COMPONENT 2A - Project 2A2

Knowledge, monitoring, management and beneficial use of coral reef ecosystems

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FINAL REPORT

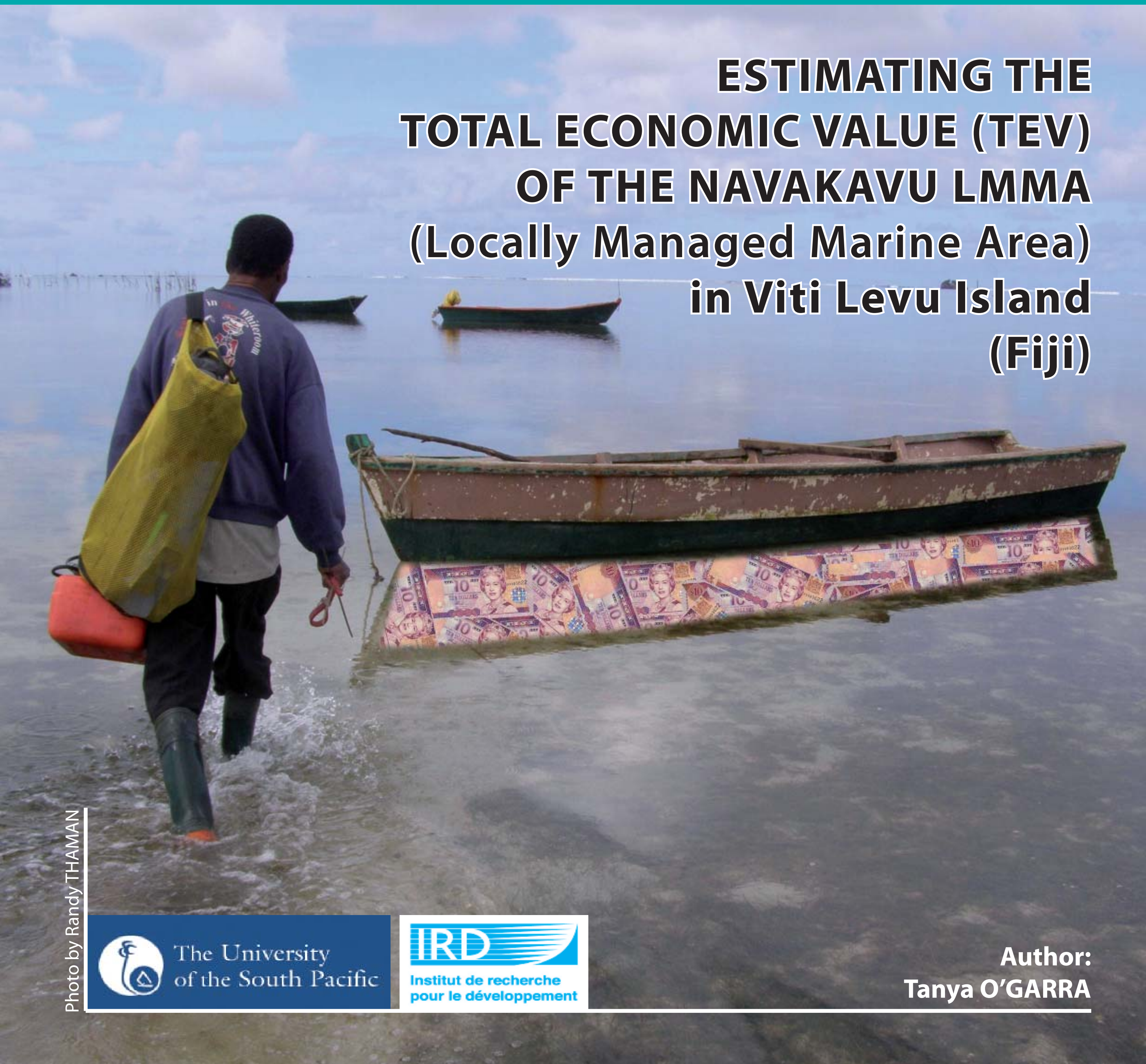

Photo by Randy THAMAN

ESTIMATING THE TOTAL ECONOMIC VALUE (TEV) OF THE NAVAKAVU LMMA (Locally Managed Marine Area) in Viti Levu Island (Fiji)

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CRISP
Coral Reef InitiativeS for the Pacific
Initiatives Corail pour le Pacifique

The University of the South Pacific

IRD
Institut de recherche pour le développement

The CRISP programme is implemented as part of the policy developed by the Secretariat of the Pacific Regional Environment Programme for a contribution to conservation and sustainable development of coral reefs in the Pacific.

The Initiative for the Protection and Management of Coral Reefs in the Pacific (CRISP), sponsored by France and prepared by the French Development Agency (AFD) as part of an inter-ministerial project from 2002 onwards, aims to develop a vision for the future of these unique eco-systems and the communities that depend on them and to introduce strategies and projects to conserve their biodiversity, while developing the economic and environmental services that they provide both locally and globally. Also, it is designed as a factor for integration between developed countries (Australia, New Zealand, Japan and USA), French overseas territories and Pacific Island developing countries.

The CRISP Programme comprises three major components, which are:

Component 1A: Integrated Coastal Management and Watershed Management
- 1A1: Marine biodiversity conservation planning
- 1A2: Marine Protected Areas
- 1A3: Institutional strengthening and networking
- 1A4: Integrated coastal reef zone and watershed management

Component 2: Development of Coral Ecosystems
- 2A: Knowledge, monitoring and management of coral reef ecosytems
- 2B: Reef rehabilitation
- 2C: Development of active marine substances
- 2D: Development of regional data base (ReefBase Pacific)

Component 3: Programme Coordination and Development
- 3A: Capitalisation, value-adding and dissemination of CRISP results
- 3B: Coordination, promotion and development of CRISP activities

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COMPONENT 2A

Knowledge, monitoring and management of coral reef ecosytems

PROJECT 2A-1:
Postlarvae (fish and crustacean) capture and culture for aquarium trade and restoking

PROJECT 2A-2:
Improvement of knowledge and capacity for a better management of reef ecosystems

PROJECT 2A-3:
Synopsis and extension work on indicators for monitoring the health of coral ecosystems and developing a remote sensing tool

PROJECT 2A-4:
Testing of novel information feedback methods for local communities and users of reef and lagoon resources

PROJECT 2A-5:
Specific studies on i) the effects on the increase in atmospheric CO_2 on the health of coral formation and ii) the development of ecotourism

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SUMMARY

This report presents results from the Economic Valuation of the Navakavu LMMA study, supported by the Research Institute for Development (IRD), the Coral Reef Initiative for the South Pacific (CRISP) and the Institute of Applied Sciences (IAS) at the University of the South Pacific. The aim of this study was to estimate the total economic value (TEV) of the coastal ecosystems within the Navakavu Locally Managed Marine Area. In addition, the study aimed to estimate the economic value of the LMMA management intervention, in order to assess the economic impact of establishing a protected area.

The Navakavu LMMA is the fishing ground for four villages (Nabaka, Namakala, Muaivuso and Waiqanake), which are located on the Muaivuso Peninsula, 13km to the West of Suva. The local communities have exclusive rights to extract fish and other resources from their fishing grounds. In January 2002, in response to concerns about declining fish catches, the community set up a "no-take zone" and implemented a number of resource use regulations, with the assistance of the Fiji LMMA network and USP.

Using several valuation methodologies – a contingent valuation questionnaire, a catch survey and benefits transfer from secondary data – this study has produced estimates of the economic value of key goods and services provided by the marine ecosystems within the Navakavu LMMA. These are: fisheries, coastal protection, waste assimilation, research and education benefits and bequest values.

Results show that the TEV of the coastal ecosystems within the Navakavu LMMA ranges between FJ$3,034,460 – $3,073,442 (US$1,764,221 – $1,786,885)[1] per year, and the present value of the coastal ecosystems, over a 20-year period, ranges between FJ$28,793,197 – 29,164,050 (US$16,740,231 - $16,955,843) using a10% discount rate. Fisheries associated with these coastal ecosystems makes up about 45% of this value. The next most important service provided is coastal protection which accounts for 33% of the TEV.

[1] Exchange rate used is FJ$1.72 to US$1 (using September 2006 exchange rate, FIBS (2006))

A simple analysis of changes in finfish catches over time suggests that there has been an average increase of 3% in finfish catch between mid-2002 and late-2006. It is suggested that this increase is attributable to the establishment of the LMMA in January 2002. The value of these changes to the local community comes to about FJ$63,000. It is expected that the economic benefit to local villages from the LMMA will continue to increase, as finfish and invertebrate catches continue to increase for several years.

ACKNOWLEDGEMENTS

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LIST OF ABBREVIATIONS

CRISP	Coral Reef Initiative for the South Pacific
CV	Contingent Valuation
FLMMA	Fiji network of Locally Managed Marine Areas
IAS	Institute of Applied Sciences
IRD	Institut de Recherche pour le Developpement
LMMA	Locally Managed Marine Area
MPA	Marine Protected Area
NOAA	National Oceanic and Atmospheric Administration
NPV	Net Present Value
OC	Opportunity Cost
OLS	Ordinary Least Squares
PA	Protected Area
PV	Present Value
TCM	Travel Cost Method
TEV	Total Economic Value
USP	University of the South Pacific
WtCT	Willingness to Contribute Time
WTP	Willingness to Pay

1. INTRODUCTION

This research is concerned with the economic valuation of the coral reef, lagoon and mangrove ecosystems within the Navakavu *Locally Managed Marine Area (LMMA)* in Fiji, in the South Pacific. There are many reasons why the economic valuation of ecosystems, such as coral reefs and mangroves, is important. Firstly, economic valuation can be used to estimate the full range of benefits provided by an ecosystem, thus, providing an indicator of the importance of the ecosystem to society. Secondly, it can be used to value the costs and benefits of different management options, including conservation, controlled fishing or ecotourism, and hence, assist in policy decision-making. Thirdly, valuation can help estimate the appropriate fees to charge resource-users, such as tourists and fishers, or the appropriate taxes to impose on individuals or firms causing negative impacts on the ecosystem in question. Lastly, economic valuation can be used for advocacy purposes, to 'get numbers on the table' to help policy-makers make efficient and equitable decisions regarding resource use and management.

In Fiji, economic valuation has not yet been formally adopted as an aid to coastal resource management. To date there have been only three economic valuations associated with coastal resources in Fiji (Lal and Cerelala, 2005; Sauni et al, 2005; Lal, 1990). These are reviewed in Section 3.1. Given the dearth of valuation studies associated with coastal resources in Fiji (and indeed, the South Pacific in general), the present study will represent a significant contribution to the literature.

The economic valuations carried out in the present study will provide information on the range of benefits provided by the Navakavu coastal ecosystems to *local villages*[2], as well as the full costs of resource-use. This information will allow village leaders and other stakeholders to make more efficient decisions concerning resource use and management.

[2] Most of the benefits and costs associated with use and management of the Navakavu *yavusa* resources are considered to accrue to local villagers. Other 'users' might include: researchers from USP and other organisations; the global' community, in terms of biodiversity and carbon sequestration benefits, and poachers. However, the benefits from research and ecosystem services not considered significant enough to warrant a valuation study, and the value of the resources to poachers has yet to be explored.

The valuation of the LMMA management interventions will provide an indicator of the economic desirability of different management options in the area. This information can help in the design of appropriate management tools.

It is hoped that the Navakavu LMMA economic valuation study will be the first of a series of similar valuation studies across a range of Fiji LMMAs. This research would help establish a TEV of coral reefs and mangroves for Fiji. It would also help identify the impacts of different management interventions on the economic value of marine ecosystems in Fiji.

1.1 Aims and Objectives

The main aim of this study is to estimate the total economic value (TEV) of the coral reef, lagoon, and mangrove ecosystems within the Navakavu LMMA.

Specifically, the objectives include:
> To identify the key goods and services provided by the coral reef, lagoon and mangrove ecosystems within the Navakavu LMMA.
> To identify the most appropriate tools for estimating the economic value of the key goods and services
> To estimate the economic value of these key goods and services, and the determinants of this value

In addition, this study will attempt to estimate of the net benefit of establishing and maintaining the LMMA. Although this exercise may appear to closely resemble the previous exercise (valuing the ecosystem goods and services), in fact, valuation of the LMMA involves estimating the change in the value of the ecosystem due to the establishment and management of the LMMA (Cesar and Chong, 2004). In the past, valuations of marine protected areas (MPAs) have often measured the total value of the resource protected. This is incorrect; *the value of the MPA is equivalent the change in its value due to the protection* (Spaninks and van Beukering 1997).

2. RESEARCH FRAMEWORK

This section presents the framework used to value ecosystem goods and services. It also briefly introduces the various valuation methodologies that may be applied to the present exercise.

2.1 Total Economic Value

Studies of the economic value of coral reefs and other ecosystems typically value these ecosystems in terms of the goods and services they provide that have market value i.e. those sold on the market. However, the value of an ecosystem is not simply the value of its marketed goods (e.g. fisheries), but encompasses all the functions, goods and services provided by the ecosystem. Indeed, the commercial value of the resources provided by an ecosystem may often be insignificant compared to its non-market values, which include both subsistence values and the value of ecosystem services. For example, mangrove forests (often considered to have minor commercial value) may provide significant protection to local communities from floods, storms and coastal erosion. This protection, although non-marketed, has economic value (e.g. damage avoided).

In order to assess the true economic value of an ecosystem, one needs to take into account all the functions, goods and services provided by this ecosystem, *whether they are marketed or not.* The functions of an ecosystem are described by Constanza et al (1997: 253) as the 'habitat, biological or system properties or processes of ecosystems'. These functions in turn provide the goods and services which benefit human populations. This includes direct uses, which may be extractive (e.g. fisheries) or non-extractive (e.g.

tourism), indirect uses (e.g. coastal protection), option and quasi-option values[3], and non-use values (e.g. biodiversity). It is these goods and services that are valued. Biological and system functions are valued inasmuch as they provide goods and services for human use. This does not mean they do not have intrinsic value, but economics relies on humans for valuations to be made (for a discussion on the anthropocentric assumptions underlying economic valuation, see Bateman et al, 2002 and Boardman et al, 2001).

The economic value of all the goods and services provided by an ecosystem make up the Total Economic Value (TEV) of an ecosystem. Figure 1 shows a standard illustration of the breakdown of TEV into its various categories of value, for coral reefs.

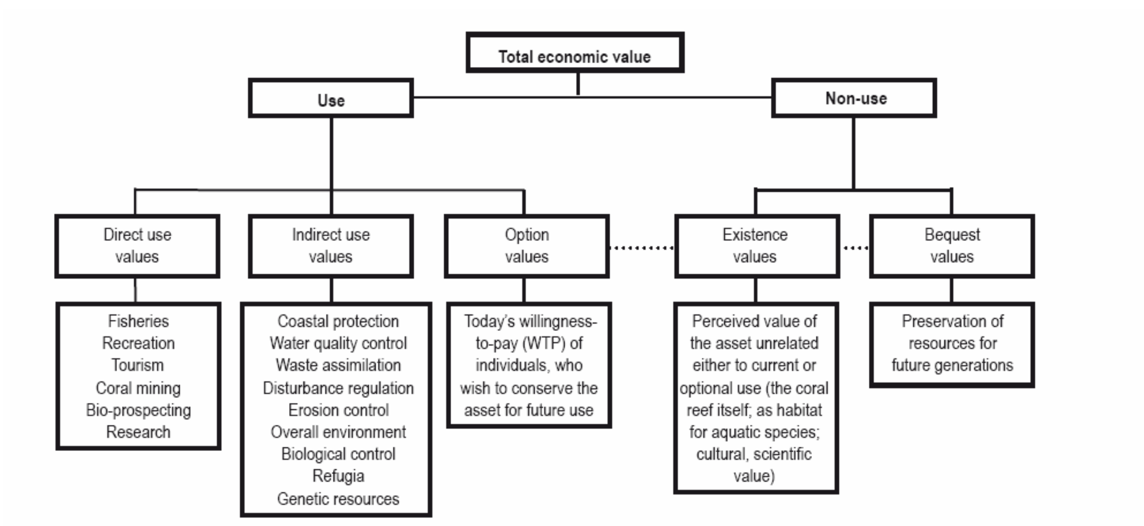


Figure 1: Total Economic Value of coral reefs (taken from Cesar and Chong, 2004)

If we are to estimate the TEV of a Marine Protected Area (MPA) such as the Navakavu LMMA, then it is also necessary to incorporate the economic costs of establishing and managing the PA (Hitchcock, 2000). These costs include: management costs (e.g.

[3] Option and quasi-option values are rather complex use values, which essentially represent the value today of potential future information about the ecosystem in question. They are an indicator of how much we value holding onto something that we do not know enough about at present, with the view that more will be learned in the future.

equipment, wages, infrastructure, etc), and opportunity costs (e.g. the value of alternative uses of resource).

Section 2.3 outlines the various methodologies available to the researcher for valuing ecosystem goods and services.

2.2 TEV over time

Most policy decisions relating to natural resources have impacts that extend over time. For example, the decision to set up a protected area will generate benefits and costs that extend over years. It is also often the case that decisions related to natural resources incur costs in the present, and benefits in the future. For this reason, it is useful to aggregate values over time, in order to properly assess the value of a project or policy decision. To do this, future costs and benefits must be *discounted* to the present value. Discounting accounts for the fact that money is worth less in the future than it is worth now.

Suppose we want to value the gross economic benefits arising from the use of a natural resource, such as a coral reef. By discounting all future values to the present, using an appropriate discount rate, we would obtain what is known as the Present Value (NPV) of the resource. The PV is calculated thus:

$$PV=\sum B_n /[1+i]^n \qquad (1)$$

where B is the gross annual economic benefits, over *n* years, at a discount rate of *i* (Boardman et al, 2001).

The choice of which discount rate to use is highly debated in economics. Use of an inappropriate discount rate may have a large effect on the results of a valuation study. As a result, most studies report values using two to three discount rates. In valuations of marine resources, discount rates used range between 5% and 15% (e.g. Gustavson, 2000;

Pendleton, 1995). This report will present results for three different discount rates: 5%, 10% and 15%, although discussion of results will focus on the10% discount rate.

Finally, calculation of the Net Present Value (NPV) of a project or natural resource (i.e. gross benefits minus costs), is calculated using the following equation:

$$NPV = \sum_{i=0}^{n} B_n /[1+i]^n \; - \; \sum_{i=0}^{n} C_n /[1+i]^n \qquad (2)$$

where B is the gross benefit per year, C is the cost per year, *i* is the discount rate and n represents the number of years that we are interested in (Boardman et al, 2001).

2.3 Valuation of goods and services

Table 1 presents the main approaches used to value the various goods and services provided by ecosystems. As can be observed, there are a large number of valuation techniques that can be used to value the goods and services provided by coral reef and associated nearshore ecosystems. Broadly, *production approaches* estimate the value of a good (or service) obtained from an ecosystem by subtracting all the costs associated with the production of that good (or service), from the total revenue obtained. Total revenue is typically calculated using market prices for the good in question. If the good (or service) is not sold on the market, but is used for subsistence purposes, then one may calculate the economic value of that good using the market price of a substitute product.

Stated preference techniques, such as Contingent Valuation (CV), and the travel cost method (TCM) are survey-based approaches which tend to be used when there is no market price for the good in question. This may occur because the good or service does not yet exist (e.g. new technologies) or because there is no market for the good (e.g. clean air). In these cases, surveys are used to elicit 'willingness to pay' values for carefully constructed scenarios, involving a hypothetical market in which the good in question is traded, and a meaningful payment method for the respondent to express their preferences. The most commonly used stated preference technique is CV. Although initially considered rather controversial, this method was formally accepted as a valid economic valuation methodology by the NOAA panel lead by Kenneth Arrow, which was appointed to assess the validity of CV estimates of the environmental impacts of the Exxon Valdez oil spill in Alaska in 1989 (Arrow et al, 1993).

Table 1: Approaches to valuing goods and services of coral reefs and mangroves*

Uses of coral reefs and mangroves	Valuation techniques
Direct extractive uses	
Fisheries (food or aquarium)	Production approach
Live coral & live rock trade	Production approach
Timber/ firewood (mangrove and coastal littoral forest)	Production approach
Subsistence products (e.g. fish, wood, medicines)	Market price, substitute price or CV
Bio-prospecting	Production method or resource rent
Direct non-extractive uses	
Tourism (consumer surplus)	CV, TC or HP
Tourism (producer surplus)	Production approach
Education & research	Production approach (expenditure on research) or CV
Indirect uses	
Coastal protection	Damage Cost or Replacement Cost approach
Waste assimilation	Production approach or Replacement Cost
Biological support (e.g. nurseries for fish)	Production approach
Carbon sequestration	Reduction in expected future damage from climate change
Option and quasi-option values	CV or other Stated Preference approach
Non-use values	
Existence	CV or existing donations to relevant charities
Bequest	CV or existing donations to relevant charities

* Where CV=Contingent Valuation; TC=Travel Cost method; HP=Hedonic Pricing

Damage Cost, Replacement Cost and Avertive Expenditure methods are used to value the physical protection to humans and human settlements, provided by the ecosystem. For example, coral reefs, mangroves and coastal littoral vegetation provide protection from floods, storms and erosion. The economic value of this protection can be estimated either by 1) valuing the cost of damage to land and homes, when the ecosystem is removed, 2) valuing the cost of replacing the coral reef of mangrove with protective infrastructure, or 3) valuing the cost of averting damage to land and homes.

For more detailed information on the valuation methods listed above, see Lal (2005), Cesar and Chong (2004), Bateman et al (2002) and Spaninks and van Beukering (1997).

3. LITERATURE REVIEW

There is a wide empirical literature on the economic valuation of marine and coastal ecosystems, especially coral reef ecosystems - although it is worth noting that only a minority of these studies have been published, and most are only available as consultancy reports. There are also a number of fairly comprehensive reviews of this literature (Cesar and Chong, 2004; Balusbramanian et al, 2003; Cartier and Ruitenbeek, 2000; Cesar, 2000). For this reason, the current study will only briefly review key studies from the past 5 years. For empirical evidence from previous studies, it is suggested that the reader refer to these reviews.

A number of these empirical valuation studies have estimated Total Economic Values associated with coral reef and mangrove ecosystems. These analyses are typically based on a combination of primary data (collected by the researcher in the field using questionnaires and interviews) and secondary data (obtained from government statistics and other studies). However, most of the reviewed studies estimate only one or two individual components of the TEV of the coastal ecosystem. These shall be reviewed first, as the results reported in these studies are often used to compose a TEV of coastal resources for a region.

3.1 Direct use values

Most coastal ecosystem valuations focus on direct use values associated with the resource, in particular fisheries and tourism. This is most likely because - due to their commercial nature - they are easier to measure and of more obvious interest to policy makers. Fisheries are considered an *extractive* direct use value of coastal ecosystems (i.e. resources are removed from the ecosystem). Other extractive uses include: coral mining, harvest of live corals for the aquarium trade and wood production from mangroves. Tourism is a *non-extractive* direct use value associated with coastal ecosystems, particularly coral reefs (i.e. individuals use it directly, but do not remove anything). Research and education activities associated with coral reefs/ mangroves may also be considered non-extractive direct use values of these ecosystems.

Extractive direct use valuations

To date there have been only three direct use valuations associated with coastal resources in Fiji (Lal and Cerelala, 2005; Sauni et al, 2005; Lal, 1990). Two of these (Lal and Cerelala, 2005; Sauni et al, 2005) value the extraction of live coral for the aquarium trade. In both studies, only the financial revenue to local villagers from coral reef harvest is considered; environmental and social impacts are not assessed (and hence, the sustainability of the extraction processes is ignored).

Lal and Cerelala (2005) use market prices to estimate the value of live coral and live rock production in two villages (Uluibau and Namada) involved in the trade. Assuming a 5-year period, each villager is estimated to receive a NPV of FJ$12,855 from the harvest of live coral, and FJ$23,187 from harvest of live rock (based on 2004/2005 prices). Similarly, Sauni et al (2005) use market prices to estimate financial returns to households associated with live coral harvest in the village of Waiqanake near Suva. They find that weekly cash income from coral harvesting comes to FJ$60/week, compared to approximately FJ$40/week from engaging in fisheries (using 2002 prices). Unfortunately, this study does not provide an estimate of the flow of financial benefits (net present value) associated with coral reef harvest over time.

The study by Lal (1990) used market prices to estimate the benefits from mangrove forests in terms of their contribution to fisheries, wood production (in both commercial and subsistence sectors) and traditional uses. Results indicated that 350 hectares of mangrove forest at Raviravi were valued at F$1,014,000, and 242 hectares of mangrove at Dreketi were valued at F$713,000 (using 1990 prices).This corresponds to an annual service of F$292 per hectare, at a 10% discount rate.

Other studies to have estimated the economic benefits from fisheries include: Hargreaves-Allen (2004), which estimates the value of fisheries to the Sampela Community in Wakatobi Marine Park, Sulawesi, at 94 million Ruipah per km^2 per year (based on 2004 market prices); the gross present value (PV) was estimated at over Rp20 billion (over 20 years with a 10% discount rate). Cesar et al (2002) estimates the gross value and net profits in 2002 associated with aquarium fish off the Kona Coast in Hawaii at: US$1.85m, and US$0.7m respectively. Gustavson (2000) uses market prices to estimate the net annual value of fisheries associated with Montego Bay at J$7.6m, and NPV over 10 years is estimated at J$76m (10% discount rate; using current 1998 prices).

A number of studies do not just estimate the direct use value of the resource as it stands, but value alternative management or use scenarios, with an aim of identifying the option with highest economic value. For example, Hodgson and Dixon (1988; 2000) estimate the PV of gross revenue for fishing in Bascuit Bay, in the Philippines, under a logging scenario versus a non-logging scenario, at US$9,108, and US$17,248 respectively (based on 10% discount rate and constant 1986 prices). Similarly, Cesar et al (2000) estimate the economic yield from fisheries in the Portland Bight Protected Area, in Jamaica, under a “with” versus a “without” management scenario. In the “without management” scenario, it is estimated that, due to the open access nature of the fishery, all profits are reduced to zero. In the "with management" scenario, the profits obtained fishing is calculated at US$6.78m/year for the PBPA area (using 1999 fish prices). These studies have greater value for decision-makers, as they provide information on the economic value of alternative uses to which a resource can be put.

Non-extractive direct use valuations

Tourism values associated with coastal areas are usually estimated by considering the revenue from tourism and recreation associated with a particular area. There are also a number of studies that use contingent valuation surveys to elicit preferences for tourism/ recreation options in the area of interest.

Recently, Brander et al (2006) carried out a meta-analysis of 52 tourism/ recreation valuations of coral reefs. They note that the value of tourism and recreation associated with coral reefs in Southeast Asia and Australia is very similar, at about US$300 per visitor per visit (using 2000 prices). An overall value for all countries comes to US$184 per visitor per visit (although the median is US$17 indicating a very skewed distribution of values).

Somewhat closer to home, Spurgeon et al (2004) estimated the tourism value of Samoa's coral reefs, using data on tourism expenditures, at US$23,000 per year (for all Samoa). Consumer surplus (CS) associated with tourism and recreation was estimated using the benefits transfer method at US$50,000 per year. These values highlight the potential error that arises if using data on revenue only: the CS is more than twice the value estimated through use of tourism-generated revenue.

Only two studies to date have estimated education and research values associated with coastal ecosystems, and both were carried out over a decade ago. Spurgeon (1992) estimates the value of research and education associated with coral reefs in Belize and Panama, using budget allocations from research institutions in the UK and the US. A research value of US$150,000 per year is calculated for Belize's reefs and $2.5 million for Panama's reefs (using 1991 budget allocations in both cases). De Groot (1992) estimates the value of research and education associated with the Galapagos Marine Park using research expenditures and expenditures on field work, training and materials, at

US$2.73 per hectare per year. No other studies that estimate the economic value of research and education associated with coastal ecosystems have been identified.

3.2 Indirect use values

Due to the challenge involved in measuring indirect use values, such as the habitat function provided by coral reefs or mangroves, most existing indirect use valuations have focused on coastal protection (see McKenzie et al, 2005; Gustavson, 2000; Cesar, 1996). Coral reefs, mangroves and coastal littoral vegetation provide protection to agricultural land and human settlements from floods, storms and erosion. The economic value of this protection can be estimated either by 1) valuing the cost of damage to land and homes, when the ecosystem is removed (*damage cost approach*), 2) valuing the cost of replacing the coral reef of mangrove with protective infrastructure (*replacement cost approach*), or 3) valuing the cost of averting damage to land and homes (*avertive expenditure approach*).

In Constanza et al (1997), estimates of the economic value of the world's ecosystems were assessed using a benefit transfer approach (for more information on benefits transfer see Bateman et al, 2002). The coastal protection function of coral reefs and mangroves were estimated at US$275,000/km^2/yr, and US$183,900/km^2/yr respectively (in 1996 US$). These values were used in Sisto (1999) to obtain estimates of the value of coastal protection provided by coral and mangroves in Fiji specifically. These values however, should only be considered broadly indicative, as they were obtained by aggregating values from across the world.

Another important indirect use values is waste assimilation. Mangroves and seagrass beds effectively process inadequately treated sewage and other waste, by absorbing excess nutrients, before this enters the sea (and affects fisheries and health). Valuation of this function would involve using the *replacement cost approach*, by which the value of the mangrove and seagrass bed waste assimilation function would be estimated as the value of the waste treatment system needed to replace it. Very few studies have estimated the value of this function. De Groot (1992) estimated the waste recycling function of the Galapagos marine area (specifically the sea shelf) at US$5,800/ km^2/yr, by calculating the cost of an artificial water purification technology needed to replace it. Woodward and Wui (2001) carried out a meta-analysis of 39 wetland valuation studies, and predict that the water purification function of wetlands approximates US$103,043/$km^2$/yr (in 1990 US$). Constanza et al (1997) place the value of waste treatment function of mangroves at US$669,600/ km^2/yr (in 1996 US$).

Other indirect use values include: habitat and biological control, and water quality control. Due to the difficulty inherent in measuring the relative contribution of an ecosystem to these services and functions of nature, there are very few valuation studies that have estimated the economic value of these indirect use values.

3.3 Option values

Option values (and the closely-related concept of *quasi-option values*) are rather complex use values, which essentially represent the value today of potential future information about the ecosystem in question. They are an indicator of how much we value holding onto something that we do not know enough about at present, with the view that more will be learned in the future.

Very few studies have attempted to estimate these values, and much of the related literature is theoretical. These values are not considered relevant to this study, as they typically apply to unique ecosystems (e.g. those with endemic species, or those containing the last remaining numbers of a particular species) which are in danger of being completely destroyed. Neither of these conditions applies to the Navakavu *iqoliqoli*.

3.4 Non-use values

Non-use values refer to the value attached to a resource, independent of one's use of it. There are two main non-use values: bequest value, and existence value.

Bequest values represent the value attached to preserving an ecosystem for use by future generations, independent of one's own use of the ecosystem. These are considered of particular relevance in Fiji, given the importance that people attach to their way of life (Turner, 2000).

There have been very few studies to directly estimate bequest value, and only one study to date has estimated bequest value associated with the marine environment. In this study, Hargreaves-Allen (2004) used a CV survey to estimate the bequest value associated with coral reefs in the Wakatobi Marine Park in Sulawesi, amongst local villagers. The bequest value was estimated at Rp412,000/km^2 (Present Value of Rp91 million), a fifth of that associated with all the reef's benefits.

Other studies include those by Walsh, Loomis and Gillman (1984) – see Riddel and Shaw (2003) – which estimated bequest values for wilderness conservation, and Greenley, Walsh, and Young (1981), which was the first study to estimate bequest values associated with preserving water quality in the South Platte River Basin in Colorado. More recently, Riddel and Shaw (2003) used a CV survey to value respondent's willingness to protect future generations from the impacts of nuclear waste storage near their homes. They found that respondents were willing to accept about half of the proposed compensation payments, in order to protect future generations. The bequest value estimated thus came to $8,828 per household.

Similarly, Ruijgrok (2006) used a CV survey to estimate bequest values associated heritage conservation in the Netherlands. They found that people who visited heritage buldings were willing to pay €11.88 per year per household to preserve historic buildings for future generations, which amounts to $33.8m per year.

Other studies addressing bequest values (e.g. Vesely, 2007; Togridou et al, 2006), only do so in the context of wider 'non-use values'. In these studies, CV surveys are typically used to estimate non-use values as a whole (including existence, option and bequest values), and bequest values are simply assessed by asking respondents about the relative influence of the bequest motive in their WTP bid.

Existence values refer to the value associated with the actual existence of an asset (e.g. ecosystem, cultural heritage) independent of one's use of the asset (hence: "non-use value"). For example, many people donate towards "save the rhino" or "save the rainforest" charities, without ever expecting to see or visit either a rhino or a rainforest. What they value is the continued existence of this asset.

Valuation of existence values is a highly contested topic in environmental and resource economics, and benefit transfer exercises are not recommended at present (Adger et al, 2002). Studies of existence values of marine resources are scant: Spash et al (2000) used the contingent valuation method to estimate non-use values associated with marine parks in Jamaica and Curacao, and found non-use values to come to US$2.08/yr per person (Curacao) and US$3.24/yr per person in Jamaica.

It is usually the case that non-use values are estimated in aggregate (see above for discussion), and bequest and existence values considered together. For example, Constanza et al (1997) estimate an overall non-use value, which they term "cultural value" for coral reefs, which comes to a tiny US$100/km/yr (in 1994 US$). It is considered that this value is only indicative of the lack of studies undertaken in this area, and does not reflect the true non-use value associated with marine resources worldwide.

Overall, the estimation and use of non-use values in policy is often contested, due to the difficulty in measuring these values. Furthermore, the use of existing values in benefit transfer exercises is also contested given that most non-use valuations have been carried out in the US. In a summary of these developed-country values, Pearce (1993) indicates that non-use values for wild species range from US$1.2 to US$64 per person per year, and for wilderness areas range from US$9 to US$ 107 per person per year. These values are unlikely to be applicable in developing country contexts, such as Fiji.

3.5 Total Economic Value Estimates

In 1997, Constanza and colleagues published a paper in *Nature,* in which the total economic value of the world's ecosystems was estimated. Each ecosystem was broken down into its component goods and services, and the extent and economic value of these goods and services were estimated using figures from a wide range of other studies. The goods and services provided by coral reefs that were valued in this study, included: disturbance regulation, waste treatment, food production, raw materials and recreation. Each hectare was calculated to produce $6,075 of services annually, and $375billion annual global benefit.

Although the study was criticised on the basis of the benefits transfer and aggregation techniques used (see Bockstael et al, 2000; Toman, 1998), the economic values reported in this paper are often used in subsequent valuations of ecosystems. For example, White et al (2000) compare their own estimates of the economic value of coral reefs in the Philippines with estimates obtained using values reported in Constanza et al (1997). Similarly, in a study of the value of Fiji's ecosystems, Sisto (1999) mostly uses the values provided by Constanza et al (1997) to produce estimates.

Most studies assessing the TEV of coastal ecosystems address individual sites (e.g. an individual MPA, or a threatened coastal area), or coral reefs/mangroves of individual countries or regions. To date, there has been one TEV study carried out in Fiji (Sisto, 1999) which estimates the TEV of Fiji's ecosystems. Using secondary data (mostly from Constanza et al, 1997) the TEV of coral reefs and mangroves, based on recreation value (for corals), disturbance regulation and food (for reef and mangroves), is estimated at FJ$849m/year (global value). These values however must be interpreted with caution, since they were mostly obtained by transferring values produced by Constanza et al (1997) to the Fiji context.

Mohd-Swahwahid and McNally (2001) carry out a TEV study for all of Samoa's ecosystem resources. Using market prices they estimate the net value of the fishery; using contingent valuation, they estimate the economic value associated with recreation and ecological functions of the marine environment; and using benefit transfer methods, they estimate the value of raw materials (other than fish/shellfish) and cultural values associated with the marine resource. The TEV of the marine ecosystems to Samoan residents is estimated at ST$18,533,332 per year (of which fisheries makes up 84%). The global value is over 10 times greater at ST$225,982,083, due to the global value of the ecological functions (all other values are assumed to remain the same as for the Samoa-only valuation). This study is more rigorous than Sisto (1999), and considered a useful source of information on South Pacific ecosystem values.

Other TEV studies in the South Pacific region include: Cesar et al (2000), which estimate the TEV of Hawaiian coral reefs at $9.7bn (annual benefits $385m), assuming no change from present state of coral reefs (over 50 years period assuming 3% discount rate).

Finally, there are a number of TEV studies in South East Asia, particularly Indonesia and the Philippines. For example, White et al (2000) estimated the TEV of Philippine coral reefs, using economic values for fisheries (local consumption and sale, and live export), tourism, coastal protection and aesthetic/ biodiversity services provided by the reefs. They estimated that the TEV of Philippine coral reefs comes to US$1.35bn/yr (assuming only 50% are used in a sustainable manner, and that there is no destructive fishing and moderate tourism).

4. STUDY SITE: THE NAVAKAVU LMMA

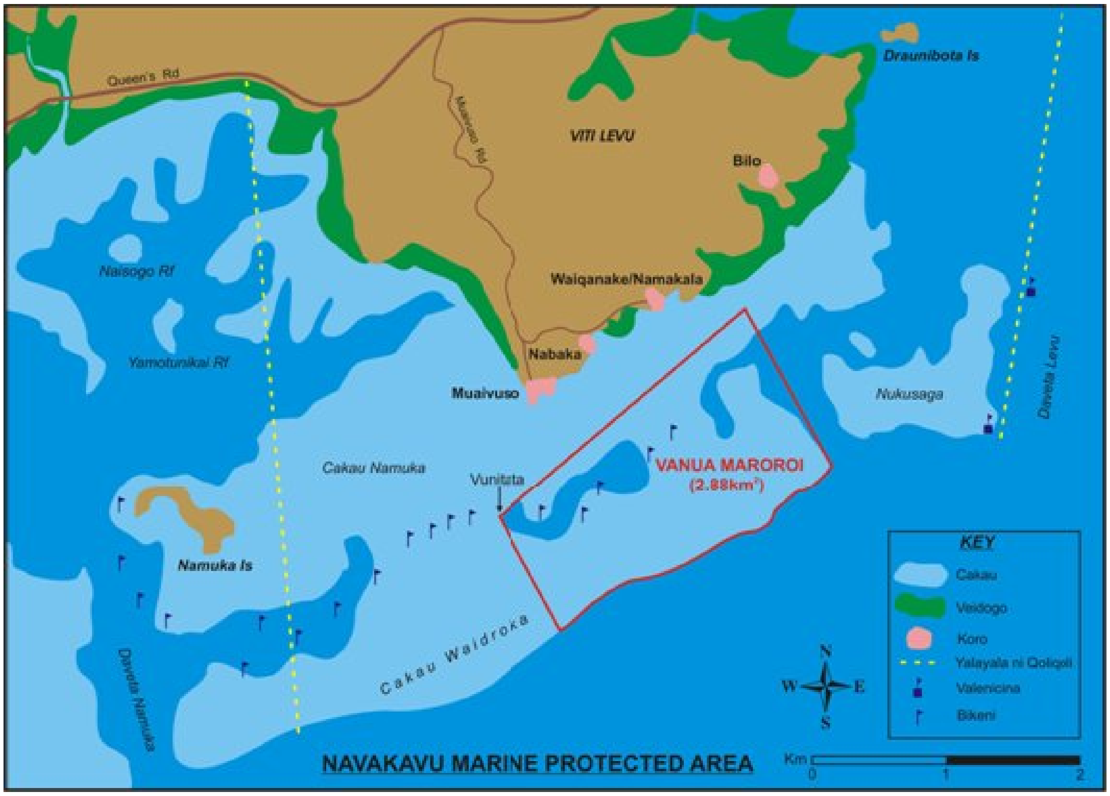
4.1 Description of study site

The *Vueti Navakavu* LMMA is located on the Muaivuso peninsula, 13km west of Fiji's capital, Suva. There are four villages on the peninsula: Muaivuso, Nabaka, Waiqanake and Namakala, with a total residential population, in 2003, of just over 600 inhabitants (Vueti Navakavu Project Site Report, August 2003). The land around these villages is owned by the villages themselves, which together form a '*yavusa'* - this refers to a clan and its land and waters. In Fiji, the land, coastal waters and indigenous people living on the land, are treated as a single, indivisible unit which is referred to as a *vanua*. The *vanua* may comprise one or more *yavusa.* The *yavusa* Navakavu covers (144,105 acres) 580km^2 of land, and 18.5 km^2 of coastal waters.

Local villages in Fiji have property rights over their land. However, the situation with coastal waters is a little more complex. Although the *vanua* or *yavusa* may incorporate coastal waters within their boundaries (extending from the shore to the seaward limit of the reef), local villagers only have customary fishing rights to these coastal waters, which are known as '*iqoliqoli'*.

The peninsula is surrounded by a fringing coral reef, mangroves, and remnants of coastal littoral forest. These are shown in Figure 2. The yellow dotted line indicates the demarcation of the *iqoliqoli* area (fishing grounds to which villages have customary fishing rights). This also coincides with the LMMA demarcation. The solid red indicates the 'no-take zone' (NTZ), where all fishing and other extractive activities are not allowed. The light blue areas represent coral reefs (in Fijian: "*cakau"*) and the green areas are mangroves ("*veidogo"*).

Figure 2: Map of Navakavu LMMA



The LMMA was formally established in 2002, after early initial support from Professor R. Thaman of the Faculty of Islands and Ocean (FIO) at the University of the South Pacific (USP), through the efforts of the staff and students of the Institute of Applied Sciences (IAS) at USP, and in association with the Fiji Locally Managed Marine Areas Network (FLMMA). The first step towards the establishment of the Navakavu LMMA involved a community-based marine resource management and sustainability workshop, held in Muaivuso village in August 1999. During this workshop, threats to the sustainable use of local resources were identified, and possible management interventions discussed and developed.

In November 2001, there was a *yavusa* meeting, involving local council leaders and chiefs. As a result of this meeting, village leaders/chiefs agreed to impose a two-year taboo (“no-take zone”) on an area of their fishing ground. This initial NTZ was established in January 2002, in the North-eastern corner of the *iqoliqoli.* It was agreed that the taboo would be reviewed after the two-year period. The community then requested assistance from the Fiji Locally Managed Marine Area (FLMMA) Network team, to establish a marine conservation management plan. In the first week of September, 2002, the FLMMA team facilitated the *yavusa* Navakavu Management Planning workshop, during which time, management aims and interventions were discussed and developed. In March 2003, the management interventions were implemented, and community-based monitoring began.

In January 2004, the NTZ was opened up to fishing after 2 years of protection. A second NTZ was established in January 2004 – this is the NTZ indicated by the solid red line in Figure 1. After results from several biological monitoring surveys (throughout 2004 to 2006) confirmed that fish and invertebrate stocks were increasing modestly, it was decided by the local chiefs, elders and *iqoliqoli* committee that the NTZ would be permanent. For more information on the history of the Navakavu LMMA process, see the ‘Vueti Navakavu Project Site Report’, August 2003.

4.2 Goods & services provided by coral reefs & mangroves in Navakavu LMMA

This study aims to estimate the TEV of the ecosystems (coral reef and lagoon, and mangrove) within the Navakavu *iqoliqoli*. The first step is to identify the key goods and services provided by these ecosystems. As noted earlier, the present study estimates values to local villages, as they are considered to be the main users of these resources, and it is they who will incur most of the costs and benefits associated the resource. The relative importance of the different goods and services listed in Table 2 was assessed using existing studies (Kronen, 2004; Thaman and Tamata, 1999), and expert opinion from individuals who have carried out work in the area[4].

Based on this information, the most important goods/ services provided by the coral reef , foreshore and mangrove ecosystems within the Navakavu *iqoliqoli* are considered to be: *fisheries* (commercial and subsistence) and *research and education* (through money earned and knowledge gained by local villagers associated with research and education activities in the field).

The *coastal protection* afforded by coral reefs and mangroves from storms and flooding may also have a significant indirect use value to local villages. Cyclones and tropical storms occur relatively frequently in this part of the world, and coral reefs and mangroves offer key protection to coastal villages from waves and floods. In addition, given the basic infrastructure in the four villages of the Navakavu area, it is considered that the *waste assimilation* function of mangroves is important. Organic nutrients, such as those from human and animal waste, may be retained and recycled by mangroves, which effectively act as a water purification system.

Other important indirect use values include: provision of habitat and refuge for marine species, and maintenance of biodiversity. As noted in Section 3.2, valuation of these various functions is very complex, and will not be carried out here. Furthermore, services such as maintenance of biodiversity and the provision of habitat may show up in the valuations of other goods and services, such as fisheries. This is because goods, such as fisheries, depend on habitat and biological diversity provided by the coastal ecosystems. This is most likely the reason why the values attributed to these particular indirect services provided by coral reefs and mangroves (specifically: 'biological control' and 'habitat/refugia') in Constanza et al (1997) are quite low; for example the value of these services associated with coral reefs is less than 1% of the value of coastal protection.

[4] Prof. Randy Thaman, Department of Geography, USP; Semisi Meo, Institute of Applied Sciences and FLMMA Network, USP; Dr. Mecki Kronen, Community Fisheries Scientist, South Pacific Commission; Isoa Korovulavula, Institute of Applied Sciences, USP

Table 2: Checklist of TEVs for coral reefs, foreshore/ lagoon and mangrove

	Importance of good or service in *yavusa* Navakavu [1]		
	Coral reef	**Foreshore/ lagoon**	**Mangrove**
Direct extractive use			
Fin-fisheries (commercial)	***	***	*
Fin-fisheries (subsistence)	***	***	*
Other fisheries e.g. shellfish (commercial)	*	***	**
Other fisheries e.g. shellfish (subsistence)	*	***	**
Other food (e.g. seaweed)	*	*	**
Timber/ firewood (commercial)	-	-	-
Timber/ firewood (subsistence, local use)	-	-	*
Non Timber Forest Products (e.g. medicines, dyes)	-	-	*
Curio/ jewellery/ handicrafts	-	-	-
Coral/ live rock for aquarium trade [2]	*	-	-
Aquarium fish	-	-	-
Coral blocks/ lime	-	-	-
Direct non-extractive use			
Tourism/ recreation	-	*	-
Cultural/ religious activities	-	*	-
Research/ education	***	***	***
Indirect use			
Coastal/ shoreline protection	***	-	***
Waste assimilation	-	-	***
Maintenance of biodiversity	**	**	**
Support for other key habitats & species	**	**	**
Non-use values (independent of use)			
Bequest value	**	**	**
Existence value	?	?	?
Option & quasi-option values			
Future possible use (e.g. bio-prospecting)	?	?	?
Information	?	?	?

[1] Importance of good/service to local villages ranges from zero stars (no importance) to 3 stars (***) (very important). A "?" indicates that there the importance of this value to local villagers is unknown.

[2] Extraction of coral/ live rock for the aquarium trade was practiced in the past, and may resume in the near future (see Sauni et al, 2005).

It is considered that *bequest values* may be particularly relevant, given the importance that local communities in Fiji attach to their way of life (Turner, 2000). Bequest values represent the value attached to preserving an ecosystem for use by future generations, independent of one's own use of the ecosystem.

Although the Navakavu reef and mangroves will certainly provide some global benefits in terms of carbon sequestration and biodiversity, these will not be considered in this study, as they do not represent major goods or services to local users. In addition, there appears to be no tourism in the area.

Notably, the relative contribution of the different ecosystems to some of the goods/ services listed in Table 2 cannot be easily separated out. For example, it may not be clear how much mangroves contribute to fisheries in the lagoon, compared to coral reefs. *For this reason, economic values in this study will be estimated for combined ecosystems.*

5 VALUATION OF THE NAVAKAVU LMMA: STUDY DESIGN

In the previous section, the key goods and services provided by the coral reefs, lagoon and mangroves within the Navakavu LMMA were identified. The next step is to identify the most appropriate valuation tools and data collection approaches for each good/ service being valued. These are presented in Table 3.

In this total ecosystem valuation, we are estimating what Gustavson (2000) calls the 'value at risk'. This represents the total local use values that would be lost *if the resource were completely degraded* (Gustavson, 2000). The assumption is that, in the absence of new management interventions or new threats to the resource, the benefits currently received from reefs and mangroves will not change. This rather simple valuation will provide a rough baseline economic value. Of course, there have been management interventions in the area as a result of the establishment of the Navakavu LMMA in 2002.

Thus, if we calculate the present value (PV) over the next 10 to 20 years of the Navakavu LMMA ecosystems in their present state, we must be clear about our assumptions: in this case, as stated, we assume that the current situation will remain constant in the absence of new interventions or threats.

Table 3: Key goods/ services in Navakavu iqoliqoli & valuation tools used

Key goods and services	Valuation tool	Data collection
Direct extractive use		
Fisheries (commercial)	Production approach	Catch survey in villages, and market prices from secondary sources
Fisheries (subsistence)	Production approach	Catch survey in villages, and market prices from secondary sources
Direct non-extractive use		
Research and education	Production approach	Interviews with research institutions & key informants in villages
Indirect use		
Coastal protection	Benefits transfer	Secondary data on cost of protection
Non-use		
Bequest value	CV	Surveys in villages

It is important to note that this 'value at risk' does *not* represent the potential rent owed to local communities by other users of the *iqoliqoli* (e.g. resorts), unless it was completely degraded as a result of its use. Even if the local communities leased their rights to the *iqoliqoli,* they could not claim the benefits associated with coastal protection, waste assimilation or bequest values, as these indirect use benefits would still accrue to the villages (assuming the reefs and mangroves are intact). Only the fisheries value – or a fraction of it – would be payable to the local communities, if they leased their rights to the *iqoliqoli.* How much of the fisheries value would be payable to them by other users depends on how much of their current catch they are forgoing. If the local users were completely restricted from extracting fish from the *iqoliqoli* as part of the lease contract, then the full (net) value of the fisheries benefit would be payable to them.

5.1 Study design for valuation of fisheries

The analysis of catch data depends on the availability of reliable and systematic fisheries data. Long-term fisheries statistics for the Navakavu area do not exist; only two small-scale socio-economic surveys of fisheries activities in the *yavusa* Navakavu area have been carried out (e.g. Cakacaka (2007); Kronen, 2004). These involved snapshot surveys of catch activity; in order to add to these existing studies, the present study has generated primary data using questionnaires. These are described below.

5.1.1. Description of household questionnaire

This study involved two survey studies: a household survey that was carried out with the heads of household (or their spouse), and an individual survey that was carried out with all other individuals of adult age (over 21). The household questionnaire was the main questionnaire used in this study. It was used to elicit household characteristics, including household catch data, as well as information about the respondent themselves, and bequest values. The shorter individual questionnaire was essentially a CV questionnaire, designed to elicit bequest values. The individual questionnaire is described in Section 5.2.1.

The pilot household questionnaire was developed by the researcher during September 2006, and completed using information gleaned through pre-pilot interviews carried out in the field on the 9th October 2006. The pre-pilot interviews involved the assistance of one local villager, who arranged the interviews and acted as translator where necessary. A draft version of the household questionnaire was tested in the field on the 12th October 2006. Questionnaires were administered (in Fijian) by two local villagers, chosen by the *iqoliqoli* committee. These villagers had been trained in survey administration by the FLMMA network, and had previous experience in questionnaire administration. They were also trained by the researcher in administration of the pilot survey for this study. A total of fifteen pilot questionnaires were collected, and these were inputted and analysed by the researcher over the following week. On the basis of the pilot survey findings a final questionnaire was drafted.

The final household questionnaire established: socio-demographic characteristics of the respondent (e.g. gender, age, education levels etc) and their household (e.g. number of people living in household, family composition etc); livelihood activities of the respondent and the household; wealth indicators of the household (e.g. cash income, savings, boat ownership etc); individual attitudes towards the *iqoliqoli* and towards the LMMA; and other uses of the *iqoliqoli* (other than fishing/gleaning).

The questionnaire included two sections addressing <u>fishing activities</u> related to the Navkavu *iqoliqoli*. The first section established general fishing activities per household, including: average fishing effort per household (in terms of average frequency and time spent fishing/gleaning); fishing grounds; gear used by each household; and most frequently harvested species.

The second section aimed to measure the catch (fish and invertebrates) harvested during the last trip. For this section, interviewers were required to record: the type of fish or invertebrate species caught, the total number of fish/ invertebrates caught, their average size (see Section 7.1 for discussion on size measurement), and the number and size of fish/ invertebrates sold, used for household consumption and/or given as gifts (to extended family, for community gatherings or other ritual obligations). Size data was obtained with the aid of a ruler (all interviewers were provided with a ruler).

This process was repeated for each species in each household's catch. Preferably, the interviewer would help to count and measure the fish themselves; however, it was not always possible for them to see the catch (for example, if the last fishing trip had been 2 days before and the catch already used) so in these cases data was gathered based on the respondent's memory. Although this is clearly a limitation of the study, there were insufficient resources available to allow for a longer study that would allow for the collection of catch data on the day of the catch.

Finally, the questionnaire aimed to establish how much respondents would be willing to contribute (in time and/or money) towards the conservation of the Navakavu *iqoliqoli* for future generations, *independent of their own use of the resource.* The structure of this question is described in Section 5.2.1 (bequest value study design).

The full household questionnaire can be found in Annex 1.

5.2 Study design for valuation of bequest value

Given the lack of a market for non-use values, bequest values can only be measured using stated preference survey methods, such as contingent valuation (CV). This is the approach used here.

5.2.1. Description of contingent valuation questionnaire

The individual questionnaire is a shorter version of the household questionnaire, described above; all questions relating to the household – including catch questions – were omitted. Thus, the individual questionnaire established: socio-economic characteristics of the respondent; livelihood activities of the respondent; attitudes towards the *iqoliqoli;* and the contingent valuation (CV) question. Note: the CV question was included in the household questionnaire too.

The CV question aimed to establish how much respondents would be willing to contribute (in time and/or money) towards the conservation of the Navakavu *iqoliqoli* for future generations, *independent of their own use of the resource.* This was measured using a <u>contingent valuation</u> (CV) approach.

Firstly, respondents were reminded of the benefits that the *iqoliqoli* provides them (e.g. fish, shellfish, protection from storms etc), and reminded that good management ensures continued benefits. Then they were presented with the following scenario: "*I would now like you to imagine that there was a threat to the marine environment in the Navakavu iqoliqoli. Imagine that this threat could destroy the marine environment."* They were then asked to imagine that, in order to prevent this destruction, the community decided to close of the *iqoliqoli* to everyone. At this stage, interviewers were required to ask respondents if they understood the scenario. Any questions were explained using standard answers that were agreed-upon during training.

Respondents were then asked to imagine that *even if they couldn't use the iqoliqoli* anymore, they still had the same amount of food and income from other activities. Again, interviewers were required to check that respondents understood the scenario.

Finally, respondents were asked to imagine that this restriction on their use of the *iqoliqoli* were to last their lifetime, but that future generations would definitely be able to use it for all activities. They were also advised however, that for future generations to be able to use it, the community would need to give money and time towards conservation efforts.

Respondents were first asked whether they would be willing to contribute some of their time to help towards the recovery and conservation of the *iqoliqoli.* Those who said yes were asked for their willingness to contribute time (WtCT) per week, using a payment ladder elicitation format (Figure 3). This involves asking respondents to choose their maximum WTP (or in this case: WtCT) for the good being valued, from a series of amounts read out by the interviewer, starting at zero and increasing by discrete amounts to a maximum. In this case, interviewers presented respondents with the payment ladder on a card, whilst they read out the values.

Figure 3: Example of payment ladder used to establish WtCT

"How many hours a week would you be willing to contribute for the next five years?"

TICK ONE ONLY:

Half an hour per week	
45 minutes per week	
1 hour per week	
1 ½ hours	
2 hours	
2 ½ hours	
3 hours	
3 ½ hours	
4 hours	
5 hours	
6 hours	
8 hours	
10 hours	
12 hours	
15 hours	
18 hours	
21 hours	
25 hours	
More: (specify…….………….)	

Respondents were also asked whether *instead* of contributing time, they would be willing to contribute money. Those who said yes were asked for their willingness to pay (WTP), using a payment ladder with monetary values (starting at zero and increasing to $100). Any zero WtCT or WTP responses were followed up with an open-ended question, asking why they were not willing to contribute time or money. Finally, respondents were asked whether they found this question hard. Surprisingly, very few admitted to finding it difficult (20%); this does not correspond with findings in the CV literature on extent of task difficulty associated with this method.

5.3 Study design for valuation of research and education value

In order to estimate the economic value of research and education activities related to the *iqoliqoli* and LMMA in the *yavusa* Navakavu, gross financial expenditures have been used. These include: payments received for food, lodging and fees paid by researchers and students; capital equipment donations (e.g. boats and other gear); access fees for the *iqoliqoli;* and other direct payments to local communities for support and assistance with research and education activities. Data on number of research/ education visits and payments made per visit has been obtained from the FLMMA liaison officer for the *yavusa* Mavakavu (Semisi Meo), and from researchers who have worked in the field over the past 6 months.

5.4 Valuation of Navakavu LMMA management interventions

An additional aim of this study is to estimate the economic value of the Navakavu LMMA. This involves comparing the costs of establishing and managing the LMMA with the benefits from the intervention. There are two broad approaches to valuing the changes in the provision of the key goods/ services associated with the coral reefs and mangroves as a result of the LMMA:

1. Value the actual change in provision of goods/ services since LMMA established.
2. Value different *scenarios* of change in the provision of goods/ services within the LMMA

Unfortunately, for reasons discussed in greater detail in Section 12, the available data was not adequate to properly assess the economic value of the LMMA within the timeframe available to the researcher. Thus, this study presents a simple valuation of the change in finfish catches between 2002 and 2006, using data from Kronen (2002), Cakacaka (2007) and data from the present study. This is intended solely as an indicator of the extent of economic benefits associated with one component of the LMMA (i.e. finfish catch).

6. SURVEY RESULTS

This section summarises data collection associated with the household and individual surveys, and describes the samples of survey respondents.

6.1 Data collection

The final household and individual surveys were carried out in mid-December 2006. This involved a rigorous one-day training programme (on the 11th December 2006), which started at 8am and finished after 8pm. Two postgraduate students from USP assisted in training, as well as one villager (who had also been involved in the pre-pilots and pilot surveys, and who showed an aptitude for questionnaire administration). A total of 12 youths from the four villages of the Muaivuso Peninsula were trained to carry out the interviews.

Surveys were carried out in all four villages over 5 days between the 12th and the 16th December. A total of 118 household questionnaires (average time per questionnaire: 75 minutes) and 86 individual questionnaires (average time: 45 minutes) were completed. The researcher collected the completed questionnaires at the end of each day (between the 12th and 16th December), and with the assistance of a local villager (who also helped with training and pilot interviews), went through each questionnaire with each interviewer. Incomplete or incorrectly completed questionnaires were returned to interviewers, with an explanation of the problem, for completion. About 20 household questionnaires and 30 individual questionnaires were returned for this purpose.

Validation of data produced was carried out on two occasions by the researcher, who verified answers given in randomly selected questionnaires (n=5) with respondents. In all cases, the information given in the questionnaires was verified.

Comment on use of local youths as enumerators

The use of local villagers as enumerators for this study was a condition set by the *iqoliqoli* committee. Despite rigorous training, it could not be expected that the quality of the data collected by local youths would be of a standard required by CV studies. CV questionnaires are more complex than standard socio-economic questionnaires, and require highly trained individuals with a good understanding of the method used to be able to collect high-quality data. However, this limitation presented an opportunity to assess the relative value of using highly qualified individuals as enumerators, as is typically the case for CV studies.

Overall, it was found that the quality of the data produced was much lower than that produced in similar studies coordinated by the researcher, where interviews were carried out by highly trained and qualified enumerators. In particular, the amount of missing data was very high. This, despite the emphasis made during training that no answers be left out. Missing data is a problem for statistical analysis, and can reduce the sample size significantly in regression analysis. Also, as noted above, questionnaires had to be returned to interviewers frequently for clarification of answers (e.g. if they ticked "yes" and "no" to the same question) and completion.

Finally, there were a significant number of unusable questionnaires: 10 household questionnaires (note that this is after sending interviewers back to complete incomplete questionnaires, or asking for clarification of answers) and over 30 individual questionnaires were not useable.

6.2 Sample Description

This section presents descriptive statistics for the survey samples (household and individual questionnaires). This includes: socio-economic characteristics and livelihood activities of the households in the area; socio-economic characteristics and livelihood activities of individual respondents (interviewed using household or individual questionnaires); individual attitudes towards the marine environment, and attitudes towards the LMMA.

Household socio-economic characteristics and livelihood activities

Table 4 presents summary socio-economic characteristics of all the households interviewed for this study. These data were provided by the heads of household or their spouses in the household survey.

Table 4: Household socio-economic characteristics

Variable	Sample statistics (n=118)
Household size (mean number of people)	5.27 (2.33) [1]
Number of females >15 yrs old per household (mean)	1.99 (1.47)
Number of males >15 yrs old per household (mean)	1.91 (1.07)
Gross monthly household income (mean FJ$)[1]	224.10 (205.71)
% households with savings	63.6
Household savings (mean FJ$) [2]	375.22 (469.6)
% households receive remittance	11.9
% households own a television	69.8
% households own a boat	39.0

[1] Figures in brackets are standard deviations
[2] Income and savings taken as mid-interval of income/savings categories

As results show, there are on average just over 5 residents per household. Summary household statistics per village (Table 5) indicate that Nabaka households are the largest (average 6.03 people per households) and Muaivuso households the smallest (average 4.95 people per household).The gross monthly income per household is FJ$224.10, with Nabaka households having the highest average income ($298.75) and Muaivuso households having the lowest income ($192.86). This is as expected, given that the larger the households, the more likely there are more people working and contributing towards household income. Standard deviations for income and savings are large, indicating that there is a wide range of values for these statistics.

Table 5: Household socio-economic characteristics per village

Variable	Muaivuso (n=28)	Nabaka (n=21)	Namakala (n=22)	Waiqanake (n=47)
Household size (mean number of people)	4.95 (2.06) [1]	6.03 (2.99)	5.35 (2.30)	5.11 (2.16)
Gross monthly household income (mean FJ$)[1]	192.86 (156.03)	295.19 (256.26)	210.02 (90.16)	217.52 (240.91)
% households with savings	71.4	71.4	40.9	66.0
Household savings (mean FJ$) [2]	450 (547.22)	448.23 (516.42)	152.86 (235.16)	398.15 (462.56)
% households receive remittance	10.7	28.6	4.55	8.51
% households own a television	66.6	76.2	54.5	76.1
% households own a boat	42.9	23.8	45.5	40.4

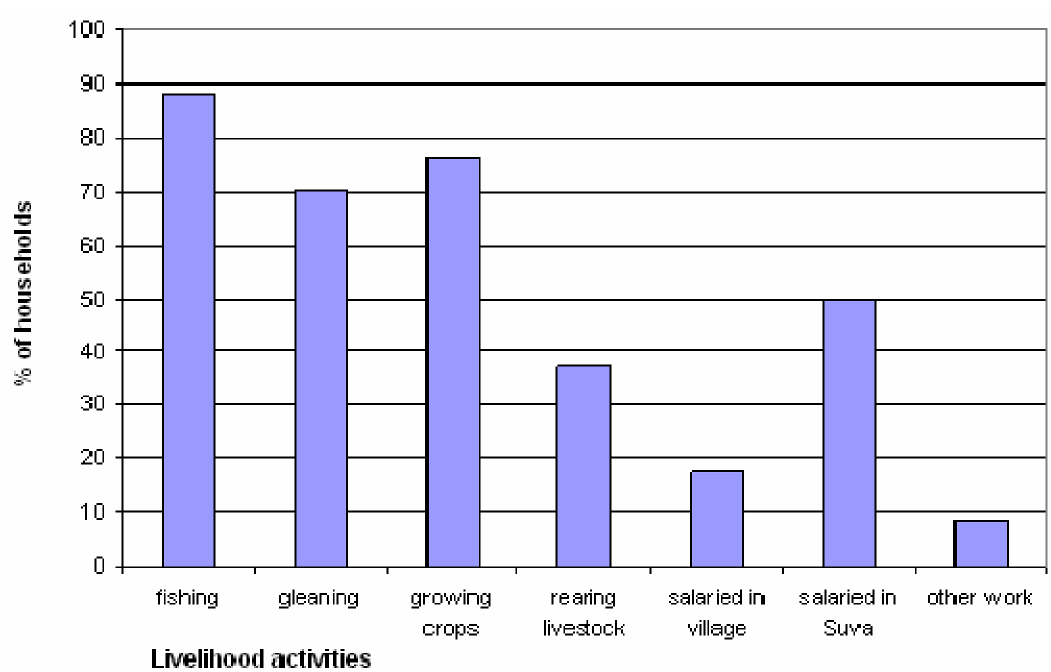
[1] Figures in brackets are standard deviations
[2] Income and savings taken as mid-interval of income/savings categories

Overall, 64% of interviewed households have savings, with Muaivuso and Nabaka having the highest proportion of households with savings – and the highest mean savings – and Waiqanake having significantly fewer households with savings (and lower mean savings per household).

On the whole, it appears that Nabaka households have the highest wealth levels (on the basis of the following indicators: average household income, savings, TV ownership, and remittance). The low levels of boat ownership in this village might at first suggest that fishing is not as important a livelihood activity for residents as it is for the other three villages. However, an inspection of household livelihoods (see below for summary statistics and discussion) per village indicates that 40% of Nabaka households consider fishing to be their most important livelihood activity, compared to 36.4% of households in Muaivuso, 25.4% of Namakala households and 22.2% of Waiqanake households. It is possible that Nabaka households are less likely to own boats, despite fishing being the major source of income for two fifths of households in the village, for the very simple reason that they are further inland than the other three villages; this, however, would need to be confirmed in the field.

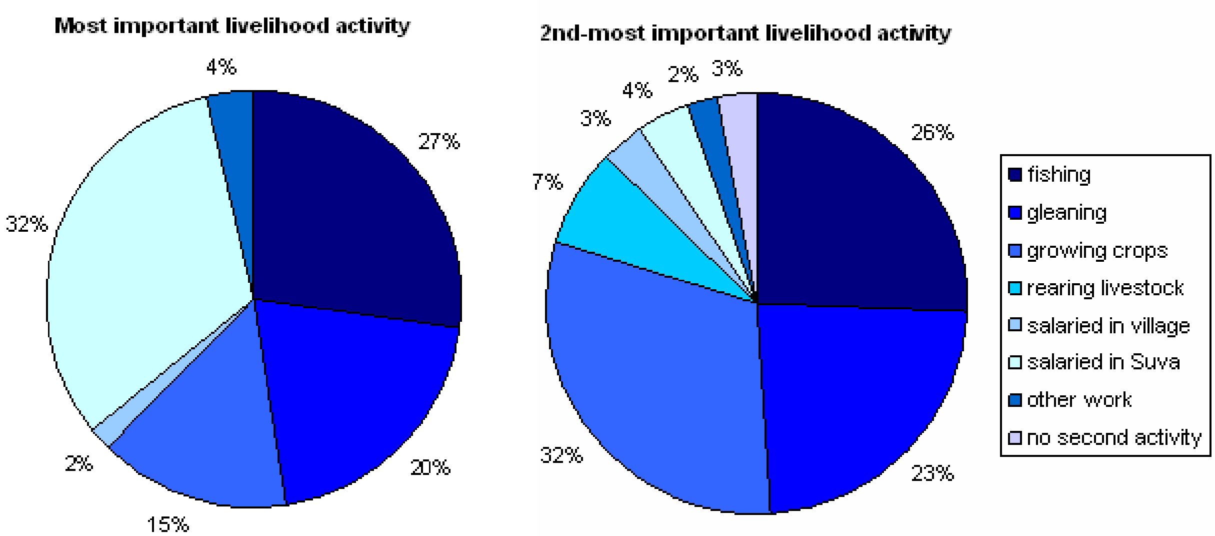
The overall distribution of household livelihood activities in the *yavusa* Navakavu is detailed in Figure 4. Most households engage in fishing (88.1%), growing crops (76.3%) and/or gleaning (70.3%). Half of all households (49.5%) engage in 4 or more livelihood activities; only 3% of households engage in only one livelihood activity. Diversification is a typical strategy adopted by rural communities, such as the *yavusa* Navakavu community (Allison and Ellis, 2001), and is reflected in these statistics.

Figure 4: Percentage of households engaging in livelihood activities



Respondents to the household questionnaire were asked to indicate which livelihood activity was the 'most important' for their household (in terms of the amount of cash and food it generates for their households), and which was the second most important livelihood activity. The distribution of results, presented in Figure 5, indicates that the livelihood activity that generates the most cash and food, overall, is salaried work in Suva (32% of households) followed by fishing (27%) and gleaning (20%). Rearing livestock was not considered the most important activity for any households. Notably, if we inspect the statistics on a village basis, Nabaka households are the most likely to regard salaried work in Suva as their most important source of income (50%), followed by Muaivuso households (40%).

Figure 5: Most and second-most important household livelihood activities



Growing crops is considered the second-most important household activity by 32% of households, followed by fishing (26%) and gleaning (23%). Salaried work in Suva is the second-most important activity to only 4% of households – reflecting the fact that few other activities generate more income than salaried work in Suva.

Individual socio-economic characteristics and livelihood activities

Table 6 presents summary socio-economic statistics for all individual respondents interviewed for this study. Statistics are presented separately for individual respondents to the household survey (heads of household or their spouses) and individual respondents to the individual survey (randomly selected individuals over 21 years of age), as well as in aggregate for all individual respondents.

Table 6: Individual socio-economic characteristics

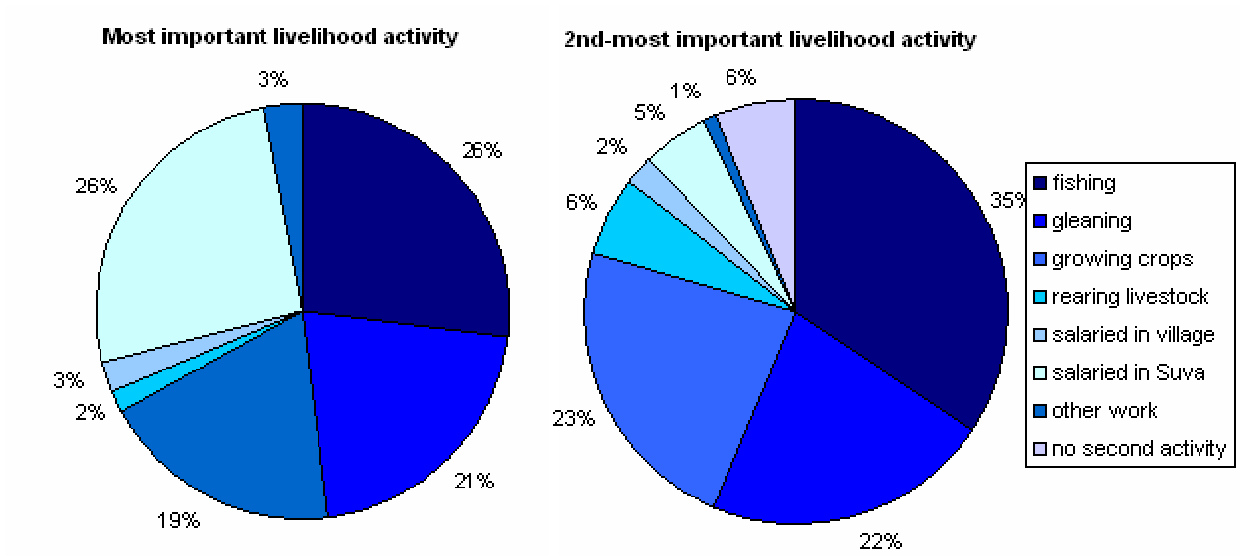
Variable	Household survey (n=118)	Individual survey (n=86)	All individuals (n=204)
Gender (% male)	54	48.8	52.0
Age	43.3 (14.03) [1]	31.7 (12.8)	38.4 (14.67)
Highest education level (%)			
Primary	36.5	33.7	35.3
Secondary school yr 10 (16 yrs old)	43.5	29.1	37.3
Secondary school yr 12 (18 yrs old)	17.4	33.7	24.4
University	2.61	3.49	2.99
% migrated to *yavusa* Navakavu from other place of origin	61.2	40.7	52.5

[1] Figures in brackets are standard deviations

On average, the sample was 52% male, with an average age of 38.4 years. The household survey sample had a greater proportion of males compared to the individual survey, although this difference is not significant; however, the household survey sample was significantly older than the individual survey sample at the 1% level (t-test statistic: p=0.000). This is as expected, given that heads of household (or their spouses) are most likely older members of the community. Education levels also differ significantly between samples, with 37.2% of individual survey respondents having completed a minimum of secondary school year 12 education (until 18 years of age) compared to 19.5% of household survey respondents. This difference (significant at the 1% level, p=0.000) is most likely due to the construction of the road in 1994, which increased accessibility to Suva and hence, the accessibility of students to secondary schools in the capital[5].

Individual respondents were asked which activities they engaged in to generate food and cash (Figure 6). As we found with regards to household livelihood activities, fishing was the most common activity (83% of individuals engage in fishing), followed by gleaning and growing crops (60.8% and 59.3% of individuals engage in these activities respectively). A quarter of individual respondents engage in 4 or more livelihood activities and only 6.4% engage in only one livelihood activity. This suggests that livelihood diversification occurs at an individual level rather than at the household level. This contrasts to the 'western' model of income generation, whereby individual household members typically engage in one (or even two) livelihood activities each.

Figure 6: Most and second-most important individual livelihood activities



The most important income-generating activities amongst individuals interviewed in this study (Figure 6) are salaried work in Suva and fishing (26% in both cases). Gleaning and growing crops are the most important activity for 21% and 19% of individual respondents respectively. Fishing is the second-most important activity for 35% of individuals, followed by growing crops (23%) and gleaning (22%).

Respondents were also asked to indicate *how much time* they spent, on average, each day, on these livelihood activities. One third (33%) claimed to spend 3 hours or less engaged in livelihood activities, whilst one fifth (21%) claim to spend 8 hours or more each day working to generate food and/or cash. Overall, the average number of hours spent generating livelihoods comes to 5 hours per day.

Attitudes towards the marine environment

Attitudes towards the Navakavu marine environment were elicited by asking all respondents (in both surveys) for their level of agreement with a number of statements. All statements were pre-tested during pilot surveys, in order to ensure adequate understanding of them. Table 7 presents overall mean attitudes (rating from 1 to 5, where 1= "strongly disagree" and 5= "strongly agree").

Table 7: Mean percentage distributions for attitude statements (all respondents)

Statement	SD	D	N	A	SA
1. "If *no-one* ever used the marine resources in Navakavu, then it wouldn't matter if they became degraded."	13.7	52.5	10.8	18.4	4.9
2. "We have a responsibility to protect our marine environment, even if it costs us money"	0	0	7.8	63.7	28.4
3. "I mostly value the marine resources in Navakavu because my household gets fish and seafood there."	0	0	2.9	30.9	66.2
4. "Even if my household didn't use the marine resources in Navakavu, we would have a responsibility to protect the marine environment for future generations."	1.5	1.0	13.7	41.7	42.2
5. "The environmental problems in our marine environment have been exaggerated."	27.5	23.5	11.3	28.4	9.3

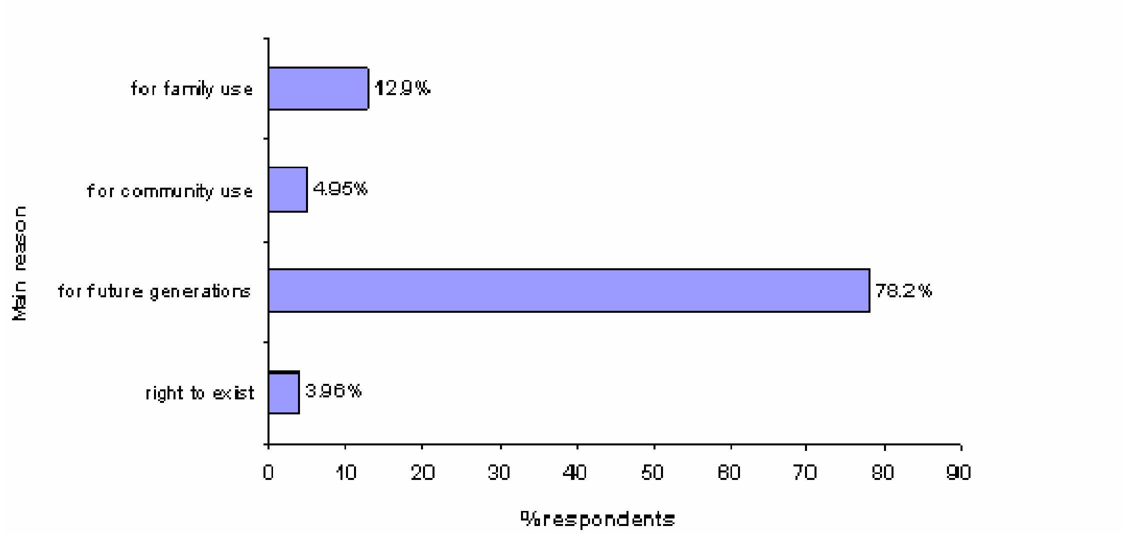
(1) SD=strongly disagree, D=disagree, N=neither agree nor disagree, A=agree, SA=strongly agree

Statement 1 reflects an *anthropocentric* view of the Navakavu marine environment (i.e. if it isn't for human use, then it doesn't matter if it becomes degraded). Results show that most respondents (66.2%) do not agree with this statement, thus rejecting the anthropocentric view of their environment. Statement 2 established whether respondents are willing to make *trade-offs* between their marine environment and money. Results clearly indicate that respondents value their environment. Statement 3 reflects *selfish use motivations* associated with the Navakavu marine environment. Responses to this question (97% of respondents agree or strongly agree with this statement) clearly indicate that respondents value their resource mostly because they directly benefit from it. However, responses to statement 4 indicate that *bequest motives* (i.e. wanting to protect the marine environment for future generations) are also very strong, with 83% of respondents agreeing with the statement. Finally, statement 5 is worded in a way to allow respondents to agree with a negative view of environmental management of their resource. Half of respondents (51%) disagree with this statement – however, 37.7% of respondents were found to agree with it. This latter result would benefit from further enquiry to establish reasons for agreement.

Overall, it appears that respondents strongly feel that they have a responsibility to protect their marine resource, even if no-one uses it. However, they mostly value their marine environment because they - or future generations - can use it.

In order to ascertain the *main* reason that respondents value their *iqoliqoli,* all respondents were presented with four statements reflecting the main reasons (identified through pre-pilots) for protecting the Navakavu *iqoliqoli,* and were asked to indicate which reason they mostly agreed with. The distribution of results, in Figure 7, clearly shows that the bequest motive ('for future generations') is the main motivation for protecting the marine resource for most respondents (78.2%). The next most important motivation for protecting the *iqoliqoli* is 'for family use' (12.9%), followed by 'for community use' (4.95%) and 'it has a right to exist' (3.96%). Thus, the *bequest motive* is clearly dominant.

Figure 7: Main reason given for protecting the marine environment in Navakavu *iqoliqoli*

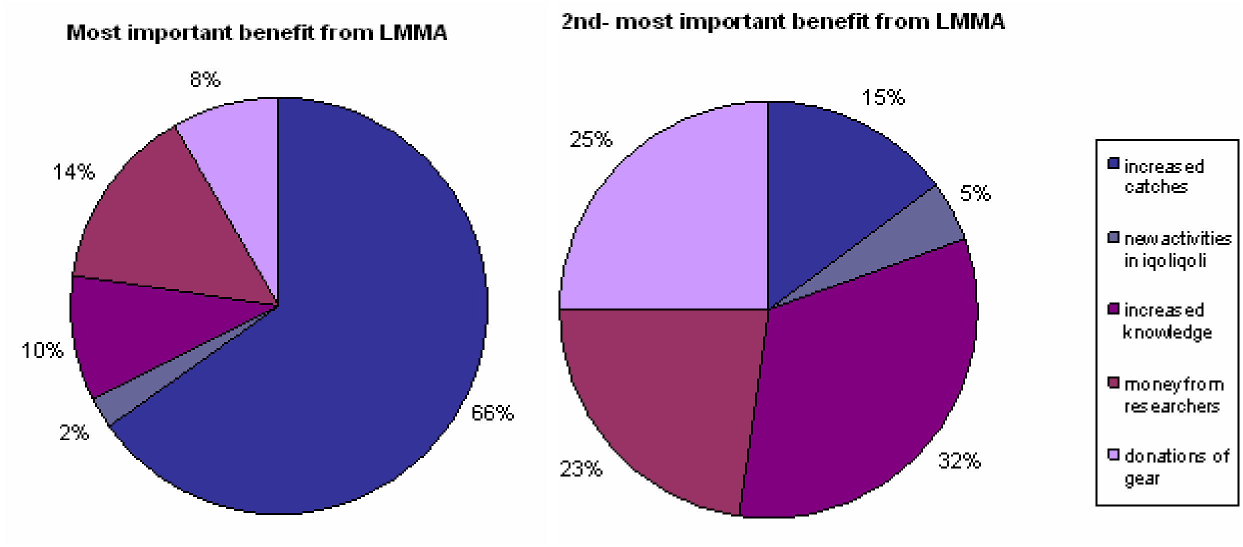


Attitudes towards the LMMA

All respondents were asked to indicate whether they had participated in decision-making related to the LMMA. Just under half of all respondents (48.5%) said that they had been involved, mostly through attendance at the meetings. Only a marginally higher proportion of those involved in the decision-making were male (53.5%). The average age of those who has been involved was 39.5 – only marginally higher than the average age for the whole sample (38.4).

Respondents were then asked to indicate whether their household had benefited from the LMMA. Most respondents (83.9%) said that they had benefited. The most important benefit (see Figure 8 for distribution of results) was the increase in finfish and invertebrate catches – 66% of respondents reported this as the main benefit to their households. This is followed by 'money from researchers and students' doing fieldwork (most important benefit to 14% of households)[6].

Figure 8: Most and second-most important benefits that household has obtained from Navakavu LMMA



7. VALUATION OF FISHERIES

The analysis of catch data depends on the availability of reliable and systematic fisheries data. Long-term fisheries statistics for the Muaivuso area do not exist. There have, however, been two small-scale socio-economic surveys of fisheries activities in the *yavusa* Navakavu area (e.g. Cakacaka (2007); Kronen, 2004). The Kronen (2004) study, carried in August 2002, involved questionnaires eliciting information on average annual catches from 28 households in Muaivuso village. This study will provide some indication of baseline fisheries levels prior to the implementation of the LMMA (in March 2003), which will assist in the estimation of the economic impact of the LMMA. Unfortunately,

[6] Researchers and students doing fieldwork in the area are required to pay fees, to cover food, lodging (if applicable) and access to the *iqoliqoli* and/or other areas of the *yavusa* Navakavu. See Section 9 for analysis of value of revenue from research and education activities.

the study fails to provide detailed catch data by weight, and so changes in catch levels for particular species are not available. Cakacaka (2007) interviewed a total of 43 households in all four villages on the Muaivuso peninsula in July 2004, and measured catches (abundance and weight) from one trip per household. Both these snapshot surveys will provide information for the economic impact estimation in Section 12.

For the present study, it was considered most appropriate to generate primary data on fishing activities using semi-structured interviews and questionnaires (details on questionnaire development and structure, and data collection are found in Section 5.1).

7.1 Measuring weight from length

Catch data was measured in terms of length[7] (for finfish, bivalves) and diameter (for beche-de-mer) or maximum carapace width (for crabs), according to specifications set out in http://www.fao.org/docrep/003/F0752E/F0752E03.htm. Conversion of length to weight data for finfish was carried out using length-weight (LW) ratios set out in FishBase (www.fishbase.org)[8]. These LW ratios are listed for the individual species analysed in this study, in Annex 1.

The measurement of invertebrate weights from length or width data is more complex, and very little has been published in this area. Furthermore, FishBase does not include existing LW ratios for invertebrates. Thus, LW ratios were obtained through an extensive trawl of journals and internet search engines, and in most cases, proxy values were used. LW ratios for BDM species were obtained from Conand (1989); LW ratios for *Anandara* spp. (Fijian: *kaikoso*) were proxied by LW ratios for *A. demiri* (source: Morello et al, 2004); *octopus* spp. values were proxied by values for *Octopus vulgaris* in the Canary Islands (source: Hernandez-Garcia et al, 2002); LW ratios for *Scylla serrata* were proxied

[7] Interviewees were instructed to obtain fork-length data for finfish (i.e. length from tip of the snout with closed mouth to the centre of the fork in the tail). However, given that a lot of the catch data was based on recall, it is not expected that measurements are precise.

[8] Weight of fish is estimated from length data, using the equation: $W = \mathbf{a} \cdot L^{\mathbf{b}}$, where *a* and *b* are constants that are specific to individual fish species. The values of *a* and *b* can be obtained from FishBase.

by values for *S. paramamosain* and *S. olivacea* in the Mekong Delta (source: Christensen et al, 2004). LW values for *Trochus niloticus* were calculated by using data on length and weight from a sample of 32 trochus individuals provided in Nash et al (1994)[9]. Finally, due to a lack of information on diameter-weight relationships for *Tripnesutes gratilla* (sea urchin), or indeed any other Echinoderm, it has been assumed, on the basis of 10 measurements taken by the author, that one sea urchin weighs 150 grams. LW ratios for Strombids have not been found; thus, weights have not been assessed for this invertebrate taxa. This is not considered to affect the results significantly as they only made up 5% of the invertebrate catch by number.

7.2 General fishing activity

This section summarises general fishing activity in each household, including: average fishing effort, main fishing gears used, main locations for fishing, main species harvested on average, and date of last trip. Data on fish/invertebrate catch were collected *per household*. Hence catch data per individual is not presented here.

Fishing effort

Results from the questionnaires indicate that almost all (94%) of the interviewed households engage in fishing/gleaning activities in their *iqoliqoli*. Of these, 53.2% fish for 7 or more months a year, and 44% fish for 12 months per year. During the months when they fish, most households (67.6%) fish/glean for 2-3 days a week, and only 14% of households fish or glean for four or more days a week. On average, during the months when they fish, households spend two and a half (2.46) days a week fishing/ gleaning in their *iqoliqoli*, and 3.95 hours per fishing/gleaning trip. Overall, fishers go on fishing trips 79.3 days per year (equivalent to fishing every 4 to 5 days). There are on average 2 fishers per household and of all interviewed respondents, the proportion of males to

[9] This involved a linear regression of logW *vs.* logL, from which *a* was estimated as the intercept, and *b* as the slope (see www.fishbase.org).

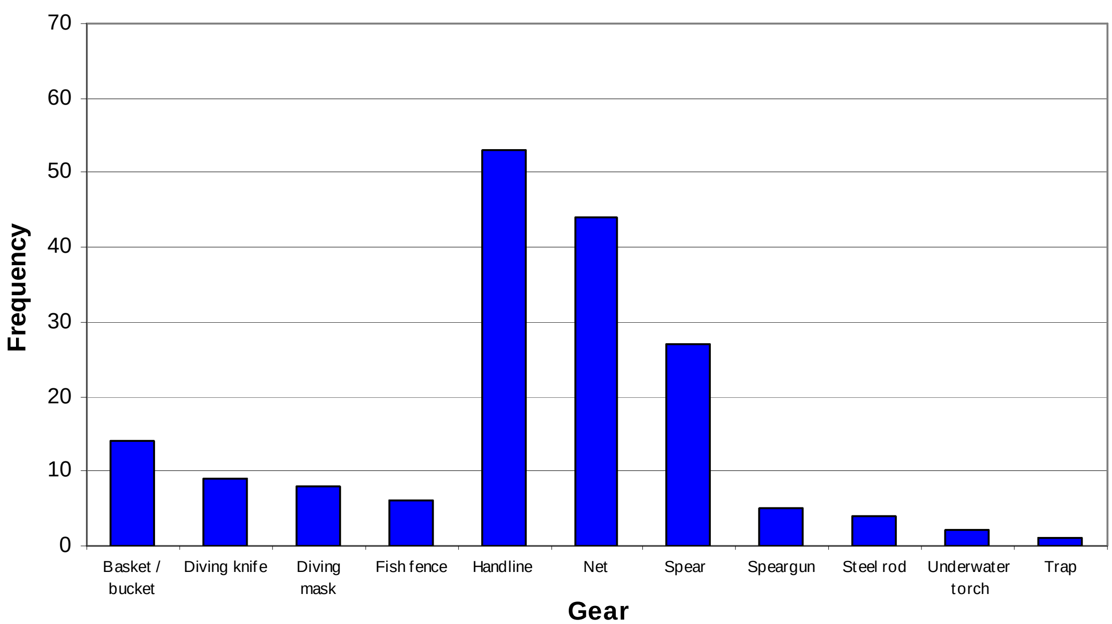
females who fish or collect seafood from the *iqoliqoli* is almost identical (49.7% male, 50.3% female).

Fishing methods and grounds

Results of the survey indicate that households mostly fish along the reef (55% of households do so) and in the lagoon area (48.7%). Only 6% of households fish/glean around the mangrove area.

Figure 9 presents the frequency distribution for fishing gears used by households for fishing/gleaning in the Navakavu *iqoliqoli.* Results indicate that the most frequently used fishing gear is the handline (47.8% of households use this), followed by nets (39.6%) and spears (24.3%).

Figure 9: Fishing/ gleaning gear used by households in *yavusa* Navakavu



What is harvested on average?

Respondents were asked to indicate, overall, what fish or shellfish they caught/ collected most frequently in the Navakavu marine environment. It is expected that these results will provide some indication of how representative the catch data collected for this study is (see next section). Results indicate that there are two species that clearly dominate the catch: *Tripneustes gratilla* (common name: cake urchin; Fijian: *cawaki*) is the most harvested species (35% of households consider this to be their most frequently harvested product from the *iqoliqoli*) and the second-most is *Lethrinus harak* (Blackspot emperor; *kabatia)* (27.9% of households consider this their most harvested product). The next most frequently harvested species is *Lethrinus atikinsoni* (Yellow-tailed emperor; *sabutu*) (7.2%) – thus, Lethrinids (emperors) are harvested as frequently as urchins.

All other species are harvested much less frequently. For example, the next most frequently harvested species are *Donabella auricularia* (Sea hare; *veata/ kotia/ senikavere)* and *Siganus spinus* (Vermiculate rabbitfish; *nuqa*). In both cases, 5.4% of households consider these their most frequently harvested species.

7.3 Analysis of catch from last fishing trip

In this section we present catch data based on the last fishing trip that respondents went on. This data will be used as the basis for the economic valuation of fisheries resources associated with the Navakavu *iqoliqoli*.

Respondents were first asked when was the last time *anyone* in their household had gone fishing and/ or gleaning. Figure 10 shows the distribution of responses. As the distribution shows, most households (n=39; 35.5% of all fishing households) had last gone fishing/gleaning between 2 and 7 days ago. On average, 1.51 household members went fishing on the last fishing trip; and 72% of respondents had also been on that trip.

Figure 10: Date of last fishing trip

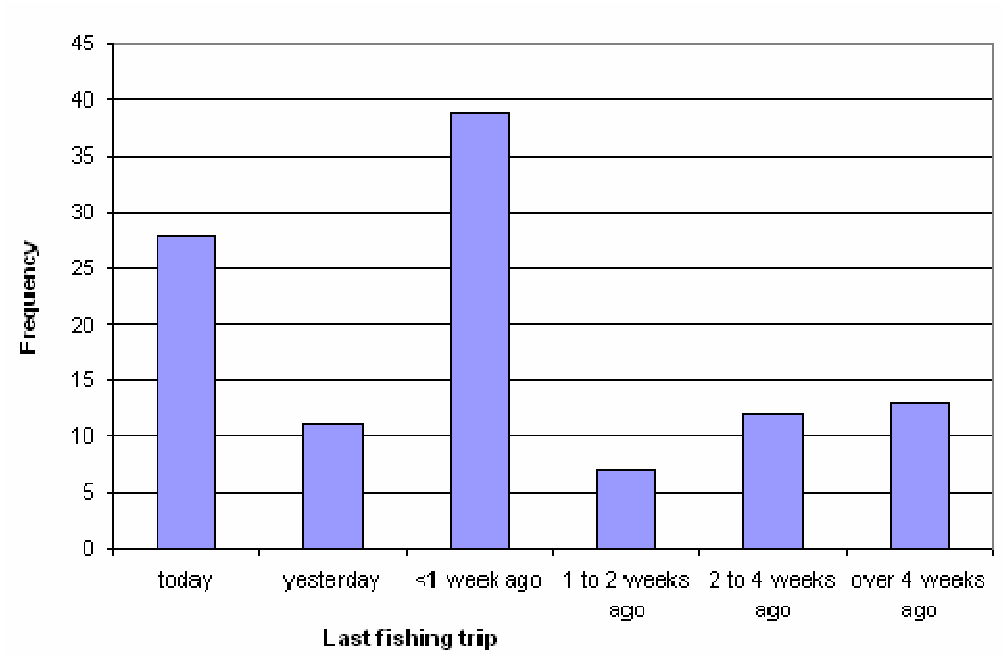


Figure 11: Fishing/gleaning gear *used during last fishing/gleaning trip*

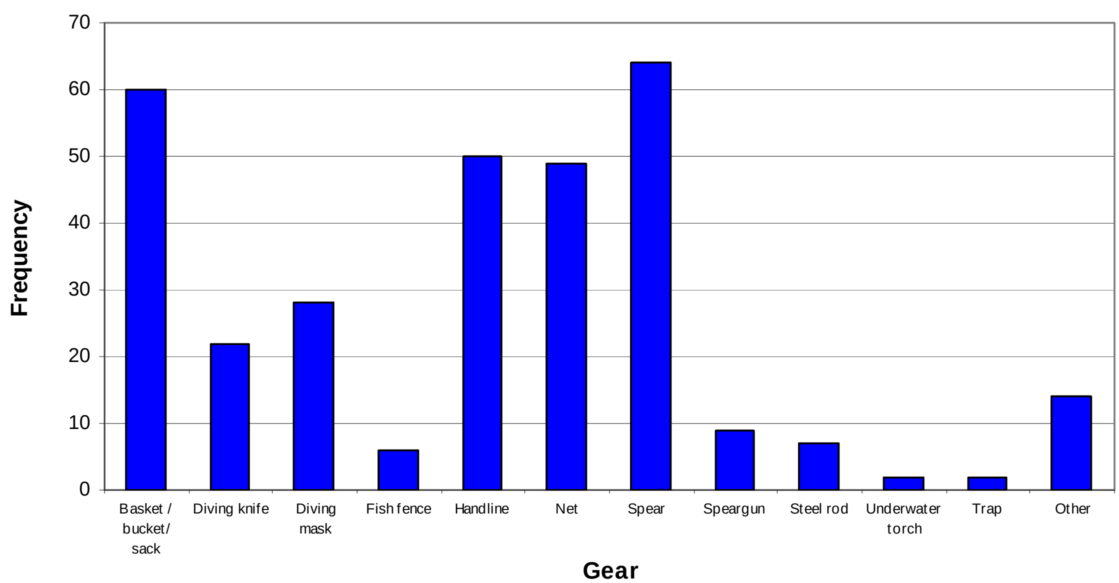


Figure 11 shows the distribution of gears used during the last trip. The distribution of gears used during the last trip is similar to the distribution of the Figure 9 (distribution of gears that are *usually* used by households), although spears were used much more frequently during the last trip. In addition, many respondents (n=64) claimed to use a "sack" during their last trip, whereas this was not even recorded as a response in Figure 9. Overall, handlines, nets and spears are the most frequently used gears.

Table 8 presents the catch composition by family, for finfish caught during the last fishing trip. Inspection of results indicates that Lethrinids accounted for most of the finfish catch by weight (50.4% of the total finfish catch). The most harvested Lethrinid species was *Lethrinus harak* (in Fijian: *kabatia*), which made up 76% of the Lethrinid catch (and 38% of the total finfish catch) (see Table 9 for more detailed breakdown of catch per finfish species). Carangids made up the second-most harvested finfish family (11.5%), followed by Siganids (10.8%) and Scarids (9.66%).

Table 8: Percentage contribution of finfish families to total finfish catch by weight

Fish family	Common name	Weight of catch per fish family (kg)	% of total catch
Lethrinidae	Emperor	945.7	50.4%
Carangidae	Jacks & trevally	216.7	11.5%
Siganidae	Rabbit fish	202.1	10.8%
Scaridae	Parrot fish	181.3	9.66%
Lutjanidae	Snapper	148.9	7.93%
Muglidae	Mullet	85.7	4.56%
Scombridae	Tunas & mackerel	34.5	1.84%
Hemirhamphidae	Halfbeak	29.5	1.57%
Serranidae	Grouper	16.4	0.87%
Mullidae	Goatfish	13.1	0.70%
Gerreidae	Silver biddy	3.27	0.17%
Acanthuridae	Surgeonfish	0.38	0.02%
Total weight		1877.4	

Table 9 presents a more detailed breakdown of catch per finfish species. Results indicate that, after *L. harak,* the most harvested finfish species by weight were *L. atkinsoni/ L. mahsena* (in Fijian both known as: *sabutu*) which accounted for 12% of the total finfish catch (or 23% of the Lethrinid catch). *Caranx* spp. (Fijian: *saqa*) and *Siganus spinus/ Sig. vermiculatus* (Fijian: *nuqa*) make up just under 11% of the total finfish catch each by weight, followed by *Scarus* spp. (Fijian: *ulavi*) which makes up just under 10% of the total catch. About 3% of the total catch is made up of nine different species that account for under 1% of the total catch each.

Table 9: Percentage contribution of finfish species to total finfish catch by weight

Fijian name	Latin name	Common name	Family	Weight of catch (kg)	% of total catch by weight
kabatia	*Lethrinus Harak/ Le. Obsoletuys*	Thumbprint (or blackspot) emperor	Lethrinidae	719.28	38.3
sabutu/ cabutu	*Lethrinus atkinsoni/ Le. mahsena*	Yellow-tailed emperor/ Sky emperor	Lethrinidae	221.57	11.8
saqa	*Caranx spp. (mostly C. ignobilis)*	Trevally spp.	Carangidae	205.22	10.9
nuqa	*Siganus spinus/ Sig. vermiculatus*	Little spinefoot/ Vermiculate rabbitfish	Siganidae	202.11	10.8
ulavi	*Scarus spp. (mostly Sc. Ghoban)*	Parrotfish (mostly Bluebarred parrotfish)	Scaridae	181.27	9.66
kake	*Lutjanus fulviflamma/ Lu. Monostigma*	Dory snapper/ Onespot snapper (also known as seapearch)	Lutjanidae	148.94	7.93
kanace	*Valamugil seheli/ Crenimugl crenilabis*	Bluespot mullet/ Fringe lipped mullet / Warty lipped mullet	Mugilidae	85.67	4.56
salala	*Rastrelliger kanagurta*	Striped (or Chub) mackerel	Scombridae	34.48	1.84
gaka/ busa	*Hemiramphus far*	Garfish (also: Spotted halfbeak)	Hemirhamphidae	20.15	1.07
daunau	*Parupeneus indicus*	Indian goatfish	Mullidae	13.13	0.70
kodro	*Caranx tille/ C. papuensis*	Tille trevally/ brassy trevally	Carangidae	11.46	0.61
kawakawa	*Cephalopholis argus*	Peacrock grouper	Serranidae	10.5	0.56
buse	*Hyporhampus dussumieri*	Dussumier's garfish/ halfbeak	Hemirhamphidae	9.3	0.50
senikawakawa	*Epinephelus merra/ E. hexagonatus*	Honeycomb grouper/ Starspotted grouper	Serranidae	5.84	0.31
kawago	*Lethrinus nebulosus*	Spangled emperor	Lethrinidae	4.85	0.26
matu	*Gerres sp.*	Silver biddy	Gerreidae	3.27	0.17
balagi	*Acantharus mata*	Elongate surgeonfish	Acanthuridae	0.38	0.02
senicauca	*Epinephelus spp.*	Rock cod	Serranidae	0.02	0.00
Total number species caught		**18**	**Total weight**	**1877.44**	

These results tentatively confirm findings in Kronen (2004) which suggest that the most frequently caught finfish species (according to the number of households that claim to harvest them regularly) were *L. harak* (Fijian: *kabatia*) and *L. atkinsoni/ mahsena* (Fijian: *sabutu*). An analysis of fin fish catch frequency (based on the same measure as above) using data from the present study confirms that *kabatia* and *sabutu* were the most frequently caught species during the last fishing trip (52.5% and 11.9% of all surveyed households caught these species respectively).

Kabatia and *sabutu* are also found to make up a major proportion of the finfish catch in Cakacaka (2007), with *sabutu* making up 11.4% and *kabatia* making up 10% of the total catch by weight. However, Cakacaka (2007) found that the most harvested finfish species by weight was *Rastreglier spp.* (common name: Striped or Chub mackerel; Fijian: *salasala*), from the Scrombidae family, with 45.8% of the total finfish weight made up by this species. In the present study, this species makes up less than 2% of the total catch by weight. Furthermore, the present study finds that Carangids and Siganids make up 11.5% and 10.8% of the total catch by weight, whereas in Cakacaka (2007), these finfish families are not even listed as major contributors to finfish catch.

These marked differences are most likely due to seasonal variation. Pelagic species, such as *Rastreliger spp.,* tend to exhibit strong seasonality; they are more abundant in the winter months (especially March to July), which is when Cakacaka (2007) carried out the household survey. The present study was carried out in December (low season for this species). Other species to exhibit seasonality (although to a lesser extent than *Rastreliger spp.)* include pelagics such as mullet (high season is August to September), and reef fish such as rabbit fish (November to December).

Table 10 presents summary catch results for invertebrates (by family), and Table 11 presents a more detailed breakdown by species. As can be observed in Tables 10 and 11, *Tripneustes gratilla* (family Echinoidea) clearly dominates the overall invertebrate catch by weight: results show that 79.5% of the total invertebrate catch is made up by this species (in Fijian: *cawaki*). Although striking, this result is perhaps unsurprising, given the huge increase in urchin abundance in the Navakavu *iqoliqoli* (Meo, pers. comm.., March 2007). Between 2004 and 2005 there was over an eight-fold increase in *T. gratilla* abundance in the open harvest area[10] of the Navakavu *iqoliqoli* (Navakavu LMMA Site Report, 2005). Urchin abundance has been linked to increased macro-algae cover (Dumas et al, 2007). It is suggested that the huge increase in urchin abundance in the Navakavu *iqoliqoli* might be a sign that there is a problem with the health of the reef: overfishing of fish herbivores, such as rabbitfish, may lead to increased algae cover, and hence increased urchin abundances. If this were to be the case, then the economic value of the *iqoliqoli* would surely decrease. This is an area that would require further research.

Given the possible error introduced by the use of proxies to estimate weights from lengths for many of the invertebrate data[11], it may be useful to assess total catch in terms of numbers caught per species. To this end, Columns 7 and 8 in Table 11 present numbers of invertebrates caught per species, and percentage contributions of each species to total catch (by numbers caught).

Table 10: Percentage contribution of invertebrate family to total catch by weight

Invertebrate family	Common name	Weight of catch per invertebrate family (kg)	% of total catch
Echinoidea	Urchin	1570.2	79.5
Holothuria	Beche-de-mer	134.08	6.79
Scylla serrata	Crab	132.21	6.69
Octopididae.	Octopus	54.27	2.75
Arcidae	Bivalve	39.29	1.99
Trochus niloticus	Trochus	24.27	1.23
Aplysiidae	Sea hare	21.2	1.07
Strombidae	Gastropod	?? (a)	-
Total weight		1,975.3	

(a) Due to lack of information on length-weight ratios for Strombidae species (specifically: *Lambis lambis* and *Strombus gibberulus*), it has not been possible to estimate weights for this family.

[10] The open harvest area includes any area of the *iqoliqoli* except for the MPA which is closed off to fishing.
[11] The sensitivity of the results to assumptions made is tested in Section 13.

Table 11: Percentage contribution of invertebrate species to total invertebrate catch by weight and by number caught

Fijian name	Latin name	Common name	Family	Weight (kg)	% of total catch (by weight)	Numbers caught/ collected	% of total catch (by numbers)
cawaki	*Tripneustes gratilla*	Cake urchin	Echinoidea	1570.2	79.5	10,468	63.2
qari	*Scylla serrata*	Mangrove crab	Portunidae	132.21	6.69	195	1.18
sucuwalu	*Holothuria fuscogilva*	White teatfish (beche-de-mer)	Holothuria	58.43	2.96	124	0.75
kuita	*Octopus spp.*	Octopus	Octopodidae	54.27	2.75	173	1.05
kaikoso	*Anandara spp.*	Mangrove clam	Arcidae	39.29	1.99	2,490	15.0
dairo	*Holothuria scabra*	Sandfish (beche-de-mer)	Holothuria	36.73	1.86	122	0.74
lesi	*Bohadschia graffei*	Beche-de-mer	Holothuria	34.44	1.74	280	1.69
sici/ vivili	*Trochus niloticus*	Trochus	Trochidae	24.27	1.23	166	1.00
veata /kotia/ senikavere	*Dolabella auricularia*	Sea Hare	Aplysiidae	21.2	1.07	1114	6.73
tarasea	*Actinopyga mauritana*	Surf redfish (beche-de-mer)	Holothuria	4.48	0.23	20	0.12
yaga	*Lambis lambis*	Spider conch	Strombidae	? (a)	? (a)	1,240	7.49
gera/ golea	*Strombus gibberulus gibbesus*	White hump-backed conch	Strombidae	? (a)	? (a)	160	0.97
nama	*Caulerpa racemosa*	Sea grapes (green algae)		-	-	-	-
Total number species caught/ collected		**13**	**Total weight**	**1,975.3**		**16,552**	

(a) Due to lack of information on length-weight ratios for *Lambis lambis* and *Strombus gibberulus*, it has not been possible to estimate weights for these species.

Results in Table 11 confirm that *T. gratilla* is the most harvested invertebrate species by number as well as by weight: just over 10,000 urchins were collected on one trip in all four villages. This amounts to about one sack per household (assuming an average of 100 urchins per sack). However, in terms of numbers collected, the second-most harvested invertebrate species is *Anandara* spp. (in Fijian: *Kaikoso*) – 15% of the total catch by number caught is made up of *kaikoso*, however this only makes up 2% of the catch by weight. Similarly, *Dolabella auricularia* (in Fijian: *veata*) makes up just under 7% of the total catch by number, but just over 1% by weight.

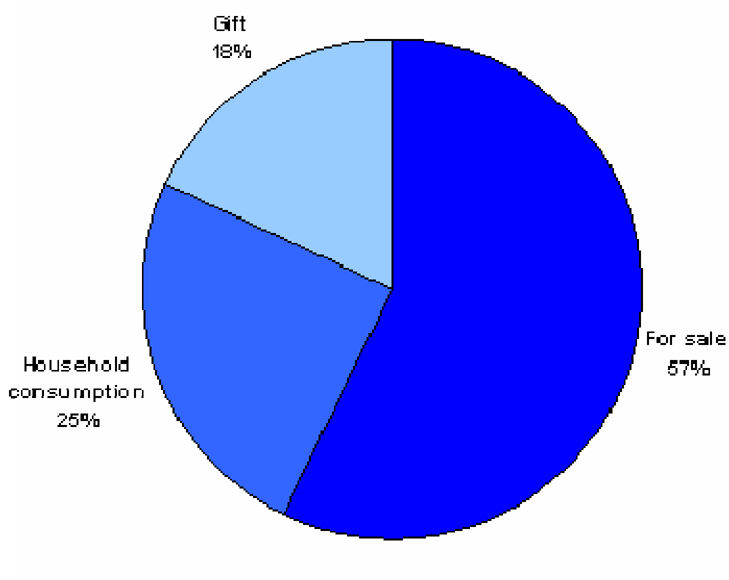
Overall, results indicate that the total weight of the catch obtained during the last trip made by 111 interviewed fishing households comes to 3,853 kilograms, of which 51% (1,975.3kg) consists of invertebrates and the other half (1,877.4 kilos) is made up of finfish.

Uses of catch

Respondents were asked to indicate, for each species recorded, how much of their catch they sold, how much they retained for household consumption and how much they gave as gifts (to extended family, community, other). Figure 12 shows the distribution of results.

As results indicate, most (57%) of the total catch (52% finfish; 63% invertebrates) was for sale. One quarter of the catch was for household consumption (28% finfish; 21% invertebrates), and just under a fifth was for gifts (20% finfish; 16.5% invertebrates).

Figure 12: Distribution of uses to which fish and invertebrate catch is put



7.4 Economic value of catch

In this section we use market prices to estimate the gross economic value of fish and invertebrate catch from the Navakavu *iqoliqoli.* We also use market prices, and information from the survey, to estimate the costs associated with fishing activities, and hence estimate the net present value of the fishery.

7.4.1 Gross economic benefits from fishing

The first step in the estimation of the net economic benefits from fisheries in the Navakavu *iqoliqoli,* involves estimating the gross economic benefits from the fisheries. Prices of finfish and invertebrates were obtained from Korovulavula et al (2007). Finfish were grouped into four price categories, listed in Table 12. These prices are used to estimate the gross economic value of the finfish catch from the last trip[12] (Table 13).

Table 12: Price categories for finfish

Category	Fish family	Average price (FJ$/kg)
1	Lethrinidae, Serranidae	5.45
2	Carangidae, Lutjanidae, Mullidae, Scaridae, Siganidae	4.40
3	Acanthuridae, Muglidae, Scombridae,	3.90
4	Gerreidae, Hemirhamphidae	2.50

Table 13: Gross economic benefits per finfish families (based on one fishing trip)

Fish family	Common name	Average price (FJ$/k)	Weight of catch per fish family (kg)	Gross benefits per fish family (FJ$)
Lethrinidae	Emperor	5.45	945.7	5154.07
Carangidae	Trevally	4.40	216.7	953.48
Siganidae	Rabbit fish	4.40	202.1	889.24
Scaridae	Parrot fish	4.40	181.3	797.72
Lutjanidae	Snapper	4.40	148.9	655.16
Muglidae	Mullet	3.90	85.7	334.23
Scombridae	Tunas & mackerel	3.90	34.5	134.55
Hemirhamphidae	Halfbeak	2.50	29.5	73.75
Serranidae	Grouper	5.45	16.4	89.38
Mullidae	Goatfish	4.40	13.1	57.64
Gerreidae	Silver biddy	2.50	3.27	8.18
Acanthuridae	Surgeonfish	3.90	0.38	1.48
Total				**$9,148.87**

Source: Korovulavula et al (2007)

As can be observed, the gross economic value from the Lethrinid catch accounted for half of the total value of the fin fisheries. Trevally, rabbitfish and parrotfish all made up 8-9% of the total value each.

[12] Gross economic value of finfish catch from last trip = total weight caught during last trip (per fish family) (kg) x average price per fish family (FJ$/kg)

Data on market prices for invertebrates was less available than that for finfish. As a result, the market price of some species has been proxied by market prices for other species for which there is data (detailed in Table 14). Table 14 presents gross economic benefits for invertebrate catch during one trip.[13]

Table 14: Gross economic benefits per invertebrate taxa (based on one fishing trip)

Invertebrate taxa	Common name	Average price (FJ$/kg)	Weight of catch per invertebrate taxa (kg)	Gross benefits per invert taxa (FJ$)
Echinoidea	Urchin	2.22 [1]	1570.2	3489.33
Holothuria fuscogilva	White teatfish	60.00	58.43	3505.80
Other holothuria	beche-de-mer	20.15	76.65	1544.50
Portunidae	Mud crab	9.59	132.21	1267.89
Octopididae.	Octopus	5.99	54.27	325.08
Arcidae	Bivalve	4.05 [2]	39.29	159.12
Trochus niloticus	Topshell	6.66 [3]	24.27	161.64
Aplysiidae	Sea hare	20.15 [4]	21.2	427.18
Total				**$10,291.73**

Source: Korovulavula et al (2007)
[1] Assuming price of $5/basket (average 15 urchins per basket, 0.15kg per urchin)
[2] Price of oysters used as proxy
[3] Price of giant clam used as proxy
[4] Price of "other holothuria" used as proxy

Although results in Table 14 indicate that the economic value associated with *T. gratilla* accounts for about a third (33.9%) of the total economic benefit from invertebrates, this is largely a consequence of the very large quantities harvested rather than the price. *Holothuria fuscilgova* - at $60/kg - provides the greatest return per kilogram. Thus, although it makes up 3% of the total invertebrate catch by weight, its economic value is 34% of the total economic value associated with the invertebrate catch.

[13] Gross economic value of invertebrate catch from last trip = total weight harvested during last trip (per family) (kg) x average price per family (FJ$/kg)

In order to calculate the flow of gross economic benefits from fishing over time, two key assumptions have been made. These are:

1. That the catch data collected in this survey (for one fishing trip) is representative of catches throughout the year for *all reef fish* and for *most invertebrate species*. This clearly has its limitations, as most species exhibit at least some seasonal variation. For example, octopus is most abundant between March-May, whereas Siganids (rabbitfish) are most abundant during November and December. However, this variability could not be incorporated into the analysis for lack of time. Seasonal variability has only been considered for pelagic species (*Rastrelliger spp*. (Chub mackerel) and *Valamugil seheli* (Bluespot mullet)), and for *Tripneustes gratilla* (sea urchin). This is discussed below.
2. That the catch during this year is representative of catches over the following 10 to 20 years.

Seasonal variation

Pelagic species such as mackerel and mullet are seasonal; both are more abundant in the Navakavu *iqoliqoli* during the winter months (May to September). The harvest of sea urchins is also seasonal, and mostly takes place during the summer months (November-February). This seasonality has been incorporated into the analysis using time-series catch and/or abundance data from studies carried out in various parts of the world, including Thailand (Boonragsa, 1987), Zanzibar (Mwebaza-Ndawula, 1990) and Australia (Virgona et al, 1998). Unfortunately no studies were identified that were based in Fiji.

Using data on monthly catches of *Rastrelliger kanagurrta* in Thailand (Boonragsa, 1985), it was estimated that fish catches are approximately five times greater during high season. Mwebaza-Ndawula (1990) find artisanal catches of *R. kanagurta* in Kenya to be just over three times greater during high season. The present study will use the Thailand value.

Mullet catch variability has been assessed using catch data from New South Wales in Australia (Virgona et al, 1998), such that the catch is five times greater during the high season. Data on seasonal variation in abundance of *Tripneustes gratilla* was not found. There are many studies exploring the determinants of variability (e.g. Dumas et al, 2007, Vaitilingon et al, 2005), but none found that provide time-series catch or abundance data. Hence*, it will be assumed that the urchin catch is five times greater during high season.*

Table 15: Calculating catches for seasonal fisheries

	Mackerel	**Mullet**	**Urchin**
High season	March-June	Aug-Sept	Nov-Feb
Length of high season (months)	4	2	4
No. of trips per year during high season [1]	26.4	13.22	26.4
Catch per trip during high season (kg) [2]	172.5	428.5	1,570.2
Total fished during high season (kg) [3]	4,560.35	5,664.08	41,511.06
Low season	July-Feb	Oct-July	March-Sept
Length of low season (months)	8	10	8
No. of trips per year during low season [1]	52.87	66.09	52.8
Catch per trip during low season (kg) [2]	34.5	85.7	314.04
Total fished during low season (kg) [3]	1,824.14	5,664.08	16,604.43
Total fished per year (kg/yr)	6,384.49	11,328.17	58,115.49

[1] The average number of fishing/gleaning trips made per household per year comes to 79.31 (see footnote 14 below). Number of trips during the high(low) season=(length of high(low) season/12months) x 79.31
[2] Calculated using assumption that catch during high season is five times the low season catch.
[3] Total fished=catch per trip x number of trips per year

Using these assumptions, we can proceed to estimate the gross economic benefits from fishing/ gleaning activities in the Navakavu *iqoliqoli* over time. Using the average number of fishing trips made per household per year (79.31 trips/year)[14], the total annual catch for *non-seasonal fisheries* comes to 139,370.7 kg/year. Add to this the total weight of seasonal fisheries (75,828.2 kg/year), as assessed in Table 15, and the total annual catch comes to 215,198.8 kg/year.

[14] Average number of trips per year= [(average number of trips per week)x(52 weeks/year)] x [(average number of months spent fishing and/or gleaning per year) / (12 months)]

The gross economic benefits from fishing/gleaning activities for all fisheries are valued at FJ$1,426,018 per year (with finfish catches accounting for 53% of the total value per year). This amounts to $12,847 per household per year.[15]

This estimate represents the full economic value (before deduction of costs) of all fish and invertebrates extracted by the local community from the *yavusa* Navakavu, based on current 2006 prices. However, not all of this is sold in the market; in fact, only 57.3% is exchanged for money. Table 16 summarises the relative gross economic value of the main uses to which the fish/ invertebrates are put. The gross income from the sale of fish/invertebrates comes to FJ$817,108 per year, which amounts to $7,361 per household per year (or FJ$613 per household per month).

Table 16: Gross economic value of different uses of catch

	For sale	Household consumption	Gifts (to family, community etc)
% total catch	57.3	24.6	18.2
Gross annual economic value (FJ$)	817,108	365,061	259,535

* Percentages may not add up due to rounding up of values

If we compare this gross monthly cash income of FJ$613 from fisheries, with the average household monthly income value for the sample ($244/month), presented in Table 4 in Section 6.2 (summary statistics of survey sample), it is clear that there is a large difference between these values. Although the costs of fishing have yet to be deducted from the gross benefits, it is unlikely that the net benefits will drop to as low as

[15] It has been commented on that the estimate of gross benefits from fishing/gleaning over a year would be more accurate if appropriate weights were assigned to trips according to the type of collection activity (i.e. fishing versus gleaning). Unfortunately, the survey did not elicit specific data on number of trips per year for fishing versus gleaning; hence, the results presented here are for mixed trips involving both fishing and gleaning.

$244/month. Fishing is very much a low impact activity in this area, involving very simple technologies, so it is unlikely that the costs will be very high.

There are a number of possible explanations for this difference between the estimated revenue from the sale of fish catches per household, and the reported average income per household: 1) the estimate of $613 is an overestimate, due to inadequate assumptions made about invertebrate LW ratios and/or prices, as well as assumptions about the representativeness of the reported catch for catches throughout the year. The influence of these assumptions on the final results will be tested in the sensitivity analysis in Section 13). 2) There has been misreporting of catches or even more likely, misreporting of average income values. It is considered that many respondents might prefer to under-report their true income, especially to other members of their community such as the interviewers. Fijian culture requires village and community members to share their wealth and make donations towards traditional obligations (e.g. funerals, weddings) (Crocombe, 2001), hence it is not altogether unlikely that the full extent of a household's wealth is not revealed. 3) The prices used to convert catch weight into economic values are not appropriate.

A few words on point number 3: a number of fishers sell their catch to middlemen in Suva, who then sell the fish at the market or elsewhere. Prices paid by middlemen will certainly be lower compared to the municipal market prices; the mark-up can range from anywhere between 25% to over 75%. Thus, a number of fishers are probably receiving less cash for their fish (although of course, they spend less time selling it, thus reducing labour costs). Unfortunately the questionnaire failed to identify the number of households that sold their catch to middlemen, and the prices charged. Hence, the discrepancy between the estimated value of fish sold on the market and the reported average income per household may be a real one, and not a consequence of inaccurate assumptions or misreporting, as suggested in points 1 and 2. For the purpose of this study however, the use of market prices is appropriate, as there is no reason why the middleman price may be a more accurate reflection of the fish value than market prices.

Given our interest in estimating the value of the Navakavu *iqoliqoli* resources over time, estimation of the Present Value of the fisheries has been carried out for a 10 year and 20 year scenario, using a 5%, 10% and 15% discount rate (Table 17).

Table 17: Present values for fisheries from the Navakavu iqoliqoli

Present value	**Discount rates (*i*)**		
	i=5%	***i=10%***	***i=15%***
PV over 10 year period (FJ$)	12,437,350	10,188,280	8,582,871
PV over 20 year period (FJ$)	19,197,352	13,566,512	10,351,936

As results show, the PV (before deduction of costs) of fisheries from the Navakavu *iqoliqoli* ranges between FJ$8,582,871 (*i*=15%) and $12,437,350 (*i*=5%) over a 10-year period, and FJ$10,351,936 (*i*=15%) and $19,197,352 (*i*=5%) over a 20-year period.

7.4.2 Costs of fishing and gleaning activities

Fishing and gleaning involve costs, which must be deducted from the gross value of the fisheries if we are to obtain the net value of the resource. The main costs include: capital assets (boats, engines and fishing gear), operating and maintenance costs (fuel for boat engines, repairs) and labour costs.

Table 18 summarises the number of boats recorded in the household questionnaires (n=118) and the mean cost of boats. Data was also obtained in the questionnaires on the date of purchase, which has allowed for boat costs to be adjusted to current 2006 FJ$[16].

[16] The price paid for boats purchased before 2006 must be adjusted to account for inflation, given that $1 in the past had greater relative value than $1 in the present (i.e. you could buy more with $1 in the past). Boat prices reported in the survey were adjusted using the Consumer Price Index (CPI) for the appropriate years (FIBS (2006). For details please contact the author.

Table 18: Number and cost of boats in *yavusa* Navkavu [1]

	Wooden boats (no engine)	Wooden boats (with engine)	Fibreglass boats	All boats
Number of boats	8	3	2	13
Mean cost per boat (current 2006 FJ$)	524.42	1,649	12,000[2]	1,108.90
Min/ max (current 2006 FJ$)	82 / 1096	477 / 11895	12000 / 12000	82 / 12000
Total cost all boats (current 2006 FJ$)	4,195.36	4,947	24,000	13,142.36

[1] Costs of boats have been converted to current 2006 prices, using inflation rates provided in FIBS (2006)
[2] Only based on data for one boat (cost of boat was not given by other respondent)

As results in Table 18 show, most boats are wooden, ranging in price from $82 to over $1000 current prices. Only 2 households claim to own fibreglass boats (with engines), and no other boat type was recorded in the interviews.

Table 19: Fishing gear: ownership, price per unit, lifetime and average cost per year

Gear	Number of HHs who own	Cost per unit (FJ$) [1]	Lifetime (years)	Cost per year (FJ$)	Total costs per year
Basket	3	3	3	1.00	3.00
Bucket	11	3	3	1.00	11.00
Handline	53	8	1	8.00	424.00
Diving knife	9	4	3	1.33	12.00
Diving mask	8	65	3	21.67	173.33
Net	44	150	2	75.00	3,300
Spear	27	30	4	7.50	202.50
Speargun	5	130	4	32.50	162.50
Steel rod	4	10	4	2.50	10.00
Underwater torch	2	50	3	16.67	33.33
Trap	1	25	3	8.33	8.33
				total	4,340

[1] Source: Bob's Hook, Line and Sinker fishing tackle shop, 14 Thomson Street, Suva (March 2006)

Table 19 details the different types of fishing gear used by households in the *yavusa* Navakavu and the number of households that regularly use each type of fishing gear. The most frequently used gear was the handline: just under half (47.7%) of all fishing households regularly using them. This is followed by nets (39.6% of households use nets) and spears (24.3% use them regularly). Other fishing gear used includes sacks, bags and gloves. However, these are not included in the valuation as they may not be purchased specifically with regards to fishing/gleaning. The total estimated costs of fishing gear (taking into account price per unit, number of households that own the gear and average lifetime per fishing gear type) come to FJ$4,340 per year.

Finally, Table 20 details the running costs associated with fishing/gleaning activities in the Navakavu *iqoliqoli.* These include: maintenance costs for the boats, fuel costs for boats with engines and the opportunity cost of labour. The main identified maintenance costs include paint, spare parts and servicing of engines. Using data from the household surveys, the average expenditure on these comes to FJ$490.80 per household per year. Fuel costs are only incurred by households that own boats with engines, and come to FJ$1,467 per household per year.

Table 20: Mean running costs associated with fishing/gleaning in Navakavu *iqoliqoli*

Running costs	**Average cost per household per year (FJ$)**	**Total cost for all households per year (FJ$)**
Maintenance costs for boat (FJ$) [1]		
Paint	220.21(220.82) [1]	2,862.60
Spare parts	83.88 (81.01)	1,090.44
Engine service	186.72 (61.10)	933.60
Fuel costs (for boats with engine) (FJ$)[2, 3]	1,467.24 (828.70)	7,336.20
Opportunity cost of labour [4]	491.33 (536.98)	54,537.76
Total running costs per year (FJ$)		66,760.60

[1] Figures in brackets are standard deviations
[2] Boat-related costs are assessed for boat-owning households only (n=13) and engine-related costs for households that own engines (n=5). All other costs are assumed to accrue to all fishing households (n=111)
[3]Assuming that the price of fuel is $1.50 per litre
[4] Assuming that the opportunity cost of labour is FJ$0.95 (based on average wage rate for unskilled workers (FIBS, 2006) and assuming that 1-2 people (average 1.5) per household fish at any one time.

The opportunity costs of labour are equivalent to the potential earnings foregone in another income-generating activity. It has been assumed here that the opportunity costs of labour are equivalent to FJ$0.95/ hour, the average wage in Fiji for unskilled workers (Census, 2006). Using this value, the opportunity cost of labour on fishing is estimated at FJ$491/household/year (based on an average of 345 person hours (s.d. 375) spent per year fishing/ gleaning, and average of 1.5 household members fishing at any one time).

Overall, the total value of running costs (including the opportunity costs of labour) associated with fishing/gleaning activities in the Navakavu *iqoliqoli* come to $66,760 for all fishing households per year, equivalent to an average of $601 per household/year.

Notably, there will also be costs associated with the transportation of fish to Suva market several times a week, and the opportunity cost of time spent selling the fish (unless the fisher sells the catch to a middleman). However, it is considered that these costs are almost negligible, hence they have not been incorporated into the valuation.

7.4.3 Net present value from fishing/gleaning activities

The net present value (NPV) of fish/invertebrates extracted from the Navakavu *iqoliqoli* is estimated for a 10 year and a 20 year scenario, using 5%, 10% and 15% discount rates. In order to incorporate the cost of the capital assets (namely boats and engines), it has been assumed that all boats have been purchased in the year 2006, and that they have a lifetime of 10 years. Thus, for the 10-year scenario, it is assumed that each boat-owning household (n=46) purchases and uses one boat, whereas for the 20 year scenario it is assumed that each household purchases 2 boats. These impacts of these assumptions on the final results will be assessed in the sensitivity analysis (Section 13).

The NPV is calculated using the following equation:

$$NPV = \sum_{i=0}^{n} B_n / [1+i]^n - \sum_{i=0}^{n} C_n / [1+i]^n \qquad (1)$$

where B is the gross benefit per year, C is the cost per year, *i* is the discount rate and n represents the number of years that we are interested in.

Table 21 presents estimates of the PV of gross benefits from fisheries (also in Table 17), the PV of total costs (capital and running costs) and the NPV estimates for both 10 and 20-year scenarios.

Table 21: NPV for fisheries from the Navakavu *iqoliqoli*

Present value	**Discount rates (*i*)**		
	i=5%	***i=10%***	***i=15%***
PV of gross benefits over 10-year period (FJ$)	12,437,350	10,188,280	8,582,871
PV of gross benefits over 20-year period (FJ$)	19,197,352	13,566,512	10,351,936
PV of costs over 10-year period (FJ$)	633,262	521,124	441,079
PV of costs over 20-year period (FJ$)	983,454	702,703	542,426
NPV over 10-year period (FJ$)	11,804,088	9,667,156	8,141,792
NPV over 20-year period (FJ$)	18,213,898	12,863,808	9,809,510

As figures indicate, costs represent only a small proportion (about 5%) of the NPV estimates. This is somewhat lower than values estimated by Nicholson (1994) for fishers in the Montego Marine Park in Jamaica, where total operating costs (with exception of labour payments) were estimated at between 11% and 34% of gross revenue. The values in the present study are suggestive of the relatively low-impact fishing approaches used by fishers in the *yavusa* Navakavu. The fact that only two households own fibreglass boats with engines is indicative of this low-impact approach to fisheries. These results also suggest that there is a high economic yield relative to inputs into fishing/gleaning activities.

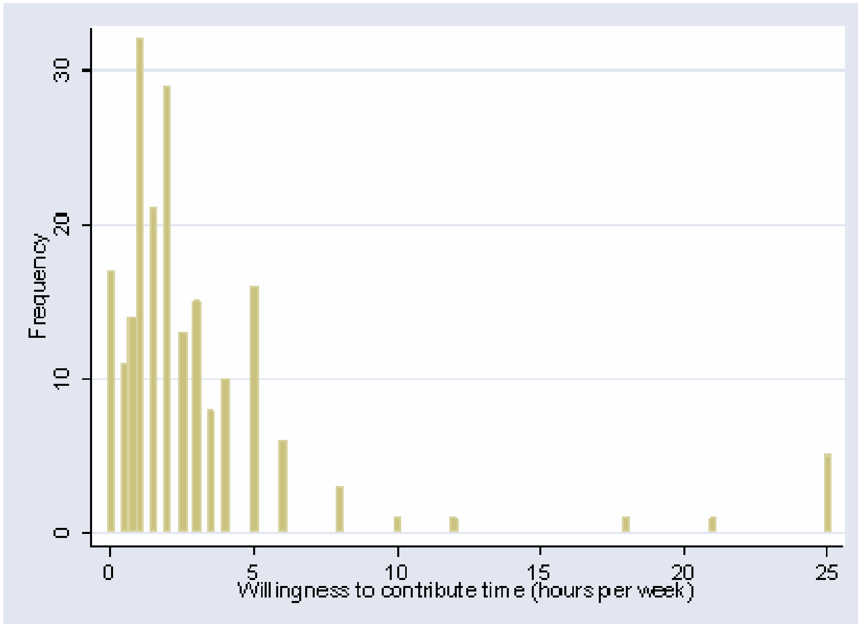
8. BEQUEST VALUE

For this valuation, it was deemed appropriate to elicit WTP values from the whole population of adults in the *yavusa* Navakavu, and not just the heads of household. Thus, an additional 120 respondents of adult age (over 21) were asked to complete a contingent valuation questionnaire. Of these questionnaires, 34 were unuseable, and dropped from the analysis. Thus, the results presented in this section are based on a sample of 204 respondents from all four villages, including the 118 heads of household who completed the household questionnaire. This represents approximately 25% of the total adult population of the *yavusa* Navakavu. Note that the data has not been weighted to make the sample representative of the full adult population, as there is no existing information on the socio-economic characteristics of the whole population.

8.1 Willingness to contribute time

As explained in Section 5.2.1 (CV questionnaire description), all respondents were asked whether they would be willing to contribute some of their time to help in the recovery and conservation of the Navakavu *iqoliqoli*, for use by future generations, *even if this means they cannot use it themselves.* Those who were willing to contribute time were then asked how many hours they would be willing to contribute per week. Figure 13 shows the distribution of responses.

Figure 13: Distribution of willingness to contribute time per week towards the conservation of the *iqoliqoli* for future generations (WtCT)



Results in Figure 13 show that the distribution is skewed to the right; this is typical of WTP distributions and is due to the preferences of respondents (n=5) for whom bequest values are probably very high. Most respondents however (83% of sample) were willing to contribute between half an hour and 5 hours per week.

The distribution also shows that there are 17 respondents (8% of sample) who stated zero 'willingness to contribute time' (from hereon: WtCT) towards conservation of the *iqoliqoli* for future generations. Of these, three respondents (1.5% of the sample) gave 'protest' zero values. Protests are non-valid representations of respondents' preferences; they occur when survey respondents state zero WTP (or in this case: WtCT) for a good, even though they actually value it; this typically happens when respondents 'protest' against some aspect of the survey instrument, or if they refuse to allocate monetary values to a good on ethical grounds. In this case, all three protests were due to "not being informed by the committee" about the proposed scenario. This is in effect a refusal to accept the scenario in the questionnaire, and hence represents a protest response. Protests are typically dropped from the analysis.

Summary statistics, presented in Table 22, indicate that the average amount of time that respondents are willing to contribute towards conservation of the *iqoliqoli* for future generations comes to just over 3 hours per week per person of adult age. If we consider that, on average, respondents claim to spend 5 hours per day engaged in activities that generate income and food (see Section 6.2 for summary statistics), then assuming that they work 6 days a week, this comes to 30 hours a week spent on livelihood activities. Thus, the amount of time they would be willing to contribute towards conservation of the *iqoliqoli* represents about 10% of the total amount of time that respondents claim to spend on livelihood generation.

Table 22: Summary statistics for WtCT

Summary statistics	Responses (n=204)
Number respondents willing to contribute time towards conservation of *iqoliqoli* for future generations only	187
% sample WtCT	91.7
Number respondents WtCT=0 (valid)	14
% valid WtCT =0	6.97
Number respondents WtCT =0 (protests)	3
% protests	1.47
Mean WtCT (hours) (no protests) (s.d.)	3.03 (4.35)
Median WtCT (hours) (no protests)	2.0
Minimum/Maximum	0/ 25

Converting WtCT into Economic Estimates

In this section, mean WtCT values are converted into monetary values. The assumption is that time spent contributing towards conservation of the *iqoliqoli* entails an opportunity cost, and hence has an economic value. The value of time used here will be the average wage rate for Fiji. The use of the wage rate of time assumes that the individual is making a trade-off between work time and time spent contributing towards the *iqoliqoli*[17].

Using the wage rate of time, the economic value of WtCT was estimated using the following formula:

$$\text{mean WTP} = \sum (\text{WtCT}_i \, . \, \text{wage rate}_i) \, / \, n \qquad (1)$$

Using the average wage rate of $0.65-$1.25 per hour for unskilled workers (source: Census, 1996), the value of time that respondents are willing to contribute towards conserving the *iqoliqoli* for future generations is found to range between FJ$7.88 and FJ$15.15 per month per individual (see Table 23).

Table 23: Economic value of WtCT (FJ$) using average wage rate

	Average wage per hour (FJ$/hr)	**Economic value of WtCT per week per individual (FJ$)**	**Economic value of WtCT per year per individual (FJ$)**
Unadjusted Census 1996 wage rates			
lower bound	0.65	1.97	102.41
upper bound	1.25	3.79	196.95
Adjusted Census 1996 wage rates1			
lower bound	0.87	2.57	133.68
upper bound	1.68	4.94	257.08

1 Adjusted wage rates are based on average 2.7% inflation rate between 1994 and 2005

However, given that almost 10 years have passed since the last population census was carried out in Fiji (the following census is currently underway), average wage rates have also been adjusted to account for inflation. The average rate of inflation is 2.7% per year

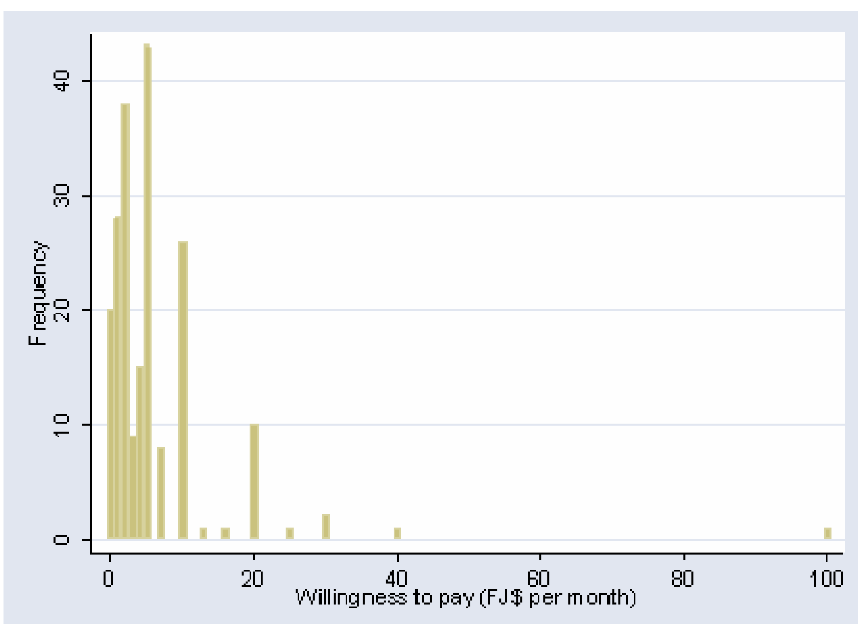
[17] If indeed, the respondent were using leisure time to contribute towards conservation of the iqoliqoli for future generations, then the leisure rate of time (developed by Cesario, 1976) would be used; this is equivalent to a third of the value of work time (or the wage rate).

between 1994 and 2005 (FIBS, 2006). Adjusted results indicate that the opportunity cost of time that respondents are willing to contribute towards the *iqoliqoli* for future generations is FJ$2.57-$4.94 per individual per week, or FJ$133.68-$257.08 per individual per year. This is in effect, the mean bequest value.

8.2 Willingness to pay

In order to explore whether respondents have a preference for contributing money rather than time, they were also asked whether, *instead* of contributing time, they would be willing to contribute money towards the recovery and conservation of the Navakavu iqoliqoli for future generations. This allows us to explore differences between economic estimates of bequest value obtained using two different payment vehicles (time and money). Respondents that said that they were willing to pay, were asked how much using a payment ladder. Figure 14 presents the distribution of results.

Figure 14: Distribution of monthly willingness to pay towards the conservation of the *iqoliqoli* for future generations (WTP)



The distribution for WTP is even more skewed that the distribution for WtCT, due to a single outlier of FJ$100. This has the effect of dragging the value of mean WTP upwards. Summary statistics in Table 2 confirm that mean WTP towards the conservation of the *iqoliqoli* for future generations was FJ$6.13 per individual per month, which is $2.13 over than the median value.

The WTP payment vehicle elicited only a marginally higher rate of zero responses (n=20) compared to the WtCT payment vehicle (n=17). This is somewhat unexpected, as developing country valuation studies often find that respondents have a significant preference for contributing time rather than money. This is usually because money is more scarce than time in developing country contexts. For this reason, studies set in developing countries (e.g. Biro, 1998; Whittington et al, 1990) usually elicit time contributions, or time savings, associated with the good or service being valued, to capture values of respondents who might have little money to contribute, but who nonetheless positively value the good or service in question. Similarly, it might have been expected that the proportion of respondents stating zero WTP would be much higher in the present study, given the lack of available cash in rural areas, such as the *yavusa* Navakavu. It is suggested that the relatively low rate of zero WTP responses in the present study is the consequence of a cultural practice of donating and sharing gifts, money and other goods to the community, church and family members (Crocombe, 2001). As observed during the pilot surveys, the elicitation of WTP was neither controversial nor new to respondents. This suggests that, contrary to some expert opinion, CV methods may be appropriate in developing countries if respondents are used to donating money or other goods towards public or communal goods or services.

Summary statistics, presented in Table 24, indicate that 6% (n=12) of zero WTP responses were protests. Protest responses included: “I was not informed about this”, “I don’t know where my money will go”, “I don’t agree with the idea of giving money” and “I prefer to donate time rather than money”. These responses were dropped from the analysis.

Table 24: Summary statistics for WTP

Summary statistics[1]	Responses (n=204)
Number respondents WTP>0	184
% sample WTP>0	90.2
Number respondents WTP=0 (valid)	8
% valid WTP	3.9
Number respondents WTP=0 (protests)	12
% protests	5.88
Mean WTP (FJ$) (no protests) (s.d.)	6.13 (9.10)
Median WTP (FJ$) (no protests)	4.00
Minimum/Maximum	0/ 100

Overall, statistics indicate that the mean WTP towards the conservation of the *iqoliqoli* for future generations was FJ$6.13 per individual per month (or FJ$73.56 per individual per year).

8.3 Comparing and aggregating estimates

The previous sections have produced economic estimates of bequest value using two different payment vehicles: WtCT and WTP. Results indicate that, using the time-based payment vehicle (WtCT), the opportunity cost of time that respondents are willing to contribute towards conserving the *iqoliqoli* for future generations ranges between FJ$133.68-$257.08 per individual per year (using the adjusted wage rate of time) - this represents an average of FJ$195.38 per individual per year.

Using the WTP payment vehicle, which directly elicited monetary contributions, respondents indicated that they would be WTP FJ$73.56 per individual per year. This estimate is 38% lower than the value estimated using the value of time. This discrepancy between estimates may be due to a number of reasons. Firstly, the opportunity cost of time used to convert time values into monetary values may be inappropriate. Do we use the lower bound or upper bound of the average wage rate? Additionally: would respondents use work time or leisure time to contribute towards conservation of the *iqoliqoli*? As mentioned in footnote 17, if they were using leisure time, then the opportunity cost of time used would be one third of the wage rate. This would bring the economic estimate produced using WtCT values much closer to the WTP value.

Secondly, the discrepancy between estimates may simply indicate that respondents have a preference for contributing time than money. As noted, this is usually found to be the case in developing country contexts where money is more scarce than time. Finally, it is possible that respondents are behaving strategically when answering the WTP question format (known as *strategic bias*). Respondents often have an incentive to misrepresent their preferences when directly asked *how much they'd be willing to pay,* in order to influence policy decisions in their favour (Bateman et al, 2002).

An aggregate estimate of bequest value can be obtained by multiplying these figures by the total number of individuals of adult age in the *yavusa* Navakavu. Using an estimate of 320 adults[18], the total bequest value comes to FJ$62,521 per year (using WtCT estimates) or $23,539 (using WTP estimates).

As noted in Section 5.2.1, the valuation scenario involved a long-term commitment towards conservation of the *iqoliqoli* for future generations. For this reason, it is useful to aggregate values over time, in order to obtain a measure of the overall economic bequest value over time. This aggregate value, or 'Present Value' (PV), is calculated by adjusting annual economic values using a discount rate, as described in Section 2.2. Assuming a 20-year time period, and using three discount rates of 5%, 10% and 15%, the PV of the bequest value associated with the Navakavu *iqoliqoli* (presented in Table 25) ranges from $841,667 (5% discount rate) to $453,859 (*i*=15%), if using the WtCT economic estimates; or FJ$316,890 (*i*=5%) to $170,879 (*i*=15%) if using the WTP values.

[18] The survey established that there were a total of 412 individuals over 15 years of age living in the interviewed HHs (average of 3.5 over-15 year-olds per HH). Assuming that there are on average 2.5 individuals *over 21 years of age* per household, the total number of adults (over 21 year olds) living in the area was estimated at 320. This is half of the estimated total population.

Table 25: Present values for bequest values associated with the Navakavu *iqoliqoli*

Present value[1]	Discount rates (*i*)		
	i=5%	***i=10%***	***i=15%***
Using value of time estimates (FJ$)	841,667	594,795	453,859
Using WTP estimates (FJ$)	316,890	223,942	170,879

[1] Over a 20-year period

8.4 Econometric model

Variables influencing a respondent's willingness to contribute time or money towards the *iqoliqoli* for future generations were determined using ordinary least squares (OLS) regressions. Explanatory variables, identified through the literature review (see Section 3), include: socio-demographic characteristics, wealth indicators, indicators of respondent's main income/ food-generating activity, average number of hours worked per day per respondent, number of non-adults in each household, and whether respondent has been involved in LMMA decision-making. Variables included in the regressions are presented in Table 26, and results of the regressions are presented in Table 27.

Table 26: Variables included in OLS regression

Variable Name	Variable Description
Dependent variables	
WtCT	Number of hours that respondents are willing to contribute per week towards the conservation of the *iqoliqoli* for future generations
WTP	Willingness to pay per month towards the conservation of the *iqoliqoli* for future generations
Explanatory variables	
YADJ	Income values calculated using mid intervals of income levels, and divided by 100
OWNBOAT	Dummy indicating whether respondent owns a boat: 1=yes, 0=no
SAVINGS	Household savings calculated using mid intervals of savings levels, and divided by 100
MALE	Dummy indicating gender: 1=male, 0=female
AGE	Age of respondent
EDUC	Dummy for minimum secondary school education year 12 (up to 18 years old): 1=yes, 0=no
LOCAL	Dummy indicating whether respondent was born in the village: 1=yes, 0=no
FISHER	Dummy indicating whether respondent's main activity for cash and/or food is fishing or gleaning: 1=yes, 0=no
WORKSUVA	Dummy indicating whether respondent's main activity for cash and/or food is salaried work in Suva: 1=yes, 0=no
WORKHOURS	Average number of hours a day that a respondent spends on activities that generate income and/or food
CHILDPERHH	Number of children (<15 year olds) living in household
USEMARINE	Dummy indicating whether respondent's household uses the marine environment for activities other than fishing or gleaning: 1=yes, 0=no
LMMADECIS	Dummy indicating whether respondent was involved in decision-making for the LMMA: 1=yes, 0=no

Table 27: OLS regression on WtCT and WTP (bequest value)

	WtCT			WTP [1]		
Variable	Coefficient		t-value	Coefficient		t-value
YADJ	-0.004		-0.04	0.04		0.20
OWNBOAT	-		-	2.67	***	2.85
SAVINGS	-		-	0.31	**	2.17
MALE	2.00	***	3.10	2.03	***	2.80
AGE	0.03		1.14	-0.00		-0.09
EDUC	0.69		1.17	0.93		0.92
LOCAL	0.79		1.12	0.63		0.80
FISHER	1.58	**	2.23	1.66	**	1.98
WORKSUVA	-		-	3.62	***	2.90
WORKHOURS	0.25	**	2.03	-		-
UNDER21	0.61	*	1.90	-0.12		-0.43
USEMARINE	-0.51		-0.59	-0.11		-0.11
LMMADECIS	1.37	***	2.64	2.95	***	3.60
Constant	-3.04	*	-1.76	-0.97		-0.43
Adjusted R^2	0.17			0.24		-
N	199			189		

[1] An outlier of $100 was omitted from the WT regression

*Significant at 10% level, ** significant at 5% level, *** significant at 1% level

As results in Table 27 show, respondent's willingness to contribute time and/or money towards the *iqoliqoli* is determined strongly by gender and involvement in LMMA decision-making, such that males who have been involved in LMMA decision-making are willing to contribute more time and money. The strong positive influence of involvement in decision-making on respondent's value for the *iqoliqoli* is particularly interesting. It suggests that the value attached to one's environment is largely driven by the ability to influence decisions associated with it. This finding might support the demand for greater involvement of women and youths in decision-making processes associated with the *iqoliqoli*.

Respondents whose main activity is fishing and/or gleaning (FISHER) are also significantly more willing to contribute time and money. This latter relationship is as expected: respondents who depend on the *iqoliqoli* for income and food are probably more 'connected' to their marine environment, and hence probably more likely to value the resource for future generations.

WtCT is also determined by the number of hours that respondents work each day, although the sign on the coefficient is negative, suggesting that the *more hours* respondents work, the *more time* they are willing to contribute towards the *iqoliqoli.* This is contrary to expectations: one would expect that respondents who spend longer hours earning income or securing food for the household would be willing to contribute less time, not more. An inspection of the data reveals that individuals who work less than 4 hours per day are the least willing to contribute time (average 2 hours per week), whereas respondents who work 4-6 hours per day are willing to contribute the most amount of time (3.67 hours per week). Respondents who work over 8 hours per day are willing to contribute less time than those who work 4-8 hours per week, but more than those who spend less than 4 hours per day on work (average WtCT 3.23 hours per week).

There are various possible explanations for these results. Firstly, respondents who work less than 4 hours per day may be old and may feel unable to contribute much effort towards conserving the *iqoliqoli.* Summary statistics, however, refute this hypothesis. In fact, respondents who work less than 4 hours per day make up the youngest age group (average age 36, compared to average ages of 40 and 38 for respondents who work 4-8 hours, and over 8 hours per week, respectively). Secondly, it is possible that respondents who spend less than 4 hours a day earning income or collecting food may actually be spending most of their time looking after the home - thus, one would expect them mostly to be female. Again, summary statistics refute this: half (54%) of the sub-sample who work less than 4 hours per day are women. Thirdly, these results may simply highlight a lack of motivation (and hence, low WtCT) amongst individuals who do not have much to do with their time. This is an interesting finding that might merit further qualitative investigation.

The WTP model indicates that males who have been involved in LMMA decision-making, and who either work mainly as fishers, or in salaried jobs in Suva, are willing to pay more towards the *iqoliqoli* for future generations. Average household income does not appear to significantly influence WTP as predicted by theory; however, boat ownership and amount of household savings are significant predictors of WTP. Thus, these may constitute more appropriate wealth indicators than average household income. It is usually the case that developing country valuation studies use indicators of wealth other than average income.

Both regressions perform adequately: 17% of the variance in the WtCT model is explained by the regressors, whilst 24% of the variance in the WTP model is explained by the regressors. This is very acceptable; regressions on CV data usually yield R^2 values between 10% and 40%, although studies reporting an R^2 under 15% are considered unreliable (Mitchell and Carson, 1989).

9. VALUE OF RESEARCH AND EDUCATION

This section estimates the economic benefits to local communities associated with research and education activities related to the *iqoliqoli* in the yavusa Navakavu. The value of research and education activities to local communities was identified in the pre-pilot interviews as a major benefit, and confirmed by survey results: 14% of all households identified the economic benefits from research and education as the *most* important benefit associated with the LMMA (second only to 'increased catches') and 23% identified this as the second-most important benefit.

This finding is not surprising. In the late 1990s, Prof Thaman and students from the Marine Studies Programme at USP carried out field work in the *yavusa* Navakavu, and it was as a result of this work, and the information generated buy it, that villagers were able to identify the need for marine management. In 2001 they requested the support of USP to set up an LMMA. This example clearly highlights impact that research and education activities related to the *iqoliqoli* have had on the local communities. The LMMA is now set up, and the villagers are benefiting from this.

In order to estimate the economic value of research and education activities related to the *iqoliqoli* and LMMA in the *yavusa* Navakavu, gross financial expenditures have been used. These include: payments received for food, lodging and fees paid by researchers and students; capital equipment donations (e.g. boats and other gear); access fees for the *iqoliqoli;* and other direct payments to local communities for support and assistance with research and education activities. Data on number of research/ education visits and payments made per visit has been obtained from the FLMMA liaison officer for the *yavusa* Mavakavu (Semisi Meo), and from researchers who have worked in the field over the past 6 months.

There are also a number of benefits to local villagers associated with the information generated through these research activities. These include: increased know-how and ability to manage their marine resources, and local expertise in biological and socio-economic monitoring procedures (through training). These benefits are likely to have a significant impact in the long-run on the welfare of the *yavusa* Navakavu communities. However, they have not been estimated in the present study. Such a valuation would perhaps be better carried out *ex post*, when the benefits of the information generated are palpable and measurable. Furthermore, it would be difficult to disentangle the value of information generated through research at the Navakavu site from other values, such as the direct use values of the *iqoliqoli* (e.g. fishing). For example, it would be very difficult to identify how much of the fisheries value within the Navakavu *iqoliqoli* is attributable to better management as a result of information generated through research (i.e. is the information value equal to 75% or 10% of the fish catch value?) In addition, the multiplier effects of these activities on the livelihoods of local communities have not been considered here either.

Finally, it is important to note that the benefits of research and education activities are likely to accrue to a wider range of beneficiaries, from researchers and students, to industry and government. Information generated through research in the area will most likely generate benefits for a wide range of individuals, organisations and institutions. However, the purpose of the present study is to estimate the economic benefits from research/ education to the local community. Future research into the wider range of economic benefits of research in the area would be of great interest, particularly to funding bodies and research institutions.

9.1 Data and analysis

Table 28 summarises the research and/or education-related activities that have taken place in the *yavusa* Navakavu over the past 5 years in association with the *iqoliqoli*. Research activities include: field visits by researchers from USP or other institutions (e.g. CRISP or TNC), and research and monitoring by FLMMA team members. Education activities include field trips by USP students.

As can be observed, payments are made to the community for each research/ education-related activity. These payments cover food, lodging (where relevant), assistance with translation and survey administration, as well as fees to secure access to the *iqoliqoli*. Villages host researchers and/or student groups in rotating order. If there are more than 20 participants involved, then half of the money is given to the hosting village and the other half to the *iqoliqoli* committee. If there are fewer than 20 participants, then the village keeps the money. The *iqoliqoli* committee uses the money to help manage the LMMA; the village uses the money to cover food and other support costs, and to support village development projects (e.g. infrastructure, education etc)[19].

[19] Source of information: pre-pilot interviews and focus group sessions headed by TNC MPA and Poverty research group, and attended by researcher from the present study.

Table 28: Research and education benefits associated with iqoliqoli

Date	Details of activity	Number of people	Amount paid to community (FJ$)
19 Oct 2005	Pacific Island Community Conservation Course field trip (1/2 day)	30	500
1-2 Aug 2006	FLMMA biological working group monitoring activity	30	1500
11 Aug 2006	Community Monitors Data Collection Training Workshop	30	1500
Oct 2006	CRISP/ FLMMA biological monitoring test and comparison	15	750
Nov 2006	TNC study (Poverty reduction and MPAs) field work (3 days) • Food for 15 people for 3 days • Other support payments	15	800
Nov/ Dec 2006	MSc student research (fisheries and LMMA management) • Food and lodging for 28 days • Assistance from one local villager • Total $30 per day	1	720
Dec 2006	Surveys for CRISP Economic Valuation Project: • Catering for survey trainers and evaluators ($10/person) • Payment for survey work (including pre-pilots and pilots)	 15 14	 150 1,105
throughout 2006	Fish larvae research (CRISP & Ecocean) • Access to *iqoliqoli* (28 days over year) • Assistance from local fishermen (CONFIRM) • Total $35-$40 per trip	various	1,100
Feb 2007	ICM field trip (1 meal)	20	140
May 2007 - forthcoming	USP Student field Trip (1 day) • Catering for 110 students • Other support payments • Total $40 per person	110	approx. 5,000
throughout 2007	Fish larvae PhD research • Access to *iqoliqoli* for 15 days per month all year • Other support payments • Total expected: $200 per month	1-2	2,400
	Total paid over 3 years (Oct 2005-Dec 2007)		15,665

The total amount paid to the community between October 2005 and January 2007 comes to FJ$8,137.71 in constant 2006 Fijian dollars (value obtained by adjusting 2005 payments to inflation rate). If we include expected expenditures for 2007, then this value comes to $15,678 between October 2005 and December 2007.

If we assume that the amount of money paid to the community during 2006 (FJ$7,625) is representative of payments made to the community for fieldwork research/ education activities related to the *iqoliqoli* over the following 10 years, then the PV of benefits from research and education over the next 10 years ranges between FJ$66,503 ($i$=5) and $45,893 ($i$=15%). Over the next 20 years, these values range between FJ$102,649 ($i$=5%) and $55,352 ($i$=15%). Table 29 summarises PVs associated with research and education activities associated with the Navkavu *iqoliqoli*.

Table 29: Present values of research and education activities associated with the Navakavu *iqoliqoli*

Present value	Discount rates (i)		
	i=5%	*i=10%*	*i=15%*
PV over 10-year period (FJ$)	66,503	54,447	45,893
PV over 20-year period (FJ$)	102,649	72,541	55,352

Deducting costs of food and catering

In this valuation, gross financial expenditures have been used to proxy the economic value of research and education related to the Navakavu *iqoliqoli*. The main cost to local communities associated with these activities is considered to be the cost of food. Labour costs are considered to be negligible; any assistance provided is paid for, and labour costs associated with food preparation are likely to be very small.

In general, researchers/ students pay about $10 per day for catering. Thus, during 2006, a total of about $1,630 was paid to cover catering expenses. If we assume that the cost of catering is 50% of the total price paid, or $5 per person per day (including breakfast, lunch and afternoon tea), then the cost of food production for 2006 would amount to $815. This is about 11% of the total revenue from research and education activities. If we deduct this cost from the gross expenditures in 2006, then the net benefit from research activities comes to $6,810.

Table 30 presents the net present value (NPV) of research and education activities over a 10-year and 20-year period, for a 5%, 10% and 15% discount rate.

Table 30: NPV of research and education activities at the Navakavu iqoliqoli

Present value	**Discount rates (*i*)**		
	***i*=5%**	***i*=10%**	***i*=15%**
PV of gross benefits over 10-year period (FJ$)	66,503	54,447	45,893
PV of gross benefits over 20-year period (FJ$)	102,649	72,541	55,352
PV of costs over 10-year period (FJ$)	7,108	5,823	4,905
PV of costs over 20-year period (FJ$)	10,971	7,754	5,916
NPV over 10-year period (FJ$)	59,395	48,655	40,988
NPV over 20-year period (FJ$)	91,678	64,787	49,436

Overall, results indicate that the NPV of research and education activities ranges between FJ$59,395 (*i*=5%) and $40,988 (*i*=15%) over the next 10 years, and FJ$91,678 (*i*=5%) and $49,436 (*i*=15%) over the next 20 years.

10. VALUE OF COASTAL PROTECTION AND WASTE ASSIMILATION

In this section, the economic value of the coastal protection and waste assimilation services provided by the marine ecosystems in the Navakavu *iqoliqoli* are estimated using a benefits transfer approach. This involves transferring values from other studies to the Navakavu context. None of the studies used for this exercise was carried out in Fiji, which means that the transfer of values is potentially subject to considerable error. However, given the dearth of available evidence on either coastal protection expenditures or the value of the waste assimilation function of coastal ecosystems in Fiji, these estimates will at least provide some indication of the scale of the benefits associated with coastal protection in the *yavusa* Navakavu.

Value of coastal protection

Estimates of the value of coastal protection provided by coral reefs and mangroves are obtained by transferring values from two studies: Constanza et al (1997) and McKenzie et al (2005).

Constanza et al (1997) estimate the value of the coastal protection function of coral reefs and mangroves, by transferring values from various other studies from different parts of the world. They value the coastal protection provided by reefs at US$275,000 per km^2 of reef per year, and the value of mangroves at US$183,900 per km^2 of mangrove per year (1996 prices). This is equivalent to US$353,300 (FJ$607,755) per km^2 of reef per year and US$236,292 (FJ$406,423) per km^2 of mangrove per year, in current 2006 prices[20]. However, the values produced by Constanza et al (1997) are in US$ equivalents. In order for these values to apply to a Fijian context, it is necessary to adjust them for income effects. This has been done by multiplying the coastal protection estimates by the ratio of purchasing power Gross National Income (GNI) per capita from Fiji to that of the U.S. (source of GNI per capita data: World Bank, 2007).

[20] Values were adjusted to inflation using the Consumer Purchasing Index (CPI) (FIBS, 2006). Exchange rate used is FJ$1.72 to US$1 (using September 2006 exchange rate, FIBS (2006))

Thus, the estimate of coastal protection value, using income-adjusted benefits transfer of estimates from Constanza et al (1997) yields a value of FJ$85,135 (US$49,497) per km^2 of coral reef per year, and FJ$56,932 (US$33,100) per km^2 of mangrove per year in current 2006 prices.

In McKenzie et al (2005), values for coastal protection afforded by *coral reefs* in the Marshall Islands are estimated using a preventative expenditures approach (i.e. the expense that would be incurred to prevent coastal damage). They estimate that the expenditure on coastal walls for protection ranges between US$3,000 and US$17,500 per metre, depending on the materials and structures used (using 2005 prices). These values include capital expenditures, maintenance costs and assume a 25-year lifetime. Using the mid point of this range of values, and adjusting prices to inflation, the value of coastal protection in McKenzie et al (2005) is US$10,510 (or FJ$17,099) per metre (current 2006 prices) or US$410 (FJ$705.20) per metre per year.

The Navakavu *iqoliqoli* has an area of 18.5 km^2. If we assume that 10 km^2 is composed of coral reefs, and 3 km^2 is composed of mangroves, then the annual value of coastal protection from the marine ecosystem is estimated at FJ$851,352/yr for the reefs and FJ$170,797/yr for the mangroves (using Constanza et al (1997) values). This comes to a total of FJ$1,022,148 (US$594,272) in 2006 prices.

If we use coastal protection values provided in McKenzie et al (1997), we need to make an assumption about the length of the coastal protection structure that would need to be built to provide the same amount of protection as the reef. For this purpose, we assume that the structure would need to go round the peninsula – this would have a length of about 10km. Thus, annual costs associated with coastal protection would come to about FJ$7m per year. This value has not been adjusted, as there is a very small difference between the GNI per capita for Fiji and that for the Marshall Islands (see World Bank, 2007).

As can be observed, the values produced using estimates from McKenzie et al (1997) are about seven times greater than the values derived using Constanza et al (1997). Given that the study by McKenzie et al (1997) was based in the Marshall Islands, where concrete and other aggregates used for sea wall construction are scarce and costly (see report for details), it is considered that the costs of sea walls presented in the study may not reflect the costs in other countries such as Fiji where concrete is less scarce. It is therefore considered that the estimates produced using the Constanza et al (1997) are more appropriate for the present study.

Table 31 summarises PVs associated with the coastal protection function of coral reefs and mangroves within the Navkavu *iqoliqoli* (based on Constanza et al (1997) values).

Table 31: Present values of coastal protection function associated with the Navakavu *iqoliqoli*

Present value	**Discount rates (*i*)**		
	i=5%	***i=10%***	***i=15%***
Coral reefs			
PV over 10-year period (FJ$)	7,425,262	6,082,538	5,124,088
PV over 20-year period (FJ$)	11,461,073	8,099,387	6,180,243
Mangroves			
PV over 10-year period (FJ$)	1,489,643	1,220,268	1,027,985
PV over 20-year period (FJ$)	2,299,300	1,624,888	1,239,869

As results show, the coastal protection provided by coral reefs has higher economic value than that for mangroves. This is likely to reflect the higher costs associated with replacing coral reefs compared to the costs of replacing mangroves. However, it may also indicate that coral reefs are more effective at dissipating wave energy than mangroves. Overall, using a 10% discount rate, and a 20-year period, the value of coastal protection function of coral reefs and mangroves in the Navakavu *iqoliqoli* comes to a total of FJ$9,724,275 (US$5,653,648).

Value of waste assimilation function

Mangroves are considered to have a significant waste assimilation function (Bann, 2002), and yet despite this, very few studies have valued this important function. The present study will use the same benefits transfer approach as used above to estimate the value of the waste assimilation function associated with the mangroves in the Navakavu *iqoliqoli*. Using the value of US$669,600/ km^2/yr from Constanza et al (1997), the income-adjusted estimate of the waste assimilation function of the mangroves comes to FJ$207,297/$km^2$/yr (US$120,251/km^2/yr). Assuming the mangroves cover an area of 3 km^2, the value comes to FJ$621,890/yr (US$361,563/yr) for all the *iqoliqoli* (in 2006 prices). Table 32 summarises PVs associated with the waste assimilation function of mangroves within the Navkavu *iqoliqoli*.

Table 32: Present values of waste assimilation function of mangroves in the Navakavu *iqoliqoli*

Present value	**Discount rates (*i*)**		
	i=5%	***i=10%***	***i=15%***
PV over 10-year period (FJ$)	5,423,955	4,443,131	3,742,009
PV over 20-year period (FJ$)	8,372,007	5,916,385	4,514,502

If we compare results in Tables 31 and 32, it is clear that the waste assimilation function of mangroves is about four times the value of their coastal protection function.

12. TOTAL ECONOMIC VALUE

The TEV of the Navakavu *iqoliqoli* to local villages can now be estimated by adding up the fisheries value, bequest value, research and education values and coastal protection values. This assumes that the TEV is equivalent to the sum of its components. TEV estimates are presented in Table 33.

Table 33: Economic values of Navakavu *iqoliqoli* to local community (FJ$)

Component of TEV	Economic value per year	PV (20-year period, *i=10%)*
Fisheries	1,359,257	12,863,808
Bequest value		
using WtCT	62,521	594,795
using WTP	23,539	223,942
Research/education	7,625	64,787
Coastal protection		
Coral reefs	851,352	8,099,387
Mangroves	170,797	1,624,888
Waste assimilation	621,890	5,916,385
Total [1]	3,034,460 – 3,073,442	28,793,197 – 29,164,050

[1] The range of values presented = the lower bound and upper bound of bequest values

As results indicate, fisheries make up the largest component of the TEV: about 45% of the TEV is based on the fisheries value. This is followed by coastal protection, which makes up about 33% of the TEV. Most of this coastal protection value is attributable to reefs, which make up 28% of the TEV. The economic value of the waste assimilation function of mangroves is also a significant component of TEV: about 20% of the TEV value is attributable to this service. Bequest values and research/ education values account for the remaining 2% of the TEV (bequest values make up 1.5%).

It must be noted that the relative contribution of coastal protection and waste assimilation to the TEV of the Navakavu coastal ecosystems should be taken with caution, given the potential error involved in transferring values from one study to another. Nonetheless, these values are indicative, in terms of scale, of the relative contribution made by different components of coastal ecosystems in the Navakavu *iqoliqoli* to the economic value of the ecosystem. Fisheries are typically considered the main benefit provided by these ecosystems to local communities; the results in this report confirm this to be the case.

12. VALUE OF LMMA MANAGEMENT INTERVENTIONS

A secondary aim of this study was to estimate the economic value of the Navakavu LMMA management intervention. This involves comparing the costs of establishing and managing the LMMA with the benefits from the intervention. There are two broad approaches to valuing the changes in the provision of the key goods/ services associated with the coral reefs and mangroves as a result of the LMMA:

1. Value the actual change in provision of goods/ services since LMMA established.
2. Value different *scenarios* of change in the provision of goods/ services within the LMMA

The first approach is preferred, as actual data on changes can be used to assess the real economic impacts of the LMMA on local communities. However, despite the fact that biological monitoring has been carried out in the LMMA since March 2003, the data was not useable in the present study as it was based on frequency counts of fish and invertebrates (using underwater visual censuses), rather than biomass or catch measurements. It is suggested that future monitoring surveys for LMMAs include regular catch surveys, in order to assess the economic value of the LMMA. The only data that is useable in the context of the present study, is the catch data provided in Kronen (2004) and Cakacaka (2007). Although sampling and data collection methods vary considerably between these studies and the present study, the data can be used to provide a broad overview of the economic benefits of the LMMA in terms of catch (see Section 12.2).

The second approach is useable if there is sufficient expert knowledge on expected changes in the provision of goods and services within the *iqoliqqoli* under different scenarios. For example, one could estimate and compare the economic impact of the following scenarios: a) no management intervention, b) establishment of a "no-take zone" only, and 3) establishment of a "no-take zone" *and* regulation of other external negative influences. Scenario 3 is equivalent to the LMMA set-up, which involved setting up a NTZ as well as managing other negative practices.

Unfortunately, the 'scenario' approach was also non-useable due to the lack of adequate expert knowledge regarding the expected impacts of the different scenarios on the provision of goods and services in the Navakavu *iqoliqoli.* The understanding of the impact of LMMAs on biological and socio-economic factors is a relatively new area of study and research in Fiji, and it is only now that 'lessons learned' are starting to emerge.

In light of these limitations, as well as restrictions on the researcher's time, it is not possible to properly evaluate the economic value of the LMMA at present. For this reason, a very simple valuation will be carried out here, mostly to provide an indication of the scale of economic impacts that might be expected in the Navakavu LMMA. Given that the main aim of the Navakavu LMMA was to stall the decline in fish catches, this brief analysis will focus on this only.

12.1 Method

Using finfish catch data[21] from August 2002 (Kronen, 2004) and July 2004 (Cakacaka, 2007), as well as the data from December 2006 (produced for the present study), a rough approximation of finfish catch changes over time can be estimated. Seasonality of fish species will not be incorporated into the analysis presented here.

[21] Kronen (2004) do not present weight details for invertebrate catch, hence why we are using finfish catch data here only.

Kronen (2004) estimated average finfish catch per trip for 'serious fishers' (i.e. fishers who fish more often and as major source of income) (n=16) and other randomly selected individual fishers (n=16) from 28 households, using a survey carried out in the village of Muaivuso in August 2002. Catch data was collected in this study by asking fishers to state their average annual catch per species. It is expected that this approach will reduce the reliability of the data, as fishers may not average out fish catches over one year in a systematic manner.

Cakacaka (2007) measured catches from one fishing trip in July 2004 for 43 households in all four villages in the *yavusa* Navakavu. The researcher collected this data by directly measuring the size and quantity of species caught from fishing trips. The data produced thus is considered fairly reliable. It is not clear how the sample for this study was selected, and whether data was mostly obtained from more 'serious' fishers or from randomly selected fishers.

In order to compare finfish catches over time (between 2002 and 2006) it is assumed that fishing effort remains constant. For this purpose, the estimate of 79.3 fishing trips per household per year obtained from the present study will be used. This figure will be multiplied by the average catch per household per trip for the whole for the whole *yavusa* Navakavu estimated in Kronen (2004), Cakacaka (2007) and the present study[22]. In order to obtain an estimate of catch per trip for the whole *yavusa* it is necessary to scale up the values presented in Kronen (2004) and Cakacaka (2007) to a total of 111 households (as used in the present study). In this way, we have estimated overall catch per year for 111 households, based on the same fishing effort per household.

[22] Catch weight per trip from Kronen (2004) was based on data obtained from randomly selected individual fishers. In order to convert individual catch data to household data, catch was multiplied by 1.4 (average number of fishers who went fishing on each trip).

12.2 Results

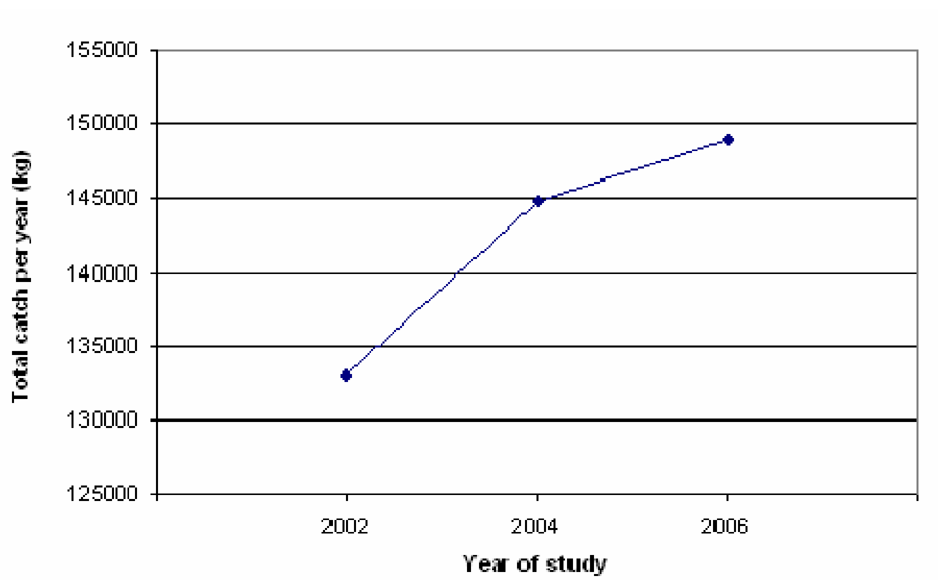
Estimated catches per year for the whole *yavusa* Navakavu (based on 111 households) for 2002, 2004 and 2006 are presented in Table 34, and Figure 15. As noted, these figures have not incorporated seasonality impacts of pelagic or other fish species.

Table 34: Changes in weight and value of finfish over time

Study dates	Total finfish catch per trip[1] (kg)	Total finfish catch per year[1,2] (kg)	Total value of catch per year (FJ$) [3]
August 2002	1818.30	133,107.56	532,430.24
July 2004	1825.82	144,805.86	579,223.43
December 2006	1877.44	148,899.77	595,599.07

[1] Total catch for 111 households
[2] Assuming constant effort (79.3 fishing trips per household per year)
[3] Assuming price of fish is average FJ$4/kg

Figure 15: Changing weight of finfish catch over time (2002-2006)



Using these estimates, finfish catch (and the economic value of the catch) in the Navakavu *iqoliqoli* increased by 8.79% between 2002 and 2004, and increased by 2.83%

from 2004 to 2006. This is equivalent to an average increase of 5.8% every two years, or 2.9% per year.

On the basis of these findings, it is tentatively suggested that finfish catches have increased by about 3% per year since the establishment of the LMMA in January 2002. This increase is partially confirmed by results presented in Hubert (2007) which measured perceptions of changes in catch for key finfish species (*Lethrinus harak* (common name: Blackspot emperor; Fijian: *kabatia*), *Lethrinus atkinsoni* (Yellow-tailed emperor; *sabutu*) and *Parupeneus Sp. (*Indian goatfish; *daunau))*, using semi-structured questionnaires. Findings show interviewed fishers (n=22) perceived a 35% increase in *L. harak* catches between 2002 and 2006 (or an average 8.8% increase per year) and a 32% increase in *L. atkinsoni* catches (8% increase per year) over the same time period. However, results in Hubert (2007) also show a perceived decreased in *Parupeneus Sp* catches from 2002-2006 (overall 38%, average 9.5% per year).

Economic Value of the Navakavu LMMA

Using the above values, an approximate economic value may be estimated for the LMMA, in terms of finfish catches, at just over FJ$63,000 between 2002 and 2006. It is expected that finfish catches will continue to increase for some years, thus increasing the gross benefits per year from the LMMA. In addition, increases in invertebrate catches will add to the value of the LMMA, as well as research and education-related payments made to the villages for visits associated with the LMMA.

Additional benefits associated with the LMMA, that have not been estimated here include: the patrol boat donated to the *yavusa* Navakavu to control poaching, the value of decreased poaching resulting from use of a patrol boat, training of villagers in biological and socio-economic monitoring methods, and increased social cohesion associated with better decision-making and management of resources.

Costs to local villagers are considered minimal, as most costs associated with the set-up of the LMMA were incurred by the FLMMA network (for training, extension, materials and support) or other external bodies, such as USP and government agencies.

This simple valuation suggests that the economic benefits to local villagers from the LMMA are significant, and will continue to increase over a number of years. This is an area that would benefit from further investigation.

13. SENSITIVITY ANALYSIS

In this section, a sensitivity analysis is carried out on the results in order to assess the influence of the various assumptions made on the final valuations. Most assumptions in this study have been made with regards to the catch data. They include:

1. That the estimated catch over a year (based on 2006 statistics for one trip), is representative of catches over the following 10 to 20 years.
2. Assumptions about the weight of various invertebrate species, namely *T. gratilla.*
3. That the opportunity cost of labour is $0.95/hour (based on unskilled labour)

The sensitivity of the economic values produced in this report to the assumptions made will be assessed by modifying one assumption at a time. This is known as *partial sensitivity analysis* (for more information, see Boardman et al, 2001).

Sensitivity analysis 1: Varying catch rates over the next 10 and 20 years

The NPV of the fisheries has been estimated on the assumption that the catch rate will stay constant. However, it is possible that the catch rate will increase, maybe due to the adoption of more sophisticated fishing technologies or increased market prices. On the other hand, it is possible that catches would decrease due to environmental impacts on fish biomass, reduced fishing effort or decreasing market prices. Assuming all other factors remain constant, results of a sensitivity analysis are presented in Table 35 for two scenarios: 1) doubling of catch rate after ten years, 2) halving of catch rate after ten years

Table 35: Results of Sensitivity Analysis 1

Statistics	Original assumption	New assumptions	
	Catch remains constant	**Catch doubles after 10 years**	**Catch halves after 10 years**
Total weight of catch per year (kg)	305,564	458,346	229,173
PV of catch (*i*=10%) over 20-year period	14,010,209	18,066,670	11,981,964
NPV of catch (*i*=10%) over 20-year period [1]	12,358,221	16,414,711	10,329,975

[1] Assuming costs of fishing remain constant

Results show that changing catch rates will have a marked effect on the economic benefits from the fishery. However, this scenario is fairly unlikely for as increased catches may lead to increased revenue in the short-run, but may lead to stock declines in the long-run. It is also unlikely that catches will increase without there being corresponding changes in price (e.g. decline in price as supply increases).

Sensitivity analysis 2: Altering assumptions about invertebrate weights

In this analysis, the focus will be on *T. gratilla (*sea urchins; *cawaki*). This species was the most abundantly harvested invertebrate (by number *and* weight harvested). Given the lack of available information on the diameter-weight ratio, which would have allowed for the conversion of diameter data (collected in the catch surveys) into weight data, an assumption was made that an individual sea urchin weighed on average 150 grams (including the shell). This assumption was based on a small sample (n=10) of *T. gratilla* that were weighed by the researcher.

This sensitivity analysis will assume two different weights per individual sea urchin of 100 grams, and 200 grams. The influence of these changes in the assumed weight per sea urchin are summarised in Table 36.

Table 36: Results of Sensitivity Analysis 2

Statistics	Original assumption	New assumptions	
	150g per urchin	100g per urchin	200g per urchin
Total weight of urchin catch from one trip (kg)	1,570.20	1,055.11	2,779.42
Gross benefits of catch from one trip (FJ$)	2,617.00	1,758.50	4,632.33
Total weight of invert catch from one trip (kg)	1,975.52	1,460.42	3,184.72
Gross benefits of invert catch from one trip (FJ$)	9,419.39	8,560.91	11,434.76
PV (gross) of invert catch (*i*=10%)[1]	7,107,161	6,459,417	8,627,807
NPV of total catch (finfish & inverts) (*i*=10%)[1]	12,358,220	11,710,476	13,878,867

[1] Period of 20 years

As figures show, the impact of the assumed average weight per sea urchin can have a notable effect on final NPV estimates. Estimates vary by about 5 to 10%. Nonetheless, the relative scale of the values produced is the same, and the NPV of the fishery is still high.

Sensitivity analysis 3: varying the opportunity cost of labour

It has been assumed in this study tat the opportunity cost (OC) of labour is equivalent to the average Fijian wage of an unskilled worker (FJ0.65-$1.25/ hour). If the OC of labour in the *yavusa* Navakavu is higher, then the bequest value estimated using WtCT estimates will be proportionately higher and the running costs associated with fishing activities will aso be higher (and hence, NPV of fishery lower). Similarly, if the OC of time is lower, then the bequest value will be lower and the NPV of the fishery higher.

Assuming that the OC for an average adult in the *yavusa* Navakavu is double the value of $0.95/ hour used in this study, then the PV of the bequest value would amount to FJ$1,189,590 (over10-year period for a 10% discount rate), compared to a value of over half a million (FJ$594,794) estimated using the value of $0.95/hour. If the OC of time used were half the average wage rate used in this study, then the NPV of bequest value would come to FJ$297,397.

These values differ quite significantly – depending on our assumptions about the OC of a villager's time, the value they attach to conserving their *iqoliqoli* for future generations could range between $300,000 and $1.2m. For this reason, bequest values are presented in terms of estimates calculated from the WtCT data as well as from directly elicited WTP data.

14. DISCUSSION AND CONCLUSIONS

This study has estimated the total economic value of the coastal ecosystems within the Navakavu *locally managed marine area* in the southeast of Fiji, on the Muaivuso Peninsula, 13km from the capital of Suva. The key goods and services provided by the coral reefs, lagoon and mangroves in this area were: fisheries (direct use, extractive value), bequest value (non-use value), research and education benefits (direct use, non-extractive value) and coastal protection (indirect use value). The economic values estimated in this study accrue to local communities only.

Assuming that the TEV of an ecosystem is equivalent to the sum of its parts, then the TEV of the coastal ecosystems within the Navakavu LMMA ranges between FJ$3,034,460 – $3,073,442 per year. The present value of the coastal ecosystems, over a 20-year period ranges between FJ$28,793,197 – 29,164,050 (using a10% discount rate). Fisheries associated with these coastal ecosystems makes up about 45% of this value. The next most important service provided is coastal protection which accounts for 33% of the TEV.

These values assume that the goods and services provided by the marine ecosystems in the Navakavu LMMA are constant over time. However, since the establishment of the LMMA in January 2002, there have been reported increases in both finfish and invertebrate catches. A simple valuation of the increased finfish catch suggests that the economic value of these changes since the establishment of the LMMA comes to about FJ$63,000. If, as expected, annual finfish and invertebrate catches will continue to increase over the next few years, then the economic benefit to local villagers of the ecosystems within the LMMA should increase notably.

This study is the first to have estimated the TEV of a coastal ecosystem - including coral reefs, lagoon and mangroves - in Fiji. It is hoped that it will lead to further studies of a similar nature; this will allow for a detailed economic evaluation of Fiji's marine resources. Furthermore, this is the first study to address the economic valuation of LMMA interventions; although a thorough valuation was not possible at this stage, the value of carrying out such analyses has been highlighted. Information on the economic benefits of LMMAs can be used to compare the costs and benefits of different management options, such as conservation, controlled fishing and/or ecotourism, and hence, assist in policy decision-making.

A number of limitations apply to the results presented in this study: firstly, the catch data used in this study as the basis for economic valuation of fisheries was based on catch from one trip per household. A more accurate representation of fish catches might have been obtained through systematic collection of catch data from several trips per household over a year. The approach used here was dictated by resource constraints. Future studies might collect catch data from several fishing trips per household at different times of the year. Another approach might be to request villagers to complete "catch diaries" every day for a month at different times of the year. A combination of methods would certainly yield the most accurate picture of fish catches in the *iqoliqoli*.

A second limitation of this study - as highlighted in Section 13 – is associated with the collection of length (or diameter) data for invertebrates. The lack of length/ diameter-weight ratios for many invertebrate species made the estimation of weight very difficult, and the use of proxies can be subject to a large potential error. Future studies would collect weight data directly, for both finfish and invertebrates, thus avoiding the use of L-W ratios.

Thirdly, the use of local villagers to carry out the interviews was not considered the best approach to the collection of data. This is mostly because the surveys were complex, and included some contingent valuation questions that require a high level of training for appropriate delivery.

Finally, the study did not properly estimate the economic value of the management interventions associated with the LMMA, due a lack of adequate data and expert opinion on the impacts o the LMMA on the ecosystem goods and services. However, it is considered that valuation of the Navakavu LMMA is possible, although not within the time and resource constraints of the present study. This would be a valuable exercise that would provide very useful information on the economic benefits from the establishment of LMMAs in Fiji.

Overall, it is considered that this valuation study provides a good starting point for future valuation studies, and is a significant contribution to the literature.

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ANNEX 1 Table of *a* and *b* values used to calculate weight from length of fish and invertebrate species

Species name in Fijian	Species name in Latin	a	b	Comments
balagi	*Acantharus mata*	0.027	2.945	Source: Fishbase
buse	*Hyporhamphus dussumieri*	0.0007	3.41	Source: Fishbase
cawaki	*Tripneustes gratilla*			Assumed that 1 urchin weighs 150g
dairo	*Holothuria scabra*	0.00175	2.277	LW ratio for lengths in mm
gaka/ busa	*Hemiramphus far*	0.3298	1.8314	Source: Fishbase
gera/ golea	*Strombus gibberulus gibbesus*			No LW ratio found; no proxy found
kabatia	*Lethrinus Harak/ Le. obsoletuys*	0.017	3.0423	Source: Fishbase
kaikoso	*Anandara spp. (esp. anandara scapha)*	0.00012	3.1884	Using LW ratios for *A. demiri* (source: Morello et al, 2004)
kake	*Lutjanus fulviflamma/ Lu. Monostigma*	0.205	2.9599	Source: Fishbase
kanace	*Valamugil seheli/ Crenimugl crenilabis*	0.0066	3.25	Source: Fishbase
kawago	*Lethrinus nebulosus*	0.0204	2.975	Source: Fishbase
kawakawa	*Cephalopholis argus*	0.0093	3.1807	Source: Fishbase
kodro	*Caranx tille/ C. papuensis*	0.0088	3.163	Source: Fishbase
kuita	*Octopus spp.*	0.0007	3.096	Using LW ratio for octopus vulgaris, Canary Islands (source: Hernandez-Garcia et al, 2002)
lesi	*Bohadschia graffei*	0.00152	2.217	LW ratio for lengths in mm
matu	*Gerres sp.*	0.0095	3.3371	Source: Fishbase
nuqa	*Siganus spinus/ Sig. vermiculatus*	0.015	3.0925	Source: Fishbase
qari	*Scylla serrata*	0.25	2.94	Using LW ratio for mud crabs in Mekong delta (source: Christensen et al, 2004)
sabutu/ cabutu	*Lethrinus atkinsoni/ Le. mahsena*	0.0178	3.0574	Source: Fishbase
salala	*Rastrelliger kanagurta*	0.0061	3.191	Source: Fishbase
saqa	*Caranx spp. (mostly C. ignobilis)*	0.0296	2.9780	Source: Fishbase
senicauca	*Epinephelus spp.*	0.011	3.05	Source: Fishbase
senikawakawa	*Epinephelus merra/ E. hexagonatus*	0.0096	3.1960	Source: Fishbase
Sici.vivili	*Trochus niloticus*	0.558	2.7797	Calculated using length and weight data from SPC (1994) report for Cook Islands
sucuwalu	*Holothuria fuscogilva*	0.001102	2.407	LW ratio for lengths in mm
tarasea	*Actinopyga mauritana (Holothuria)*	0.000647	2.456	LW ratio for lengths in mm
ulavi	*Scarus spp. (mostly Sc. ghoban)*	0.0165	3.0412	Source: Fishbase
vai	*Himantura uarnak*	0.0624	2.8300	Source: Fishbase
veata /kotia/ senikavere	*Dolabella auricularia*	0.001677	2.344	Using H. nobilis LW ratio as proxy

ANNEX 2 HOUSEHOLD QUESTIONNAIRE

Navakavu Socio-Economic Survey: Household Questionnaire

THIS QUESTIONNAIRE TO BE CARRIED OUT WITH HEAD OF HOUSEHOLD OR THEIR SPOUSE ONLY

QUESTIONNAIRE NUMBER:…………

DATE:……………………………………TIME: ………………………………………..

NAME OF INTERVIEWER:…………………………………………………………………

VILLAGE: CIRCLE ONE ONLY:

Muaivuso	1
Nabaka	2
Namakala	3
Waiqanake	4

NAME OF HOUSE:……..

NAME OF HEAD OF HOUSEHOLD:……………………………………………………….

BRIEF DESCRIPTION OF HOUSE (interviewer to fill in by himself or herself):

CIRCLE THE CORRECT RESPONSE

Questions	YES	NO
Are walls of house made of concrete?	1	2
Are walls made of corrugated iron?	1	2
Does household own a television?	1	2
Does the household have a radio?	1	2
Does the household have a gas stove?	1	2

Introduction

Hello, I am doing a survey for USP on the Navakavu marine environment, and the Navakavu LMMA. Would you be willing to answer some questions?

IF YES: continue interview
IF NO: ask if the wife/ husband would be willing to complete questionnaire.

IF THERE IS SOMEONE ELSE PRESENT, ASK IF THERE IS SOMEWHERE YOU CAN GO WHERE YOU CAN DO INTERVIEW MORE PRIVATELY.

IF NOT, GO TO CORNER OF ROOM TO DO INTERVIEW QUIETLY.

SECTION A. Individual Demographic Information

Firstly, I will need some basic information about you:

A.1 CIRCLE GENDER OF RESPONDENT:

Male	1
Female	2

A.2 How old are you?...

A.3 What is your highest level of education? Is it…? READ OUT

CIRCLE ONE ONLY:

Primary school	1
Secondary School year 10 (up to 16 years old)	2
Secondary School year 12 (up to 18 years old)	3
University /college undergraduate degree	4

A.4 How long have you been living in this village?…………………………………….

A.5 What activities do YOU engage in for food and for cash?

TICK RESPONSES IN TABLE

What is 1st most important activity you engage in for food and cash?
What is your 2nd-most important activity?

TICK ALL CORRECT RESPONSES

	Activity	Tick if respondent engages in activity	1st most important	2nd most important
1	Fishing			
2	Gleaning (collecting seafood)			
3	Growing crops			
4	Rearing livestock			
5	Salaried work in village			
6	Salaried work in Suva			
7	Other (specify:………………………….)			

A.6 Approximately, how many hours a day do you spend on all these activities?

………………………………………………hours a day

SECTION B. Household Demographic Information

Now I will ask some questions about your household:

B.1 How many people live in your household ALL the time?.....................................

B.2 How many are males over 15 years old?..

B.3 How many are females over 15 years old?...

B.4 Are there members of your family who now live in Suva or other towns for work?

CIRCLE ONE ONLY:

Yes	1
No	2

B.5 What activities does YOUR HOUSEHOLD engage in for food and for cash?

TICK RESPONSES IN TABLE

Which activity gives your household the most food and cash?
Which activity gives you the 2nd-most food and cash?

TICK ALL CORRECT RESPONSES

	Activity	Tick if household engages in activity	1st most important	2nd most important
1	Fishing			
2	Gleaning (collecting seafood)			
3	Growing crops			
4	Rearing livestock			
5	Salaried work in village			
6	Salaried work in Suva			
7	Other (specify:………………………….)			

B.6 Does your household get remittance?

CIRCLE ONE ONLY:

Yes	1
No	2

B.7 What is your household's average monthly CASH income from all activities (including remittance)? Is it….? READ OUT EACH ONE

CIRCLE ONE ONLY:

Under $50 per month?	1
Between $50 and $100 per month?	2
Between $101 and $200 per month?	3
Between $201 and $300 per month?	4
Between $301 and $500 per month?	5
Between $501 and $750 per month?	6
Over $700 per month?	7

DON'T READ OUT THESE OPTIONS, BUT CIRCLE IF THIS IS WHAT RESPONDENT ANSWERS:

Don't know	8
Refused to answer question	9

B.8 Does your house have any savings?

CIRCLE ONE ONLY:

Yes	1	GO TO B.9
No	2	GO TO B.10
Don't know	3	GO TO B.10

B.9 How much savings does your household have? Is it…? READ OUT EACH ONE

CIRCLE ONE ONLY

Under $100 in total	1
Between $100 and $500 in total	2
Between $501 and $1000	3
Over $1000	4

DON'T READ OUT THESE OPTIONS, BUT CIRCLE IF THIS IS WHAT RESPONDENT ANSWERS:

Don't know	5
Refused to answer question	6

B.10 Does your household own a boat?

CIRCLE ONE ONLY:

Yes	1	GO TO B.11
No	2	GO TO SECTION C

B.11 What type of boat is it? Is it…? READ OUT

CIRCLE ONE ONLY:

A wooden boat	1
An aluminium boat	2
A fibreglass boat	3
Other (specify:……………………………….)	4

B.12 Does the boat have an engine?

CIRCLE ONE ONLY:

Yes	1	GO TO B.13
No	2	GO TO B.14

B.13 Approximately how much fuel does the boat use per fishing trip?

……………………………………litres

B.14 When did you buy the boat and how much did it cost?

FILL IN RESPONSES

Date of purchase	Cost?

B.15 Could you tell me how much it costs to maintain and repair the boat, and how often do you have to do it?

FILL IN RESPONSES

Type of repairs	Cost?	How often repaired?

SECTION C. Livelihood & Fishing Activities

C.1 In total, how many people in your household fish or collect seafood?

....
IF NONE: THEN GO TO SECTION E

C.2 Do YOU fish or collect shellfish in the Navakavu iqoliqoli?

CIRCLE ONE ONLY:

Yes	1
No	2

C.3 How many months a year does your household fish or take things from the sea?

CIRCLE ONE ONLY:

Less than 3 months a year	1
Between 4 and 6 months a year	2
Between 7 and 9 months a year	3
Between 10 and 11 months a year	4
12 months a year	5

C.4 On average, how many days a week does your household fish or take things from the sea?

CIRCLE ONE ONLY:

1 day a week	1
2 days/ week	2
3 days/ week	3
4 days/ week	4
5 days/ week	5
6 days/ week	6

C.5 On average, how many hours are spent fishing or collecting shellfish on each trip?
……………………………………………..…..hours

C.6 Where does your household usually fish or collect seafood. Is it…? READ OUT

CIRCLE ALL ANSWERS

On the reef	1
On the sea-grass flats or lagoon	2
Along the mangroves	3
Anywhere else? (specify:…………………………………………..)	4

C.7 What fish or shellfish does your household usually get from the reef, lagoon or mangroves? *FILL IN FISH & INVERTEBRATE NAMES IN TABLE BELOW*

What does your household usually catch or collect most? What do you usually catch or collect 2nd-most? What do you usually catch or collect 3rd-most?

TICK CORRECT RESPONSES FOR 1ST-most, 2ND-most & 3RD most

Fish or shellfish name	1st most	2nd most	3rd most
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			

C.8 Apart from fish and shellfish, does your household collect other things from the reef, lagoon or mangroves?

CIRCLE ONE ONLY:

Yes	1	GO TO C.8
No	2	GO TO C.9

C.9 What do you collect?

……………………………………………………………………………………………

C.10 What fishing gears does your household usually use?

CIRCLE ALL THAT APPLY:

Fishing gears	Use this technique
Handline	1
Net	2
Speargun	3
Fish fence	4
Other (specify:……………………………………………….)	5

SECTION D. MOST RECENT CATCH

D.1 Did anyone in your household fish or collect things from the reef, lagoon or mangroves today?

CIRCLE ONE ONLY:

Yes	1	GO TO D.3
No	2	GO TO D.2

IF NO:
D.2 When was the last time anyone in your household fished or collected seafood?

CIRCLE ONE ONLY:

Yesterday	1
Less than a week ago	2
Between 1 week and 2 weeks ago	3
Between 2 weeks and 4 weeks ago	4
Over 4 weeks ago (specify:…………………………………………)	5

D.3 How many members of your household went fishing today (or the last time you fished)?

……………………………………………………………………………………………

D.4 Did YOU go fishing today (or the last time your household fished)?

CIRCLE ONE ONLY:

Yes	1
No	2

D.5 Where did your household fish or collect seafood today (or the last time you fished)? Was it…? READ OUT

CIRCLE ALL ANSWERS

On the reef	1
On the sea-grass flats or lagoon	2
Along the mangroves	3
Anywhere else? (specify:…………………………………………..)	4

D.6 In total, how many hours did your household spend fishing or collecting seafood today (or last time you fished)?

……………………………………………hours

D.7 I'd now like to ask you what fish or seafood did your household catch or collect today (or the last time you fished), what gear did you use and how much did you catch or collect?

I would also like to know, for each species, how much you plan to sell, how much you plan to use for household consumption, and how much you plan to give as gifts?

FILL IN RESPONSES BELOW– DON'T LEAVE OUT ANY INFORMATION!!!

Fish/ invertebrate name:……………………………………………………………

Gear used:……………………………………………………………………………..

Number of heaps/ bundles:……………………………………………………………

If fish/ invertebrates not in heaps/bundles tick here: ☐

Do all heaps/ bundles have same number of fish/ invertebrates? Yes ☐ No ☐

Number of fish/ invertebrates in each heap/ bundle:…………………… …………………

……………………………………………………………………………………………

If fish/ invertebrates not in heaps/bundles, write total number here:…………

Average size of fish/ invertebrates in each heap/ bundle:…………………………………..

……………………………………………………………………………………………

Number and size of fish/invertebrates FOR SALE:………………………………………..

Number and size of fish/invertebrates FOR HOUSEHOLD (to eat):………………...……

Number and size of fish/invertebrates FOR GIFTS:…………………… ………………

Fish/ invertebrate name:……………………………………………………………

Gear used:……………………………………………………………………………..

Number of heaps/ bundles:……………………………………………………………

If fish/ invertebrates not in heaps/bundles tick here: ☐

Do all heaps/ bundles have same number of fish/ invertebrates? Yes ☐ No ☐

Number of fish/ invertebrates in each heap/ bundle:…………………… …………………

……………………………………………………………………………………………

If fish/ invertebrates not in heaps/bundles, write total number here:…………

Average size of fish/ invertebrates in each heap/ bundle:…………………………………..

……………………………………………………………………………………………

Number and size of fish/invertebrates FOR SALE:………………………………………..

Number and size of fish/invertebrates FOR HOUSEHOLD (to eat):………………...……

Number and size of fish/invertebrates FOR GIFTS:…………………… ………………

Fish/ invertebrate name:……………………………………………………………

Gear used:……………………………………………………………………………..

Number of heaps/ bundles:……………………………………………………………

If fish/ invertebrates not in heaps/bundles tick here: ☐

Do all heaps/ bundles have same number of fish/ invertebrates? Yes ☐ No ☐

Number of fish/ invertebrates in each heap/ bundle:…………………… …………………

……………………………………………………………………………………………

If fish/ invertebrates not in heaps/bundles, write total number here:…………

Average size of fish/ invertebrates in each heap/ bundle:…………………………………..

……………………………………………………………………………………………

Number and size of fish/invertebrates FOR SALE:………………………………………..

Number and size of fish/invertebrates FOR HOUSEHOLD (to eat):………………...……

Number and size of fish/invertebrates FOR GIFTS:…………………… ………………

Fish/ invertebrate name:………………………………………………………………

Gear used:……………………………………………………………………………..

Number of heaps/ bundles:…………………………………………………………………

If fish/ invertebrates not in heaps/bundles tick here: ☐

Do all heaps/ bundles have same number of fish/ invertebrates? Yes ☐ No ☐

Number of fish/ invertebrates in each heap/ bundle:…………………… …………………

…………………………………………………………………………………………………

If fish/ invertebrates not in heaps/bundles, write total number here:…………

Average size of fish/ invertebrates in each heap/ bundle:…………………………………..

…………………………………………………………………………………………………

Number and size of fish/invertebrates FOR SALE:………………………………………..

Number and size of fish/invertebrates FOR HOUSEHOLD (to eat):………………...……

Number and size of fish/invertebrates FOR GIFTS:…………………… ………………

Fish/ invertebrate name:………………………………………………………………

Gear used:……………………………………………………………………………..

Number of heaps/ bundles:…………………………………………………………………

If fish/ invertebrates not in heaps/bundles tick here: ☐

Do all heaps/ bundles have same number of fish/ invertebrates? Yes ☐ No ☐

Number of fish/ invertebrates in each heap/ bundle:…………………… …………………

…………………………………………………………………………………………………

If fish/ invertebrates not in heaps/bundles, write total number here:…………

Average size of fish/ invertebrates in each heap/ bundle:…………………………………..

…………………………………………………………………………………………………

Number and size of fish/invertebrates FOR SALE:………………………………………..

Number and size of fish/invertebrates FOR HOUSEHOLD (to eat):………………...……

Number and size of fish/invertebrates FOR GIFTS:…………………… ………………

Fish/ invertebrate name:……………………………………………………………

Gear used:………………………………………………………………………………..

Number of heaps/ bundles:……………………………………………………………

If fish/ invertebrates not in heaps/bundles tick here: ☐

Do all heaps/ bundles have same number of fish/ invertebrates? Yes ☐ No ☐

Number of fish/ invertebrates in each heap/ bundle:…………………… …………………

………………………………………………………………………………………………

If fish/ invertebrates not in heaps/bundles, write total number here:…………

Average size of fish/ invertebrates in each heap/ bundle:…………………………………..

………………………………………………………………………………………………

Number and size of fish/invertebrates FOR SALE:………………………………………..

Number and size of fish/invertebrates FOR HOUSEHOLD (to eat):………………...……

Number and size of fish/invertebrates FOR GIFTS:…………………… ………………

Fish/ invertebrate name:……………………………………………………………

Gear used:………………………………………………………………………………..

Number of heaps/ bundles:……………………………………………………………

If fish/ invertebrates not in heaps/bundles tick here: ☐

Do all heaps/ bundles have same number of fish/ invertebrates? Yes ☐ No ☐

Number of fish/ invertebrates in each heap/ bundle:…………………… …………………

………………………………………………………………………………………………

If fish/ invertebrates not in heaps/bundles, write total number here:…………

Average size of fish/ invertebrates in each heap/ bundle:…………………………………..

………………………………………………………………………………………………

Number and size of fish/invertebrates FOR SALE:………………………………………..

Number and size of fish/invertebrates FOR HOUSEHOLD (to eat):………………...……

Number and size of fish/invertebrates FOR GIFTS:…………………… ………………

***QUESTION TO INTERVIEWER*: did you count and measure catches yourself, or did respondent tell you what they remembered?

CIRCLE ONE ONLY:

I counted and measured catch myself	1
They told me what they remembered	2

D.8 Did your household use a boat to fish today (or the last time you fished)?

CIRCLE ONE ONLY:

Yes	1	GO TO D.9
No	2	GO TO SECTION E

IF YES:
D.9 Did the boat belong to your household?

CIRCLE ONE ONLY:

Yes	1
No	2

D.10 Were there other people using the boat when you went fishing or collecting seafood today (or the last time you fished)?

CIRCLE ONE ONLY:

Yes	1	GO TO D.11
No	2	GO TO D.15

D.11 How many people? ……………………………………………………………

D.12 How many were members of your household?..

D.13 Did you share the costs of the trip?

CIRCLE ONE ONLY:

Yes	1	GO TO D.14
No	2	GO TO SECTION E

D.14 How were the costs shared? How much did each person contribute?

FILL IN RESPONSES

How did you pay?	Circle answer	How much?
Money	1	
Shared catch	2	
Other (specify:…………………………….…….)	3	

NOW GO TO SECTION E

ONLY ASK NON-BOAT OWNERS:
D.15 Did you pay the boat owner (either in cash or in fish) to use the boat?

CIRCLE ONE ONLY:

Yes	1	GO TO D.16
No	2	GO TO SECTION E

D.16 How did you pay, and how much did you pay?

FILL IN RESPONSES

How did you pay?	Circle answer	How much?
Money	1	
Shared catch	2	
Other (specify:……………………….)	3	

SECTION E. Environmental attitudes and knowledge

I have a few questions about your attitudes towards the marine environment in the yavusa Navakavu.

E.1 Apart from fishing and collecting things from the reef, lagoon or mangrove, does your household use the Navakavu iqoliqoli for any other activities?

CIRCLE ONE ONLY:

Yes	1	GO TO E.2
No	2	GO TO E.3

E.2 What other activities does your household use the Navakavu iqoliqoli for?

CIRCLE ALL THAT APPLY

Swimming	1
Children playing	2
Cultural activities (specify:…………………………….)	3
Other (specify:……………………………)	4

E.3 I am going to read out some statements about the marine environment in the yavusa Navakavu. Please tell me whether you agree or not with each statement by saying whether you 'strongly agree', 'agree', 'neither agree nor disagree', 'disagree' or 'strongly disagree'.

SHOW RESPONDENT ATTITUDE SCALE

PLEASE READ OUT STATEMENTS EXACTLY AS WRITTEN:

INSERT ONE NUMBER FROM SCALE FOR EACH STATEMENT:

	Statements	RATING
1	"If no-one ever used the marine resources in Navakavu, then it wouldn't matter if they became degraded."	
2	"We have a responsibility to protect our marine environment, even if it costs us money"	
3	"I mostly value the marine resources in Navakavu because my household gets fish and seafood there."	
4	"Even if my household didn't use the marine resources in Navakavu, we would have a responsibility to protect the marine environment for future generations."	
5	"The environmental problems in our marine environment have been exaggerated."	

E.4 I would like you to think about the reasons why we should protect our marine environment in Navakavu. I'm going to read out a number of reasons, and after I've read them all, I'd like you to tell me, which statement you most agree with.

CIRCLE ONE ONLY:

READ OUT: "The most important reason for protecting our marine environment is……"	
….so that my family can continue using it."	1
….so that future generations can use it."	2
….because it has a right to exist, even if no-one uses it."	3
….so that the community can continue using it."	4

Now I will ask some questions about the LMMA.

E.5 Have you personally been involved in the decisions about the LMMA?

CIRCLE ONE ONLY:

Yes	1	GO TO E.6
No	2	GO TO E.7

E.6 How have you been involved?

…………………………………………………………………………………………………

E.7 Have you noticed any change in the amount of finfish that your household catches per fishing trip, since the LMMA was set up?

CIRCLE ONE ONLY:

Yes	1	GO TO E.8
No	2	GO TO E.9

E.8 How has it changed?

CIRCLE ONE ONLY:

It has increased	1
It has decreased	2

E.9 Have you noticed any change in the amount of invertebrates that your household collects per trip, since the LMMA was set up?

CIRCLE ONE ONLY:

Yes	1	GO TO E.10
No	2	GO TO E.11

E.10 How has it changed?

CIRCLE ONE ONLY:

It has increased	1
It has decreased	2

E.11 Has your household benefited from the LMMA management in the Navakavu iqoliqoli?

CIRCLE ONE ONLY:

Yes	1	GO TO E.12
No	2	GO TO SECTION F

IF YES:
E.12 I am going to read out a list of benefits from the LMMA management. Please tell me which is the 1st-most important benefit to your household from the LMMA. Which is the 2nd-Most important benefit?

TICK CORRECT RESPONSES

ADVANTAGES	1st-most important	2nd-most important
Increase of fishes/ invertebrates		
New activities taking place in the iqoliqoli, such as tourism		
Increased knowledge about how to manage the iqoliqoli		
Money from researchers and students who come and work in the community		
Gear from USP, fisheries, NGOs, such as the patrol boat		
Anything other (specify):……………………………………………………		

SECTION F. Willingness to Pay

PLEASE READ OUT THE FOLLOWING EXACTLY AS IT IS WRITTEN:

F.1 At present the Navakavu iqoliqoli provides many benefits to the villages in the area, such as fish, shellfish, seaweed and shells from the reef and lagoon, and timber, dye and medicines from the mangroves. The coral reef and mangroves also help protect the land from storms and waves from the sea. The also provide habitat for many species of fish and shellfish, and contribute to biodiversity.

Good management of the marine environment will ensure that the villages can continue to enjoy these benefits.

I would now like you to imagine that there was a threat to the marine environment in the Navakavu iqoliqi. Imagine that this threat could destroy the marine environment.

Imagine that in order to prevent this destruction, the community decided to close off the whole iqoliqoli area to everyone - especially outsiders. This would mean that no-one could go fishing, collect seafood, or cut wood or plants from mangroves. It would also mean that people from outside could not use it for tourism or anything else. By not taking goods and using the marine environment, the iqoliqoli could recover to its present condition.

CHECK THAT RESPONDENT UNDERSTANDS

I'd also like you to imagine that, even though you couldn't use your marine environment anymore, you still had the same amount of income and food as you do at the moment. This might be because you are obtaining cash and food from other activities.

CHECK AGAIN THAT RESPONDENT UNDERSTANDS

Now, imagine that this restriction on the iqoliqoli were to last your lifetime, but that future generations would definitely be able to use the iqoliqoli for all activities. However, for this to happen, the community would need to give money and time towards conservation efforts.

Would you be willing to contribute any of your own time to help in the recovery and conservation of the Navakavu iqoliqoli, for use by future generations? Remember that you would not be able to use it – but your income would be the same as before.

CIRCLE ONE ONLY:

Yes	1	GO TO F.2
No	2	GO TO F.3
Don't know	3	GO TO F.2

IF YES:
F.2 How many hours a week would you be willing to contribute for the next five years? I am going to read out some amounts of time, and I would like you to tell me to stop when I reach the MAXIMUM amount of hours per week that you would be willing to spend helping to protect the iqoliqoli. Please be as realistic as possible. Remember that you have demands on your time.

SHOW PAYMENT CARD

TICK ONE ONLY

Amount of time per week	Maximum you would be willing to contribute per week
Half an hour per week	
45 minutes per week	
1 hour per week	
1 ½ hours	
2 hours	
2 ½ hours	
3 hours	
3 ½ hours	
4 hours	
5 hours	
6 hours	
8 hours	
10 hours	
12 hours	
15 hours	
18 hours	
21 hours	
25 hours	
More: (specify……..………….)	

NOW GO TO QUESTION F.4

F.3 Why would you NOT be willing to contribute time?

…………………………………………………………………………………………………

…………………………………………………………………………………………………

F.4 Imagine that instead of contributing time, you could contribute some money towards helping protect with the iqoliqoli for future generations. Would you prefer to donate money rather than time? Remember that you would NOT be able to use the iqoliqoli - but your income would be the same as before.

CIRCLE ONE ONLY:

Yes	1	GO TO F.5
No	2	GO TO F.6
Don't know	3	GO TO F.5

IF YES:
F.5 How much money would you be willing to contribute each month? I am going to read out some amounts of money, and I would like you to tell me to stop when I reach the MAXIMUM amount that you would be willing to donate every month for the next five years. Please be as realistic as possible. Remember that you have other expenses.

SHOW PAYMENT CARD

TICK ONE ONLY

Amount of money per month	Maximum you would be willing to contribute per month
$1 per month	
$2	
$3	
$4	
$5	
$7	
$10	
$13	
$16	
$20	
$25	
$30	
$35	
$40	
$50	
$75	
$100	
More (specify:……………)	

NOW GO TO QUESTION F.7

F.6 Why would you NOT be willing to contribute money?

…………………………………………………………………………………………………

…………………………………………………………………………………………………

F.7 Is there anything else you would prefer to contribute, such as fish or crops?

CIRCLE ONE ONLY:

Yes	1	GO TO F.8
No	2	GO TO F.9

F.8 What would you prefer to contribute, and how much per month?

…………………………………………………………………………………………………

…………………………………………………………………………………………………

F.9 Did you find these last questions hard to answer?

CIRCLE ONE ONLY:

Yes	1
No	2

OKAY, THANK YOU THAT IS THE END OF THE INTERVIEW!!

H. Questions for interviewer

H.1 How long did interview take?

…………………………………………………………………………………………………

H.2 Did you have to explain any of the questions?

CIRCLE ONE ONLY:

Yes	1	GO TO F.3
No	2	END