Fisheries Training Programme

unuftp.is Final Project 2009

REEF FISH ASSESSMENT IN FIJI'S "I QOLIQOLI"

Nanise Kuridrani Tuqiri
Department of Fisheries
Ministry of Primary Industries
Fiji Islands
nanik@fisheries.gov.fj

Supervisors:

Hreiðar Þór Valtýsson
hreidar@unak.is
Hlynur Ármannsson
hlynur@unak.is
University of Akureyki

ABSTRACT

The main objective of the study was to provide an overview of finfish stocks in fishing grounds (*I Qoliqoli*) around Fiji. Under water census was conducted in 16 fishing grounds in different areas of the Fiji Group. Two fishing grounds from each area were surveyed. The abundance and biomass of finfishes in a fishing ground was estimated. The fishing grounds in outer islands have a higher biomass than the main islands (Viti Levu) of the Fiji Group. Abundance and biomass of finfishes among habitats within a fishing ground was also determined. Abundance was higher in the lagoon but somewhat similar in the reef area, reef slope, back reef and fore reef. However, fore reef had higher biomass. There was a slight variation in the size distribution among depths and habitats. Due to the lack of catch data for each fishing ground surveyed it was not possible to determine the status of exploitation of the stock. However, this study implies that highly commercial fishes are rare in areas with higher human population. If more information on catches will be gathered, the data sampled here will improve the data analysis and sampling scheme of the department as well as enhance the gathering of catch data/CPUE during the visual transect surveys in fishing communities.

This paper should be cited as:
Tuquiri, N. K. 2010. *Reef fish assessment in Fiji's I Qoliquli.* United Nations University Fisheries Training Programme, Iceland [final project].
http://www.unuftp.is/static/fellows/document/nanise09prf.pdf

TABLE OF CONTENTS

LIST OF FIGURES **3**
LIST OF TABLES **5**
1. INTRODUCTION **6**
1.1. Location 6
1.2. Fisheries in Fiji 6
1.3. Inshore Fisheries – importance, status and management 7
1.3.1. Reef finfish in Fiji – importance and status 8
1.4. On-going Data Collection 9
1.5. Purpose of the Study 10
2. METHODOLOGY **10**
2.1 Underwater Visual Census 10
2.2 Sampling Design 11
2.3 Site Description 12
2.3.1. East Fiji (Lau) 12
2.3.2. Central Fiji (Ovalau and Motoriki) 12
2.3.3. North Fiji (Natewa and Tunuloa District) 13
2.3.4. South Fiji (Kadavu) 13
2.3.5. Viti Levu 14
2.4 Data Analysis 15
3 RESULTS **16**
3.1 Fish Abundance and Species Assemblages 16
3.1.1 Density and Biomass of Finfishes per I Qoliqoli 16
3.1.2 Abundance and Biomass per Habitat 17
3.1.3 Abundance and Biomass of 5 Important Food Fish by Habitat 27
3.2 Size Distribution by *I Qoliqoli*/Area Habitat and Depth 28
3.3 Trophic Network of Fish Community 33
4 DISCUSSION **34**
4.1 Catch information 36
5 CONCLUSION **36**
ACKNOWLEDGEMENTS **37**
LIST OF REREFENCES **38**
APPENDIX **41**

LIST OF FIGURES

Figure 1: Map of Fiji Islands - with approximately 6,437 km^2 of reef. (National Geographic Magazine, 2004). 6
Figure 2: During visual counts in deep area/slope (left) and in shallow area (right). (MRIS Project, DOF, 2006) 11
Figure 3: Location of the study sites (marked in blue). (Reef Base Online GIS). 15
Figure 4: Fish abundance by habitat in all *I Qoliqoli* 18
Figure 5: Fish biomass by habitats in all *I Qoliqoli* 18
Figure 6: Fish Abundance (No/500m^2) by habitat in Nayau Island and Oneata Island, East Fiji. 19
Figure 7: Fish Abundance (No/500m^2) by habitat in Namuana and Naikorokoro, Kadavu Island, South Fiji. 19
Figure 8: Fish Abundance (No/500m^2) by habitat in Tikina Levuka (left) and Tikina Nasinu (right), Ovalau Island, Central Fiji 19
Figure 9: Fish Abundance (No/500m^2) by habitat in Karoko (left) and Vusasivo (right), Vanua Levu, North Fiji 20
Figure 10: Fish Abundance (No/500m^2) by habitat in Wananavu (top left), Rakiraki (top right), Ba (bottom left) and Tavua (bottom right), Viti Levu. 20
Figure 11: Fish Abundance (No/500m^2) by habitat in Lami (top left), Mau (top right), Galoa (bottom left) and Namaqumaqua (bottom right), Viti Levu 21
Figure 12: Fish Biomass (W (kg)/500m^2) in Oneata Island (left) and Nayau Island (right), Lau group, East Fiji 21
Figure 13: Fish Biomass (W (kg)/500m^2) in Namuana (left) and Naikorokoro Druwe (right) 22
Figure 14: Fish biomass (W (kg)/500m^2) in Tikina Levuka (left) and Tikina Nasinu (right), Ovalau Island, Central Fiji 22
Figure 15: Fish biomass (W (kg)/500m^2) by habitat in Karoko (left) and Vusasivo (right) in Cakaudrove, Vanua Levu, North Fiji 22
Figure 16: Fish biomass (W (kg)/500m^2) by habitat in Rakiraki (top left), Wananavu (top right), Ba (bottom left) and Tavua (bottom right), Viti Levu. 23
Figure 17: Fish biomass (W (kg)/500m2) in Galoa (top left), Namaqumaqua (top right), Lami (bottom left) and Mau (bottom right), Viti Levu. 23
Figure 18: Fish abundance (No/transect) and biomass (kg/transect) in lagoon area. 24
Figure 19: Fish abundance (No/transect) and biomass (kg/transect) in reef area. 24
Figure 20: Fish abundance (No/transect) and biomass (kg/transect) in back reef. 25
Figure 21: Fish abundance (No/transect) and biomass (kg/transect) in reef slope 25
Figure 22: Fish abundance (No/transect) and biomass (kg/transect) in reef channel. 26
Figure 23: Fish abundance (No/transect) and biomass (kg/transect) in fore reef. 26
Figure 24: Fish abundance (No/transect) and biomass (kg/transect) in outer reef. 27
Figure 25: Size distribution of fishe by habitat 29
Figure 26: Length distribution by depth. 29
Figure 27: Length distribution in Oneata and Nayau Island, East Fiji. The blue bar are not fully represented (the idea is that probably some fishes were not observed). Orange bar is fully represented or observed. 30
Figure 28: Length distribution in Tikina Levuka and Tikina Nasinu. The *I Qoliqoli* is located adjacently to each other. The blue bar are not fully represented (the idea is that probably some fishes were not observed). Orange bar is fully represented or observed. 30

Figure 29: Length distribution in Naikorokoro and Namuana, South Fiji. The *I Qoliqoli* is located adjacently to each other. The blue bar are not fully represented (the idea is that probably some fishes were not observed). Orange bar is fully represented or observed....... 31
Figure 30: Length distribution in Vusasivo and Karoko, North Fiji. The *I Qoliqoli* is located along the same coastline in Natewa district. The blue bar are not fully represented (the idea is that probably some fishes were not observed). Orange bar is fully represented or observed. 31
Figure 31: Length distribution in Wananavu and Rakiraki, North Viti Levu. The *I Qoliqoli* are located adjacently. The blue bar are not fully represented (the idea is that probably some fishes were not observed). Orange bar is fully represented or observed. 32
Figure 32: Length distribution in Galoa and Namaqumaqua, South Viti Levu. The *I Qoliqoli* is located on the same coastline. The blue bar are not fully represented (the idea is that probably some fishes were not observed). Orange bar is fully represented or observed....... 32
Figure 33: Length distribution in Ba and Tavua, West Viti Levu. The *I Qoliqoli* is located adjacently. The blue bar are not fully represented (the idea is that probably some fishes were not observed). Orange bar is fully represented or observed. 33
Figure 34: Length distribution in Lami and Mau, East Viti Levu. The *I Qoliqoli* is located on the same coastline. The blue bar are not fully represented (the idea is that probably some fishes were not observed). Orange bar is fully represented or observed. 33
Figure 35: Trophic network of fish community in Nayau Island and Oneata Island (Lau Group), East Fiji........ 45
Figure 36: Trophic network of fish community in Tikina Levuka and Tikina Nasinu, Ovalau, Central Fiji........ 45
Figure 37: Trophic network of fish community in Naikorokoro and Namuana, Kadavu Island, South Fiji........ 46
Figure 38: Trophic network of fish community in Karoko (Tunuloa) and Vusasivo (Natewa), North Fiji........ 46
Figure 39: Trophic network of fish community in Rakiraki and Wananavu, Ra, North Viti Levu 47
Figure 40: Trophic network of fish comunity in Galoa and Namaqumaqua, Serua, South Viti Levu 47
Figure 41: Trophic network of fish community in Ba and Tavua, Ba Province, West Viti Levu 48
Figure 42: Trophic network of fish community in Lami and Mau, East Viti Levu............... 48

LIST OF TABLES

Table 1: The *I Qoliqoli* surveyed, and number of transects. Geographical location within the Fiji Groups is shown in Figure 3. The areas are ordered according to the different fishing intensity (low to high intensity). 11
Table 2: Mean abundance and biomass estimates for each *I Qoliqoli* (per 500 m^2), in outer islands fishing grounds (*I Qoliqoli*). 17
Table 3: Mean abundance and biomass estimates for each *I Qoliqoli* (per 500 m^2) in main island, Viti Levu........ 17
Table 4: Abundance (No/transect) of 5 important food fish by habitat. 27
Table 5: Biomass (kg/transect) of 5 important food fish by habitat. 28
Table 6: Dominant trophic network in each fish grounds. The graph is on Figure 35 – Figure 42 in appendix 3a which shows the biomass. 34
Table 7: Total fish count and number of species per Family. 41
Table8: Abundance and Biomass per 500m^2 with standard error (SE) of the most important food fish families per I Qoliqoli. The list of families is arranged according to the high commercial to the least. However, Shark (Carcharhinidae) is placed on the list, because of the high commercial values of shark fins. 42
Table 9: Abundance and biomass per 500m^2 with standard error (SE) of the most important food fish families in the main island Viti Levu. The list of the species is arranged according to the high commercial to the least. However, Shark (Carcharchinidae) is placed on the list, because of its high value in shark fin trade. 43
Table 10: Fish species assigned into trophic groups (Jennings et al., 1995 and Fish Base (www.fishbase.org)) 49

1. INTRODUCTION

1.1. Location

Fiji is located at the heart of the Pacific Ocean, midway between the Equator and the South Pole and lies on longitudes 175^{o}E and latitudes 18^{o}S (Figure 1). Fiji comprises about 330 islands and islets, of which approximately 100 are inhabited. The total land area is approximately 18,300km^2. The two main islands are Viti Levu and Vanua Levu. Fiji's Exclusive Economic Zone (EEZ) has as area of 1.3 million km^2. The population in September 2007 wass approximately 837,270, of which 57% are indigenous Fijian and most of them live on the coast (Fiji Bureau of Statistics 2009).

Figure 1: Map of Fiji Islands - with approximately 6,437 km^2 of reef (National Geographic Magazine 2004).

1.2. Fisheries in Fiji

For centuries, Fiji has relied on the sea and its bountiful resources as a source of food and economic development. In addition, fisheries resources are of cultural significance to the Fijian people (Veitayaki 1995).

The fisheries sector is currently the third largest natural resource sector in Fiji, contributing F$92 million to GDP or 2.5% of total GDP (Teh *et al.* 2009). The country's fisheries can be placed into six categories which are: coastal commercial (artisanal fishery), coastal subsistence, offshore locally based, offshore foreign based, freshwater and aquaculture (FAO 2009). Offshore fisheries are tuna long lining oriented while coastal or inshore fisheries are for subsistence purposes and artisanal, for sale in local markets and for export (finfish, beachdemer, trochus for buttons, aquarium fish and live rock).

1.3. Inshore Fisheries – importance, status and management

The inshore areas are the main domain of subsistence and artisanal fishers (small scale fisheries) (Teh *et al.* 2009). Over 100 species of finfish and 50 species of invertebrates from inshore areas are included in Fiji's fish market statistics (FAO 2009). Artisanal and subsistence fisheries make up 60 – 80% of the nation's catches (Teh *et al.* 2009), emphasizing the importance of inshore fisheries to food security and the economy. Also Starkhouse (2009) estimated that the artisanal and subsistence fisheries, together, deliver an annual catch of over 17,000 tonnes of reef-associated finfish, invertebrates and marine plants, which have a gross value of approximately US$ 54 million per year. However, the true volume of subsistence catches is uncertain (Teh *et al.* 2009) because landing occurs at every coastal village throughout the country, roughly in proportion to the distribution of the population (FAO 2009), with inadequate financial resources (funds to employ data collectors) to collect subsistence landing data.

About 50 % of all rural households are involved in subsistence fisheries. Starkhouse (2009) estimated that there are more than 28,000 fishers (with and without a fishing license) that rely on Fiji's coral reefs for food and/or income. The per capita consumption of seafood is 44 kg per year, higher than the world average (Asian Developmental Bank 2005). However, it varies between different areas of Fiji.

The common fishing methods used by both artisanal and subsistence fishers are hand line, gleaning (for invertebrates), use of spear/spear gun to dive at night as well as daytime and gillnets. Other methods of fishing include crab trap, push nets, cast nets, line trawling (*vakasavuba*), long spears (*cocoka*), jigging, and fish traps. Derris root (duva) is illegal under the fisheries act; however some rural fishers occasionally use it. Nowadays, it is common among artisanal fishermen to dive with a spear gun at night, whereby the catch is greater and larger fish are caught compared to other methods used.

Artisanal fishers more often use boats than subsistence fishers. To fish within the inshore area, fishers used bamboo raft, wooden boats (14 ft) without engine. Fibreglass boats (mostly 23 ft with 40-60 hp) are used by artisanal fishers to travel to long distance fishing ground as well as quickly transporting the catch to major outlets. For the last few years, the department has been assisting artisanal fishermen, providing 23 ft fibreglass boats and fishing gears for tuna fishing around Fishing Aggregating Devices (FAD) under the small scale subsidy scheme (2/3 paid by a fisherman and 1/3 by the government). The intention is to promote offshore fishing relieving pressure on inshore fisheries.

The main fisheries resource use practice in Fiji is the ownership of fishing rights to the customary fishing areas extending to the outer reef slope (Veitayaki 1999). Like the land (Veitayaki 1999), the laws of Fiji recognise the customary rights to fish in traditional fishing grounds (*I Qoliqoli*) and allow the owners of customary rights to dictate the issue of fishing licenses within delineated customary areas by the Fisheries Division (Hunt 1999). Consequently, there are 410 traditional demarcated fishing grounds (*I Qoliqoli*) (Batibasaga 2006) of which people are expected to use their own allocations, and those seeking to use grounds belonging to others are expected to get permission from the owners (Veitayaki 1999).

Artisanal fishers who wish to fish in specific *I Qoliqoli* must obtain fishing licenses from the Fisheries Department, which are renewed every year. However, the village chiefs' consent is required first before the Fisheries Department issues the license. As of September 2009, the average licensed fishermen recorded by the Fisheries Department are about 5000.

Fiji's inshore fisheries are dynamic with significant changes in resources use each year (Asian Developemental Bank, 2005). Commercial exploitation due to economic demands to which people are subjected and their increased capacity and productivity levels has given most communities the capability to deplete coastal resources rapidly (Veitayaki 1995). As a result, around 70 *I Qoliqoli* are considered to be over exploited, while 250 are considered fully developed (Teh *et al.* 2009). Burke *et al.* (2004) stated that overfishing could be a major pressure on coral reef systems reducing levels of biodiversity and typically resulting in shifts in fish size, abundance, and species composition, altering the ecological balance on the reef. Other major causes of degradation to the coral reef area in Fiji are agricultural activities, beach and sand mining in some areas, building of jetties and groynes (concrete structure that run perpendicular to the shoreline to create beaches), sewage pollution, inappropriate solid waste disposal, soil erosion and siltation, improper disposal of industrial waste in urban areas and natural hazards such as climate change, sea level rise and hurricanes (Aldersberg 2004).

Numerous non-governmental organisations such as World Wild Fund for Nature (WWF), Conservation International (CI), Wildlife Conservation Society (WCS), and Coral Reef InitiativeS for Pacific (CRISP) with the two local institutions, University of the South Pacific (USP) and Fiji Institute of Technology (FIT) are engaged in conservation and inshore sustainable management activities in some areas of Fiji. Department of Fisheries (DOF) is acting as a secretariat of these conservation activities under the Fiji Locally Managed Marine Area (FLMMA) network.

1.3.1. Reef finfish in Fiji – importance and status

Fish is an important constituent in the diets in Fiji, as is common throughout the Pacific Islands (Veitayaki, 1995). It is highly desirable part of the diets because of its taste and cultural significance. Fish contribute for almost 25% of the overall protein supply eaten by locals.

The commonly targeted food fish are Lethrinidaes (Emperors), Lutjanidae (Snappers), Serranidae (Groupers), Carangidae (Trevallys), Haemulidae (Harlequin sweetlips), Mugilidae (Mullets), Scombridae (Tunas), Acanthuridae (Surgeonfishes), Scaridae (Parrotfishes), Labridae (Wrasses), Siganidae (Rabbitfishes) and Sphyraenidae (Barracudas). Due to the high fish price in the local market, the fishers are driven to sell the big fish and consume the smaller ones.

There has been a declining catch yield of fish over the years. Fish species that occur in schools such as *Siganus spinus, Valamugil seheli, Rastrelliger kanagurta,* that used to be in abundance in catch yield 20 – 30 years back are very scarce nowadays (own observation, unpublished data). *Epinephelus polyphekadion* and *Epinephelus fuscogattatus* that aggregate annually to spawn is declining in numbers. The growing local demand for fish because of population increase, diet preference and political instabilities has led to the decline (Raj 2009). The artisanal catch landing of finfish for 2007 was approximately 4,418 MT and has decreased from approximately 6,240 MT in 2004.

Live Reef Fish Food Trade (LRFFT) that commenced in 1999 could also contributed to the decline of some of the targeted fish stock in the northern part (Bua province) of Fiji. The most targeted species includes Serranidaes (coral trout, grouper and rock cod), and the Humphead wrasse (*Cheilinus undulatus*) (Yeeting, 2001) with the estimated LRFFT stock in 2001 in the Bua area (northern Fiji) to be 3,750 tonnes.

Several studies have outlined the status of reef finfishes in inshore areas of Fiji. Jennings *et al.* (1995) suggested that Fijian reefs and their associated shallow water had the capacity to sustain total yields of reef associated fish of at least 3.4 tonne km^{-2} qoliqoli $year^{-1}$ or 10.2 tonne km^{-2} reef $year^{-1}$. Kuster *et al.* (2005) estimated that over the 20 year period, the reef of Ono I Lau (East Fiji) have sustained a yield of between of 2.9 and 3.7 tonnes km^{-2} $year^{-1}$ of reef-associated fish. Joined research between DOF and Society for the Conservation of Reef Fish Aggregation (SCRFA) revealed the scarcity of some of the large reef fish species such as the big Groupers (*Epinephelus polyphekadion, Epinephelus fuscogattatus, E. lanceolatus), Cheilinus undulatus (*Wrasse*),* and *Bolbometapon muricatum* (Parrotfish). Jennings *et al.* (2005) reported the declining in abundance of larger fishes in ten fishing grounds in Kadavu (south of Fiji). Dulvy and Polunin (2004a) also reported the status of *B. muricatum*, which is locally extinct in some islands. While Sadovy *et al.* (2006) highlighted the disappearance and close to extinction of some of the main reef fish spawning aggregation sites in Fiji.

The disappearance of the large reef fish species could possibly have an impact on the marine ecosystems. Fishing may lead to changes in the size, abundance and biomass (Jennings *et al.* 1995) thus; Jennings *et al.* (1996) suggested that the annual removal of 5% of fish biomass might cause structural changes in reef fish communities. The targeted species are mostly the top predators or the invertebrate feeders and piscivorous feeders. Studied conducted by Wilson *et al.* (2010) on coral reef fish communities in Fiji suggested that overfishing and habitat degradation through climate change posed as the biggest threats to sustainability of marine resources.

1.4. On-going Data Collection

The Fiji Fisheries Department is the main government body that is responsible for the management, conservation and sustainability of marine resources in Fiji. Consequently, the department set up two projects to gather independent fisheries data and dependent fisheries data within the inshore area or *I Qoliqoli*. The Statistics Section within the Management Services Section is responsible for gathering dependent fisheries data by collecting catch data from the artisanal fishers. The data are gathered from major fish markets around the country; whilst, Marine Resource Inventory Survey Project (MRIS Project) within the Research Section is responsible on collecting independent fisheries data, by undertaking underwater visual census with divers recording fish and invertebrates sighted along 50 m transect lines.

The objective of the MRIS Project is to undertake fisheries resource inventory of all the *I Qoliqoli* in Fiji (i.e. a total of 410 delineated traditional marine area boundaries, which include the major rivers and streams). The project is to gather baseline biological, ecological and socio-economic information and data sets on fisheries resources that would allow the department to understand the health, productivity and biodiversity that exist within each traditional fishing boundary. It would help in the formulation of appropriate management plan for each *I Qoliqoli.* In addition to that, the information will also allow the department to promote:

- Better living standards and alternative livelihoods for local communities
- Maintenance of food security

- Appropriate conservation actions and strategies that need to be incorporated as a precautionary strategy, and using adaptive management approaches (to species, ecosystem-based and socio-economic level).
- Community based inshore resource conservation, planning and management and their social and technical empowerments (co-management arrangement, utilizing a bottom-up approach).

The MRIS Project employed two methods of collecting data that are socio-economic survey (prepared questionnaires for household interview) and biological survey (underwater visual census).

1.5. Purpose of the Study

This study is undertaken in the spirit of the FAO Code of Conduct for Responsible Fisheries that states that conservation and management decisions for fisheries should be based on the best scientific evidence available. This project provides an overview of the status of finfishes in 16 *I Qoliqoli* in Fiji. The study is to estimate the total yield of reef-associated fish in each *I Qoliqoli* surveyed by underwater visual census. The aims and objectives of this project were to:

1. Estimate population abundance, species assemblages' and composition.
2. Estimate the mean sizes and the size distribution within an *I Qoliqoli* (fishing grounds).
3. Estimate the existing stock of the most important food fish family in an *I Qoliqoli.*
4. Determine the Trophic Network of fish community in Fiji.

2. METHODOLOGY

Most research or sampling conducted in coral reef areas use underwater visual census (Brock 1982). Visual census is the best non-destructive method of population assessment in coral reef area, inexpensive and gives a rapid assessment of the area in limited time available. UVC provides a rapid estimation of relative abundance, biomass and length frequency distributions of reef fish. It involves the counting and estimation of fish sizes observed underwater by divers on a given transect (Yeeting 2001). It is based on onsite visual counts.

2.1 Underwater Visual Census

UVC is conducted along random paths (chosen by chance) along a 50 m x 5 m transect. A 50 m tape was placed on the substrate (sand, rubble or coral reef) to establish transect for each census carried out. Two divers were on the other side of the transect line, recording fish at 10 m interval (Figure 2). Therefore, the counting is done at every 10 m and a 5 m width from the transect line. Fish count, species identification and length (size) estimation were taken. Counting starts after 2 minutes in the water after the fishes are familiar with the presence of the divers. UVC method was also applied to surveying of invertebrates. Data were then recorded on a prepared data sheets.

Visual counts with scuba gears are used in deep part of the fishing ground (reef slope and channel) while snorkelling is conducted in shallow areas (lagoon and reef area).

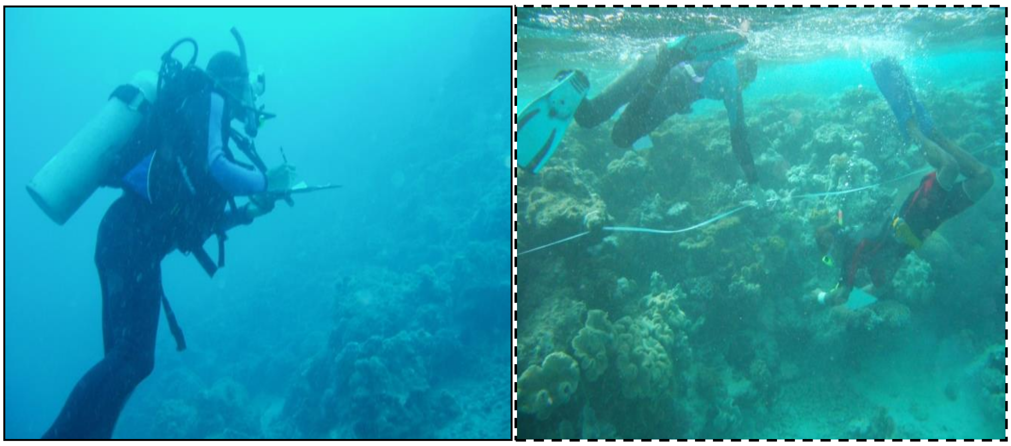

Figure 2: During visual counts in deep area/slope (left) and in shallow area (right) (DOF 2006).

2.2 Sampling Design

The objective of DOF is to survey 10–12 *I Qoliqoli* per year. The *I Qoliqoli* survey is randomly chosen by the department or sometimes upon request by the communities. The number of stations depends on the area of the *I Qoliqoli*, therefore each *I Qoliqoli* have different number of stations.

In this study, 16 *I Qoliqoli* from different areas of the Fiji group are analysed. The surveys were conducted from 2006–2008. Tabulated below are the survey areas with the number of stations (Table 1).

The number of transects are the same as the number of stations per fishing ground (1 transect/station). Each station represent different habitat within a fishing ground. All the fish that the divers come across are recorded (species name and estimated length).

Table 1: The *I Qoliqoli* surveyed, and number of transects. Geographical location within the Fiji Groups is shown in Figure 3. The areas are ordered according to the different fishing intensity (low to high intensity).

Areas	I Qoliqoli	Number of Transect
East Fiji [Lau Group]	Oneata Island	4
	Nayau	13
South Fiji [Kadavu]	Namuana	8
	Naikorokoro_Druwe	16
Central Fiji	Tikina Nasinu	10
	Tikina Levuka	5
North Fiji [Vanua Levu]	Karoko	3
	Vusasivo	4
Viti Levu		
Northern Viti Levu	Wananavu	5
	Rakiraki	4
Western Viti Levu	Tavua	30
	Ba	15
Southern Viti Levu	Galoa	12
	Namaqumaqua	8
Eastern Viti Levu	Mau	7
	Lami	5

2.3 Site Description

2.3.1. East Fiji (Lau)

Lau Islands are located on the far eastern part of the Fiji Group. Access to the island is by commercial or government vessels, which visit all islands once a month, depending on the availability of the vessel, or else by small airplanes once a week. The survey was conducted in Nayau Island and Oneata Island. The population of Nayau Island is approximately 500 people while Oneata is approximately 200 people.

Copra is the main source of income. Also the islanders are one of the best mat weavers and *masi* (traditional cloth use in traditional ceremony such as weddings, births etc.) makers selling their products in Suva (capital of Fiji). It is a lucrative business in Fiji. Few islands are involved in seaweed farming with the assistance of the Fiji Fisheries Department. The dried seaweeds are exported to Japan to be used as cosmetics and the pharmaceutical product. Still, subsistence farming and fishing is an important way of life in the island. If cash is needed then extra fish from the subsistence catch is sold to government officials who work in the islands.

Live Reef Fish Food Trade was conducted in Oneata Island, Lakeba Island and Bukatatanoa Reef in 2002 to 2003.

2.3.2. Central Fiji (Ovalau and Motoriki)

Lomaiviti Province is on central Fiji. The survey was conducted in the island of Ovalau, which lies off the eastern coast of Viti Levu, Fiji's main island. The population on Ovalau Island is approximately 3,000 people (Fiji Bureau of Statistics, 2009). The survey was undertaken in the *I Qoliqoli* of Tikina Levuka (11 villagers) and Tikina Nasinu (7 villagers). The fishing ground is located adjacently to each other.

Fiji's old capital, Levuka is on Ovalau. Whalers and missionaries founded Levuka in the 1830s. By the mid 19th century it was one of the main ports of call for trading ships and whalers throughout the South Pacific (UNESCO Report, 2000).

Tuna Cannery Company, Pacific Fishing Company (PAFCO) situated in Levuka provides employment to some of the islanders. Some in both islands practices small-scale artisanal fisheries and farming. The men planted *yaqona* (dried roots used for traditional drink in traditional ceremony but now as a social drink in every households), which is a lucrative business in Fiji. Fish caught is either sold in the village or taken to Suva and Levuka. However, subsistence fishing and farming is still an important way of life.

2.3.3. North Fiji (Natewa and Tunuloa District)

Vanua Levu (Fiji's second largest island) is on the northern part of Fiji, with a population of approximately 136,000 people (Fiji Bureau of Statistics, 2009). There are three provinces on this island. Great Sea Reef, third longest barrier reef in the world is located on the north coast (Figure 1). Some parts of the reef are being protected as a no take zone (no fishing and harvesting) by the local communities.

The survey was conducted in the *I Qoliqoli* of Vusasivo (2 villagers) and Karoko (1 village) with the population of approximately 600 and 300 people respectively, both in the province of Cakaudrove.

The main source of income is artisanal farming and fishing. Fish is mostly sold to middlemen who sell them in major fish markets in the North, Labasa and Savusavu Town. Gold Hold Seafood Company based in Labasa is the major buyer of seafood (fish and beachdemers) in the North. The beachdemers are exported while the fish are sold in Suva.
Live Reef Fish Food Trade (LRFFT) was also conducted in Bua province, but not in the *I Qoliqoli* surveyed. It occurred in Galoa and Tavea Island area between 1998 till 2004, but now only Tavea Island is involved (2008 until now).

2.3.4. South Fiji (Kadavu)

Kadavu is located in the southern part of Fiji with a population of approximately 10,000 people (Fiji Bureau of Statistics, 2009). The *I Qoliqoli* surveyed is located adjacently to each other on the leeward side of the island. The main sources of income are *yaqona* farming and artisanal fishing. Villagers rely on the sea when the *yaqona* plant is not ready to be uprooted and sold. *Yaqona* takes about 3–4 years to mature. Fish are either sold in Vunisea government station, middlemen in some of the villagers or else transported to Suva via the commercial vessel.

The island is just off the southern coast of Viti Levu and access to the island is by commercial vessel that goes once a week and by small planes that fly daily. Poachers from Suva, which may practise illegal fishing such as diving using scuba or some destructive methods, target the fishing ground heavily. Each village have fish wardens that police the fishing ground. However, it is not so successful since poachers come at night in high powered boats. The first marine reserve established and gazetted in Fiji is located in Waisomo *I Qoliqoli* on the Great Astrolabe Reef (Figure 1). Reef fish spawning survey in Kadavu, by DOF and SCARFA in 2008, identified five spawning aggregation sites for *Epinephelus polyphekadion*, *E. fuscogattatus* and *Plectropomus areolatus*.

2.3.5. Viti Levu

North-western coast

The *I Qoliqoli* surveyed are under the jurisdictions of the *Vanua Ba* and *Tilivabukuya* and *Tavua*. Both are located on the northwestern coast of Viti Levu (Figure 3). In the last census report (1996-2007) the overall population of Ba and Tavua are 18,526 and 2,388 respectively with the population of Indo Fijians decreasing significantly (Fiji Bureau of Statistics, 2009). The areas are dominated by sugarcane farms, which provide employment to the local during the harvesting season. Vatukoula Goldmine also employed the people of Tavua for over the years (1934 – 2006), which increased dynamite fishing in these areas. Mine workers smuggled out dynamites and sold to fishermen, which became a norm and a fast way to earn easy cash. It's not only killed more fish at one time and its habitat but also more and more people were seriously injured as a result of dynamite fishing. Consequently, the Chief of the vanua Tavua established an *I Qoliqoli* committee in 2003 to fight against dynamite fishing in the area. The Chief supported and funded the policing of dynamite fishing in his fishing ground. However, illegal fishing is still common in the *I Qoliqoli* of *Ba* and *Tilivabukuya*. Fishers used crowbars to break corals and rubbles to fetch for holothurians species and sell to Chinese buyers. There is still an occasionally use of dynamite to catch fish. Small-scale commercial fisheries dominate in this area. Fishermen often travel as far as the Yasawa Group, and Bua Province in Vanua Levu to have a good catch. There is no community based management policies that governs the fishing ground, maybe because of the clash of ownership, which results in poor governance of the fishing ground.

South Coast of Viti Levu – Serua Province.

In this area, the population has increased from approximately 15,000 in 1997 to approximately 18,000 in 2007 (Fiji Bureau of Statistics 2009). The main sources of income in this area are tourists, fishing and logging. Coastal development for tourist resorts is common. The Pacific Harbour Tourism Complex is located in the province. Also the forest area is common with the much-debated mahogany trees. Majority of the fishers are both subsistence and artisanal. The catches are mostly sold on the roadside or else taken to Sigatoka or Navua town. Aquarium fisheries are conducted between Culanuku and Wainiyabia fishing area and also recreational fisheries such as sport fishing, scuba, fish feeding and shark dive and feeding. They are all based in the Pacific Harbour Tourism Complex.

South East Coast of Viti Levu

The areas are near the capital city of Fiji, Suva. Suva, being the largest urban centre in the South Pacific, has an increase in industrial and urban growth. The total population of Suva and its peri-urban area (surrounding area) is approximately 74,000 and 11,000 respectively (Fiji Bureau of Statistics 2009). The waste effluent from the city and industry enters the sea indirectly/directly and are then carried by currents to the neighbouring fishing areas. The fishing grounds also accommodate people residing in Suva. Low-income earner in the town area uses the fishing ground for extra source of protein.

North Coast of Viti Levu (Rakiraki District)

The area is more laid back compared to other areas of Viti Levu. The artesian water company (Fiji Water) located within the vicinity of Rakiraki provides employment to some of the locals. A few small tourist resorts are found along this coastline. The population is around 30,000 but continued to decrease at a faster rate (Fiji Bureau of Statistics 2009). Majority of the people living in this area are subsistence fishers and small-scale commercial farmers.

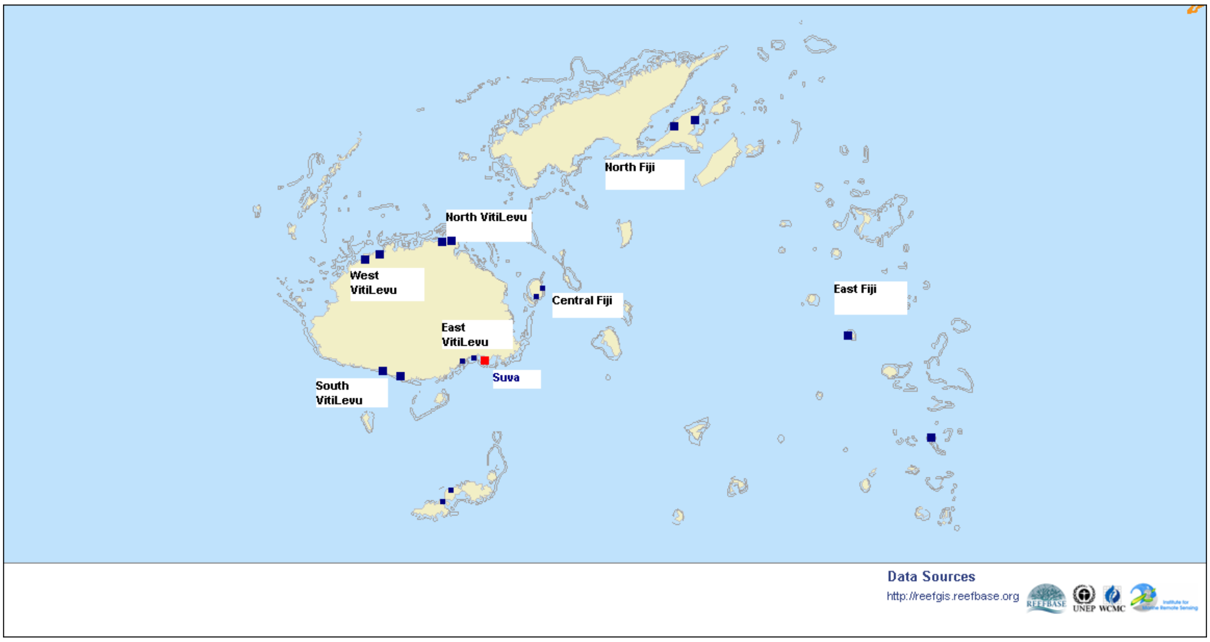

Figure 3: Location of the study sites (marked in blue) (Reef Base Online GIS).

2.4 Data Analysis

The data were analysed in Pasgear 2 software (version September 2008) (Kolding 2008), which is a customised database package primarily, intended for experimental or artisanal fishery, downloaded from www.imr.no/forskning/bistandsarbeid/data/pasgear_2/en. The software is useful for testing fishing data such as under water visual census (UVC) described by Labrosse *et al*. (2002). Before importing into the Pasgear, the species were given species identification codes. The species identification codes with coefficient a and b were provided by Dr. Jeppe Kolding of the University of Bergen. Species that were not in the list were given the identification code and the coefficient a and b were borrowed from the Fish Base website.

The software automatically estimates weights from length – weight relationships. Abundance is estimated from the observed number of species per transect ($500m^2$).

$$\boldsymbol{D = \frac{\sum_{i=1}^{p} ni}{Ld}}$$

where;
ni - number of fish seen
L – length of transect (50 m)
d – Width from the transect (5 m)

Biomass is calculated from the observed weight that is the number of fish multiplies by the weight from the length – weight relationship.

$$\mathbf{B = DW}$$

where:
D - the density of fish per $500m^2$ by the number of stations per fishing grounds
W – weight from the length – weight relationship.

Size distributions were determined on the length frequencies curve. The trophic network group is calculated in biomass and then imported to excel for the identification of species with the different trophic group.

The list of the important food fish species is obtained from the 'Food Fishes of Fiji' chart of the Fiji Fisheries Department. These are Groupers (*Plectropomus spp, Epinepheus spp, Cephalopholis spp*), Parrotfishes (*Chlorurus spp, Scarus spp*), Emperors (*Lethrinus spp, Gnathodentex spp*), Snappers (*Lutjanus spp*), Goatfishes (*Parupeneus spp*), Rabbitfishes (*Siganus spp*), Surgeonfishes (*Acanthurus spp, Ctenocahetus spp*), Barracudas, *Mugilidae spp, Hemiramphidae spp*, Tunas and Sweetlips (*Plectorhinchus spp*).

3 RESULTS

3.1 Fish Abundance and Species Assemblages

A total of 544 fish species belonging to 55 families were recorded. The most diversified families are Pomacentridae (107 species), Labridae (63 species), Chaetodontidae (39 species), Acanthuridae (36 species) and Scaridae (35 species).

Damselfishes (Pomacentridae) and Surgeonfishes (Acanthuridae) had the highest fish counts, which were 9,827 and 4,204 respectively. Wrasses (Labridae) had high species diversity (66 species) but low fish count (1,402) as compared to Fusiliers (Caesionidae) that had low species diversity (12 species) and high fish counts (3,832). In addition, low numbers (1,412) of Butterflyfishes were observed but with high species diversity. The fish count and diversity (number of species) per family are shown in Table 7 in appendix 1.

3.1.1 Density and Biomass of Finfishes per I Qoliqoli

Abundance and biomass of finfishes per 500 m^2 in each fishing grounds (*I Qoliqoli*) varies (Table 2 and 3). Of all the fishing grounds surveyed, Lami in East Viti Levu had the highest fish abundance (504/500 m^2) and biomass (135.1 kg/500 m^2) followed by Nayau (Lau Group) in East Fiji. Of all areas, Namaqumaqua (South Viti Levu) had the lowest fish abundance (43.3/500 m^2) and fish biomass (7.0 kg/500 m^2).

Table 2: Mean abundance and biomass estimates for each *I Qoliqoli* (per 500 m^2), in outer islands fishing grounds (*I Qoliqoli*).

	East Fiji		**South Fiji**		**Central Fiji**		**North Fiji**	
	Nayau	**Oneata**	**Naikorokoro**	**Namuana**	**Tikina Levuka**	**Tikina Nasinu**	**Vusasivo**	**Karoko**
Abundance (No/transect)	466.7± 232.8	110.8± 165.1	237.4± 131.3	288.5± 101.9	100± 26.9	80.2± 15.5	76.0± 15.6	255.5± 187.4
Biomass (W(kg)/transect)	124.4± 74.9	11.9± 13.9	60.4± 68	52.9± 28.9	71.4± 70.2	18.4± 7.9	2.9± 3.1	19.9± 5.3

Table 3: Mean abundance and biomass estimates for each *I Qoliqoli* (per 500 m^2) in main island, Viti Levu.

	North Viti Levu		**West Viti Levu**		**South Viti Levu**		**East Viti Levu**	
	Rakiraki	**Wananavu**	**Ba**	**Tavua**	**Namaqumaqua**	**Galoa**	**Mau**	**Lami**
Abundance (No/transect)	315± 169.7	199.5± 3.5	299.7± 117.1	187.2± 202.6	43.3± 18.9	159± 122.5	186.4± 131	504± 215
Biomass (w(kg)/transect)	64.6± 33	42.3± 4.3	21.3±1 0.3	43.2± 54.4	7.0± 3.5	17.3± 17.8	26.5± 25	135.1± 125.8

3.1.2 Abundance and Biomass per Habitat

The average abundance was highest in the lagoons but the variance was also high. The abundance of fish in lagoon, reef area, reef slope, back reef and fore reef were somewhat similar but different from the reef channel and outer reef (Figure 4). The biomass varied but was highest in the fore reef and lagoon but lowest in back reef and reef channel (Figure 5). East Fiji (Lau Group) (Figure 6 & 12): In lagoon and back reef area, more fish with high biomass were sighted in Nayau Island than Oneata. The fore reef of Oneata Island was not surveyed because of bad weather (strong currents).

South Fiji (Kadavu Island) (Figure 7 & 13): High fish abundance was seen in Namuana reef area but low biomass. While, high fish biomass was observed in Naikorokoro reef slope with low abundance.

Central Fiji (Ovalau Island) (Figure 8 & 14): Tikina Levuka had high abundance and biomass in all areas.

North Fiji (Vanua Levu) (Figure 9 & 15): Karoko had high abundance and biomass.

Viti Levu: Rakiraki had high abundance and biomass than Wananavu, while Ba had high abundance with low biomass and Tavua had low abundance with high biomass (Figure 10 & 16). In south Viti Levu (Figure 11 & 17), Galoa had high abundance and high biomass compared to Namaqumaqua. Lami had high abundance and biomass than Mau.

The abundance and biomass among *I Qoliqolis* varies. The number of transects observed were not equal due to the different area demarcated for each village/community. However, in areas less than 5 m depth the mean sizes of fish were less than 15 cm (Figure 26), which were mostly juvenile fish. Location of the fishing ground influences the distribution of fish within the habitat (Figure 18 – 24). Fishing grounds in outer islands had high mean abundance and biomass in the lagoon than the main islands. The abundance and biomass of fish per habitat among *I Qoliqoli* show less variation.

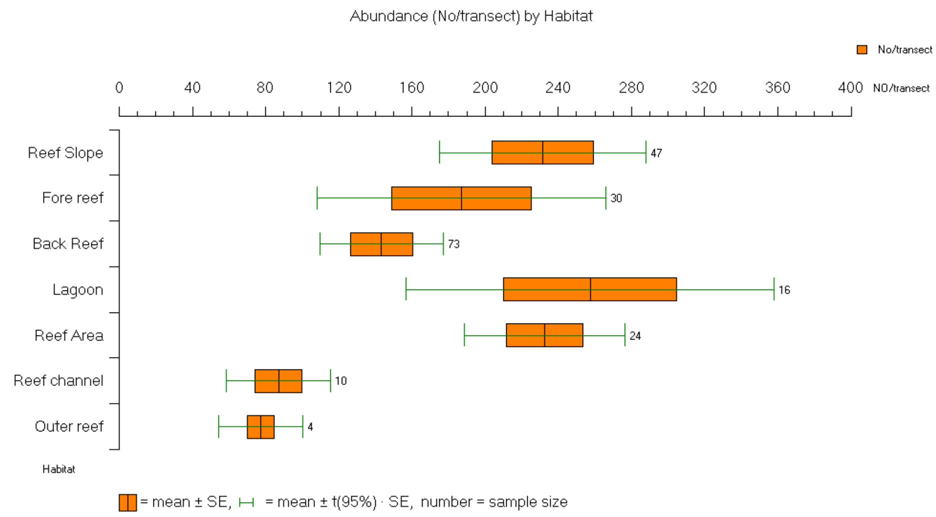

Figure 4: Fish abundance by habitat in all *I Qoliqoli.*

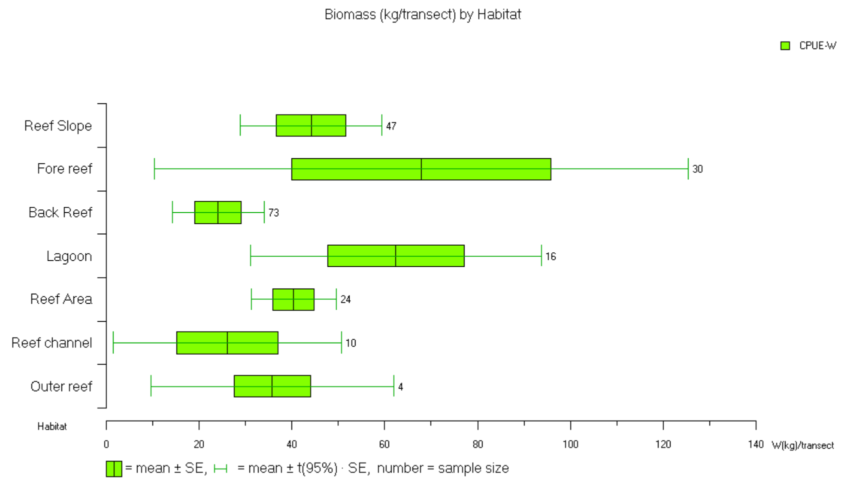

Figure 5: Fish biomass by habitats in all *I Qoliqoli.*

Overall, in the fore reef, Lami (East Viti Levu) has the highest fish abundance of mean (629.5/ 500 m^2) and with the mean biomass of 61.9 kg/500 m^2, followed by 463.5/ 500 m^2 in Nayau Island (East Fiji) and with a mean biomass of 323.1 kg/500 m^2.

Lami and Nayau Island have also the highest mean fish abundance and biomass in the back reef area. High mean fish abundance was also sighted in the lagoon and reef channel area of Nayau Island. The reef area and reef slope (drop off) of Namuana has high mean fish abundance.

Fish Abundance by Habitat in *I Qoliqoli*

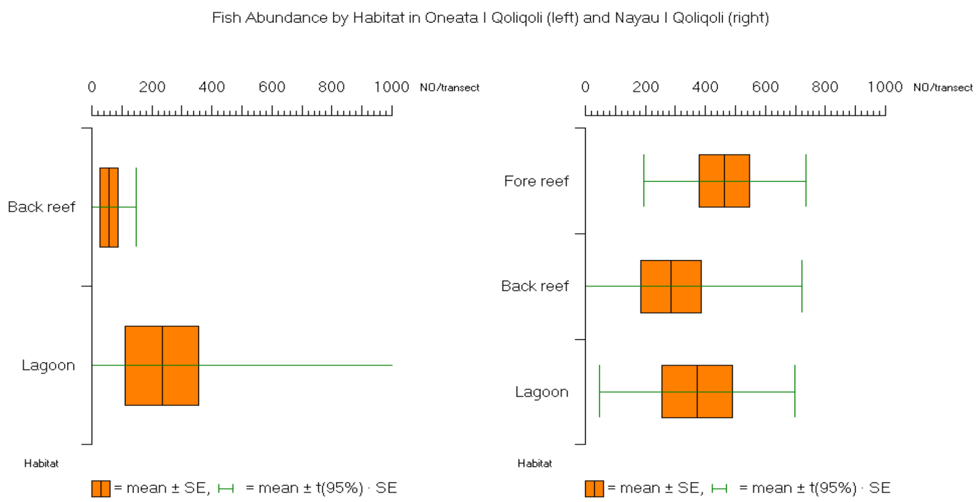

Figure 6: Fish Abundance (No/500m^2) by habitat in Nayau Island and Oneata Island, East Fiji.

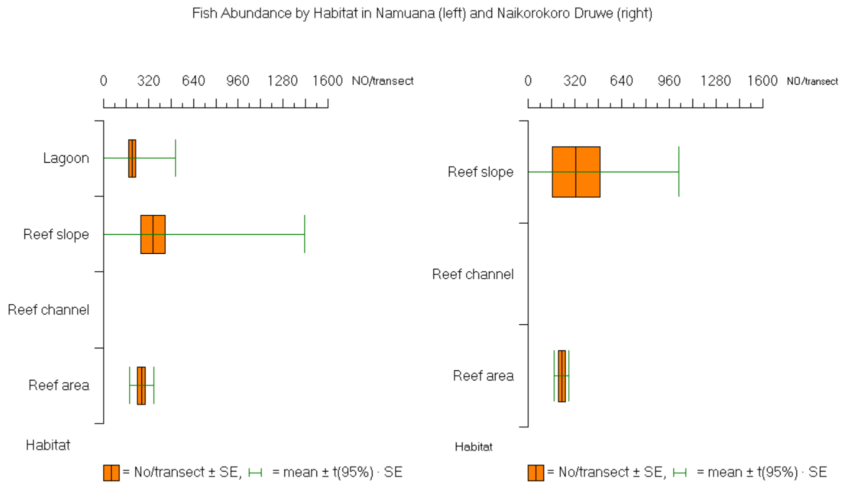

Figure 7: Fish Abundance (No/500m^2) by habitat in Namuana and Naikorokoro, Kadavu Island, South Fiji.

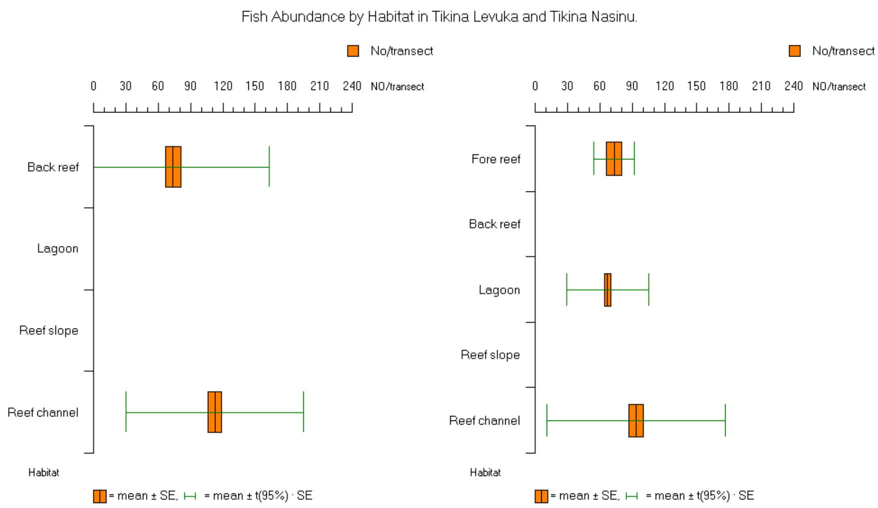

Figure 8: Fish Abundance (No/500m^2) by habitat in Tikina Levuka (left) and Tikina Nasinu (right), Ovalau Island, Central Fiji.

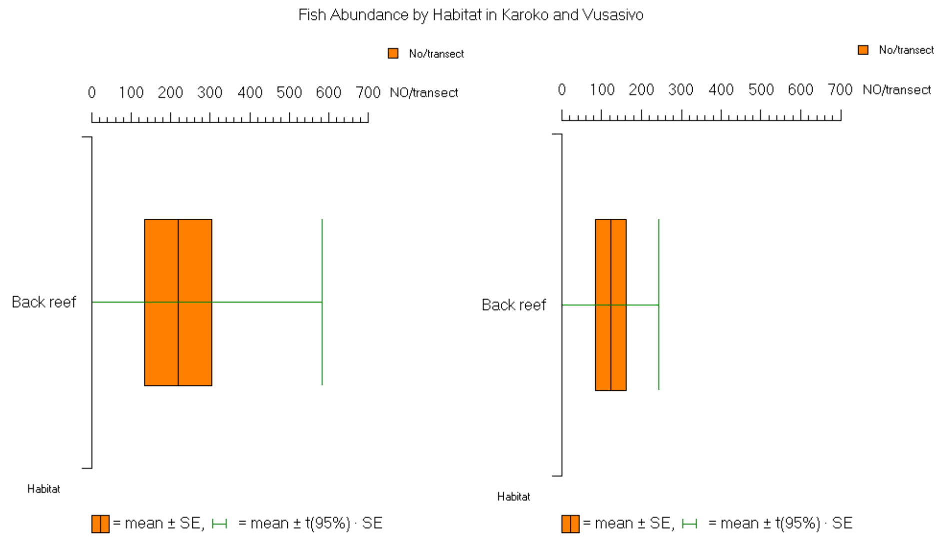

Figure 9: Fish Abundance (No/500m^2) by habitat in Karoko (left) and Vusasivo (right), Vanua Levu, North Fiji.

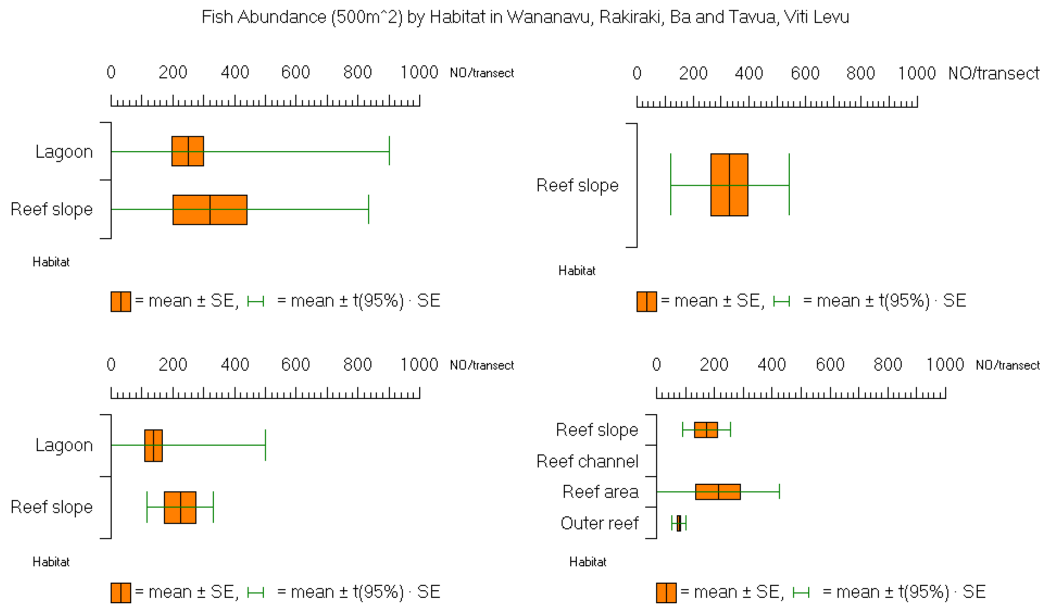

Figure 10: Fish Abundance (No/500m^2) by habitat in Wananavu (top left), Rakiraki (top right), Ba (bottom left) and Tavua (bottom right), Viti Levu.

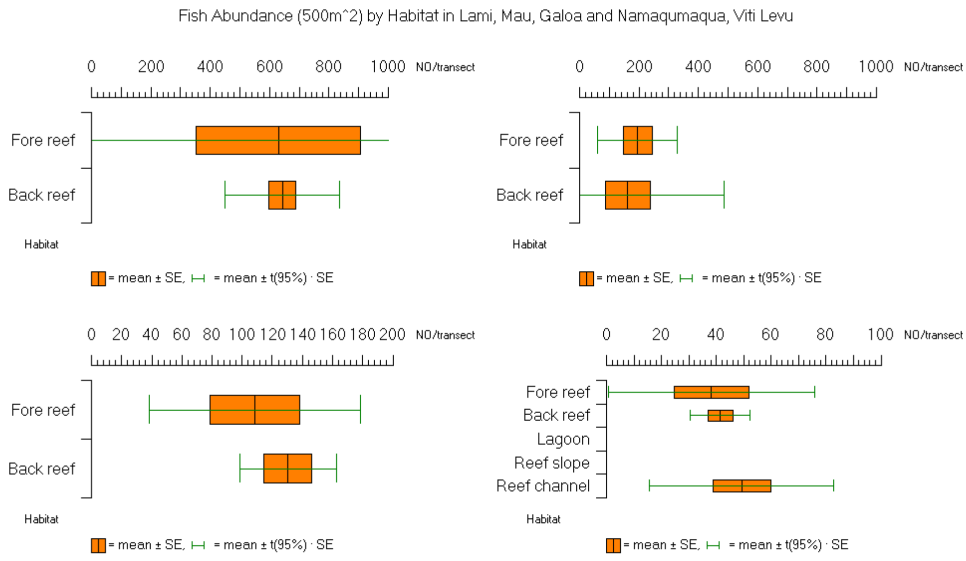

Figure 11: Fish Abundance (No/500m^2) by habitat in Lami (top left), Mau (top right), Galoa (bottom left) and Namaqumaqua (bottom right), Viti Levu.

Biomass by Habitat in *I Qoliqoli*

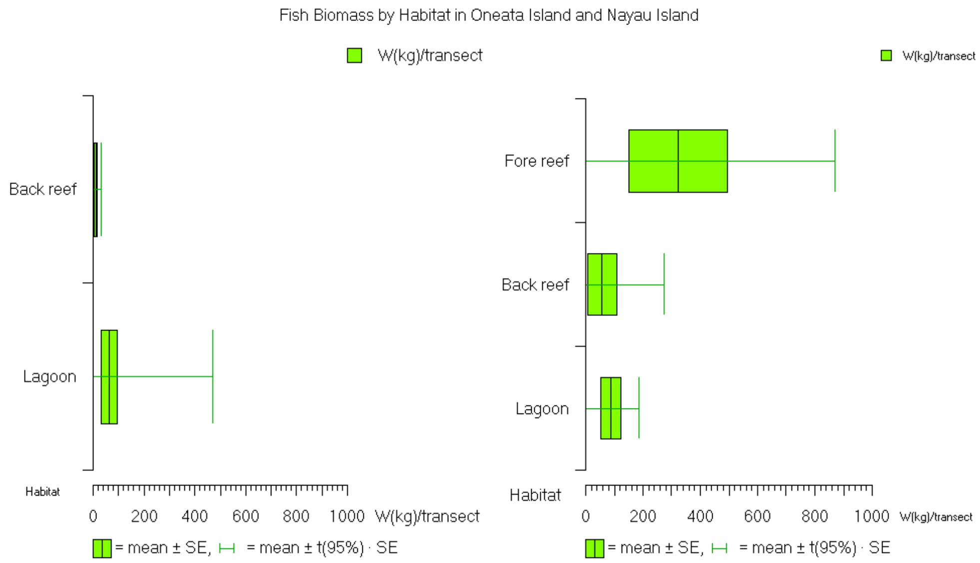

Figure 12: Fish Biomass (W (kg)/500m^2) in Oneata Island (left) and Nayau Island (right), Lau group, East Fiji.

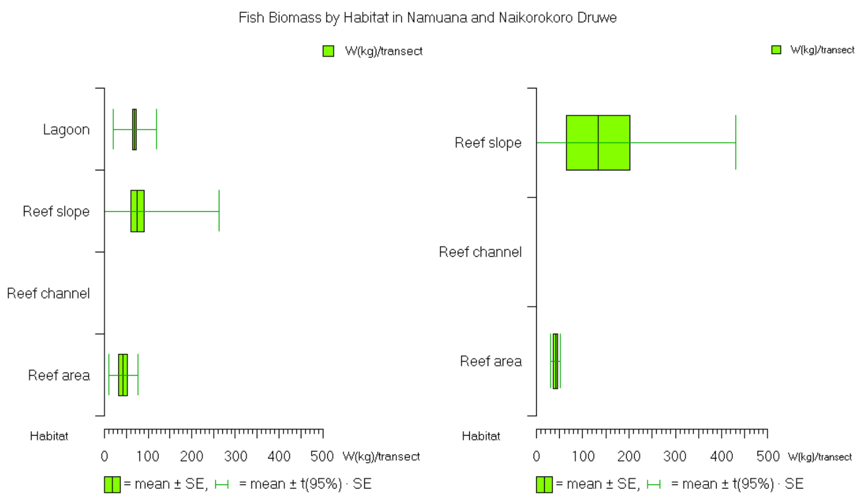

Figure 13: Fish Biomass (W (kg)/500m^2) in Namuana (left) and Naikorokoro Druwe (right).

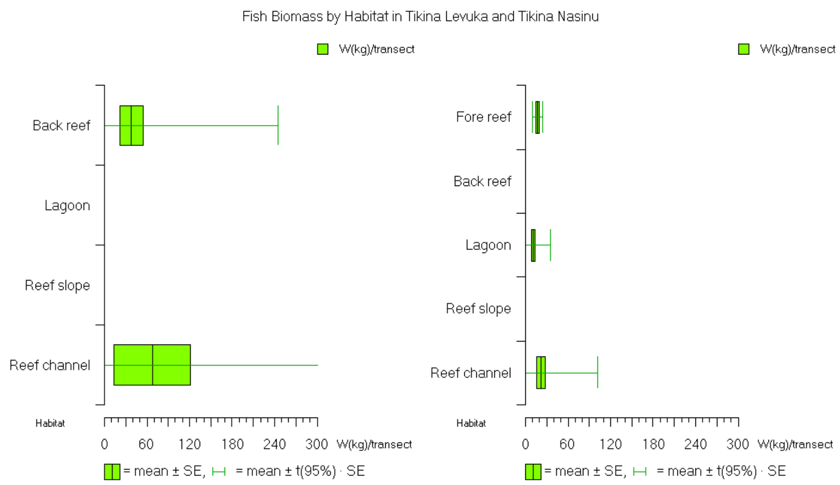

Figure 14: Fish biomass (W (kg)/500m^2) in Tikina Levuka (left) and Tikina Nasinu (right), Ovalau Island, Central Fiji.

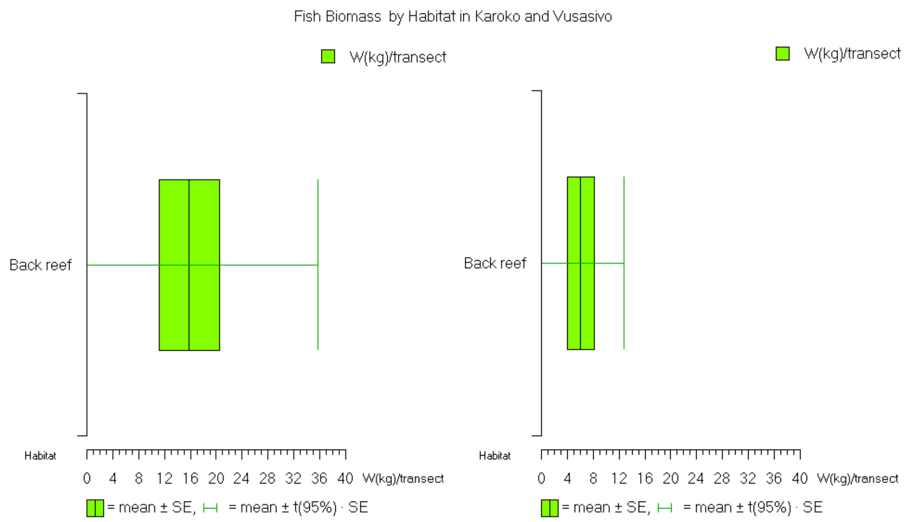

Figure 15: Fish biomass (W (kg)/500m^2) by habitat in Karoko (left) and Vusasivo (right) in Cakaudrove, Vanua Levu, North Fiji.

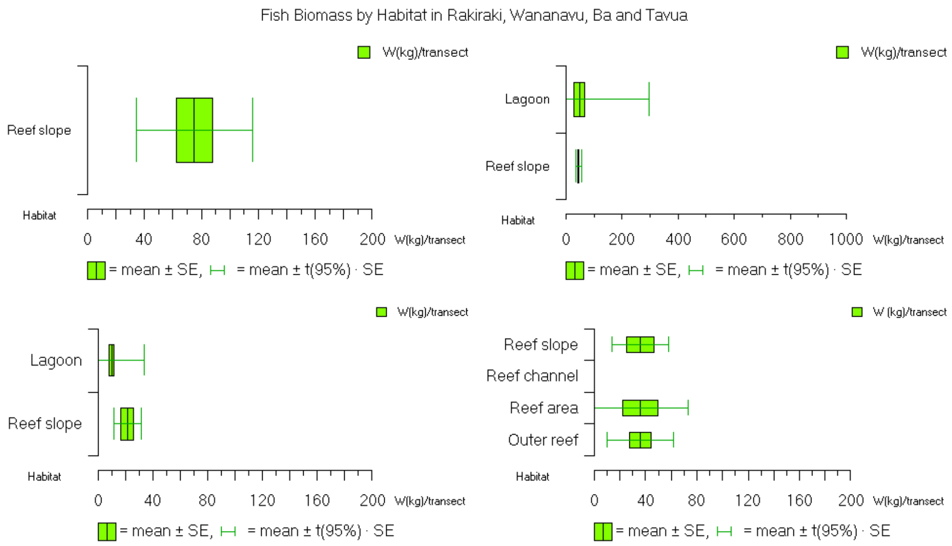

Figure 16: Fish biomass (W (kg)/500m^2) by habitat in Rakiraki (top left), Wananavu (top right), Ba (bottom left) and Tavua (bottom right), Viti Levu.

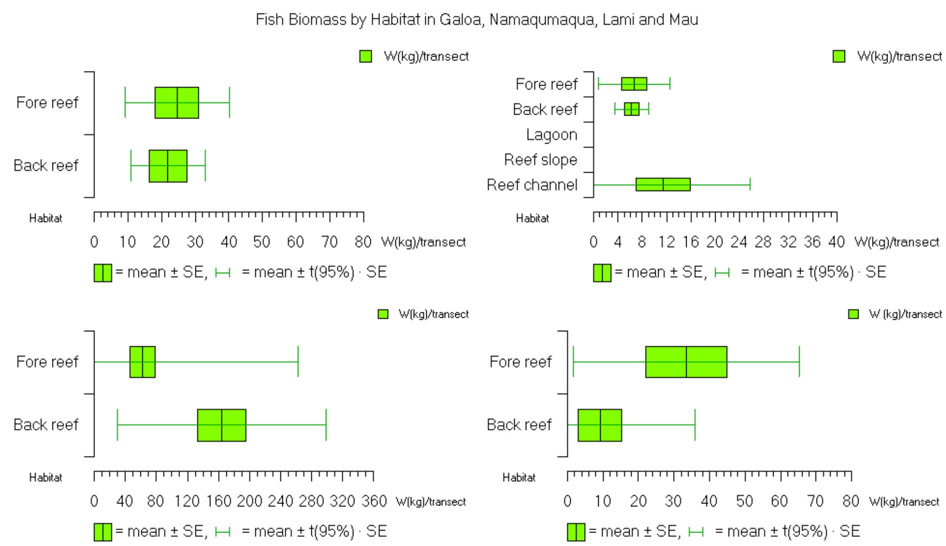

Figure 17: Fish biomass (W (kg)/500m2) in Galoa (top left), Namaqumaqua (top right), Lami (bottom left) and Mau (bottom right), Viti Levu.

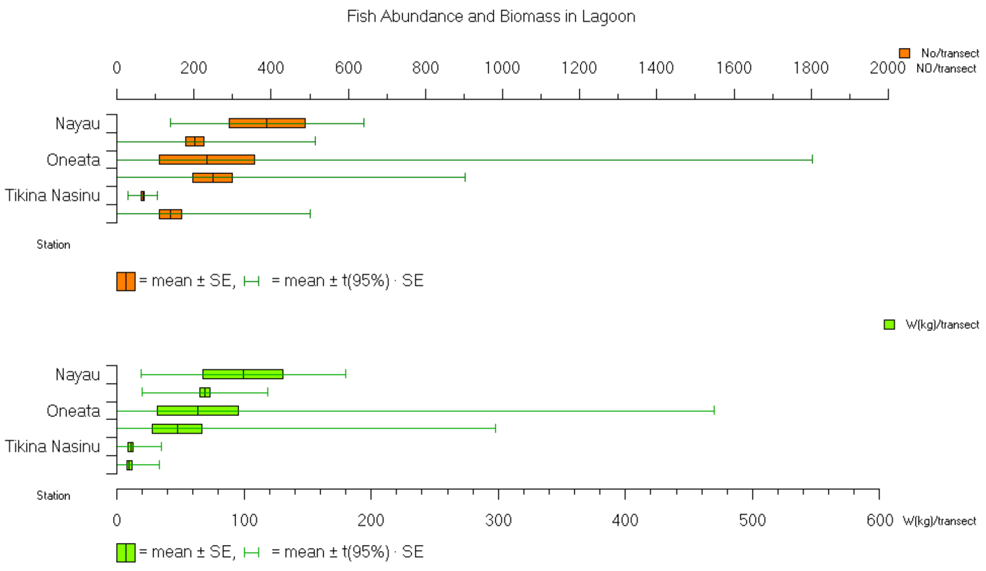

Figure 18: Fish abundance (No/transect) and biomass (kg/transect) in lagoon area.

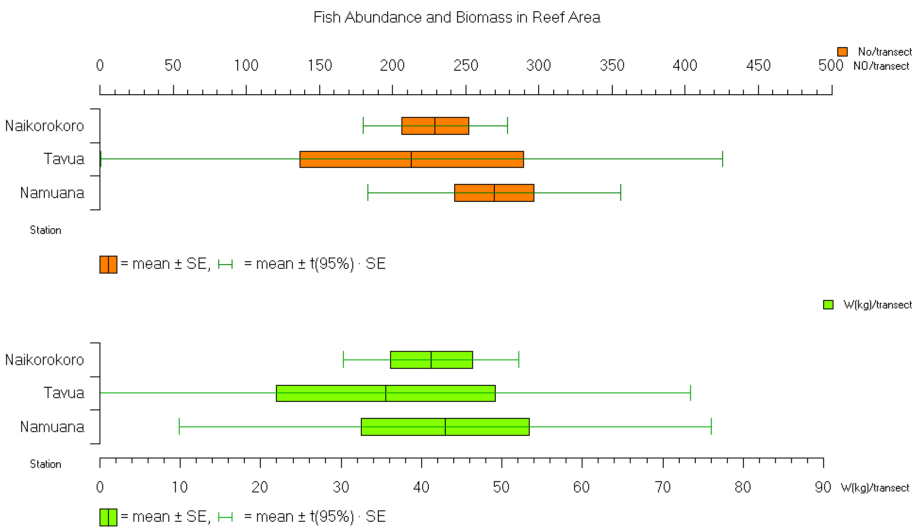

Figure 19: Fish abundance (No/transect) and biomass (kg/transect) in reef area.

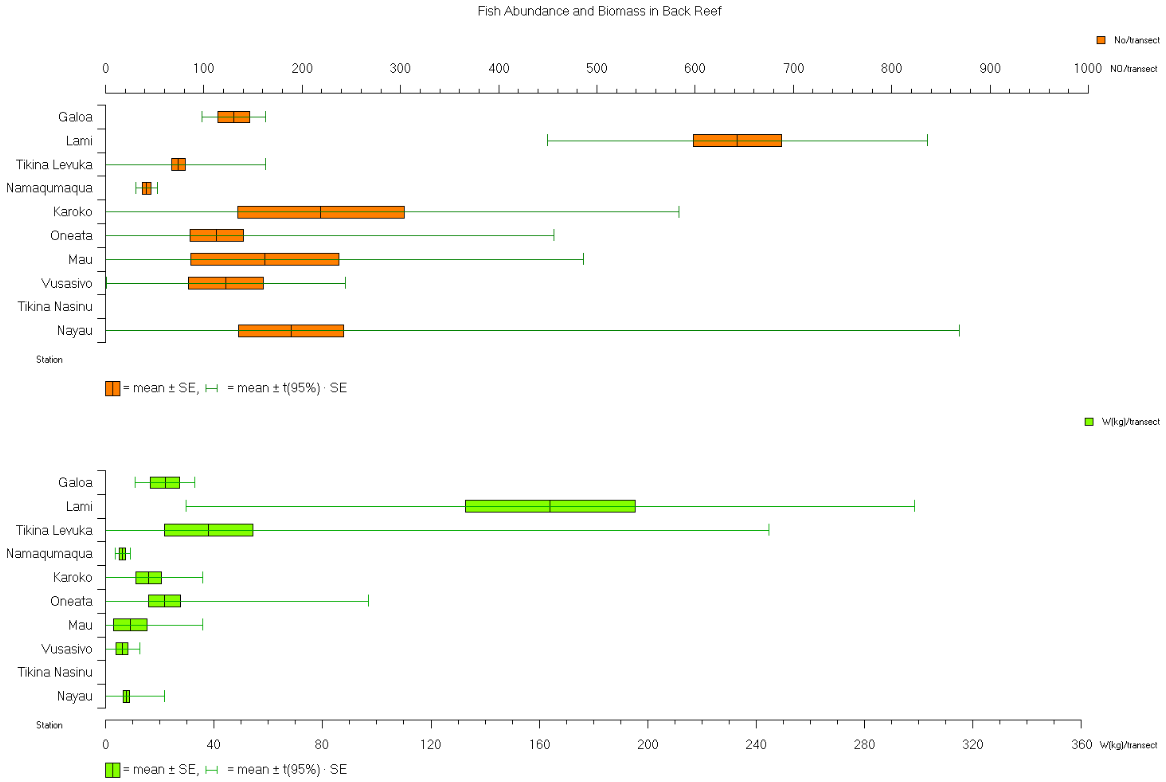

Figure 20: Fish abundance (No/transect) and biomass (kg/transect) in back reef.

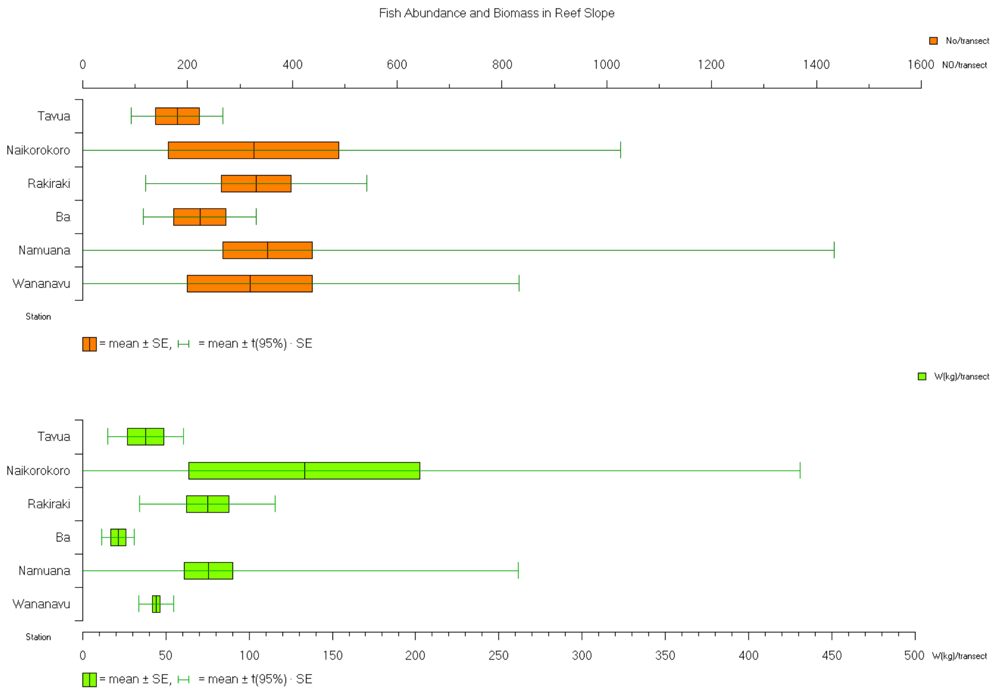

Figure 21: Fish abundance (No/transect) and biomass (kg/transect) in reef slope.

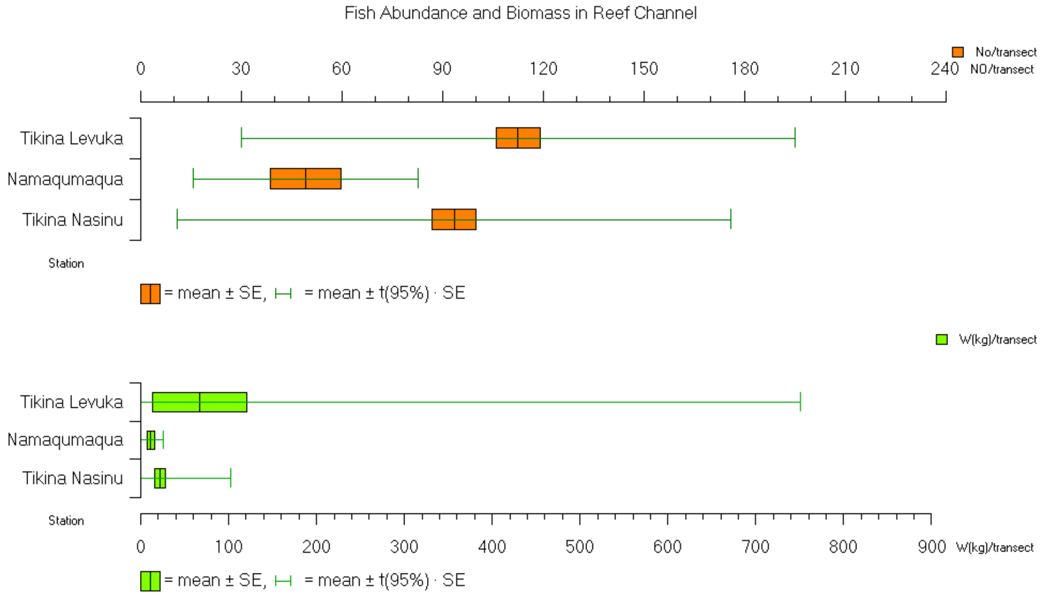

Figure 22: Fish abundance (No/transect) and biomass (kg/transect) in reef channel.

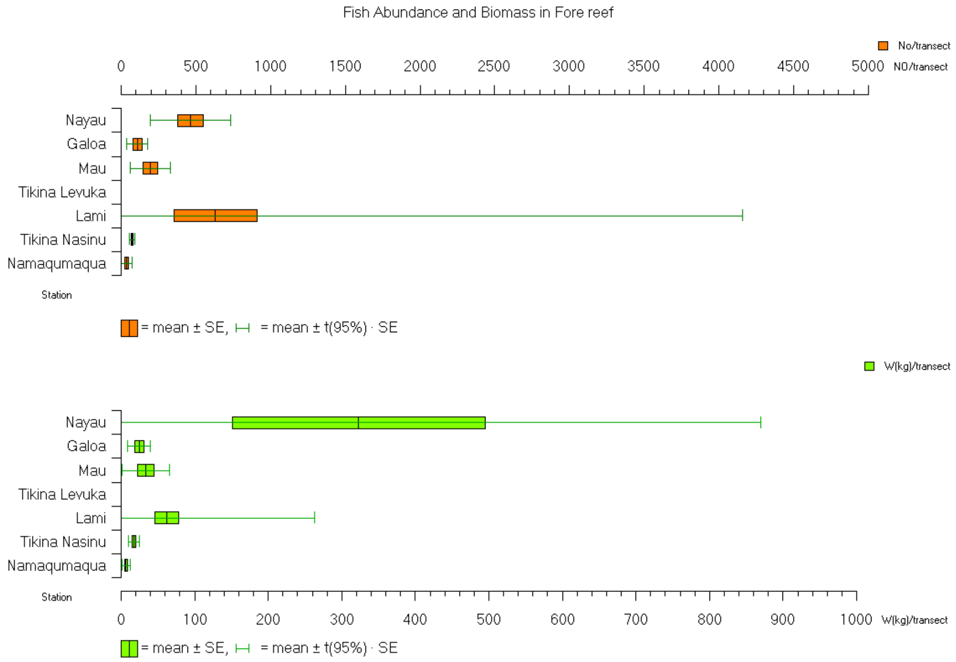

Figure 23: Fish abundance (No/transect) and biomass (kg/transect) in fore reef.

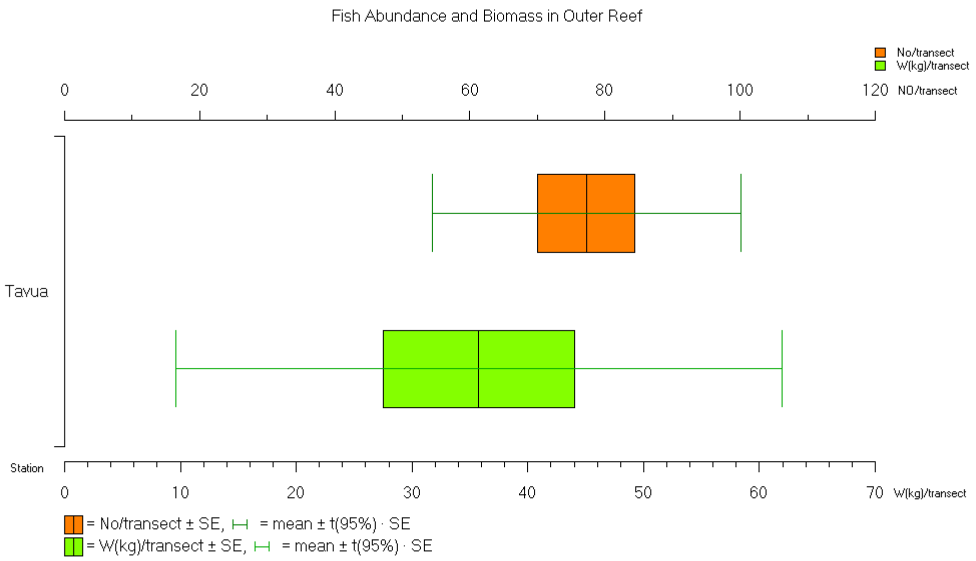

Figure 24: Fish abundance (No/transect) and biomass (kg/transect) in outer reef.

3.1.3 Abundance and Biomass of 5 Important Food Fish by Habitat

The 5 most important food fish families (commonly used as both subsistence and commercial) are shown in table 4, with Lutjanidae (Snapper), Lethrinidae (Emperor) and Serranidae (Grouper) listed as highly commercial. All were observed in all habitats except for Serranidae (Groupers), which was not sighted, in the outer reef (Table 4), probably because of the behaviour of the fish, preferring to hide and feed among corals. Groupers are rarely found in schools and only aggregate when it is time to spawn on reef channels and promontories. High mean abundance of groupers was sighted in lagoon. These are *Epinephelus merra* which commonly seen in shallow coral reef area. Also juvenile groupers are found closer to the shore to seek protection until they reach maturity.

High mean abundance and biomass density of Lutjanidae (Snappers), Lethrinidae (Emperor), Mullidae (Goatfish) and Scaridae (Parrotfish) were seen in lagoon area, while high mean abundance and density biomass of Acanthuridae (Surgeonfish) were found in the reef area (Table 4 and 5).

Tikina Nasinu (Central Fiji) had high mean abundance (9.4/transect) and biomass denstity (2 kg/transect) of Lethrinidae, while high mean abundance (87.3/transect) and biomass (14.4 kg/transect) of Scaridae were observed in Namuana. The other food fish have generally the highest mean abundance and biomass in Nayau Island (Table 8 and 9 in appendix 2a and 2b).

Table 4: Abundance (No/transect) of 5 important food fish by habitat.

Family	**Lagoon**	**Back Reef**	**Reef Area**	**Reef Slope**	**Reef Channel**	**Fore reef**	**Outer reef**
Lutjanidae	23.9±44	8.2±25.7	8±16	22.1±50.3	11.9±21.4	11.2±20.3	4.3±3.2
Lethrinidae	12.5±19.8	2.6±5.2	5±4	2.4±9.9	4.8±7.7	6.8±9.9	0.3±0.5
Serranidae	1.9±2.3	1.3±5.8	0.7±1.1	0.7±1.0	0.4±0.5	1.5±2.2	NULL
Scaridae	33.5±26.1	8.9±10.9	23.5±16.4	30.1±43	8.1±7.5	21.2±30.1	17.8±5.1
Acanthuridae	44.9±42	21.6±48.5	52.4±37.8	12.8±23.8	15.9±10.1	30.5±45.6	13.8±4.9
Mullidae	11.6±27.6	4.3±8.3	10.8±10.9	2.9±6	8.3±12.4	8.6±13.7	1.3±1.5

Table 5: Biomass (kg/transect) of 5 important food fish by habitat.

Family	Lagoon	Back Reef	Reef Area	Reef Slope	Reef Channel	Fore reef	Outer reef
Lutjanidae	13.3±24.6	2±6.8	1.5±2.6	4.1±8.2	9.6±24.4	4.5±8.9	1.1±1.4
Lethrinidae	6.1±15.4	0.7±1.6	0.9±1	0.8±2.7	2.2±2.8	4.2±11.9	0.2±0.3
Serranidae	0.8±1.1	0.2±0.5	0.2±0.8	0.3±0.8	0.2±0.2	0.8±1.7	NULL
Scaridae	11.4±9.5	3.1±5.3	7.5±8.8	7.2±6.7	2.5±2.6	9.9±15.6	16.5±10.9
Acanthuridae	10.6±11.1	5.8±15.4	10.8±7.5	3.7±8.7	3.7±3.2	7.7±12.5	6.7±2.5
Mullidae	7.3±23.4	0.8±1.7	3.1±7.7	0.7±1.6	2±2.9	2.2±3.5	0.5±0.8

3.2 Size Distribution by *I Qoliqoli*/Area Habitat and Depth

The mean length in outer reef is higher than the other habitats but it also has the lowest number of observation. There is no big difference in the mean lengths observed in other habitats (Figure 25).

In general, bigger fishes are found in the deeper part of the fishing grounds. Between 10 m and 25 m the dominant mean sizes are from 20–25 cm. However, some fish of these sizes (20 – 25 cm) are found in the shallow part (4 m – 10 m) of the fishing grounds (Figure 26).
Figure 27 – 34 illustrates the size distribution in an area. Steepen slope probably due to high fishing pressure (with the large fish removed), or more small fish in an *I Qoliqoli* (smaller community).

Less than 10 cm fish were fully observed in East Fiji (Figure 27), North Fiji (Figure 30), South Viti Levu (Figure 32) East Viti Levu (Figure (Figure 34) and West Viti Levu (Figure 33), thus this may be due to the high abundance of juvenile fish present. The fully observed fish in Central Fiji (Figure 28) and South Fiji (Figure 29) were bigger than 15 cm length, which probably due to its medium to large community. The increased in biomass and abundance in the size classes (11 – 25 cm), suggested some form of compensatory indirect effect of exploitation (Dulvy *et al*., 2004a).

The steeper slope shown by West Viti Levu (Figure 33) may represent the increase in fishing pressure in the area. According to Dulvy *et al*, (2004a) steepend slope of community size spectra represents exploitation.

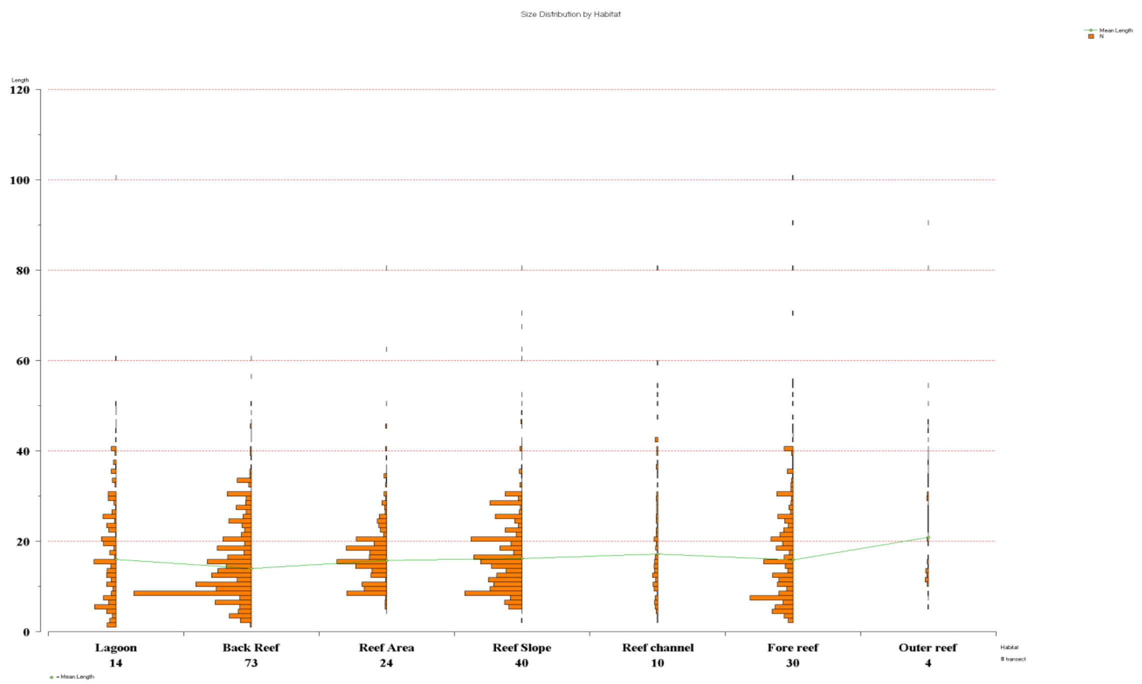

Figure 25: Size distribution of fish by habitat.

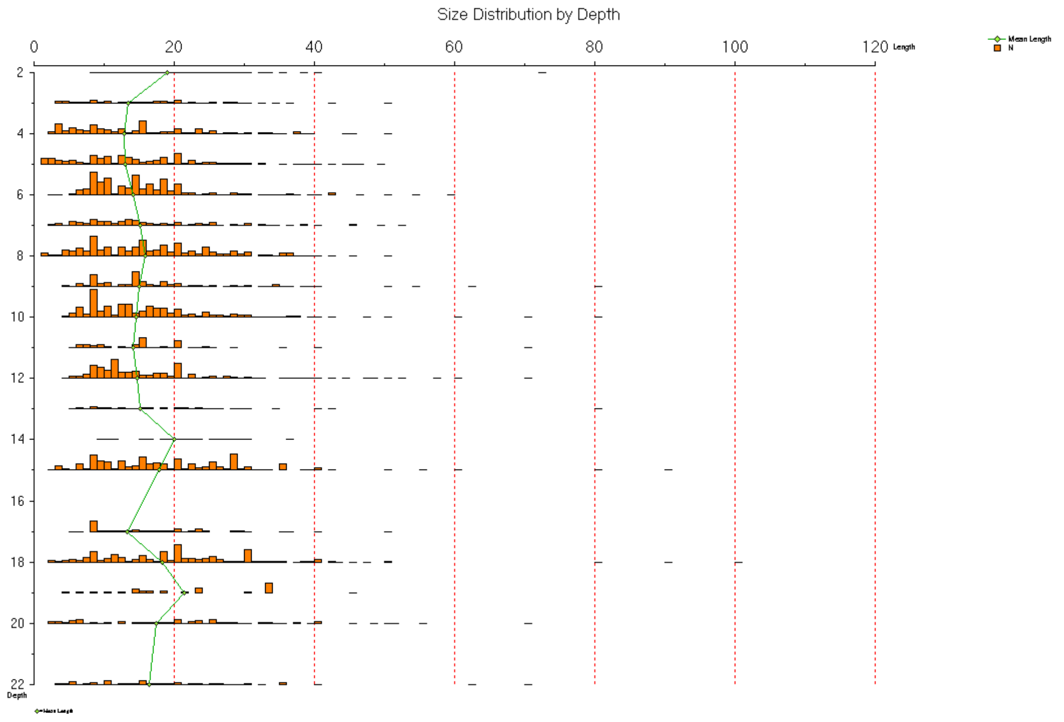

Figure 26: Length distribution by depth.

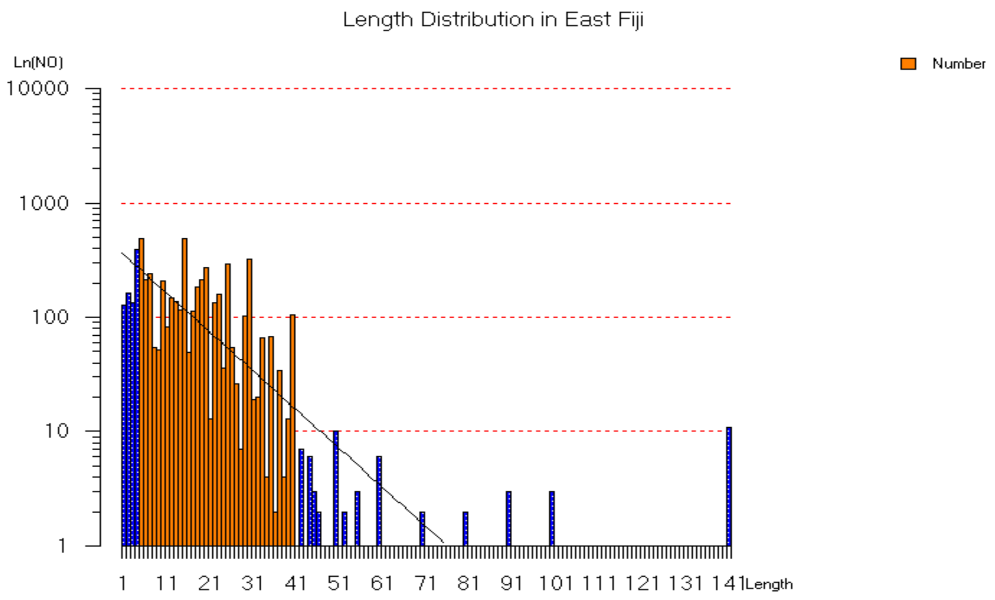

Figure 27: Length distribution in Oneata and Nayau Island, East Fiji. The blue bars are not fully represented (the idea is that probably some fishes were not observed). Orange bar is fully represented or observed.

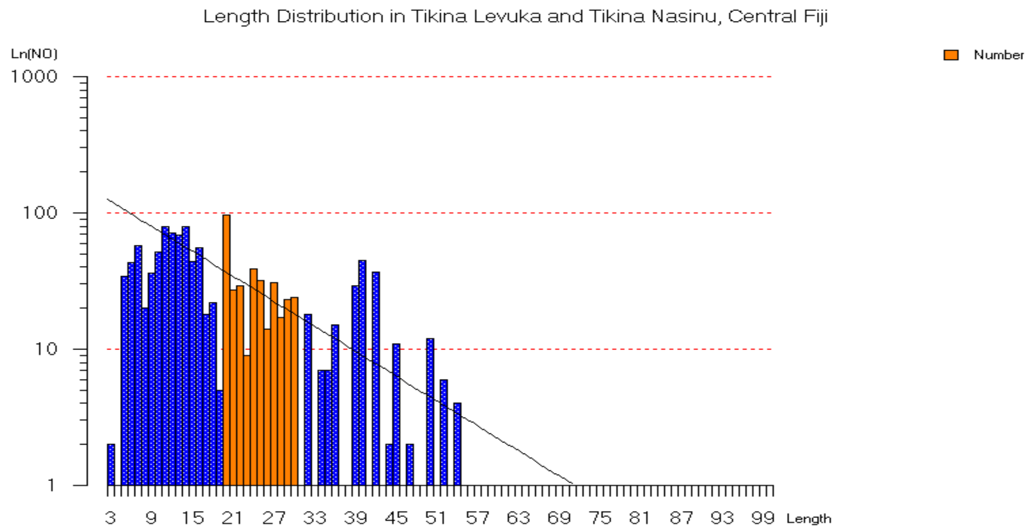

Figure 28: Length distribution in Tikina Levuka and Tikina Nasinu. The *I Qoliqoli* is located adjacently to each other. The blue bars are not fully represented (the idea is that probably some fishes were not observed). Orange bar is fully represented or observed.

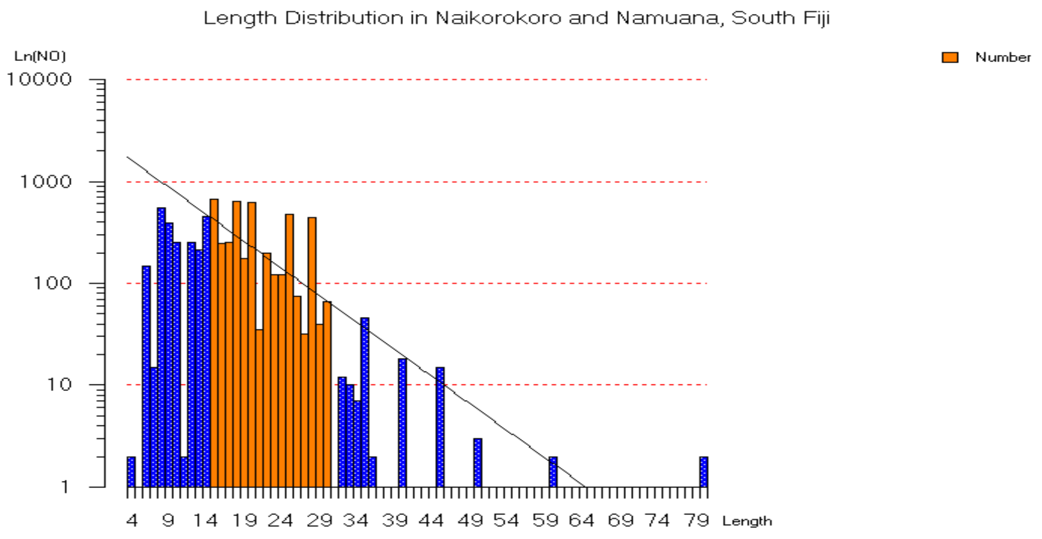

Figure 29: Length distribution in Naikorokoro and Namuana, South Fiji. The *I Qoliqoli* is located adjacently to each other. The blue bars are not fully represented (the idea is that probably some fishes were not observed). Orange bar is fully represented or observed.

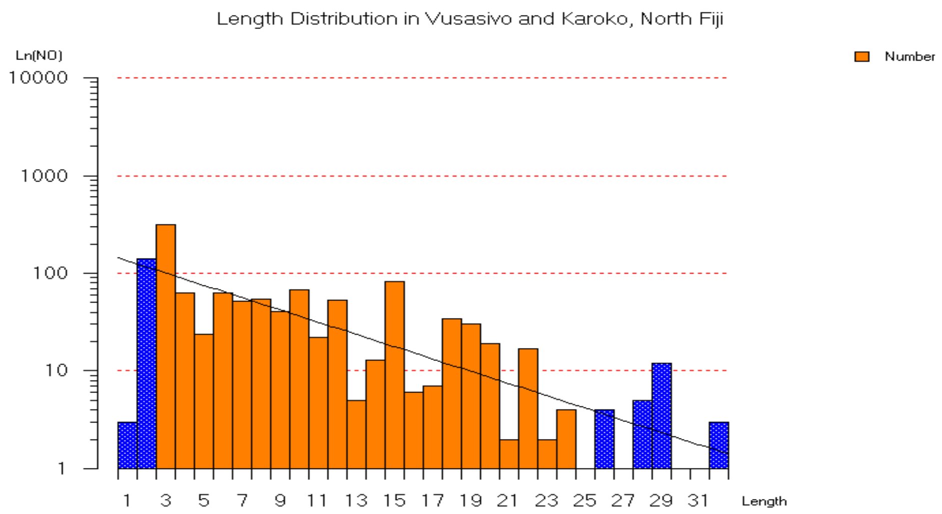

Figure 30: Length distribution in Vusasivo and Karoko, North Fiji. The *I Qoliqoli* is located along the same coastline in Natewa district. The blue bars are not fully represented (the idea is that probably some fishes were not observed). Orange bar is fully represented or observed.

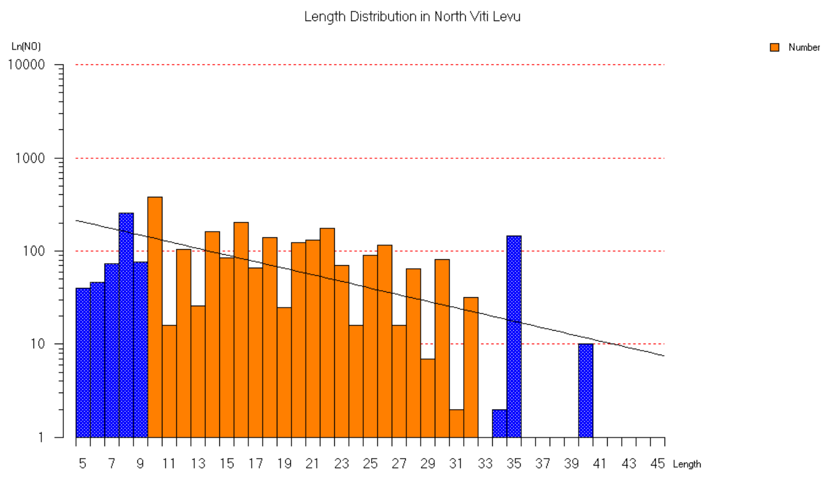

Figure 31: Length distribution in Wananavu and Rakiraki, North Viti Levu. The *I Qoliqoli* are located adjacently. The blue bars are not fully represented (the idea is that probably some fishes were not observed). Orange bar is fully represented or observed.

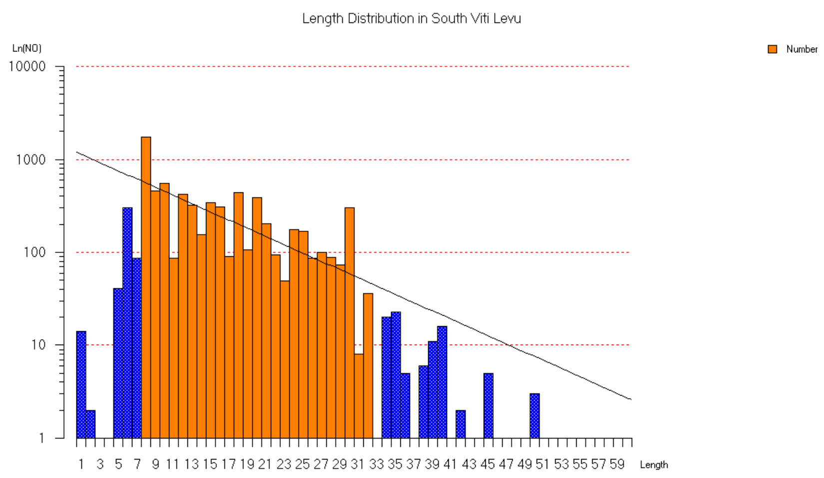

Figure 32: Length distribution in Galoa and Namaqumaqua, South Viti Levu. The *I Qoliqoli* is located on the same coastline. The blue bars are not fully represented (the idea is that probably some fishes were not observed). Orange bar is fully represented or observed.

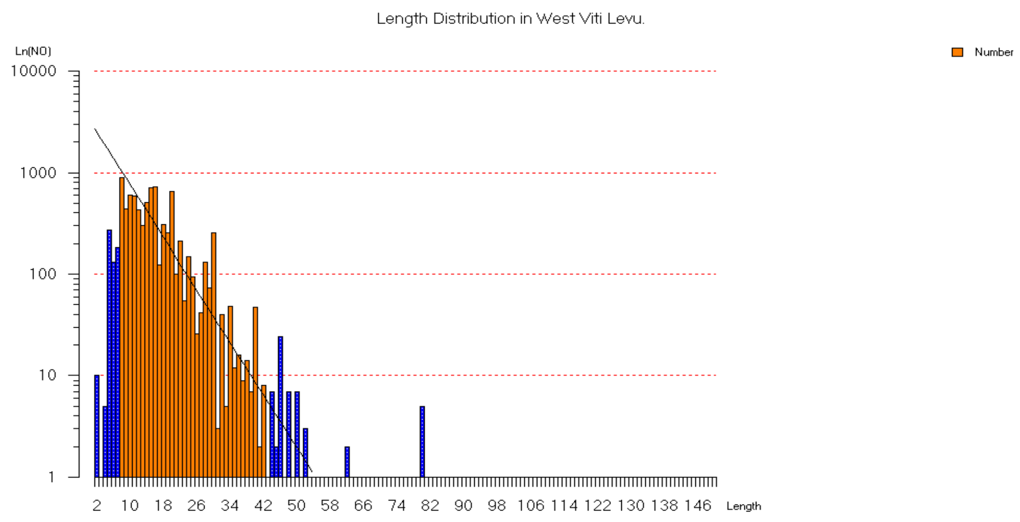

Figure 33: Length distribution in Ba and Tavua, West Viti Levu. The *I Qoliqoli* is located adjacently. The blue bars are not fully represented (the idea is that probably some fishes were not observed). Orange bar is fully represented or observed.

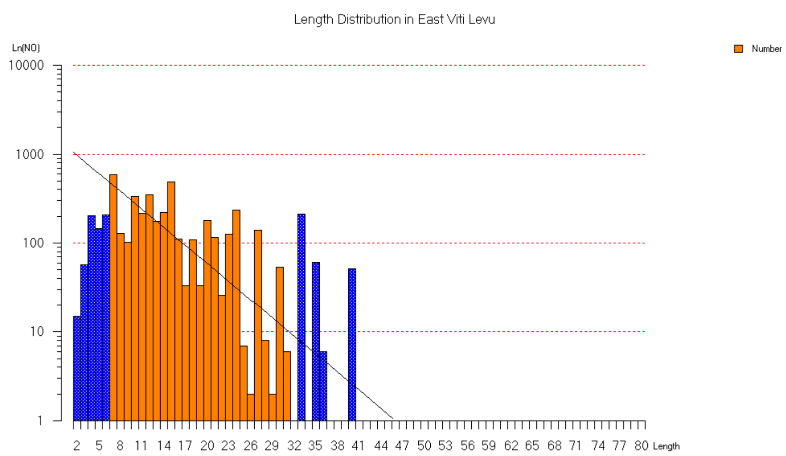

Figure 34: Length distribution in Lami and Mau, East Viti Levu. The *I Qoliqoli* is located on the same coastline. The blue bars are not fully represented (the idea is that probably some fishes were not observed). Orange bar is fully represented or observed.

3.3 Trophic Network of Fish Community

Dominant trophic groups differ in different fishing grounds (Table 6). Figures 35–42 in appendix 3a illustrate the trophic composition per *I Qoliqoli.* In summary the dominant trophic group in the big islands such as Viti Levu, Vanua Levu and Kadavu are herbivorous feeders. However, the dominant trophic group in Ovalau (big island) and Vusasivo (Vanua Levu) were invertebrate and piscivorous feeders. Similar results were observed in Ba and Rakiraki with the dominant of planktivorous feeder. High biomass of omnivorous and detrivorous was observed in Galoa.

Table 6: Dominant trophic network in each fish ground. The graph is on Figure 35 – Figure 42 in appendix 3a, which shows the biomass.

I Qoliqoli	Dominant Trophic Group
Nayau	Invertebrate Feeder
Oneata	Herbivore
Tikina Levuka	Invertebrate Feeder
Tikina Nasinu	Invertebrate and Piscivore Feeder
Naikorokoro	Herbivore
Namuana	Herbivore
Karoko	Herbivore
Vusasivo	Invertebrate and |Piscivore
Rakiraki	Planktivore
Wananavu	Herbivore
Galoa	Omnivore and Detrivore
Namaqumaqua	Herbivore
Ba	Planktivore
Tavua	Herbivore
Lami	Herbivore
Mau	Herbivore

4 DISCUSSION

Generally, the small bodied fishes such as Damselfishes (Pomacentridae) and Butterflyfishes (Chaetodontidae) are found to be in large numbers, while the bigger fishes (top predators and most important food fishes) are less abundant. The bigger fishes are the piscivorous/ invertebrate feeders that are favoured by both artisanal and subsistence fishers. These are mostly, Snappers (Lutjanidae), Emperors (Lethrinidae), Groupers (Serranidae), Trevallys Carangidae), Barracudas (Sphyraenidae), and Tunas (Scombridae). The islands *I Qoliqoli* (outside the main island, Viti Levu and Vanua Levu) had higher mean abundance and biomass of these fishes than the two major islands (Table 8 and 9). Studied by Jennings *et al*. (1995) in six *I Qoliqoli* in Fiji showed that the biomass of invertebrate feeders is significantly higher in the least intensively fished *I Qoliqoli*.

Habitat characteristics influence fish communities' structure (Jennings *et al*. 1997) or the distribution of fish within an *I Qoliqoli*. High mean abundance was seen in lagoon areas but low mean biomass (kg/transect), while high mean biomass (kg/transect) was detected in fore reef with less mean abundance (Figure 4 – 5). Fishes that were seen dominating the lagoon are mostly the non-food fish such as damselfish, butterflyfish and juveniles of important food fish. Lagoon provides good nursery ground for juvenile fishes because of its calm waters (less predation). Most of these fishes were found in small schools to protect them from predators.

Nearly all habitats showed high variance in mean length, which is an indication of some bigger fishes (such as top predators), sighted with a high abundance of small fish population in lagoon and back reef area. These top predators (Sharks, Snappers, Emperors, Barracudas, Trevallys, Tunas), were not sighted in all fishing grounds (within 500m^2 or transect) (Table 8), considering the widespread foraging behaviour of Snappers (Lutjanidae) (Espana 2003) as well as Sharks (Carchahinidae), Emperors (Lethrinidae), Barracudas and Tuna (Scombridae), Trevally (Carangidae.

The food fishes, Scaridae (Parrotfish), Acanthuridae (Surgeonfish), Mullidae (Goatfish) and Labridae (Wrasses) are found to be abundant in all fishing grounds (Table 5 and Table 6). However, these fishes are classified as minor commercial and are mostly used as subsistence, except *Bolbometapon muricatum* (Parrotfishh) and *Cheilinus undulatus* (Wrasses), which are highly commercial. These fishes (Parrotfishes, Surgeonfishes, Wrasses and Goatfishes) are mainly herbivorous, omnivorous and detrivorous feeders (Table 9). Considering the feeding structure, high mean abundance of Acanthuridae and Scaridae were seen in the lagoon and reef area (Table 4). According to local fishermen in Viti Levu (especially in South Viti Levu), the dominant daily catch compositions are mainly the minor commercial fishes (Holocentridae, Mullidae, Scaridae, Labridae, Acanthuridae and Lethrinidae (*Lethrinus harak*). The removal of herbivorous could lead to ecological transition (McClanahan *et al.* 2002).

Higher mean abundance and biomass was sighted in Lagoon and Reef area of the outer islands than the main islands, for example, Nayau, Oneata of East Fiji, Naikorokoro, and Namuana of South Fiji (Figure 19 – 20). This is probably due to the findings by Kuster *et al*. (2005) in Lau Islands that the increase in outboard vessels appeared to have a social impact causing traditional shore based fishing activities of women to be less. During low tides women wade in this area to fish and glean for edible invertebrates such as bivalves, univalves, octopus and sea cucumbers. Now, men are taking the responsibility by spear dive in fore reefs and outer reefs.

Presumbly, high population coupled with land effluents may cause the low mean abundance and biomass in lagoon and reef area of the main islands. Therefore, the habitat could be destroyed which may lead to fish moving to other undisturbed areas. This also influences the distribution of the community trophic group. The dominant fish group in the main islands of Viti Levu, Vanua Levu and Kadavu, are the herbivorous feeders (Table 6). Perhaps because of more development in these areas coupled with the annual rainfall of 2000 mm – 3000 mm, more land effluents enters the sea. This could lead to algal blooming, which could increase the abundance of herbivorous feeder. Algal bloom is common along the reef area on the Coral Coast (South Viti Levu), therefore overfishing of herbivorous fish could be a contributing factor whereby less herbivorous to feed on the algae.

Lami (East Viti Levu) fore reef has high fish abundance but low biomass compared to Nayau Island (East Fiji) which has low fish abundance but high biomass within the 10 m – 20 m depth range. The possible explanation for this is the low abundance of bigger fishes in the main island Viti Levu with the high abundance of small sizes between 10 m – 25 m depth. In Viti Levu, fishermen spend 3 -4 days out in the sea to meet the market demand. Marine protected area (MPA) could also affect the fish community in a fishing ground. In Tikina Levuka and Tikina Nasinu, certain areas of the fishing ground were closed during the survey (6 months before the survey were conducted).The intention was to breed and conserve the fish for the 2007 Annual Methodist Conference Meeting in the island of Ovalau. Therefore, the dominant trophic group sighted in the fishing grounds were the invertebrate feeder and piscivore feeder. According to Hoffmann (2002), reefs surrounding Ovalau and harbour surrounding Levuka have been affected by the PAFCO effluent. During the survey, villagers were complaining on the high number of sharks sighted around Levuka harbour. It could have been the herbivorous feeder to be the dominated group because the villagers depend on the sea for livelihood that is the higher removal of target fishes.

4.1 Catch information

There was no catch data available to calculate the total yield of the fishing grounds or the exploitation of the stocks. Consequently, this study will improve the sampling scheme of the department and to impose the gathering of catch data/CPUE during the visual transect survey in fishing communities.

It should be considered that visual transect underestimated the abundance of cryptic fish species. Jennings and Polunin (1995) tested visual transect to estimate the biomass of *Lethrinus spp* in six *I Qoliqolis* in Fiji. The research discovered that the stock was not reflected in catches taken from the same reef areas at a similar time of day.

Therefore it must be noted that the study is to gather baseline biological information to allow DOF to understand the health and productivity of an *I Qoliqoli,* which then assist in the formulation of appropriate management plan for each *I Qoliqoli*.

5 CONCLUSION

Overall, fish abundance (density and biomass) is higher in outer islands than the main islands of Viti Levu and Vanua Levu. In all areas, there is a low fish count of the most important food fishes but high diversity. The dominant fishes in all fishing grounds are Damselfishes (Pomacentridae), Surgeonfishes (Acanthuridae), Parrotfishes (Scaridae), Wrasses (Labridae) and Goatfishes (Mullidae).

Lagoon showed high abundance but not much variation in the reef area, ref slope, back reef and fore reef. Fore reef had the highest biomass with higher variation. The lagoon of fishing grounds that is far from the high populated area (islands) had high biomass and abundance than the main island Viti Levu.The means size distribution pattern between habitats and depths in a fishing ground is rather consistent.

Herbivorous feeders is the dominant trophic group in the fishing grounds surveyed especially in high islands (Viti Levu, Vanua Levu and Kadavu), while invertebrate feeder is dominant in small islands. Highly commercial fishes (mostly invertebrate and piscivorous fish) are rare in areas with higher human population.

This study highlights the lack of basic catch data for the inshore fisheries in Fiji; therefore there is a gap in the sampling scheme. Catch data is needed for the determination of the status of the exploitation of stocks. This study will assist DOF to determine daily catch limits, gear restrictions and most of all the number of fishing licenses renting to artisanal fishers. Also the study enhances the analysis of biological data as well as data management.

ACKNOWLEDGEMENTS

There is never just one person responsible for putting a report together.

I would like to express my sincere appreciation to my supervisors Mr. Hreiðar Þór Valtýsson and Mr. Hlynur Ármannsson of University of Akureyri for your endless support and words of encouragement.

To Dr. Tumi Tomasson and Mr. Thor Asgeirsson of UNU-FTP, thank you for your critical comments and advice throughout the course, and Ms Sigríður Kr. Ingvarsdóttir, thank you very much for your warm and kind attention. Also I cannot forget and really appreciate the support and assistance of Mr. Bjarni, University of Akureyri.

My sincere gratitude goes to Dr. Jeppe Kolding of University of Bergen. Thank you very much for your assistance in the Pasgear Software.

My appreciation goes to SPC especially Mr. Ueta Faasili (SPC Fisheries Advisor) for nominating me to participate in this training programme.

I would also like to thank the MRIS Team in the Fiji Fisheries Department for the gathering of the biological data, which enables me to improve my skills and knowledge in the evaluation of fisheries stock in the Fiji Islands. I also appreciate the support given by the Fiji Fisheries Senior Management particularly the Director Fisheries (Mr Sanaila Naqali) and the Principal Research Officer (Mr Aisake.T. Batibasaga).

LIST OF RERERENCES

Albersberg, B. (2002). Sustainable Coastal Resource management for Fiji. A Background Paper prepared for the Fiji National Workshop on Integrated Coastal Management.

Asian Development Bank (2005). Fisheries Sector Review. Republic of the Fiji Islands.

Batibasaga, A.T. (2006). Report on activities to International Coral Reef Initiative (ICRI).

Brock, R.E. (1982). A Critique of the Visual Census Method for Assessing Coral Reef Populations. *Bulletin of Marine Science* 32 (1): 269-276.

Burke, L and Maiden, J. (2004). Reefs at Risk in the Caribbean. Threats to Reefs. World Resource Institute. pp. 31.

Dulvy, N.K., Polunin, N.V.C., Mill, A.C., Graham, N.A.J. (2004a). Size structural change in lightly exploited coral reef fish communities: evidence for weak indirect effects. *Canadian Journal of Fisheries and Aquatic Sciences* 61: 466 – 475.

Dulvy, N.K and Polunin, N.V.C. (2004b). Using informal knowledge to infer human induced rarity of a conspicuous reef fish. *Animal Conservation* 7:365 – 374.

Espana, P.H. (2003). Ecological importance of snappers in the stability of modelled coastal ecosystems. *Ecological Modelling* 168:13 -24.

Fiji Bureau of Statistics (2009). Online Report. [December 2009] <http://www.statsfiji.gov.fj/>

Friedlander, A.M., Parrish, J.D. (1998). Habitat characteristics affecting fish assemblages on a Hawaiian coral reef. *Journal of Experimental Marine Biology and Ecology* 224: 1–30.

Food and Agriculture Organization of the United Nations (FAO) (2009). National Fishery Sector Overview Fiji. Fishery and Aquaculture Country Profile. Rome: FAO.

Gallucci, V.F., Saila, S.B., Gustafson, D.J., Rothschild, B.J. (1996). Stock Assessment-Quantitative Methods and Applications for Small-Scale Fisheries. London: Lewis Publishers.

Graham, N.A.J., Dulvy, N.K., Jennings, S., Polunin,N.V.C. (2005). Size-spectra as indicators of the effects of fishing on coral reef fish assemblages. *Coral Reefs* 24: 118–124.

Hoffmann, T.C. (2002). Coral reef health and effects of socio-economic factors in Fiji and Cook Islands. *Marine Pollution Bulletin* 44:1281-1293.

Hunt, C. (1999). Fiji's Fisheries: their contribution to development and their future. *Marine Policy* 23(6): 571- 585.

Jennings, S and Polunin, N.V.C. (1995). Biased Underwater Visual Census Biomass Estimates for Target Species in Tropical Reef Fisheries. *Journal of Fish Biology* 47:733-736.

Jennings, S., Grandcourt, E.M., Polunin, N.V.C. (1995). The effects of fishing on the diversity, biomass and trophic structure of Seychelles' reef fish communities. *Coral Reefs* 14:225-235.

Jennings, S., Polunin, N.V.C. (1996). Effects of Fishing Effort and Catch Rate upon the Structure and Biomass of Fijian Reef Fish Communities. *Journal of Applied Ecology* 33: 400-412.

Jennings, S., Polunin, N.V.C. (1997). Impacts of predator depletion by fishing on the biomass and diversity of non – target reef fish communities. *Coral Reefs* 16: 71 – 82.

Kuster, C., Vuki, V.C., Zann, L.P. (2005). Long term trends in subsistence fishing patterns and coral reef fisheries yield from a remote Fijian village. *Fisheries Research* 76: 221-228.

Kuster, C., Vuki, V.C., Zann, L.P. (2006). Validation of the accuracy of household reporting of subsistence fishing catch and effort: a Fijian case study. *Fisheries Management and Ecology* 13:177–184.

Labrosse, P., Kulbicki, M., Ferraris, J. (2002). Underwater Visual Census Surveys – Proper use and Implementation. Noumea: Secretariat of the South Pacific.

MacClanahan, T, Polunin, N, Done, T. (2002). Ecological states and the resilience of coral reefs. *Conservation Ecology* 6 (2):18.

National Fishery Sector Overview –Fiji. FAO Report October 2009. Rome: FAO.

National Geographic Magazine (2004). Map of Fiji. [November 2009]. <ngm.nationalgeographic.com/ngm/0411/feature3/map.html>

Raj, J., Evans, N. (2009). The Role of Trade in Fisheries Production and Consumption in Fiji. Suva: Marine Studies Programme, University of the South Pacific.

Reef Base Online GIS. Map of Fiji. [December 2009] <reefgis.reefbase.org>

Sadovy, Y., Domeier,M. (2005). Are aggregation fisheries sustainbale? Reef fish fisheries as a case study. *Coral Reefs* 24: 254–262.

Sadovy, Y.,Batibasaga,A. (2006). Reef Fishery Workshop in Fiji.

Starkhouse, B.A. (2009). What's the catch: Uncovering the Catch Volume and Value of Fiji's Coral Reef Based Artisanal and Subsistence Fisheries. MSc Thesis. University of British Columbia.

Teh, L.C.L.,Teh, L.S.L., Starkhouse,B., Sumaila, U.R. (2009). An overview of socio-economic and ecological perspectives of Fiji's inshore reef fisheries. *Marine Policy* 33:807–817.

UNESCO (Office of the Regional Advisor for Culture in Asia and the Pacific) (2000). Culture Heritage Management and Tourism: Models for Cooperation among Stakeholders: A Case Study on Levuka, Fiji Islands.

Veitayaki, J. (1995). *Fisheries development in Fiji: the quest for sustainability*. Institute of Pacific Studies. Suva: University of the South Pacific.

Veitayaki, J. (1999). *Customary Marine Tenure and the empowerment of resource owners in Fiji,* Oceans in the new millennium: challenges and opportunities for the Islands.Constanta: International Oceans Institute. p. 148-150.

Wilson, S.K, Fisher, R, Pratchett, M.S., Graham, N.A.J... Dulvy, N.K.,Turner, R.A. Cakacaka, A., Polunin, N.V.C and Rushton,S.P. (2008). Exploitation and habitat degradation as agents of change within coral reef fish communities. *Global Change Biology* 14: 2796–2809.

Wilson, S.K, Fisher, R, Pratchett, M.S, Graham, N.A.J, Dulvy, N.K, Turner, R.A, Cakacaka, A, Polunin, N.V.C. (2010). Habitat degradation and fishing effects on the size structure of coral reef fish communities. Ecological Applications 20(2): 445-451.

Yeeting B.M., Labrosse P., Adams, T.J.H. (2001). The Live Reef Food Fish of Bua Province, Fiji Islands. Technical Report. Noumea: Secretariat of the South Pacific.

APPENDIX
Appendix 1
Table 7: Total fish count and number of species per Family.

Family	Total Count of Fishes	No. Of Species
Carangidae	63	10
Carcharhinidae	12	1
Haemulidae	26	7
Lethrinidae	752	17
Lutjanidae	2,842	22
Scombridae	363	4
Serranidae	216	21
Sphyraenidae	146	2
Scaridae	3,358	38
Acanthuridae	4,204	37
Labridae	1,401	67
Balistidae	249	12
Caesionidae	3,832	11
Gerreidae	21	
Hemiramphidae	95	2
Holocentridae	239	16
Mugilidae	65	3
Mullidae	1,121	15
Nemipteridae	370	8
Siganidae	1,057	14
Terapontidae	22	1
Zanclidae	139	1
Nemipteridae	370	8
Aulostomidae	3	1
Blennidae	76	7
Bothidae	1	1
Chaetodontidae	1,412	41
Chanidae	6	1
Cichlidae	2	1
Cirrhitidae	2	1
Dasyatidae	1	1
Diodontidae	6	2
Echeneidae	4	1
Eleotridae	2	1
Ephippidae	37	3
Fistularidae	2	1
Gerreidae	21	2
Gobiidae	27	8
Kyphosidae	47	3
Monacanthidae	6	5
Apogonidae	165	16
Ostraciidae	4	3
Pinguipedidae	91	6
Platycephalidae	4	1
Plotosidae	30	1
Polynemidae	5	1
Pomacanthidae	687	11
Pomacentridae	9,827	110
Priacanthidae	1	1
Scorpaenidae	3	1
Soleidae	7	1
Sparidae	2	1
Syngnathidae	5	1
Synodontidae	7	3
Muraenidae	2	2
Tetraodontidae	27	10
TOTAL	**33,094**	

Appendix 2a

Table 8: Abundance and Biomass per 500m^2 with standard error (SE) of the most important food fish families per I Qoliqoli. The list of families is arranged according to the high commercial to the least. However, Shark (Carcharhinidae) is placed on the list, because of the high commercial values of shark fins.

Family	Nayau Is		Oneata Is		Naikorokoro		Namuana		Tikina Nasinu		Tikina Levuka		Karoko		Vusasivo	
	Density	Biomass	Density	Biomass	Density	Biomass	Density	Biomass	Density	Biomass	Density	Biomass	Density	Biomass	Density	Biomass
Lutjanidae	54.3±55.1	28.1±30	27.5±48.4	3.6±4.6	3.6±4.6	0.6±0.6			1.6±3.6	1.3±2.8	25.5±34.6	29.7±54.8	3±4.2	1.2±1.7	3±4.2	1.2±1.7
Lethrinidae	8.4±11.2	2.4±4.1	7.5±15	0.1±0.3	4±3.4	0.9±1.4	4.3±4.3	0.7±0.7	9.4±2.7	2±0.9	3±2.8	3.1±3.3	1±1.4	0.1±0.2		
Serranidae	4.7±3	2.5±2.9	0.5±1	0.3±0.5	0.7±1.4	0±0.1	0.3±0.5	0±0.1	0.6±0.9	0.2±0.2	0.5±0.7	0.6±0.9	2±2.8	0.3±0.4	2±2.8	0.3±0.4
Carangidae	0.3±0.8	0.7±1.7					0.3±0.5	0.1±0.3	0.4±0.9	0.9±2.1			15±2.1			
Haemulidae	0.3±0.5	0.3±0.6														
Scombridae	0.3±0.5	1.3±2.3					16.5±21.8	3.9±4.8								
Sphyraenidae																
Scaridae	59.3±32.2	23.2±19.5	27.5±48.4	3.6±4.6	19.2±13.8	4.6±3.5	87.3±114.5	14.4±8.7	7.4±2.5	2.9±0.4	6±3.4	5±3.8	28±28.3	4.3±1.2	28±28.3	4.3±1.2
Acanthuridae	84.6±75.9	19.2±20.3	27.5±48.4	3.6±4.6	61.1±31.2	11.1±8.3	79.5±36.5	21.8±18.2	11.2±8.5	1.9±2.2	21.5±6.4	7.3±1.9	38.5±31.8	8.2±1.8	38.5±31.8	8.2±1.8
Mullidae	28.9±38.2	17.1±32.1	1.5±1.7	0.4±0.4	5.9±4.8	0.9±0.8	9.8±13.3	2.7±4.5	15.8±16.8	4.5±4.6	3.5±0.7	1.4±0.8	10±9.9	0.8±0.2	10±9.9	0.8±0.2
Labridae	16±17.7	5.2±6.3	9±11.6	0.7±0.8	14.6±7.6	2.3±1.6	13±6.7	1.7±0.8	9.4±2.7	2±0.9	4	3.1±3.3	10.5±10.6	1±0.2	10.5±10.6	1±0.2
Holocentridae	7.6±13.1	1±1.3			0.9±1.5	0.4±1			1.8±1.8	1.1±1.2	1±1.4	0.3±0.4	1.5±2.1	0.5±0.7	1.5±2.1	0.5±0.7
Nemipteridae	1.1±1.7	0.1±0.1	3.8±6.8	0.1±0.1	39.2±104.9	23.2±67.6	4.8±4	0.9±1.2	3.8±4.4	1±1.4	0.5±0.7	0.1±0.1	1±1.4	0.2±0.3	1±1.4	0.2±0.3
Siganidae	1.6±2.3	0.2±0.4			11.2±7.8	2.4±3.4	21±23.8	2±2.6	1.2±1.3	0.2±0.2	4.5±0.7	0.9±0.2				
Caesionidae	27.9±50.2	5.5±10			1±3	0.1±0.2			4.8±6.7	0.2±0.3	15±21.2	0.5±0.7				
Balistidae	4.7±3.6	2±3.3	2±4		2.1±2.2	2.4±5.7	2.5±3	0.5±0.7	1.2±0.8	0.6±1.2	3	8.1±2	1	0.1±0.2	1	0.1±0.2
Carcharhinidae	0.4±0.8	2.8	5.1													

This paper should be cited as:
Tuquiri, N. K. 2010. *Reef fish assessment in Fiji's I Qoliquli.* United Nations University Fisheries Training Programme, Iceland [final project].
http://www.unuftp.is/static/fellows/document/nanise09prf.pdf

Appendix 2b

Table 9: Abundance and biomass per 500m^2 with standard error (SE) of the most important food fish families in the main island Viti Levu. The list of the species is arranged according to the high commercial to the least. However, Shark (Carcharchinidae) is placed on the list, because of its high value in shark fin trade.

Family	Rakiraki		Wananavu		Ba		Tavua		Galoa		Namaqumaqua		Lami		Mau	
	Density	Biomass	Density	Biomass	Density	Biomass	Density	Biomass	Density	Biomass	Density	Biomass	Density	Biomass	Density	Biomass
Lutjanidae	73±11.3	17.3±2.2	7.5±0.7	2.3±0.1	4.1±9.7	1.4±2.5	28.8±53.8	6.3±10.7	18.6±40.1	2.7±4.3			13±18.4	2.5±3.5	13±26.9	1.8±3.3
Lethrinidae			3±1.0	0.1±0.01			4.7±15.4	0.8±2.4	3.9±6.9	1.7±3.5	2.1±2.9	0.7±1.1			12.2±11.8	3.4±2.8
Serranidae			4.5±2.1	1±0	0.6±0.8	0.4±0.7	0.4±0.5	0.3±1	0.3±0.7	0.1±0.2			26.5±31.8	2.4±1.2	2.8±2.4	0.4±0.3
Carangidae			7.5±10.6	3±4.3			1±4	0.3±1.1	0.1±0.3	0.2±0.5	0.1±0.4	0.1±0.3				
Haemulidae	0.5±0.7	0.8±0.3			0.1±0.4		0.4±0.8	0.1±0.01								
Scombridae	50±70.7	24.4±34.5					0.3±0.7	0.2±0.6	0.2±1	0.1±0.3			32.5±46	13.9±19.7		
Sphyraenidae			5±7.1	2.2±3.1			2.3±9	0.3±1								
Scaridae	7±7.1	1.2±1.5	11±15.6	4±5.6	27.7±16	5.4±3.9	22.9±16.2	8.8±6.9	6±7	2.1±2.7	2.6±4.5	0.8±1.5	5.5±7.8	1.5±2.1	35.4±36.6	11.6±21
Acanthuridae	5.5±6.4	1.6±1.0	15.5±12	5.2±5.2	4±3.6	0.8±0.8	9.8±13.1	4±5.9	8.4±9.1	1.7±2.1	10±6.2	2.1±1.2	58.5±82.7	23.7±33.5	29±19.3	3.6±2.5
Mullidae	0.5±0.7	0.3±0.4	19±5.7	5.1±3.8	1.3±3	0.2±0.4	6±11	3.4±9.5	4.5±7	0.9±1.7	3.1±3.4	0.7±0.6	31±33.9	5.6±1.6	8±4.6	1.3±1.4
Labridae	4.5±2.1	0.3±0.1	4.5±6.4	0.6±0.9	10±6.7	1±0.9	9.1±4.7	1.3±1.2	3.9±5.9	0.4±0.8	5.9±4.2	0.9±0.9	19±26.9	0.7±1	6.2±10	0.3±0.4
Holocentridae			7±1.0	1.0±0.1	1.9±4.9	1.2±3.2	0.4±1	0.1±0.3	1.1±5.1	0.4±1.9	0.1±0.4					
Nemipteridae	3±1.4	0.2±0.1	2±0.1	0.4±0.1	6.3±6.2	0.5±0.4	4±2.2	0.4±0.3	0.7±1.6	0.1±0.4	0.8±0.9	0.1±0.1			1.6±1.7	0.2±0.2
Siganidae	1.5±0.7	0.3±0.1	17±5.7	2.4±2.2	3.4±2.9	0.3±0.2	18.9±50.4	9.4±35.3	0.6±1.6	0±0.1	1.4±2	0.2±0.3	62±87.7	2.3±3.3	8.4±15.6	0.8±1.3
Caesionidae	81.5±54.4	14.9±3.6	10±14.1	0.3±0.4	112.1±141	8.5±11.6	31.4±87.3	3.7±10.6	20±38.1	1.5±3						
Balistidae	0.5±0.7		1.5±0.7	0.3±0.3			1.3±2	0.4±1	0.8±1.8	0.1±0.2	2±2.8	0.4±0.7	0.5±0.7	0±0.1	0.8±1.8	
Carcharhinidae							0.2±0.4	1.5±4.3							0.2±0.4	0.9±2
Mugilidae			12.5±17.7	16.1±8.7												

Gerreidae			3.5±0.7	0.6±0.1												

Appendix 3a

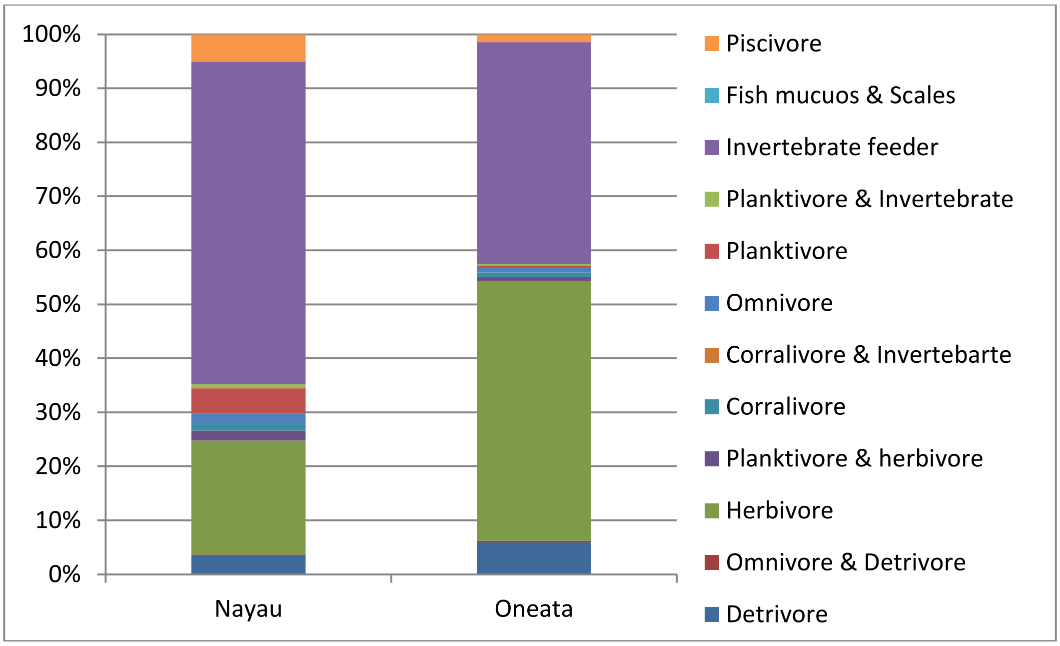

Figure 35: Trophic network of fish community in Nayau Island and Oneata Island (Lau Group), East Fiji.

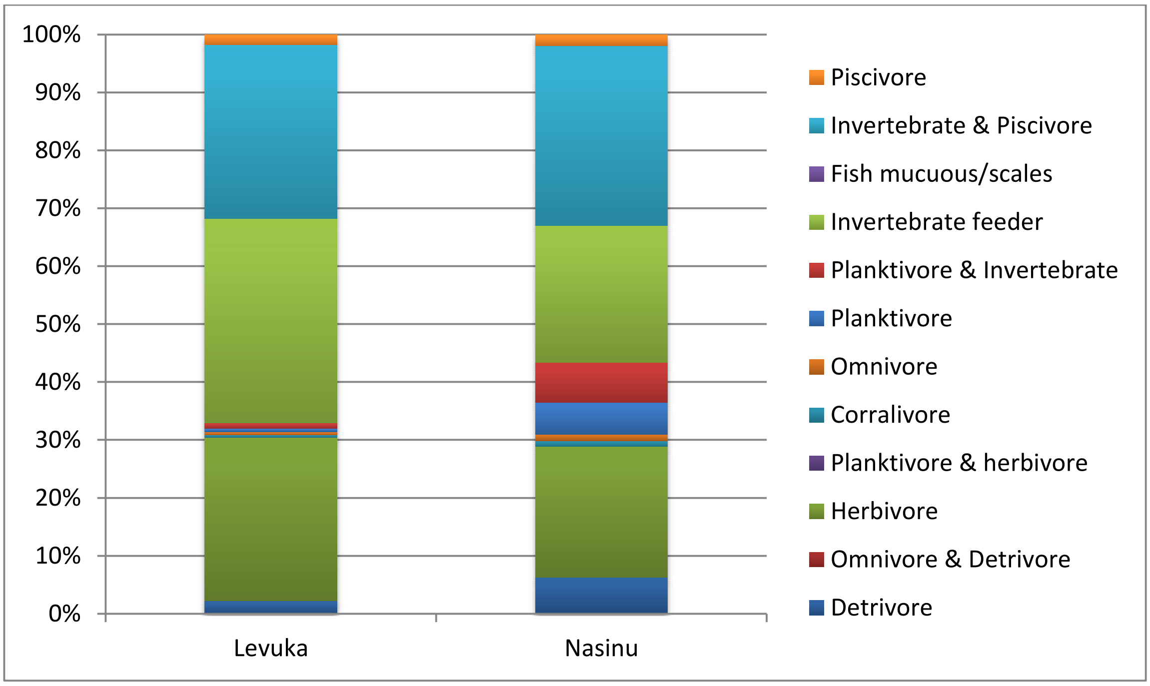

Figure 36: Trophic network of fish community in Tikina Levuka and Tikina Nasinu, Ovalau, Central Fiji.

This paper should be cited as:
Tuquiri, N. K. 2010. *Reef fish assessment in Fiji's I Qoliquli.* United Nations University Fisheries Training Programme, Iceland [final project].
http://www.unuftp.is/static/fellows/document/nanise09prf.pdf

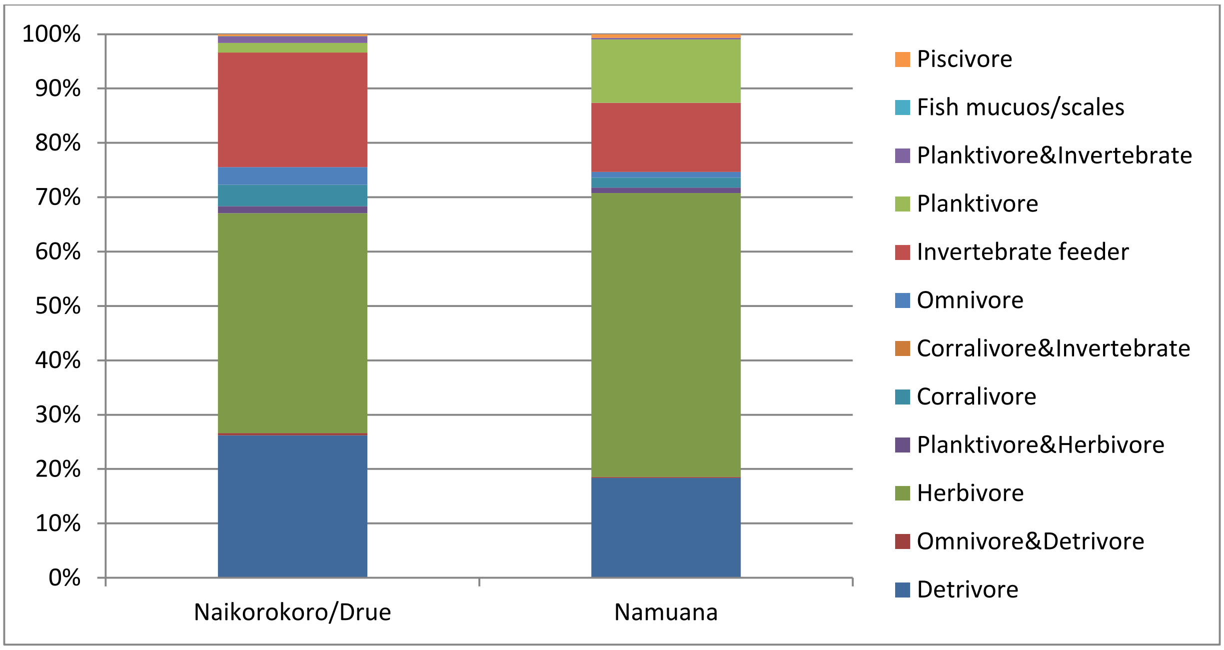

Figure 37: Trophic network of fish community in Naikorokoro and Namuana, Kadavu Island, South Fiji.

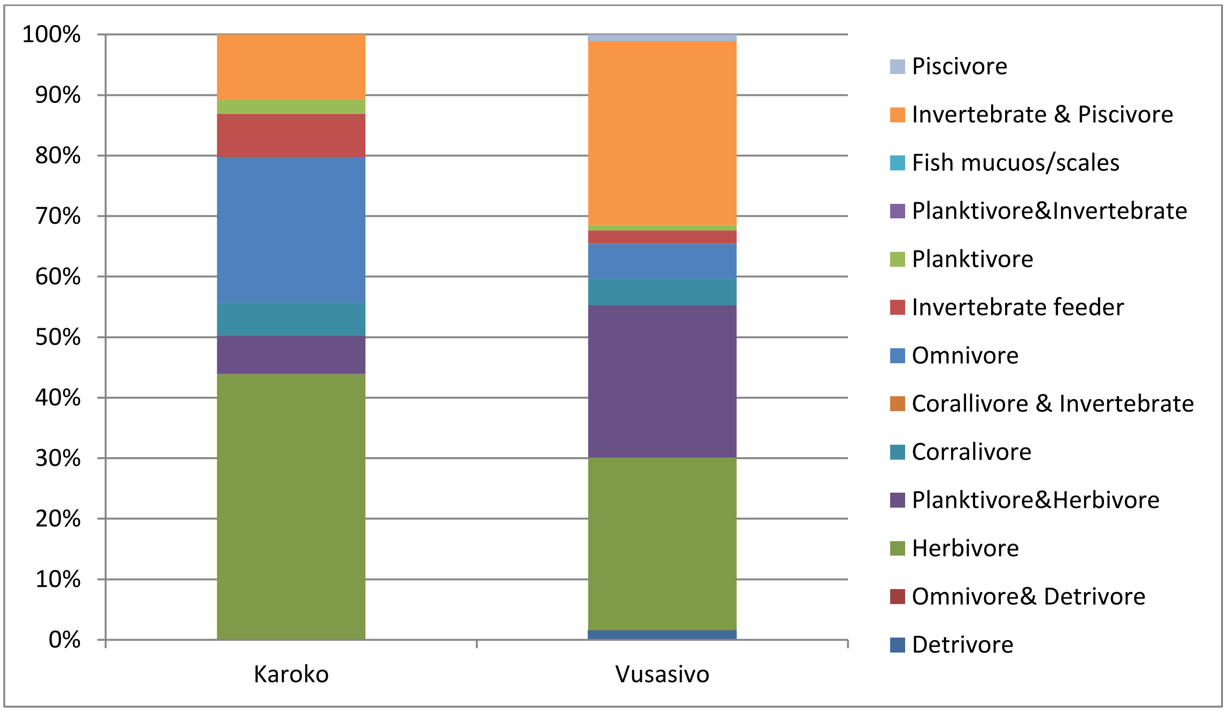

Figure 38: Trophic network of fish community in Karoko (Tunuloa) and Vusasivo (Natewa), North Fiji.

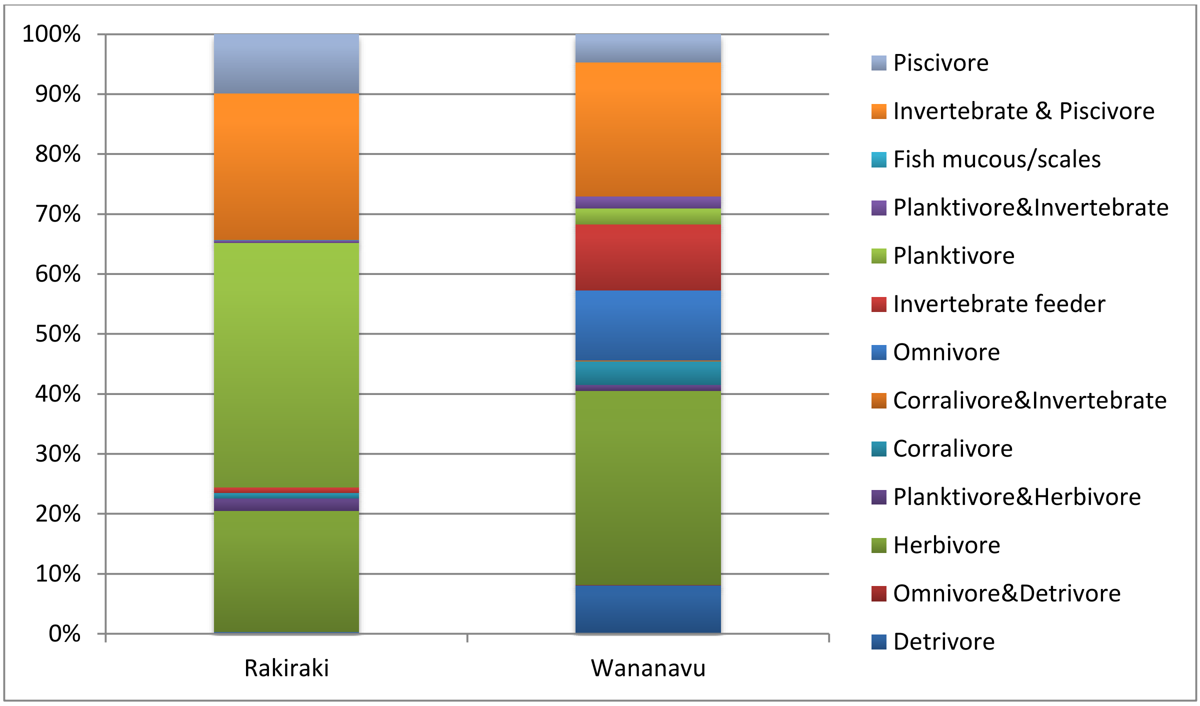

Figure 39: Trophic network of fish community in Rakiraki and Wananavu, Ra, North Viti Levu.

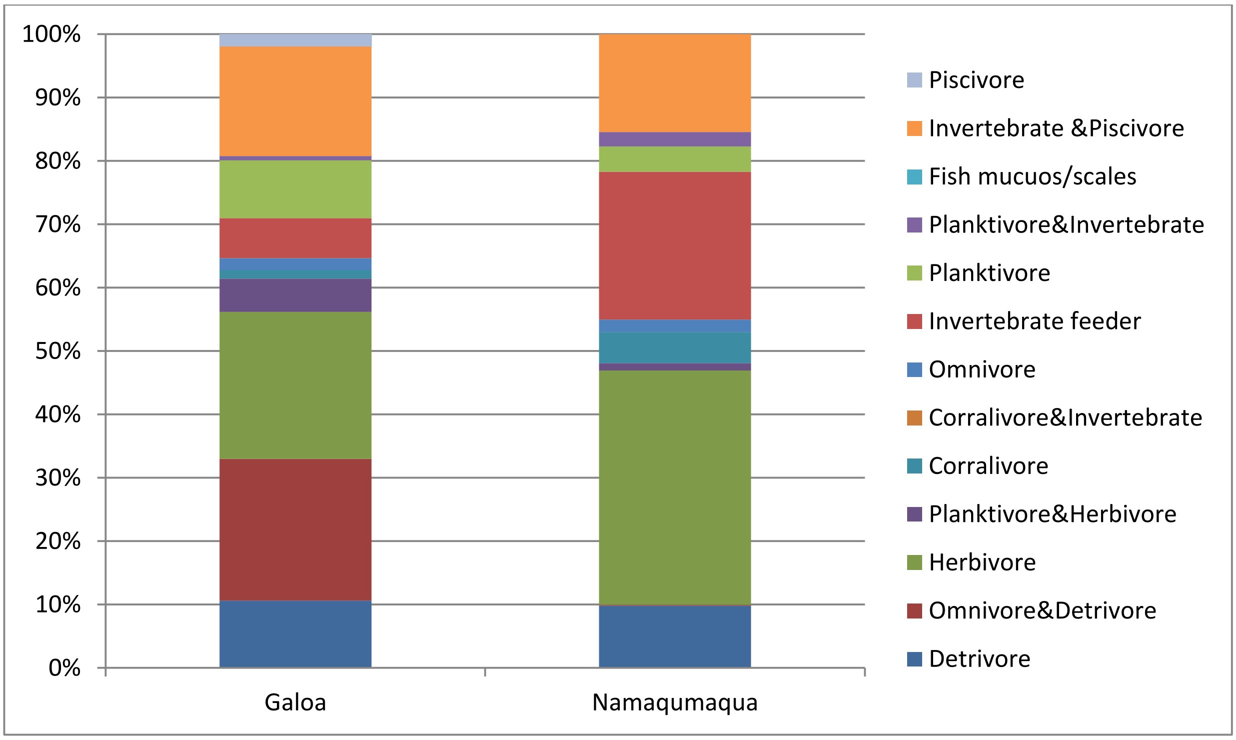

Figure 40: Trophic network of fish comunity in Galoa and Namaqumaqua, Serua, South Viti Levu.

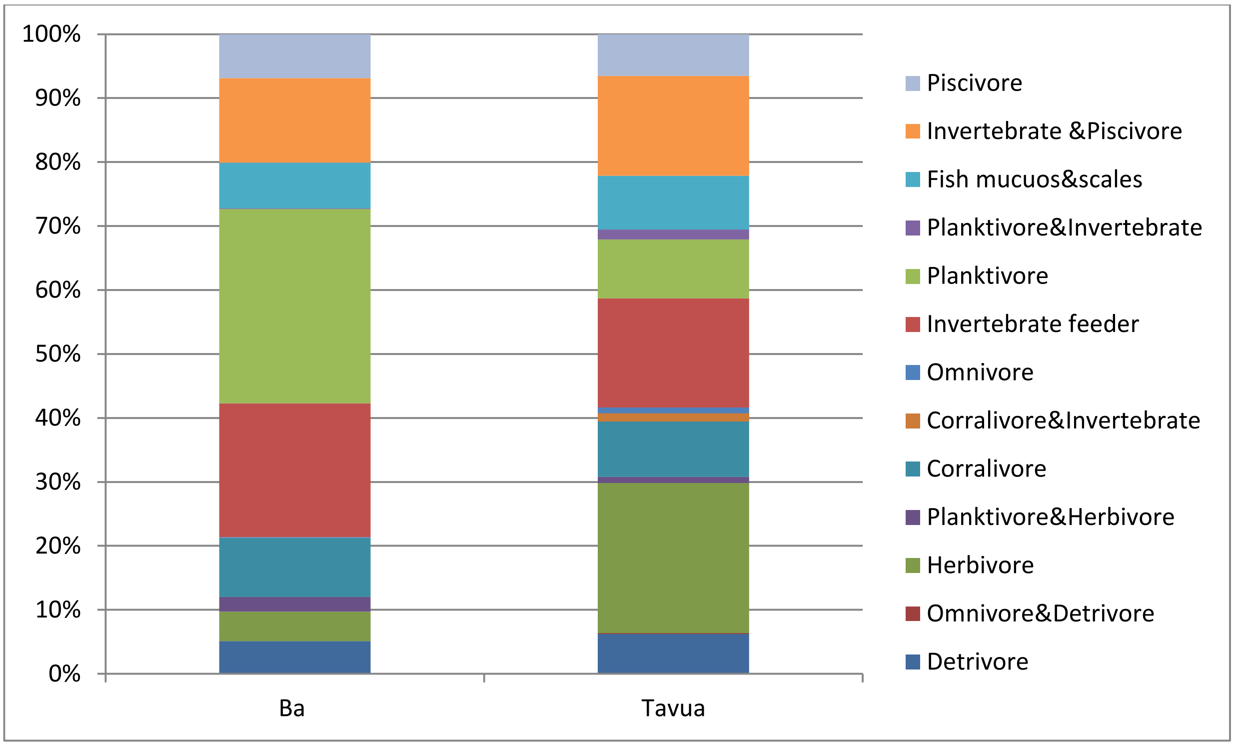

Figure 41: Trophic network of fish community in Ba and Tavua, Ba Province, West Viti Levu.

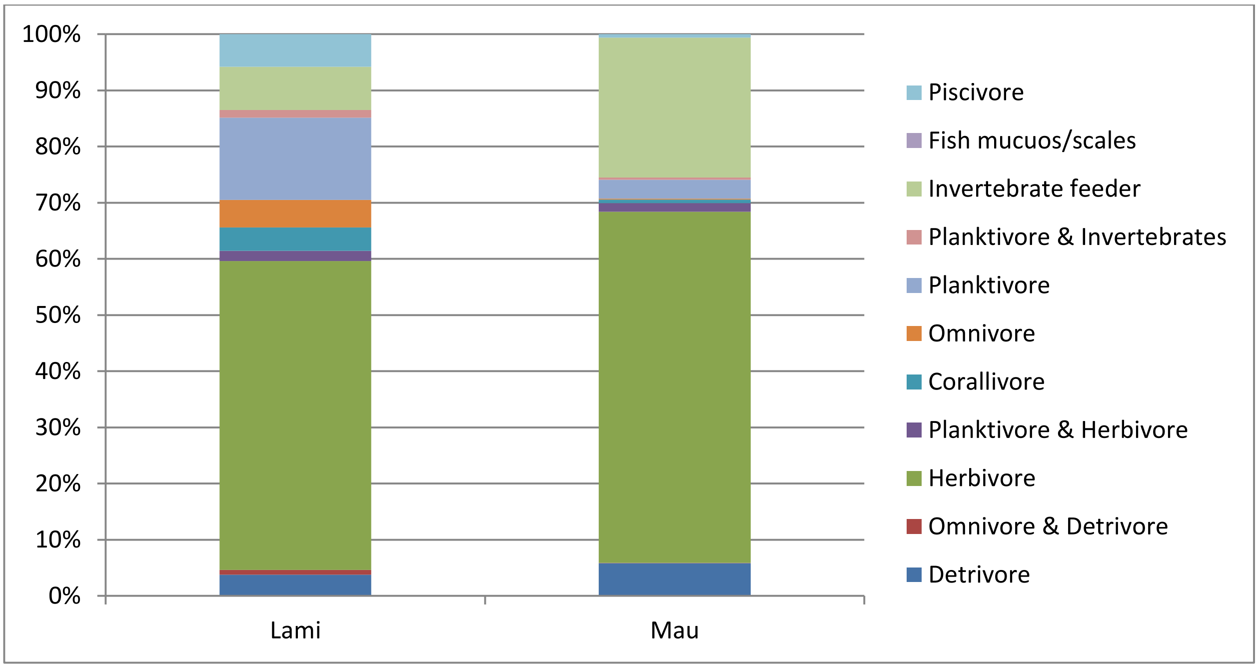

Figure 42: Trophic network of fish community in Lami and Mau, East Viti Levu.

Appendix 3b

Table 10: Fish species assigned into trophic groups (Jennings et al. 1995 and Fish Base (www.fishbase.org)).

Family	**Trophic Group**
Acanthuridae	
Acanthurus grammoptilus	Herbivorous
Acanthurus maculiceps	Herbivorous
Acanthurus nigrofuscus	Herbivorous
Acanthurus achilles	Herbivorous
Acanthurus albipectoralis	Herbivorous
Acanthurus auranticavus	Herbivorous
Acanthurus blochii	Herbivorous
Acanthurus fowleri	Herbivorous
Acanthurus grandoculis	Herbivorous
Acanthurus guttatus	Herbivorous
Acanthurus japonicus	Herbivorous
Acanthurus leuchocheilus	Herbivorous
Acanthurus lineatus	Herbivorous
Acanthurus mata	Herbivorous
Acanthurus nigricans	Herbivorous
Acanthurus nigricauda	Herbivorous
Acanthurus nigroris	Herbivorous
Acanthurus nubilus	Herbivorous
Acanthurus olivaceous	Herbivorous
Acanthurus pyroferus	Herbivorous
Acanthurus quttus	Herbivorous
Acanthurus sp.	Herbivorous
Acanthurus thompsoni	Herbivorous
Acanthurus triostegus	Herbivorous
Acanthurus xanthopterus	Herbivorous
Ctenochaetus binotatus	Herbivorous
Ctenochaetus citrinellus	Herbivorous
Ctenochaetus cyanocheilus	Herbivorous
Ctenochaetus marginatus	Herbivorous
Ctenochaetus sp.	Herbivorous
Ctenochaetus striatus	Herbivorous
Naso annulatus	Herbivorous
Naso brachycentron	Herbivorous
Naso brevirostis	Herbivorous
Naso caesius	Herbivorous
Naso hexacanthus	Herbivorous
Naso lituratus	Herbivorous
Naso unicornis	Herbivorous
Naso vlamingii	Herbivorous
Zebrasoma desjardini	Herbivorous

Zebrasoma rostratum	Herbivorous
Zebrasoma scopas	Herbivorous
Zebrasoma veliferum	Herbivorous
Apogonidae	
Apogon compressus	Planktivore & Invertebrate
Apogon cookii	Planktivore & Invertebrate
Apogon dispar	Planktivore & Invertebrate
Apogon guamensis	Planktivore & Invertebrate
Apogon heptacanthus	Planktivore & Invertebrate
Apogon nigrofasciatus	Planktivore & Invertebrate
Apogon novemfasciatus	Planktivore & Invertebrate
Apogon novemferum	Planktivore & Invertebrate
Archamia zosterophora	Planktivore & Invertebrate
Cheilodipterus quinquelineatus	Invertebrate & Piscivore
Cheilodipterus sp.	Invertebrate & Piscivore
Cheilodipterus macrodon	Piscivore
Fowleria variegata	Planktivore & Invertebrate
Sphaeramia orbicularis	Invertebrate feeder
Balistidae	
Balistapus undulatus	Omnivore
Rhinecanthus aculeatus	Omnivore
Rhinecanthus lunula	Omnivore
Rhinecanthus rectangulus	Omnivore
Rhinecanthus verrucosus	Omnivore
Sufflamen bursa	Invertebrate feeder
Sufflamen chrysopterus	Invertebrate feeder
Xanthichthys auromarginatus	Planktivore.
Pseudobalistes flavimarginatus	Invertebrate feeder
Melichthys vidua	Omnivore
Abalistes stellatus	Invertebrate feeder
Bleniidae	
Cirripectes chelomatus	Herbivore
Glyptoparus delicatulus	Herbivore
Plagiotremus landandus	Fish mucuous & scales
Plagiotremus rhinorhynchos	Fish mucuous & scales
Plagiotremus sp.	Fish mucuous & scales
Salarias fasciatus	Herbivore
Meiacanthus atrodorsalis	Planktivore & Invertebrate
Caesionidae	
Caesio caerulaurea	Planktivore
Caesio lunaris	Planktivore
Caesio teres	Planktivore
Caesio varilineata	Planktivore
Caesio xanthorota	Planktivore

Pterocaesio digramma	Planktivore
Pterocaesio marri	Planktivore
Pterocaesio pisang	Planktivore
Pterocaesio tile	Planktivore
Pterocaesio trilineata	Planktivore
Gymnocaesio gymnoptera	Planktivore
Carangidae	
Caranx ignobilis	Invertebrate feeder & Piscivore
Caranx melampygus	Invertebrate feeder & Piscivore
Gnathanodon speciosus	Invertebrate feeder & Piscivore
Scomberoides commersonnianus	Invertebrate feeder & Piscivore
Scomberoides lysan	Invertebrate feeder & Piscivore
Elagatis bipinnulata	Invertebrate feeder & Piscivore
Caranx lugubris	Piscivore
Caranx papuensis	Piscivore
Carangoides plagiotaenia	Planktivore & Invertebrate
Carangoides sp.	Planktivore & Invertebrate
Carchahinidae	
Triaenodon obesus	Invertebrate feeder & Piscivore
Chanidae	
Chanos chanos	Herbivore
Chichlidae	
Hemichromis sp.	Invertebrate feeder & Piscivore
Cirrhitidae	
Paracirrhites forsteri	Invertebrate feeder & Piscivore
Chaetodontidae	
Chaetodon auriga	Corralivore
Chaetodon austriacus	Corralivore
Chaetodon baronessa	Corralivore
Chaetodon benetti	Corralivore
Chaetodon cellicaudus	Corralivore
Chaetodon citrinellus	Corralivore
Chaetodon decussatus	Corralivore
Chaetodon ephippium	Corralivore
Chaetodon falcula	Corralivore
Chaetodon fasciatus	Corralivore
Chaetodon guentheri	Corralivore
Chaetodon kleinii	Corralivore
Chaetodon lineolatus	Corralivore
Chaetodon lunula	Corralivore
Chaetodon lunulatus	Corralivore
Chaetodon melannotus	Corralivore
Chaetodon mertensii	Corralivore
Chaetodon mesoleucus	Corralivore

Chaetodon meyersi	Corralivore
Chaetodon ocellicaudus	Corralivore
Chaetodon ornatissimus	Corralivore
Chaetodon ornatus	Corralivore
Chaetodon oxycephalus	Corralivore
Chaetodon pelewensis	Corralivore
Chaetodon plebeius	Corralivore
Chaetodon punctatofasciatus	Corralivore
Chaetodon rafflesi	Corralivore
Chaetodon reticulatus	Corralivore
Chaetodon semeion	Corralivore
Chaetodon sp.	Corralivore
Chaetodon speculum	Corralivore
Chaetodon trifascialis	Corralivore
Chaetodon trifasciatus	Corralivore
Chaetodon ulientensis	Corralivore
Chaetodon unimaculatus	Corralivore
Chaetodon vagabundus	Corralivore
Dasyatidae	
Taeniura lymma	Invertebrate feeder
Diodontidae	
Diodon hystrix	Invertebrate feeder
Diodon liturosus	Invertebrate feeder
Echeneidae	
Echeneis naucrates	Piscivore
Eleotridae	
Oxyeleotris sp.	Invertebrate feeder & Piscivore
Ephippidae	
Platax boersii	Omnivore
Platax orbicularis	Omnivore
Platax teira	Omnivore
Fistularidae	
Fistularia commersonii	Invertebrate feeder & Piscivore
Gerreidae	
Gerres argyreus	Detrivore
Gerres oyena	Planktivore & Invertebrate
Gobiidae	
Amblyeleotris randalli	Planktivore
Amblygobius nocturnus	Omnivore & Detrivore
Amblygobius phalaena	Omnivore & Detrivore
Cryptocentrio cyanotaenia	Planktivore
Istigobius decoratus	Herbivore
Stonogobiops xanthorhinica	Planktivore
Valenciennea sexguttata	Invertebrate feeder

Valenciennea strigata	Invertebrate feeder
Haemulidae	
Haemulon sp.	Omnivore
Plectorhinchus albovittatus	Invertebrate feeder
Plectorhinchus chaetodonoides	Invertebrate feeder
Plectorhinchus multivittatum	Invertebrate feeder
Plectorhinchus pictus	Invertebrate feeder
Plectorhinchus sp.	Invertebrate feeder
Plectorhinchus vittatus	Invertebrate feeder
Hemiramphidae	
Hemiramphus far	Herbivore
Hyporhamphus dussumieri	Planktivore
Holocentridae	
Myripristis adusta	Planktivore
Myripristis amaena	Invertebrate feeder
Myripristis hexagon	Planktivore
Myripristis murdjan	Planktivore
Myripristis pralinia	Planktivore
Myripristis violacea	Invertebrate feeder
Myripristis vittata	Planktivore
Neoniphon argenteus	Invertebrate feeder
Neoniphon opercularis	Invertebrate feeder
Neoniphon sammara	Invertebrate feeder
Sargocentron candimaculatum	Invertebrate feeder
Sargocentron diadema	Planktivore
Sargocentron ittodai	Invertebrate feeder
Sargocentron spiniferum	Invertebrate feeder & Piscivore
Sargocentron tiere	Invertebrate feeder & Piscivore
Sargocentron violaceum	Invertebrate feeder
Kyphosidae	
Kyphosus bigibbus	Herbivore
Kyphosus cinerascens	Herbivore
Kyphosus vaigiensis	Invertebrate feeder
Labridae	
Anampes geographicus	Invertebrate feeder
Anampses caeruleopunctatus	Invertebrate feeder
Anampses geographicus	Invertebrate feeder
Anampses meleagrides	Invertebrate feeder
Anampses neoguinaicus	Invertebrate feeder
Bodianus bilunulatus	Invertebrate feeder
Bodianus loxozonus	Invertebrate feeder
Bodianus mesothorax	Invertebrate feeder
Cheilinus chlorourus	Invertebrate feeder
Cheilinus digrammus	Piscivore

Cheilinus fasciatus	Invertebrate feeder
Cheilinus lunulatus	Invertebrate feeder
Cheilinus oxycephalus	Invertebrate feeder
Cheilinus trilobatus	Invertebrate feeder
Cheilinus undulatus	Invertebrate feeder
Cheilio inermis	Invertebrate feeder
Coris aygula	Invertebrate feeder
Coris bulbifrons	Invertebrate feeder
Coris gaimard	Invertebrate feeder
Epibulus epibulus	Invertebrate & Piscivore
Epibulus insidiator	Invertebrate & Piscivore
Gomphosus varius	Invertebrate feeder
Halichoeres hortulanus	Invertebrate feeder
Halichoeres argus	Invertebrate feeder
Halichoeres binotopsis	Invertebrate feeder
Halichoeres biocellatus	Invertebrate feeder
Halichoeres chloropterus	Invertebrate feeder
Halichoeres dussumieri	Invertebrate feeder
Halichoeres hortulanus	Invertebrate feeder
Halichoeres leucurus	Invertebrate feeder
Halichoeres margaritaceus	Invertebrate feeder
Halichoeres marginatus	Invertebrate feeder
Halichoeres melanurus	Invertebrate feeder
Halichoeres nigrescens	Invertebrate feeder
Halichoeres ornatissimus	Invertebrate feeder
Halichoeres prosopeion	Invertebrate feeder
Halichoeres sp.	Invertebrate feeder
Halichoeres trimaculatus	Invertebrate feeder
Halichoeres vrolikii	Invertebrate feeder
Hemigymnus fasciatus	Invertebrate feeder & Piscivore
Hemigymnus melapterus	Invertebrate feeder & Piscivore
Hologymnosus doliatus	Invertebrate feeder & Piscivore
Labroides bicolor	Invertebrate feeder
Labroides dimidiatus	Invertebrate feeder
Labroides pectoralis	Fish mucous & scales
Labropsis australis	Corralivore
Novaculichltys taeniourus	Invertebrate feeder
Oxycheilinus digrammus	Invertebrate feeder
Oxycheilinus rhodochrous	Invertebrate feeder
Oxycheilinus sp.	Invertebrate feeder
Oxycheilinus unifasciatus	Invertebrate feeder & Piscivore
Pseudodax mollucanus	Omnivore
Pseudojuloides cerasinus	Invertebrate feeder
Stethojulis bandanensis	Planktivore & Invertebrate

Stethojulis notialis	Invertebrate feeder
Stethojulis strigiventer	Detrivore
Thalassoma amblycephalum	Planktivore.
Thalassoma hardwicke	Invertebrate feeder
Thalassoma intesceris	Invertebrate feeder
Thalassoma jansenii	Invertebrate feeder
Thalassoma klunzingeri	Invertebrate feeder
Thalassoma lunare	Invertebrate feeder
Thalassoma lutescens	Invertebrate feeder
Thalassoma purpureum	Invertebrate feeder
Thalassoma quinquevittatum	Invertebrate feeder
Thalassoma sp.	Invertebrate feeder
Thalassoma trilobatum	Invertebrate feeder
Lethrinidae	
Gnathodentex aureolineatus	Invertebrate feeder & Piscivore
Gymnocranius frenatus	Invertebrate feeder.
Gymnocranius grandoculis	Invertebrate feeder & Piscivore
Gymnocranius microdon	Invertebrate feeder
Lethrinus atkinsoni	Invertebrate feeder & Piscivore
Lethrinus erythracanthus	Invertebrate feeder
Lethrinus harak	Invertebrate feeder & Piscivore
Lethrinus mahsena	Invertebrate feeder & Piscivore
Lethrinus microdon	Invertebrate feeder & Piscivore
Lethrinus nebulosus	Invertebrate feeder & Piscivore
Lethrinus obsoletus	Invertebrate feeder & Piscivore
Lethrinus olivaceous	Invertebrate feeder & Piscivore
Lethrinus ornatus	Invertebrate feeder & Piscivore
Lethrinus rubrioperculatus	Invertebrate feeder & Piscivore
Lethrinus sp.	Invertebrate feeder & Piscivore
Lethrinus xanthochilus	Invertebrate feeder & Piscivore
Monotaxis grandoculis	Invertebrate feeder
Lutjanidae	
Aphareus furca	Invertebrate feeder & Piscivore
Aprion virescens	Piscivore
Lutjanus argentimaculatus	Piscivore
Lutjanus biguttatus	Invertebrate feeder & Piscivore
Lutjanus bohar	Piscivore
Lutjanus boutton	Invertebrate feeder & Piscivore
Lutjanus ehrenbergii	Invertebrate feeder & Piscivore
Lutjanus fulviflammus	Invertebrate feeder & Piscivore
Lutjanus fulvus	Invertebrate feeder & Piscivore
Lutjanus gibbus	Invertebrate feeder & Piscivore
Lutjanus kasmira	Invertebrate feeder & Piscivore
Lutjanus lemniscatus	Invertebrate feeder & Piscivore

Lutjanus maxweberi	Invertebrate feeder & Piscivore
Lutjanus monostigma	Invertebrate feeder & Piscivore
Lutjanus quinquelineatus	Invertebrate feeder & Piscivore
Lutjanus rivulatus	Invertebrate feeder & Piscivore
Lutjanus russelli	Invertebrate feeder & Piscivore
Lutjanus semicinctus	Piscivore
Lutjanus vittus	Invertebrate feeder & Piscivore
Macolor macularis	Planktivore
Macolor niger	Planktivore
Symphorichthys spilurus	Invertebrate feeder & Piscivore
Monacanthidae	
Aluterus scriptus	Omnivore
Amanses scopas	Omnivore
Oxymonacanthus longirostris	Corralivore
Paraluteres prionurus	Invertebrate feeder
Pseudalutarius sp.	Invertebrate feeder
Mugilidae	
Crenimugil crenilabis	Omnivore
Liza vaigiensis	Omnivore
Valamugi seheli	Herbivore
Mullidae	
Mulloidichthys flavolineatus	Invertebrate feeder & Piscivore
Mulloidichthys mimicus	Invertebrate feeder & Piscivore
Mulloidichthys pflugeri	Invertebrate feeder & Piscivore
Mulloidichthys vanicolensis	Invertebrate feeder
Parupeneus barberinoides	Invertebrate feeder
Parupeneus barberinus	Planktivore & Invertebrate
Parupeneus bifasciatus	Invertebrate feeder & Piscivore
Parupeneus ciliatus	Invertebrate feeder & Piscivore
Parupeneus cyclostomus	Invertebrate feeder & Piscivore
Parupeneus heptacanthus	Invertebrate feeder & Piscivore
Parupeneus indicus	Invertebrate feeder & Piscivore
Parupeneus multifasciatus	Invertebrate feeder
Parupeneus sp.	Invertebrate feeder & Piscivore
Parupeneus trifasciatus	Invertebrate feeder & Piscivore
Upeneus moleccensis	Invertebrate feeder & Piscivore
Muraenidae	
Gymnothorax javanicus	Invertebrate feeder & Piscivore
Gymnothorax richardsoni	Invertebrate feeder & Piscivore
Nemipteridae	
Scolopsis affinis	Invertebrate feeder
Scolopsis bilineata	Invertebrate feeder & Piscivore
Scolopsis frenatus	Invertebrate feeder
Scolopsis lineatus	Invertebrate feeder & Piscivore

Scolopsis monogramma	Invertebrate feeder & Piscivore
Scolopsis sp.	Invertebrate feeder
Scolopsis temporalis	Planktivore & Invertebrate
Scolopsis trilineatus	Planktivore & Invertebrate
Ostraciidae	
Ostracion cubicus	Omnivore
Ostracion meleagris	Omnivore
Rhynchostracion nasus	Omnivore
Pinguipedidae	
Parapercis clathrata	Planktivore
Parapercis cylindrica	Planktivore
Parapercis hexophthalma	Planktivore
Parapercis millepunctata	Planktivore
Synodus variegatus	Piscivore
Platycephalidae	
Papilloculiceps sp.	Invertebrate feeder
Plotosidae	
Plotosus lineatus	Planktivore & Invertebrate
Polynemidae	
Polydactylus sexfilis	Invertebrate feeder
Pomacanthidae	
Pomacanthus imperator	Invertebrate feeder
Pomacanthus semicirculatus	Omnivore
Pygoplites diacanthus	Invertebrate feeder
Centropyge bispinosus	Herbivorous
Centropyge centropyge	Herbivorous
Centropyge colini	Herbivorous
Centropyge flavissimus	Herbivorous
Centropyge heraldi	Herbivorous
Centropyge multicolor	Herbivorous
Centropyge multispinis	Herbivorous
Centropyge sp.	Herbivorous
Centropyge tibicen	Herbivorous
Centropyge woodheadi	Herbivorous
Pomacentridae	
Abudefduf bengalensis	Omnivore
Abudefduf sexfasciatus	Planktivore & Herbivore
Abudefduf sordidus	Omnivore
Abudefduf vaigiensis	Planktivore & Herbivore
Abudefduf whitleyi	Planktivore
Altrichthys azurelineatus	Planktivore
Amblyglyphidodon aureus	Planktivore
Amblyglyphidodon batunai	Planktivore
Amblyglyphidodon curacao	Planktivore & Herbivore

Amblyglyphidodon indicus	Planktivore
Amblyglyphidodon leucogaster	Planktivore
Amblyglyphidodon sp.	Planktivore
Amblyglyphidodon ternatensis	Planktivore
Amphiprion allardi	Planktivore
Amphiprion chrysopterus	Planktivore
Amphiprion clarkii	Planktivore
Amphiprion melanopus	Planktivore
Amphiprion rubrocinctus	Planktivore
Amphiprion sp.	Planktivore
Cheiloprion labiatus	Corralivore
Chromis agilis	Planktivore & Herbivore
Chromis analis	Planktivore
Chromis atripectoralis	Planktivore
Chromis caudalis	Planktivore
Chromis chrysura	Planktivore
Chromis dimidiata	Planktivore & Herbivore
Chromis elerae	Planktivore & Herbivore
Chromis iomelas	Planktivore & Herbivore
Chromis margaritifer	Planktivore
Chromis retrofasciata	Planktivore & Herbivore
Chromis sp.	Planktivore & Herbivore
Chromis ternatensis	Planktivore & Herbivore
Chromis viridis	Planktiovore.
Chromis weberi	Planktivore & Herbivore
Chromis xanthura	Planktivore & Herbivore
Chrysiptera biocellata	Herbivore
Chrysiptera brownriggii	Omnivore
Chrysiptera caeruleolineata	Invertebrate feeder
Chrysiptera cyanea	Omnivore
Chrysiptera glauca	Herbivore
Chrysiptera parasema	Planktivore
Chrysiptera rollandi	Planktivore
Chrysiptera springeri	Planktiovore & Herbivore
Chrysiptera starcki	Planktivore & Herbivore
Chrysiptera talboti	Planktivore
Chrysiptera taupou	Planktivore & Herbivore
Chrysiptera tricincta	Planktivore & Herbivore
Chrysiptera unimaculata	Planktivore & Herbivore
Dascyllus aruanus	Omnivore & Detrivore
Dascyllus flavicaudus	Omnivore & Detrivore
Dascyllus melanurus	Omnivore & Detrivore
Dascyllus reticulatus	Omnivore & Detrivore
Dascyllus trimaculatus	Omnivore & Detrivore

Dischistodus chrysopoecilus	Herbivore
Dischistodus prosoptaenia	Herbivore
Hemiglyphidodon plegiometopon	Herbivore
Lepidozygus tapeinosoma	Planktivore
Neoglyphidodon bonang	Planktivore & Herbivore
Neoglyphidodon carlsoni	Planktivore & Herbivore
Neoglyphidodon melas	Planktivore & Herbivore
Neoglyphidodon nigroris	Planktivore & Herbivore
Neoglyphidodon polyacanthus	Planktivore & Herbivore
Neoglyphidodon sp.	Planktivore & Herbivore
Neoglyphidodon thoracotaeniatus	Planktivore & Herbivore
Neopomacentrus azysron	Planktivore
Neopomacentrus bankieri	Planktivore
Neopomacentrus cyanomos	Planktivore
Neopomacentrus sp.	Planktivore
Neopomacentrus violascens	Planktivore
Plectroglyphidodon dickii	Omnivore
Plectroglyphidodon lacrymatus	Omnivore
Plectroglyphidodon leucozonus	Omnivore
Plectroglyphidodon phoenixensis	Herbivore
Plectroglyphidodon plectroglyphidodon	Herbivore
Pomacentridae brachialis	Planktivore & Herbivore
Pomacentridae imitator	Planktivore & Herbivore
Pomacentrus adelus	Planktivore & Herbivore
Pomacentrus albicaudatus	Planktivore & Herbivore
Pomacentrus amboinensis	Planktivore & Herbivore
Pomacentrus azyrson	Planktivore & Herbivore
Pomacentrus bankanensis	Planktivore & Herbivore
Pomacentrus brachialis	Planktivore & Herbivore
Pomacentrus chrysurus	Planktivore & Herbivore
Pomacentrus coelestis	Planktivore & Herbivore
Pomacentrus colini	Planktivore & Herbivore
Pomacentrus cuneatus	Planktivore & Herbivore
Pomacentrus lepidogenys	Planktivore & Herbivore
Pomacentrus littoralis	Planktivore & Herbivore
Pomacentrus milleri	Planktivore & Herbivore
Pomacentrus moluccensis	Planktivore & Herbivore
Pomacentrus nigromanus	Planktivore & Herbivore
Pomacentrus pavo	Planktivore & Herbivore
Pomacentrus philippinus	Planktivore & Herbivore
Pomacentrus polyspines	Planktivore & Herbivore
Pomacentrus proteus	Planktivore & Herbivore
Pomacentrus similis	Planktivore & Herbivore
Pomacentrus simsiang	Planktivore & Herbivore

Pomacentrus sp.	Planktivore & Herbivore
Pomacentrus spilotoceps	Planktivore & Herbivore
Pomacentrus trichourus	Planktivore & Herbivore
Pomacentrus tripunctatus	Planktivore & Herbivore
Pomacentrus vaiula	Planktivore & Herbivore
Pomacentrus violascens	Planktivore & Herbivore
Pomachromis richardsoni	Planktivore & Herbivore
Premnas biaculeatus	Planktivore & Herbivore
Stegastes albifasciatus	Herbivore
Stegastes fasciolatus	Herbivore
Stegastes gascoynei	Herbivore
Stegastes lividus	Herbivore
Stegastes nigricans	Herbivore
Stegastes obreptus	Herbivore
Priacanthidae	
Priacanthus hamrur	Invertebrate feeder & Piscivore
Scaridae	
Calotomus carolinus	Herbivorous
Calotomus spinidens	Herbivorous
Cetoscarus bicolor	Herbivorous
Chlorurus bleekeri	Herbivorous
Chlorurus bowersi	Herbivorous
Chlorurus capistratoides	Herbivorous
Chlorurus gibbus	Herbivorous
Chlorurus japanensis	Herbivorous
Chlorurus microrhinos	Herbivorous
Chlorurus sordidus	Herbivorous
Chlorurus sp.	Herbivorous
Chlorurus troschelii	Herbivorous
Hipposcarus harid	Herbivorous
Hipposcarus longiceps	Herbivorous
Leptoscarus vaigiensis	Herbivorous
Scarus niger	Herbivorous
Scarus altipinnis	Herbivorous
Scarus bleekeri	Herbivorous
Scarus chameleon	Herbivorous
Scarus dimidiatus	Herbivorous
Scarus flavipectoralis	Herbivorous
Scarus forsteni	Herbivorous
Scarus frenatus	Herbivorous
Scarus ghobban	Herbivorous
Scarus globiceps	Herbivorous
Scarus niger	Herbivorous
Scarus oviceps	Herbivorous

Scarus prasiognathos	Herbivorous
Scarus psittacus	Herbivorous
Scarus quoyi	Herbivorous
Scarus rivulatus	Herbivorous
Scarus rubroviolaceus	Herbivorous
Scarus russelii	Herbivorous
Scarus schlegeli	Herbivorous
Scarus spinus	Herbivorous
Scarus stronglycephalus	Herbivorous
Scarus tricolor	Herbivorous
Scarus xanthopleura	Herbivorous
Scombridae	
Rastrelliger kanagurta	Planktivore
Sarda orientalis	Invertebrate & Piscivore
Scomberomorus commerson	Piscivore
Thunnus obesus	Invertebrate feeder & Piscivore
Scorpaenidae	
Pterois volitan	Planktivore & Invertebrate
Serranidae	
Anyperodon leucogrammicus	Invertebrate feeder & Piscivore
Cephalopholis argus	Piscivore
Cephalopholis boenack	Invertebrate feeder & Piscivore
Cephalopholis urodeta	Invertebrate feeder & Piscivore
Epinephelus areolatus	Invertebrate feeder & Piscivore
Epinephelus bontoides	Invertebrate feeder & Piscivore
Epinephelus caeruleopunctatus	Invertebrate feeder & Piscivore
Epinephelus coiodes	Invertebrate feeder & Piscivore
Epinephelus longispinis	Invertebrate feeder & Piscivore
Epinephelus maculatus	Invertebrate feeder & Piscivore
Epinephelus malabaricus	Invertebrate feeder & Piscivore
Epinephelus merra	Invertebrate feeder & Piscivore
Epinephelus polyphekadion	Invertebrate feeder & Piscivore
Epinephelus sp	Invertebrate feeder & Piscivore
Gracila albormarginata	Invertebrate feeder
Plectropomus areolatus	Piscivore
Plectropomus leopardus	Invertebrate feeder & Piscivore
Plectropomus maculatus	Invertebrate feeder & Piscivore
Plectropomus pessuliferus	Piscivore
Pseudanthias pascalus	Planktivore
Variola louti	Invertebrate feeder & Piscivore
Siganidae	
Siganus argenteus	Herbivorous
Siganus corallinus	Herbivorous
Siganus doliatus	Herbivorous

Siganus guttatus	Herbivorous
Siganus puelloides	Omnivore
Siganus punctatissimus	Herbivorous
Siganus punctatus	Herbivorous
Siganus sp.	Herbivorous
Siganus spinus	Herbivorous
Siganus stellatus	Herbivorous
Siganus uspi	Herbivorous
Siganus vermiculatus	Herbivorous
Siganus virgatus	Herbivorous
Siganus vulpinus	Herbivorous
Soleidae	
Soleidae sp.	Invertebrate feeder
Sparidae	
Sarpa salpa	Omivore
Sphyraenidae	
Sphyraena qenie	Invertebrate feeder & Piscivore
Sphyraena sp.	Invertebrate feeder & Piscivore
Syngnathidae	
Corythoichthys haematopterus	Planktivore
Synodontidae	
Saurida nebulosa	Piscivore
Synodus dermatogenys	Invertebrate feeder
Synodus variegatus	Invertebrate feeder
Terapontidae	
Terapon jarbua	Omnivore
Tetraodontidae	
Arothron hispidus	
Arothron meleagris	Corrallivore & Invertebrate
Arothron nigropunctatus	Corrallivore & Invertebrate
Arothron sp.	Corrallivore & Invertebrate
Canthigaster amboinensis	Omnivore
Canthigaster bennetti	Omnivore
Canthigaster coronata	Omnivore
Canthigaster ocellicincta	Omnivore
Canthigaster solandri	Omnivore
Canthigaster valentini	Omnivore
Zanclidae	
Zanclus cornutus	Invertebrate feeder