefficient economic management as fishers at a local level have insufficient incentives to respond to increasing impacts on fish stocks, and in turn, future catch rates and economic return. Such a trend threatens the long-term sustainability and economic viability of vulnerable marine resources. Those living in areas affected by over-fishing often struggle to stay above the poverty line; even those fishers who work and have sufficient access to markets. The consumption of fish is higher in rural coastal areas compared to that in urban areas (FAO, 2010). The Ministry of Agriculture (Zann, 1981) stated that the average consumption rate of fish was 70g/person/day, with 30g/person/day in the urban areas and 330g/person/day in subsistence fishing areas. In 1991, A. Vuki, Chairman of the Kubulau Resource Management Committee explained that the high price of fish in urban areas greatly contributed to the lack of local fish consumption (Jupiter & Egli, 2011). These rising prices have also contributed heavily to a decline in artisanal catches between 1996 and 2002, yet the percentage of catch sold is increasing (Jupiter, et al., 2010b). CPUE surveys, which were conducted throughout coastal Fijian villages, have recorded that over 70% of catch is being sold (Jupiter, et al., 2010b). In the past such trends were confined to urban areas however, the demands of the economy have expanded and therefore fishing effort has increased in rural areas in order to fulfill the goals of an increasingly goods and services-focused economy (Vuki, 1991). As a result, rural communities, where external employment opportunities are minimal, are also being heavily affected by over-fishing.

Over-fishing of Fiji's inshore zone is often attributed to high fish prices, increasing population densities and new fishing technologies. However, many argue, the contributions of social changes to fisheries impacts (Hotta, 2000). Fijian youth now place less value on traditional cultural practices and management systems associated with the natural environment, as there is a greater drive for commercial and economic

success (Veitayaki, 2000). This phenomenon is linked to the deterioration of traditional governance structures in urbanised areas. It is especially notable in and around Suva (Bartlett & Manua, 2009).

The Fijians' heavy reliance on inshore resources for sustenance and economic development, are greatly contributing to the rapid loss of fish species and stocks in the region (Department of Environment, 2012). Data on fisheries are often minimal and unreliable, yet it has been identified that over the last several decades there has been increasing pressure on fish stocks and their habitats (Caddya & Cochraneb, 2001). This trend is illustrated by the status of *qoliqoli* in Fiji. There are 410 traditionally established *qoliqoli,* of which 70 are viewed as over-exploited and 250 as fully developed (Jupiter & Egli, 2011).

2.6.1 Land use affecting inshore marine areas

Increasing pressure from population growth, urbanization and industrial and economic development of the past several decades has led to increasing damage to the natural environment (Chape & Watling, 1991). Issues such as increasing coastal development, mangrove removal, uncontrolled industrialisation, population growth, ineffective catchment management and over-fishing are some of Fiji's largest threats to the future use and health of the aquatic environment.

2.6.2 Coastal development

Widespread coastal development is having a heavy impact on the ecology of coastal zones. Most commonly, the construction of resorts, ports and roads is altering sediment transport patterns and current systems, causing destruction and degradation of reefs and estuarine environments (Institute of Marine Resources, 2004). This leads to increased nutrient loading through sedimentation, smothering marine life and de-oxygenating the

water.

2.6.3 Mangrove removal

Mangroves play an important role in protecting the coastline from erosion, providing nursery habitats for marine species, and serving as habitats for a variety of invertebrates and bird life. The felling and infilling of mangroves which has been increasing steadily with the growth in coastal development have been affecting coastlines throughout Fiji, especially on the island of Viti Levu. The use of mangrove habitats as dumping grounds is also very common, as the majority of rubbish dumps are located in mangrove-inhabited areas (Kailola, 2008). Hotel developments such as Denurau and Raviravi have reclaimed large areas where previously mangroves grew (Watling & Chape., 1992).

2.6.4 Industrial development

Coastal habitats are dramatically affected by industrial developments The pollutants, the leaching of heavy metals and the altering of water temperature and circulation currents decrease ecological productivity and devastate local wildlife (Wilkinson & Buddemeier, 1994). Walu Bay is a prime example of industrial development's impact on coastal habitats. Tributyl Tin (TBT) from marine anti-foul paints, petroleum pollutants, heavy metal from local battery factories and waste water discharge from food processing factories all pollute the local waterways (United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP), 1999).

2.6.5 Population growth

The increase in refuse driven by a growing population has caused major issues in all of Fiji's municipal centers. The Lami rubbish dump, which caters for the greater Suva area has exceeded its carrying capacity (University of the South Pacific, 2004; Seeto, 1992). Pollutants such as heavy metals, oil and pesticides leak into the nearby waters as a result of inadequate segregation of waste and improper waste disposal procedures (Seeto,

1992). The Kinova Sewage Treatment Plant (STP) feeds nutrient enriched waste into Laucala Bay, which is also subject to storm water run-off from the roads and silt transported from the Rewa River. The Kinnova STP is serving a population of 180,000. This is far beyond its operating capacity, posing a significant health risk (Seeto, 1992). During flooding and torrential rain raw sewage and increased levels of nutrients and sediments flow freely into the Bay. Such an increase in pollutants causes large sediment plumes to form extending beyond the lagoon and out to the neighbouring islands and reefs (Seeto, 1992).

2.6.6 Catchment management

Inadequate catchment management also enhances the loading of pollutants, nutrients and sediments in waterways, reaching reefs and lagoons at the coast. Common damaging practices include: failure to build buffer zones between farming areas, sugar cane fields and waterways, allowing stock to pollute waterways, planting on slopes, discharging of agricultural waste directly into waterways, unsustainable logging practices and burning of fields for grazing (Muehlig-Hofmann et al., 2006; University of the South Pacific, 2004). Studies conducted of the Rewa River revealed excessive levels of nutrients in the water (Mosley & Aalbersberg, 2002).

2.6.7 Over-fishing

The exploitation of fish and other marine species is a significant issue on both a subsistence and commercial scale. Over-fishing major fish predators has brought an increase in invertebrate populations such as sea urchins, snails and starfish, which has had lethal effects on inshore habitats (Caldwell, Hoffmann, Palumbi, Teisch, & Tu, 2009). Localised extinctions of giant clams, sea cucumber and trocus have been reported and attributed to over-fishing (Caldwell et al., 2009; Hotta, 2000). Such practices can also be detrimental to the livelihoods of the local people as fish stocks and

coastal habitats are rapidly degraded. Damaging fishing methods such as explosives, fine mesh nets and the use of pesticides compound the destruction of aquatic habitats (Salm, Clark & Siirila, 2000). The use of pesticides, dynamite and derris are officially banned, but are still widely practised and are often seasonal, depending on the abundance of target species. In some areas, such as Sasa, Fong (1994) claimed that there was no use of dynamite. The international trading of corals and tropical species poses serious risk to targeted reefs, yet could still be managed sustainably at the same time as maintaining the economic benefits to the country as the world's second largest exporter of reef products (Sulu et al., 2002).

The formulation of the Sustainable Development Bill is a significant step forward for the Department of Environment and aims to strengthen the protection of the coastal environment and fisheries. The strength of such a move will be determined by the resolve of local government (South Pacific Regional Environmental Programme (SPREP), 2012; Department of Environment, 2012).

2.7 Customary tenure and community involvement

The recognition and implementation of customary resource tenure is fundamental to ensuring legal and customary resource rights and involvement in decision-making processes in Fiji, enabling community-based marine management (Johannes, 2002; Techera, 2010; Polunin, 1984). The legal recognition of customary marine tenure differs greatly from the legal recognition of customary tenure in Fijian terrestrial environments. Consideration and discussion surrounding legal rights and responsibilities of customary stakeholders is necessary in order to establish an ethical practice of conservation. However, such practices can also have consequences in the form of misunderstandings, as shown in the case of Navatu village, where the villagers discovered that the Marine

Reserves established in their waters were not closed to fishing and had no legal form of protection (Goetze et al., 2011).

Customary resource tenure often serves as a determinant for resource management boundaries and can limit the scale and level at which decision-making is processed. Therefore, the mapping of tenure boundaries serves to reduce conflict over resource rights and access.

For example, initial conflict may have been avoided between Kubulau Village and the neighboring village, Navatu, if the customary boundaries had been used in the first place as the designated protected area boundaries. After extensive consultation, the protected area boundaries were shifted to match the customary boundaries (Jupiter & Egli, 2011; Weeks, Russ, Bucol, & Alcala, 2010). These customary boundaries added greater biological value to the Namena Reserve, while minimising the cost to the Navatu villagers fishing practices (Klein, Steinback, Scholz & Possingham, 2008). Such management decisions have a far higher chance of gaining local support, as local knowledge, traditions and goals are incorporated into the final plan (Drew, 2005).

Creating a sense of ownership through community driven management targets, encourages community-based monitoring and accountability. Management plans that identify issues associated with community well-being from ecosystem services, i.e. water quality and fisheries, are often favoured over plans that focus on issue that are seen not to be as vital to a local community (Veitayaki, 2000).

Planning processes are also opportunities to discuss the relationship of community management goals with national targets (Lindsay, 1998). Addressing such relationships, along with the development of enforcement protocols, could enhance the effectiveness of management plans and reduce the risk of conflict associated with resources. Defining the relationship between local and government regulation can aid effective enforcement

by involving local management (Kellert et al., 2000).

Fishing licenses have been effective in such cases as Kubulau District where license regulations, link directly to government regulations and local wardens are also empowered to control fishing in their local area (Jupiter et al., 2010a). However, there is need for transparency throughout the planning and implementation processes, in relation to costs and benefits as some practice may be in conflict with customary rights and management ideals.

There is heavy reliance on respect for traditional hierarchy and authority in order to create effective and long-term management plans in Fiji (Aswani, 2005; Hoffman, 2002; Tiraa, 2006). Management actions can often be perceived as challenges to traditional authority by environmental or management bodies if there is a sense of exclusion, inequity or failure to respect traditional practices and beliefs (Hoffmann, 2002). Historic erosion of customary institutions could be further impacted by new market access for natural resources (Cinner, Sutton, & Bond, 2007). Navatu residents demonstrated a high economic dependency on fishing, which is enhanced through the presence of a middleman living in the village, to sell their catch commercially (Clarke & Jupiter, 2010a). The commercial aspect of their fishing puts pressure on community rules, and as a result can drive fishers to openly disrespect and violate community rules.

In Fiji, management rules are imposed and governed purely by the national legal system. Communities hold no authority to enforce or manage rules and often community-driven restrictions can be in breach of national laws (Veitayaki, 2000). Historically, breaching community restrictions often led to beatings, property destruction, banishment or executions, which are now illegal (Munro, 1996; Tiraa, 2006). However, in contemporary times, fishing licenses are withheld, verbal warnings are issued or public shaming takes place. Nevertheless, these punishments are often ineffective, given the potential financial benefit of breaching such restrictions.

Taking the law into your own hands can also result in criminal prosecution. For example, in 2008, the Chief of Macuata Province, on Vanua Levu, seized a boat found to be catching fish in a *tabu* area. The chief was arrested, but the charges were later dropped (Wildlife Conservation Society (WCS), no date). There is a great need to insure that community restrictions and taboo do not breach national laws.

Community-Based Natural Resource Management (CBNRM) can be improved through the marrying of customary resource tenure with legal goals and decision-making (Lynch & Alcorn, 1994; Reti, 1993). Lindsay (1998) declared that a failure to recognise customary resource tenure and decision-making processes often causes conflict over resources. With limited government support for investment, management outcomes are often ineffective. For community-based management measures to be effective, local community management practitioners and facilitators need to be legally recognised and gain rights to make decisions that relate directly to the individual needs and circumstances of their communities (Lindsay 1998).

2.8 Legal reform

Institutional and legal reform in Fiji is needed to create sustainable and effective CBNRM, as current management processes create challenges for resource owners through criminal law restrictions (Evans, 2004; Lane, 2008; Minter, 2008). New legislation is being constructed to cover fisheries, forestry and protected areas in order to provide greater protection for natural resources (Techera & Troniak, 2009).

Community-based natural resource management initiatives in Fiji have provided information on barriers and issues affecting resource management, which allows for the resolution of these issues at a governmental level.

For example, Locally Managed Marine Areas (LMMAs) have facilitated the identification of issues for legal reform in Fiji. Such reforms include: training in

fisheries enforcement for police and magistrates, improved training and resources for community fish wardens, enhanced power for the Fisheries Department to terminate fishing licenses and develop a transparent process for releasing public information on restricted areas to assist with decision-making and enhanced power for management authorities to use community resource committees (Minter, 2008). Fishing penalties are often not issued and those that do eventuate are inadequate deterrents for those in breach of the Fisheries Act (1991), as the maximum penalty for many offences is $500FJ ($281.900 USD, 15/4/2012), with many much lower (Minter, 2008).

Currently local communities can take action in the following ways: protecting *tabu* areas using license conditions; not renewing licences of vessels in breach of community restrictions or national laws; increasing the presence of fish wardens and reporting breaches to the national LMMA or fisheries officers. Vessels, which have breached community or national laws, have recently been placed on a blacklist, to be made available at all LMMA sites and refusal of license applications is encouraged (SPREP, 2012).

Despite clans holding significant power over the uses of their land, environmental goals are often undermined by limited awareness of unsustainable land use impacts, large economic incentives for short term resource ventures, poorly implemented natural resource management and environmental protection laws and limited integration of national laws and community resource management goals and practices (Lane 2008). According to the Environmental Management Act 2005 (EMA), landowners must be informed of the impacts of a proposed development prior to initiation and before consenting to new leases, giving stakeholders opportunity for consultation and inquiry. The EMA must be further promoted to ensure awareness and its lawful application.

Chapter 3: Research design and methods

The multifaceted nature of this investigation led to the employment of the mixed-method approach. Social, biophysical and geographic information was collected through the use of literature searches, focus groups, semi-structured interviews and in situ surveys of fishing activity. The fieldwork conducted to fulfill the aims detailed in Chapter 1 (Aims 2 and 3) was undertaken by myself, with the support of a translator. This chapter details the "mixed-method" approach and the individual methods used for each of the aims. Section 2.1 reviews the chosen methodologies and provides a site description, while Section 2.2 will describe the methods used in this study. For this study a combination of qualitative and quantitative research methods will be adopted, using quantitative data as an ancillary to support the qualitative data. This form of mixed methods research is called exploratory design and is commonly used in situations where instruments are not available, the variables of the research are unknown, or there is no guiding framework or theory.

3.1 Review of methodology

3.1.2 Ontological and epistemological perspectives on community-based marine management in Fiji

Worldviews, values and attitudes can shape human behaviour. Understanding those values and views can inform the design of protected area plans and can also serve as a fundamental ingredient in the governance of community-based environmental management initiatives. In contemporary management practice it is recognised that potential protected or managed areas cannot be seen in isolation from the communities that use or inhabit them (Lockwood et al. 2006). They also cannot purely been seen as wildlife conservation areas, as the perceptions of local communities may vary, valuing

these areas instead for their cultural or subsistence wealth. Various communities may value the same geographic area differently and therefore there is no single 'right way' to conserve or manage an area.

Case-based conservation emphasises that, in order to find a balance between the natural environment and the pressures of modern society, we must acknowledge and utilise the knowledge and indigenous worldviews of those cultures still living amid natural ecosystems (Knudston & Suzuki, 1992). If sustainable development planning, contemporary development strategies and resource management arrangements are to be successful then they must incorporate an understanding of the worldviews, resource management systems, social institutions, and the local empirical knowledge that constitute indigenous communities (Veitayaki, 2002). This concept of case-based management formed the basis for the development of this research project.

Determining how to conserve and manage our natural environment is one of the greatest challenges of our time (Ostrom, 2001). For many years it has frequented debates in political, management and academic fields. Conservation involves striving to achieve a balance between people and their environment. This balance encompasses philosophical understandings of nature and society as well as the practical issues of capital and power distribution and environmental governance (Robbins, 2004). Often small indigenous communities inhabiting some of most biologically diverse regions in the world are those who are most negatively affected by conservation initiatives (West, Igoe & Brockington, 2006). The narratives, the relationship with the environment and the tendency to conserve the environment in the indigenous people, shift and evolve over time (Hames, 2007). Some groups are motivated to conserve their environment by cultural or voluntary measures and others require incentive or coercion to change

damaging habits. Such measures have a significant effect on the implementation and success of conservation initiatives (Escobar, 1998).

In Fiji, the community-based marine management network called Fiji Locally Managed Marine Areas (FLMMA) manages and constructs relationships between the ontology of the marine environment, the indigenous people, the epistemology of learning and knowing, and the pragmatics of the decision-making process. In an environment where state policy, legislation and enforcement are weak and, in some cases, non-existent, aligning the world views of indigenous people and civil society institutions such as FLMMA can generate greater agreement and therefore the sustainable success of environmental management interventions (Agrawal, 2005). Both indigenous communities and environmental practitioners need to understand root assumptions about the world and each other.

3.1.3 Methodological framework

The aims of this study include describing local knowledge of marine resources in Namata River Estuary and validating this knowledge through comparisons between literature and in situ sampling.

Combining qualitative and quantitative research methods, to form a mixed method approach, has been increasingly viewed as the third major research approach. Traditionally qualitative and quantitative methods have been utilised exclusively in social science and fundamental science fields respectively. Mixed method research has been defined in various ways and, after their analysis of 19 different definitions of such an approach, Johnson and colleagues proposed this definition:

> Mixed methods research is the type of research in which a researcher or team of researchers combines elements of qualitative and quantitative research approaches (e.g., use of qualitative and quantitative viewpoints, data collection,

> analysis, inference techniques) for the broad purposes of breadth and depth of understanding and corroboration. (Johnson et al., 2007, p.123)

Creswell (2003) and his colleagues proposed that the mixed methods approach is in the center of a continuum, between qualitative and quantitative research. Definitions of mixed methods can vary between research fields; therefore they have distinguished four major types of mixed methods designs: Triangulation, the Embedded Design, the Explanatory Design, and the Exploratory Design. The purpose of the Triangulation Design is to gather complimentary data on the same topic (Morse, 1991) in order to understand the research problem. The Triangulation method aims to overlap the strengths and weaknesses of qualitative and quantitative methods, in order to directly compare or contrast quantitative statistical results with qualitative findings or to justify or elaborate quantitative results with qualitative data (Ritchie & Lewis, 2003; Patton, 1990). The Embedded Design entails using one data set in a supportive role in a study utilising another data type, (Creswell & Plano Clark, 2007; Creswell, Plano Clark, Gutmann, & Hanson, 2003) for the purpose of answering different questions using differing data types. The Explanatory Design is a two-step mixed method design which uses qualitative data to explain or elaborate on quantitative results, (Creswell et al., 2003). The Exploratory Design is also a two-step design using qualitative finding to elaborate or explain quantitative results. However, the Exploratory Design should be used in circumstances where research instruments are not available, the variables of the research are unknown, or there is no guiding framework or theory (Creswell et al., 2003).

For the present study an Exploratory Design was used, emphasising qualitative data with quantitative data as ancillary (Caracelli & Greene, 1993). Following a series of qualitative interviews the data collected during the initial phase was used to guide the

selection of local fishing experts in the village and the selection of study sites for the in-situ sampling of the Maumi Estuary and Namata river mouth.

In order to form a cohesive sampling plan, the characteristics and limitations of sampling methods, such as participant selection, time constraints, budget, experience, distribution of interviews, group discussions and biophysical sampling, as well as interpretation and analysis of data were evaluated using academic literature and consultation with researchers familiar with the Maumi area, (Clarke & Jupiter, 2010a; Leedy & Ormrod, 2005; Roberts & Taylor, 2002).

The practical elements of the research were finalised on arrival in Fiji. With a total time frame of three months, biophysical fishing surveys and interviews had to be well organised and implemented. In addition, the interviews and group discussions needed to occur prior to the fishing validation studies. Thorough consultation with our host institution, the Fiji National University and the people of Maumi Village, took place in order to arrange meetings and assess the logistics of the study.

3.2. Study methods

3.2.1 Understanding existing marine management in Fiji, Maumi Estuary and Namata River (Aim 1)

The aims of this study were established prior to my arrival in Fiji and entailed a three-stage process of information gathering. The initial stage (Aim 1) entailed the review and evaluation of marine management practices in Fiji. This included investigations of community-based management processes, regional and local governance, regional and local case studies and the history of marine management in developing nations and the cultural processes that must be acknowledged in environmental management practice in Fiji.

Marine management practices in Fiji were reviewed using academic and grey literature sourced from the Auckland University of Technology Library database, Fiji National University (FNU) and University of South Pacific (USP) Library databases as well as resources from local libraries in Suva, Fiji eg. Fiji Ministry of the Environment, FLMMA in Lami, the Wildlife Conservation Society (WCS) and the Fiji Government Fisheries Departmental Library. For the purpose of this study, the definition of grey literature offered by The Fourth International Conference on Grey Literature (GL '99) in Washington, DC, in October 1999: "That which is produced on all levels of government, academics, business and industry in print and electronic formats, but which is not controlled by commercial publishers" will be used. Various other academic databases and government documents both in Fiji and overseas were sourced online using Google Scholar, Scopus and Science Direct to gather information. The information was categorised by keywords using Endnote X3 (Bld 5276).

3.2.2 Describe local knowledge of marine resources in Namata River and Maumi Estuary

Following the investigation of marine management practices in Fiji (Aim 1), an investigation into the local knowledge of marine management practices and the future expectations of the Maumi villagers was undertaken in partial fulfillment of Aim 2. Semi-structured interviews (Aim 2) were also used to collect information on local marine habitats, customary fishing grounds, significant fish species distributions and temporal and spatial resource use patterns in Namata River and Maumi Estuary.

This section describes the methods used for collecting local knowledge of marine resource use, marine habitats, fishing grounds, significant fish species distributions and abundance in Namata River and Maumi Estuary.

3.2.3 Ecological perception model

One of the most significant challenges facing the field of environmental management is in developing the ability to manage people's behaviours, motivations and the biophysical environment to form cohesive solutions (Milton, 1996). Expectancy research, whereby values are regarded as a product of the human mind and not the environment, focuses on identifying behavioral motivations and the meaning attained from an experience (Banfield, 2004; Milton, 1996). The greatest hindrance of this theory is its inability to form a connection between the psychological world and the physical environment, disabling its potential application in the management of natural resources.

The ecological perception model used as the theoretical framework for this study, offers a more holistic approach to structure this resource management research. This theory sets the foundations for the qualitative focus group and semi-structured interviews detailed in Chapter 2, Section 2.4. Based on ecological perception theory, which was developed in the 1950s, the ecological perception model does not attempt to understand behavioural motives, but seeks to understand the processes of seeking and detecting environmental information, developing perceptions and activity participation (Gibson, 1950; Michaels & Carello, 1981).

Peirskalla and Lee (1998) propose that the environment is the focus of the ecological perception model as it is the source of information to the observer. The environment functions as the information source, providing information such as environmental patterns, which illuminate specific information. The role of the perceiver is to discover such information by engaging in various activities.

Within this theory, the information discovered by the perceiver is called the 'affordances'. 'Affordances' are gathered by the perceiver in the human environment, and materialise in the form of something invariant, objective, real, physical and psychical that can be offered, supplied, or endowed by the environment and may be available to the observer (Gibson, 1966). Some examples of affordance in an estuary include consumption (e.g. fish harvesting), shelter (e.g. mangrove forest) and psychical processes such as relaxation and stress release (Gibson, 1979; Pierskalla & Lee, 1998). Moreover, the environment in which an activity is conducted will to some degree, determine the type of activity conducted and therefore the type of information perceived or gathered (Banfield, 2004). The type of information perceived will also depend on the individuals' perception and skills associated with the activity.

According to the affordance model, researchers should address the significance of an activity, information flows and feedback, instead of the motivations or cause of the act selection. This approach encompasses the design of the survey used in the research. Instead of aiming to determine the motivations of participants' activities, this research followed the theoretical approach of the ecological affordance model, combining and contrasting the both social and biophysical variables.

A person's perception of the environment and resource quality is predisposed by an individual's knowledge of the environment, (Milton, 1996). Therefore, repeated experiences in a set environment will develop a greater level of knowledge and therefore perceptual skills (Fenton & Reser, 1988). This allows for more acute information collection. The activity selected, can prove to be a determining factor in the quality and quantity of information collected (Pierskalla & Lee, 1998).

3.2.4 Local knowledge of marine management practices and future expectations

Local marine management practices and future management expectations in the Maumi Estuary and Namata River were described using a focus group methodology within the Maumi village. This focus group contributed to the qualitative section and to Aim 2 of this study.

Focus groups commonly involve a small group of people in discussion of interviews focusing on a given issue or topic (United Nations (UN), 2006). This allows the researcher to follow the dynamic of the group discussion as the dynamics of the group may be of core interest to the researcher and lead to the further enlightenment of an issue. The reactions and opinions expressed may be more realistic than those observed during an interview due to heated discussion or disagreement (UN, 2006). Individuals' views are often challenged more profoundly than in an interview setting and therefore focus groups are often complimentary to semi-structured interview undertaken for the same study (UN, 2006).

Aim of the focus group

The focus group aimed to achieve the following:

- To gain an understanding of the current and preferred future management practices for the Maumi Estuary and Namata River.

Methods

Participants

A community meeting was held on the 17th of September 2011 in the community meeting house in Maumi Village, lasting for approximately one and a half hours. All

adults in the village, over the age of 18, were invited to attend the meeting and take part in the focus group. Of the ten adults, six volunteered to participate.

Focus group design

The focus group was facilitated by a semi-structured survey of 27 open-ended questions (Appendix 1) that were designed to facilitate discussion with and between participants. The questions in this survey were based on previous work by Bollard-Breen (2006) and will be used to compare with other studies.

An interview schedule was designed with key questions. The questions were grouped thematically and were used as prompts during the interview. The questions encompassed issues such as the perceived management status of the local waterways, past management of the aquatic environment, the perceived effectiveness of current management schemes, ownership of the waterways, understanding and perceptions of Marine Protected Areas (MPAs) and future management desires (Appendix 1).

Each open-ended question was addressed to the group by the facilitator, with the assistance of the translator. All responses were written down by the facilitator for the group to review. Discussion and questions were encouraged from all participants throughout the workshop. The discussion was recorded using a Dictaphone to ensure the accuracy of responses and to attain any additional information that may not have been written down by the facilitator. A translator was present as this was a requirement to gain ethics approval.

Limitations

As the focus group was conducted in a group setting, the participants may have been influenced by peer pressure to disclose or withhold certain opinions. In addition, because village leaders scheduled the focus group, there may have been some participant selection bias influencing the group. Finally, those community members who were eligible to attend, in order to maximise attendance, scheduled the focus

group. However, those who could not attend may have offered additional or differing opinions and therefore altered the findings of the focus group.

Analysis

General descriptions and summaries of qualitative information for each open-ended question were made. Findings were transcribed and organised into key themes and common statements.

3.2.5 Local knowledge of marine resources

Semi-structured interviews were used for this study and were based on a set of guiding questions (UN, 2006). As a form of participatory research, they facilitate the gathering of information about other people's views. Although all guideline questions were asked during the semi-structured interview, new questions that arose during the interview were open for exploration (UN, 2006). The flexibility of a semi-structured interview allowed for the participant to describe events, feelings and observations (UN, 2006). Participants were asked to complete a series of questions that required drawing their answers onto a pre-printed map of the local area. This common approach to participatory research often involves drawing figures, or diagrams, mapping or using tools to demonstrate a visual answer (UN, 2006). This offers advantages including enabling illiterate members of a community to participate in the research, facilitating a balanced representation of the population (UN, 2006). This method also enables people from a wide range of socio-economic, age and gender identities to be represented.

Aims of the semi-structured interviews

The interviews aimed to gather information on local fishing activities and the environmental conditions of the Maumi Estuary and Namata River. The questions were designed for this survey (Appendix 2 and 3) to collect a variety of qualitative,

quantitative and spatial data, describing marine and estuarine-based activities, spatial temporal patterns of use, social value associated with the waterways, existing use and management practices along with the use of inshore marine environments for harvesting marine organisms.

Methods

Participants

Participants were both fishers and non-fishers. The participant households were randomly selected, with the addition of four prominent fishers as recommended by one of the village leaders. Every participant was over 18 years of age and living in the village at the time of the interviews. In total, 18 people were selected for the interview, which comprised 22% of the village adult population. Ten of the 18 participants were invited to complete a second more detailed interview about their fishing practices. Their selection was based on their extensive fishing and/or gleaning experience.

The interviews were conducted during the month of August, 2011. Each adult, in the selected households, was invited to complete an interview. All of those approached were active and willing participants of this study. A description in English translated into Fijian, was given verbally. A written information sheet (Appendix 4) was also provided to each participant before they were asked to sign the consent agreement (Appendix 5) and continue to the interview.

Interview Design

The semi-structured interview was designed using a standardised open-ended approach. However, a more conversational strategy was adopted in delivering the survey, as some of the questions needed to be explained and have examples supplied (Babbie, 1989).

This section of the study was delivered in two separate semi-structured interviews that were conducted sequentially. Each interview addressed the inquiry by using a combination of qualitative, quantitative and spatial questions. The spatial questions required respondents to mark locations and areas related to resource use on a map of the Namata River and Maumi Estuary. These areas were later digitised and entered into a geographical information system (GIS) using ArcGIS10 (ESRI, 2011).

The first interview contained questions on general demographics, local estuarine and marine habitats, spatial and temporal patterns relating to the waterways and the social value of the waterways (Appendix 2).

The interview was divided into four sections. Section one aimed to describe the respondents, their history of interactions with the estuary and the use of aquatic resources.

Section two investigated the flora and fauna of the estuarine habitats that the participants frequent. The participants were asked to mark and describe these habitats on a map. Participants also identified fish that they observed in the local waterways and a table and, where possible, translations of species names are offered (Chapter 4). Translations were noted from interview participants using visual aids and from academic literature by P.A. Ryan, (1980), A.P. Jenkins, (2001) & P.J. Kailola, (2001).

Section three of the interview explored the spatial and temporal patterns that they observed while visiting the estuary and detected environmental change from a variety of impacts. Respondents were asked to map and describe changes in 15 biophysical variables.

Section four of the interview required respondents to assess the social value of the estuary. They were asked to rate the quality of the site they visited most recently for 13

biophysical and social characteristics. The respondents were also asked to rate the overall quality of the site. Sites were rated from 1-10 representing a range of quality from very poor (1), to outstanding (10) from each of the variables.

The second interview targeted 10 regular fishers in the village, selected from the first survey due to their fishing experience (Appendix 3). The interview aimed to gather additional information on fishing and gleaning habits, catch rates, spatial and temporal variations, conflict over resources, and environmental changes.

The second interview was divided into four sections. The first section aimed to describe the respondents fishing areas and catch. Respondents were also asked to mark and describe their fishing areas and launching points on the maps provided.

The second section of the interview assessed the frequency with which the fishers visited their sites. Respondents were also asked to identify and describe their fishing techniques and collection methods.

The third section of the interview aimed to describe changes in their catch over time.

Section four aimed to describe social and spatial conflicts between users of the marine resource. Respondents were asked to describe social conditions of the areas they frequented and determine crowding norms using the numerical approach, based on a set of question proposed by Donnelly, Gibson and Ivanchevich (1992) and modified by Bollard-Breen and Breen (2008).

A translator was present throughout the interview process to ask the assigned questions and act as an intermediary between the participant and the researcher. An information sheet and consent form were issued and explained to each participant (Appendix 4 and 5). The interview usually lasted between one and two hours and was conducted in the

participants dwelling. All interviews were recorded. The transcripts and anecdotal observations were collated following the interviews to assist with interpretation of results.

Limitations

Several limitations restricted the extent of the interview period. Time constraints allowed the interviews of only 18 residents of the village and the language barrier required the use of an intermediary translator. Steps were taken to minimise this bias by answers being recorded on paper as the interview was conducted and also on a voice recorder to be translated at a later date. The limitations of cross-cultural research were also evident. There may have been sensitive cultural information applicable, but not disclosed in the interviews, due to the presence of a foreigner, thus limiting the cultural depth portrayed in the findings. The political status of the country may have had a negative impact on the extent of information provided by the participants, as they may have felt the need to restrict the disclosure of certain information, due to fears of negative consequences. In addition, the map used to assist the answering of the spatial elements of the questionnaire was printed in black and white and therefore, identification of certain physical elements may have been impaired, however this was minimised through extensive explanation.

Analysis

All analyses and graphs relating to the surveys were done using SPSS statistical software (www.SPSS.com).

A principal components analysis (PCA) with orthogonal varimax rotation was used to explore responses to the quality of sites in Section Four of the first interview. Factor analysis was then used to identify a reduced number of dimensions that explained the variance among the 10 variables influencing the quality of the site. Factors were interpreted as part of the solution only if they had an eigen value of at least one and

explained at least 5% of the variance. Variables were interpreted as belonging in a factor if they had a loading of at least 0.30 and did not load similarly on any other factors. A reliability analysis (Cronbach's Alpha) (Cronbach, 1951) was then conducted to test internal consistency based on the average inter-item correlation. The variable overall quality was not included in the analysis.

In addition for each factor, the mean factor score for each site was mapped using ArcGIS10. By mapping the score it was possible to identify perceived patterns of site quality.

3.2.6 Assess local knowledge with the use of in situ sampling (Aim 3)

Aim of fishing validation surveys

The opportunistic fishing validation surveys were conducted to validate local knowledge with in situ sampling.

Survey Methods

Survey design

The fishing validation surveys were designed using the three most widely used methods of harvesting marine animals, as described by the participants during the interview process. These methods were line fishing, netting and crabbing.

Fishing validation data (Paloheirno & Dickie, 1964; Ricker, 1944) were collected through a series of repeated fishing trips spanning three days, between the 6th and the 9th of September, 2011. On the 6th of September study sites were selected and environmental observations, including vegetation at each site, were noted (Figure 3). A fiberglass boat with an outboard motor was used. The researcher and translator accompanied a prominent village fisherman, who conducted all fishing for the surveys.

The catch at each site was recorded after half an hour of fishing (number caught, species name, length, and time at landing). The fisher, as part of the traditional harvest claimed the catch for the day.

Each day four crab pots, a single fishing net and six hand lines were dropped at different sites (Figure 2). I recorded catch, as well as environmental variables (salinity, depth, water clarity, estimated cloud cover, pH, surface temperature), at each site. The following equipment was used to take the above measurements:

1. Monitoring manual
2. Invertebrate marine life and vegetation identification sheets
3. Data sheets
4. Pencils
5. Small water sample containers
6. Large water sample bottle
7. PH indicator papers
8. Thermometer
9. Hand-held conductivity meter
10. Ruler (for water depth)
11. Cylinder apparatus for measuring water clarity (tube, cap and magnet set)
12. Ice-cream containers (for examining stream bed samples)
13. Tweezers (for picking out/examining invertebrates)
14. Magnifying glass
15. Camera
16. Calculator
17. Pocketknife
18. Sealed bags for vegetation samples
19. Equipment bucket to hold everything (except the clarity tube)
20. Stopwatch.

The water salinity was measured using a portable conductivity meter and the depth using a long 4m ruler. PH was measured using sampling containers and pH indicator papers. I used a thermometer to gauge water temperature. The water clarity was measured at each site using a tube cap and magnet set. The same sites were targeted each day and harvesting time was standardised by method.

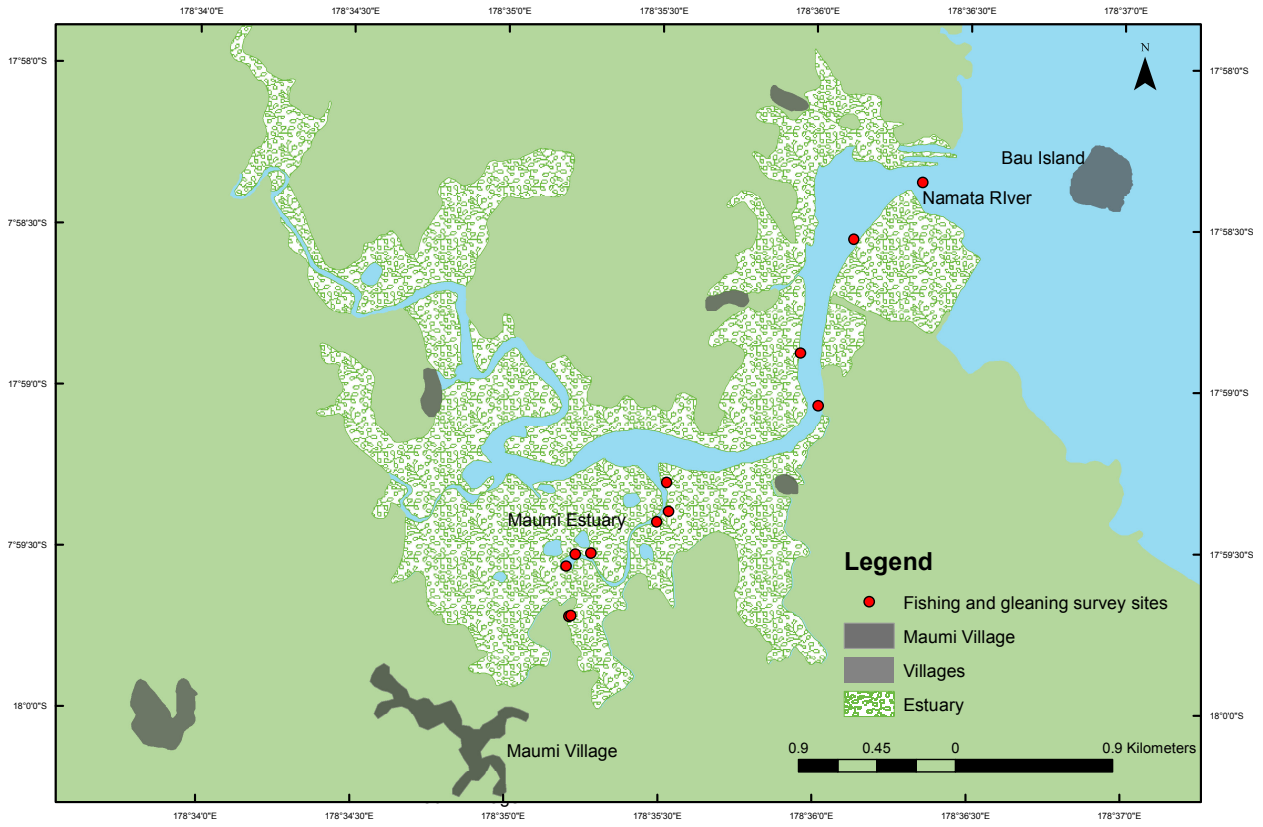

Figure 1: Map of in situ fishing survey study sites.

Figure 2: 'Namata River', where four of the Fishing Validation studies were conducted. Source: Katie Shaw-Brown (9/7/2011).

Fishing:

Line fishing:

At each site a 0.8mm nylon hand line and a No.10 hook was lowered into the water for half an hour using mangrove prawns as bait (Figure 4). Survey respondents indicated that mangrove prawns were the most common bait used for line fishing in this estuary.

Figure 3: 'Namata River customary line fishermen'. Source: Katie Shaw-Brown (9/7/2011).

Netting:

The 40 meter long nylon net was placed, at low tide, along the edge of a stand of mangroves, situated on the edge of the river (Figure 5). The bottom of the net was held in place by small rocks tied to the bottom corners and the top of the net was tied to mangrove trees at each corner. The net was left for 24 hours before being checked for catch and then replaced.

Figure 4: Net set at the netting site along the edge of the mangroves at high tide. Source: Katie Shaw-Brown (9/7/2011).

Environmental variables were recorded when the net was first placed each day and included: cloud cover, water temperature, salinity, pH levels, water clarity, depth, GPS location and time. The catch at each site was also recorded at the end of each 24-hour period. Catch variables recorded included: number caught, species name and length and time of retrieval.

Gleaning:

Crabbing:

Crab cages were used to capture the crabs. Both mangrove crab and tuna head were used as bait. The sites were restricted to highly tidal areas toward the head of the river, upstream from Maumi Village and close to the riverbank. The traps were placed on site at low tide and tied to trees with nylon string. The cages were left for ten to 12 hours and checked for catch before being replaced.

Figure 5: Crab traps used at each of the 'crabbing' sites. Source: Katie Shaw-Brown (9/7/2011).

At each site, the following environmental variables were recorded: cloud cover, water temperature, salinity, pH levels, depth, GPS location and time. The catch at each site was also recorded (number caught, species name, length).

Limitations

Time and research budget both acted as major limiting factors influencing data outcomes of the catch per unit effort (CPUE) surveys. Only three days were spent on the river doing CPUE surveys due the cost of hiring a motor boat and the limited time that local fisherman had available to participate in the research. This led to a smaller than desired data set and therefore decreased the validity of any conclusions formed. The use of only one local fisher may have led to bias in the sample. The fishing survey was only conducted during the day and therefore, providing data that would indicate a more acute temporal variation was not possible. Changes in bait could have

influenced the catch data retrieved as certain marine species may have a greater preference for certain prey than for others. The presence of an outside researcher in the vessel could have also enhanced distractions and noise levels leading to the fisherman being less aware of movement in the water and increased disturbance of the aquatic environment. The use of a power boat could also have caused greater disturbance of the fish and may have changed catch rates, compared to rafts of canoes. However, due to the standardised harvesting times and vessel type, the researcher aimed to reduce the influence of these limitations.

Analysis

The analysis and graphs of the fishing validation study were conducted using SPSS (www.SPSS.com).

For each study site vegetation was noted and displayed in tables separated by method and site. The environmental variables including pH, temperature, salinity, water clarity, cloud cover and water depth were noted at each site across four study days and the means for each variable over this period were also graphed. Numbers in each catch were also displayed by method and day in a bar graph. The number of animals and species caught at each site were depicted in a histogram. Catch per minute values were analysed using an independent samples t-test to determine the significance of variance between the means gathered from interview and fishing validation data for both gleaning and fishing methods. Equal variances were not assumed due to the differences in sample size.

3.3 Ethical considerations

3.3.1 Approval process

Ethical considerations in social science apply to the "appropriateness of the researcher's behaviours in relation to the subjects of the research or those who are affected by it"

(Gray, 2004). Permission was requested from, granted by, the local village leaders to conduct the fieldwork for this study in Maumi Village. Potential participants were informed through a door-to-door approach, whereby an information sheet (Appendix 4) and explanation of the nature, purpose, sponsor of the research and approximate completion time (two hours) of the interview was provided. All questions were optional and the opportunity to provide additional information was offered. The AUT University Ethics Committee (AUTEC) approved the survey instruments, methods of data collection and analysis in June 2011 (approval number 11/131).

3.3.2 Animal ethics

Animal ethics approval was not required as the fishing validation surveys, which involved the catching and death of fish, crabs and prawns, were undertaken with local fishers who were carrying out pre-planned fishing activities for subsistence purposes.

3.3.3 Informed consent

Each participant was given a consent form and information sheet to keep. Before the interview took place, the consent form (Appendix 5) and information sheet (Appendix 4) were explained and if the participant chose to take part, the consent form would be signed. The participant was offered a copy of the consent form for their records.

3.3.4 Confidentiality and anonymity

Confidentiality was ensured through a coding process, whereby each interview and associated consent form were given a number. All raw and processed data were held in locked premises where only the researcher had access, in both Fiji and New Zealand. All raw data and identification material were destroyed on completion of the study. A confidentially agreement was also signed by the translator, agreeing to not disclose or discuss any of the information collected for the study to anybody other than the primary researcher.

3.3.5 Cross-cultural considerations

When conducting research in a developing country, race, ethnicity, marital status, gender and non-demographic traits such as worldview, can often define the researcher in relation to the community. This can determine the direction or quality of the research, especially given many studies are conducted by those not from the study's community (Storey & Scheyvens, 2003).

Research conducted by an 'outsider' commonly produces knowledge that is tainted by the researcher's position of relative wealth and power and by a lack of significant local contribution. This engages the debate of the advantages and disadvantages of 'insider' or 'outsider' research (Agar, 1980; Grafanaki, 1996). Yet this over simplifies the complexities of development research. However, the issues associated with cross-cultural research need to be acknowledged.

In this study, a male translator of local heritage was used to act as intermediary throughout all sections of the study. The presence of a young, female, researcher of European descent may have altered the dynamics and information collected during the study. Time was spent in the village prior to the undertaking the study and accepted cultural protocols were followed, including the offering of a s*evusevu* (gift) of Kava root and the wearing of appropriate dress. During the time spent in the village the researcher stayed in the local meeting-house with one of the community leaders and his family. The local people accommodated the goals of the research and each part of the fieldwork was guided and encouraged by local leaders.

Chapter 4: Study site descriptions

This chapter offers a general description of the Dravo District, which is home to the Maumi Village, followed by a description of the Maumi Village and its people. The Maumi village acted as the study for the focus groups and the semi-structured interviews (Chapter 3). In the section 4.3 of this chapter the study sites used for the in situ fishing survey will be described and the physical attributes observed at each study sites will be displayed.

4.1 Dravo District

Maumi village is situated in Tailevu, one of Fiji's 14 provinces. Tailevu is on Fiji's largest island Viti Levu, which covers an area of approximately 755km^2 and contains approximately 55,692 people (Fiji Islands Bureau of Statistics, 2011). Tailevu province contains the towns of Nausori and Korovou and is home to approximately 13,930 families. Nausori is the main urban area with a population of 24,919 in 2007 (Fiji Islands Bureau of Statistics, 2011). Tailevu includes the districts of Bau, Nakelo, Verata, Wainibuka, and Sawakasa. Bau District includes Bau Island, the seat of the central Kubuna Confederacy, one of three traditional chiefly hierarchies in Fiji. Kubuna's Paramount Chief, called the *Vunivalu of Bau,* is considered the most senior such chief in Fiji (Fiji Islands Bureau of Statistics, 2011, 2010; Rumsey, 1999). A provincial council governs Tailevu, as in other provinces. Tailevu Province is served by several major road networks, and is abundant in taro, kava and mahogany plantations, which serves as a major source of revenue for the region (Fraenkel, Firth & Lal, 2009; Fiji Islands Bureau of Statistics, 2011, 2010).

4.2 Maumi Village demographics

Maumi Village contains 54 homes and sits upon the ridgeline above the Namata River

and Maumi Estuary. During colonial times (exact dates unknown), the Maumi Village people lived on Maumi Island situated in the middle of Maumi Estuary and access to the mainland was by a large bridge (Lal, 1992). Following this period, the Maumi villagers inhabited a small village on the edge of the Maumi Estuary. Approximately 50 years ago the village was moved from the edge of the Maumi Estuary and re-built on its present site along the upper ridgeline. There are five villages surrounding the Namata River and Maumi Estuary, including Bau, Namata and Maumi Villages, which share strong family linkages to the Maumi Village people (Figure 1).

Limited demographic information on the Maumi population however, based on this research, several conclusions can be drawn. Currently the Maumi population is composed of only native Fijian people and a one traditional clan. All of the Maumi Village people are practicing Christians. There is one main road leading in and out of Maumi Village which heads to the nearest market town, Nausori.

Maumi Village is sheltered by mangrove stands, creating a dense forest, which stretches from the coastal ridgeline to the river mouth and surrounds. Mangroves are estuarine flora, flourishing in the tropics and sub-tropics. (Haynes, 2011; Robertson, 2000). Such flora, inhabit low energy and low gradient of brackish, coastal zones, which display large tidal amplitudes. Mangroves, such as those found near Maumi Village, are a major ecosystem forming a fringe between terrestrial and marine environments.

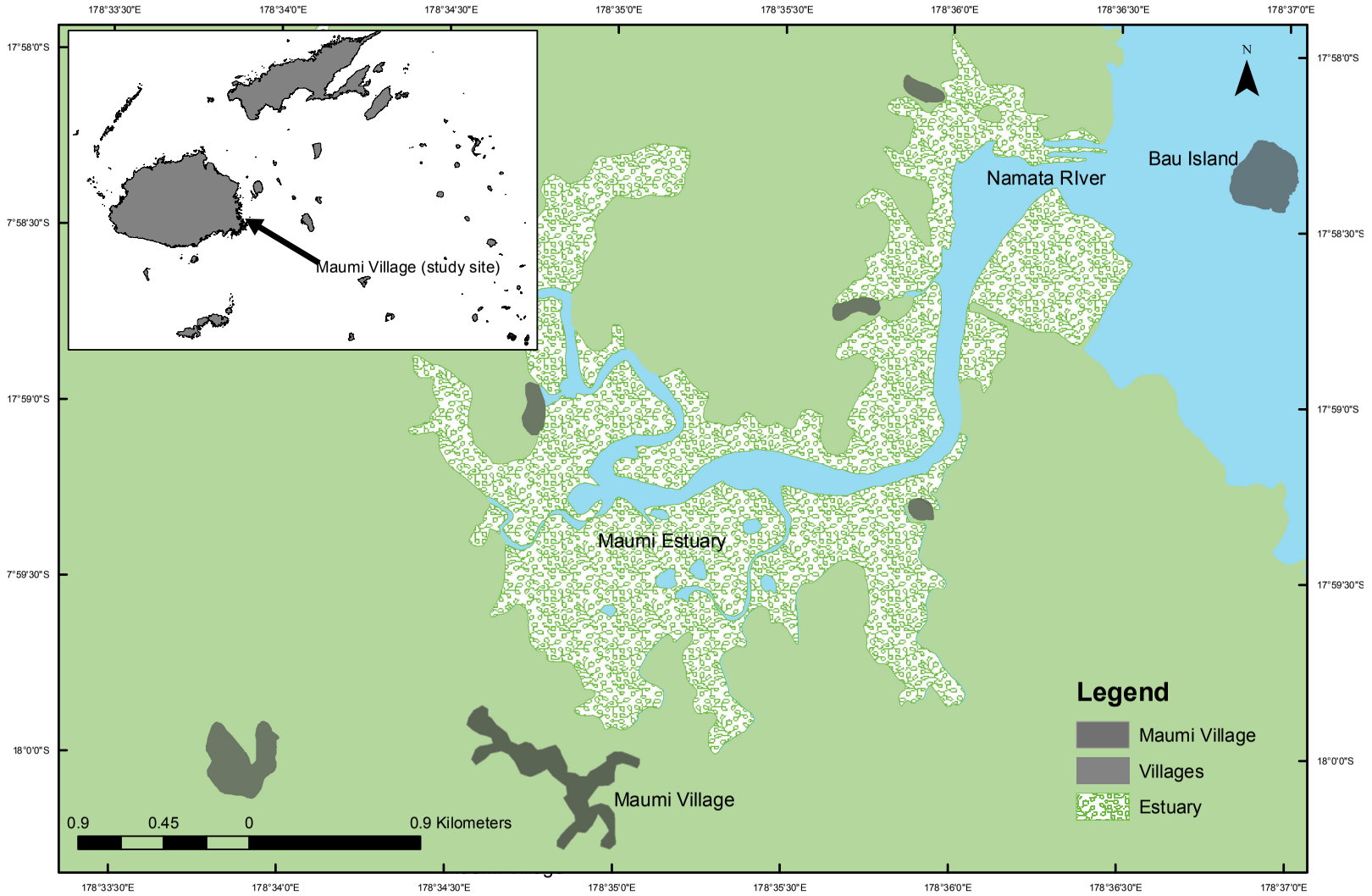

Figure 6: Map of the Maumi Estuary, Namata River, where this study was conducted, with an insert of the Fiji Islands. Marked on the map is Maumi Village, where the workshops and interviews took place and the Namata River and Maumi Estuary, which were the source of the biophysical and fishing data.

4.3 In situ fishing survey sites

Each day four crab pots, a single fishing net and six hand lines were dropped at different sites. Fishing sites were distributed from the launching point out at the Namata river mouth (Figure 2). The fishing sites extended from the end of the main estuarine channel to the mouth of the Namata River. Each fishing site was situated against the bank of the river where the fish find refuge and feed. A total of six fishing sites were selected along the river, three controls sites and three common fishing sites (Figure 2). The researcher chose three control sites and the participating fisher selected the three remaining study sites. The sites selected by the fisher were sites regularly visited to catch fish, lay nets or crab traps. The control sites served to determine the impact of local knowledge on fishing, gleaning and netting catch rates and if a variation was present, what catch method or geographic positions varied.

One netting survey site was placed at the point where the estuarine stream met the main Namata River (Figure 2). This site was selected by the local guide, as it was commonly used for netting. Due to the fisherman only having access to one net, only one netting site could be studied at a time.

The crabbing sites were limited to the shallow, estuarine areas closer to the village. The first crab traps were laid on the 6th of September, to be collected 12 hours later, the following morning (Figure 6). Each crabbing and fishing site was situated against the bank of the river where the fish and crabs find refuge and feed.

The crabbing sites were the four sites closest to the village and were composed of two local fishing sites commonly visited by the prominent village fisherman and two control sites, chosen by the researcher, dispersed alternately between the locally used sites (Figure 2).

At each study site, environmental observations were recorded including the type of vegetation present within a 20m radius of the study site (Tables 1, 2 and 3). The vegetation at all sites consisted of a variety of mangrove species. *Tiri selala* was the most commonly occurring species, as it was identified at 73% of study sites.

Table 1: The local and scientific name of each species of flora within a 20m radius of the fishing study sites.

Fishing control site 1		**Fishing site 1**		**Fishing control site 2**		**Fishing site 2**		**Fishing control site 3**		**Fishing site 3**	
Scientific name	**Local name**	**Scientific name**	**Local name**	**Scientific name**	**Local name**	**Scientific name**	**Local name**	**Scientific name**	**Local name**	**Scientific name**	**Local name**
Rhizophora stylosa	Tiri tabua	*Rhizophora samoensis*	Ttiri wai	*Rhizophora stylosa*	Tiri tabua	*Rhizophora samoensis*	Tiri wai	*Rhizophora selela*	Tiri selala	*Rhizophora selela*	Tiri selala
Rhizophora selela	Tiri selala	*Rhizophora stylosa*	Tiri tabua	*Rhizophora samoensis*	Tiri wai	*Rhizophora stylosa*	Tiri tabua				
		Rhizophora selela	Tiri selala								

Table 2: The local and scientific name of each species within a 20m radius of the netting site.

Netting site	
Scientific name	**Local name**
Rhizophora selela	Tiri selala
Xylocarpus granatum	Dabi
Rhizophoraceae:Bruguiera gymnorrhiza	Dogo
Rhizophora samoensis	Tiri Wai

Table 3: The local and scientific name of each species of flora within a 20m radius of the crabbing sites.

Crabbing control site 1		**Crabbing site 1**		**Crabbing control site 2**		**Crabbing site 2**	
Scientific name	**Local name**	**Scientific name**	**Local name**	**Scientific name**	**Local name**	**Scientific name**	**Local name**
Rhizophora samoensis	Tiri wai	*Rhizophora selela*	Tiri selala	*Xylocarpus granatum*	Dabi	*Rhizophoraceae: Bruguiera gymnorrhiza*	Dogo
Rhizophora selela	Tiri selala	*Rhizophoraceae: Bruguiera gymnorrhiza*	Dogo	*Rhizophora samoensis*	Tiri wai	*Rhizophora selela*	Tiri Selala
Rhizophoraceae: Bruguiera gymnorrhiza	Dogo	*Pometia acuminata*	Dawa			*Rhizophora samoensis*	Tiri Wai
Pometia acuminata	Dawa	*Xylocarpus granatum*	Dabi				
Xylocarpus granatum	Dabi						

The following graphs depict the environmental conditions measured at each study site throughout the fishing validation surveys. Average pH, temperature, water clarity, cloud cover, depth and salinity were recorded and graphed for each site (Figures 7 to 12).

Mean temperature and pH showed little variability throughout the three days of the study (Figures 7 and 8).

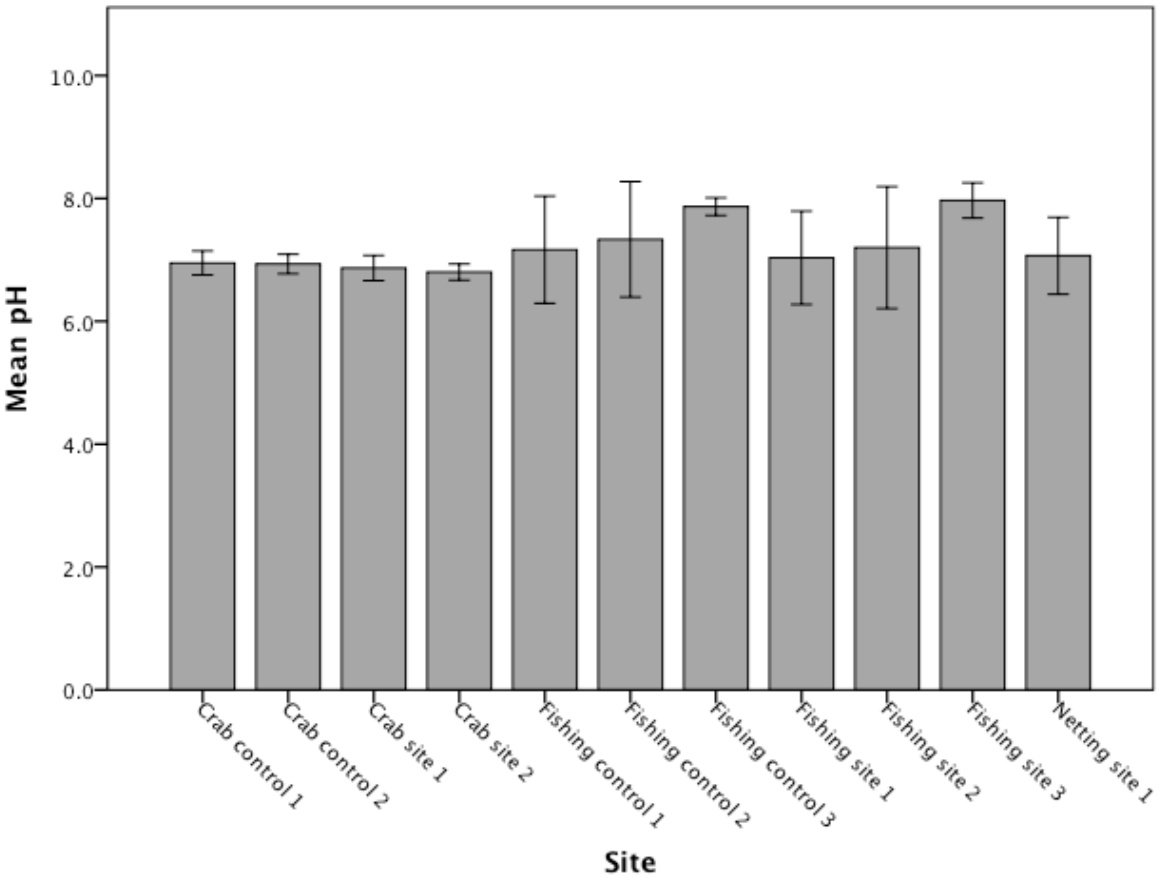

Figure 7: The mean pH levels and variance, recorded though the fishing survey and arranged by study site.

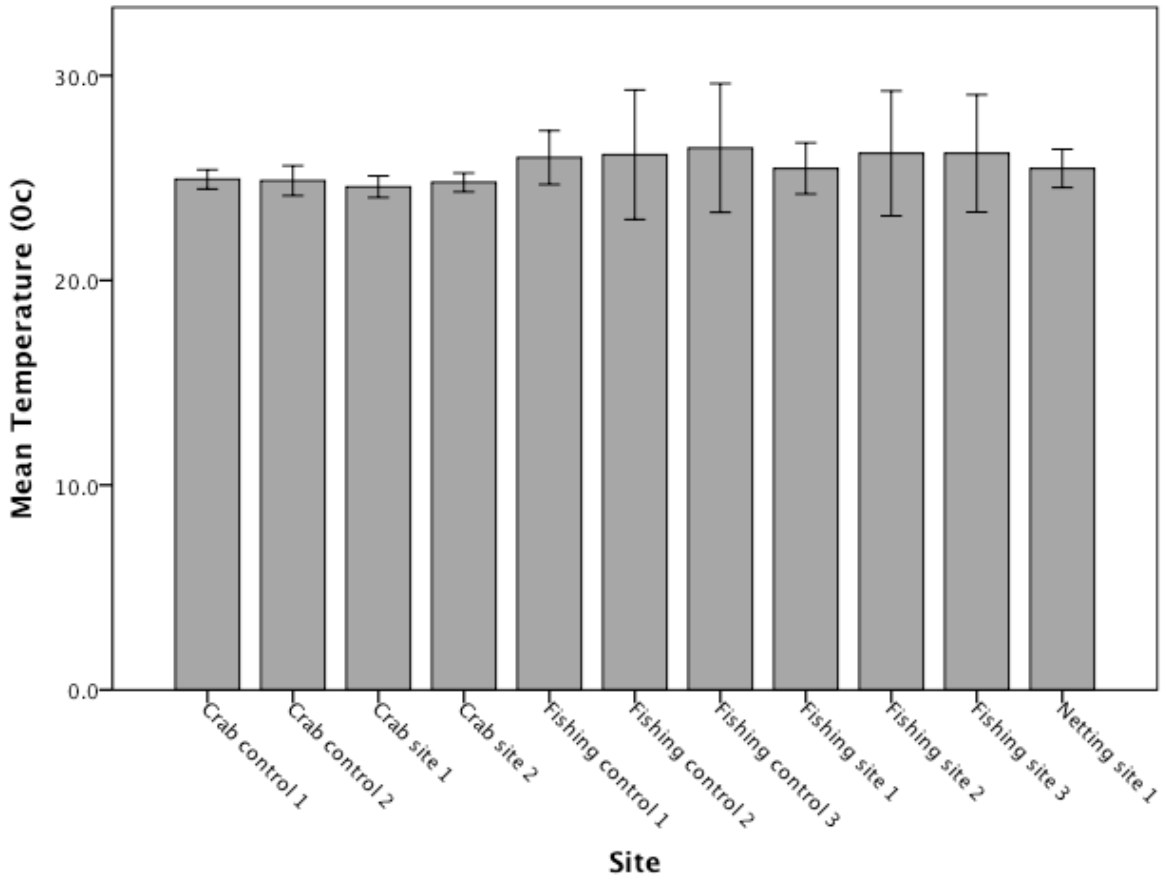

Figure 8: The mean and variance of temperature levels recorded throughout the fishing survey and arranged by study site.

Water clarity varied from approximately 40-70% with Fishing Site 1 demonstrating the highest reading and the greatest variance (Figure 9).

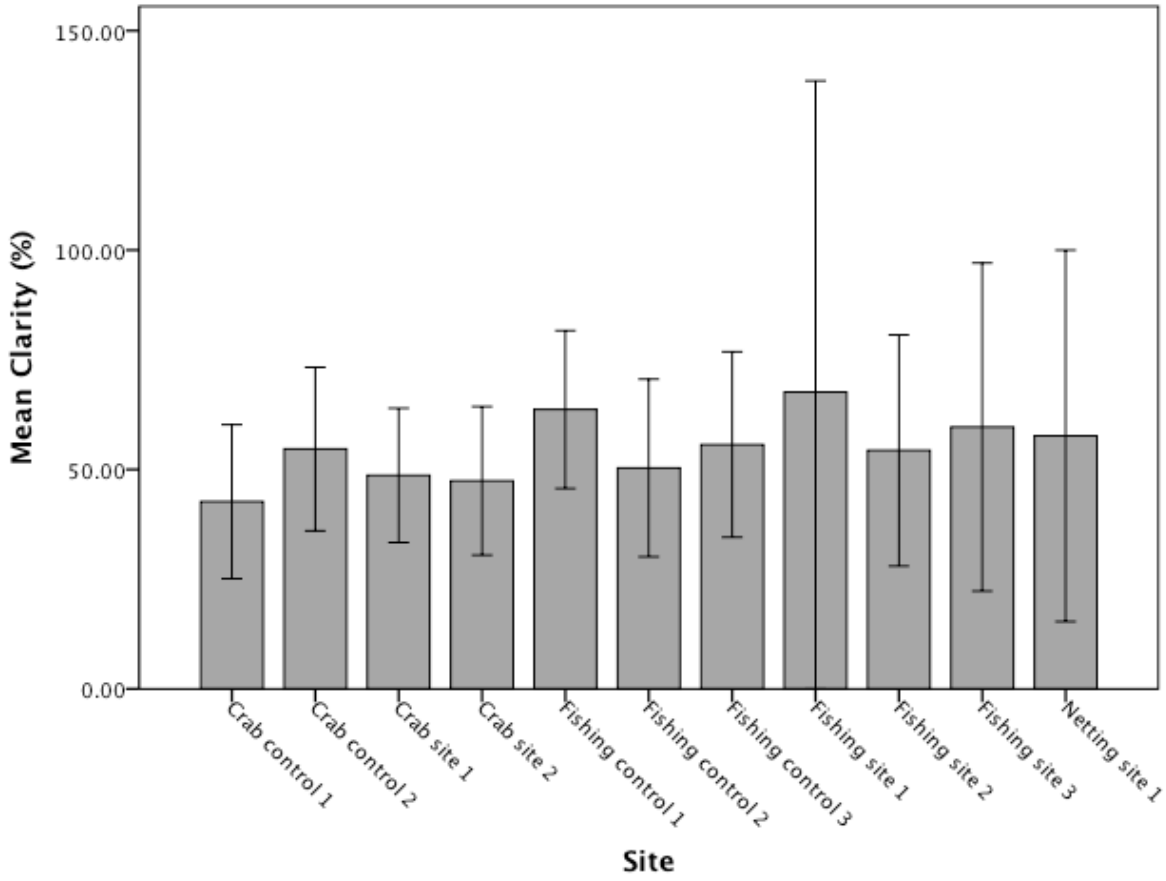

Figure 9: The mean and variance of water clarity, recorded throughout the fishing survey and arranged by study site.

Cloud cover showed little variability throughout the crabbing sites, however variation increased through the other sites with “Fishing Site 1” and “Netting Site” showing the greatest variance (Figure 10).

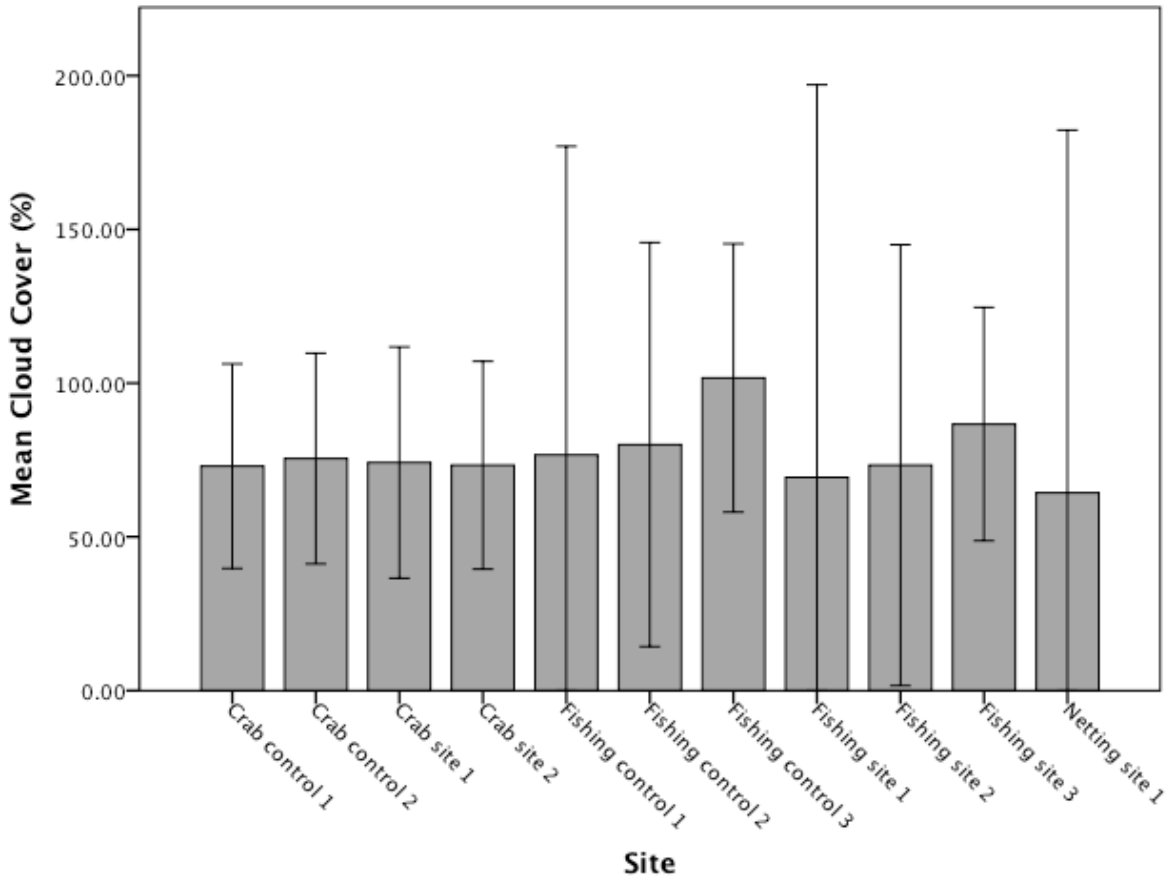

Figure 10: The mean and variance of cloud cover recorded through the fishing survey and arranged by study site.

There was a noticeable variation in the water depth of each study site, which reflected a change in tides and bathymetry (Figure 11). Crab control 1 and netting site 1 had the lowest measured mean depth and fishing site one displayed the greatest average depth. Fishing control 2 and netting 1 had the greatest variance.

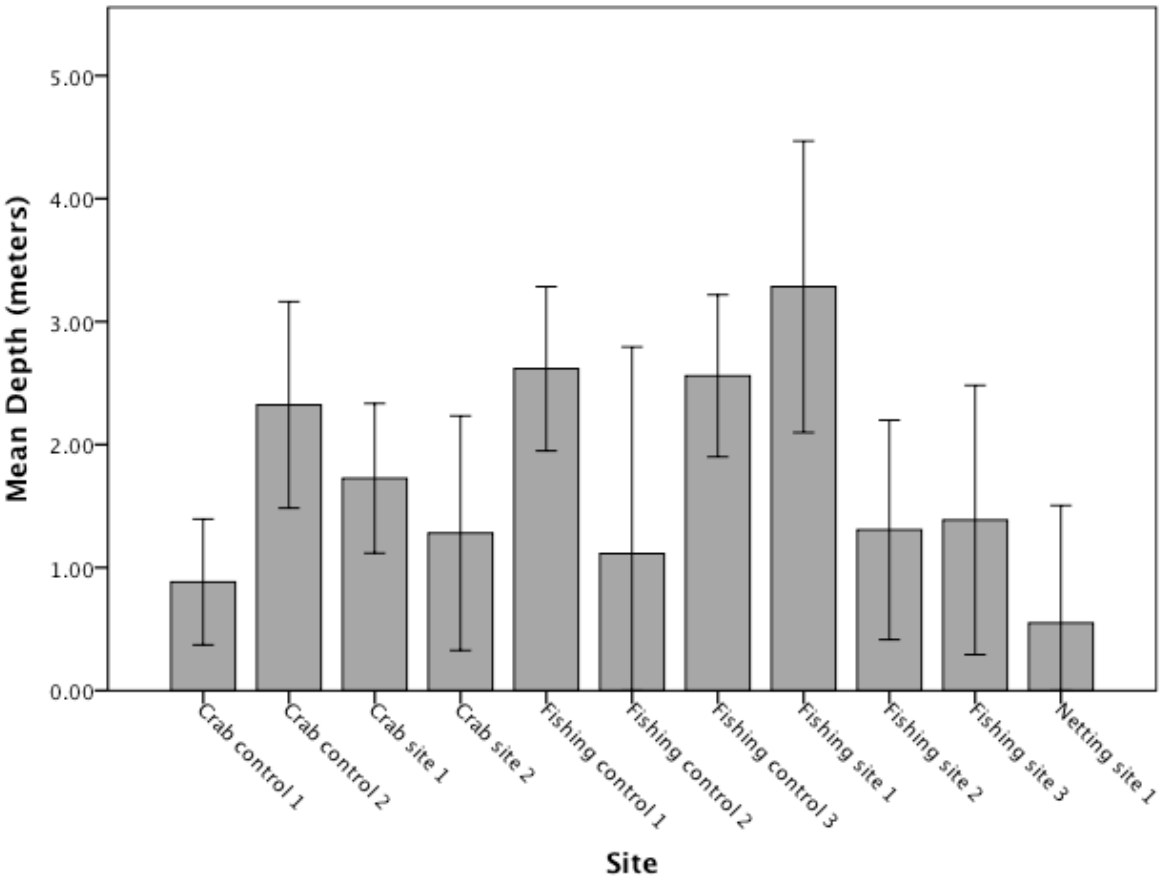

Figure 11: The mean and variance of water depth, in meters, recorded throughout the fishing survey and arranged by study site.

Salinity levels varied between 22 (crabbing site 1) and 30bpt (fishing site 3) with the greatest variance shown between Fishing Control 1 and Fishing Site 2 (Figure 12).

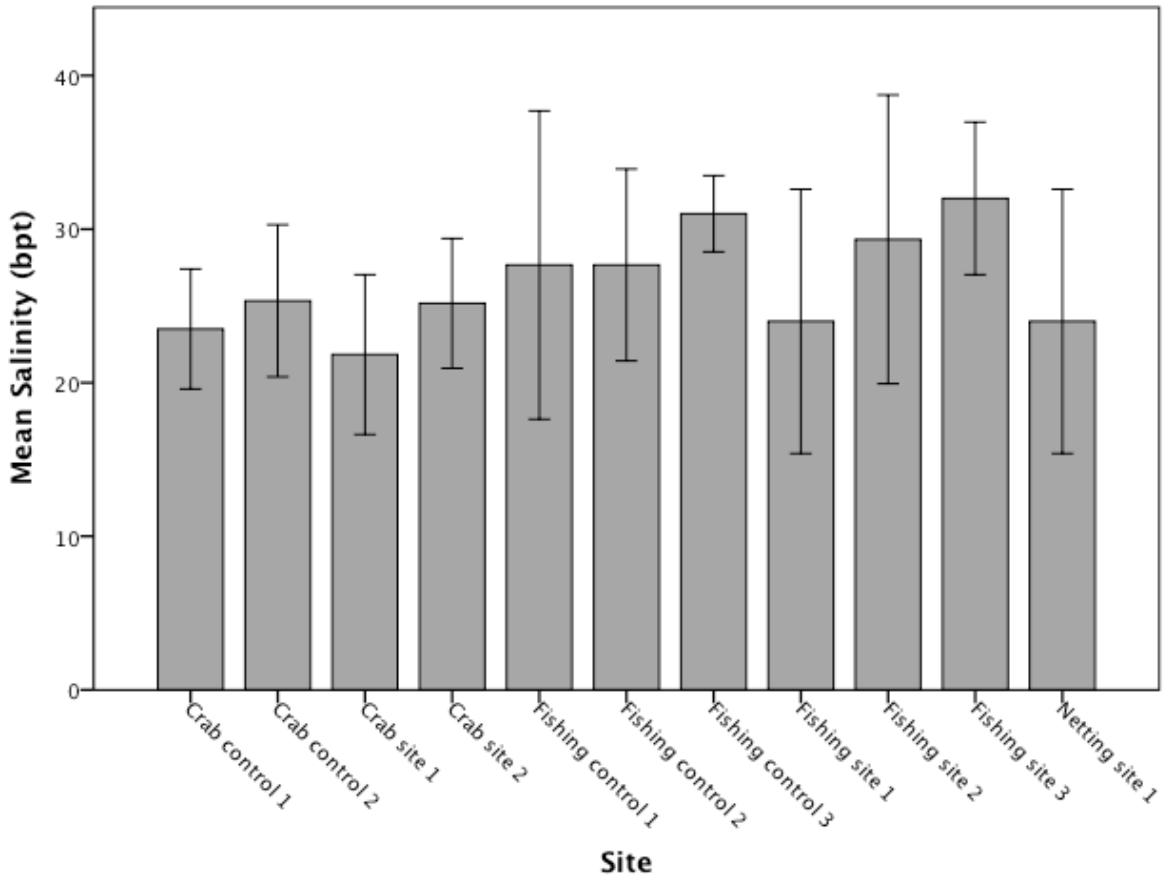

Figure 12: The mean and variance of salinity levels recorded throughout the fishing survey and arranged by study site.

Chapter 5: Local ecological knowledge of marine resources in Namata River and Maumi Estuary

This chapter details the results of a focus group conducted as part of this study, in Maumi Village, September 2011 and two semi-structured interviews that were conducted in order to gather information on local ecological knowledge of the Maumi Estuary and Namata River. The findings of the in situ fishing survey are displayed at the end of this chapter. These results provide a detailed analysis of the effects of these conditions on the choice of estuary and river sites for the people of Maumi Village. If multiple use opportunities are to be effectively managed, it is vital to understand how regular users of the Maumi Estuary and Namata River are influenced by changes to the environment and how they experience, perceive and value the natural and social environments. The focus group findings discussed in this chapter were gathered from a group of local villagers, who described their views on current and future management of the local estuary and river systems in a series of open-ended questions and maps as per Chapter 2. The semi-structured interviews reported on in this chapter were conducted in August 2011 in the Maumi Village in Tailevu. The results of the two semi-structured interviews are presented based on the section of the interview, as described in Chapter 2 and shown in Appendix 2 and 3. This chapter also describes the results of the fishing validation study that was conducted in the Maumi Estuary and Namata River.

5.1 Focus group for understanding local marine management practices (Aim 2)

The understanding of the current management situation in combination with the perspectives of the local people was vital to establishing whether the current marine resources near Maumi Village were effectively managed. The current management practices and perspectives, as well as future management desires were captured by a

group workshop formed by six local villagers in September 2011. The six participants were considered the community leaders and spoke on behalf of their village. There were 27 open-ended questions posed to guide the discussion. The resulting responses are summarised below in sections based on temporal perspectives and further displayed in the original transcript taken during the focus group. The workshop lasted approximately one and a half hours.

5.1.1 Past management practices

According to the participants of the workshop, there were no current restrictions in place, relating the use of the estuary and river. The area was used to gather food and building materials in the form of mangrove trees by the Maumi village people. In the past (until the establishment of the new Maumi Village on the ridgeline) *tabu* have been enforced as a result of a ceremony, cultural event or grieving process. For example, after the death of the previous chief of Bau Island, in 1977 a *tabu* of 100 nights was placed on fishing activities in the river and estuary as a sign of respect. A *tabu* was put in place for a church conference in 2006 and since then there have been no further taboo periods. *Tabus* ceased to be used after the village was moved from the water edge to the ridgeline. It is acknowledged that a greater abundance and diversity of fish was found in the estuary and river after *tabu* periods.

5.1.2 Current management and governance

The participants were aware that their activities on the estuary could have a detrimental effect on the environment. Dumping rubbish, run-off from farming activities, the use of outboard motors and even frequent swimming were acknowledged to affect the marine organisms, and disturb sediment in the waterways. According to the participants, the government owns the waterways and governs the requirement for fishing licensing. This is viewed as a hindrance to the community's economic stability. It limits those who can

sell their catch in markets because of the financial cost of acquiring a fishing permit. Focus group participants stated that many people from outside the area, including commercial fishers, come to fishing in the waters of their historic *qoliqoli* (*qoliqoli* have not been utlised in the area since the relocation of the old Maumi Village). The designation of fishing grounds *(qoliqoli*) was viewed by participants of the focus group, as an administrative system that had few practical implications. The right to sell their fish catch is also restricted through the issue of fishing licences. There were also size restrictions placed on fish catch by the government in an attempt to control fish stock depletion, however these are rarely obeyed by the Maumi Village people due the drop in fish stocks and therefore catch. They catch what they can to feed their families and the remainder is sold. This has led to only a few locals having the ability to gain an income from their fishing efforts. Gleaning and fishing are primarily a means of collection for local consumption (subsistence). There was little respect for government established restrictions as many local people, as well as those from outside the area, are compelled, out of necessity, to use the waterways as food source as well as income, by selling what they catch, without permission or license.

5.1.3 Future management desires

There was consensus among the participants that the current government management of the waterways is positive; it increases diversity of both brackish water species and flora in the area and that further management schemes would be too costly. However, there was still a strong desire to establish an MPA in order to increase fish stocks, reduce pollution and erosion and ensure a stable food supply and income for future generations. Focus group participants acknowledged that enforcement of the restrictions of any future MPA would be hindered by the distance of the village from the estuary.

5.1.4 Focus group: Questions and Answers.

Q 1. Are there any management measures/restrictions in place for the Maumi Estuary and/or the Namata River at present?

A. There is no management of the Namata River or Maumi Estuary taking place at present.

The waterways are used as a food source.

The surrounding mangroves are used for firewood and building material.

Q 2. Have there been management measures/restrictions put in place on the Namata River or Maumi Estuary in the past?

A. Yes, restrictions (*tabu*) were put in place after the death of the chief, usually a *tabu* for 100 nights (3months).

The first born child of the eldest person in the family: there will be a management taking place for women looking after the first born child within four nights.

Q 3. Have these restrictions differed from the current situation? How?

A. Yes, the *tabu* has been used in the past, but not at present.

Presently, the area is primarily used as a food source and a source of firewood.

Tabu took place when they lived in the old Maumi Village.

The current settlement does not enforce *tabu*.

Q 4. Have past or present management/restrictions achieved their aim?

A. In 1977 when the Maumi chief died, there was a t*abu* following his death.

In 2006 there was a *tabu* for 6months before a Church Conference took place.

Since 2006 there has been no *tabu.*

Q 5. Did the restrictions/ management plans impact the Namata River or Maumi Estuary environment?

A. A greater abundance of fish in the local waterways was observed after *tabu* periods.

There were a lot more fish found in the river.

A greater variety of fish species were found ie sharks, oysters and zebra fish.

Q 6. Do your activities on the water affect the Namata River and/or Maumi Estuary environment?

A. Yes, auto boats affect the riverbanks, as the use and disturbance of the water has led to greater soil erosion.

Oil from the auto boats affects the species in the river.

Pollution from dumping of rubbish ie plastic, tin, metal etc.

All the inland streams feed into the Maumi Estuary and Namata River, so chemicals, rubbish and run-off from roads and local villages pollute the local waterways.

Swimming in the waterways also disturbs the habitat of the marine species and also disturbs the sediment.

Q 7. Do you feel that the *qoliqoli* network is of benefit to local communities?

A. The *qoliqoli* is of more benefit to the government and not so much to the locals.

When selling fish at market you are required to have a licence from the Ministry of Fisheries and therefore many communities are only relying on fish for their own consumption.

Q 8. Who owns the Namata River and Maumi Estuary?

A. The government owns the river and estuary and any activities that take place on the water are at the discretion of the government. The Maumi people have to use the estuary and river under the authority and guidance of the government.

Q 9. Are you happy with the way the Namata River or Maumi Estuary are currently managed?

A. Yes, because when the area is managed we have a lot of fish.

More fish means greater fish species diversity.

Also, there is a large diversity in mangrove species in the area.

Q 10. Would you change anything about how the estuary and river are managed?

A. No, because that would mean spending a lot of money.

Q 11. What is a marine protected area?

A. Protecting our estuary in order to increase the presence of fish and other organisms.

Q 12. Would you like to have a Marine Protected Area?

A. Yes, we would really like one.

We want to get back what we have lost from the Maumi Estuary.

Also we need to improve and protect the Maumi Estuary for the benefit of future generations.

Q 13. Where would you put a Marine Protected Area and why?

A. Refer to Figure 13. The responses from this question were drawn on a map provided during the focus group and then digitised for display in this thesis.

Q 14. Where are the current fishing grounds?

A. Refer to Figure 13. The responses from this question were drawn on a map provided during the focus group and then digitised for display in this thesis.

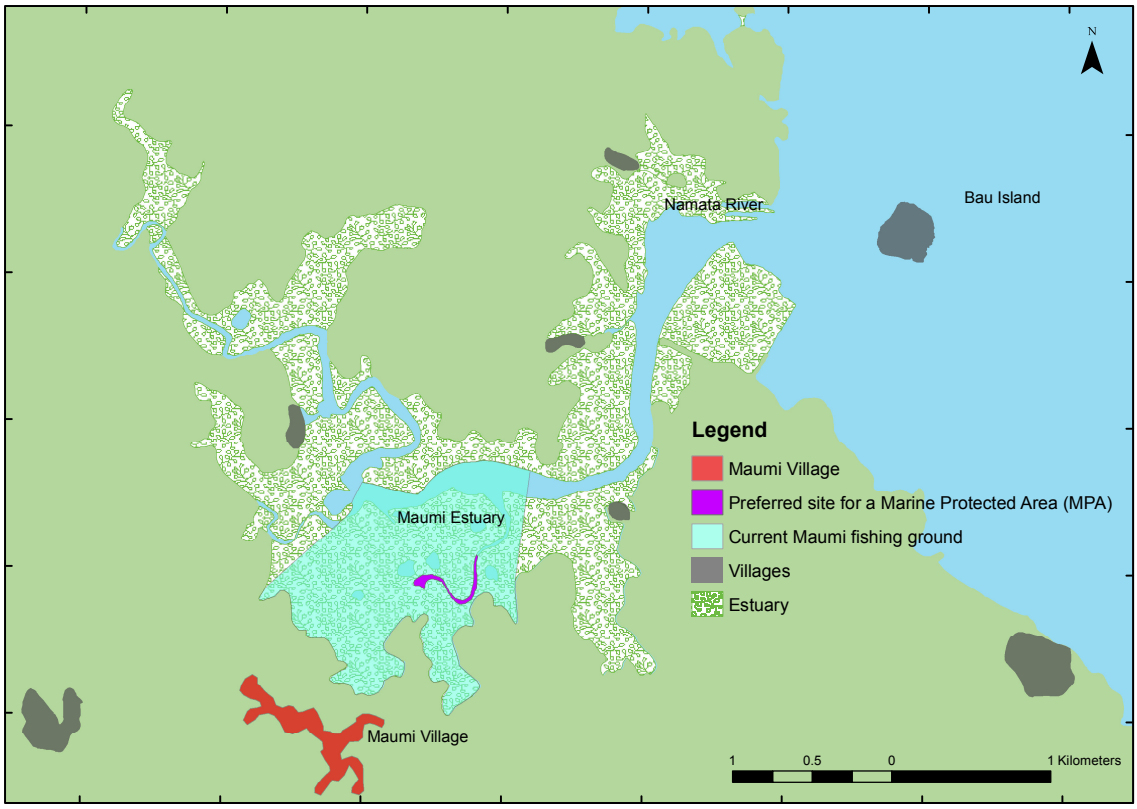

Figure 13: A site map depicting the responses of questions 13 and 14 as described above.

Q 15. Are the boundaries of the local *qoliqoli* respected?

A. No. Anyone can go and fish in the estuary and river.

A lot of people catch fish in the estuary without the concern of the local people or owners.

Since the area is owned by the government.

Q 16. What government/fisheries department laws/restrictions are put in place at present?

A. A lot of rule and regulations are put in place at present.

There are limitations on the size of the species caught and also the size of your catch.

There are size limitations in place, which are recommended by the Ministry of Fisheries, put in place in order to avoid the unrecoverable loss of species.

You also have to have a boat licence as well as have a licence for the boat driver.

Q 17. Are the government laws respected by those who use the river and estuary?

A. No. Only a few people/ not all the communities obey the laws.

A lot of people break the laws.

A lot of people live by the river ie Namata Village people and the Namuka Village people, who use the river as their primary source of meat and food.

Q 18. Have the laws and restrictions changed over time?

No.

A. Everyone has to follow the laws introduced and imposed by the Ministry of Fisheries.

Q 19. Are there presently any limitations on catching marine animals?

A. No. Anyone can go and catch fish at any time you want.

Since the area is a food source for many of the people living in the area.

Q 20. If so, where and for how long?

A. N/A

Q 21. Have there been restrictions on marine animal catching in the past?

A. No.

Q 22. How would you like such change to happen?

A. As soon as possible, to avoid conditions getting worse in the future.

Q 23. What would you like to see changed?

A. Improvement of fish abundance, as we want to have a lot of fish in the estuary.

The depth of water needs to increase, as it is presently very shallow and the width of the river should be wider, like it used to be.

Q 24. Do you think there is need for management/improved management of the waterways?

A. Yes, we really want increased management in the area, as there is a lot of pollution in the area, which affects the waterways.

Through management we hope a lot of change will occur in relation to increase abundance of fish and number of fish species.

Q 25. How are management restrictions enforced? Is it effective?

A. Enforced by the government.

Yes, changes have occurred which have increased the number of fish and other marine species in the waterways.

Some fish that were not seen in the area, began to re-appear in the waterways, since the implementations of management.

Q 26. What challenges may occur as a result of having or implementing an MPA?

A. Challenges would be that the village would be far away from the MPA, as they have no auto-boat.

The result would be more fish species would be found in greater abundance.

There would be difficulties in monitoring and supervising the *qoliqoli*/ MPA area, due to the villages distance from the water.

Q 27. What benefits do you see from having an MPA?

A. There would be increases in the number and size of fish. This trend may also apply to other marine species like mud lobster and crabs.

5.2 Semi-structured interview 1: Estuary interactions and ideas survey: an investigation of activities, knowledge and perceptions associated with Maumi Estuary and Namata River (Aim 2)

5.2.1 Section 1: Demographics and history of interactions of the Maumi Village people with the Maumi Estuary and Namata River.

The survey participants who contributed to this study were all from Maumi Village and were composed of a group of 18 villagers of both genders (Female 39% and Male 61%). Fifty six percent of participants were over the age of 50, providing a more experienced perception of the Maumi Estuary and Namata River environment. Of the 18 participants, 72.2% had lived in Maumi Village their whole lives. A reasonably high level of education was achieved, as 38.9% had graduated from secondary school and 22.2% were attending or had studied at a tertiary institute. The size of the participants households ranged from three people to over seven people.

The use of the Maumi Estuary and Namata River

The Maumi Estuary and Namata River are a vital part of the lives of Maumi villagers. While only six percent of villagers visit the estuary or river on a daily basis, 61% use the waterways between one and several times a week. The main uses of the waterways were fishing (89%), crabbing (6%) and swimming (6%) (Figure 14). Respondents indicated that their secondary activities included swimming (28%), gleaning (17%), drawing water (6%), spear fishing (22%) and diving (6%) (Figure 15). For the purpose of this study diving is clarified as diving without breathing apparatus and often without swimming aids such as fins or snorkel. When participants were asked if they owned a boat, 83% indicated that they did not however, definitions of what a boat was varied throughout the study group. Some participants regarded a boat as a vessel with a motor and some considered a canoe without a motor to fall into the boat category as well. The

Maumi Village people had access to three canoes but no one in the Maumi Village owned a boat with a motor.

Fishing was the dominant activity conducted by interview participants, with 89% of them selecting it as their primary activity undertaken in the waterways.

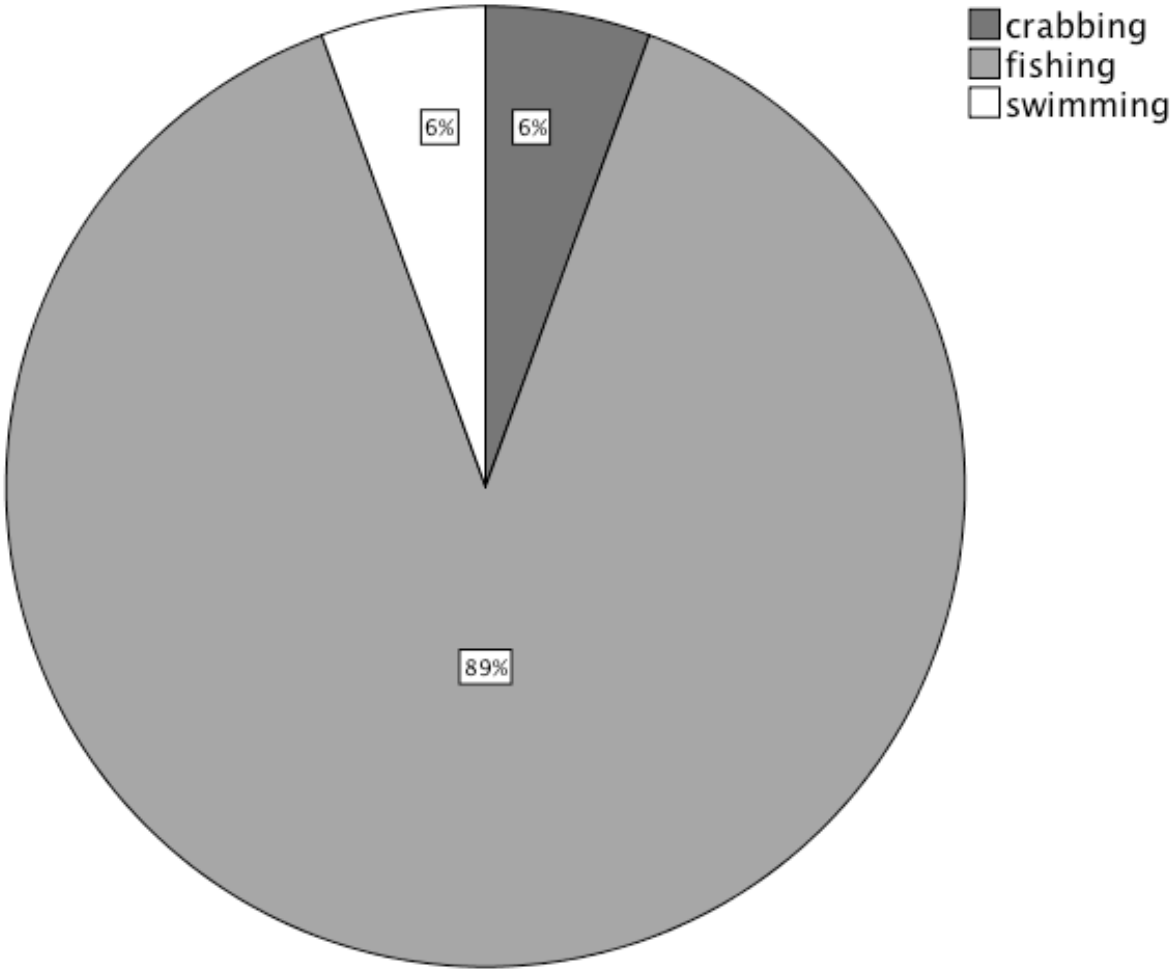

Figure 14: The frequency of participant selection of participants primary activity conducted in the Maumi Estuary or Namata River.

Figure 15 shows the secondary activity conducted by interview participants. Swimming, spear fishing and gleaning contributed 28, 22 and 17% respectively and represented the top three secondary activities, although for some swimming was a primary activity.

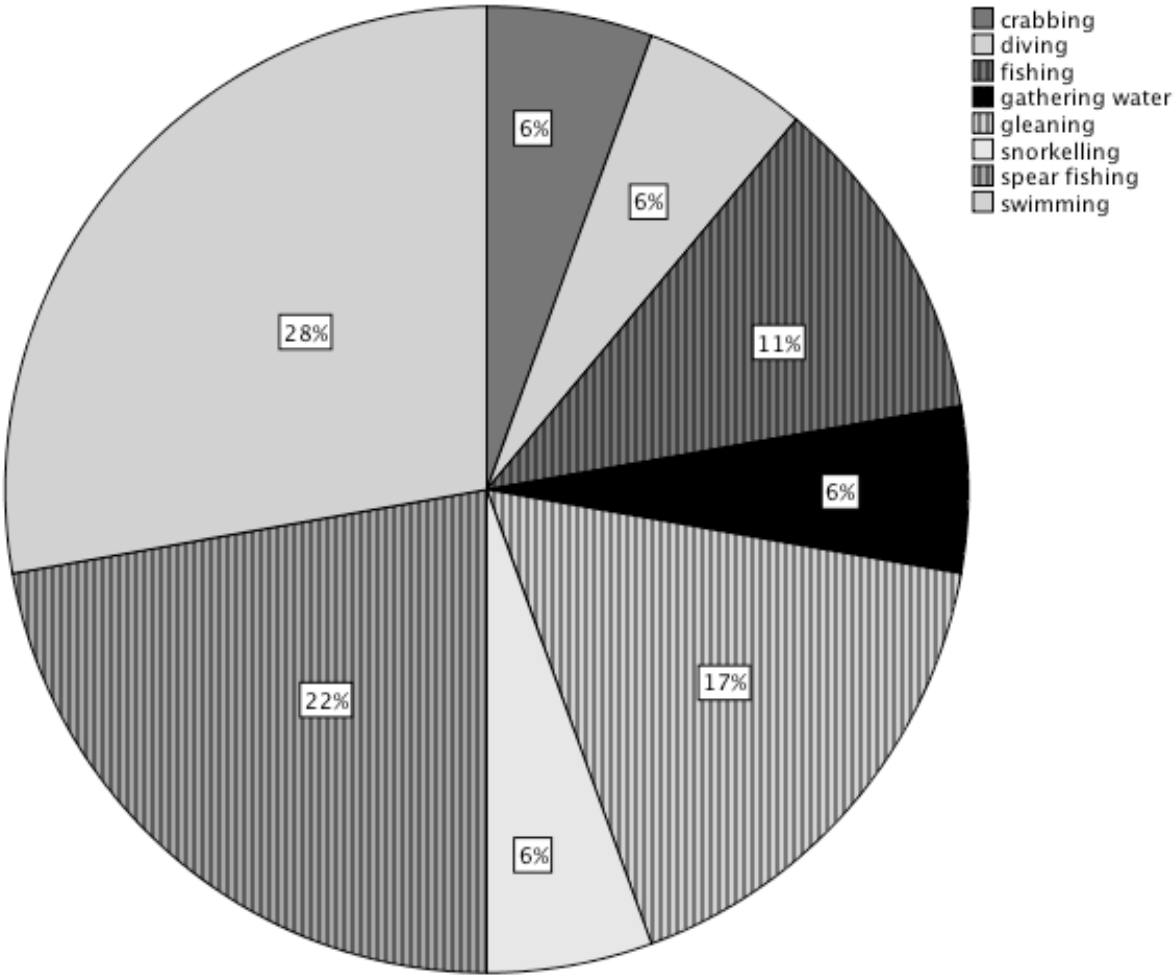

Figure 15: The frequency of participants' selection of their secondary activity on Maumi Estuary or Namata River.

All males primarily fished (100%) while females took part in a greater variety of activities on the water, including swimming and gleaning, with 71% of female participants identifying fishing as their primary activity.

Use of aquatic resources

The following data describe the temporal patterns of marine species collection or harvesting. Of the 18 participants, 44% had one person in their household who fished or collected seafood regularly, while 28% had two. Seafood or fish was prepared between two and three days a week by 55% of participants, with 28% preparing seafood or fish to eat once a week. Fish was more often sourced from the Maumi waterways (78%),

however other seafood was more commonly sourced from the local shops (67%). Fishing commonly occurred once (28%) or twice a week (33%) in the participant households and other seafood was collected or bought less frequently with just over half (56%) of participants acquiring seafood once a week, and 22% collected or bought seafood three times a week.

5.2.2 Section 2: Estuarine and marine habitats and species observed

Estuarine flora and fauna

Participants were asked to name species of flora and fauna that they found in the Maumi Estuary and Namata River environments. Qari (*Scylla serrata),* Pa'a se widri (*Lutjanus malabaricus*) and Mana (*Thalassina anomala*) were the most commonly identified species to inhabit the estuary (Table 1). Other commonly identified species included the fish, Kawakawa (*Epinephelus fuscoguttatus*) Saqaleka (*Caranx ignobilis*) and 'Kurukoto' (exact sp. unknown). A wide variety of other species ranging from vertebrates, fish species and other marine animals were identified less frequently by participants.

According to participants, various mangrove species dominated the flora found in close vicinity to the river and estuary. Of the 18 participants, seven identified Tiri selala (*Rhizophora selela)* and six identified Tiri Wai (*Rhizophora samoensis)* as the dominant mangrove species observed (Table 2). Danoa (*Canaga odorata*), Sangali (*Lumnitzera littorea*) and Dogo (*Bruguiera gymnorrhiza*) were the second most commonly identified plant species.

Table 4: Species of marine animals identified as being seen in or around the Maumi Estuary or Namata River are displayed with frequency of identification by survey participants, (n= 18).

Species local name	Species taxonomic name	Species common name	Frequency of identification
Qari	*Scylla serrata*	Mud crab	13
Pa'a se widri	*Lutjanus malabaricus*	Snapper	12
Mana, Tola	*Thalassina anomala*	Mud lobster	12
Saqa (gen.), Saqaleka	*Caranx ignobilis*	Great trevally	8
Kurukoto	exact species unknown		8
Kawakawa	*Epinephelus fuscoguttatus*	Sea bass	7
Nuqa, Volaca	*Siganus vermiculatus, S. spinus*	Spinefoot, rabbitfish	7
Sulawesi	*Uca dussumieri*	Fiddler crab	5
Moci, Uraura	*Palaemon concinnus*	Mangrove Prawns	5
Kake, Kwake	*Lutjanus monostigma*	Black-spot sea perch	4
Cebe, Kaikai	*Leiognathus equulus*	Ponyfish	4
Quitawa	exact species unknown	Zebra fish	4
Kabatia, Kabatiko	*Lethrinus harak*	Thumbprint emperor	3
Damu	*Lutjanus argentimaculatus*	Mangrove jack	3
Kanace, Sevou	*Valamugil seheli*	Blue-spot mullet	2
Ogo	*Sphyraena barracuda*	Barracuda	2
Vai			2
	exact species unknown	Sharks	2
	exact species unknown	Sea eels	2
Dadney	exact species unknown		1
Deururu	exact species unknown		1
Saku	*Tylosurus crocodilus*	Long tom	1
Retekau	exact species unknown		1
Draumitiri	exact species unknown		1
Drekerukuio	exact species unknown		1
Ki	*Upeneus vittatus*	Yellow-striped goatfish	1
Daru	exact species unknown		1
Ururu	exact species unknown		1
Kaikau	exact species unknown		1
Hebe	exact species unknown		1
Touisi	exact species unknown		1
Tanabe, Dadreu	*L. fulvus*	Red tail snapper	1
Molisa	*V. buchanani*	Blue-tail or Buchanan's mullet	1
Donu, Droudroua	*Plectropomus leopardus*	Coral trout	1
	exact species unknown	Oysters	1
	exact species unknown	Rays	1
Cio	exact species unknown		1

Table 5: Species of flora identified as being seen in or around the Maumi Estuary or Namata River are displayed with the frequency of identification by survey participants.

Local species name	Taxonomic species name	Common species name	Frequency of identification
Tiri selala	*Rhizophora selela*	Red Mangrove	7
Tiriwai	*Rhizophora samoensis*	Red Mangrove	6
Danoa	*Canaga odorata (Anonaceae)*		4
Sagali	*Lumnitzera littorea Rhizophoraceae:*		4
Dogo	*Bruguiera gymnorrhiza*	Black mangrove	4
Dabi	*Xylocarpus granatum*	Puzzlenut tree	3
Makosoi	*Canaga odorata (Anonaceae)*		1
Tarauwau	*Dracontomelon sylvestre (Anacardiaceae)*		1
Moli-unumi	*Rutaceae*	Guppy	1
Bua ini viti	*Rhizophora mucronata (Rhizophoraceae)*		1
Sinugaga	*Excaecaria agallocha (Euphorbiaceae)*		1
Coconut trees			1
Bilu			1
Vutu			1
Tavola			1
Mulomulo			1

5.2.3 Section 3: Observed changes to environment

Changes observed

Participants, in this section of the survey, provided their perceptions of a variety of environmental variables. They were asked to state whether they had witnessed any changes or variations in the 15 variables, providing yes or no responses. Eighty-three percent of participants declared that they had witnessed changes in the distribution of flora, with many commenting that mangrove removal for building and firewood was very common and in places, had increased the prevalence of run-off and sedimentation (Fig 16). Only 39% of participants spoke of changes in algal growth, which is often linked to increase run-off of pollutants into waterways. Changes in water clarity were

acknowledged by 83% of participants, with a variety of factors attributed to this including: vegetation removal, tidal variations, human disturbance and weather conditions. Changes in bathymetry of the estuary and riverbed were noticed by a large proportion (94%) of participants. The presence of run-off and pollution in the estuary was acknowledged by 89% and 72% respectively, many of who made reference to the use of the estuary as a rubbish dump and a depository for farming run-off and sediment. Participants believed there had been a change in the abundance of fish (67%) however only 33% believed there had been a change in other marine animals. Several participants noted a decrease in catch rate over the period they had been using the waterways. Over-fishing was considered quite common with 78% of participants admitting to having seen it or to being involved in it. However, fewer (33%) participants stated that they saw commercial fishing vessels in the area. Neither diving (6%) nor snorkeling (11%) were common activities undertaken in Maumi waters. Eighty-nine percent of participant thought that cyclones occurred on a regular basis with many claiming they happened every year. There was some discrepancy between cyclones and very strong wind. No participants brought to light any other natural processes that occurred in the area. It is interesting to note that scenic beauty remained highly rated at 67%, on a 1-10 point scale, despite such a range of human disturbances (Fig 16. Appendix 2).

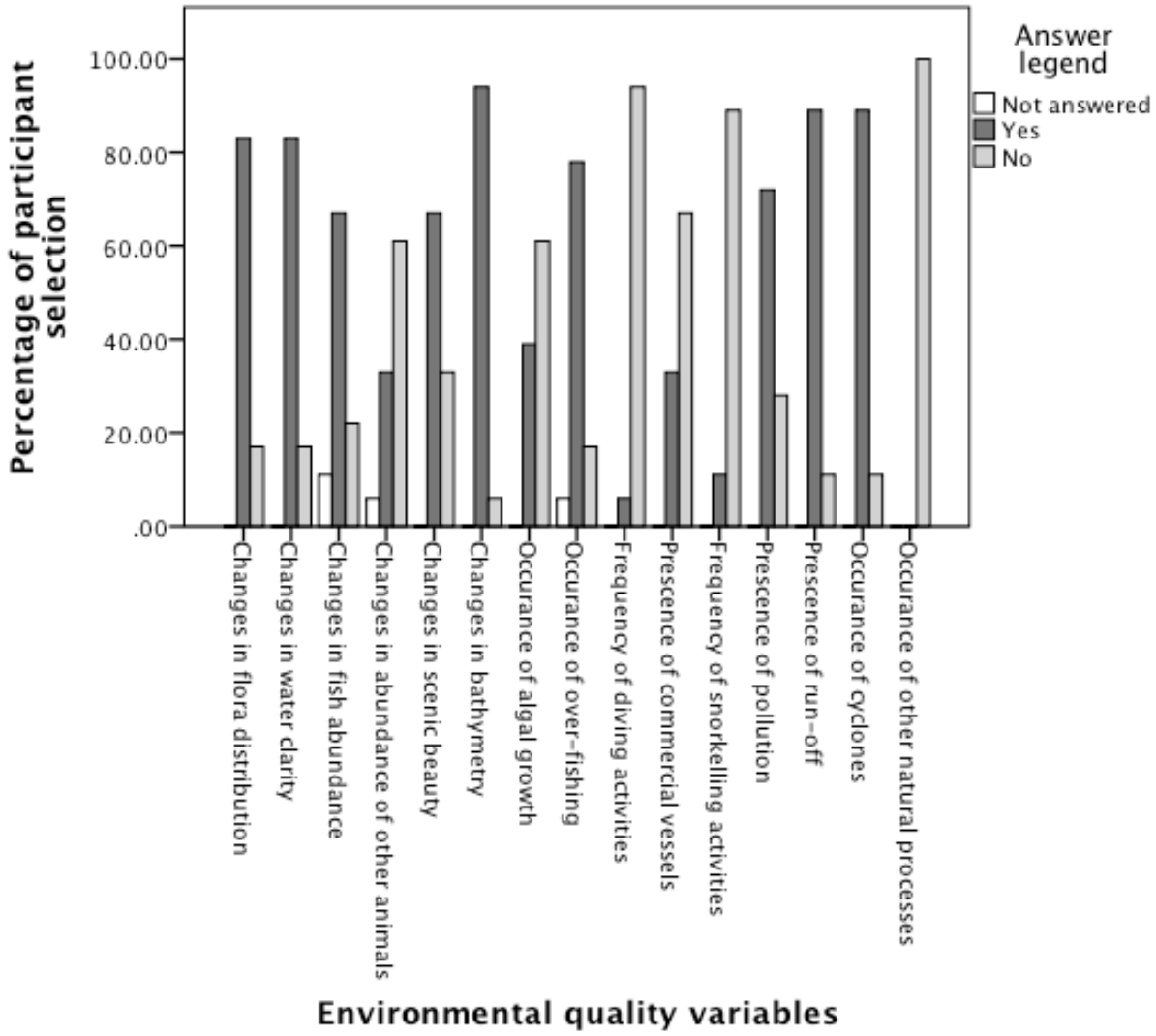

Figure 16: The percentage of participants that answered 'yes' or 'no' when asked if they had witnessed any changes to the 15 environmental variables.

5.2.4 Section 4: Social value of the estuary

Quality of the last site the participants visited

The following table represents a factor analysis of perceived quality, based on the level of influence of each variable on the perceived quality of the respondents last visited estuarine site, on the Namata River and Maumi Estuary. Mean scores for each variable were calculated over the 18 respondents to questions using a 10 point scale where 1 = very poor, 5 = average and 10 = outstanding. Factor domains were visual landscape, underwater landscape, access and shelter, and fish. Domain means were calculated

across variables in each domain and Cronbach's Alpha (Cronbach, 1951) was calculated as a test for reliability for each domain.

The respondents were asked to rate the last site in either the estuary or river that they visited for 10 perceived quality variables. The factor analysis allowed the reduction of the 10 variables into four groups or domains: visual landscape, underwater landscape, access and shelter, and fish (Table 6). These four groups explained seventy-six percent of the variance using PCA factor analysis with orthogonal varimax rotation.

Table 6: A factor analysis of perceived quality was based on the level of influence of each variable on perceived quality, measured from each respondents last visited site on the Namata River or Maumi Estuary.

Quality Variable	**Mean Score**	**Factor loading**	**% of total variance**	**Domain mean**	**Cronbach's Alpha**
Visual landscape			**23.38**	**7.65**	**0.77**
Scenic beauty	7.28	0.699			
Sunlight	8.50	0.867			
Current	7.17	0.855			
Underwater landscape			**19.22**	**4.42**	**0.80**
Water clarity	4.56	0.892			
Underwater topography	4.28	0.916			
Access and shelter			**17.36**	**7.09**	**0.64**
Access	6.17	0.725			
Shelter	7.89	0.669			
Presence of marine animals	7.22	0.775			
Fish			**16.54**	**5.36**	**0.70**
Number of fish	5.11	0.744			
Diversity of fish species	5.61	0.914			

The visual landscape domain, which was best represented by the variables "scenic beauty", "sunlight" and "current", explained more of the overall variance than the other three factors (23.38%). The sites that rated highest for this factor were found at the entrance of the Maumi Estuary and further upstream (Figure 17), however, several sites throughout the region rated high for this factor. Sites coloured in red had the highest factor scores, while sites coloured in green had the lowest (Figures 17 to 20). A higher

factor score does not necessarily imply a higher 1 to 10 quality rating, but in general, the higher scores did correspond to higher ratings (poor to outstanding) for the groups of variables in each domain.

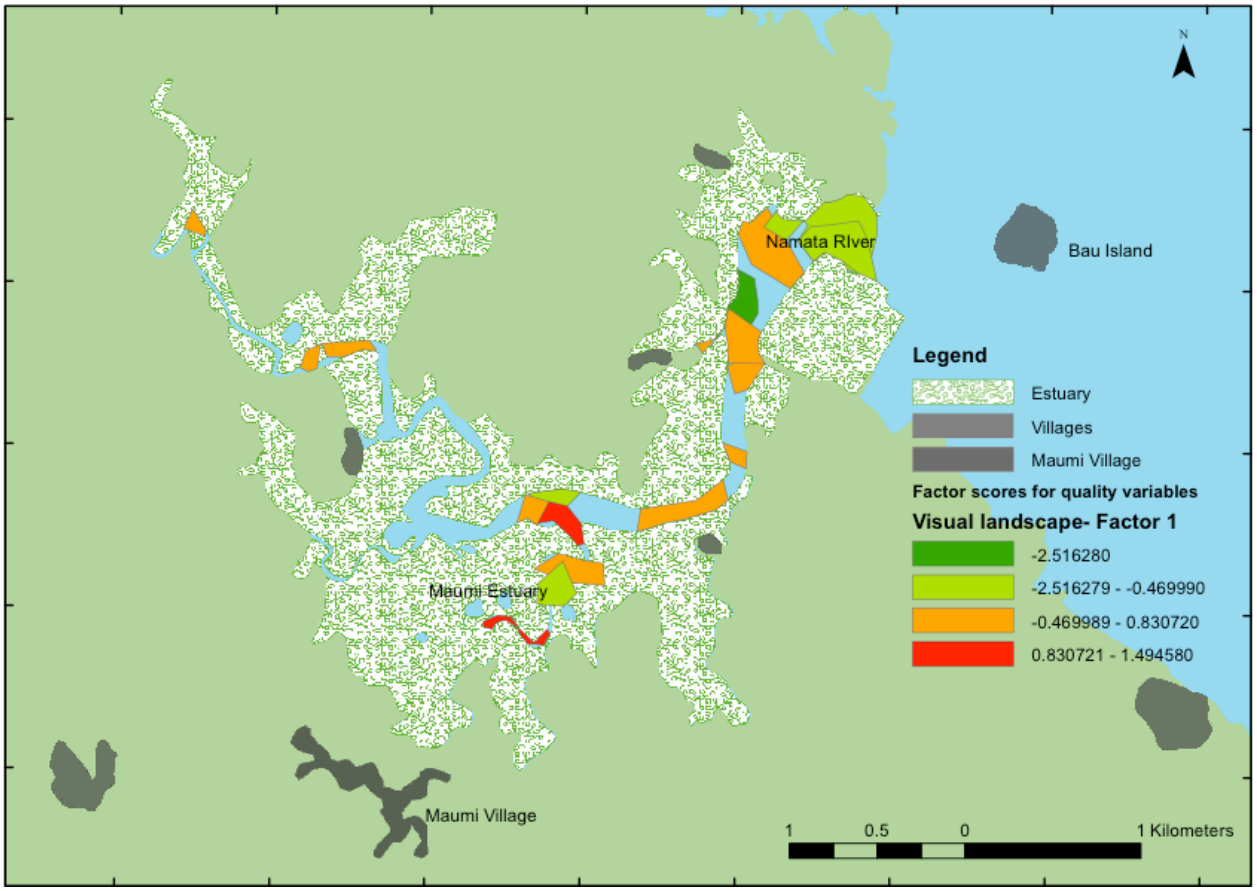

Figure 17: A map of the categorised mean factor score gauging visual perception of the landscape for each respondent's site (n=18 sites). Factor scores were classified into four categories in ArcGIS10 using the quantile classification method. On the map sites coloured in red had the highest factor scores, while sites coloured in green had the lowest (applies to figures 17 to 20).

The underwater landscape domain explained 19.22% of the overall variance. "Water clarity" and "underwater topography" both represented this domain. The sites nearest the mouth of the Namata River and along the Namata River were rated highest for this factor (Figure 18). Access and shelter explained a further 17.36% of the overall variance. The variables "access", "shelter" and "presence of marine animals" best describe this factor. Figure 19 shows that sites closer to the Maumi Village were rated higher for access and shelter to the estuary and river.

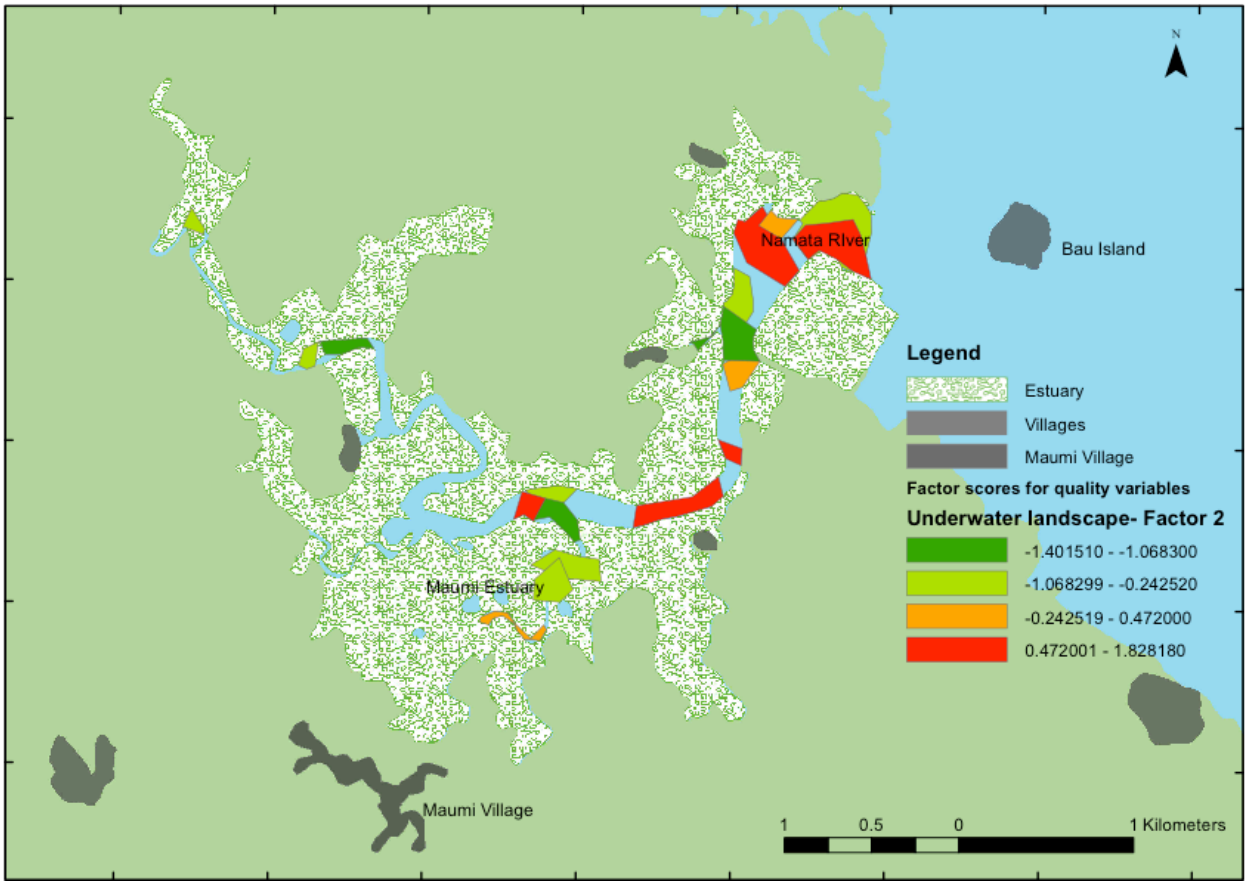

Figure 18: A map of the categorised mean factor scores gauging perception of the quality of the underwater landscape for each respondent's site (n=18 sites). Factor scores were classified into four categories in ArcGIS10 using quantile classification.

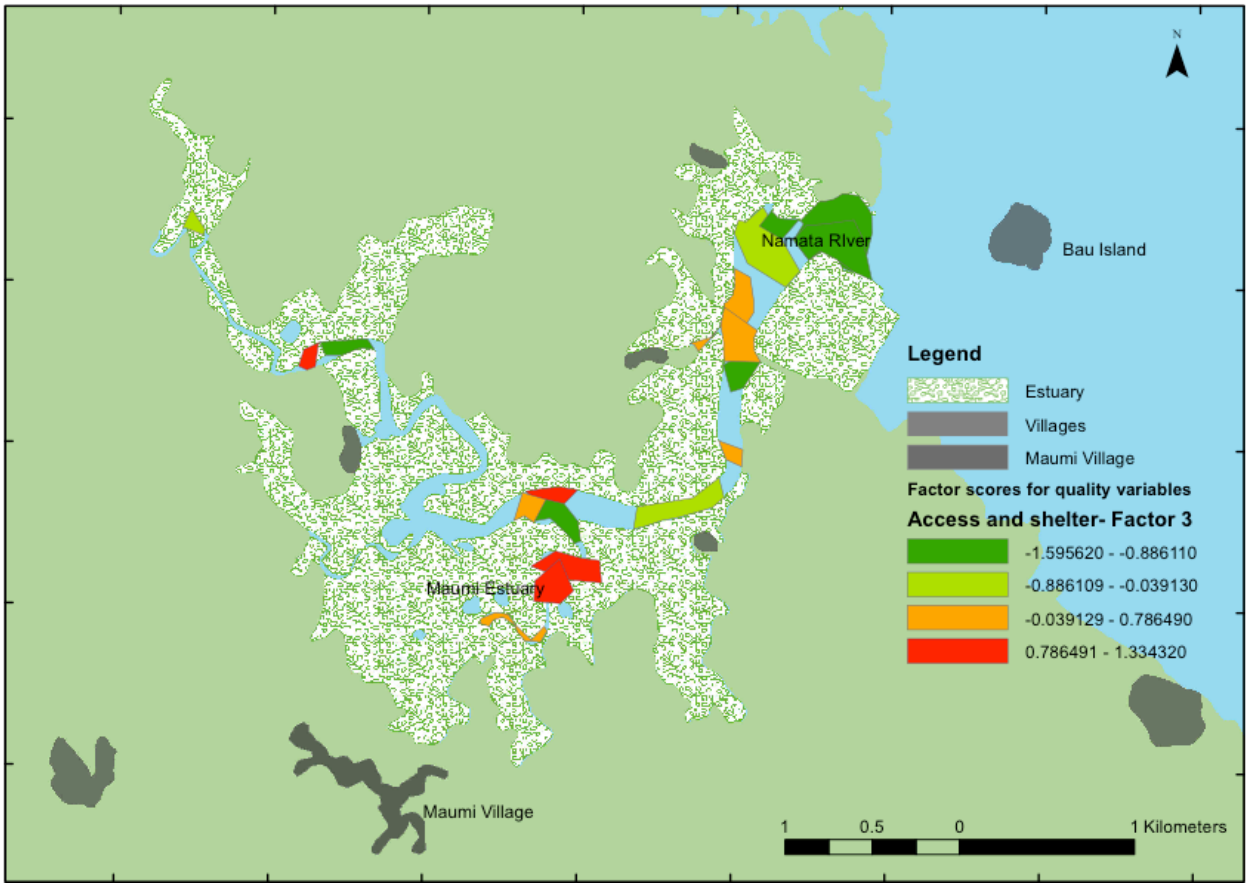

Figure 19: A map of the categorised mean factor scores gauging the perception of the quality of access and shelter of the landscape, for each respondent's site (n=18 sites). Factor scores were classified into four categories in ArcGIS10 using the quantile classification method.

Finally, the variables related to fish were found to explain 16.54% of the overall variance. "Diversity of fish species" was the most important variable in this factor in explaining the overall variance; however the number of fish also strongly contributed. The sites rated highest for fish are seen in the inner estuary near to Maumi Village, at the confluence where the Namata River meets the inner estuary and upstream from the Maumi Village (Figure 20).

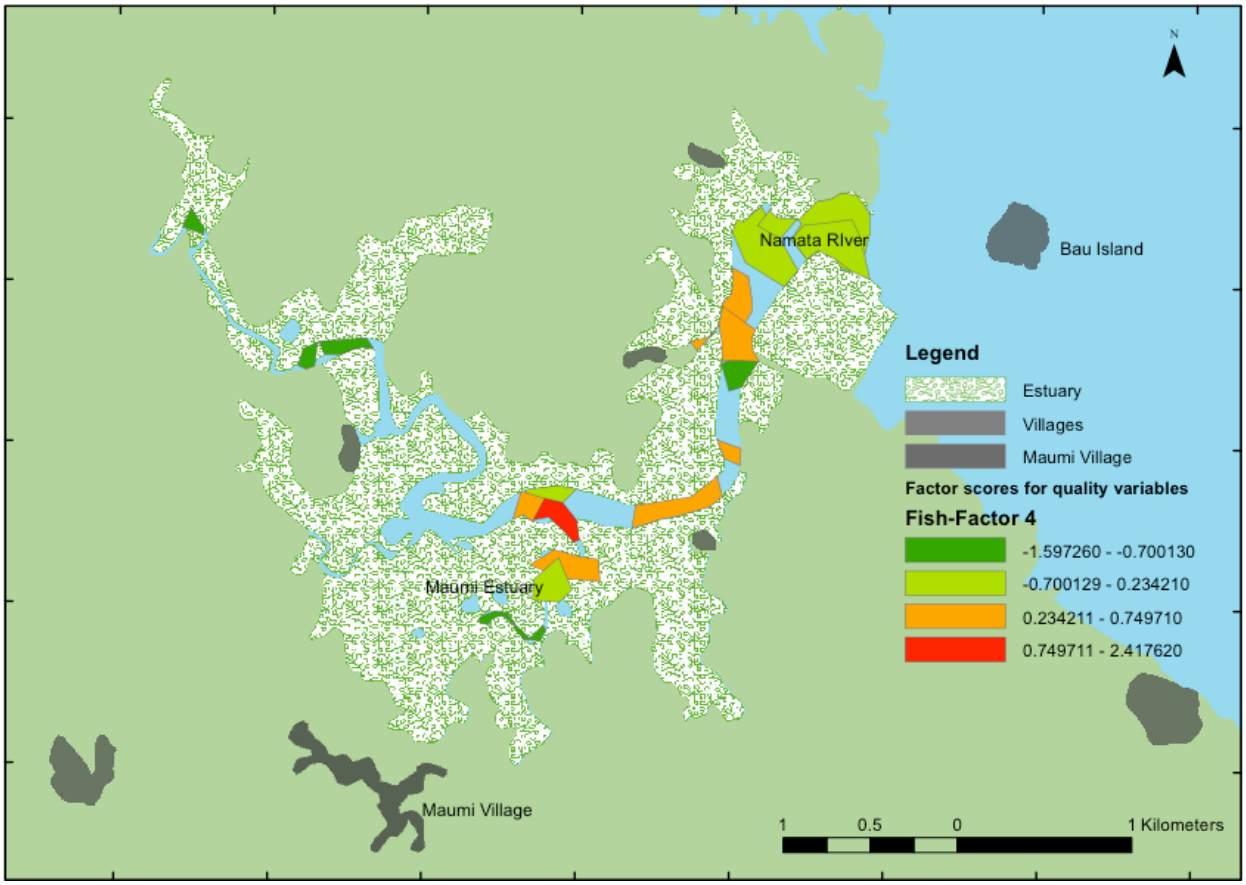

Figure 20: A map of the categorised mean factor scores gauging abundance and diversity of fish at each respondent's site (n=18 sites). Factor score were classified into four categories in ArcGIS10 using the quantile classification method.

Areas of social significance

Participants were asked to describe and label areas on the Maumi Estuary and Namata River that were of cultural, historical and personal significance to them. Each description was coded by theme and each theme was assigned a colour in order to be represented on the following maps.

Participants described areas of cultural significance in Figure 21. The areas chosen fell under the four cultural categories: colonial history, food harvesting, the old village site and taboo areas. The old village site was at the waters edge several decades ago and has since been moved to the ridgeline, looking over the estuary. It was explained that now the village has moved, villagers must travel further to collect food. Maumi Island situated in the middle of Maumi Estuary is a significant part of the history and culture

of the area, as the local people inhabited it in the past. The Namata area has been under cultural taboos in the past. When the chief of Bau Island died, fishing was prohibited as a sign of respect.

Areas of cultural significance were identified on maps and the results are shown in Figures 21, 22 and 23. These sites included the old village site and the site of the old bridge, which stretched from Maumi Island to the mainland and was declared to be the longest bridge in Fiji, during its time. Participants identified several burial grounds and an area of spiritual importance.

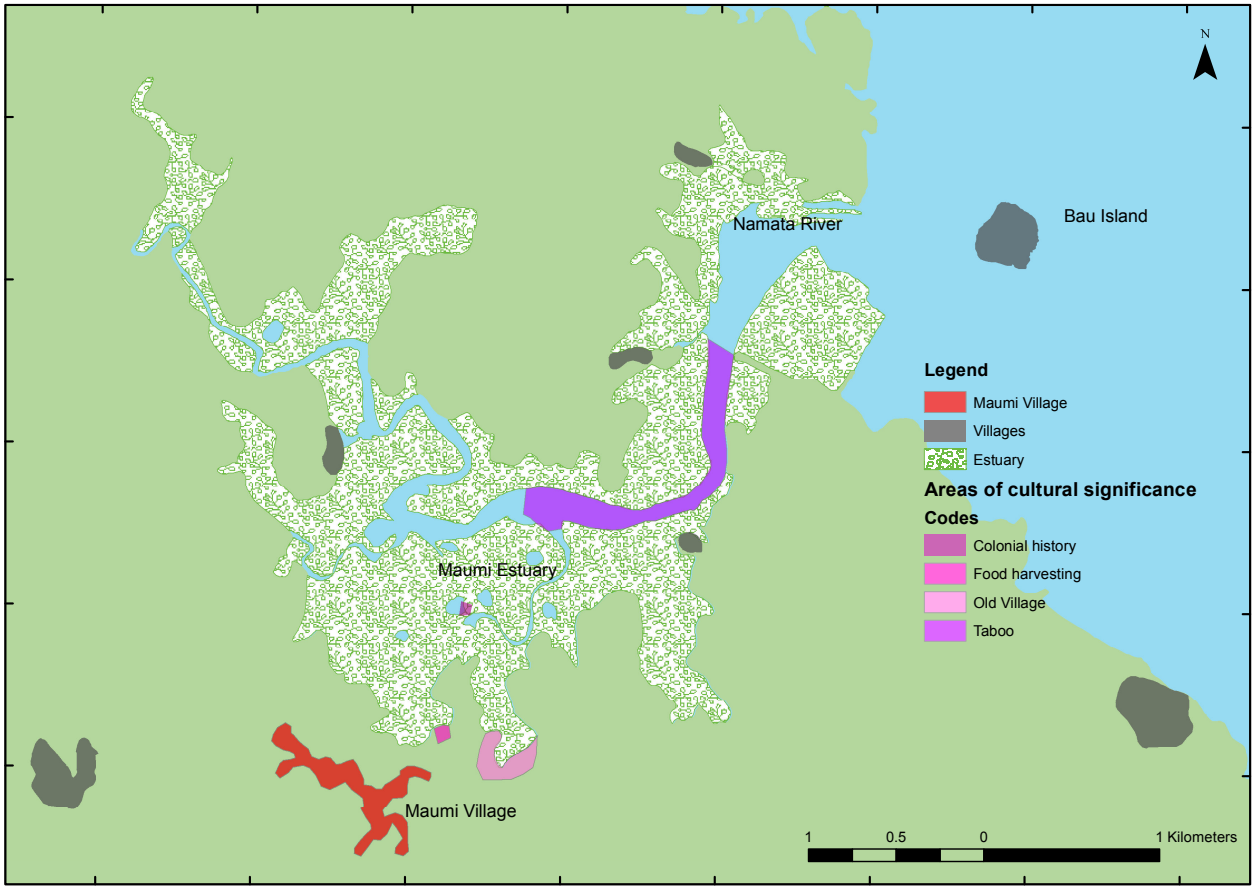

Figure 21: This figure categorises areas of cultural significance identified by interview participants.

Areas of historical significance included the old village site and burial grounds, the site of the old bridge connecting Maumi Island to the mainland and areas of spiritual significance that served as totems and places to connect with ancestors.

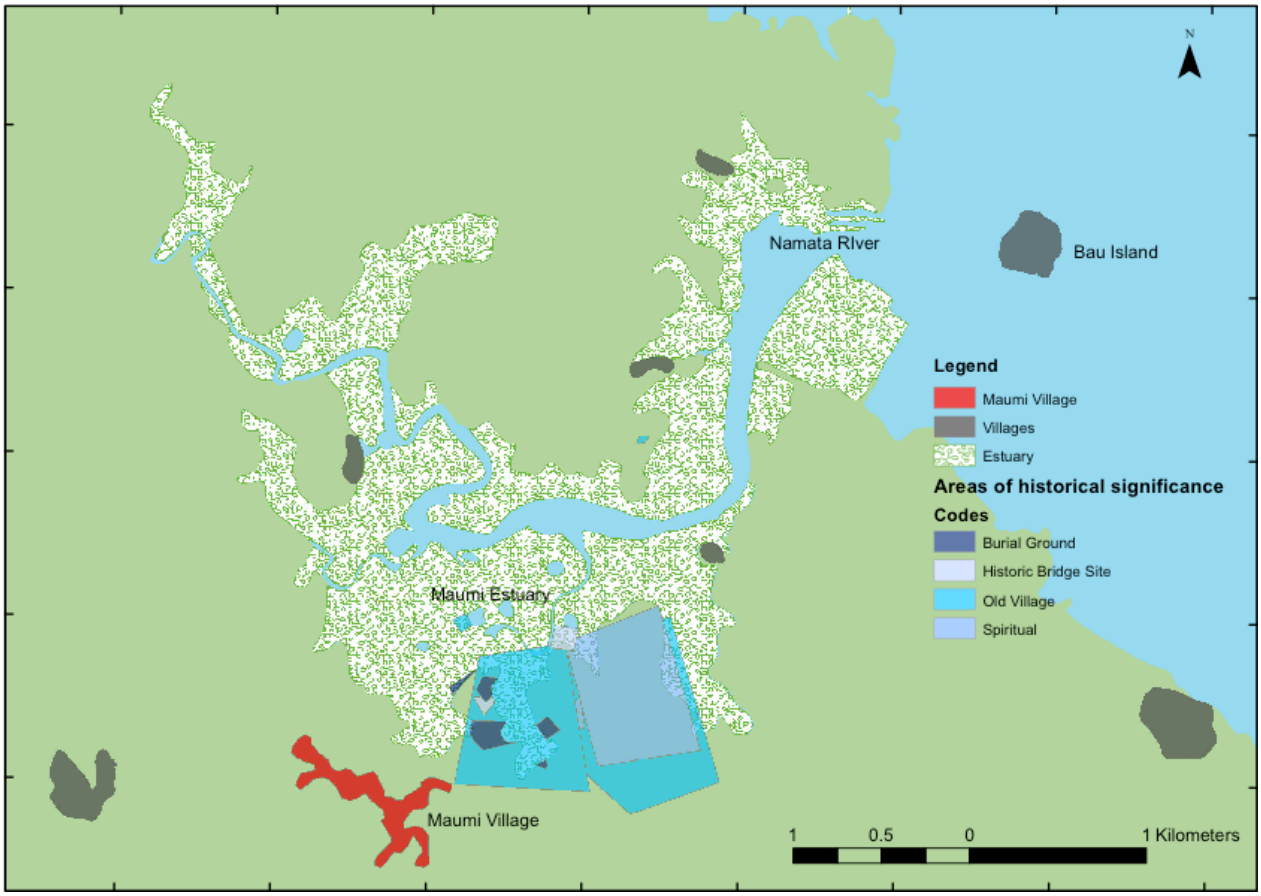

Figure 22: This figure categorises areas of historical significance identified by interview participants.

Areas of personal significance included burial grounds, areas used for "cultural harvesting" where the bark of mangrove trees was stripped for making traditional clothes and mats. Areas of food collection and harvest were used for farming, crabbing and fishing. An area marked for future use was designated for ecotourism development.

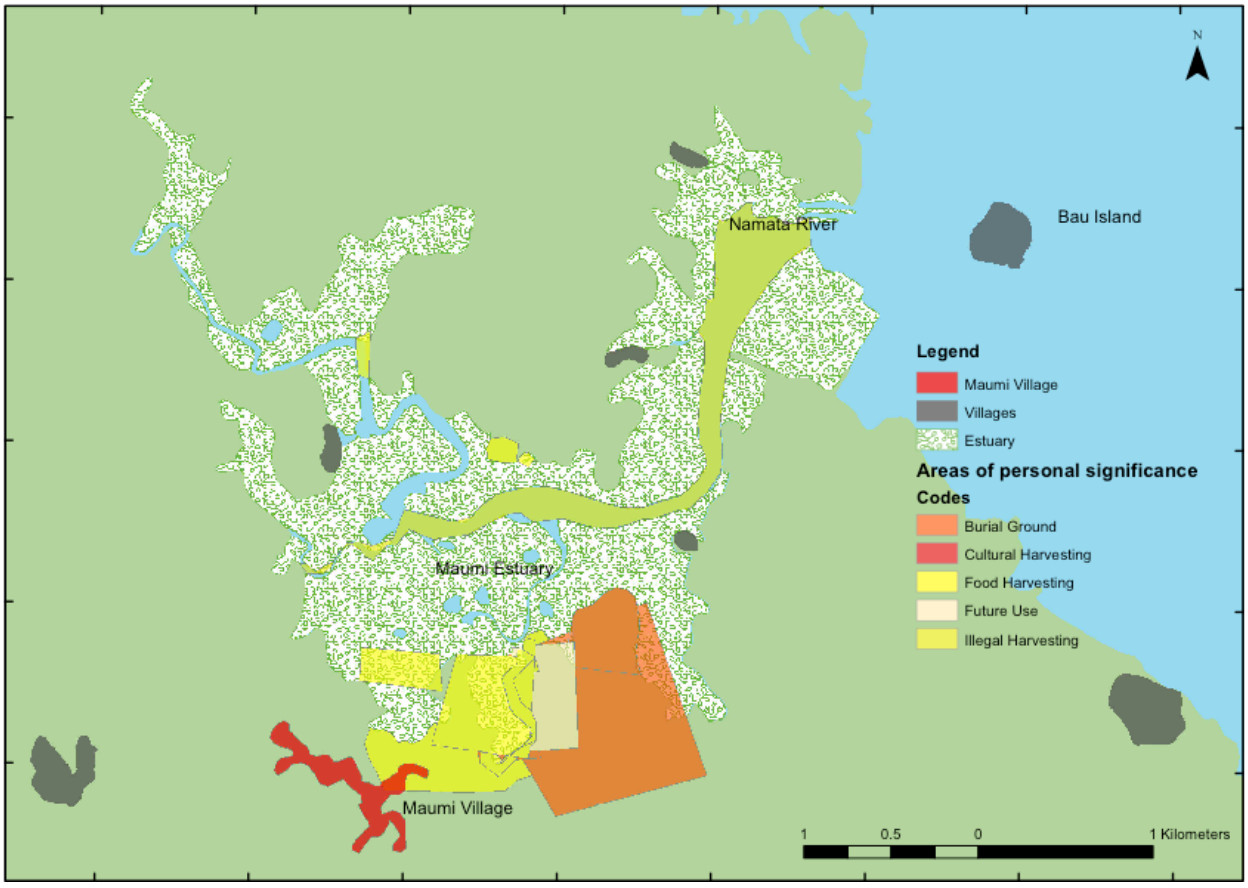

Figure 23: This figure categorises areas of personal significance identified by survey participants.

5.3 Semi-structured interview 2: Fishing practices and activities in Maumi Estuary and Namata River (Aim 2)

A sub-set of survey respondents from survey one volunteered to participate in the second survey. These individuals were asked to participate due to their extensive fishing and gleaning experience. In total, ten respondents participated in the second survey.

5.3.1 Section 1: Fishing areas and catch

Figure 24 shows the areas of fishing for the ten respondents involved with survey two. Most gleaning occurred in the Maumi Estuary and most fishing occurred in the Namata River and near the river mouth.

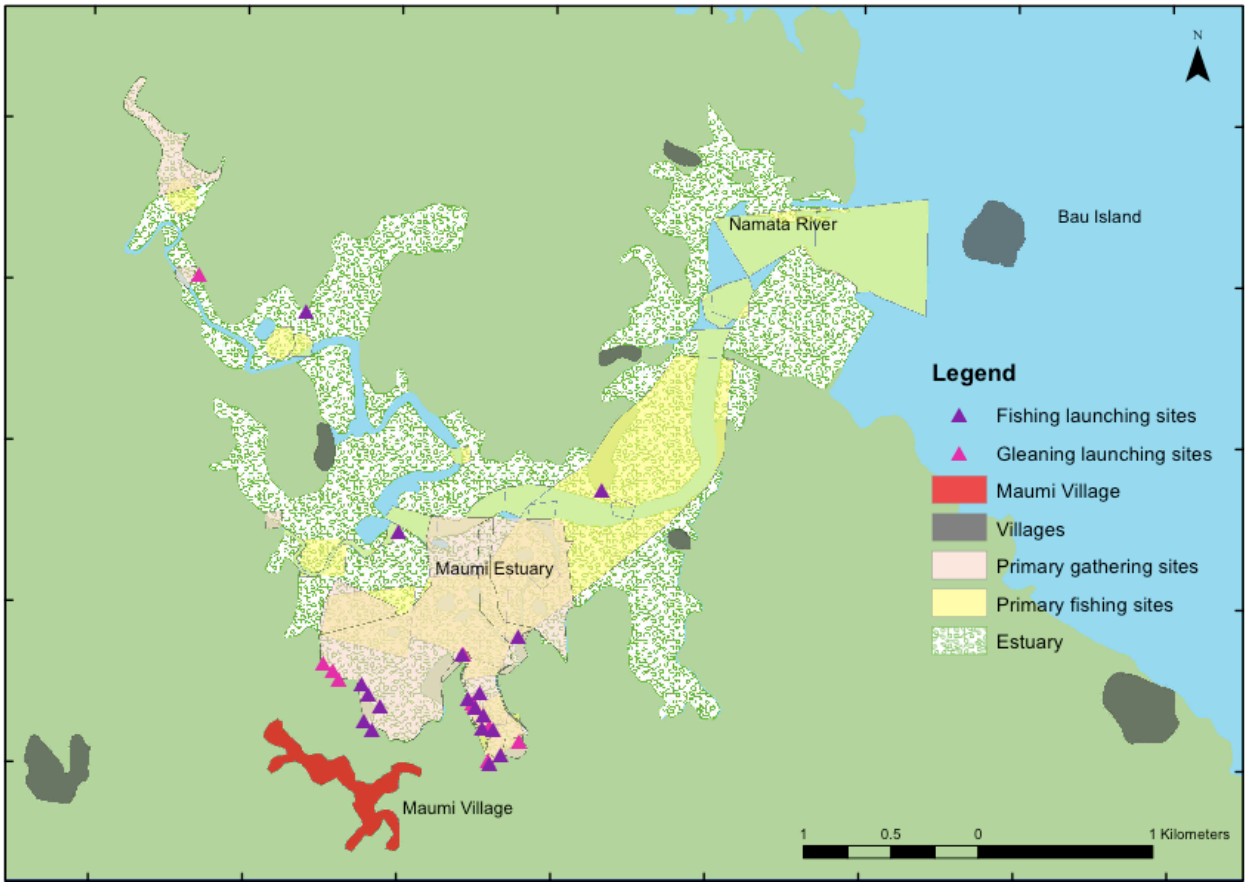

Figure 24: This figure depicts launching sites for both fishing and gleaning and most frequented sites for fishing and gleaning, as identified by interview participants.

A species list of all species the respondents caught at their most frequented fishing and gleaning sites is provided in Table 7. Most respondents reported catching snapper (*Lutjanus malabaricus),* mud crab (*Scylla serrata*), mud lobster (*Thalassina anomala)* and mangrove prawns (*Palaemon concinnus).*

Table 7: A table of species caught by interview participants at their most frequented fishing or gleaning site. Species are ranked by frequency and those highlighted in grey were the most commonly identified (by over 50% of participants).

Species local	Species taxanomic	Species common
Pa'a se widri	*Lutjanus malabaricus*	Snapper
Qari	*Scylla serrata*	Mud crab
Mana, tola	*Thalassina anomala*	Mud lobster
Nuqa, Volaca	*Siganus vermiculatus, S. spinus*	Spinefoot, rabbitfish
Moci, Uraura	Palaemon concinnus	Mangrove Prawns
Saqa (gen.), Saqaleka	*Caranx ignobilis*	Great trevally
Cebe, Kaikai	*Leiognathus equulus*	Ponyfish
Kawakawa	*Epinephelus fuscoguttatus*	Sea bass
Kurukoto		
Kabatia, Kabatiko	*Lethrinus harak*	Thumbprint emperor
Kanace, Sevou	*Valamugil seheli*	Blue-spot mullet
Quitawa	exact species unknown	Zebra fish
Kuka	exact species unknown	
Kake, Kwake	*Lutjanus monostigma*	Black-spot sea perch
Ogo	*Sphyraena barracuda*	Barracuda
Drekerukuio	exact species unknown	
Kaikau	exact species unknown	
Molisa	*V. buchanani*	Blue-tail or Buchanan's mullet
Donu, Droudroua	*Plectropomus leopardus*	Coral trout
	exact species unknown	Rays
Redrala	exact species unknown	
Dardreau	exact species unknown	
Daru	exact species unknown	
Draunatiri	exact species unknown	
Karace	exact species unknown	
Velu	exact species unknown	

5.3.2 Section 2: Fishing techniques and frequency

Section two of the second survey assessed the respondent's fishing technique and fishing frequency.

All of the respondents fish mainly used line fishing (Table 8). Participants also fished or gleaned using other methods including: spear fishing, netting and crab cages.

Table 8: A table of the main method used to fish and the frequency of participant selection.

Catch method	Frequency of method use
Line fishing	8
Crab cages	4
Netting	3
Spear fishing	1

The distance travelled to fishing area from each participants launch point, was recorded and categorised. Most participants claimed to travel up to 100m from their launch site to their most commonly frequented fishing site.

Table 9: The distances from shore, travelled by survey participants to their chosen fishing site.

Distance from shore (m)	Frequency of participant selection
15-30	1
30-50	0
50-100	6
100-300	1
300-600	3
600-900	1
900-1200	1
1200-1500	2
1500-1800	1
1800-2000	1

Figure 25 shows that of the 10 participants who responded to this question, five took 0-15min to catch their first fish, four took between 15 and 30min and two took over

100mins to do the same. Ninety percent of participants commonly achieve a catch of 0-30 fish.

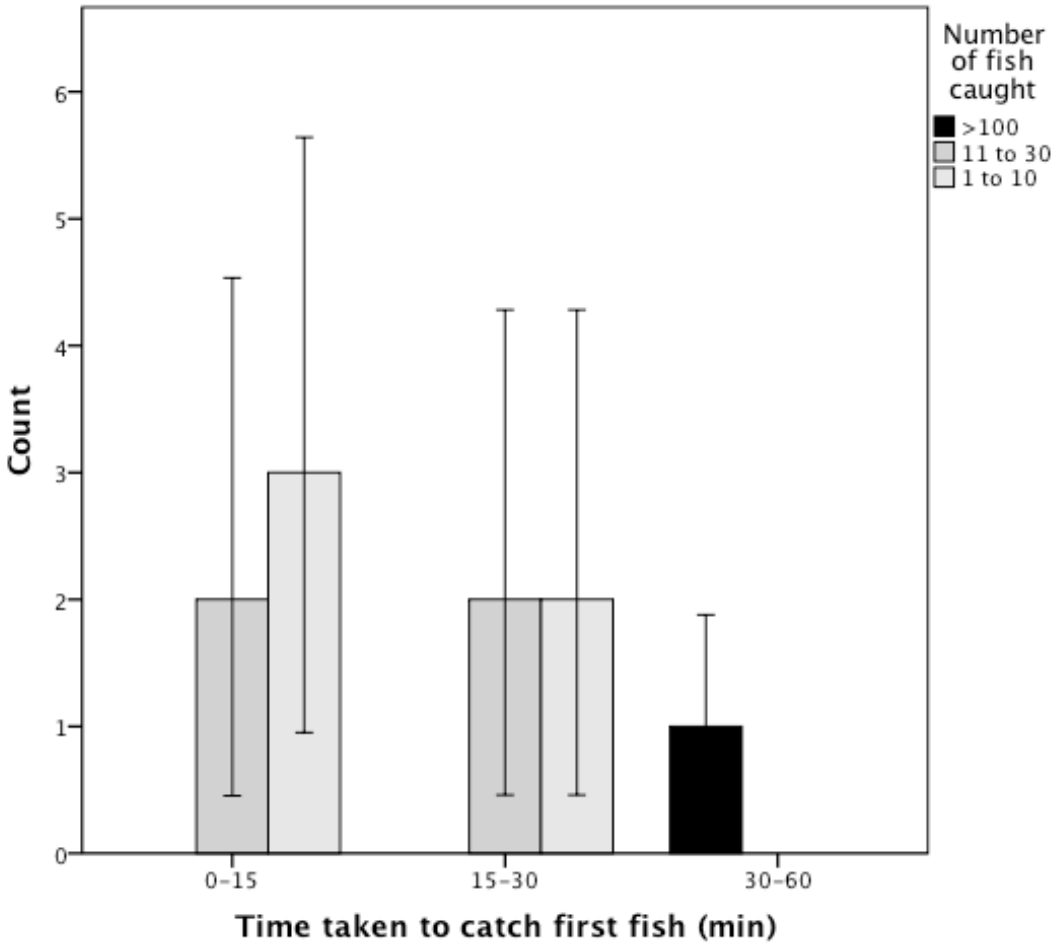

Figure 25: The time taken to catch the first fish using line fishing techniques, arranged by the number of fish caught, as indicated by a count of interview participants, with a 95% confidence interval.

Figure 26 shows that of the 8 participants who responded to this question, two took between 0-15 minutes to catch their first marine animal (mainly crabs), four took between 15 and 30 minutes and two took over 100 minutes to do the same. Seventy-five percent of participants commonly achieved a catch within 0-30 minutes.

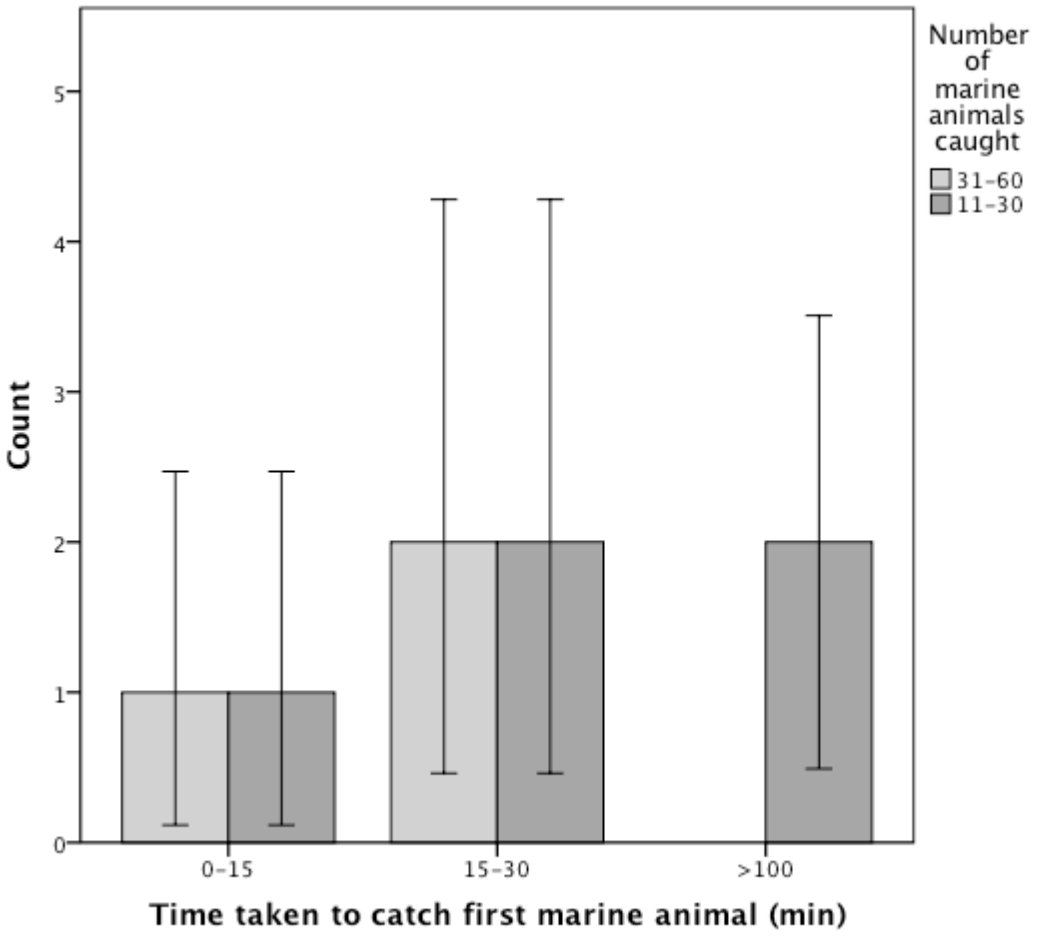

Figure 26: The time taken to catch the first marine animals using crabbing, gleaning and netting techniques, arranged by the number in each catch, as indicated by the count of interview participants.

5.3.3 Section 3: Perceived temporal changes in catch

Section 3 describes the temporal variation between fishing and gleaning activities from a multi-generational perspective. Of those respondents who answered, 60% claimed that fewer people fished' or gleaned compared to when their father fished and 50% of respondents indicated fewer people fished than in their grandfather's time.

Twenty percent of the survey participants owned boats. However, there were some inconsistencies with what qualified as a boat, as in Survey 1. The majority (91%) of participants' fathers or grandfathers did not own boats. Ninety-one percent of participants voiced that fewer people owned boats in their father's time, compared to

the present. All respondents indicated that fewer people owned boats in their grandfather's time.

Ninety-one and 100% of participants declared that there had been no change in the location of where they fished or gleaning respectively from when their mothers, fathers, grandmothers and grandfathers were fishers. The time taken to catch their first fish has steadily increased over the generations, with 73% of participants answering yes, when asked if their catch times had increased. When asked if the number of marine animal caught has decreased, increased or stayed the same, 90% of participants claimed that their catch size had either decreased or stayed the same compared to past generations. However, 64% of participants also declared that the number of trips they take to catch marine animals had decreased while 18% said trip frequency had remained the same. Thirty-six percent of survey participants had changed their fishing methods since their ancestors fished and gleaned. Fifty-five percent of participants also claimed to maintain the same fishing or gleaning routine that had been used by their fathers, mothers, grandfathers and grandmothers.

5.3.4 Section 4: Perceived spatial conflicts between users of the estuary and river

This following section addresses the frequency and presence of conflict on the estuary and river.

Participants were asked how often other people on the water were of benefit to the activity they were conducting. Of the ten people who answered 33% said that other people benefitted their activities every week, 17% said every month, while only 11% said that such occurrences benefitted them every day. Fifty percent of participants claimed that other people using the estuary and river while they were there, was

detrimental to their activities. Such disruptions occurred weekly for 39% of participants and 11% claimed that the presence of others was disruptive on a daily or monthly basis.

Participants were asked how often they encounter another vessel at their favourite site. Thirty-three percent admitted this occurred on a weekly basis however, only six percent claimed this happened either daily or monthly. Seventeen percent of participants stated that another vessel at their chosen site was seen less than twice a year.

Conflict on the water was experienced by 82% of respondents and, of those six percent experienced conflict on a daily or monthly basis, 18% on a weekly basis and 17% less than twice a year. Of respondents who answered the question asking what issues trigger water-based conflict 12% stated that the conflict experienced was over access to space and resources.

5.4 In situ fishing survey (Aim 3)

5.4.1 Catch attributes by survey site

The catch sizes varied widely throughout the sites. Fishing control site 2 and the netting site showed the greatest average catch of two fish. However, they also showed the greatest variation in catch. Five of the eleven sites had a catch rate of zero.

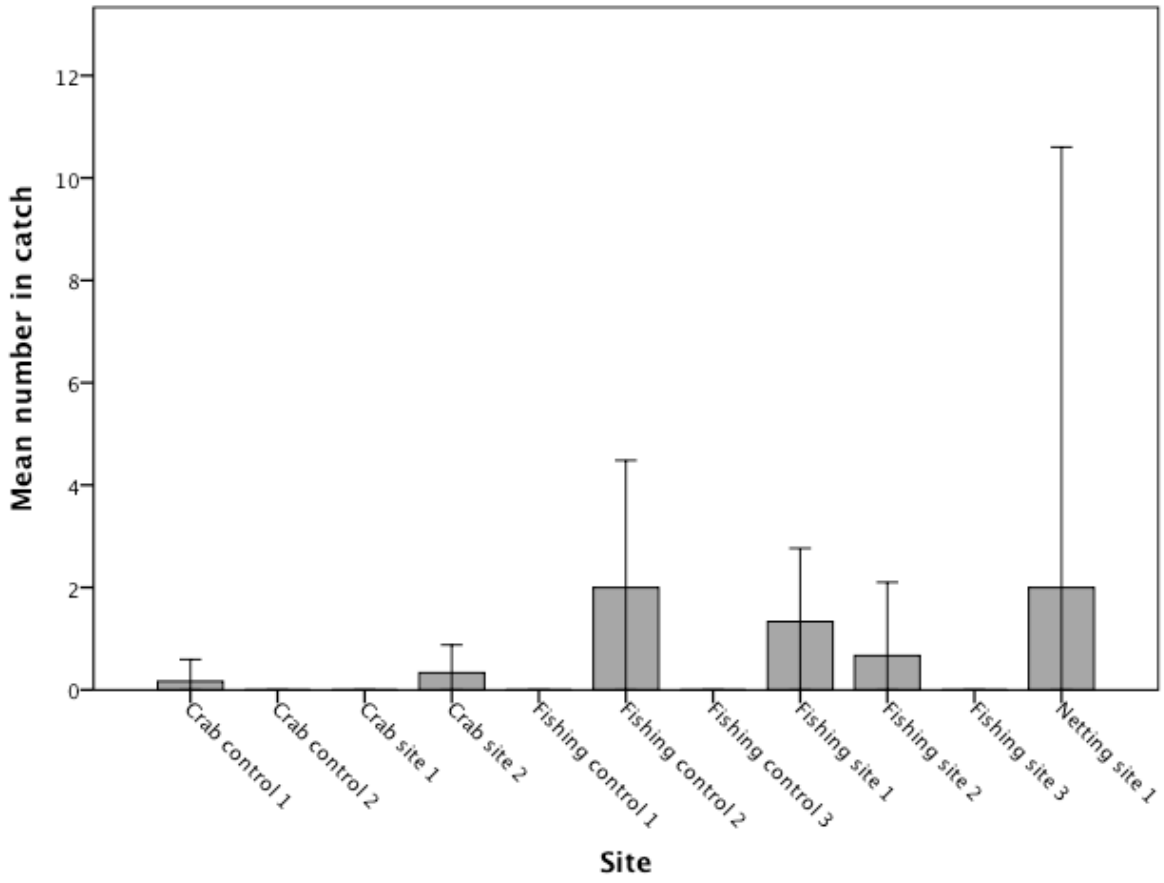

Figure 27: The average catch of marine organisms at each site, over the three days of data collection.

The number of marine organisms varied between sites and days (Figure 28). The crab traps were laid on the first day and the following three days were spent gathering catch data. On one of the four days, the netting site caught six fish but failed to catch anything on the other three days. Fishing control site 2 and fishing site 1 were the most consistent sites of the 11, where at least one fish was caught on each study day. At five of the sites nothing was caught over the three days (crabbing control site 2, crabbing site 1, fishing control site 1, fishing control site 3 and fishing site 3) (Figure 28).

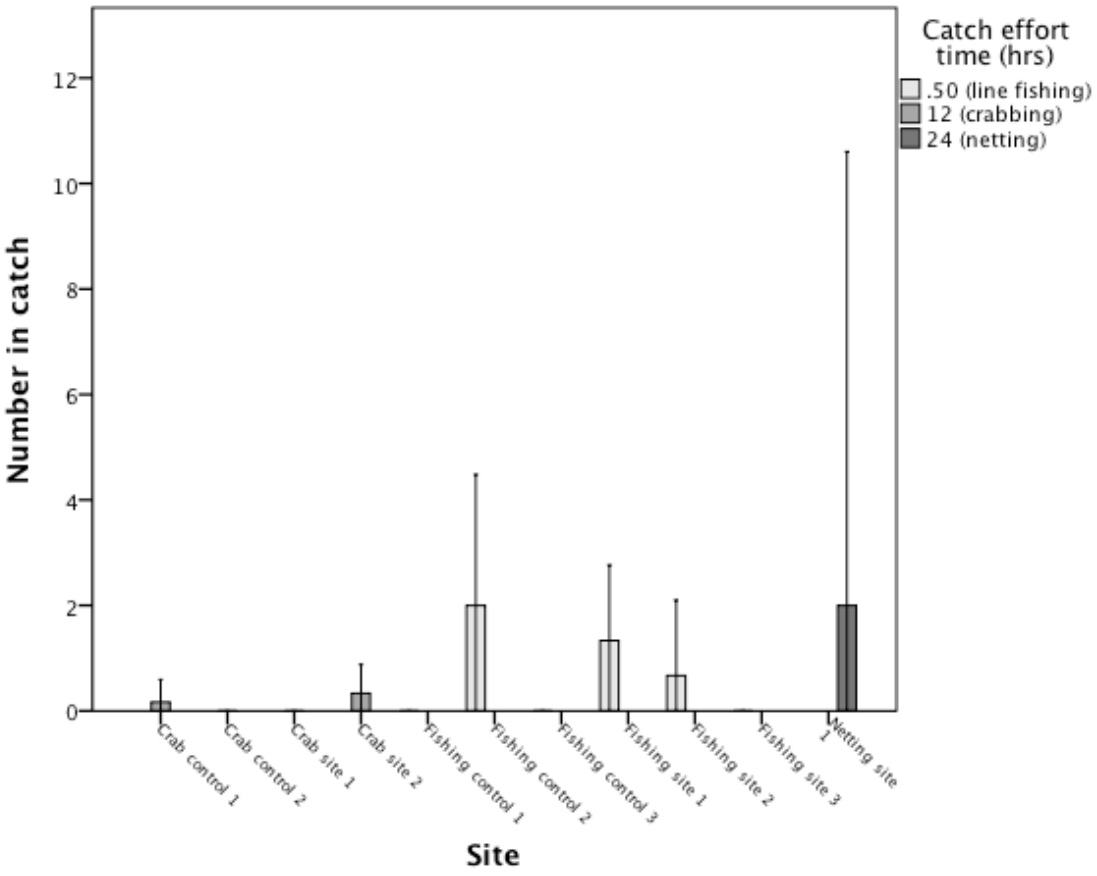

Figure 28: This graph displays the catch at each site arranged by the time spent at each site and method used.

Of the sites on Figure 28, only one species of marine animal was caught on any one day, with the exception being at the netting site. Five species were caught here on the day the site yielded a catch (Figures 29, 30 & 31).

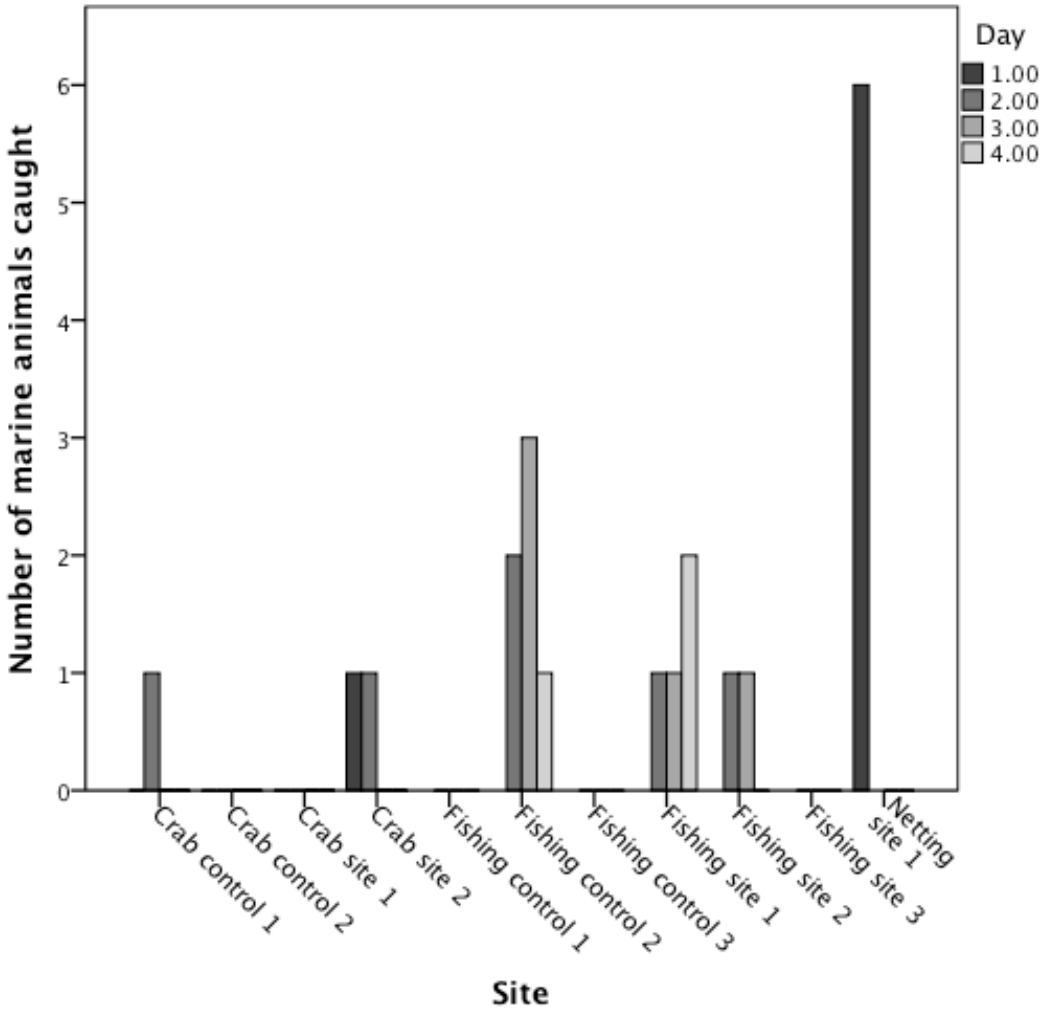

Figure 29: This graph shows the number of marine animals caught at each site over the three day study period.

Figure 30: Measurement of a mud crab caught during the fishing validation surveys. Source: Katie Shaw-Brown (7/9/2011).

Figure 31: A *Leiognathus equulus* (Ponyfish/Cebe) caught during the fishing validation surveys. Source: Katie Shaw-Brown (19/11/2011).

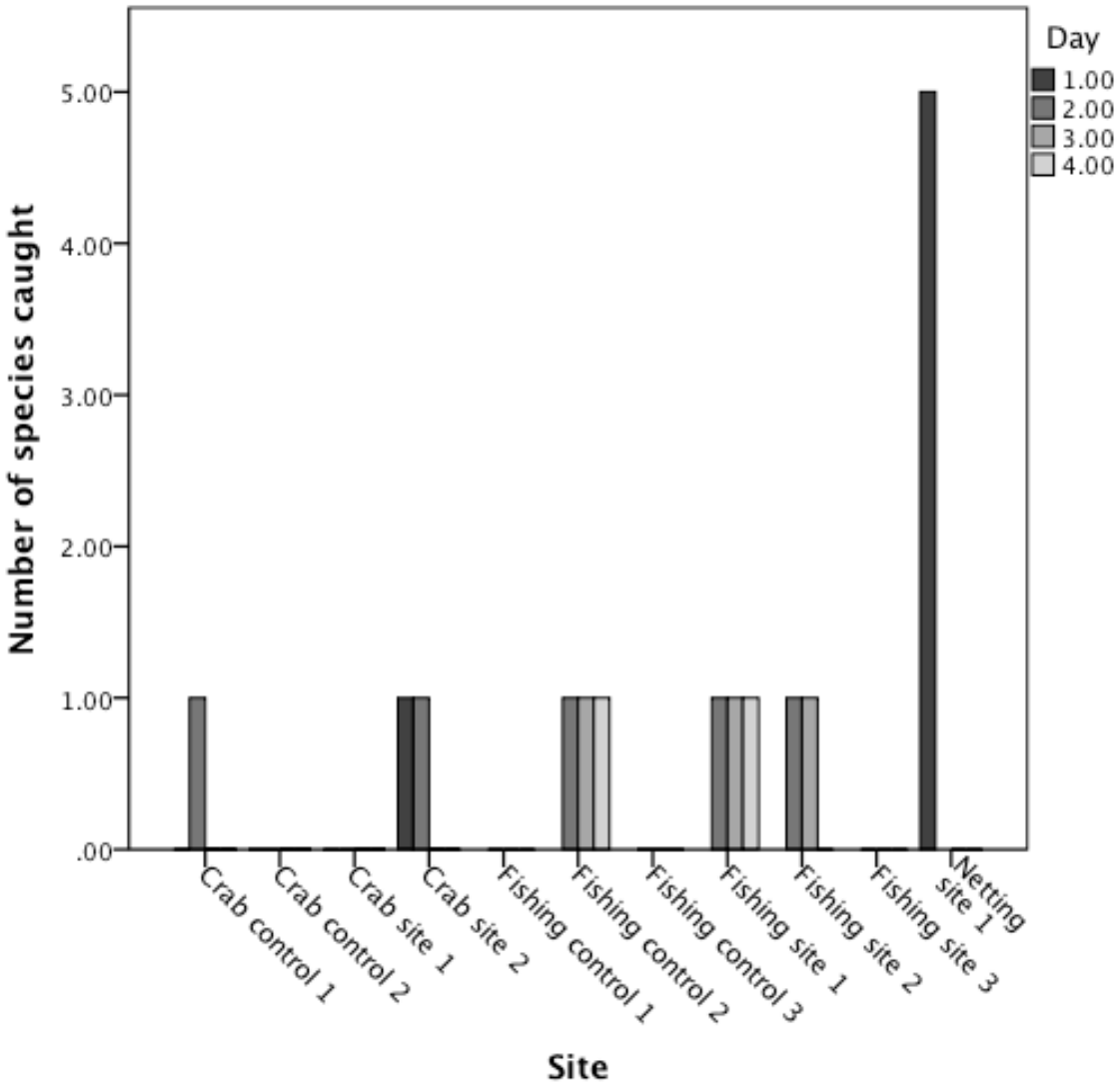

Figure 32: The number of species caught at each study site of the three day study period.

The catch per minute at all sites was remarkably low with the catch rate never exceeding 0.10 per/min at any site on any day (Figure 32). The highest catch rate was achieved at fishing control site 2 (0.1 per/min).

5.5 Comparative findings of in situ study and semi-structured interviews

The calculated fishing catch per minute from the fishing interviews and the catch per minute from the in situ fishing surveys are compared in Figure 33. The catch rates

varied between the in situ fishing survey and the interviews implying that interview participants over-estimated their actual catch rate.

The same trend is reflected in the Figure 35, which shows the same comparison for gleaning.

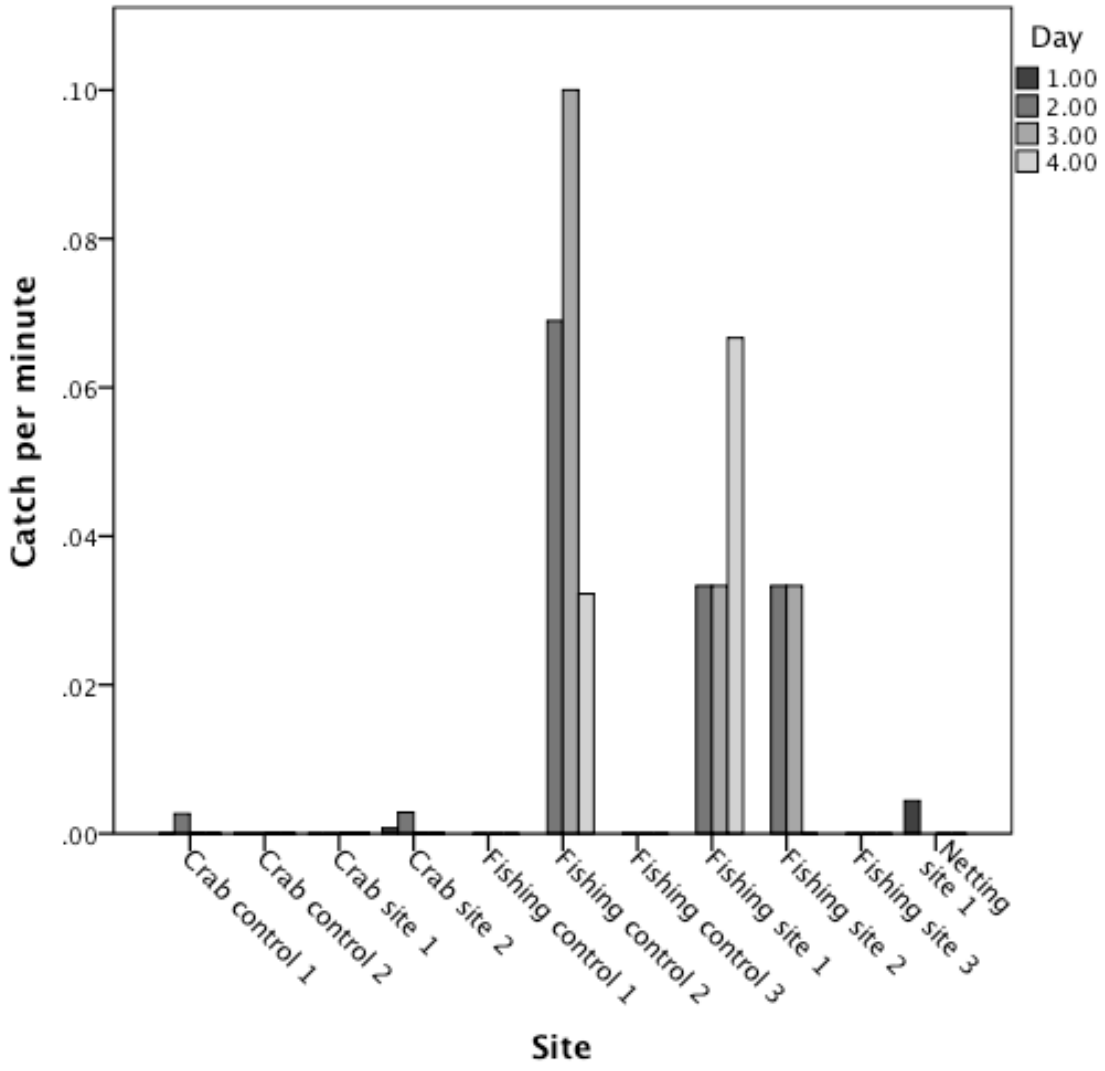

Figure 33: The catch per minute at each study site over the three day study period.

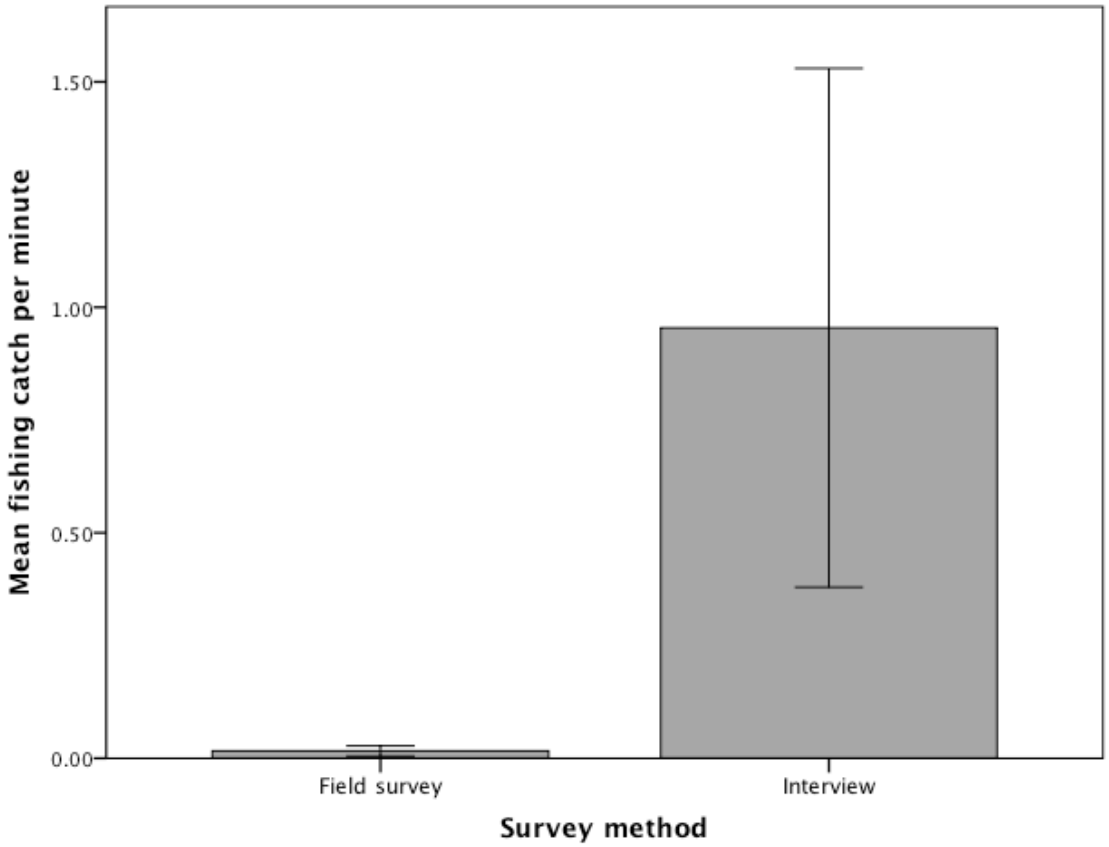

Figure 34: The catch per minute for fishing, from the in situ fishing surveys compared to the perceived catch per minute from the fisher interviews.

The following figure compares the perceived catch per minute from the in situ fishing surveys and from the interviews (Figure 35).

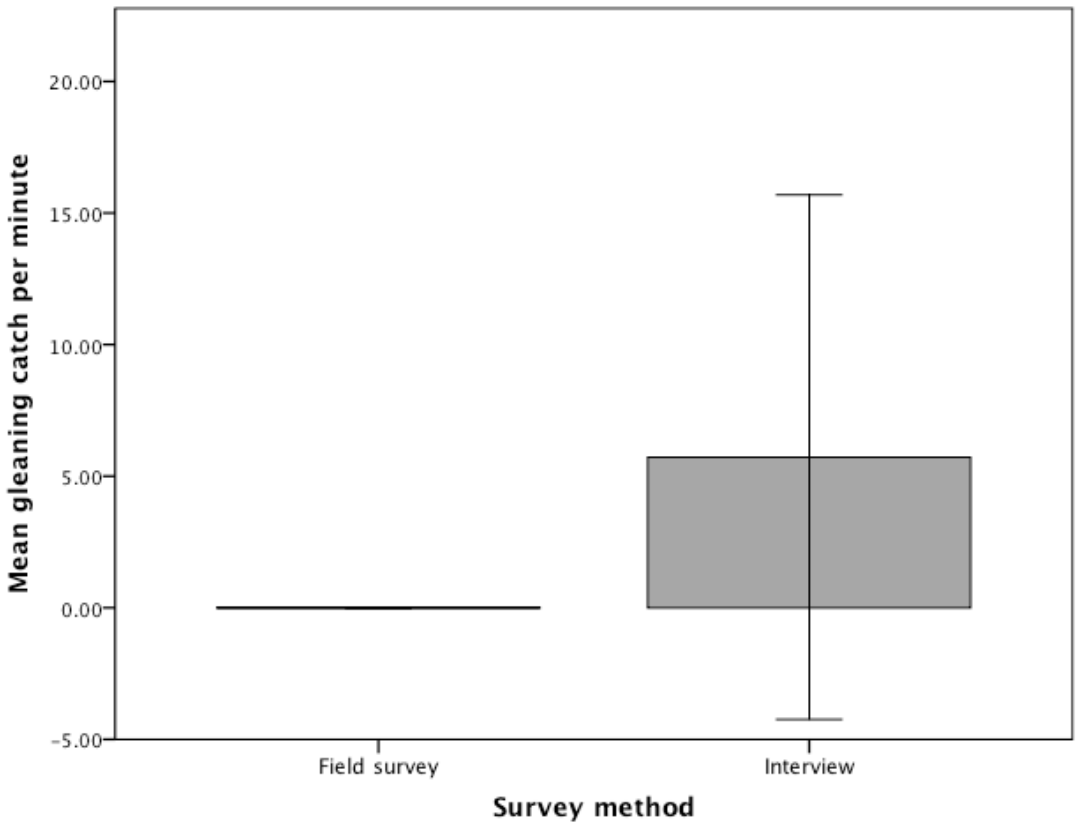

Figure 35: The actual catch per minute for gleaning, comparing the fishing validation surveys with the catch per minute data from the interviews.

This study found that the catch per minute rate described by the interview participants when gleaning, was not statistically different (sig.= 0.210, t=-1.405), from the data collected in during the in situ fishing surveys (Table 10). This implies that the perceived catch rates provided by the interview participants were an accurate reflection of the actual catch rates. However, it could be an artifact of the large variance (Figure 34).

Table 10: The independent samples t-test compares the distribution of catch per minute between the in situ fishing surveys (n=25) and the interviews (n=7).

Independent Samples Test

		F	Sig.	t	df	Sig. (2-tailed)
Gleaning	Equal variances assumed	21.927	.000	-2.777	30	.009
	Equal variances not assumed			-1.405	6.000	.210

The fishing study showed that the catch rate for fish described by the interview participants was significantly different (sig.=0.005, t=-3.632) from the catch rate experienced during the in situ fishing surveys (Table 11).

Table 11: This independent samples t-test compares the distribution of catch per minute between the in situ fishing surveys (n=25) and the interviews (n=11).

Independent Samples Test

		F	Sig.	t	df	Sig. (2-tailed)
Fishing	Equal variances assumed	48.739	.000	-5.576	34	.000
	Equal variances not assumed			-3.632	10.009	.005

Chapter 6: Discussion

In the following chapter, I explored the results in light of the aims of the study and the evolving marine management practices in Fiji (Chapter 3). I addressed the findings from the field surveys conducted in Maumi Village including the focus group, semi-structured interviews and the fishing validation study (Chapter 4). A critique of each of these approaches is offered, followed by a discussion of the findings in relation to the context of Maumi Village and the surrounding area. Furthermore, I discuss the cultural context of the research findings and their relationship to broader conservation principles.

6.1 Main findings

The current system governing resource use in isolated areas of Fiji is a combination of traditional and contemporary methods that encompass the needs of the local communities. The ability to understand the changes in the culture of resource use plays a pivotal role in determining the successes and failures of stakeholder engagement and, therefore, of resource management schemes in Fiji.

6.1.1 Local ecological knowledge of marine resources

The acknowledgement that traditional knowledge and the experiences of local people are a key component of ensuring effective environmental management has penetrated both science and management fields in recent decades (Cooke & Moce, 1995; Jennings & Polunin, 1996). The historical knowledge held in the minds of local people has the potential to enrich the knowledge of those non-local stakeholders in the present. Contemporary resource management needs to include these ideals. The extensive work of Johannes (2002) uncovered the potential failure of contemporary resource users to

comprehend a system of resource management employed by people whose perception of their environment differs from our own/the contemporary users/managers.

In the past resource use practices were less damaging, given low population densities and a greater focus on artisanal resource consumption. However societal and environmental changes have rendered such historic practices less relevant. This trend is mirrored in the findings of the following focus group and semi-structured interviews, carried out in Maumi Village. Many participants expressed concern over the increased demands on the natural environment from both commercial users and local subsistence users.

6.1.2 Focus group for understanding local marine management practices (Aim 2)

The six people who participated in this focus group were prominent local fishers, village leaders and their spouses. These individuals provided a depth and breadth of local knowledge of their area and were considered a source of reliable and significant information, representing the values and leaderships goals of the local community. Focus groups are widely used in community-based resource management to collaborate and discuss ideas and concepts, (Jupiter et al., 2011).

Coastal communities in Fiji are living in a convergence zone between technological and socioeconomic modernisation and a traditional culture with a strong indigenous social structure. Findings from the Maumi Village focus group indicate that the traditional resource governance method of fishing *tabu*, has been primarily initiated as a product of a cultural or social event. Even though it is often a social practice, they are an effective method of managing fish stocks. Such practices are not commonly used today, but other social and cultural vessels such as religion, could be used to encourage conservation

outcomes. Religious belief systems are a significant part of Fijian society and are an effective way of passing on information and ideas. Several studies have investigated the role of religion in promoting conservation in developing nations (Sharma, Rikhari, & Palni, 1999; Tomalin, 2004).

Encouraging conservation and marine resource management is not only important at a local level. It is also important to ensure the value of the natural environment is reflected and enforced through regional government bodies. In some areas of Fiji, the local people have become bystanders to the governance of their marine resources, as government officials and external experts have become the dominant decision makers. Often, the traditional owners and those with traditional fishing rights are then prescribed ways in which to utilise their own resources. In other situations, there is much skepticism regarding government incentives, as there is lack of understanding and communication (Hooper, 2000). The state of local resources and local enthusiasm towards their management are often negatively affected by the commonly short lifetime of fisheries and environmental development projects that have been introduced with the aim of increasing productivity, employment and economic profits (Hooper, 2000). Often projects struggle to meet goals, when there is a lack of community involvement and integration of socio-cultural perspectives (Veitayaki, 1997). This commonly leads to a sense of failure within the targeted communities and therefore a similar lack of enthusiasm for future projects. Combating these challenges forms a fundamental goal of community-based management as this model aims to produce solutions to resource management with the full involvement of stakeholders, encouraging a sense of ownership and therefore improving the longevity of management initiatives. This community-based model inspired this study and the involvement of the local community in my research.

The current management and governance of Maumi Estuary and Namata River reflect, on a micro-scale, the challenges currently facing Fijian resource management. Inadequate catchment management, over-fishing, population growth, increasing industrial development, coastal development and mangrove removal are all issues that affect environmental conservation in Fiji and affect the daily lives of those people living in the Namata area. The local Maumi people acknowledge that their actions are damaging the local environment. However, a lack of infrastructure in place to manage such issues and enforce resource restrictions continues to inhibit sustainable development practices.

The LMMA network in Fiji has also described similar challenges it has experienced in the establishment and maintenance of community-based marine management programmes (UNDP, 2012). The ability of communities to enforce the marine resource restrictions against poachers and unlicensed fishers remains a major constraint. At some sites the lack of authority over poaching has led to local people loosing motivation and faith in the management practice, as others gain the rewards of their hard work (UNDP, 2012). Legal recognition of community-managed marine areas needs to be strengthened. The government had gazetted only one site in 2009 (UNDP, 2012). At this site fish wardens had been trained and given legal power to arrest offenders.

Inconsistent support from local and regional authorities limits the effectiveness of many LMMAs in Fiji. Village wardens often struggle to carry out enforcement duties due to lack of resources. Many LMMA villages believe access to motorised patrol boats to be a keystone in the effective management of marine areas (UNDP, 2012). In instances where villages have a marine patrol boat, operation is often limited by maintenance and fueling costs of the vessel. Only sanctioned fish wardens can take offenders to police and, therefore in some cases traditional forms of punishment such as public shaming

may be inflicted (UNPD, 2012). However, reluctance by official agencies to become involved in LMMA enforcement inhibits the effectiveness of such disciplinary strategies (UNDP, 2012). The establishment of new inshore fisheries legislation establishing clearer regulations, harsher fines and the increase of support for local wardens in *tabu* areas are hoped to improve the situation (UNDP, 2012).

Study participants had the impression that the government controled the waterways around Maumi Village and therefore any activity conducted on the waterways was at the government's discretion. This perception could be a product of limited understanding of current governance systems, fueled by ineffective top-down communication or a result of ground-root experiences with government agencies and representatives. There are restrictions in the form of fishing licences and limits to the size of fish allowed to be caught. Currently, fishers must attain a licence from the Fisheries Department, in order to fish within a specific *qoliqoli* and those from outside the area must obtain the permission of the local Chief, in order to minimise disputes (Teh, Starkhouse, & Rashid Sumaila, 2009). The Fisheries Department seeks permission from qoliqoli owners before associated permits are issued to outside fishers (Teh, Starkhouse, & Rashid Sumaila, 2009). In the Maumi Village these restrictions were often not adhered too, as such limitations impacted heavily on the livelihoods of the local people in relation to their ability to acquire food for consumption and sale. Enforcement and monitoring of such laws were also very infrequent.

Between 1981 and 1995 the average annual number of recorded fishers in Fiji reached 3964 prior to a drop between 2004 and 2011 down to 1888. These figures apply to those with a fishing licence and not those who gain permission directly from the local chief or those who fish in their own *qoliqol*i (Teh, Starkhouse, & Rashid Sumaila, 2009). A study conducted in the province of Macuata (Vanua Levu) revealed that most of the

fishers did not have licences, due the high cost (FJ $650) and the long and complicated application process, (Veitayaki,1998, 2000; Veitayaki, Aalbersberg, Tawake, Rupeni & Tabunakawai, 2003). Clearly such activities are not limited to Maumi villagers.

The exploitation of fisheries in Fiji involves a variety of sectors, including, subsistence, artisanal, aquaculture, recreational and industrial, each varying in characteristics, purpose and associated issues (Hooper, 2000). Fijian communities are slowly beginning to address the ecological issues associated with the decrease in resources. Their approach includes various ways to create a more sustainable fishery and improve habits of resource use through the integration of traditional, community-based resource use methods and contemporary frameworks (Weeks et al., 2010).

This bottom-up movement towards local resource sustainability has also encouraged interest in the development of sustainable resource management programmes in the Maumi Village area. Despite the social and economic impact of current restrictions on the use of the local waterways, the Maumi people still regard the current management scheme as a positive move towards conserving the environment. Most focus group participants wished to establish an MPA in their local area in order to increase the size and population of fish, encourage economic stability and maintain the natural resources for future generations. However, the geography of the area was predicted to hinder the effectiveness of such management measures. If an MPA was to be established, the Maumi Village's distance from the river and estuary would hinder the capacity for local monitoring and enforcement.

6.1.3 Semi-structured interview 1: Estuary interactions and ideas survey: an investigation of activities, knowledge and perceptions associated with Maumi Estuary and Namata River (Aim 2)

Participant selection

The participant group used for the interview provided a sub-sample of the Maumi Village adult population. The participants comprised a group with an older, educated demographic, with 50% of participants over 50 years and over 50% having at least attended high school. As a group they provided a greater knowledge base from which to collect information. Most participants understood basic environmental concepts and the experiences of many participants offered detailed and temporally broad responses throughout the interview process. This allowed for the collection of information about the activities and ideals of current and past generations at a local scale. A larger study group that included people from surrounding villages would have provided a stronger representation of the local population. A study of other stakeholders, including commercial users of the local waterways would also have offered a more holistic view of resource use in the area and the pressures on the marine environment.

Findings

The Fijian marine environment and its marine resources are under threats from various sources including unsustainable fisheries practices, development activities and pollution. Inshore areas are continually bombarded with over-fishing, poaching, inadequate equipment use and fish poisoning, whereas offshore, illegal, unreported and unregulated fishing continues (Jupiter & Egli, 2011). Development often causes more unique issues, such as coastal reclamation, sand dredging, siltation and drainage, sometimes driven by land clearing for agriculture, and often causes more and unique issues such as the resulting deforestation and erosion. These characteristics are reflected in the findings of the following interviews. Many participants reported pollution,

overfishing and increased run-off, as a result of vegetation removal, to be major impacts on the local marine populations.

Compounding the effects, population growth and urbanisation have oblique effects on the degradation of the marine environment. MPAs have been used as a fundamental tool in the toolkit of integrated management and are an important contributor to the sustainable development movement (Techera & Troniak, 2009).

Several issues relating to the local environmental conditions of the Maumi waterways and estuary were raised during the interview process. Pollution, increased sedimentation and over-fishing are all processes known to have a detrimental effect on fish stocks (Kellert et al., 2000; Veitayaki, 2000). An observation was made by participants that mangrove removal was increasing the rate of sedimentation and run-off. It was indicated that mangrove removal was conducted by both the local residents and outside developers. Water clarity was said to be declining and a combination of human driven activities such as vegetation removal and natural processes such as tidal variations and weather, affected clarity. Changes in bathymetry were heavily attributed to vegetation removal along the water's edge, as the depth and width of the water channels was said to have decreased. The dumping of rubbish, farming run-off and sedimentation caused by vegetation removal contribute greatly to the noticeable levels of pollution in the waterways. This pollution affects the health and growth of marine species and therefore the communities that rely on those marine species for food.

During the interviews, participants identified a range of marine species. Mud crab (*Scylla serrata),* snapper (*Lutjanus malabaricus)* and mud lobster (*Thalassina anomala)* were the most commonly identified. These species are the most commonly targeted food sources of the Maumi Village people.

Participants also reported a reduction in catch rates and number of fish in the waterways. Many participants either admitted to over-fishing or to knowing others who overfished in the area, despite government restrictions on catch sizes. The growing local demand for fish has led to a decline in fish stocks throughout populated coastal areas such as Tailevu, where Maumi Village is situated. Between 1996 and 2002 there was an increase in fishing pressure driven by high fish prices, which caused a decline in catch rates. However, a study conducted by Jennings and Pounin (1996), revealed that catch rates at remote *qoliqoli* sites did not vary significantly over a 20-year period. An estimate of the weight of annual subsistence catches by Zann and Vuki was 17000 tonne (1997) which vary from Gillett and Lightfoot's estimate of 12600 tonne (2002), revealing the inadequacy and unreliability of catch estimation methods due to the lack of monitoring (Teh et al., 2009; Gillett & Lightfoot, 2001; Vuki, Zann, Naqasima & Vuki, 2000).

Increased exploitation driven by high fish prices has led to rapidly depleting marine resources around Fiji's coastal regions. In Tailevu, the Maumi people also remarked on the increasing number of commercial vessels seen along the coast, but rarely at the head of the river. The sustainable use of marine resources is a major challenge for Fiji. Increasing economic demands drive the desire for increased capacity and productivity, then fish numbers drop to uneconomic levels. This is characteristic of the boom/bust cycles demonstrated in Fiji (Johannes, 1989; Munro & Fakahau, 1993).

The attitude of a population toward their natural resources will invariably affect their behaviour and therefore natural resource and management outcomes. The attitude of individuals or a population is influenced by the popular worldview and the concepts surrounding it (Tuivavalagi, 2002). Worldviews and concepts need to be considered when acting as environmental development and management practitioners. Those views

of the resident population that are being served, personal views and those of others in the professional team need to be considered (Farrelly, 2010). In much of Fiji, native Fijians have adopted Christianity, which has a worldview promoting humans as stewards of the natural environment instead of worshippers and consumers (Tuivavalagi, 2002). Other religions and faiths, such as Hinduism, in Fiji need to be considered when designing environmental strategies and implementing projects, in order to find the most appropriate cultural balance for the affected stakeholders.

Recognising the importance of the variety of human-environment relationships is vital to developing a greater awareness of the implications and responses to environmental sustainability and management in Fiji. Further understanding of how relationships are negotiated in local settings and social structures is also required. Understanding the new hybridisations of the merging worldviews in Fiji will aid in the durability and sustainability of environmental initiatives at all scales. These worldviews need to be considered and utilised in the development of resource management initiatives. They were investigated in this study through an analysis of environmental perception of Maumi Village participants.

Despite such heavy human disturbance to the environment, scenic beauty was still rated highly among the participants. An analysis of quality variables was performed using data gathered from participants, revealing that the quality of the 'Visual landscape' was rated highly compared to the quality of the 'Underwater landscape', 'Access and shelter' and 'Fish'. The sites of the highest quality varied on a spatial scale; however the sites situated at the confluence of the Namata River and Maumi Estuary were consistently labeled high quality sites in each category. This area is more open; the current is stronger; there are no villages in the immediate vicinity of these sites and the

mangrove forest grows densely along the river edge. All these factors aid in the perceptions of the local people. All of these factors would increase the number and diversity of marine species, as this area is the first point of entry for fish into the estuary, from the main river channel, for feeding and breeding.

Areas of social significance were noted by participants to provide information on the values of the local people and whether there was a geographical pattern associated with them. Areas of cultural significance were primarily marked within the waterways of the Maumi Estuary and Namata River, yet areas noted as being of personal or historical significance were primarily land-based. Therefore, cultural values would be of greatest influence in the decision making of the Maumi people, when designing and implementing an MPA or marine management program in the area.

6.1.4 Semi-structured interview 2: Fishing practices and activities in Namata River and Maumi Estuary (Aim 2)

Participant selection

A subset of ten experienced fishers participated in the following survey, which gathered detailed information on fishing and gleaning practices in the local area. Despite being a smaller group of participants this more experienced group allowed for the collection more reliable data.

Fewer people in the Maumi Village are fishing compared to two generations ago. Many have shifted their focus to land-based agriculture, growing vegetables and farming small herds of cattle. This is a product of decreasing catch rates. However, the increased vegetation removal and chemical use associated with intensified agriculture will have further contributed to marine habitat degradation. In Fiji, between 1981 and 2005 registered fishing vessel numbers peaked at 2112 and slumped to a low of 727 in 2004

(FAO, 2005). In 2003, it was estimated that 2137 artisanal inshore fishers and 3000 subsistence fishers gained employment through the fisheries sector (FAO, 2005). The true number of subsistence fishers is unknown. The FAO has indicated that there are 3000 subsistence fishers in Fiji and half of all rural households partake in subsistence fishing (FAO, 2010). How these statistics were calculated is unknown.

Findings

There was clear distinction between the spatial distribution of gleaning sites and those marked as fishing sites, by participants. Gleaning sites were closer to the village and were contained within the estuary, as most gleaning is conducted on foot in the shallows where crustaceans burrow, so such sites are naturally within comfortable walking distance from the local village The majority of fishing sites used by participants were out in the Namata River close to the river mouth. This is where the fish are bigger and the catch rate is higher. Fish move out of the shelter of the estuary as they reach adulthood or migrate back to the estuary to breed (Blaber, Brewer, & Salini, 1989).

A range of species were caught in the estuary with all crustaceans described being caught by over 50% of participants. Most fishers caught fish with a line and used other methods to glean and collect fish, such as crab cages, nets and spear fishing. Common fishing methods in Fiji include hand lines, spears, gillnet, seine net, hookah (diving with surface supplied air), and reef gleaning (FAO, 2010). Maumi villagers use hand lines, gleaning nets and crab traps for crustaceans. From the launch point to their fishing or gleaning site, most claimed to travel around 100m and the data show the distance to gleaning sites was less than that to fishing sites.

Ninety percent of respondents took less than 30 minutes to catch their first fish. However, several acknowledged that these data could be unreliable, as they tend to move from site to site if they have not caught anything within a given period of time.

This period of time is often determined by environmental conditions. Ninety percent of participants also acknowledged that they usually caught between 0 and 30 fish; however the size of these fish was not discussed.

A temporal evaluation of fishing methods and routine was conducted, which examined changes over the past two generations. There was an acceptance that the number of people fishing in the local community had decreased, especially between the last generation and the present. Twenty percent of participants claimed to own a boat; however, it was discovered that there were inconsistencies as to the definition of a 'boat'. The data from this particular enquiry may require further investigation. Despite this lack of consistency, almost all participants expressed that fewer people owned boats in the past, than in the present.

Very few participants said there had been any change in where they were fishing compared to past generations. On a broader spatial scale this would be attributed to access to 'boats' and the restrictions of the traditionally designated *qoliqoli*, however fishing or gleaning sites within this area may still have varied. Time taken to catch fish has increased and catch size has decreased, creating a picture of depleting fish stocks spanning at least two generations. As a result, there is a decreasing reliance on subsistence marine resources, reducing the number of trips taken to collect marine species. This could be a product of declining fish stocks, and therefore the local waterways becoming a less reliable food source and, therefore, local villagers are forced to rely more heavily on local markets. A change in fishing methods or equipment by over a third of participants could have influenced catch rates. This shift in method may also have been driven by greater access to boats, decreasing fish stocks or even a change in market demand for the fishers catch. The above data reflect a shift in fishing and collection habits of the local fishers, which may be either a product, or the driver

for a variety of linked social and natural processes in the area. The relative significance and relationship between such factors require further investigation.

The trends described by these study findings are similar to other studies throughout Fiji. Due to the uptake of new technologies and the depletion of fish populations, fishers are investing in alternative sources of food and income through land-based farming and forestry, as well as adopting more invasive fishing methods to optimise their catch rate (Clarke & Jupiter, 2010a). Prior to the 1990s duva, a plant based poison, was widely used to stun and catch fish in Fiji. It is now illegal, but is occasionally used today (Teh et al., 2009). The illegal practice of dynamite fishing still occurs today, and is commonly witnessed in Western Viti Levu, Fiji. Dynamite fishing is damaging ecologically and therefore, incurs huge economic costs to society through impacts to subsistence and commercial fishing industries (FAO, 2010).

This transformation of declining marine populations coupled with increasing economic pressure, both locally and regionally, is affecting most Fijian communities and demands the contribution of modern management. However, many traditional communities still fail to recognise the environmental issues and scientific relevance of the inter-relationships within the ecosystem (Clarke, & Jupiter, 2010b; Veitayaki, 2003). This scientific knowledge is required to supply information on the nature of ecosystems and resources. Modern fishing methods and related technology also have a huge impact on the sustainability of the resource base, as both commercial and subsistence fishers have increased catch range and capacity (Veitayaki, 1995, 2000). The increased number of fishers makes it vital that there is greater awareness of the significance of ensuring that production levels are below the population replenishment threshold. This situation is only exacerbated by the deterioration of the marine environment.

Conflict while on the river or estuary was examined through the use of categorised questions. Fifty percent of participants admitted that the presence of others on the estuary or river was a detriment to their activities while benefits from the presence of others were less evident. Vessels were most commonly witnessed on a weekly basis, with just 17% of participants saying they only saw other vessels less than two times per year. The majority of participants experienced conflict while using the local waterways, with several people saying that such conflict was primarily a result of competition for access to space and resources. Peoples' perceptions of crowding vary, influencing uses and the potential application of management in the area (Bollard-Breen & Breen, 2008).

6.1.5 In situ fishing survey (Aim 3)

Throughout the survey period the physical attributes of each site were recorded in order to establish any correlation between environmental conditions and catch size.

Vegetation varied little between fishing sites, as the sites were based at the confluence of the inner estuary and the Namata River and along the river edge. Vegetation at these sites was dominated by dense mangrove stands. The two sites situated near and at the river mouth were dominated by Tiri selala (*Rhizophora selala*). This could be caused by a competitive dominance relating to salinity levels or wind exposure. The inner estuary where the crabbing and netting sites were situated, displayed far greater varieties of flora compared to the banks of the Namata River. This could also be attributed to shelter levels, access to nutrients or salinity levels.

The mean temperature and pH levels at each site show little variation over the study period and water clarity varied moderately. Fishing Site 1, which is closest to the confluence of the Namata River and the inner Maumi Estuary, showed greatest variability in clarity, which may be attributed to the increased disturbance caused by the

current gradient. Fishing Site 1 showed the greatest average depth, which also would have contributed to the limited water clarity. Villagers often stated that fishing during rain or in stormy conditions was the most effective time to catch fish, as the water clarity was low and therefore the fish could not recognise the hooks and were more inclined to attempt to catch the bait. The average salinity levels at each site varied between 22 and 30ppt, with the crabbing and netting sites showing slightly lower levels than the fishing sites. However, fishing Site 1 displayed lower salinity levels than other fishing sites and averaged the same as the netting site. This trend is expected as the crabbing and netting sites were situated in the inner estuary and therefore, these waters would have a higher freshwater content and lower salinity, than the sites on the Namata River.

Catch rates varied throughout the study, with some sites displaying an overall catch rate of zero. There appeared to be no relationship between time spent fishing or gleaning and the catch rate. Fishing control site 2 and fishing site 1 were the most consistent in terms of providing a catch each day of the study. Variation in species of catch was very low, with the exception of the netting site. This is unexpected given the vast number of species identified during the first interview. The fishing sites that produced the most frequent catch also displayed the greatest catches overall.

Documented subsistence catch rates in Fiji are hard to find and are based on crude surveys undertaken as early as 1979, only covering Viti Levu. This data deficiency is common throughout developing nations emphasising the importance of thorough studies to gather traditional ecological knowledge, with the goal of establishing a gauge of long-term marine resource changes (Ban, Jones & Vincent, 2009; Clarke & Jupiter, 2010b; FAO, 2010). Using various sources of data (including non-fishery surveys), it

has been recently estimated that Fiji's coastal fishery production consists of about 17,400 tonnes by subsistence fishing (Department of Fisheries, 2005b).

There was a significant variation between catch per minute rates gathered from the fishing validation survey and those estimated from the interviews. The information gathered from the participants painted a picture of far greater catch rates than those extrapolated from the field survey data. Further study is needed to establish the accuracy of social data gathered and what factors influence the accuracy of such data. The limited time frame used to conduct the fishing validation survey would have inhibited the accuracy of the final data. Either, the limited time frame or the reliability of the social, along with compounding environmental factors may have resulted in such a large polarity in results.

The contemporary use of community-based management in the context of developing nations has thrived through the utilisation of traditional and cultural values and a participatory approach. Given the appropriate measures, the development of an MPA near the Maumi Village will provide a sustainable and ecologically healthy food source for the local people. This case-based approach, which builds on the established system of authority, land and marine tenure, custom and tradition, enforcement, beliefs and conflict management may offer a superior solution to other contemporary models.

Chapter 7: Conclusions

I will discuss how lessons learned from past experiences could aid in the future development of resource management in the Maumi community and other Fijian coastal villages. I will also address the question: 'Can combined ethnological and ecological information be used to aid traditional fisheries management in Maumi Village and throughout Fiji?' through reference to this study and findings from Chapter Two. Recommendations for future research in this field will be provided with the hope that these will enhance the further development of similar studies in tropical island communities

This research served as a baseline study of Maumi Village and the surrounding area, gathering information on resource use, water-based activities, spatial and temporal changes and environmental management perceptions in the area. The research concepts adopted for this study were based on previous studies conducted in other Pacific Island nations, including work by Aswani and Hamilton (2004), Johannes (1980) and Sabetian (2002a & 2002b).

The following research aims were fulfilled:

1) Conduct a review of existing marine management in Fiji.
2) Describe local knowledge of marine habitats, customary fishing grounds, significant fish species and their distributions and abundance in Namata River Estuary.
3) Validate local knowledge with the use of in-situ sampling.

These aims were met by employing several research methods as presented in Chapter Three. Chapter Two provided a review of Fijian marine management practices. Chapter Five presented the results of a focus group conducted in the local village on

historical, current and potential management practices that govern the local waterways. This chapter also addressed two semi-structured interviews that were conducted to gather demographic information, information regarding use of the waterways and temporal and spatial trends in catching marine animals. Chapter Four also presented the results of a fishing validation survey of local marine animal catch conducted to validate information gathered in the social surveys.

The findings of this study are discussed in Chapter Six and concluded in Chapter Seven.

7.1 Summary of findings

At an international level the conservation of marine habitats has been driven by the regulation of fisheries activities. These regulations can range from the enforcement of a single restriction such as catch limits, to the use of multiple management tools. With ecosystem-based management emerging as a model of choice for many governing bodies and policy makers, there has been an upsurge in the desire to encompass environmental, social and development aims within their plans. Marine Protected Areas (MPAs) have served the purpose of filling this niche, as they enable the conservation of biological diversity and cultural heritage; integrated coastal management and sustainable resource use; and offering a breadth of benefits to people, the marine environment and marine industries.

The establishment MPAs is driven by the need to conserve habitats and biodiversity and for the maintenance of fisheries, both locally and on a regional scale. However, MPAs are often established for individual reasons, such as: the conservation of unique elements of marine habitats; the protection of entire ecosystems; the protection of natural or cultural heritage (i.e. shipwrecks or traditionally sacred sites); or for recreational uses. In Fiji, where traditional practice, village governance and customary

marine space are all inherently linked, there is great need to protect marine areas in order to preserve cultural diversity and living heritage.

There have been many cases in the deployment of MPAs where successful ecological outcomes have been achieved. In Fiji many of these MPAs have taken the form of community-driven Locally Managed Marine Areas (LMMAs). Such protected areas offer positive ecological outcomes, often in the form of increased diversity of marine life, and/or improvement of ecosystem health (Jupiter & Egli, 2011; WCS, 2012b). However, these aims are sometimes achieved at the expense of local livelihoods through loss of regular fishing access during seasonal fishing bans, gear limitations or a breach of restrictions by individuals or outside parties. It is now recognised that marine diversity protection is a goal which cannot be achieved in isolation and therefore, the role of MPAs and LMMA's in Fiji, is now to succeed at reaching these triple bottom line goals- providing cost-efficient and effective conservation solutions that are also fair (Salomon, et al., 2010).

The people of Maumi Village in Fiji have openly acknowledged the desire for more protection for their natural marine resources. They wish to establish a MPA in the form of a LMMA to protect their natural resources, provide a food source for themselves and future generations, as well as provide economic stability through the local sale of produce. However, there is concern over the current governance of their local marine life, as people from outside the local village and commercial vessels are often seen fishing inside the local villages fishing grounds, using both legal and illegal fishing techniques. The Maumi people also feel that in the event they were to establish a LMMA, its effectiveness would be limited by a lack of enforcement from local authorities; their geographical distance from the waterways; and the lack of recognisation of enforcement powers the villagers may have.

Findings from the interviews; noted increasing vegetation removal causing accelerated run-off; the lack of enforcement of fisheries laws and regulations; and over-fishing from local, commercial and outsider parties have been identified as contributing factors to the decline in marine populations witnessed over the past two generations, in the Maumi Estuary and Namata River. Combating these challenges through effective governance and holistic management strategies is essential to ensuring the health and productivity of their local marine habitats.

The final in situ fishing survey completing this study took place on the local Namata River and Maumi Estuary, documenting the fishing activities and catch. This was undertaken in order to compare data gathered during the interviews with those from actual fishing, gleaning and crabbing activities. The estimates of catch rates obtained from the interviews were greater than those obtained from the in situ surveys. However, the time length of the in situ surveys limited the reliability of the data. In order to form a more representative picture of current marine populations and the catch rates of local people, further long-term studies would be needed.

7.2 Conclusions

Maumi Village experiences resource management issues that mirror those experienced throughout Fiji. Prior to the establishment of an effective LMMA, at the wishes of the Maumi Village people, several challenges would need to be addressed. These include:

The facilitation of collaborative management between civil society and governments, as strengthening trust and capacities is fundamental to achieving healthy and productive marine ecosystems.

The effective enforcement of fisheries legislation and laws. When enforcement is weak, it is vital that local communities are involved in design and enforcement of management

initiatives, as they are perfectly placed to provide surveillance of illegal activities. As this is the case in Fiji, such policy and law development can take time, as these government developments need to be coupled with local stakeholder investment.

Community-based management of natural resources involves shared management authority and responsibility between resource users or community groups at local levels and central government authorities. In data-poor, small-scale fisheries systems, such as that of Maumi Village, community-based planning efforts can be informed by participatory research approaches that involve community members and stakeholder groups in the design, development and implementation of research. A community-based survey effort revealed temporal changes in habitat use patterns and declines in key fisheries species and habitats. Fishing activities in Maumi Village are primarily non-commercial in nature. Many of the direct benefits from local fisheries are distributed through social-kinship networks. The fishing community exhibited a high capacity for engagement in community-based planning efforts and also provided input on proposed management measures. Participatory resource assessments hold promise for building local social adaptive capacity, bringing together disparate stakeholder groups, and building place-based natural resource management plans reflective of local contexts and community priorities.

Active collaboration between governments and communities builds trust and common understanding of the importance of these regulations. In the past provincial planning and policy processes were not teamed with local initiatives, yet as society changes developing nations and local communities are realising that despite community-based marine management being an ever evolving process, it actually works. This is demonstrated by the success and progress of this approach in Fiji.

7.3 Implications for Maumi Village people

Given the significance of damaging human activities and depleting fish stocks there is a clear need for a stronger and well-implemented environmental management program in the Maumi area. The people have described an area bombarded by the pressures a steadily developing, economic society without the infrastructure to support the environment, on which such a society depends.

Although the goals of this study have been focused on natural conservation, the most pressing issues raised have been social, economic and political in nature. Therefore social values and perceptions of the area surrounding Maumi Village should be an integral part of any planning and evaluation process. Information required to investigate potential management, includes attitudes toward management programs, the social and cultural values and perceptions, community expectations of management and scientific justification for management.

It is important that the potential effectiveness of any proposed management plan be evaluated and compared with other cases in Fiji prior to initiation. Identifying factors based on the experience of other coastal communities, that influence the effectiveness of MPAs, such as proximity to urban areas, access to alternate sources of income and proximity to the proposed protected area will increase the success of management initiatives in other Fijian communities (Jupiter et al., 2010b).

I recommend that social and ecological data be used, in combination with GIS and a range of decision support tools, in evaluating the potential for a MPA in this region. There is great need for spatially explicit social data (Chapter 4) to be collected across the entire Namata region to assist in future planning and evaluation. Using these tools with an adaptive, community-based approach will provide a transparent process for

decision making and will aid in the exploration of a range of options and opportunities for effective conservation and sustainable use.

Management plans are noted to be more effective with the use of current information, data and technology and have the ability to adapt to environmental conditions (Watchman, Groom, & Perrine, 2001). With the limitations of data-poor regions, I recommend that future research should utilise current information on social settings to enable maximum sustainability and economic viability of the resulting conservations plans.

Finally, I recommend that through the development of the methods I have employed, further exploration of the relationships between social values and ecological characteristics, and the likely effects of increased resource use in the Namata region, should be undertaken. Current and accurate spatial and ecological data of the area need to be accessible to all sectors in order to provide better insight into the impacts and conservation potential of the Maumi Village and Namata catchment.

7.4 Implications for Fiji

Planning for conservation often involves many social and ecological objectives. Maps and other forms of marine spatial management aim to manage different ecosystem processes, species and human uses. The planning process for MPAs should be undertaken using the most accurate and current data available as well as the knowledge and input of the local community and other stakeholders. The combination of social perceptions and local knowledge with scientific information provides a more holistic understanding of the natural environment increasing the sustainability and effectiveness of management actions (Dinsdale & Fenton, 2006; Robertson, 2000). Furthermore, feelings of stewardship for the environment and empowerment of the local community

can be achieved where governmental and local bodies work together, also encouraging the longevity and effectiveness of conservation actions (Viswanathan et al., 2004).

The local people share great depths of knowledge about their natural environment. Their knowledge and perceptions can be used to evaluate temporal and spatial trends in environmental conditions and to assess the effectiveness of current and future environmental management strategies (Dinsdale & Fenton, 2006; Aswani & Hamilton, 2004; Johannes, 2002). Through this sharing of knowledge, environmental managers can also make more informed decisions, and inspire the contributions of the local community in the decision-making process (Viswanathan et al., 2004).

Of the relatively small amount of literature published on Fiji's marine environment, much has been focused on Fiji tuna fisheries, both inshore and offshore. There is a need to take a far broader view of fisheries and coastal conservation, investigating relationships between both inshore and offshore zones and the economic, ecological and social implications of activities, on various scales (Viswanathan et al., 2004). Such research can form the basis for policy and development, and decision-making at a government level, as well as acting as a catalyst for more focused research in applicable areas.

Since the release of the Brundtland Report or Our Common Future, in 1987 (United Nations, 1987) international understanding of sustainable resource use has increased and a large body of literature has developed exploring sustainable fisheries and related elements. Such literature includes the 1995 FAO Code of Conduct for Responsible Fisheries (Food and Agriculture Organisation, 1995), which aimed to set out the long-term maintenance of the fisheries industry. As in other parts of the world, Fiji's fisheries developments have contributed significantly to issues such as marine pollution and loss

of traditional harvesting methods, yet those issues addressed in the literature are often found to be environmental and economic in nature (Food and Agriculture Organisation, 2008). Such issues are significant in Fiji as they have implications for ecosystem health, economic development, and food security.

The South Pacific is one of the most recent regions to experience pressure from the consequences of the use of their marine habitat. Fiji can learn much from the experiences of other countries, especially some other Pacific nations such as New Zealand. New Zealand's fisheries management experiences suggest that the development of a sustainable and economically sound fisheries sector is to be achieved through a holistic and integrated management structure, whereby both inshore and offshore and local and regional fisheries are intertwined. There is a great need for Fiji's fisheries management to be enhanced by a pre-emptive and bold plan.

7.5 Future research directions

Unique meaning can often be associated with physical locations, ranging from cultural, personal, historical or even national or multi-national significance (Hancock, 1999). This is often the cause of politics and social actions being built around the identities of place (Goodchild, Anselin, Appelbaum, & Harthorn, 2000). However there is still a void in the research related to the symbolic meaning of space using spatial analysis across spatial and temporal scales, exploring patterns of use, meanings and values. Such research could aid in the development of more socially sustainable management mechanisms in Fiji.

The application for spatial analysis in the social sciences has great potential and could address theoretical questions of space and place, as well as offering technical solutions for social investigation and management. Scientific research is rapidly becoming more

interdisciplinary and spatial analysis methods are engaging many disciplines to create cross-disciplinary frameworks (Goodchild et al., 2000). The need for spatial and locational information in order to support decision-making is growing. The role of spatially integrated social science is also becoming recognised as a component of decision support systems.

Given the opportunity to further develop this study, I would seek to conduct thorough marine and aquatic habitat mapping of the Namata area in combination with species distribution and abundance studies. Mapping of resource use of local communities and commercial stakeholders would be overlaid to form a more cohesive picture of ecological and social areas of significance, to aid in further marine planning.

Research is needed to assess and combat the sampling biases associated with the collection of social data and the contribution of community to planning decisions. There has often been uncertainty as to the reliability of the information provided and of contributions of stakeholder communities (Dinsdale & Fenton, 2006). Unlike scientific information, the local ecological knowledge (LEK) gathered from continual observation can be a mix of scientific and practical knowledge influenced by values, cultural beliefs and social motivations (Olsson & Folke, 2001). The integration of LEK and scientific information has the potential to produce more effective management outcomes and develop a sense of ownerships within contributing communities.

Future studies need to continually investigate the relationships between ecological and social information at both spatial and temporal scales. Existing and new conservation and environmental management programs need to incorporate social and ecological data into the planning and protection of inshore coastal zones and other marine areas.

Finally, it is important to assess the adaptive capacity of management plans, through investigating whether the effects of management settings are reflected in the social and ecological data collected over large time scales. It is essential to undertake such assessments over longer time scales, to determine, to what extent, management initiatives impact social and ecological communities. Robust baseline data are essential for such studies, as is ensuring management initiatives are designed, measured and altered, relative to the intended objectives.

The merging of social and ecological aims and information, along with sound planning and assessment will optimise the success of ecosystem-based conservation goals.

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Appendices

Appendix 1: Focus group (Aim 2)

Questions:

Q. Are there any management measure/restrictions in place for the estuary/river at present?

Q. Have there been management measures/restrictions, put in place on the river/estuary in the past?

Q. Have these restrictions differed from the current situation? How?

Q. Have past or present management/restrictions achieved their aim?

Q. Did the restrictions/ management plans impact the river/estuary environment?

Q. Do your activities on the water affect the river/estuary environment?

Q. Do you feel that the *qoliqoli* network is of benefit to local communities?

Q. Who owns the river and estuary?

Q. Are you happy with the way the estuary and river are currently managed?

Q. Would you change anything about how the estuary and river are managed?

Q. What is a Marine Protected Area?

Q. Would you like to have a Marine Protected Area?

Q. Where would you put a Marine Protected Area and why?

Q. Where are the current fishing grounds?

Q. Are the boundaries of the local *qoliqoli* respected?

Q. What government/fisheries department laws/restrictions are put in place at present?

Q. Are the government laws respected by those who use the river and estuary?

Q. Have the laws and restrictions changed over time?

Q. Are there presently any limitations on catching marine animals?

Q. If so, for where and for how long?

Q. Have there been restrictions on marine animal catching in the past?

Q. How would you like such change to happen?

Q. What would you like to see change?

Q. Do you think there is need for management/ improved management of the waterways?

Q. How are management restrictions enforced? Is it effective?

Q. What challenges may occur as a result of having or implementing an MPA?

Q. What benefits do you see from having an MPA?

Appendix 2: Semi-structured interview 1 (Aim 2)

Estuarine Interactions and Ideas Survey No.: Date:

Katherine Shaw-Brown
Auckland University of Technology

Estuary interactions and ideas survey:
an investigation of activities, knowledge and ideas associated with Bau estuary, Maumi, Fiji.

Please answer all the following questions to the best of your ability and use the maps provided, where applicable. If you are unable to answer a question or choose not to answer please skip to the next question.

Section 1: General Demographics

1. What is your gender? Please tick.

Female	Male

2. What is your age? Please tick.

18-20	21-25	26-30	31-40	41-50	50+

3. What is the highest level of education you have completed? Please tick.

No education	Primary School	High School	Tertiary Institute

4. How many people live and eat in your household? Please tick.

1	2	3	4	5	6	7	>7

Estuarine Interactions and Ideas Survey No.: Date:

5. Have you lived by the estuary your whole life? Please tick.

Yes	No

6. What activities do you do, which involve the estuary? Please tick all that apply.

Fishing	
Gathering water	
Gleaning	
Swimming	
Diving	
Snorkeling	
Gathering Muscles etc	
Spear fishing	
Other (please state)	

7. How often do you visit the estuary to partake in these activities? Please tick one.

Every Day	
Several times per week	
Once a week	
Every couple of weeks	
Once a month or less	

8. How many people in your household regularly fish or collect shellfish? Please tick.

1	2	3	4	5	>5

9. Do you own a boat? Please tick.

Yes	No

10. During an average/normal week, how many days do you prepare fresh fish and other fresh seafood for your family? Please tick.

1	2	3	4	5	6	7

1 Katherine Shaw-Brown, AUT, Auckland, New Zealand

11. Where do you get your fresh fish and how often? Please tick all that apply and state how often.

Local shops	
Maumi Estuary	
Local reef spots	
Other (please state)	

Once a week	
Twice a week	
Three times a week	
Four times a week	
Five times a week	
Six times a week	
Every day	

12. Where do you get other types of seafood? Please tick and state how often.

Local shops	
Maumi Estuary	
Local reef spots	
Other villagers	
Other (please state)	

Once a week	
Twice a week	
Three times a week	
Four time a week	
Five times a week	
Six times a week	
Every day	

Section 2: Marine and estuarine habitats

1. What fish do you find in the estuary?

_____
_____
_____
_____

2. What marine plants do you find in the estuary?

_____
_____
_____
_____

3. What other animals do you find in the estuary?

Estuarine Interactions and Ideas Survey No.: Date:

_____
_____
_____
_____

4. What types of habitats have you observed in the Bau Estuary?

_____
_____
_____
_____

Using the back of this survey form, please answer questions in Section 3.
Section 3: Spatial and temporal patterns

1. What areas in the estuary do you feel have the greatest and lowest numbers of fish? Please mark on the map provided or label areas with the greatest and least numbers of fish.

2. What areas in the estuary do you feel host the highest and lowest number of other marine animals? Please mark or label on the map provided.

3. What areas in the estuary do you feel have the highest and lowest number of marine plants? Please mark on the map provided.

4a. Have you noticed any changes in where the marine plants are growing, during the time you have been using the estuary? Please tick.

Yes	No

b. Yes, please mark on the map where these changes have occurred and describe them.
Describe:_____
_____
_____
_____

Estuarine Interactions and Ideas Survey No.: Date:

5. Have you observed changes in any of the following features or elements during the period you have be using the estuary? Please tick and explain.

Features	**Yes**	**No**	**Explain:**	**Where?**
a. Changes in water clarity				Please mark on the map provided with an 'A'.
b. Changes in the number of fish				Please mark on the map provided with a 'b'.
c. Changes in the number of other marine animals				Please mark on the map provided with a 'c'.
d. Changes in scenic beauty				Please mark on the map provided with a 'd'.
e. Changes in the depth of the estuary				Please mark on the map provided with a 'e'.

Estuarine Interactions and Ideas Survey No.: Date:

6. What changes have you observed over the course of your contact with the estuary? Please indicate which activity and how often it has occurred:

Cyclones or other natural disturbances (please name)? Please tick and state how often.

Activity	**Yes**	**No**	**How often?**	**Where?**
a. Algal growth				Please mark on the map provided and label with a capital 'A'.
b. Over-fishing				Please mark on the map provided and label with a capital 'B'.
c. Scuba diving				Please mark on the map provided and label with a capital 'C'
d. Presence of commercial vessels				Please mark on the map provided and label with a capital 'D'.
e. Snorkeling				Please mark on the map provided and label with a capital 'E'.
f. Pollution				Please mark on the map provided and label with a capital 'F'.
g. Farming run-off				Please mark on the map provided and label with a capital 'G'.
h. Cyclones				Please mark on the map provided and label with a capital 'H'.
i. Other natural processes				Please mark on the map provided and label with a capital 'I'.

Estuarine Interactions and Ideas Survey No.: Date:

Section 4: The social value of Bau Estuary

1. Please rate the quality of the site you visited most recently for several characteristics. Please tick. Mark on the map.

	Poor quality									**High Quality**
Characteristic	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Water clarity										
Presence of fish										
Presence of vertebrates (species)										
Scenic beauty										
Presence of marine fauna (cover and quality)										
Access										
Shelter										
Compared to other areas of the estuary										
Amount of sunlight										
Depth/ underwater topography										
Diversity of fish life										
Presence of marine animals										
Current strength										
Overall quality of this site is										

2a. Are there areas in the estuary that are of personal significance to you?

Yes	No

b. 'Yes', please mark and label these areas on the map provided and explain why they are of significance.

_____
_____
_____
_____

Estuarine Interactions and Ideas Survey No.: Date:

3a. Are there areas in the estuary that are of cultural significance to you?

Yes	No

b. 'Yes', please mark and label these areas on the map provided and explain why they are of significance.

_____
_____
_____
_____

4a. Are there areas in the estuary that are of historical significance to you?

Yes	No

b. 'Yes', please mark and label these areas on the map provided and explain why they are of significance.

_____
_____
_____
_____

Appendix 3: Semi-structured interview 2 (Aim 2)

Fishing Survey No.: Date:

Katherine Shaw-Brown
Auckland University of Technology

Survey of fishing practices and activities in Bau estuary, Maumi, Fiji.

If you are the primary collector of marine species, for food in your household please answer the following questions; if not please go to the end:

Fishers Survey
Fishers, men or women, 18yrs and older:

1. Which areas do you fish? Please mark on the map provided.

2. What species do you commonly catch?

_____
_____
_____
_____

3. How far do you travel from the shore to your usual place of fishing/collection on the estuary? Please state activity and tick.

Activity:_____

50-100 meters	100-300 meters	300-600 meters	600-900 meters	900-1200 meters	1200-1500 meters	1500-1800 meters	1800-2100 meters

4. Approximately how long does it take you to catch your first fish? Please tick.

Up to 15 minutes	
15-30 minutes	
30-60 minutes	
Over 60 minutes	

Fishing Survey No.: Date:

5. Approximately how many fish do you usually catch? Please tick.

1-10	
11-30	
31-60	
61-100	
101-200	
201-300	

6. Do you fish in one area per trip or multiple areas per trip? Please tick or number and mark sites on the map provided.

One only			
Multiple		Number	

7. If you fish in multiple areas which ones do you combine during one fishing trip? Please mark on the map provided.

8. Please mark your launching point on the map provided.

9. How often do you visit each fishing site each week? Please tick.

Fishing Site	Number of times visited per week
Site 1	
Site 2	
Site 3	
Site 4	
Site 5	
Site 6	

10. How often do you go out to collect fish? Please tick.

Twice a day	
Everyday	
2-3 times per week	
Less than twice a week	
Twice a month	
Less than twice a month	

11. Average number of hours per trip? Please tick.

Under 1 hour	
1 hours	
2 hours	
3 hours	
4 hours	
5 hours	
6 hours	

Fishing Survey No.: Date:

12. Number of trips per year? Please tick.

0-10	
11-20	
21-50	
51-100	
101-200	
201-300	
300+	

13. What techniques or collection activities do you do? Please tick all that apply.

Netting	
vakaravi,	
vola	
lawa tabu	
Barriers and fences	
Ba ni ika (Pre-set fish fences)	
Moka (stone weirs)	
Tusaliali (barrier)	
Latilati ni dreke ni wai (fish fences)	
Yavirau or leaf sweep / Fish Drive	
Line fishing (siwa)	
Cina (Nocturnal Fishing)	
Vakacakaa (Gleaning)	
Vakacakaa (Gleaning)	
Vivili	
Diving	

14a. Do you use a boat to go and collect fish? Please tick.

Yes	No

b. Yes, do you own the boat you use to go and collect your catch? Please tick.

Yes	No

15. How many people do you take on each trip? Please tick.

1	
2	
3	
4	
5	
Over 5	

Fishing Survey No.: Date:

16. When do you go to catch fish? Tick those that apply.

Day		**Week**		**Month**	
Morning		Monday		January	
Day		Tuesday		February	
Night		Wednesday		March	
		Thursday		April	
		Friday		May	
		Saturday		June	
		Sunday		July	
				August	
				September	
				October	
				November	
				December	

17. Which preservation method do you use for your catch? Please tick.

Drying	
Smoking	
Pickling	
Freezing	
Salting	
Canning	
Other	

18. Do you notice any change over time in the areas you are collecting/ catching the largest number of fish? Please tick and detail on map.

Yes		Details:	
No			

19. Do you sell your catch? Please tick.

Yes	No

20. How often do you sell your catch? Please tick.

Every day	
Every Week	
Every Month	
Several times per year	
Less than two times per year	

Fishing Survey No.: Date:

---

21. Do you collect sea animals other than fish?

Yes	No

If 'Yes' please answer the following questions. If 'no', skip to question 43.

22. In which areas do you collect sea animals other than fish?
Mark on the map provided.

23. What species do you commonly collect?

_____
_____
_____
_____

24. How far do you travel from the shore to your usual place of marine organism collection on the estuary? Please state activity and tick.
Activity:_____

50-100 meters	100-300 meters	300-600 meters	600-900 meters	900-1200 meters	1200-1500 meters	1500-1800 meters	1800-2100 meters

25. Approximately how long does it take you to catch your first marine animal? Please tick.

Up to 15 minutes	
15-30 minutes	
30-60 minutes	
Over 60 minutes	

26. Approximately how many marine animals do you usually catch? Please tick.

1-10	
11-30	
31-60	
61-100	
101-200	
201-300	

Fishing Survey No.: Date:

27a. When you search for marine animals, do you collect in only one of the sites per trip or do you usually visit several sites during one trip? Please tick and mark on the map.

One only	
Multiple	

b. Yes, which ones do you usually combine during one trip? Please mark on the map provided.

28. Please mark your launching point on the map provided.

29. How often do you visit each collection site each week? Please tick.

Habitat	Number of times visited per week
Habitat 1	
Habitat 2	
Habitat 3	
Habitat 4	
Habitat 5	
Habitat 6	

30. How often do you go out to collect marine organisms? Please tick.

Twice a day	
Everyday	
2-3 times per week	
Less than twice a week	
Twice a month	
Less than twice a month	

31. Average number of hours per trip? Please tick.

Under 1 hour	
1 hours	
2 hours	
3 hours	
4 hours	
5 hours	
6 hours	

32. Number of trips per year? Please tick.

0-10	
11-20	
21-50	
51-100	

101-200	
201-300	
300+	

33. What techniques or collection activities do you do? Please tick all that apply.

Netting	
vakaravi,	
vola	
lawa tabu	
Barriers and fences	
Ba ni ika (Pre-set fish fences)	
Moka (stone weirs)	
Tusaliali (barrier)	
Latilati ni dreke ni wai (fish fences)	
Yavirau or leaf sweep / Fish Drive	
Line fishing (siwa)	
Cina (Nocturnal Fishing)	
Vakacakaa (Gleaning)	
Vakacakaa (Gleaning)	
Vivili	
Diving	

34. Do you collect other sea creatures alone or do you go with others? Please tick.

Alone	
With others	

35. Which preservation method do you use for your catch? Please tick.

Drying	
Smoking	
Pickling	
Freezing	
Salting	
Canning	
Other	

36. How often do you go gleaning? Please tick.

Twice a day	
Everyday	
2-3 times per week	
Less than twice a week	
Twice a month	
Less than twice a month	

Fishing Survey No.: Date:

37. Do you use boat transport? Please tick.

Yes	No

38. How long is a usual trip? Please tick.

Under 1 hour	
1 hours	
2 hours	
3 hours	
4 hours	
5 hours	
6 hours	

39. When do you collect marine animals? Tick those that apply.

Day		**Week**		**Month**	
Morning		Monday		January	
Day		Tuesday		February	
Night		Wednesday		March	
		Thursday		April	
		Friday		May	
		Saturday		June	
		Sunday		July	
				August	
				September	
				October	
				November	
				December	

40. Do you notice any change over time in the areas you are collecting/ catching the largest number of marine animals? Please tick and detail on the map.

Yes		Details:	
No			

41. Do you sell your catch? Please tick.

Yes	No

42. How often do you sell your catch? Please tick.

Every day	
Every Week	
Every Month	
Several times per year	
Less than two times per year	

Spatial conflict

43. How often is the presence of other people of benefit to your activities on the estuary? Please tick.

Every day	
Every Week	
Every Month	
Several times per year	
Less than two times per year	

44. How often is the presence of other people detrimental to your activities in the estuary? Please tick.

Every day	
Every Week	
Every Month	
Several times per year	
Less than two times per year	

45. How often do you encounter another vessel or other users in your fishing site? Please tick.

Every day	
Every Week	
Every Month	
Several times per year	
Less than two times per year	

46. How often would you personally experience conflict with other people while on the estuary? Please tick.

Every day	
Every Week	
Every Month	
Several times per year	
Less than two times per year	

47a. Has there ever been conflict over access to space or resources on the estuary? Please tick.

Yes	No

b. Yes, where, when, over what resource and how often does this occur? Please tick and mark and label on the map.

Every day	
Every Week	
Every Month	
Several times per year	
Less than two times per year	

Resource: (please state)_____

_____

Temporal changes

48. Are there more of less people fishing/collecting at your fishing/ collecting sites than in your father and grandfather's time? Please tick.

	More people	Less people
Father's time		
Grandfather's time		

49. Do more people now have motorised boats than in your father's and grandfather's time? Please tick.

	More boats	Less Boats
Father's time		
Grandfather's time		

50. Are your fishing/gleaning sites at the same spot as when you father and grandfather fished? How have they changed?
Describe and mark on the map:
_____
_____
_____

	Have changed	Have not changed
Father's sites		
Grandfather's sites		

Fishing Survey No.: Date:

51. Has the length of time it takes for you catch your fist marine animal changed within your lifetime?

Yes	
No	

52. Has the number of organisms you catch increased or decreased or stayed the same?

Increased	
Decreased	
Stayed the same	

53. Has the number of trips you take increased, decreased or stayed the same?

Increased	
Decreased	
Stayed the same	

54. Have your fishing methods changed over time and compared to your father and grandfather?

Yes	
No	

How?

_____
_____
_____

55. If you own your own boat, have you always?

Yes	
No	

56. Did you father and grandfather own boats?

	Yes	No
Father		
Grandfather		

57. Are the times you fish different from that of your father and grandfather?

	Yes	No
Father		
Grandfather		

Fishing Survey No.: Date:

How?_____
_____
_____

Has the amount of your catch that you sell increased, decreased or stayed the same over time?

	Increase	Decrease	Stayed the same
You			
Father			
Grandfather			

Thank you for your time and cooperation,
Katherine Shaw-Brown
rnr7232@aut.ac.nz

Appendix 4: Participant Information Sheet

The use of local resource knowledge and customary fisheries management to assist marine spatial planning in Fiji, using Bau Estuary as a case study.

PARTICIPANT INFORMATION SHEET

Project Title

The use of local resource knowledge and customary fisheries management to assist marine spatial planning in Fiji, using Bau Estuary as a case study.

An Invitation:

We are inviting you to volunteer as a participant in a study being conducted through Auckland University of Technology and Fiji National University on marine management in Bau Estuary. This consent form provides you with the information you will need when considering whether to participate in this evaluation. All evaluation and research studies carried out at AUT and FNU are governed by state laws regulating human subjects research. If you decide to participate, we will ask you to sign this consent form which states that you have read the *Summary of the Study*, that any questions you have about the evaluation have been answered, and that you agree to participate. You will be given a copy of this form to keep for your records.

Our research aims to determine the how useful and effective marine spatial planning in Bau Estuary is, by using surveys and focus groups of the local village people and biophysical surveys in the estuary. Bau estuary is north east of Nausori and is governed

by several locally designated fishing grounds, connected to several surrounding villages. Bau Estuary is also the location of several collaborative research projects with Fiji National University. Similar research has been conducted in the Solomon Islands by, (Aswani and Hamilton, 2004 and Sabetian, 2002) and the completion of this study may determine the adaptability of such a scheme in other areas of Fiji. Your participation is voluntary and you can withdraw at any time without any adverse consequences. You may also refuse to answer any questions that you feel uncomfortable with. Our research team consists of:

Dr Barbara Breen (Auckland University of Technology)

Katherine Shaw-Brown (Auckland University of Technology)

Mr. Lepani Kolinasaw (Fiji National University)

Purpose:

Fiji is an area of biological and cultural wealth and as an island nation the people have a close association with the ocean, as a source of economic stability and sustenance. The country relies heavily on fisheries as a source of trade and for the well-being of its people; therefore, the effective management of both inshore and offshore marine environments are vital. Despite the adoption of various marine management strategies there still exists a conflict between state driven policy and management of marine resource at a local level. Past research, (Sabetian, 2002, Aswani, 2006), has demonstrated that by, adopting an ecosystem-based management approach, whereby local knowledge, political issues, cultural elements, economic considerations and biophysical environments are all integrated a sustainable place-based management scheme can be implemented.

Using the Bau estuary as a case study, I will investigate the use of an ecosystem-based approach to marine spatial planning in Fiji.

How was I chosen for this invitation?

You were chosen because you are a coastal resource user within the Maumi estuary region.

What will happen in this research?

You are invited to complete a questionnaire during a face to face interview with you. The questionnaire has questions about your association with Bau Estuary and your knowledge of the Bau Estuary marine environment. As a survey participant we will be asking you questions about your activities involving the estuary, your food collection habits, the animals you collect, the times and places you collect sea animals and how you feel the estuary is looked-after. This will be undertaken in an interview setting. You may also be asked to contribute to a group discussion session. We may also ask to count and measure your fishing catch for scientific purposes only. We plan to use this information to build a map of valuable areas within the estuary to be protected, based on your values of the estuary and the distribution and abundance of estuarine species.

The interview will probably take about 2 hours. All materials, such as pens/pencils, maps, will be provided to you during the interview.

How will my privacy be protected?

A Consent Form will be provided to you so your privacy and knowledge are protected. All information will be stored in a secure and safe location at the Wellesley Street Campus and Auckland University of Technology.

Presentation of results in the final report will all be in a summarised format and no individuals or organizations will be identified.

During the interview no names of participants or contact details are recorded, only a reference number (e.g. Participant Number 001).

The Intellectual Property and ownership of your knowledge and your participation is voluntary and you can choose to withdraw at any time.

What are the risks?

If you choose to participate in this study, the information you provide will be confidential and will be stored in locked holdings, which can only be accessed by the researchers. After such a time that the information is no longer need for this research project, the raw data and information you provide will be destroyed. If you feel uncomfortable providing us with information about your activities and perceptions in relation to the estuary, for any reason, you can choose not to participate in this study. For example, you may choose not to participate due to your concerns about commercial sensitivity.

What are the costs of participating in this research?

No particular cost other than your time, which we expect will be around two hours.

Will I receive feedback on the results of this research?

The results of this research will be presented in a report to the Fiji Nation University and Auckland University of Technology and will be a part of a post-graduate thesis, which will be available online at the AUT library.

What do I do if I have Concerns about this Research?

Any concerns regarding the nature of this project should be notified in the first instance to Dr Barbara Bollard-Breen, (Ph: 09-921-9999 ext 8837, Fax: 921-9743, Email: bbreen@aut.ac.nz).

Should you have any concerns regarding the conduct of the research, please direct these to the Executive Secretary, AUTEC, Madeline Banda, *madeline.banda@aut.ac.nz* , 09-921 9999 ext 8044.

Further Information about this Research:

If you have any questions or would like further information please feel free to contact the Researcher, Project Supervisor Dr Barbara Bollard-Breen, (Ph: 09-921-9999 ext 8837, Fax: 921-9743, Email: bbreen@aut.ac.nz).

Appendix 5: Participant Consent Form

Consent Form

Project title: **The use of local resource knowledge and customary fisheries management to assist marine spatial planning in Fiji, using Bau Estuary as a case study.**

Researcher: ***Katherine Shaw-Brown***

- ○ I have read and understood the information provided about this research project in the Information Sheet dated 12 May 2011.
- ○ I have been given the opportunity to ask questions and to have them answered.
- ○ I understand that notes will be taken during the meeting.
- ○ I understand that a marine chart will be used during the meeting and information I provide will be drawn/indicated on the marine chart.

- ○ I understand that I may withdraw myself or any information that I have provided for this project at any time prior to completion of data collection, without being disadvantaged in any way.
- ○ If I withdraw, I understand that all relevant information including transcripts, or parts thereof, will be destroyed.

○ I agree to take part in this research.

Participants

Signature.....……

Participants

Name.....……

Participants Contact Details (if appropriate):

……

…….

……

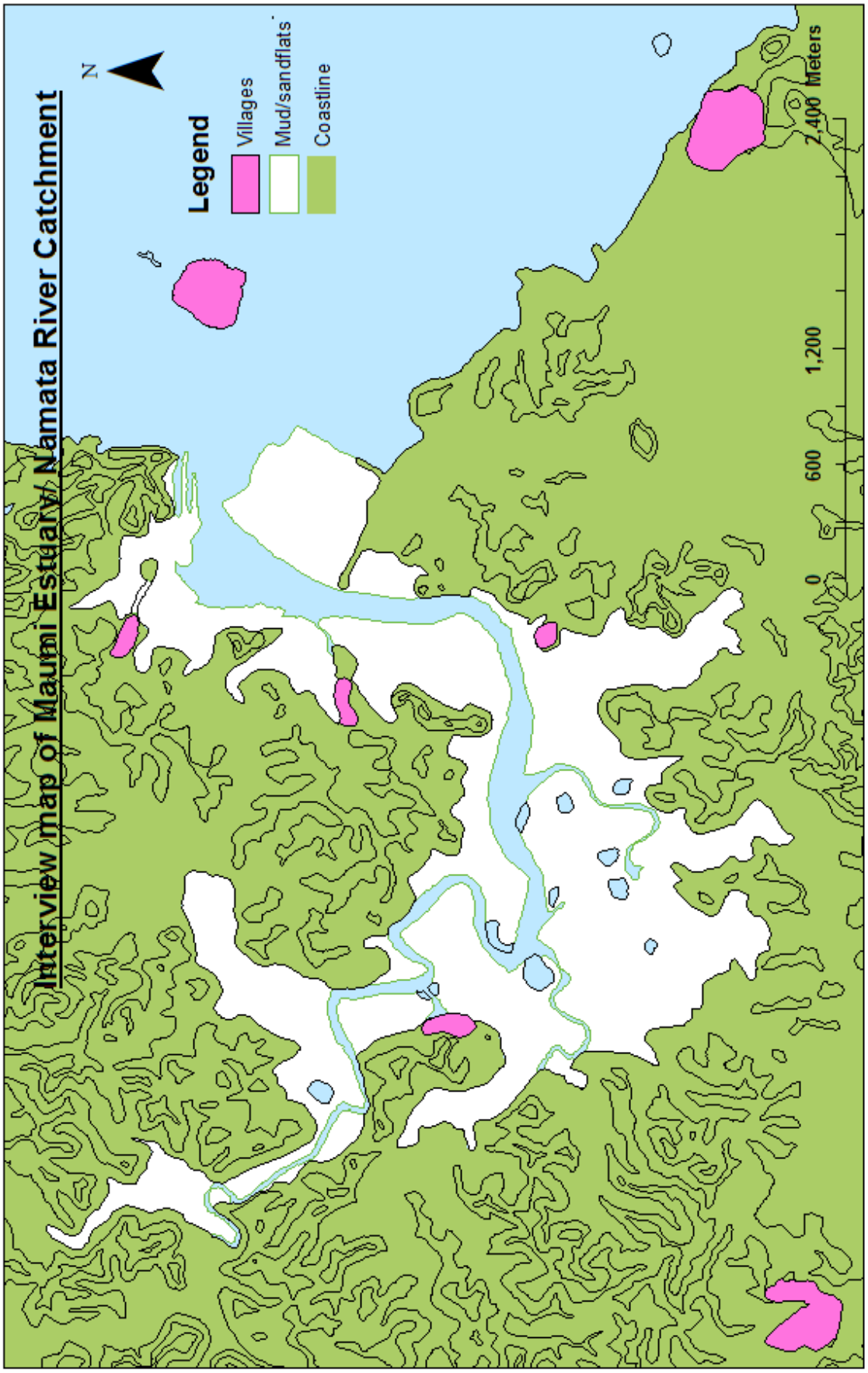
…….

Date: ……

Approved by the Auckland University of Technology Ethics Committee ……

Note: The Participant should retain a copy of this form.

Appendix 6: Interview Map (Aim 2)



Appendix 7: Translator Confidentiality Agreement

Translator Confidentiality Agreement

Project title: **The use of local resource knowledge and customary fisheries management to assist marine spatial planning in Fiji, using Bau Estuary as a case study.**

Researcher: ***Katherine Shaw-Brown***

- I have agreed to take on the role of translator for this specific Masters research fieldwork.
- In agreeing to take on the role of Translator for this specific research project and in doing so I hereby declare that all information gathered, discussed and translated in direct relation to this project is in strict confidence and is not to be discussed with any person outside of those directly involved with the collection of data and information related to this project.

Name:……

Signed:……

Date:……

Appendix 8: Focus group transcript (Aim 2)

QUESTION NUMBER	QUESTION	ANSWER
1	Are there any management measure/restrictions in place for the estuary/ river at present?	There is no management of the river or estuary, taking place at present. The estuary and river is used as a source of food. Mangroves used for firewood and building materials.
2	Has there been management measures/restrictions put in place on the river/estuary in the past?	Yes, restrictions (tabu), were put in place after the death of the chief. The tabu usually lasts for 100 nights, (3months). When the eldest person in the family has their first born child there will be restrictions put in place that apply to the women looking after the child and they will last for four nights.
3	Have these restrictions	Yes, the tabu has been used in the past, but not at present.

	differed from the current situation? How?	Presently, the area is primarily used as a food source and a source of firewood. Tabu only took place when they lived in the old Maumi village. The current settlement does not enforce tabu.
4	Have past or present management/restrictions achieved their aim?	In 1977 when the Maumi chief died, there was a tabu following his death. In 2006 there was a tabu for 6months before a Church Conference took place Since 2006 there has been no tabu
5	Did the restrictions/ management plans impact the river/estuary environment?	A greater fish abundance was experienced after tabu periods There were a lot more fish found in the river A greater variety of fish species were found ie sharks, oysters and zebra fish

6	Do your activities on the water affect the river/estuary environment?	Yes, auto boats affect the river banks, as the use and disturbance of the water leads to greater soil erosion Oil from the auto boats affects the species in the river Pollution from dumping of rubbish ie. plastic, tin, metal etc All the inland streams feed into the maumi estuary, so any pollutants near the waterways feed into the estuary and river Swimming in the waterways also disturbs the habitat of the marine species and also disturbs the sediment
7	Do you feel that the qoliqoli network is of benefit to local communities?	The qoliqoli is of more benefit to the government and not so much to the locals When selling fish at market you are required to have a license from the ministry of fisheries and therefore many communities are only relying on fish for their own consumption

8	Who owns the river and estuary?	The government owns the river, estuary and any activities that take place on the water are at the discretion of the government. The Maumi people have to use the estuary and river under the authority and guidance of the government
9	Are you happy with the way the estuary and river are currently managed?	Yes, because when the area is managed we have a lot of fish More fish means greater fish species diversity Also there is a large diversity in mangrove species in the area
10	Would you change anything about how the estuary and river are managed?	No, because that would mean spending a lot of money
11	Would you like to have a Marine Protected Area?	Yes, we would really like one We want to get back what we have lost from the estuary

		Also we need to improve and protect the estuary for the benefit of future generations
12	What is a marine protected area?	Protecting our estuary in order to increase the presence of fish and other organisms
13	Where would you put a Marine Protected Area and why?	Refer to map
14	Where are the current fishing grounds?	Refer to map
15	Are the boundaries of the local qoliqoli respected?	No. Anyone can go and fish in the estuary and river A lot of people catch fish in the estuary without the concern of the local people or owners Since the area is owned by the government

16	What government/fisheries department laws/restrictions are put in place at present?	A lot of rule and regulations are put in place at present. There are limitations on the size of the species caught and also the size of your catch. There are size limitations in place, which are recommended by the Ministry of Forestry and Fisheries, in place in order to avoid the unrecoverable loss of species. You also have to have a boat license as well as have a license for the boat driver.
17	Are the government laws respected by those who use the river and estuary?	No. Only a few people/ not all the communities obey the laws. A lot of people break the laws. A lot of people living by the river ie Namata village, Namuka village actually use the river as their primary source of meat and food.
18	Have the laws and restrictions	No. Everyone has to follow the laws introduced and imposed by the Ministry of Forestry and

	changed over time?	Fisheries
19	Are there presently any limitations on catching marine animals?	No. Anyone can go and catch fish at any time you want. Since the area is a food source for many of the people living in the area.
20	Have there been restrictions on marine animal catching in the past?	No.
21	How would you like such change to happen?	As soon as possible, to avoid conditions getting worse in the future.
22	What would you like to see change?	Improvement of fish abundance, as we want to have a lot of fish in the estuary. The depth of water needs to increase, as it is presently very shallow and the width of the river should be wider, like it used to be.

23	Do you think there is need for management/improved management of the waterways?	Yes, we really want increased management in the area, as there is a lot of pollution in the area, which affects the waterways. Through management we hope a lot of change will occur in relation to increase abundance of fish and number of fish species.
24	How are management restrictions enforced? Is it effective?	Enforced by the government. Yes, a lot of changes have occurred, which have increased the number of fish and other marine species. Some fish that were not seen in the area, began to re-appear in the waterways, since the implementations of management.
25	What challenges may occur as a result of having or	Challenges would be that the village would be far away from the MPA, as they have no auto-boat.

	implementing an MPA?	The result would be more fish species would be found in greater abundance. There would be difficulties in monitoring and supervising the qoliqoli/ MPA area, due to the villages distance from the water.
26	What benefits do you see from having an MPA?	There would be increases in the number and size of fish. This trend may also apply to other marine species like, mud lobster and crabs.