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THE FISHERIES AND MARINE ENVIRONMENT OF ONO-I-LAU, FIJI ISLANDS, IN 2002

by

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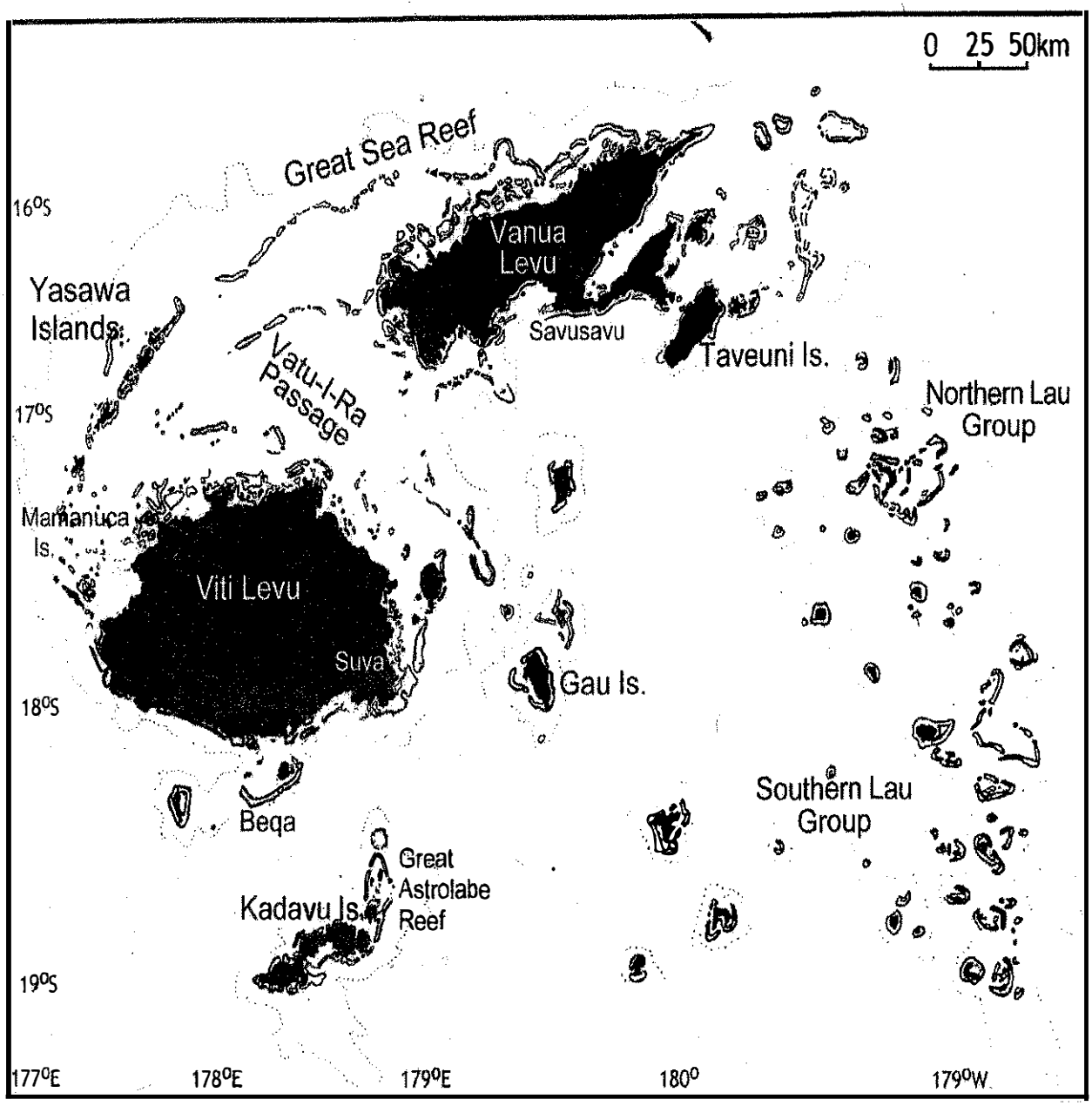

Figure 1: Map of Fiji showing Southern Lau Group

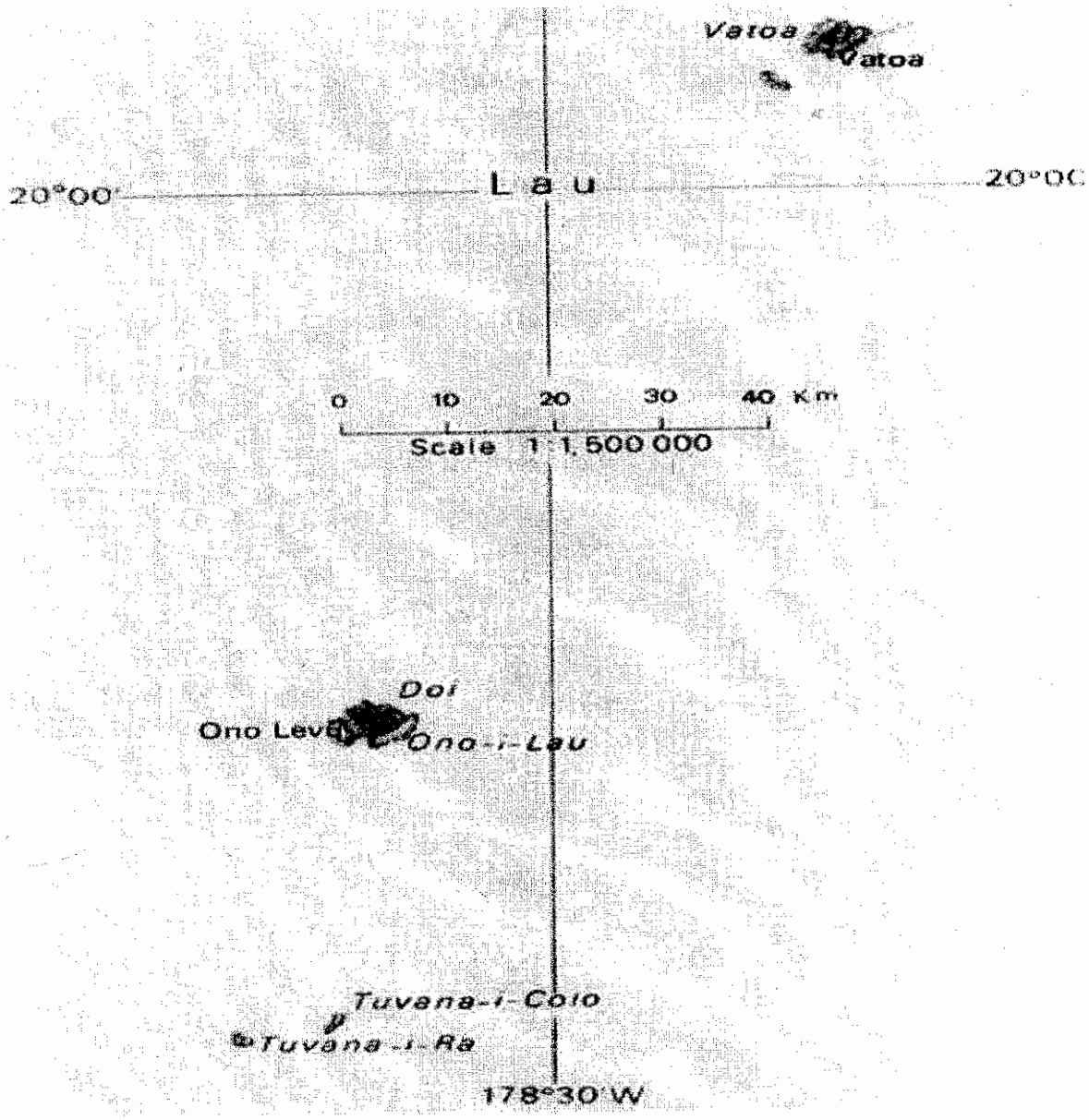

Figure 2: Map of Ono-i-Lau showing the island Groups

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ABSTRACT

Ono i-Lau is the most isolated island group in Fiji. The period of the study was from May to August, 2002. This investigation was undertaken to identify the major issues affecting the marine environment and the subsistence fisheries. Underwater video transect, household surveys and creel censuses were used to assess the coral reefs, seafood consumption and subsistence fisheries of Ono-i-Lau.

There are five major coral reef types or zones present at Ono-i-Lau which include the outer slope, back reef and reef top zones of the barrier reef, fringing reef and lagoon patch reef. The live coral cover (20-40%) at the backreef consisted mainly of massive growth forms such as *Porites* and *Montastrea* species, and encrusting growth forms such as *Pavona* and *Montipora* spp. Cover of branching *Acropora* was low. The patch reefs have coral cover ranging from 10 to 30 % and are dominated by large *Porites* bommies *Pocillophora* and *Turbinaria*. The fringing reefs have live coral cover between 10 to and are dominated by massive *Porites*, *Favites* and *Pocillophora*. The mid and outer top has low coral cover (5%) dominated by intertidal forms of *Porites* bommies and low *Acropora* colonies.

Ono-i-Lau has significant terrestrial and marine biodiversity. It has a species of skink that is endemic to Fiji. It has also significant seabird and turtle rookeries on sand cays and smaller islands. There are three mangrove and three seagrass species identified at Ono i Lau. Ono-i-Lau is also important biogeographically and it is the center for distribution of *Tridacna tevoroa*. Dead shells of extinct species of giant clams (*Hippopus hippopus* and *Tridacna gigas)* were found. Other invertebrate species like beche-de-mer, pearl oysters trochus and lobsters have been heavily exploited in recent years because of commercial fishing. Fish were generally abundant within the Ono-i-Lau lagoon. Large schools of reef fish in particular Acanthurids, Scarids and Mullids were abundant in most reef environments.

While copra and handicrafts have been traditional sources of income, they provide little return. The islands current lack of cold storage and infrequent and unsuitable transport prevents the sale of fresh marine products. The sale of dried beche-de-mer and pearl shell also provide little return. Seaweed farming is seen as the most promising opportunity for Ono-I-Lau. Fishing remains an important activity on Ono-i-Lau with 93% of households reporting fishing activity in the previous week and the majority owning a range of modern fishing equipment. Fresh seafood remains the major source of protein with the rate of consumption (263g/capita/day).

The offshore islands (Tuvana-i-ra and Tuvana-i-colo) and Vuata Ono reefs should be protected as giant clam bioregion sanctuary. Udui, Niuta and Yanuya could be earmarked as turtle and bird sanctuaries. The traditional owners should be compensated, perhaps paid as 'custodians' through a foreign Aid scheme. The idea of setting up a Trust Fund to pay traditional owners of significant bird and turtle rookeries as 'Custodians' to ensure their protection, and to compensate for lost opportunities is a promising one

The possible closure of a proportion of the barrier in each of the four qoliqoli may be an effective way of enhancing stocks of fishes and invertebrates. The possible areas for closures need to be endorsed and supported by the people in each village so there is compliance. A list of recommendations from our research findings is provided and will need to be need to be discussed further with the stakeholders before they can be implemented.

1. INTRODUCTION

Ono-i-Lau is the most isolated and southerly island group in Fiji. It is part of the Southern Lau Group (Figure 1) and located about 400km from Suva and 280km from Tongatapu, Tonga. It consists of six islands and many islets within a reef system of 80 km^2. The population is currently 583, residing in four villages. The local community exercise customary tenure over their lagoonal waters. The community has a largely subsistence economy relying predominantly on fish and gardens (Vuki *et al.* 1992).

Ono-i-Lau is unique in the Fiji Islands and has been inhabited since ancient times by oceanic peoples of Polynesian and Melanesian origin. It was culturally important in the migration and trading route between Tonga and Fiji.

A rural development program commenced in 1998 to develop community-based seaweed farming. This has provided an important economic base for the island and renewed interest by the community in marine resources and their conservation. In response to this interest a project to develop a community-based system of marine protected areas (MPA's) was initiated by the University of the South Pacific (USP), Fiji and Southern Cross University (SCU), Australia in May, 1999.

Preliminary discussions were undertaken with the Tikina Representative to the Lau Provincial Council between 1999 and 2000. In October, 2000, a preliminary visit to Ono-i-Lau was undertaken by Professor Leon Zann and Dr. Veikila Vuki with the staff of the Fiji Fisheries Department. Discussions were initiated with the villagers in Matokana and the representative of Ono to the Lau Provincial Council about the possibility of setting up Marine Protected Areas in the Matokana qoliqoli. During this preliminary visit, several sites were documented on video.

Community-based or locally managed MPA's have been found to be effective in other parts of Fiji (Veitayaki, 1997) and the Pacific (Zann, 1999) where conventional centralised approaches have failed. The sustainable use of marine resources is vital to the well being of the local community who rely on them for subsistence. Effective community-based management at Ono-i-Lau could also serve as a model for other remote Islands in Fiji.

This study was funded by the South Pacific Regional Environmental Programme (SPREP), the SCU and the USP. This report summarises the major findings of the study, identifies major issues affecting the fisheries and the marine environment and discusses some of the management options based on the principles of community-based management.

2.GEOGRAPHY, DEMOGRAPHY, ECONOMY AND MARINE TENURE

2.1 GEOGRAPHY

The Ono-i-Lau group is located in the southern section of the Lau archipelago in the eastern part of Fiji at 20 • 40' S and 178 ° 44' W (Figure 1). Ono-i-Lau consists of six main islands situated within a barrier reef. The islands of Ono-levu, Doi and Davura are volcanic in origin and are part of the rim of a breached crater. Tuvana-i-ra is a small, low limestone island about 40km from Ono-levu. It is 4km in diameter with a very shallow lagoon. Tuvana-i-colo is located on the east and has a broad fringing reef but no lagoon. These islands are uninhabited and are occasionally visited by temporary copra cutters and occasional supply ships. Including all islets and stacks, there are over one hundred islands covering a total land area of 7.9 km^2 within a reef system of 80 Km^2 (Ferry & Lewis, 1993; Vuki *et al.*, 1992).

The island group supports a range of marine and intertidal habitats including mangroves, mudflats, seagrass beds, fringing reefs and barrier reefs. Also situated approximately 5 km from the main group is the submerged reef formation of Vuata-Ono. The vegetation on the island group is predominantly grassland and scrub with plantations of coconut and introduced pine, and occasional stands of medium forest. The drainage features on the islands of Ono-i-Lau are poorly developed, with no permanent streams or open ponds (Ferry & Lewis, 1993).

2.2 CLIMATE

The climate in the region is controlled by the SE Trade Winds, which produce pronounced wet and dry seasons. Average annual rainfall is 1530 mm, with the wet season extending from November to April, and the dry season from May to October. The average annual temperature is 24.6 °C (monthly mean temperature range 22.4°C to 26.9°C), with maximum temperatures between November to April and minimum temperatures between May to October.

2.3 DEMOGRAPHY

There are four villages in the group, which include Nukuni, Lovoni and Matokana situated on the principal island of Ono-Levu and Doi situated on Doi island. These four villages or yavusa constitute the Ono-i-Lau Tikina (district) (Vuki *et al.*, 1992). At the 1986 census the total population was 595 and in 1992, Ferry & Lewis (1993) estimated the population to be 513. Due to the islands proximity to Tonga the people of Ono-i-Lau have a strong Polynesian influence both physically and culturally. Along with other islands in the southern Lau group the people speak a distinct dialect incorporating elements of Polynesian (Jones & Pinheiro, 2000).

2.4 ECONOMY

For the greater part of the twentieth century, the main economic activities on Ono-i-Lau revolved around copra, and the seashell trade. The demise of the copra industry resulted in stagnant economic activities, however the majority of people continued with it despite its low return. Other sources of income include trade of handicrafts, such as mats, tapa, magimagi (sinnet) and pearl shell which are used for house-building and decorations. In response to the lack of opportunities for income generation, the Fiji government introduced farming of the seaweed *Eucheuma cottonii* locally known as Lumi in mid 1999. The seaweed is used as binder in cosmetics, paints, glues and pharmaceuticals. The industry has now established itself as one of the main sources of revenue for the island.

There are no tourism ventures in Ono-i-Lau, however a small cruise ship visited the island on one occasion. The cruise ship tourists were entertained when they came ashore and the boat paid $3,000 to the Tikina for the stopover.

Each village has a co-operative store for supply of staples such as flour, sugar, tinned fish and fuel (kerosene and outboard fuel). Supplies are shipped from Suva at least once a month.

The main crops planted for local consumption are root crops such as cassava, yams, sweet potato and a variety of planted vegetables. Breadfruit are abundant along with fruit trees.

2.5 CUSTOMARY MARINE TENURE

Ono-i-Lau, like the rest of the Fiji group has a system of customary marine tenure, in which local resource users have ownership over their village qoliqoli or traditional fishing grounds. Each of the four villages or yavusa has qoliqoli that generally extend from village land to the outer reef slope. The paramount chief of Ono-i-Lau, Tui Ono, has dominant authority over the qoliqolis, acting on behalf of the people. The chief of each village along with the village master fisherman (gonedau) are the two main people who govern the ownership of local fisheries resources.

3.0 DESCRIPTION OF CORAL REEFS AND CORAL BIODIVERSITY

There are five major coral reef types or zones present at Ono-i-Lau which include the outer slope, back reef and reef top zones of the barrier reef, fringing reef and lagoon patch reef. The video transect survey encompassed each of the above reef zones with the exception of the outer slope. A total of 22 sites were surveyed distributed throughout the four qoliqolis, Matokana (7 sites), Nukuni (5 sites), Lovoni (5 sites) and Doi (5 sites). The video transect data are stored at the University of the South Pacific, Fiji and at the Southern Cross University, Australia. Collections of scleractinian corals were also undertaken during the survey and they are stored at the Marine Collection at the marine Studies Programme, University of the South Pacific.

The following is a summary of the observations made at each of the survey sites. The transect data needs to be analysed to provide a quantitative description.

3.1 Back reef zone

The back reef zone (0-5 m depths) varied in width from 5-30 m with an aspect ranging from gradually sloping to vertical. The back reef situated on the windward side of the island was characterised by high live coral cover in the range of 20-40%. A relatively large number of species contributed to the coral cover with the most important groups being massive growth forms such as *Porites* and *Montastrea* species, and encrusting growth forms such as *Pavona* and *Montipora* spp. Cover of branching *Acropora* was low with the majority of cover encountered being dead.

The back reef zone at the leeward side of the island exhibited low live coral cover (< 20%) dominated by massive growth forms predominantly *Porites* spp. heavily eroded dead coral dominated the area and large areas of coral rubble was accumulated where the reef meets the sandy lagoon. Algal cover is dominated by encrusting algal turfs.

3.2 Lagoon patch reefs

Patch reefs are situated in the mid and outer lagoon (3-15m depths). The shallower patch reefs (1-5 m) have moderate coral cover (10-30 %) dominated by large *Porites* bommies, *Pocillophora* and *Turbinaria*. Tabulate and digitate forms of dead coral covered with encrusting algal turfs account for a large component of the cover.

The deeper patch reefs (7-15 m) have low coral cover (< 5%) and are dominated by bare dead coral and broken fragments of dead branching coral.

3.3 Fringing reefs

Fringing reefs line the majority of the main island shores with the exception of some sections of the leeward side of the islands and in Yao Bay. The fringing reefs generally consist of a band ranging from 5-20 m wide (1-3 m deep) adjacent to a wide intertidal flat 30-100 m wide. Live coral cover is moderate to low (10-25%) dominated by massive

Porites, *Favites* and *Pocillophora*. Cover of soft corals and macro algae (*Sargassum*) is higher than for other reef habitats particularly on leeward fringing reefs.

3.4 Reef top and crest

The barrier reef top and crest ranges from around 50-100 m wide. The outer reef crest is raised and consists of coralline-encrusted limestone and cyclone boulders. The mid and outer reef top has low coral cover (5%) dominated by intertidal forms of *Porites* bommies and low *Acropora* colonies. The outer reef top has a high cover of coralline algae and algal turfs.

4.0 BIODIVERSITY

Ono-i-Lau has an important terrestrial biodiversity with significant numbers of land birds and a new species of skink (Zug, 1989). It has some undisturbed native forest including *Pisonia*. Caribbean pines were introduced to the island in the 1970's through the government's rural pine planting programme.

4.1 Sea birds

At the time of the survey the only nesting sea bird was the Red-footed boobie (*Sula sula*) on the main seabird rookeries at Yanua, Niuta and Cakau-i-ra Island. Other birds observed include the Reef Heron (*Egretta sacra*), White tern (*Gygis alba*) and Sooty tern (*Sterna fuscata*). Anecdotal reports indicate that Common noddies (*Anous stolidus*), Black-naped terns (*Sterna sumatrana*) and White-tailed tropic birds (*Phaethon lepterus*) also occur at Ono-i-Lau.

4.2 Mangroves & Seagrasses

Threes species of mangrove are present at Ono-i-Lau which include *Rhizophora stylosa*, *Bruguiera gymnorrhiza*, and *Rhizophora mangle*. *R. stylosa* is the dominant species. The greatest concentration of mangroves is at Yao Bay and at Dulo where all three species are found. Stands of *R. stylosa* are also found lining the shores on the leeward side of Doi Island and northern shores of Ono-Levu. Large stands of *Bruguiera gymnorrhiza* are found in Vakase and Jirowai on the island of Ono-Levu.

Three species of seagrass were identified at Ono-i-Lau, *Halodule uninervis*, *Halophila ovalis* and *Syringodium isoetifolium*. The main areas of seagrass beds are located in the intertidal and adjacent subtidal zones in Yao Bay and Wailolo. They are also adjacent to the villages of Nukuni, Lovoni, Matokana and Doi. Scattered patches are also found in other parts of the intertidal flats adjacent to the main islands and adjacent to the sand cays.

4.3 Invertebrates

4.3.1 Giant clams

Ono-i-Lau is important biogeographically and it is the center for distribution of *Tridacna tevoroa* and has *Tridacna derasa, Tridacna squamosa* and, *Tridacna maxima.*

Three species of giant clam were observed during the survey, *T. maxima*, *T. squamosa* and *T. derasa*. *T. tevoroa* was been reported at Ono-i-Lau by Lucas *et al.*, 1991 and was found to be extremely rare. We found dead shells of *Hippopus hippopus* and *Tridacna gigas* in Matokana in 2000 during excavations.

Five replicate belt transect surveys (10x1m) were conducted in fringing reef, back reef, shallow patch reef, deep patch reef and reef top environments. *T. maxima* was the most abundant species with mean densities ranging from 0.96/m^2 on the deep patch reef site to 0.14/m^2 at the fringing reef site, with an overall mean of 0.48/m^2. *T. derasa* was only detected at the shallow patch reef and back reef sites with a density of 0.03/m^2 at each site. *T.squamosa* was not detected in the belt transects but were observed elsewhere on the barrier reef.

A tow survey adapted from Munro (1988) was also conducted to better assess the stocks of *T. derasa* and *T. squamosa* over intermittent lagoon patch reef. Reconnaissance surveys and anecdotal reports revealed that this habitat supports the greatest abundance of these species. The survey indicated extremely low mean density of 0.00002/m^2 for both *T. derasa* and *T. squamosa*. The survey was restricted to 15m depths but it is possible that higher densities may occur in deeper patch reefs further away from the villages.

4.3.2 Other invertebrates

The most common gastropod species encountered were *Trochus pyramis* and *Turbo chrysostomus*. They were generally rare in all habitats other than the barrier reef top where they were abundant in the outer reef slope. *Conus* spp. were generally rare.

The main bivalve species present other than *Tridacna* spp. were *Pinctada margaritifera* and was particularly abundant on lagoon patch reefs. *Anadara cornea* was found on intertidal flats.

Three species of bech-de-mer were observed at Ono-i-Lau, *Actinopyga mauritiana*, *Holothuria fuscogilva, Holothuria nobilis, Thelenota ananas, Holothuria atra* and *Bohadschia marmorata*. They were found in greatest abundance on the barrier reef top. The species *Stichopus chloronotus, Holothuria nobilis* and *Thelenota ananas* was heavily harvested in the past and was conspicuously absent during the survey.

The main crustaceans present were the lobster (*Panulirus pencillatus*) and the Slipper Lobster (*Parribacus caledonicus*) were only observed in the surge zone of the outer reef top were they were relatively abundant. The mantis shrimps (*Lysiosquilla* spp.) were

common on intertidal flats adjacent to the islands. Octopus spp. were generally rare but were observed in a wide range of reef habitats.

The land crab (*Cardisoma carnifex)* was abundant in mangrove and adjacent land areas, and the rock crab (*Grapsus albolineatus*) was abundant around rocky shores of the main islands and outer islets.

4.4 Fishes

Fish were generally abundant within the Ono-i-Lau lagoon. Large schools of reef fish in particular Acanthurids, Scarids and Mullids were abundant in most reef environments.

Fish from higher trophic levels such as Serranids, Lutjanids and Lethrinids were less abundant than herbivorous fishes, however, they were relatively common at most sites. The greatest abundances of larger fish were observed at deep (5-15 m) lagoon patch reefs and deeper sections of back reef.

Fringing reefs supported fewer fish from higher trophic levels and algal grazers, particularly Pomacentrids were more abundant in this environment.

In 1985, Victor G. Springer of the US National Museum collected fishes from Ono-i-Lau and a list of species (mainly butterfly fishes) is available at the Fijifish database- Bishop Museum website (www.bishopmuseum.org).

4.5 Sea turtles

Three species of sea turtle occur in the Ono-i-Lau Lagoon, *Chelonia mydas*, *Eretmochelys imbricata* and *Caretta caretta*. Turtle abundance is greatest in the deeper sections of the lagoon in particular Yao Bay and in lagoons near the smaller islands such as Udui and Yanuya. Anecdotal reports indicate that *C. mydas* nest on Udui Island and the distant Tuvana Islands between November and December during periods of high tide and new moon.

5.0 SUBSISTENCE FISHERIES

5.1 Fishing Craft

Over 40% of households in each village own or are in possession of a government sponsored seaweed punt. Around 50% of households in all villages with the exception of Doi own at least one outboard motor, the majority of which are 15 hp engines provided by the government in conjunction with the wooden seaweed punts. Less than 20% of households in all villages privately own at least one fiberglass, wooden or aluminium vessel. Only one traditional sailing outrigger canoe was in working order.

5.2 Fishing Activities, Frequency, Duration and Time of Fishing Trips

Adult males made up the greatest proportion of household fishing parties, accounting for around 67% of the people recorded fishing, adult females made up the second greatest proportion (22 %) with participation by children significantly less (child males 10 %, child females 2 %).

The mean frequency of household fishing trips was 1.76 days per week. The average time per fishing trip was calculated to be 3.4 hours (household survey) and 3.7 hours calculated from the creel survey. The majority of fishing occurred during daylight hours (81%), 19% occurred at night.

5.3 Fishing grounds and Fishing Gear

The majority of fishing effort is concentrated on the inside edge of the barrier reef (40%) and lagoon patch reefs (30%). Fishing trips to fringing reefs account for 16%, barrier reef top (12%) and outside edge of barrier reef (2%).

Handlines were used on 39-41% of fishing expeditions, spearfishing was undertaken on 28-33% of occasions, Gleaning or simple gathering on 14-15% of occasions, monofilament gill nets on 8-10% of occasions and 5-7% of fishing involved skin diving for clams.

Spearfishing is undertaken in a variety of habitats with the greatest concentration on the inside edge of the barrier reef (38%) and lagoon patch reefs (33%) with less on fringing reef (33%). The majority of handlining is undertaken on lagoon patch reefs (70%) and the inside edge of the barrier reef (26%). Collecting and gleaning is concentrated on the barrier reef top (75%) with less activity on fringing reefs (25%). All trips reported diving for clams were from lagoon patch reefs and netting was concentrated on the inside edge of the barrier reef (72%) and fringing reefs (18%).

Men made up the majority of fishers reported using all fishing techniques with the exception of collecting and gleaning. Women were involved in handling (25 % of people reported), collecting/gleaning (73% of people reported) and netting (40% people reported).

5.4 Catch Composition and Catch Per Unit Effort

Finfish accounted for 72% by weight of the total landings recorded in the creel surveys. The most important fish groups were Acanthurids, Lethrinids, Scarids and Serranids when combined account for 61 % of the catch by numbers and 59% by weight. A wide variety of fish groups are relatively important in the fishery with seven groups accounting for greater than 5% of the total catch by number and weight.

Invertebrates accounted for 28% by weight (whole) of the total landings recorded in the creel surveys. Ten species or species groups were recorded in the creel surveys with the giant clams *T.maxima*, *T.derasa* and gastropods *Throcus pyramis* and *Turbo chrysostomus* accounting for 86% by number and 85% by weight of the total invertebrate catch.

The average weight of fish and invertebrates caught per trip (based on 50 weighed creels) was estimated to be around 14.5 kg per trip with an average fishing unit of 2.16 people. As the average time per fishing trip was 3.7 hrs, the average Catch Per Unit Effort for finfish and invertebrates combined was estimated to be 1.81kg/person/hr.

The average weight of finfish caught per trip (based on 31 weighted creels of fishing trips targeting only finfish) was estimated to be around 14.1 kg per trip with an average fishing unit of 2.8 people. As the average time per fishing trip was 4.1 hrs, the average CPUE for finfish was estimated to be 1.25kg/person/hr.

5.5 Annual landings and Fisheries Yield

Based on the annual number of trips and average landings per trip, the total annual landings of finfish and invertebrates were estimated to be 65.97 tonnes. Based on the results of the creel survey which indicated that finfish comprise 72% of the catch and invertebrates comprise 28%, the total annual landings of finfish and invertebrates is estimated to be 47.50 and 18.47 tonnes respectively.

It was estimated that the coral and rocky reefs of Ono-i-Lau yield around 2.2 tonnes km^{-2} $year^{-1}$ of reef-associated fish (around 20 km^2 of rocky/coral reef). However, this estimate should be regarded as conservative as it is based on catches during the winter season when fishing activity is likely to be at its lowest due to the cold weather and unfavorable sea conditions.

6.0 SEAFOOD CONSUMPTION

The average daily seafood consumption was approximately 260g/capita/day (239g/capita/day for fish, 21g (wet edible flesh) /capita/day for invertebrates). Assuming for the fish component that 30% was lost during gutting and as waste after eating (Zann *et al.* 1984; Jennings & Polunin, 1995b) then the edible seafood flesh consumed was 188g/capita/day, of which 25-30% was protein (English & Lewis, 1992). Thus the protein content of this fish (47-56g) is in excess of recommended daily intake of 37g /capita/day for males and 29g/capita/day for females (SPC, FNFNC, FSM, 1983).

6.1 Fish Consumption

Examination of the mean percentage composition of fish groups consumed indicates that the Ono-i-Lau villagers are not selective in their choice of fish drawing on a wide variety of fish types. The most important fish groups consumed by weight are Acanthurids (24.6%), Lethrinids (15.6%), Scarids (15.4%), Siganids (9.5%) and Serranids (6.5%).

6.2 Marine Invertebrate Consumption

*T. maxima, (*katavatu) accounted for 30.0% of invertebrate consumption, *T. derasa*, (vasua) (13.5%), *Panulirus spp.*, (ura) (19.5%), *Octopus spp.*, (kuita) (18.4%), *Turbo chrysostomus*, (vivili) (9.2%) and *Trochus pyramis*, (tovu) (2.4%).

6.3 Tinned fish and Meat Consumption

Of the households surveyed 20% had purchased tinned fish on the previous day and consumption was estimated at 19g/capita/day. Red meat (pork or chicken) was eaten by only 10% of the households surveyed on the previous day. Generally these sources of protein are reserved for festive occasions.

7.0 SUMMARY, ISSUES, MANAGEMENT OPTIONS AND RECOMMENDATIONS

The population of Ono-i-Lau appears to be relatively stable, however a large proportion of younger people are emigrating to the mainland faced with a wider range of opportunities. There are limited opportunities for income generation on Ono-i-Lau with copra, seaweed farming and handicrafts providing the majority of revenue.

While copra and handicrafts have been traditional sources of income, they provide little return. The islands current lack of cold storage and infrequent and unsuitable transport prevents the sale of fresh marine products. The sale of dried beche-de-mer and pearl shell also provide little return.

Seaweed farming is seen as the most promising opportunity for Ono-I-Lau. The industry has shown great promise with a total revenue of $31,099 for Ono-I-Lau in 2000. However, in 2001 and 2002 production declined as the Fiji government ceased buying seaweed directly from villagers and they must now sell direct to the Real Fishing Company Pty Ltd. This has slowed returns to the villagers and is a major disincentive fro them to plant. This appears to be the main hurdle at present for growth of the industry.

The infrequent flights to the island and lack of infrastructure, make it unsuitable for tourism. There is a market for day visits by cruise ship tourists but this is infrequent. However, there is potential to cater for small numbers of nature and culture-based tourism. Ono-i-Lau can also cater for a small number of yachts that may want to visit the southern Lau Group but it has to be a port of entry.

The qoliqoli is registered under the vanua of Ono in the Registry of Qoliqoli with the Native Fisheries Commission. In practice this is not the case as each village recognizes their qoliqoli boundaries. In the past, there had been very little disputes over the boundaries of village qoliqolis. It has been the norm for fishers from one village to fish for subsistence in all qoliqoli, however they must seek permission for harvesting for sale. When seaweed farming was introduced, there were disputes when farmers from Nukuni

were establishing farms in the Lovoni qoliqoli. It may be essential to demarcate the boundaries of village qoliqoli and so that future disputes can be resolved amicably. Further discussions are needed at the provincial, tikina and village levels to develop guidelines for determining rights of usage when commercial ventures are involved.

Fishing remains an important activity on Ono-i-Lau with 93% of households reporting fishing activity in the previous week and the majority owning a range of modern fishing equipment. Fresh seafood remains the major source of protein with the rate of consumption (263g/capita/day) providing in excess of the recommended daily protein requirements (SPC, FNFNC, FSM, 1983). Consumption of imported tinned fish (19g/capita/day) and meat is low largely due to the villager's low income (Average household income of $17 FD).

The conservative annual landings estimate of 47.5 tonnes for Ono-i-Lau which represents a yield of 2.2 tonne km^{-2} $year^{-1}$ is low compared to other published estimates for Fiji islands (Jenning & Polunin, 1995a) most of which have an artisanal component. The subsistence fishers do not appear to be seeking to maximise their catch, persisting mainly with inefficient methods, namely hand line and spearfishing with a low CPUE (1.25 kg /person/hr). The high proportion of large piscivorous fish species in the catch which are not actively targeted, and the fact that fishers are not switching to more powerful fishing techniques to maintain their yield, suggests that the coral reef fishery is placing minimal impact on stocks. With the current stable population and the impediments of isolation for commercialisation of fisheries, pressure on the fish stocks of Ono-i-Lau is not likely to increase significantly.

Pearl oysters, giant clams and sea cucumbers have been overfished in Ono-I-Lau because of heavy pressure for sale. Overfishing of *T. derasa* occurred during the late 1980's by the commercial operators after the military coup of 1987. In the last two years, there has been heavy exploitation of bech de mer for sale and has caused near extinction of species of *Stichopus chloronotus*, *Holothuria nobilis*, *Thelenota ananas* and *Holothuria fuscogilva.* Reports from most parts of Fiji have indicated that it is not unusual for stocks of marine invertebrates to decline because of heavy commercial exploitation (Vuki *et. al.*, 2000).

The possible closure of a proportion of the barrier in each of the four qoliqoli may be an effective way of enhancing stocks of fishes and invertebrates. But suitable areas need to be identified based on the video transect surveys and traditional knowledge. The possible areas for closures need to be endorsed and supported by the people in each village so there is compliance.

The offshore islands (Tuvana-i-ra and Tuvana-i-colo) and Vuata Ono reefs should be protected as giant clam bioregion sanctuary. Udui, Niuta and Yanuya could be earmarked as turtle and bird sanctuaries. The traditional owners should be compensated, perhaps paid as 'custodians' through a foreign Aid scheme. The idea of setting up a Trust Fund to pay traditional owners of significant bird and turtle rookeries as 'Custodians' to ensure their protection, and to compensate for lost opportunities is a promising one.

The immediate follow-up after this phase will be to organize for the stakeholder's marine awareness meetings to present the results of the research and to gain possible endorsement from the stakeholders for the re-stocking of reefs with *Tridacna tevoroa* and trochus. Further meetings will need to be held in the villages to discuss issues on marine conservation. Some of the marine conservation issues identified Ono-i-Lau villagers during the household surveys and stakeholder's meetings include:

- Use of the fish poison (duva) reducing fish stocks and killing coral
- Increased use of nets depleting fish stocks particularly on fringing reefs. There were consistent response that stocks of *Naso* spp., *Mulloides flavolineatus* and siganids have declined on fringing reefs due to net fishing
- Diving at night with underwater torches depleting fish stocks and scaring fish into deeper water
- Divers breaking corals with anchors and while removing speared fish from holes
- Increasing numbers of outboard powered vessels scaring fish away from fringing reefs
- Numbers of larger fish are declining
- Seaweed farms shading and causing die back of seagrass beds

7.1 Recommendations

a) Totally protect turtles and *Tridacna tevoroa*

b) Protect a proportion of each village qoliqoli's reefs as fisheries refuge and train key village members in basic monitoring techniques to assess their effectiveness and to provide proof of their benefits

c) Protect the bird islands, birds and eggs

d) Re-establish extinct clams, and re-commence traditional clam gardens

e) Conduct marine awareness and stakeholder meetings on marine conservation issues and to present results of the surveys.

f) Prohibit establishment of seaweed farms on seagrass beds and remove wild Euchema seaweed from reefs

g) Regulate net fishing (eg limit nets, restrict to distant parts of reef)

h) Prohibit commercial export of all reef fish and invertebrate species

i) Establish a reef management committee in each village and within the tikina to carry out enforcement and coordination of activities within the qoliqoli and ensure that they adequately represents the various stakeholder groups (gonedau, women's groups, youth groups etc.).

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