Coral reef fish value chains in Solomon Islands: Market opportunities and market effects on fish stocks

Tom Brewer

ARC Centre of Excellence for Coral Reef Studies

James Cook University

Report to Solomon Islands Government Ministry of Fisheries and Marine Resources in collaboration with the Secretariat of the Pacific Community

All opinions, and possible errors contained within this document, are that of the author, unless clearly stated. The field work was carried out under James Cook University ethics no. H3596. Field permit clearance was provided through Secretariat of the Pacific Community in collaboration with the Solomon Islands Government Ministry for Fisheries and Marine Resources.

Acknowledgements

Thank you to Joe Giningele for his invaluable assistance conducting the field work. Thank you to the staff of Ministry of Fisheries and Marine Resources, particularly B. Buga, D. Fatai, and Dr. C. Ramofafia, for guidance on survey design, and insight into contemporary fish trading in Solomon Islands. Thank you to the provincial fisheries officers, for being so welcoming, in each of the provinces visited. Thank you to P. Cohen, R. Hamilton, K. Moon, M. Batty and S. Foale for providing helpful comments on earlier versions of the report. Thank you, to the non-government organization staff in Solomon Islands, for their time and perspectives. Finally, and most importantly, thank you to the fishers and fish traders who were willing to share their time and knowledge.

Recommended citation: Brewer, T.D. 2011. *Coral reef fish value chains in Solomon Islands: Market opportunities and market effects on fish stocks*. ARC Centre of Excellence for Coral Reef Studies report to Solomon Islands Ministry of Fisheries and Marine Resources and Secretariat of the Pacific Community. 46 pages

Cover image: Mixed reef fish section of the Honiara Central Market

Author contact:
Tom Brewer
ARC Centre of Excellence for Coral Reef Studies
James Cook University
Townsville, 4811
Australia
Email: tomdbrewer@gmail.com
Ph: (+61) 433 976 561

Executive Summary

This report summarises the key findings of a value chain analysis for coral reef fish, conducted across five provinces of Solomon Islands. It also reviews potential market opportunities and market effects on fish stocks. Data presented in this report are derived from 77 interviews with fishers and fish traders who sell fish in major markets at Guadalcanal, Western, Isabel, Central, and Malaita provinces, in addition to past research and general observations.

Analysis of fish value chains, based on interviews with fishers, middlemen and private fisheries centre operators, showed the diversity of fish value chains in Solomon Islands. Many distinct roles existed within the fishery including: (1) fishers who sell directly to market, (2) fishers who sell to middle men who then sell directly to market or to value adders such as restaurants, (3) fishers who sell directly to value adders, and (4) fishers who sell to private fish centres who on-sell to larger markets or sell direct to the local customers. Several market chain characteristics were highly variable across provinces and respondents: the means of harvesting and transporting of fish, reasons for particular fishing location and market choice, and volume of fish flowing through different 'links' in the value chains, and the resultant economic value of fish.

Means of improving reef fish value chains, to which the government could feasibly respond, were difficult to identify. However, a clear limitation to income for stakeholders directly involved in fish marketing such as fishers and middlemen, include costs incurred whilst selling fish including additional ice, market fees and time. Recommendations are made which reflect opportunities to address such issues.

The value of the Solomon Islands inshore finfish fishery has been previously estimated at $12,000,000 (Gillett 2009). This value is an estimate of the inshore fishery based on price paid to fishers for 1,500 metric tonnes of fish. Based on pricing estimates at different market scales including village, provincial capital and national capital markets, I estimate the gross income to fishers and middlemen from inshore fish stocks to be worth roughly $21,000,000. This value represents a significant component of the Solomon Islands domestic economy, highlighting the importance of ensuring sustainable inshore fisheries in the future.

Field observations and previous studies suggest that market-based fishing is having a negative effect on coral reef fish stocks and reef habitat. Depletion varied across sites, with the Malaita fishery being most depleted; however, coral reefs in close proximity to other

provincial capitals, particularly where there was adequate transport for export to Honiara, were also likely to be significantly depleted. A number of recommendations are made in light of the evident depletion.

The following recommendations, which are elaborated on in the recommendations section of the report (page 35), are made in light of: (1) the importance of coral reef fisheries to livelihoods of Solomon Islands people both directly involved in the industry and in supporting industries, (2) the evident depletion of coral reef fish stocks caused by market-based fishing, and (3) possible implementation constraints.

1) **a.** Establish and legislate size limits for fish species.
   b. Provision of size limit measuring devices to provincial fisheries officers, private fish sellers, and fishers who sell fish at open markets.
2) Signage in major provincial markets which might inhibit the sale of fish which are small (not at reproductive size) and harvested using destructive methods.
3) Routine surveys of fish in urban markets where there is at least one full time fishery officer present.
4) National endorsement of reservation of reef areas for consumption purposes only, in areas that experience severe market-based fishing pressure.
5) Actively source alternative sources of protein.
6) Improve basic hygiene facilities in major markets.
7) Commission of an in-depth study on costs and profits within the Solomon Islands reef fishery, across different stakeholders including fishers, middlemen, private fishery centres and value adders, as well as support industries including shipping, ice vendors, and fuel depots, including household expenditure patterns.
8) Conduct a review of availability of ice, for fish preservation, across Solomon Islands.

Table of Contents

List of Figures and Tables

Introduction

1.1 Reef fish and livelihoods in Solomon Islands

Reef fish are integral to the identity, food security, and livelihoods of Solomon Islands people. The majority of the nation's population lives in coastal communities and consumes fish on a regular basis as a key source of dietary protein. Per capita consumption of fish has been estimated at 33 kg/yr nationally (Bell et al. 2009), and up to 111 kg/yr in some areas (Pinca et al. 2009). Cash is now the common currency (barter and alternate currency forms including shell and feather money for trade are now relatively limited), particularly in urban areas. Urbanisation is likely fuelled, in part, by growing rural populations. Urbanisation has led to a recent, and significant, increase in the trade of coral reef fish to supply customers employed in urban areas (Brewer, unpublished data), as shown in historical census records of increased prevalence of market-based fishing gear. Trade in reef fish for consumption is, therefore, likely to play a significant role in the domestic economy, and provide an affordable source of protein to the growing urban populations. Production of inshore commercial (market-based) catch has been roughly estimated at 1,500 tonnes worth SI$12 million (Gillett 2009), based on direct value to fishers who sell at smaller markets and fisheries centres, and does not include value adding, costs, or higher prices paid at urban markets. Therefore, understanding the domestic trade of reef fish, and how the trade contributes to economic development in rural areas, food security in urban and rural areas, and fish stock condition in areas that are heavily fished to supply market demand, is important to the future ecological, social and economic prosperity of Solomon Islands.

1.2 Report requirements

The vision of Solomon Islands Government Ministry of Fisheries and Marine Resources is:

> *'sustainable and secure inshore fisheries and aquatic resources by 2020'* (SIGMFMR, 2010).

This vision is supported by five strategic pillars, of which 'markets and trade' is most relevant to this report. The strategic focus of the markets and trade pillar is:

> *"ensuring that small-scale producers maximize the value received from their resources is critical to long-term success* [sustainable and secure inshore fisheries]. *Access to markets and equitable sharing of profits from the sale of inshore and marine resources need to be a focus of this strategy"*(SIGMFMR, 2010).

This study investigates a number of the key activities within the 'markets and trade' pillar including the development of small-scale producer networks, value chain improvement, and national marketing and trade strategy for inshore fisheries, but is explicitly focused on:

'analysis of fish value chains in at least three provinces',

as stipulated in the report terms of reference, and outlined in the national strategy (SIGMFMR, 2010).

The second of the two terms of reference for this report is to:

'Undertake a review of the fishing impact on reef fish resources* [, and] *of market opportunities in selected areas.'

Here I define '***selected areas'*** as those regions included in the fish value chain study.

1.3 Value chains

The concept of value chains emerged in the 1960s as an analytical tool for agricultural research (Raikes et al. 2000). Since this time the concept has been applied to a range of settings outside of agricultural systems. The growth in theory and application of value chains suggests that they are useful in understanding benefit flows from production systems, such as fisheries.

Primary product-based (e.g. fish, crop) value chain analysis is often used to track changes in the price and costs that are incurred as a product passes between actors (e.g. farmers and wholesalers) within production systems, from initial inflow of product through to the final consumer (e.g. Taylor 2005). By disaggregating the different flows (e.g. money and resource) and actors within the chain, it is possible to identify, for example, the economic benefits to each of the actors or the volume of product flowing to different consumers (Figure 1).Value chain analysis can be used to track anything of perceived 'value' within production systems. For example, value chain analyses have been applied to address environmental management issues (e.g. Beamon 1999).

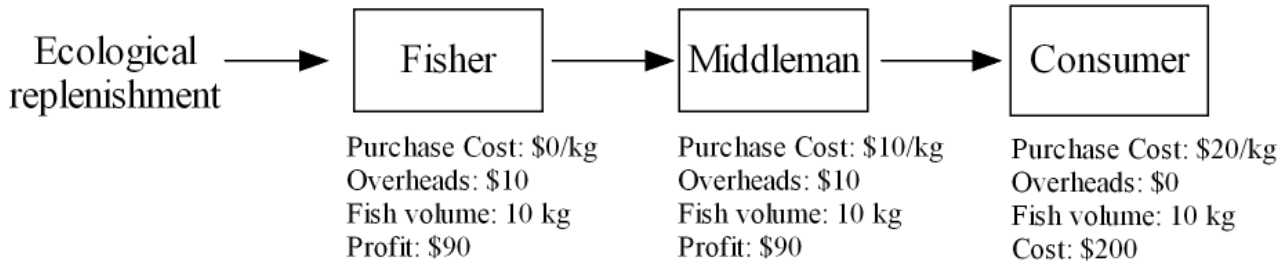

Figure 1. A conceptual fish value chain including the fisher, middleman and final consumer.
In this example the fisher incurs $10 in total overheads cost (e.g. fuel and ice), and sells the 10 kg catch for $10 per kg, providing a profit of $90. The middleman incurs a total cost of $110 including purchase cost and overheads (e.g. transport costs and market fees), and sells the fish for $20 per kg providing a profit of $90. In this example there is equitable distribution of income ($90 profit to the fisher and middleman), and some income ($10 overheads to the fisher and middleman) to supporting industries (e.g. ice vendor).

Value chains in coral reef fisheries

Very little research has been conducted using value chains to analyse coral reef fisheries (but see Ardjosoediro & Neven 2008). This lack of research might be because coral reef fisheries represent a number of challenges to traditional value chain analysis. Reef fisheries generally comprise numerous fishers using numerous gear types to catch a diverse set of species, servicing consumers or middlemen, and product prices are highly variable in time and space (depending on for example: competition, weather, and local preferences for particular fish, value adding). Additionally, supporting costs (overheads) including ice and fuel may be sourced from a number of providers, and catch and accounting records are rarely maintained. Also, trade relations between the different people in the fishery might be based on diverse factors including culture, money lending, profitability and convenience. Coral reef fisheries are not bound to discrete areas (as terrestrial farming systems are bound in fields), and the product (fish) tends to be highly mobile, so accounting for harvest across spatial areas can be problematic. Therefore, small scale artisanal coral reef fisheries lend themselves poorly to a traditional value chain analysis where a single enterprise, such as a car manufacturer or agricultural product such as rice, accounts for the flows (e.g. money, materials, time) from the initial inputs to the final outputs (Wilkinson 2006). However, value chain analysis has been used to study the live reef fish food trade in a number of studies addressing market control and income equity issues (California Environmental Associates 2011; Johnston & Yeeting 2006). Value chain analysis is likely suited to the live reef food fish trade because it is more discrete and less dynamic than domestic artisanal fisheries, with a relatively finite number of traders, working through key markets such as Hong Kong, with key middlemen located in each of the source nations (California Environmental Associates 2011).

Despite the apparent challenges of conducting a value chain analysis of small-scale coral reef fisheries generally, there are likely to be a number of benefits from such a study. By mapping fish value chain networks, it may be possible to identify inefficiencies in the marketing system, or economic inequalities that emerge between stakeholders, such as fishers and middlemen, as a result of trade relations. Value chain analysis might also present an opportunity to enhance current resource management strategies, such as controlling the buying and sale of particular species of concern at major markets. Also, value chain analysis might provide a clearer estimate of the overall economic contribution of the domestic market-based fishery to the domestic economy, which has been difficult to do to date (Gillett, 2009) because of the lack of standardised pricing and record keeping.

In conducting such a study, it is important to identify the correct scale of analysis to address the issues of greatest concern. For example, it would be possible to analyse the value chain of a single fisher in great detail but this would probably not be representative of a national system. Alternatively, analysing the value chain, as a single general model, would be informative for understanding the key types of people and markets in the chain, but would not provide insight into the reasons why people interact, the volume of fish passing through the chain, or pricing systems. Obtaining limited, but relevant, information from a large number of stakeholders, within a single time period (i.e. not tracking individual stakeholders through time) is likely the best approach to getting a representative sample in this instance, and might enable the development of a more general fish value chain model for Solomon Islands.

1.4 Market-based reef fishing in Solomon Islands

Solomon Islands consists of a vast number of fish markets, ranging in size from the Honiara central market, which operates six days a week with over thirty vendors selling fish by the pound from large eskies (insulated fibreglass chests used for fish storage), through to small, spontaneous, village markets, where fish are sold to friends and relatives. Between these two ends of the spectrum, are provincial capital markets, private trade networks including private fish sellers who store fish in deep freezers, and open village markets where fish may be sold barbequed, smoked, or as motu (cooked in traditional ovens).

As with other typical small-scale artisanal coral reef fisheries, the Solomon Islands fishery is a complex and highly dynamic system. The advent of technology and growing external markets over the last fifty years or so has increased trade opportunities beyond immediate surrounds. Fishers

and other people in the industry shift between alternative employment, fishing grounds and markets depending on a range of factors including season, weather, profitability, and competition. Also, market-based fishing in Solomon Islands, relative to industrial fishing, is comprised of many more people cooperating and competing for market share in a relatively informal manner.

1.5 Effect of market-based fishing on reef fish stocks

Awareness of the negative effect of markets on coral reef fish stocks is not new in Melanesia. Early work includes a study by Lock (1986), who showed that fishing to supply Port Moresby, the capital city of Papua New Guinea, was having a negative effect on the local fish assemblages, particularly at higher levels of fishing pressure. At this time, fishing gears, and transportation were not as sophisticated as exist now, and fish stocks were in better condition, so market effects were likely more localised.

More recently, a nation-wide assessment of coral reef fish stocks showed that some fish stocks of Solomon Islands are overfished, particularly stocks of vulnerable species (Green et al. 2006). Since this assessment market-based fishing in particular has been shown to reduce fish stocks (Aswani & Sabetian 2009; Brewer et al. 2009), however species such as *Bolbometopon muricatum* (Bumphead parrotfish or 'Topa' in Solomon Islands Pijin) were likely showing the negative effects of market-based fishing well before this time. A suite of factors are likely to contribute to the reduction of fish stocks including: (1) increasingly efficient and reliable transport (however the period of ethnic tension likely debilitated some transport systems), (2) sophisticated and/or destructive fishing gears, (3) increased urban demand associated with rural-urban migration, (4) increased income in urban areas, (5) weakening traditional management institutions, (6) national population growth, and (7) habitat loss and damage due to coastal developments, forestry and mining.

The decline in fish stocks should be of concern for two main reasons. Firstly, people of Solomon Islands are highly dependent on reef fisheries for meeting both dietary needs and income. Evidence suggests that national consumption of fish already exceeds coastal inshore supply potential (Bell et al. 2009), however this estimate does not include the significant supply of 'salt tuna' from purse seine vessels to urban centres, or offshore artisanal fishing. Given that aquaculture based alternatives are currently limited (Adams et al. 2001) there is a real and immediate need to better manage wild stocks of reef fish. Secondly, fishing can alter the ecological balance of coral reef ecosystems. If a particular group of species, which together have an important role in

maintaining the ecological function of coral reefs (such as herbivores that control algae growth), are overfished then it is possible that the coral reef will become less productive. Measures of coral reef function, including species diversity and biomass of piscivores and herbivores, are negatively affected by market-based fishing in Solomon Islands (Brewer et al. in prep.). The same study showed that local market-based fishing is strongly correlated to access to markets and urbanisation. Given that there is a strong drive for economic development in Solomon Islands, and that markets are growing and becoming more accessible (ANU Enterprise 2008), it is likely that reef fish stocks will continue to decline. Now is the time to use novel approaches such as value chains to identify strategies that might maximise income for people dependent on the coral reef fishery whilst ensuring future sustainable harvest.

1.6 Market opportunities

Given the clear evidence of the decline of coastal fish stocks, any attempt to create new market opportunities should not be designed to increase total catch. Instead, generating market opportunities should focus on improving the efficiency of current market networks to maximise incomes for fishers and fish traders, improving the condition of market centres for the well-being of fish sellers and buyers alike, and on management of fish stocks through markets to improve the condition of wild stocks for improved future catch per unit of fishing effort.

Methods

2.1 Field surveys

From September 25th to November 29th 2010 a total of 77 interviews were conducted with fishers, middlemen, and private fish sellers in five market centres across Guadalcanal, Western, Central, Malaita, and Isabel provinces (Table 1; Figure 2). Interviews were conducted in provincial capital markets which were selected because they likely account for the highest transfers (per market) of fish. Therefore, this point of sale will likely reveal some complex transfers of reef fish resources (i.e. compared to fishers selling fish solely in village markets, there are likely to be more stakeholders in larger market value chains and stakeholders sourcing and selling fish from more locations), and allow for better understanding of the effect of market-based fishing on reef fish stocks. Also, as a consequence of having large customer numbers with income, these market centres place substantial pressure on the resource and may indicate foci for fisheries management in the future.

The survey included questions relating to demographics, fishing gears, fish value chains (the focus of this report), livelihoods, perception of factors affecting fish stocks, and recommendations to improve fish stocks. However, given the terms of reference for this study, only the fish value chain section is used explicitly. All surveys were conducted in Solomon Islands Pijin. Surveys took from 45 minutes to 3 hours to complete. Potential interviewees were selected opportunistically, and approached and asked if they would be willing to be interviewed, and given the choice of being interviewed at a later time if they were busy at that time. The approach was systematic across markets, with all fish sellers present being given the opportunity to be interviewed. At some locations, particularly in Honiara Central market, it was not possible to interview all willing fish sellers due to time constraints; however, it is likely that the method used resulted in a representative sample at each market.

Region	Fishers	Middlemen & Private fish centres
Honiara (Guadalcanal)	12	12
Gizo (Western)	16	1
Tulaghi (Central)	11	1
Auki (Malaita)	15	1
Buala (Isabel)	15	3

Table 1. Interviews conducted at each study region.
Note that in some instances, interviewees were both fishers and middlemen or private fish buyers and have consequently been included in both columns. While a number of women were interviewed at locations not included in this study, only one woman is included in this study, a middleman who sells fish in Honiara Central Market.

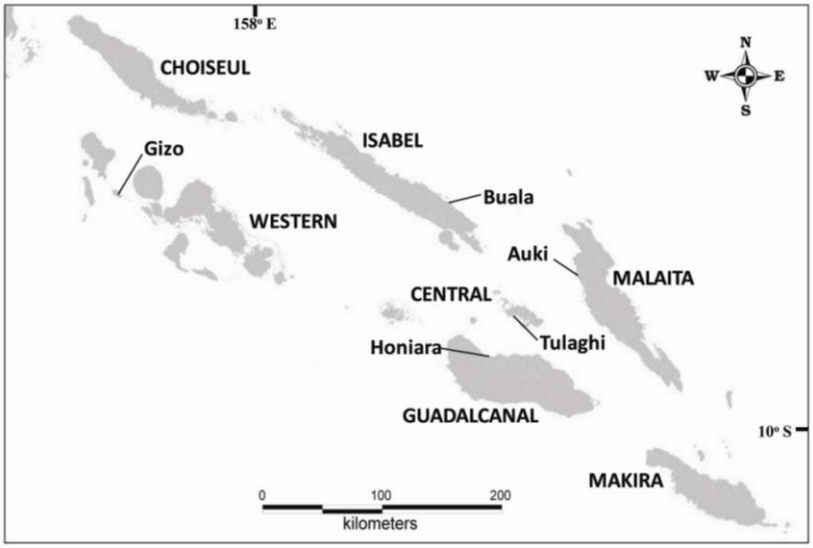

Figure 2. Map of the main provinces of Solomon Islands.
Study regions denoted with lower case.

2.2 Fish value chains

Analysing a single agent (e.g. a fisher, middlemen or private fish seller) would not be representative of the diversity of fish value chains in Solomon Islands. Therefore the traditional value chain approach (whereby a single agent tracks the flows of something of 'value' to the agent, through connections that are relevant to the agent) is adapted here to suit the terms of reference and capture a representative sample of the market-based fishery across the five provinces. This method was

achieved by analysing multiple agents (interviewees) in each of the five regions, and constructing market chain networks, connecting fishing locations, agents, and markets in each region.

Interviewees were asked a set of questions that identified transfers of fish between fishing locations, agents, and markets, reasons for fishing, buying and selling at particular locations, and the means of transport between locations (Appendix 1):

Interviewees were asked where they caught, purchased and sold fish.
Fishing, buying and selling locations and names were identified and recorded on a laminated map. Identifying the locations enabled understanding of, for example, whether particular agents were important links in the market network and whether certain markets were used for selling fish more frequently than others. Only fishing locations that included shallow and deep reef structures were included in this study. Fishing related to pelagic fish such as tuna, or fishing in close proximity to fish attracting devices (FADs) were omitted.

Interviewees were asked to estimate both the volume and frequency of harvest, buying, and selling at each of the identified locations.
Average catch, purchase and sale volume and frequency were calculated as the mean of the high and low values or, if high and low values were not given, then the average value. Average volume was then multiplied by frequency to estimate annual catch, purchase and sale volume at each location. At a number of locations, particularly Tulaghi and village markets, fish were rarely sold by weight, so obtaining an accurate estimate of catch volume was problematic.

Interviewees were asked what transportation types they used to harvest, purchase, and sell fish at each of the locations.
Transportation is frequently a limiting factor in the marketing of reef fish in Solomon Islands. Therefore obtaining a snapshot of the different transport methods used by the interviewees across the five regions may assist in improving or controlling (if there is concern of overexploitation) market access.

Interviewees were asked what price they paid for fish at each of the purchase locations (if they did not catch the fish themselves), and what price they received for the sale of fish at each location (high and low prices).
Identifying the value of fish is essential to understanding the distribution of income through the value chains. However, values varied significantly, even within markets, likely due to a number of factors including weather, market competition, and type of species. Therefore, financial flows are

not expressed within the fish value chain networks in the proceeding results section, but are instead tabulated as averages for different regions and markets and discussed more broadly for each of the regions within text.

Interviewees were asked their reason for fishing, purchasing fish, and selling fish at the identified locations.

Where multiple reasons were given, only the first response was used, assuming this to be the primary reason. Understanding the reasons why fishers fish in certain places and sell their catch to certain people, or in certain markets, is vital to identifying the limitations to market expansion or opportunities to work with fishers to manage fish stocks. For example, fishers may sell fish at a particular market because there is no public transport to get to markets that would otherwise provide greater income.

The responses for each of the above questions (except questions relating to fish pricing) were combined into fish value chain networks for each of the five study regions. First, the key nodes were drawn (e.g. fishing locations, fishers, middlemen, markets). Second, each of the nodes were linked, where appropriate (e.g. fishers to reef, middlemen to markets), to show fish volume, transportation, and reason for fishing, buying, and selling location choice (Figures 4 to 8).

Explicit overheads (costs) including fuel, maintenance, market fees, and ice were not considered in the value chains because of the inherent variability in cost associated with activities from fishing through to value adding in restaurants. For example, fishers may use more fuel, and catch less fish during periods of rough weather, and spend more money on ice during hot, cloudless days, or when ships are delayed. Similarly, middlemen may make large profits when there is no competition and high demand for the fish he/she is selling, or lose money when there is significant competition and limited demand. Instead, these costs are discussed within the results for each region. Again, if single agents were analysed, through time, this would have been feasible, however as discussed above, analysing single agents would not have adequately represented the fishery.

2.3 Review of the effect of market-based fishing on fish stocks

Although not explicitly considered within the survey, general observations were made during the field survey period, at each site, including informal discussions with interviewees regarding changes in catch, over time. Also, some rapid visual assessments were made of fish stocks on reefs

in close proximity to each of the major markets (except Honiara). However, analysis of creel (catch) surveys, in each of the major markets, would be required to confirm changing stock conditions as a result of market-based fishing. Instead, the general observations and visual assessments are used to triangulate the findings of previous studies.

2.4 Market opportunities

Review of market opportunities consisted of results from the value chain analysis, general field observations and interviews with fishers to identify any constraints they observed in relation to their fishing, transport of fish, or selling of fish including market competition. Also considered, was the receptiveness of interviewees to the implementation of market-based fisheries management strategies which might improve fish stocks, and ultimately result in increased catch per unit effort and income.

Results

3.1 General reef fish value chains

Fish value chains were highly variable across the regions surveyed. The more simple chains frequently consisted of a single fisher who fished locally, and sold their catch to a single market (Figure 3(A)), in close proximity to the fishing location. Frequently fishers caught fish at numerous locations and sold to multiple markets and private buyers due to a range of reasons. Commonly, middlemen bought from village fishers (Figure 3(B)) in a number of villages and on-sold at major markets (Figure 3(C)), or to value adders such as restaurants (Figure 3(D)), who then sold to consumers (Figure 3(H)). Also common was fishers selling directly to value adders (Figure 3(G)), such as women who barbeque or motu fish for local consumers, and sometimes direct to restaurants which on-sell to patrons (Figure 3(H)). The last identified general fish value chain was fishers selling to one or many private fish buyers (individuals with a premises and freezer storage space) (Figure 3(E)), who then on-sell to local consumers or customers at other markets (Figure 3(F)).

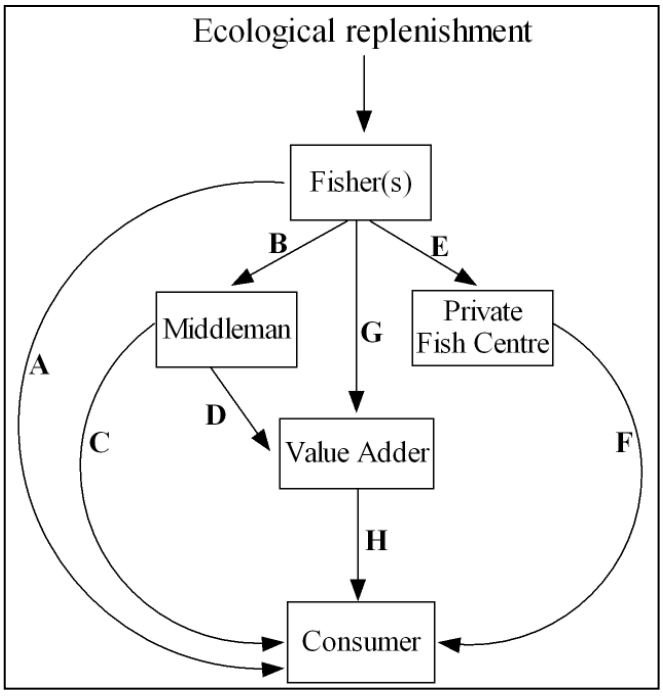

Figure 3. General value chain for Solomon Islands reef fish.
Note: this diagram does not attempt to capture all possible market chain links, but instead the purpose is to highlight the more common linkages between different people in the fish value chain networks.

3.2 Provincial value chain networks

Each of the regions surveyed had both similarities and differences in their value chain networks. Therefore, the results for each region are presented separately, highlighting how they differ, but also acknowledging the similarities. Also presented is a review of the effect of market-based fishing, and market opportunities for each of the five regions, including some province-specific recommendations.

3.2.1 Honiara

Context

Honiara, the capital of Solomon Islands, is the largest market for fresh reef fish in the country. The Central Market is the main point of trade, but fish are also sold at 'fishing village' directly to restaurants, and at road-side stalls near Panatina Plaza, among other locations. Fish sold in Honiara are primarily caught in Central, Isabel, Malaita, Western, and Guadalcanal provinces and transported by ship and private fibreglass boats with outboard motors. Cost and time associated with transport of fish from other provinces (Temotu, Makira, and Choiseul) are likely inhibitive. Evidence that the Honiara market was saturated includes some reports by fishermen that competition drives prices so low that they frequently lost money. Price of reef fish in Honiara has increased dramatically over the last few decades. One interviewee remembered selling reef fish for 5¢/kg in 1979. Another interviewee reported that in 1991 he sold reef fish in Central Market for $9/kg. Reef fish now sell for around $26.5/kg when there are many fish sellers and few customers, and rises to up to $40/kg when there is limited competition. However, the decline in the value of the Solomon Islands dollar, against major currencies, likely explains some of this temporal price increase. Ice used to preserve fish was sourced from a number of vendors throughout Honiara (costing between $10 and $30 per block of ice, depending on the size of the block and the vendor) and adjacent to where fish were caught. People selling fish in the central market paid a daily fee of $25 to the Honiara City Council. Other costs included food for the duration of time spent selling fish, and accommodation if required.

Fish value chain network

The fish value chain network associated with Honiara was complex (Figure 4), and comprised a number of different stakeholders including fishers (F), groups of village fishers (VF) who sold to middlemen (MM), people employed by middlemen to sell fish, and value adders (VA) who generally bought from middlemen to sell to restaurant clientele. Fishers often caught fish themselves, but also bought from village fishers to ensure that their esky(s) was full to maximise

profit potential. Village fishers were generally paid between $8 and $12/kg for the fish they supply to middlemen. Fishers and middlemen who sold fish in Honiara frequently had ownership claims to the reefs they fish and/or family links to the village fishers they bought fish from. The most common transport used for fishing and fish buying was a fibreglass vessel with outboard motor however; transfer of eskies on and off ships was common for Isabel Province, where ships regularly stopped at ports on the northern and southern side of the province. Transportation to market was often more elaborate than for fishing or buying from fishers. For example, to transport fish from Lau lagoon in Malaita, to the central market in Honiara required the use of three transport types; truck, ship and car. Most respondents sold fish in Honiara central market because of the relatively high prices (6/17 interviewed), or because of the large customer base (6/17 interviewed). Total volume of fish arriving in Honiara was difficult to estimate based on this study alone. A previous estimate of volume sold at the central market is 245 metric tonnes per year (Lindley 2007; seen in Weeratunge et al. 2010). Interestingly, most respondents sold consistently high volume of fish in central market, which was likely a function of volume of fish required to cover expenses. Also interesting, was that a number of middlemen, and fishers, sold fish at multiple markets, and so were not solely reliant on selling from the central market in Honiara.

Effect of market-based fishing on reef fish stocks

The Honiara market was buffered from the effects of depleted fish stocks. High sale prices enabled fishers to access fish from increasingly remote areas where fishing pressure was previously negligible. There was little open acknowledgement, among the interviewees of the negative effect of fish markets on reef fish stocks. This finding may be because many of the respondents were middlemen (5/17 interviewed), so were partly disconnected from the resource. However, some respondents suggested that the enforcement of dynamite bans (9/16 interviewed) and banning of the use of small mesh size gill nets (6/16) and night spear fishing (3/16 interviewed) would help to sustain the resource. Also, when asked, most respondents (7/8 interviewed) acknowledged that it would be possible to 'finish' the reef fish.

One concern for the sustainability of reef fish was the perverse incentive created by high fish prices in Honiara, and limited alternative employment opportunities. The potential to make substantial profits might provide fishers incentive to use destructive techniques, such as dynamite, which was mostly sourced from WWII ordinances, particularly in Malaita and Central provinces (see Conservation and Community Investment Forum 2001 for a comparative example). Heavy penalties should continue to be applied to people found guilty of fishing with dynamite.

Market opportunities

A key market opportunity for the sale of fish to Honiara customers was the elimination of expenses incurred by fishers and middlemen whilst at market, including market fees, ice, food, and accommodation. The provision of a fisheries centre, separate to the central market, would enable fishers and middlemen to sell their entire catch, and consequently avoid ongoing costs. However, fish centres that were implemented post-independence have largely failed to return an economic profit and are now mostly abandoned. The establishment of such a centre would also eliminate livelihoods for the many supporting industries such as ice vendors in Honiara. Therefore, given that the current market system is functional and provides livelihoods to both rural areas and people residing in Honiara, there is no reason to make any major changes. A far more achievable opportunity is the improvement of hygiene facilities at the central market including access to fresh water and improving, and regularly cleaning toilet facilities.

a)

c)

b)

Fish marketing in Honiara. a) Fishing village to the west of the city centre, where some reef fish are sold, particularly on Sunday when Central Market is closed. b) Mixed reef fish in an esky at Central Market. c) Reef fish in the back of a taxi at Central Market, ready for transportation to a local restaurant.

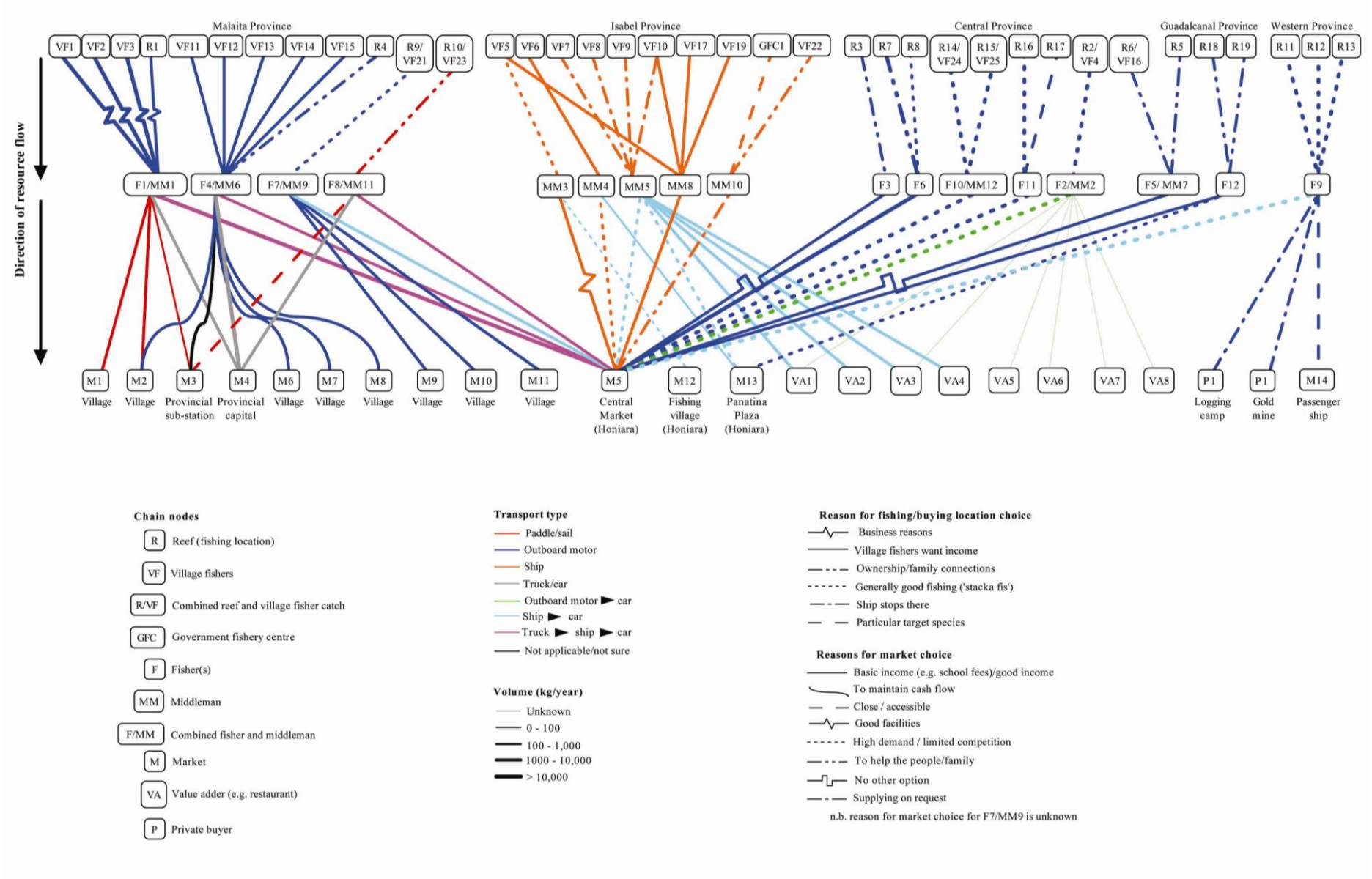

Figure 4. Fish value chain: Honiara market, Guadalcanal province.

3.2.2 Gizo

Context

Gizo, the capital of Western province, has provincial government offices, health facilities and a soon-to-be open hospital, a number of shops and an airport. Gizo township also has a recently upgraded market which is the main point of sale for reef fish. However, high value species are often sold directly to restaurants and hotels and private buyers in the area. Fish sold in Gizo are caught around Ghizo Island and adjacent reefs and islands including Vella Lavella, Ranongga, Simbo, Kolombangara and Vonavona, but also come from as far away as the eastern passage of Marovo lagoon (S. Albert pers. com.) and Choiseul province (Figure 1). Gizo market is relatively isolated from other large markets, including Honiara, making it the only non-village market accessible to many fishers in the area.

Fish value chain network

The Gizo market value chain network was relatively simple, compared to Honiara, consisting of few middlemen, and a limited number of markets (Figure 5). However, some fishers (4/15 interviewed) who sold at Gizo, also infrequently took their catch to other urban centres in Western province including Noro and Munda, and as far afield as Honiara. Much fish, not accounted for here, was likely to be shipped to Honiara on transport ships from various ports throughout the province. Local fishers generally fished, and accessed markets in Gizo using dugout canoes powered by sail and paddle, and motorized fibreglass boats. A number of fishers that were interviewed said that they lived at outlying islands including Simbo and Ranongga, but paddled closer to Gizo to fish and sold fish at the Gizo market for extended periods, before returning home. The main reasons given for choice of fishing locations were proximity or a place to rest (6/15 interviewed) and general good fishing (11/15 interviewed). All except one respondent that identified proximity as a reason for choosing a fishing location were all restricted to paddle and sail transport. Catch and sale volumes varied significantly between respondents, with some catching less than 1,000 kg per year, and others catching and selling well in excess of 10 metric tonnes per year. Most respondents sold fish at Gizo market because of the high income (5/16 interviewed) and demand (6/16 interviewed), but some respondents (4/16 interviewed) said that they sold fish at Gizo and other markets because they wanted to offer a cheap source of fish, to help the local people. Fish were sold in piles, or individually, as has been reported elsewhere (Weeratunge et al. 2010). Prices varied from between $1 for a small Acanthurids (surgeonfish, unicornfish and tang) to over $100 for a moderately large *Bolbometopon muricatum* (Bumphead Parrotfish). Interviewees that were

able to estimate the price per weight suggested that fish sold for between $10 and $15/kg. The one middleman that was interviewed said that he paid local fishers $8 per kg, and on-sold fish at Gizo market for $15/kg. Ice was mostly sourced from the provincial fisheries centre where interviewees paid between $15 and $25 per block. Market fees were also paid. Therefore most people interviewed that sell fish in Gizo had few expenses, and were likely to make a reasonable income. As well as reef fish, a significant volume of pelagic fish was also sold at Gizo market.

Fish sellers selling small mixed reef fish at Gizo market.

Effect of market-based fishing on reef fish stocks

Two fishers remarked that, in the past, they could catch a good quantity of fish (and other marine resource) close to Gizo township, but now they must paddle significantly further to be assured of a reasonable catch. A number of respondents of Melanesian decent (4/15) said that the local Gilbertese fishers, referred to as 'intruders', were responsible for fish stock decline, but were often wary of elaborating. Interestingly, this reason for resource decline was only mentioned to the field assistant who is a resident in Western province. A locally based fisheries officer said, when interviewed, that in the past 'the fish in the markets were bigger'. Most respondents (11/16 interviewed) also acknowledged that it would be possible to 'finish' the fish. The recent Tsunami in Western province might have also negatively affected coral reef habitat, which would, in turn, reduce fish catch.

Market opportunities

The Gizo artisanal fishery was a system with few overheads for fishers (except ice, market fees, and fuel for some), and reasonably high demand for fish in the market (most fishers observed selling fish were not at the market for more than half a day). Therefore, few market opportunities were immediately evident for fishers and middlemen in the vicinity of Gizo. However, it is likely that fish sales from the Gizo area to Honiara will increase of their own accord if shipping frequency continues to increase. Many respondents (8/15 interviewed) said that they would like, for example outboards, eskies, generators, and better fishing gear when asked how the government could help. However, this strategy would likely result in increased, and unsustainable, fishing and therefore I strongly dissuade any further efforts to subsidise such investment.

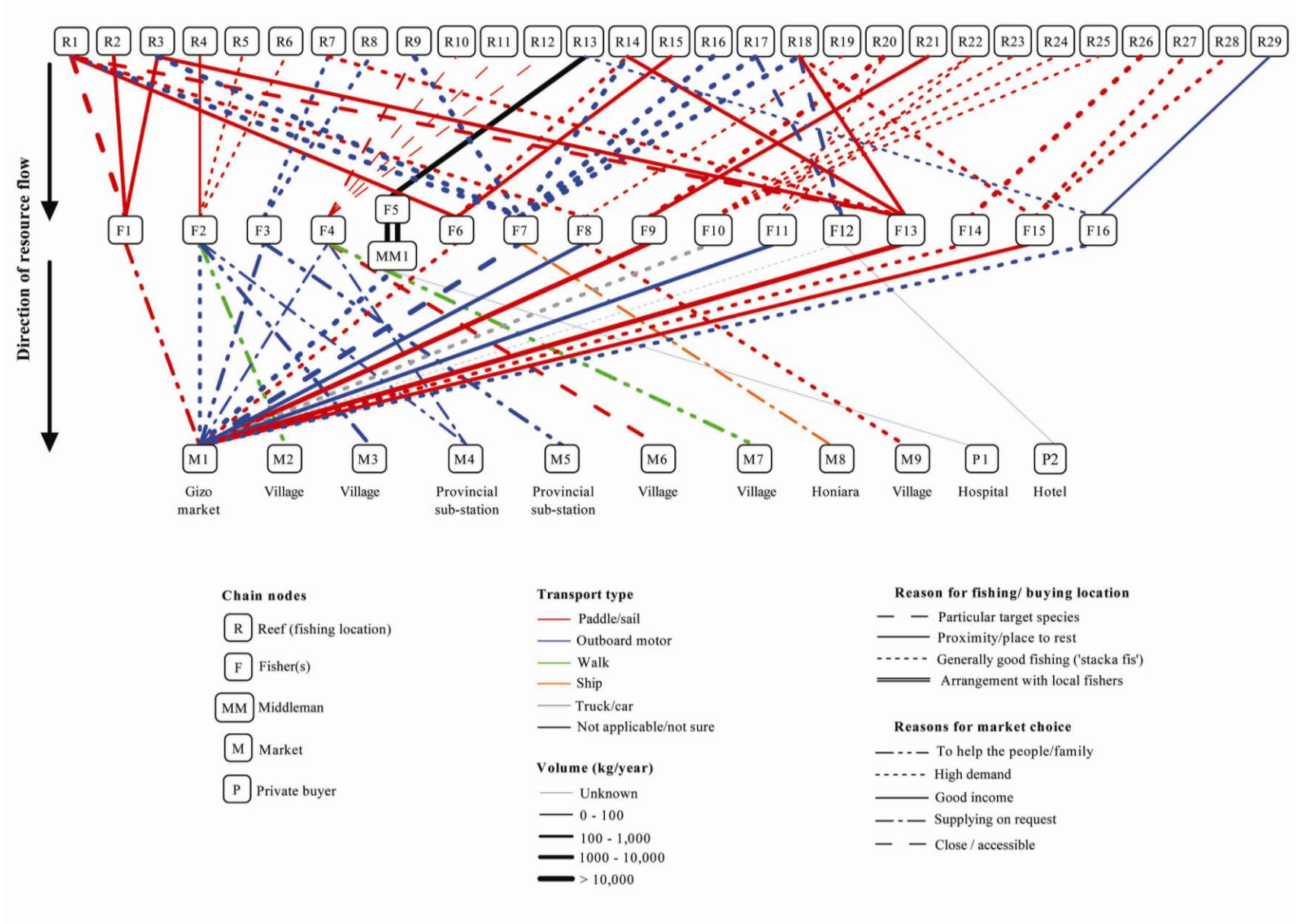

Figure 5. Fish value chain: Gizo market, Western province.

3.2.3 Tulaghi

Context

Tulaghi, the capital of Central province, is a relatively small provincial capital, in close proximity to the national capital, Honiara. Tulaghi has provincial government offices, some shops and tourist resorts. A fish tuna cannery operated in Tulaghi in the past, and since its closure the town has limited economic activity or evidence of urban growth. Reef fish are sold at the local market and on the beach, but most commonly by fishermen who actively seek customers in the Tulaghi township. Fishing, done by the fishers interviewed in Tulaghi township, is mostly on a daily basis in close proximity to Tulaghi, likely because ice is not available for fish preservation.

Fish value chain network

Tulaghi, like Gizo, represented a relatively simple value chain network (Figure 6). It comprised mostly fishers (F) fishing at close reefs (R), a limited number of middlemen (MM), markets (M) including the Tulaghi township and Honiara, village markets, and some private buyers (P) situated in Tulaghi. Local fishers fish on both shallow and deep reefs around central province, but mostly in view of Tulaghi Island, used dugout canoes, and primarily fishing lines, as determined through identifying fishing locations on the map. The main reasons for choice of fishing locations were proximity (3/11 interviewed), access to target species (3/11 interviewed), and general good fishing (11/11 interviewed). Most fishers caught between 100 kg and 10,000 kg per year at each of the reefs they frequented. The one middleman interviewed said he paid $8/kg for fresh fish bought from village fishers (VF). A number of different reasons were given by respondents, for selling at the different markets, but uniquely, two fishers sold at a particular market (village and Tulaghi) because they were unable to sell to, or obtain ice from, the government fisheries centre which may otherwise have enabled them to sell their catch in Honiara. Fish sold in Tulaghi were most commonly sold as ‘strings’ of fish, with each string commanding a different price. Six respondents estimated the selling price of their fish to be between $8/kg and $20/kg when sold on strings (a set of fish with string threaded through the gills) in Tulaghi. Private buyers in Tulaghi paid fishers between $10/kg and $15/kg for fresh reef fish.

Effect of market-based fishing on reef fish stocks

Tulaghi market to the right and fisheries centre to the left

Reasonably intense fishing in the area, to supply both Tulaghi and Honiara markets, by local fishers and fishers from Guadalcanal, was likely reducing overall fish stocks. During informal discussions, a number of fishers acknowledged that dynamite fishing had occurred in the Tulaghi area in the past, in part to supply food for dolphins at a nearby resort. There was also some evidence that fishers were focusing significant effort on fish spawning aggregations in close proximity to Tulaghi. It is likely that targeting spawning aggregations occurred near all provincial capitals during the field period, but was only observed at Tulaghi. Another concern was the mining of live and dead coral for jetty building on Tulaghi Island. This practice would likely contribute to reduced catches in the future by degrading fish habitat. When asked whether it was possible to 'finish' the fish, most (8/11 interviewed) said that it was, however, some did not believe so. Respondents that did not believe it was possible to 'finish' the fish (3/11) were predominantly line fishermen.

Market opportunities

Of the Tulaghi fishers interviewed, few had significant expenses because they did not have access to ice, and rarely used outboard motors. However, their income was probably limited for the same reasons. Some interviewed fishers (actual number unknown) were displeased that the Tulaghi fisheries centre was not operating (at the time of the field survey) because, in the past, they found it convenient to sell their whole catch to a single buyer, the fisheries centre. When asked how the government could help fishers, the primary response (8/11 interviewed) was that fishers would like the fisheries centre to reopen. Also, an interviewed middleman no longer buys fish because he cannot get mains power to run his freezer. Therefore, improved power supply in Tulaghi would likely improve livelihoods for fisher and middleman alike.

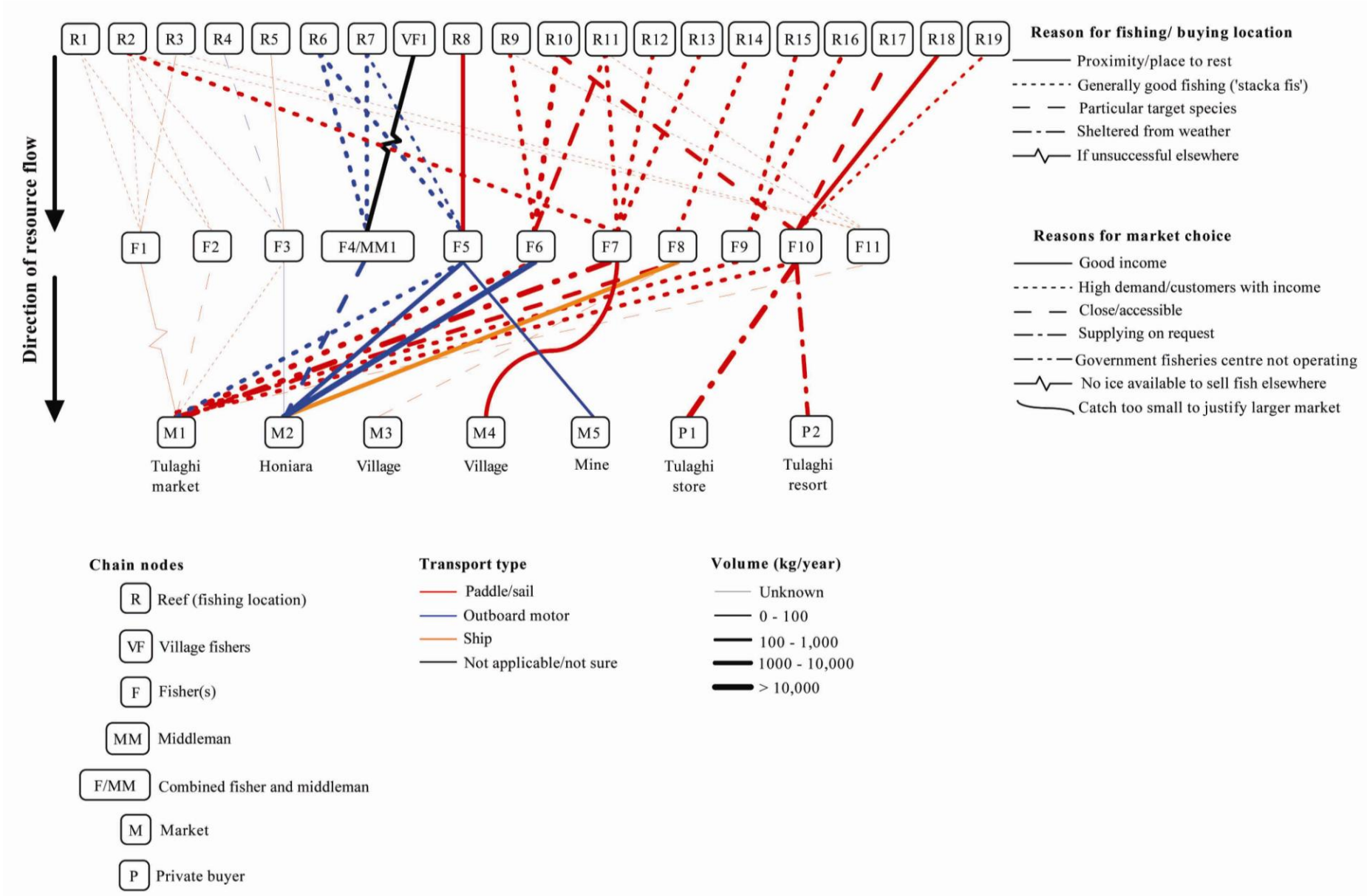

Figure 6. Fish value chain: Tulaghi market, Central province.

3.2.4 Auki

Context

Auki, the provincial capital of Malaita province, is a major urban centre with a growing population and thriving economic activity including a major port, with provincial government offices, health facilities, a number of shops, a significant road network, and an airport. The Auki reef fishery is characterized by localized fishing close to the provincial capital in Langalanga Lagoon and at Alite Reef, larger expedition fishing to remote islands including Ramos, and shoals, and elaborate transportation of fish from Lau Lagoon. Frequent and relatively cheap transport between Auki and Honiara enables Malaitan fishers to sell much of their catch at Honiara Central Market.

Fish value chain network

Like Gizo and Tulaghi, the Auki fish value chain was a two tiered network including fishers (F), village fishers (VF), middlemen (MM), and markets (M) dominated by Auki and Honiara (Figure 7). None of the interviewees said that they sold fish privately (e.g. to logging camps or mining companies), however pelagic fish were sold to private buyers including the prison in Auki. Fishers fish on a limited number of reefs around Auki, remote reefs, and Lau Lagoon, used a diverse range of transport dominated by paddle canoes. Reasons for fishing and fish buying locations were diverse among respondents and locations, but uniquely included seasonality. The one middleman interviewed bought fish from village fishers in Lau for $8/kg. Volume of fish caught and purchased ranged between 100 to 1,000 kg to >10,000 kg per year. Alite Reef (R3), to the west of Langalanga Lagoon, is fished frequently, with 8 of 15 respondents saying they fish there. A diverse range of transport types were used to transport fish to the different markets. Local fishers paddled, or used outboard motors to access Auki market, and mostly used ships and outboards to access Honiara. Fishers from further afield at Lau Lagoon used trucks to access Auki, and generally use ships to access Honiara from Auki. The majority (11/15 interviewed) of fishers and middlemen who sold at Auki also sold fish in Honiara. Volume sold at the different markets varied among fishers, but all sold greater than 1000 kg per annum to each of the markets they sold at. Reasons for selling at particular markets were diverse and varied between fishers and market locations. However, most sold at Auki because of the good income, and often continued on to Honiara when competition in Auki was high, and they were likely to make greater profit. Fish price varied significantly across each of the markets from size dependent price in villages and Takwa (the provincial sub-station), to $18 to $33/kg in Auki, and $26 to $44/kg in Honiara.

Effect of market-based fishing on reef fish stocks

Auki open market (top left)

A respondent from Lau Lagoon said that 6 years ago it was possible to fill 2 – 3 eskies in a night (roughly 150 litre volume). Now it takes 1 ½ days for the same number of people to fill 2 eskies. A number of fishers in Lilisiana, a community on the outskirts of Auki, stated that before the mangroves were cleared for fuelwood and housing, and a road built through, and rubbish dumped in, the mangroves, yellowfin tuna (though more likely to be a *Carangid* species) would commonly chase baitfish (likely *Rastrelliger* sp.) into the mangroves. Now the fishers rarely see any baitfish, and no predatory fish, in the same location. Based on a set of five untimed free-dives along the outside fringing reef of Langalanga Lagoon, it was clear that there has been significant physical damage to the reef structure. Also, much of the reef area was dominated by urchins and macroalgae. This might be, in part, due to a combination of mangrove clearing, dynamite fishing and mining of live and dead coral for land reclamation and jetty construction. Also of concern was the use of mosquito nets to harvest small fish in coastal waters, as mentioned by two respondents. These practices should be controlled to increase local fish stocks to ensure future income potential to fishers, and to reduce the severity of storm surge inundation.

Market opportunities

Opportunities for increasing fisher incomes through markets were limited in Auki. Demand appeared to be saturated at Auki market. One fisher from Lau Lagoon reported that it can take up to a week to sell a 150 litre esky of fish. Pelagics, and particularly tuna, appeared to comprise the majority of fish sold at Auki market, offering a more affordable alternative to reef fish. However, the relative pricing of reef and pelagic fish might change according to changing fuel prices because the pelagic fishery generally requires a much greater fuel investment. The present market facilities in Auki offered little shade, and were likely to be unhygienic. However, a new jetty and market area are currently under construction (Kakai 2011) which should address these issues, improving facilities for fish sellers and customers alike.

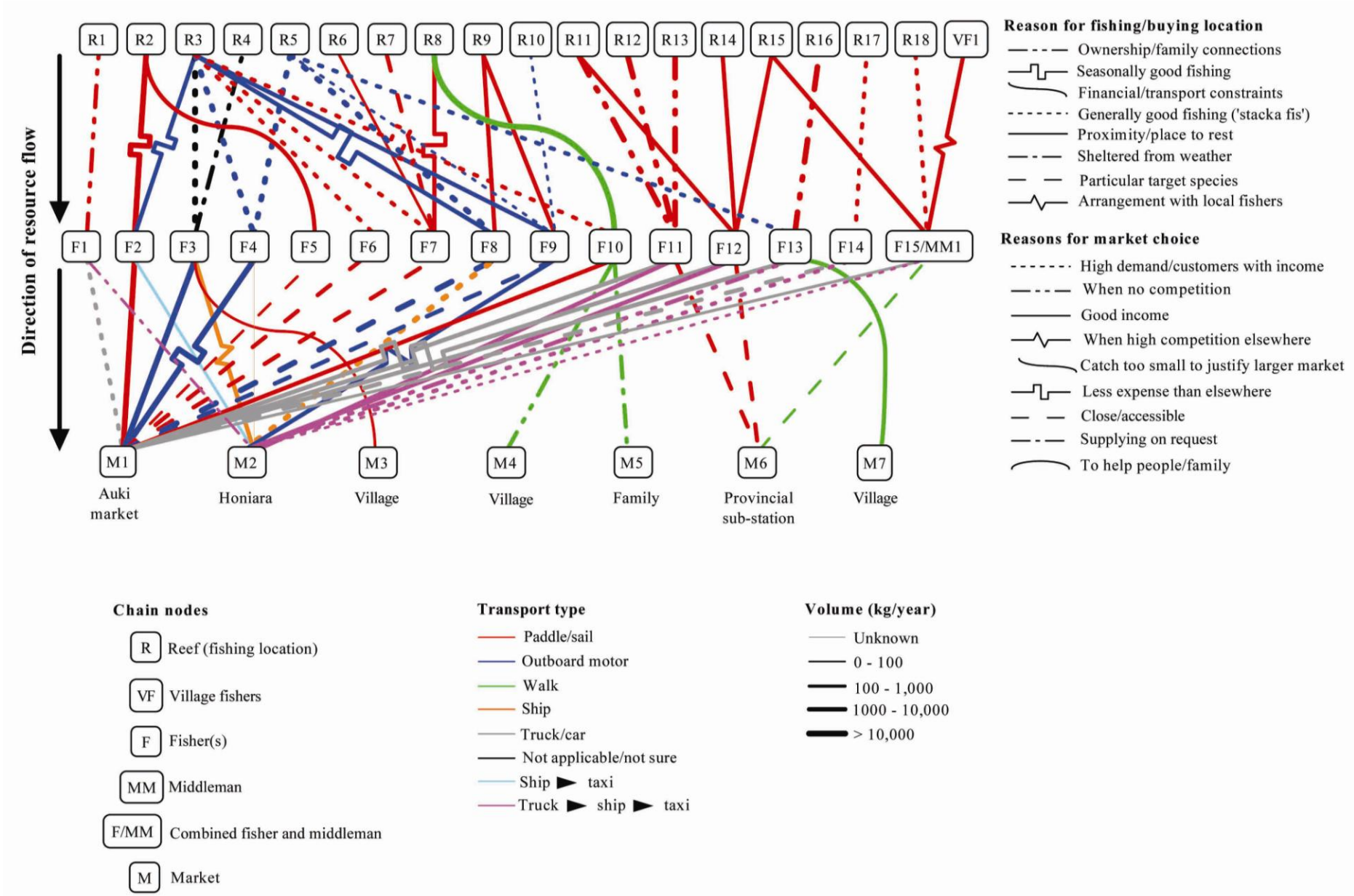

Figure 7. Fish value chain: Auki market, Malaita province

3.2.5 Buala

Context

Buala, the provincial capital of Isabel province, is a relatively small urban centre, with provincial government offices, health facilities, a number of shops and an airport, with a number of adjacent villages along the adjoining coastline. Buala township sits beside Maringe Lagoon which is sheltered by Fera Island to the north. Most of the fishing occurs at offshore shoals to the north, and most fish are sold to local private fish buyers, and on-sold to local customers and Honiara.

Fish value chain network

The Buala fish value chain network (Figure 8) differed from the other study locations in two main ways. Firstly, the majority of fishing to supply the market occurred on deep reefs (R) well to the north of Buala. This was likely a result of declined stocks on the inshore reefs (Ramohia et al. 2009), improved technology, particularly outboard motors, and potential to obtain much greater catch volume of higher value snapper species. Secondly, a number of private fish centres (PFC) existed in the Buala and Jejevo areas. Most of the fisher catch is sold here, and then on-sold locally (LC), or shipped to Honiara. The government fisheries centre was producing ice, but not buying and selling fish during the visit, and was therefore, not considered within the market chain. Fishers fish at close reefs because of transport constraints or because the lagoon offered shelter from large seas, and fish at offshore reefs when conditions permitted because they were good fishing, particularly for snapper species. Volume of fish caught by fishers ranged between 100 to 1,000 kg to >10,000 kg per year. Fishers accessed local private buyers, markets, and private fish sellers using paddle, outboard motor, and by walking. Fishers sold their catch at particular locations for a diverse range of reasons. Uniquely, however, two fishers sold to particular private fish centres because the fish centre operator provided credit for fuel, ice, and other fishing related expenses. This lending has been observed elsewhere in Solomon Islands including Kia, Wagina, and Taro (R. Hamilton pers. com). Also, one fisher sold to a particular private fish centre because he claimed that the weighing scales were ‘light’ so obtained more income. Volume of fish sold, by the fishers, to markets, private buyers, and private fish centres ranged between 100 to 1,000 kg to >10,000 kg per year. Fish price varied between sale locations and species sold. Private fish buyers generally paid $12 to $14/kg for small reef fish and up to $16/kg for snapper species, and on-sold locally for between $17 and $20/kg. The majority of fish was sold locally, however some was sent to Honiara central market. Fish were sold in Honiara, either directly by fishers, or through private fish centres and then sent by ship.

Effect of market-based fishing on reef fish stocks

Past studies have clearly shown that fishing is negatively affecting fish stocks close to Buala (Brewer et al. 2009; Ramohia et al. 2009). This might be due to the small reef area available to the growing population, and export to Honiara. Protected areas have been established; however enforcement of the rules associated with protected areas has not been completely successful, according to the opinions of a number of respondents and other members of the community. This might also be the case at other provincial capitals, however, adequate evidence was not obtained to support such statements. Other concerns for future fish resource availability included pollution from ships, as observed during the field period, and significant sedimentation, presumably caused by upstream logging; both of which are problems that protected areas cannot address. However, the vast number of deep shoals accessible from Buala likely means that fish will be available, to those with the ability to access the shoals, indefinitely. However, when asked whether it was possible to 'finish' the fish, seven of seventeen respondents believed that it would not be possible. This may be due to the seemingly vast shoals available for fishing offshore.

Buala fishers with Joe Giningele, the field assistant for this research. Photo taken from Fera Island, looking toward Santa Isabel

Market opportunities

When asked how the government could improve their fishing and fish marketing, amongst other responses, the vast majority of fishers (10/15 interviewed) suggested that the government should provide fishing gear such as boats, eskies, and outboard motors. However, such government investment would unlikely be necessary if small-scale commercial fishing was viable. One respondent said that, if provided with solar panels, and a chest freezer, he would be able to fish remotely, and make better income than having to travel to Buala township frequently. There was no apparent economic benefit in the Buala government fisheries centre reopening to buy fish, as this would have competed with the private fish centres. Therefore, in all, the Buala fish market system was quite effective, but fisher livelihoods might be improved with direct government assistance.

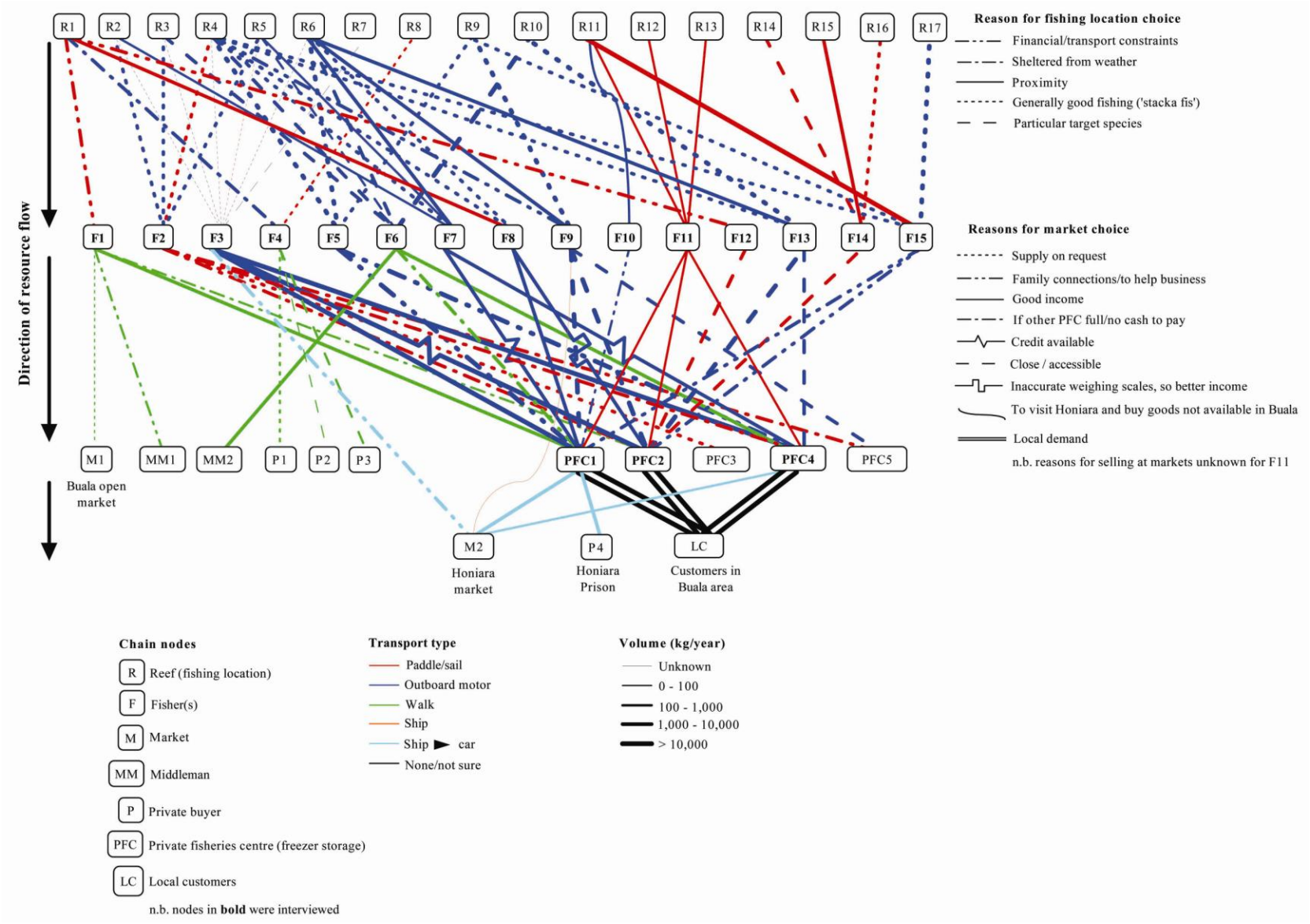

Figure 8. Fish value chain: Buala market, Isabel province.

3.3 Fish pricing

Identifying the value of fish is essential to understanding the distribution of income through the value chains. However, values varied significantly, even within markets, likely due to a number of factors including weather, market competition, and type of species. Therefore, financial flows are not expressed within the fish value chain networks (Figures 4 to 8), but are instead tabulated here as averages for different regions and markets.

The average price paid for fish in villages across Solomon Islands is $8.64/kg (Table 2), which is similar to a 2008 estimate (Gillett 2009). Many of the middlemen who sell fish in Honiara buy fish from fishers in a vast number of villages, particularly in Central, Isabel and Malaita province. This link in the chain (between village fishers and middlemen) represents a vital source of village income for people in these areas. Some fish is sold and bought at provincial sub-stations including Kia in Isabel province (likely from the government fisheries centre), and Munda and Noro in Western province. Large volumes of fish are sold at the provincial capitals (Figures 5 to 8) where fish price is significantly higher than in villages over double the price paid in villages (Table 2). The price paid in markets in Honiara is nearly 4 times greater than that paid in villages and 1 ½ times the price paid in provincial capitals. Private buyers (e.g. mines) and value adders (e.g. restaurants) pay a similar price to that paid in provincial capitals, except those in Honiara which pay slightly above market rate (probably because they are more selective in the product they buy and price might include delivery). Private fish centres operating in the Buala area pay roughly $14.50/kg for reef fish and on-sell for $18.50/kg providing a $4/kg margin for income and overheads.

	Village		Sub-station		Provincial capital		National capital		Private buyer / value adder (buying price)		Private fish centre (buying price)		Private fish centre (selling price)	
	($/kg)	n	($/kg)	n	($/kg)	n	($/kg)	n	($/kg)	n	($/kg)	n	($/kg)	n
Western province	9.71	7	14.00	3	13.50	3	35.20	1	-	-	-	-	-	-
Central province	9.60	10	-	-	9.67	3	33.33	6	12.50	-	-	-	-	-
Malaita province	7.76	17	7.33	3	22.88	17	32.51	9	-	-	-	-	-	-
Isabel province	8.44	12	10.87	5	25.00	1	36.30	3	16.57	7	14.62	30	18.50	4
Guadalcanal province	-	-	-	-	-	-	33.29	21	37.40	6	-	-	-	-
Total	8.64	46	10.76	11	20.15	24	33.40	40	24.36	15	14.62	30	18.50	4

Table 2. Fish prices at various markets across Solomon Islands.
Values shown for each province are the average price ($/kg) and the number of values (n) which contribute to estimating the average. National capital average prices in each of the provinces represent the prices estimated from interviews in each of the respective provinces. Note that for some regions, particularly Western and Central province, there are a limited number of values because fish are rarely sold by weight.

3.4 Estimated value of coral reef fisheries to fishers and middlemen

The most recent estimate of the value of reef fish to fishers of Solomon Islands is $12 million per year (Gillett 2009). This value was based on an estimated market value of fish at$8/kg at rural fisheries centres, and an estimated volume of 1,500 metric tonnes harvested annually for sale *($8/kg*1,500,000kg = $12,000,000)*.

Gillett's (2009) price estimate of $8/kg is based on direct value to fishers (*'beach price'*), and does not include costs incurred with selling fish, or price differences at different market scales. Using the volume estimate of 1,500 metric tonnes I estimate the economic value of mixed reef fish, to fishers and middlemen at national, provincial, and village markets, complementing the value estimated by Gillett. Private fish centres and private buyers are not considered in this estimate due to inadequate data and the relatively negligible contribution they are likely to make to the fishery in terms of volume. Also government fish centres, many of which are still operating, which buy fish from fishers for around $8/kg (Gillett 2009), are not included explicitly because they were visited in this study.

National capital

The volume of fish sold annually in Honiara Central Market has been estimated at 245 metric tonnes (Lindley 2007; seen in Weeratunge et al. 2010). Assuming that this volume represents total reef fish sales in Honiara, and that the average price to fishers and middlemen in Central Market for reef fish is $33.40/kg (Table 2), then the value to middlemen and fishers alone for sales in Honiara, is $8,183,000 per annum.

Provincial capitals

If we assume that the volume of mixed reef fish sold across all provincial capital markets is equal to the volume sold at Honiara central market, and the average price for reef fish in provincial capital markets is $20.15/kg (Table 2), then the value of reef fish sales in provincial capital markets, to fishers and middlemen is $4,936,750 per annum.

Provincial sub-stations and villages

Estimating total volume of fish sold at provincial sub-station and village markets is more problematic. However, considering there are over 3000 recognised villages in Solomon Islands, and the fact that many of the respondents in this study sold large volumes of fish at small market centres, the volume is likely to be significant. As stated above, the total volume of inshore fish sold in Solomon Islands is 1,500 metric tonnes. Assuming the recent figure to be correct, then 1010

metric tonnes remain unaccounted for once national (245 metric tonnes) and provincial (245 metric tonnes) capital sales are accounted for. Therefore, based on an average price of fish sold in villages at $8.40/kg (Table 2), then village sales are worth $8,484,000 per annum to local fishers.

Therefore, based on previous total fish volume estimates, and volume and fish price estimates made in this study, I conservatively estimate the reef fish fishery to be worth $21,603,750 to the fishers and middlemen of Solomon Islands. This likely represents a significant component of the Solomon Islands domestic economy.

It should be noted that the value reported here comes with limitations. The key remaining gap is an accurate estimate of fish volume sold at the different market scales. For example, during each of the visits to the Central Market for this study, I counted, on any one day, no less than 20 eskies (and sometimes up to 30) of mixed reef fish with each esky estimated at 150 litres volume (however some eskies are significantly larger). Assuming that each of these 20 eskies were full on arrival and sold within a one day period, and that the Central Market operated 6 days a week throughout the year (totalling 312 days of operation) then the volume of mixed reef fish sold at Central Market is 936 metric tonnes per year. This value far exceeds the previous estimate of 245 metric tonnes (Lindley 2007; seen in Weeratunge et al. 2010), and represents nearly 2/3 of the total estimated volume of inshore fish sales (1500 metric tonnes) within Solomon Islands annually. Conservatively assuming that this volume (936 metric tonnes) represents the total mixed reef fish volume sold in Honiara (which it is unlikely to because significant volumes of fish are sold direct to, for example restaurants), and that the average price to fishers and middlemen in Central Market for reef fish is $33.40/kg, then the value to middlemen and fishers alone for sales in Honiara, is $31,262,400 per annum. I have done this calculation, not to estimate the value of the fishery, but to highlight the variability in such estimates caused by many factors including seasonality and lack of reliable volume estimates, which are needed to obtain a better picture of the fishery as a whole.

Discussion

Fish value chain networks

Fish marketing in Solomon Islands is a highly diverse and dynamic system. That is, the people involved in the industry have very diverse roles (e.g. fishermen, middlemen, ice vendors, city councils, and restaurateurs). All market systems differed significantly, whether it be transport used, diversity of fishing locations, reasons for fishing locations, and reasons for selling at particular markets, or the volume flow of fish between the different nodes in each of the fish chain networks. This means that any general policy decisions, relating to the domestic trade of reef fish, should consider the diversity presented by the market and accommodate the mixed interests of those with some investment.

The value chain analysis illustrates aggregation points of fisheries' products and people employed in the fishery. For example, the Honiara market value chain shows clearly, that resource from throughout much of Solomon Islands is finally purchased in the Central Market. Conducting education and awareness talks, and regulation and enforcement efforts in major areas of fisher and middlemen aggregation, rather than touring villages, would save significant investment. Fishers and middlemen might then distribute such information through their own market networks.

It is evident that there is little fish processing within the reef fishery sector across the study sites, relative to the volume of fresh fish sold. Instead fish value tends to increase with increasing buyers and sellers, from capture to final sale. There may be opportunity to value add further by increasing motu and barbeque fish sale at markets, however, fishers are likely aware of such opportunities but are reticent to exploit them due to reasons such as 'shame' associated with such activities, as one Buala fishermen explained. Fishers (particularly men) may perceive such activities as 'womens' business, as women are generally responsible for selling of processed fish (Weeratunge et al. 2010). The role of women in the marketing of fish requires further investigation. Also, it is likely that much of the catch that is motu'd or barbequed was not captured in this study because only people selling fresh fish were formally interviewed. Therefore, it is not possible to draw conclusions regarding the contribution of such value adding to household incomes.

Previously, the contribution of the inshore finfish fishery to fishers has been estimated at $12,000,000 (Gillett 2009). Here I have added a complementary value which represents the gross economic value of the inshore finfish fishery to fishers and middlemen, accounting for value differences at different market scales. The estimate calculated here was $21,603,750. This value

represents a reasonable benchmark for the gross value of fish sold at village, provincial capital and national capital markets combined. However, before a more reliable value can be determined there is a need to obtain accurate estimates of the volume of fish sold at markets with different pricing, and estimate profits for fishers, middlemen, private fish centres, government fish centres and value adders.

The effect of market-based fishing on fish stocks

There is clear evidence that market–based fishing is causing decline of coral reef fish stocks. Evidence for this trend comes from field observations during the present study and past empirical analyses (Aswani & Sabetian 2009; Bell et al. 2009; Brewer et al. 2009; Green et al. 2006; Ramohia et al. 2009; Sabetian & Foale 2006). Therefore, any attempt to use coral reef fish to raise revenue, and improve the welfare of the people of Solomon Islands must be done with caution. Instead, it should be government priority to manage current market networks to maximise societal benefits.

Fishers, when presented with an opportunity to make significant income from increased exploitation, might be likely to do so. For example, the vast majority of fishers (66/68 respondents) said that they would like to make more income from fishing. When asked how they could make more income, a large portion said could if they had better gear such as nets, eskies, and new outboard motors to catch more fish (18/51 respondents), or by improving their marketing such as transporting fish to Honiara or by selling barbeque or motu at local markets (25/51 respondents). According to fishers, the main reason why they are not actively pursuing their plans to make greater income from market-based fishing was because of financial constraints (35/53 respondents). However, lack of education and awareness of opportunities, and family financial commitments likely play an important role in the suppression of fishery business expansion. Therefore it can be assumed that it is generally the will of the fishers to increase harvest, rather than finding alternate means of increasing income from current levels of fishing activity. This is concerning given the evident decline in fish stocks.

There is an urgent need to diversify livelihoods including the production of alternative sources of protein such as pigs, for two reasons. First, fish production is expected to fall short of demand in the future, which would result in a protein deficit. Second, if fuel prices continue to rise relative to incomes, then it is possible that much of the coastal fishing will become cost prohibitive, resulting in protein shortages, and unemployment, especially among people currently dependent on coastal fisheries for their livelihoods.

Market opportunities

In accordance with free market theory, I observed that the fishers and middlemen, across the study sites, are generally able to identify market opportunities and opportunistically exploit them. Some key examples include the supply of fish to logging camps and mines, value adding by *motu* and barbeque, and a sophisticated system of monitoring market competition including making phone calls to Honiara to determine competition in the central market. Key inhibitors to expansion of production include a lack of personal financial capital, a lack of unoccupied market niches, declining resource, and inhibitive overheads including maintenance of gears and fuel.

The private fish centres in Buala and other areas of Solomon Islands not included in this report, including Munda in Western province, represent an interesting opportunity for understanding the potential shift from a fishery supported by government subsidy (Lindley 2007) to one that is commercially viable. Private fish centres are run by local entrepreneurs with some business skills. The presence of private fish centres may enable local fishers to sell more fish, which can then be on-sold to larger markets through the networks established by the private fish seller. Private fish sellers that can demonstrate that they are conforming to Ministry for Fisheries and Marine Resources (MFMR) legislation, and facilitating economic development in rural areas should be supported by MFMR.

During field studies I observed, on a number of occasions, that income gained from fishing is spent on luxury goods including alcohol, particularly amongst the young men, as has been reported elsewhere in Solomon Islands (Tungale 2008). While this is likely common in commercial activities in general, and in many cases socially acceptable, it should be taken into consideration when discussing the value of the Solomon Islands inshore fisheries in enabling development.

Market opportunities are discussed further in the recommendations section.

Recommendations

The conclusions of this report, derived from in-field observations and previous studies, state that coral reef fish stocks are significantly depleted, particularly in closer proximity to urban fish markets. Therefore, simply sourcing new markets for reef fish products, which would result in increased exploitation, is not a sensible option. Instead, it is necessary to identify means of improving the efficiency of current market networks including value adding and improved environmental management, to maximise income without endangering future exploitation potential. The following recommendations are made in light of the need to balance income generation with sustainable exploitation.

Management through markets

1) **a. Establish and legislate size limits for fish species.** This should be done for a limited number of clearly identifiable select species. Species should be included based on two key criteria. First, species which are most vulnerable to overfishing because of their life history traits (e.g. aggregate to spawn) and because of their high market value should be included. Second, species that contribute a large portion of the total volume of market sales should also be included to prevent stock collapse of species that are vital to both livelihoods and protein intake. Species that exhibit both traits should be given top priority. However, if such an action was to proceed, it should not be assumed that fishers will not harvest smaller fish. Instead, it is likely that a larger portion of the smaller fish will be sold or consumed in villages, rather than in the larger urban centres. Therefore, this action should be seen primarily as a means of education and awareness raising, rather than a management intervention.

   b. Provision of size limit measuring devices to provincial fisheries officers, private fish sellers, and fishers who sell fish at open markets once size limits for select species has been established. Many fishers and private fish sellers across study locations were supportive of enforcement of catch restrictions, including size limits. One sensible method of distributing legal size measures would be to negotiate with local esky manufacturers to have measurement charts embedded within the resin of esky lids, and with boat manufacturers to have measurement charts embedded within vessel seats. Trials would be required to ensure that measures remained visible with wear. Alternatively, durable plastic measures (which had no

foreseeable alternate application) could be distributed to market-based fishers who do not own large eskies or fibreglass boats.

2) **Signage in major provincial markets** might inhibit the sale of fish which are small (not at reproductive size) and harvested using destructive methods. Education on the reason for size limits on some species, and ways of identifying fish caught with destructive methods (e.g. dynamite) should be included in this signage.

3) **Routine surveys of fish in urban markets** should be undertaken where there is at least one full time fishery officer present. This survey should acknowledge the time constraints of fisheries officers, by limiting the survey to a set of key species which best 'indicate' changes in the broader coral reef fish stock. Obtaining consistent records would be invaluable for the future management of reef fish, as over time it would be possible to identify trends, and respond through altering fisheries laws to ensure continued sustainable exploitation. Such stock assessment strategies would also be far more cost effective, than underwater census assessments.

4) **National endorsement of reservation of reef areas** for consumption purposes only, in areas that experience severe market fishing pressure. Areas which enclose fish spawning aggregation sites should be given additional support, to ensure the persistence of breeding stocks. Currently, reserves (whether temporary, permanent, relating to particular resources or fishing gears, or sacred sites) are common throughout Solomon Islands, whether established locally unaided by external agents, or established locally and aided by NGO's, or Solomon Islands government (Solomon Islands Locally Managed Marine Area network is a good example). However, enforcement of reserve regulations is difficult at the local level, without significant support from higher authority. Such endorsement of local reserves, (as outlined in the draft Fisheries Amendment Act) represents an essential contribution to future food security in Solomon Islands.

5) **Actively source alternative sources of protein.** Given the expected shortfall in fish to supply national protein intake needs (Bell et al. 2009), there is a need to increase production in other areas including aquaculture and livestock such as pigs. Concomitant with declining fish stocks (and likely increased fuel price), it would be expected that many people that currently depend

on coastal fisheries for livelihoods will not be able to obtain adequate income from fishing in the future. Fishers and communities with such characteristics should be prioritised in the development of alternative livelihood strategies.

Market opportunities

6) **Improve basic facilities in major markets.** Such facilities should include adequate access to fresh water and clean toilet facilities at Honiara Central Market. This might extend to the provision of basic accommodation for fishers who stay overnight in Honiara to sell their catch.

7) **Commission an in-depth study on costs and profits within the Solomon Islands reef fishery**, across different stakeholders including fishers, middlemen, private fishery centres and value adders, as well as support industries including shipping, ice vendors, and fuel depots. Such an analysis would show, more clearly, areas where livelihoods could potentially be enhanced by the provision of services that address current problems in the fishery. As part of this study, a survey of expenditure should be conducted across the different stakeholders to identify how fisheries production contributes to government development agenda.

8) **Conduct a review of availability of ice, for fish preservation, across Solomon Islands.** Currently, many fishers must travel to provincial centres to obtain ice, before returning to fishing grounds to catch fish. Frequently, and particularly if the ice is not high quality (i.e. melts rapidly), the ice melts before fishers return to market with their catch. This will result in either a spoilt catch or the need to buy more ice as soon as the fisher reaches the market. The provision of ice (government or private, but preferably private with minimal government support) would help to ensure fishers are able to return a profit and deliver a higher quality product to the consumer.

References

Adams, T., J. Bell, and P. Labrosse. 2001. Current status of aquaculture in the Pacific Islands in R. P. Subasinghe, P. Bueno, M. J. Phillips, C. Hough, S. E. McGladdery, and J. R. Arthur, editors. Aquaculture in the Third Millennium. Technical Proceedings of the Conference on Aquaculture in the Third Millennium, Bangkok, Thailand, 20-25 February 2000. NACA, Bangkok and FAO, Rome.

ANU Enterprise. 2008. People's survey 2008. Page 134. Australian National University.

Ardjosoediro, I., and D. Neven. 2008. The Kenya Capture Fisheries Value Chain: An AMAP-FSKG value chain finance case study. United States Agency for International Development.

Aswani, S., and A. Sabetian. 2009. Implications of Urbanization for Artisanal Parrotfish Fisheries in the Western Solomon Islands. Conservation Biology **24:** 520-530.

Beamon, B. M. 1999. Designing the green supply chain. Logistics and Information Management **12**:332-342.

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

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

California Environmental Associates. 2011. The Live Reef Food Fish Trade (LRFFT): A supply chain review and market intervention analysis.

Conservation and Community Investment Forum. 2001. Analysis of Destructive Reef Fishing Practises in the Indo-Pacific. San Francisco, USA. pp 38

Gillett, R. 2009. Fisheries in the economies of the Pacific island countries and territories. Asian Development Bank, Mandaluyong City, Philippines.

Gillett, R. E. 2010. Fisheries centres in the Pacific Islands: Lessons learned? SPC Fisheries Newsletter **133**:29-34.

Green, A., P. Ramohia, M. Ginigele, and T. Leve. 2006. Fisheries Resources: Coral Reef Fishes. In: Green, A., P. Lokani, W. Atu, P. Ramohia, P. Thomas and J. Almany (eds.) 2006. Solomon Islands Marine Assessment: Technical report of survey conducted May 13 to June 17, 2004., TNC Pacific Island Countries Report No. 1/06.

Johnston, B., and B. Yeeting. 2006. Economics and marketing of the live reef fish trade in Asia–Pacific. Proceedings of a workshop 2–4 March 2005, Noumea, New Caledonia Hosted by the Secretariat of the Pacific Community. ACIAR Working Paper No. 60.

Kakai, J. 2011. Auki jetty and market project set to go Solomon Star. http://www.solomonstarnews.com/news/national/10191-auki-jetty-and-market-project-set-to-go. Accessed: 23 April, 2011, Honiara.

Lindley, R. 2007. Interim Report of the Rural Fisheries Development Specialist. NZAID Solomon Islands Marine Resources Organizational Strengthening (SIMROS) Project, Solomon Islands Ministry of Fisheries and Marine Resources, Honiara.

Lock, J. M. 1986. Effects of fishing pressure on the fish resources of the Port Moresby Barrier and Fringing Reefs. Technical Report 86/3. Fisheries Division, Department of Primary Industry. Port Moresby.

Pinca, S., A. Vunisea, F. Lasi, K. Friedman, M. Kronen, R. Awira, P. Boblin, E. Tardy, L. Chapman, and F. Magron. 2009. Solomon Islands Country Report: Profiles and Survey Work at Nggela, Marau, Rarumana and Chubikopi (June to September 2006 and December 2006). Secretariat of the Pacific Community, Coastal Fisheries Programme, Noumea, New Caledonia.

Raikes, P., M. F. Jensen, and S. Ponte. 2000. Global commodity chain analysis and the French Filière approach: comparison and critique.26 pp.

Ramohia, P., F. Lasi, W. Atu, M. Ginigele, and F. Kavali. 2009. Fisheries Resources and Socio-economic Survey, Maringe Lagoon, Isabel Province. SIMEL Field Survey. Report 01/09

Sabetian, A., and S. Foale. 2006. Evolution of the Artisinal fisher: Case studies from the Solomon Islands and Papua New Guinea. SPC Traditional Marine Resource Management and Knowledge Information Bulletin **20**:3-10.

Solomon Islands Government Ministry of Fisheries and Marine Resources. 2010. Solomon Islands National Strategy for the Management of Inshore Fisheries and Marine Resources. 2010 - 2012. Page 6.

Taylor, D. H. 2005. Value chain analysis: an approach to supply chain improvement in agri-food chains. International Journal of Physical Distribution & Logistics Management **35**:744-761.

Tungale, R. 2008. Livelihoods and Customary Marine Resource Management Under Customary Marine Tenure: Case Studies in the Solomon Islands. Masters Thesis. Lincoln University.

Weeratunge, N., D. Pemsl, P. Rodriguez, C. O. Li, M.-C. Badjeck, A.-M. Schwarz, C. Paul, J. Prange, and I. Kelling. 2010. Planning the use of fish for food security in Solomon Islands. The WorldFish Center, Penang, Malaysia. Project Number: CT09.

Wilkinson, J. 2006. Fish: A Global Value Chain Driven onto the Rocks. Sociologia Ruralis **46**:139-153.

Appendices

Appendix 1. Fish value chain questionnaire sheet

C. Market chain analysis & target species (Artisanal fishers and middlemen)

Where do you catch or buy reef fish? *Mi laik askem yufala aboutem oketa different ples where yu save catchem or payim rip fis for salem.*

1) *(Where na bai yu save catchem or payim rip fis?)*

PR.	Ward	Place / Village *Ples/Vilij*	How many years have you been catching / buying reef fish here? *How many years na lus finis for tekem fish or payim fish for salem?*	How many kilograms of reef fish do you catch or buy on a good/ average /bad trip? *Hamasfala Kg na yu save catchem or payem lo wanfala trip boat runwhere hemi gud / no gud tumas/ bad trip?*	How often do you catch / buy reef fish here (days per fortnight) *How many times na bai yu tekem or payim fish insait lo wanfala hemi gud / no gud tumas/ bad pela fortnight?*	What transport do you normally use to catch or buy reef fish here? *What kine transport na u save usim for fishing or for payim fish lo hia?*	Who catches the reef fish that you sell? *Who na save catchem/tekem oketa reef fish blo yu for salem?*	If you do not catch the fish, what price do you pay for the reef fish / kg *Sapos yu no save catchem fish, hamas na u save payim for fish per kilo?*	Why do you catch / buy fish here? *Why na u save catchem/tekem/payim fish lo hia?*

Reef fish Sale

Where do you sell reef fish?

Mi laik askem yufala aboutem oketa different market or perhaps hem tourist resort or hotel where yu save salem oketa rip fis

PR.	Ward	Place *Ples?*	How many years have you been selling fish here? *Hamas years na yu save salem fish?*	How many kilograms of reef fish do you sell on good/average/bad trip? *Hamasfala Kg na yu save salem lo wanfala trip where hemi gud/no gud tumas/bad trip?*	How often do you sell reef fish here on a good/average/ bad month) *How many times na yu save salem reef fish lo hia lo wanfala gud/no gud tumas /bad pela fotnight?*	What transport do you normally use to get your reef fish to this market? *What kine transport na yu needim for bringim kam reef fish blo iu lo disfala market?*	What price do you get per kg for fresh reef fish? *Hamas na yu save chargim lo sapos hem no competition?*	What price do you get per kg for fresh reef fish? *Hamas na yu save chargim lo sapos hem stacka competition*	How much profit do you make on an average trip? *Hamas na iu takem profit from one pala trip lo disfala maket?*	Why do you sell fish here? *Why na yu salem fish lo hia/disfala ples/market?*