ANNUAL REPORT

WILDLIFE CONSERVATION SOCIETY
SOUTH PACIFIC PROGRAM 2009

EXECUTIVE SUMMARY

This report highlights the Wildlife Conservation Society (WCS) South Pacific Program's achievements in Fiji from January to December 2009. Through activities focused on Science, Management and Communication, WCS has helped the communities of Kubulau and Macuata in Vanua Levu and the Fiji government: (1) increase the amount of terrestrial, freshwater and marine area under protection; (2) learn about the effectiveness of their management measures; and (3) scale-up scientific findings to national-scale planning efforts.

Our scientific studies have focused on:

- Defining priority connectivity regions for Fiji;
- Assessing land-based threats to nearshore reef systems;
- Evaluating the effectiveness of marine protected areas (MPAs) based on size, longevity of protection and perceived compliance;
- Determining the extent to which intensive harvesting of Cakaulevu tabu has influenced reef fish communities;
- Trialling new tools to assess whether a depth refugia exists for targeted food fish;
- Applying novel habitat mapping and spatial modelling tools to predict fish assemblage patterns on Kubulau's reefs;
- Optimizing placement of protected areas to minimize costs to fishers; and
- Evaluating long-term changes in mangrove distributions in Kubulau.

In our efforts to help strengthen community-based management of natural resources in Fiji, WCS has:

- Assisted the Kubulau Resource Management Committee to develop Fiji's first ridge-to-reef management plan;
- Hosted workshops to build capacity for local resource managers; and
- Reviewed national legal and institutional frameworks to determine where law and custom can be integrated for successful management.

In order to ensure the uptake of scientific lessons and implementation of management actions, WCS has developed a number of communications tools to raise awareness and spread our key messages to communities and other stakeholders. These tools include: community bulletins; the EBM partner newsletter; a feature documentary; and management rule posters. In addition, WCS co-hosted the inaugural Fiji Islands Conservation Science Forum in August 2009, which was unanimously heralded for the opportunity for students, researchers and government to come together to share the latest findings to improve biodiversity conservation and resource management across Fiji.

Lastly, WCS has maintained a strong presence on national and regional committees and steering groups, including: the Protected Area Committee, the Integrated Coastal Management Committee, the NBSAP consultative group, the Fiji Locally Managed Marine Area Network executive committee and working groups, and the Round Table for Nature Conservation. Through these organizations, WCS has worked to help achieve national objectives in biodiversity protection, conservation planning, coastal management and climate change preparedness.

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INTRODUCTION

This report highlights the Wildlife Conservation Society (WCS) South Pacific Program's achievements in Fiji from January to December 2009.

The year has been eventful with another change of leadership for the program: Mr. Martin Callow departed in his role as Director, which was taken over by Associate Conservation Scientist Dr. Stacy Jupiter, while Mr. Thomas Tui was promoted to the role of Assistant Director.

Secondly, in 2009 the WCS-Fiji staff completed a ten year draft Strategic Plan (2010-2019) for our work in Fiji which aligns to the WCS Global Conservation Program, the WCS Global Marine Program, Pacific regional priorities and Fiji national priorities. The Strategic Plan defines the WCS mission for the Fiji Program:

"To preserve the functional integrity and resilience of Fiji's priority ecoscapes by integrating community-based adaptive management with science-based solutions in order to protect iconic species, maintain habitat connectivity and preserve livelihoods with the informed, active and sustainable support of local and national stakeholders"

WCS-Fiji envisions a healthy environment for Fiji where *connected, resilient ecoscapes that provide habitat for abundant and diverse species while sustaining natural resources, livelihoods and culture for Fijian communities*.

To bring our vision to reality, WCS takes a three-pronged approach by focusing on SCIENCE, MANAGEMENT, and COMMUNICATION under several broad conservation strategies: (I) Conserving Priority Ecoscapes; (II) Conserving Priority Species; (III) Strengthening Capacity, Developing Constituencies and Promoting Wise Governance; (IV) Strengthening Legislative Framework; (V) Exploring New Conservation Approaches; and (VI) Strengthening the Fiji Program.

This report focuses on WCS-Fiji's achievements under each theme (Science, Management, Communication), as well as our engagement with national and regional planning processes. Consistent with our Memorandum of Understanding (MoU) with the Fiji Department of Environment, we note the links to national priorities for each activity. Lastly, we describe our projected activities for 2010, including their: status; relationship to national priorities; potential outputs; location in Fiji; project partners; funding sources; timelines; and level of investment in conservation action.

SCIENCE

The following sub-sections present a synthesis of completed and ongoing scientific activities by WCS and partners for 2009.

Priority Connectivity Regions for Fiji

STATUS: Complete

FUNDING: David and Lucile Packard Foundation (2007-31847), Gordon and Betty Moore Foundation (540.01), John D. and Catherine T. MacArthur Foundation (01-79760-GSS), US Department of State (OESI grant SFJ00 04 GR 004).

PARTNER ORGANISATIONS: Wetlands International-Oceania

OUPUTS:

- *Journal publication*: Jenkins AP, Jupiter SD, Qauqau, I, Atherton J (2009) The importance of ecosystem-based management for conserving aquatic migratory pathways on tropical high islands: a case study from Fiji. Aquatic Conservation: Marine and Freshwater Ecosystems. doi: 10.1002/aqc.1086
- *International conference presentation*: Jenkins AP, Jupiter SD (2009) Ecosystem-based management is essential for conserving migratory high island ichthyofauna: A case study from Fiji. Presented at the 8th Indo Pacific Fish Conference, Fremantle, Australia, 31 May – 5 June 2009.
- *International workshop presentation*: Qauqau I, Jupiter SD, Jenkins AP (2009) Priority connectivity regions for conservation and restoration in Fiji. Presented at the Pacific GIS-RS Users Forum, Suva, Fiji, 1-4 December 2009.
- *Local conference presentation*: Jenkins AP, Jupiter SD (2009) Ecosystem-based management is essential for conserving migratory high island ichthyofauna: A case study from Fiji. Presented at the 1st Fiji Islands Conservation Science Forum, Suva, Fiji, 5-7 August 2009.
- *Local conference presentation*: Jupiter SD, Jenkins AP, Qauqau I (2009) Priority connectivity regions for conservation and restoration in Fiji. Presented at the 1st Fiji Islands Conservation Science Forum, Suva, Fiji, 5-7 August 2009.

RESEARCH HIGHLIGHTS:

Between 2002 and 2008, mid (n = 20) and lower (n = 8) sections of 20 river basins on Fiji's main islands (Viti Levu, Vanua Levu, Taveuni) were sampled to assess in-stream ichthyofaunal composition. Sampling methods are described in detail in Jenkins et al. (in press; Annex A). In addition, records of invasive fish in Fiji were derived from the Fiji Freshwater Fishes Database (A. Jenkins, unpublished data) and introduction records of exotic tilapia (*Oreochromis mossambicus* and *O. niloticus*) by the Fiji Department of Fisheries from 2006. Compilation of records throughout Fiji catchments show that few catchments remain where tilapia have not escaped and established in waterways (Figure 1).

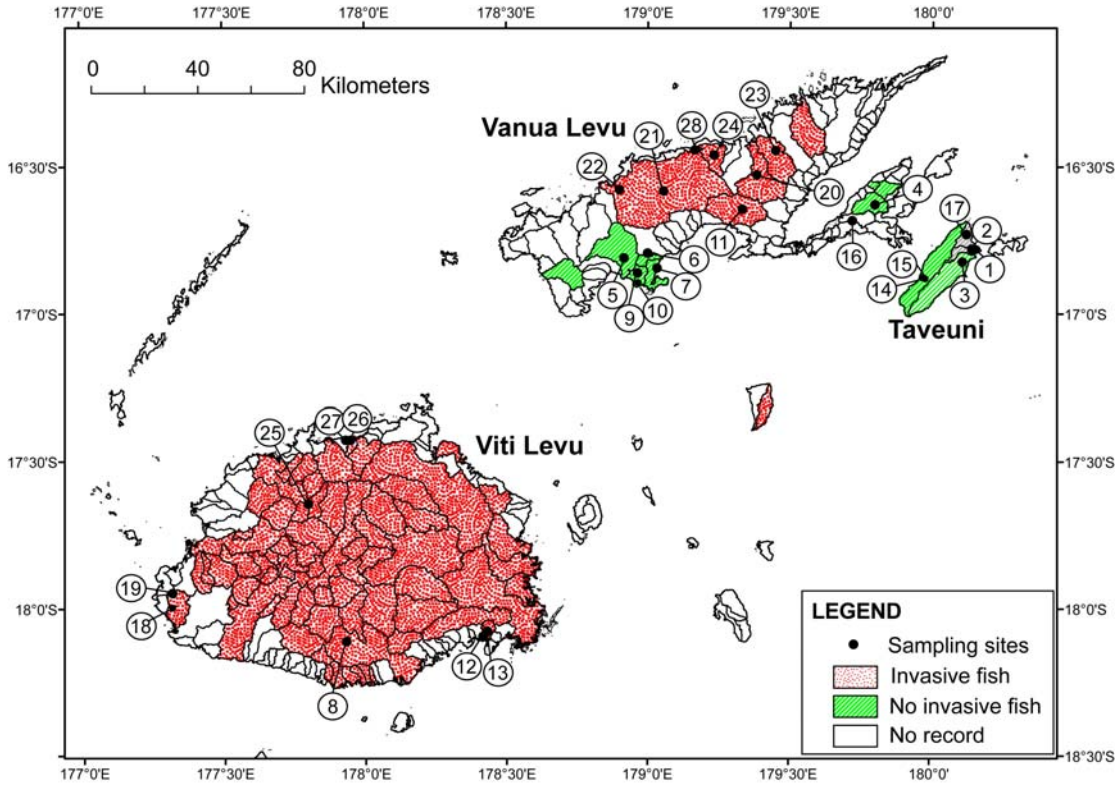


Figure 1. Catchments of Viti Levu, Vanua Levu and Taveuni within the Fiji islands archipelago. Red, stipled catchments have records of invasive fish in major waterways. Collections of fish from catchments with green, diagonal bars have no invasive fish. There are no records from open (white) catchments. Dots indicate locations of freshwater sampling sites: 1 – Tavoro low; 2 – Tavoro mid; 3 – Waitavala mid; 4 – Buca mid; 5 – Wainunu mid; 6 – Kilaka mid; 7 – Kilaka low; 8 – Navua mid; 9 – Suetabu mid; 10 – Suetabu low; 11 – Nasekawa mid; 12 – Savura low; 13 – Savura mid; 14 – Lavena low; 15 – Lavena mid; 16 – Drekeniwai mid; 17 – Navaka mid; 18 – Kubuna low; 19 – Kubuna mid; 20 – Labasa mid; 21 – Dreketi mid; 22 – Dreketi low; 23 – Qawa mid; 24 – Tabia mid; 25 – Ba mid; 26 – Waisai – low; 27 – Waisai mid; 28 – Macuata-i-wai mid.

The two factors that were most correlated with total fish species richness in mid-reaches of Fiji's rivers and streams were the presence of invasive *Oreochromis* spp. (tilapia) and catchment forest cover (Figure 2 and 3). It is well-documented that intensive logging and large-scale agriculture can increase delivery to catchment waterways and this sediment has both direct and indirect negative effects on native fishes. In catchment waterways with introduced tilapia, their nesting and foraging behaviour can further degrade in-stream water quality through bioturbation. In addition, tilapia are likely to prey on larvae and post-larvae of fish with obligatory migrations between freshwater and the sea.

Fish species that cross the greatest number of habitats are likely to be disproportionately affected by deleterious environmental conditions due to the greater probability of encountering an obstacle to free passage. Obstacles preventing their safe passage may be man-made (e.g. dams), consequences of predation by invasives; and/or consequences of degraded water quality.

Traditional community-based management of catchment areas in Fiji has already been successful at preserving native fish diversity in freshwater systems. For example, the small, coastal catchment of Macuata-i-wai, which is surrounded by heavily cultivated and degraded land, had a much greater fish diversity than non-managed catchments with comparable forest cover (Figure 2).

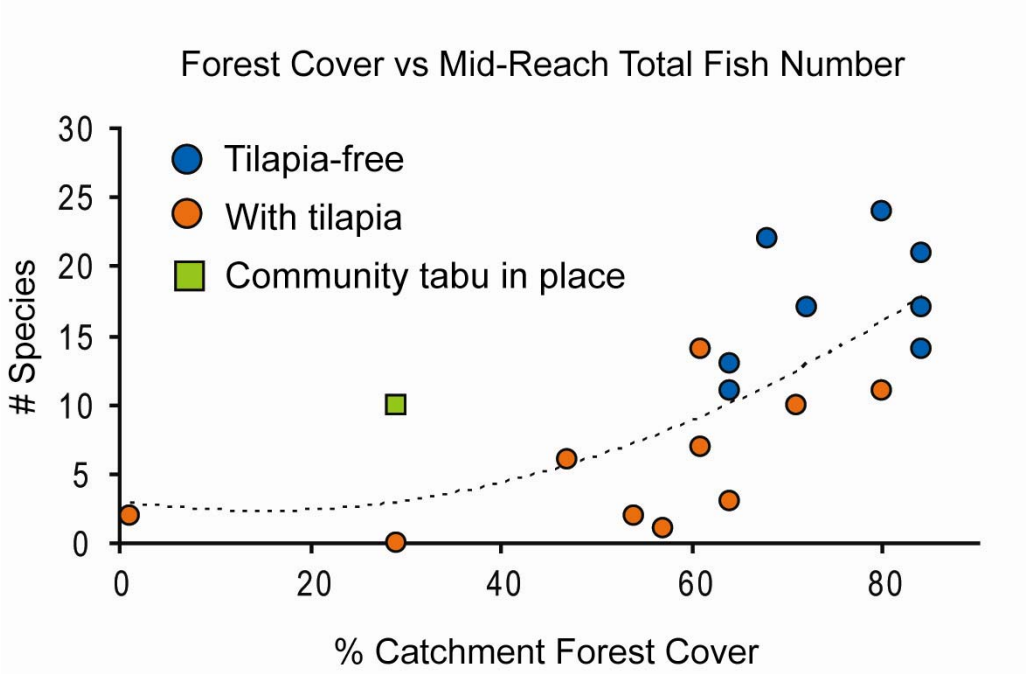


Figure 2. Relationship between catchment forest cover and total species number of fishes in mid-reaches of Fiji's waterways. Blue circles are sampling sites without *Oreochromis* spp. while orange circles represent sites with *Oreochromis* spp. The green rectangle indicates a well managed catchment (Macuata-i-wai) with prohibition on in-stream fishing, riparian clearing and dumping of waste.

Yet stream habitat alone is not enough to preserve native freshwater fauna on tropical, high islands such as those found in Fiji. The maintenance of a corridor between forest, river, estuary and sea is needed to preserve species with upstream and downstream migrations. An ecosystem approach to management is required that: (1) incorporates conservation of forests at or above 50% of catchment area; and (2) actively excludes introduction of tilapia into the hydrologic networks.

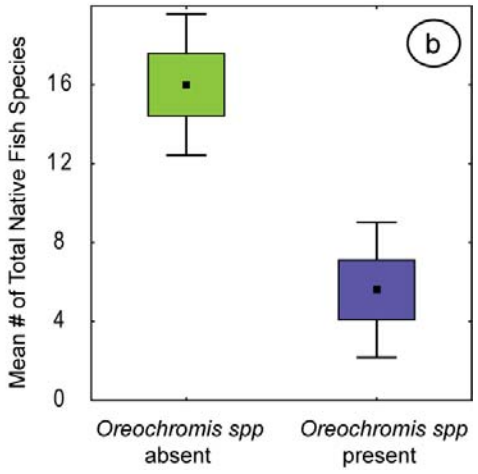


Figure 3. Mean difference in total native fish species number between mid-reach catchment sites where *Oreochromis* spp. is present (blue) and absent (green). Boxes represent ± 1 standard error and whiskers stretch across 95% confidence intervals.

Findings from this scientific study were used as the basis for a spatial prioritization exercise to identify regions across Viti Levu, Vanau Levu and Taveuni that have the highest preserved connectivity between forests and the sea through the waterways, and also to identify regions in need of restorative management actions. A set of decision rules were used that considered habitat intactness and complexity, hydrology, and sensitivity to erosion using methods described in Jenkins et al. (in press).

The ten highest scoring mapping units for intact connectivity are shown in Figure 4. They include the remote, largely undeveloped regions in Cakadrove and Macuata provinces (Udu Point, Qelewara, Natewa) and Bua province (Kubulau, Wainunu, Dama), as well as the northern and eastern side of Taveuni. Two smaller mapping units of Viti Levu, Naikorokoro and Sawakasa, scored ninth and tenth respectively due to the low density of roads and creek crossing and reasonable, proportional amounts of mangroves and reefs. The mapping units with the lowers scores (zero or below) were largely situated around the highly agricultural centres of Nadi, Ba and Labasa, which each have high urban population density, considerable forest clearing for sugar cane, extensive unsealed road networks for agriculture and logging, and records of introduced fish species. The Yarawa and combined Kolovisilou-Nubulotulotu catchments on the central Coral Coast of south Viti Levu also had low scores owing to high catchment erosion potential, records of introduced fish and little area or complexity of mangroves and coral reefs.

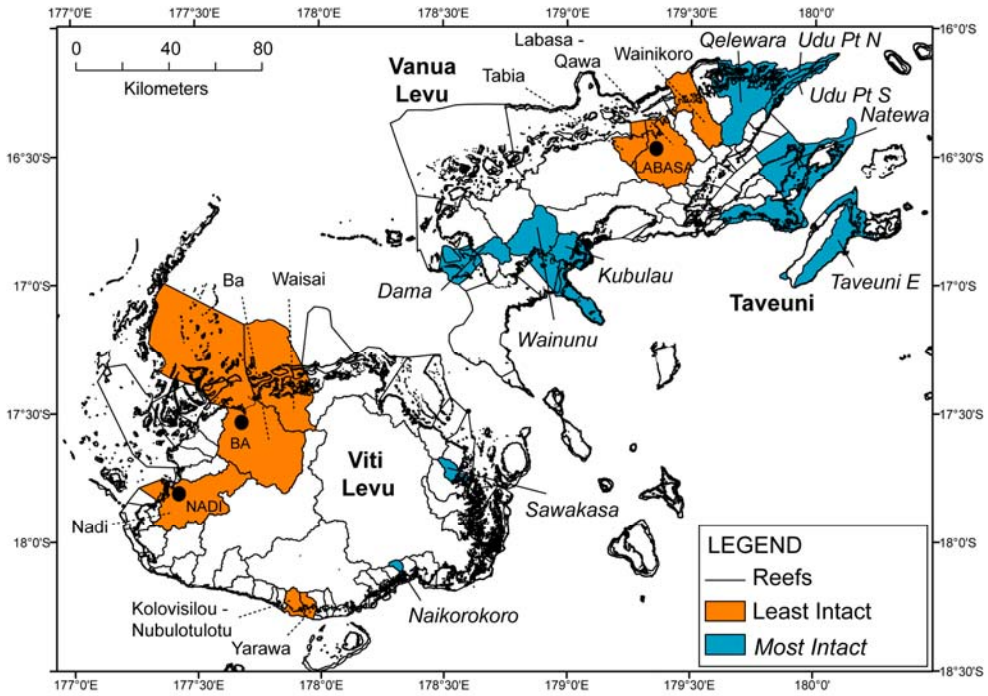


Figure 4. Mapping units (merged catchments with adjacent fishing grounds) that had the most intact (blue, solid line) and least intact (orange, dashed line) connectivity between terrestrial, freshwater, estuarine and marine areas on the main islands of Fiji.

LINKS TO NATIONAL PRIORITIES:

This study has supported Fiji government initiatives through two main areas:

(1) Invasive Species
(2) Prioritizing sites for protected areas

Invasive species

Invasive species are one of the five identified thematic groupings in the revitalized NBSAP implementation plan 2009. The work undertaken in this study supports the NBSAP strategy 3.1 to *Target research to support improved knowledge of invasives in Fiji*: Wetlands International-Oceania has nearly comprehensively assessed all known introductions of non-native fishes in Fiji's catchments. Only the open (white) catchments in Figure 1 remain unsurveyed or without records from the Fiji Department of Fisheries. All of these records have been made available to the National Resource Inventory being compiled by the Institute of Applied Sciences at USP and will be made available to the broader international public for the 20 catchments surveyed specifically for this study when the journal publication appears online.

This study provides the scientific background underpinning the negative consequences of introduction and establishment of non-native fish species in Fiji's freshwaters and the findings have been used to raise awareness in communities, government and the media about the urgent need to contain the spread of tilapia.

Protected areas

The ecological results from this study were used as a basis to more broadly identify areas with intact and degraded connectivity between terrestrial, freshwater and marine systems in Fiji's main islands in order to prioritize areas for protection and restoration. This supports strategies and actions in the Forest Conversion and Inshore Fisheries thematic sections of the revised NBSAP implementation plan to use protected areas to maintain ecosystem function and connectivity between habitats. In addition, the study helps achieve Objective 2.2 within the Forest Conversion section by providing a *case stud[y] on the relationship between forest cover and ecosystem* services. The work is directly complementary to the ongoing efforts of the national Protected Area Committee through the Programme of Work on Protected Areas (PoWPA) to prioritize sites for expansion of protected area networks in Fiji.

Assessments of Land-Based Impact from Long-term Coral Records

STATUS: Complete

FUNDING: David and Lucile Packard Foundation (2007-31847), Gordon and Betty Moore Foundation (540.01).

PARTNER ORGANISATIONS: The University of the South Pacific

OUTPUTS:

- *International conference presentation*: Jupiter S, Callow M, Tui T, Patrick A, Moy W, Yakub N, Cakacaka A, Naisilisili W, Dulunaqio S, Shaw S (2009) Integrating EBM science to provide recommendations for re-designing an MPA network in Fiji. Presented at the 2nd International Marine Conservation Congress, Fairfax, VA, USA, 20-24 May 2009.
- *Local conference presentation*: Jupiter S, Callow M, Tui T, Patrick A, Moy W, Yakub N, Cakacaka A, Naisilisili W, Dulunaqio S, Shaw S (2009) Integrating EBM science to provide recommendations for re-designing an MPA network in Fiji. Presented at the 1st Fiji Islands Conservation Science Forum, Suva, Fiji, 5-7 August 2009.

RESEARCH HIGHLIGHTS:

Human activity on land has increased global sediment loss by an order of magnitude over natural weathering rates due to human population growth driving land clearing for agriculture and development. Urbanization and mining have also contributed to localised increases in sedimentation to the nearshore. While sediment supply and turbidity are limiting factors in coral reef development, nearshore reefs are adapted to often highly turbid conditions and, when distant from human disturbance, can be highly diverse. However, nearshore reefs adjacent to highly modified catchments or those with large point-sources of terrestrial pollution may be particularly vulnerable to ecological shifts if chronically degraded water quality reduced resilience to disturbance.

In the absence of long-term water quality monitoring data to assess changes to sediment delivery over time, the ratios of certain trace elements to calcium (Ca) within long-lived coral skeletons are good natural tracers of fluvial or pollutant inputs to seawater. Barium (Ba) is one such tracer as ~50-75% of the total dissolved Ba load in nearshore waters is sourced from river discharge. Ba is attached to fine-grained clay particles in river runoff but desorbs in low salinity estuarine regions. The dissolved Ba moves offshore within the flood plume where it becomes incorporated into coral skeletons in close proportion to its local abundance. Long-term records of coral Ba/Ca concentrations can be used to identify historic periods of terrestrial disturbance which may have influenced present-day ecological conditions on nearshore reefs.

The present study focuses on two sections of coral reef within the traditional fishing grounds of Kubulau District, Vanua Levu, Republic of Fiji Islands. Strong anecdotal evidence supports the occurrence of massive fish and coral kills on nearshore reefs in Kubulau in 1998, coincident with the appearance of sediment-laden runoff from the Yanawai River that drains land from the vicinity of the Mt. Kasi gold mine (R. Murphy, pers. comm.). The mine was operated between 1932 and 1946, and then re-opened between 1996 and mid-1998. This study therefore had two primary objectives to:

(1) Use long-lived *Porites* coral Ba/Ca records to assess whether there have been detectable incidents of terrestrial pollution above typical offshore values; and
(2) Use the histories of disturbance to assess whether a combination of land-based impacts and poor enforcement of management rules has resulted in degraded reef communities within the Nasue marine protected area (MPA), adjacent to the Yanawai River.

In January 2007, coral cores were drilled from massive *Porites* coral colonies to assess the frequency and intensity that reefs have been exposed to runoff from the Yanawai River and associated land-based pollution from the Mt. Kasi gold mine. One core (S_3S_3) was located approximately 5 km southeast of the Yanawai River mouth and 3 km due west of the Nasue MPA, while a comparison core from an offshore location (S_2S_1) was collected approximately 3 km northwest of the Namena MPA within the backreef lagoon. Corals were analysed by laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) for trace element concentrations of ^{43}Ca, ^{84}Sr and ^{138}Ba using the exact protocol of Jupiter et al. (2008).

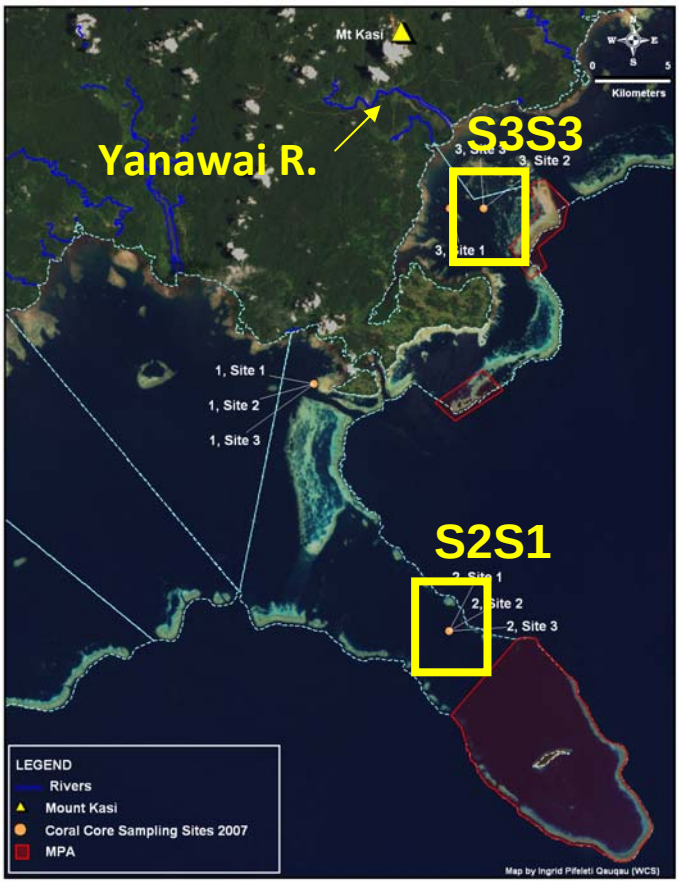


Figure 5. Locations of coral cores collected within the reefs of Kubulau qoliqoli. The location of the Mt. Kasi mine is indicated with a yellow triangle directly to the north of the Yanawai River.

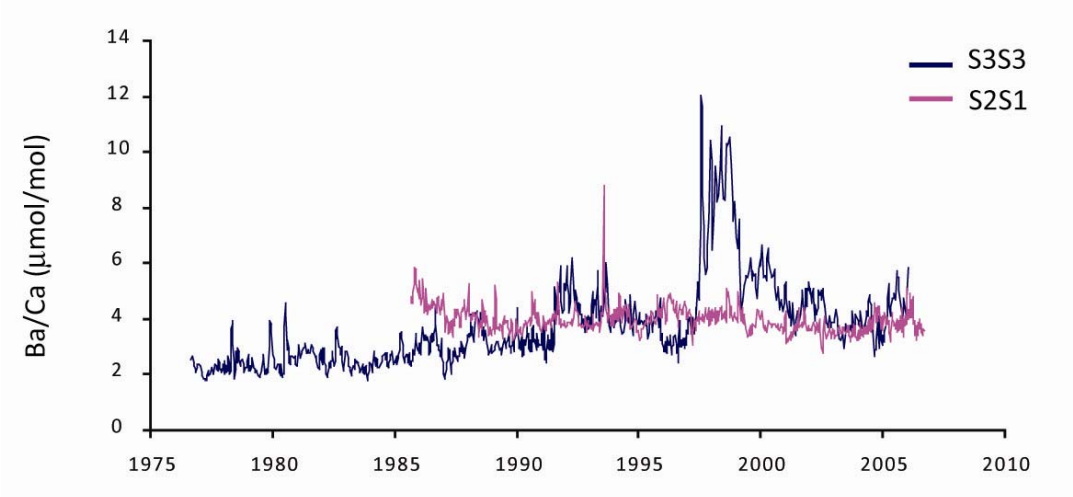


Figure 6. Coral Ba/Ca from the inshore core (S_3S_3: blue) collected near Nasue MPA and the offshore core (S_2S_1: purple) collected near Namena MPA.

Mean Ba/Ca ratios in the nearshore and offshore corals between 1986 and 2006 were nearly identical (~4 µmol/mol Ba/Ca), however the inshore coral collected near Nasue has a large peak in Ba/Ca (8-10 µmol/mol Ba/Ca) that remains elevated for several years between 1996 and 1999. This is coincident with the period when Pacific Island Gold company re-established mining operations at the Mt. Kasi gold mine.

To assess differences in reef community structure near the coral core collection locations, underwater visual census (UVC) monitoring was carried out at ten 50 m transects at 4 sites each (2 backreef, 2 forereef) inside and outside the district-wide MPAs of Nasue and Namena to measure fish abundance and size of the following families: Acanthuridae, Balistidae, Carangidae, Carcharhinidae, Chaetodontidae, Haemulidae, Kyphosidae, Labridae, Lethirinidae, Lutjanidae, Mullidae, Nemipteridae, Pomacanthidae, Scaridae, Scombridae, Serranidae (groupers only), Siganidae, and Zanclidae. Biomass was calculated from size class estimates of length (L_T) in 5 cm classes and existing published values from Fishbase (http://www.fishbase.org) used in the standard weight-length expression $M = aL_T^b$. Length-length conversions were used to convert total length field estimates to fork length values when a and b values were reported in Fishbase for fork length.

Total fish biomass (kg/ha) and abundance (#/ha) were significantly less (Mann-Whitney U test, $p < 0.01$ and $p < 0.001$ respectively) inside the Nasue MPA than at control sites directly to the south and further away from the Yanawai River mouth (Figure 7a,b). Further offshore, neither total fish biomass nor total fish abundance was significantly greater inside the Namena MPA than outside, however this had more to do with the effects of the backreef habitat structure as the backreef sites in Namena were principally composed of reef pavement that does not support robust fish communities. When only forereef sites were considered, total fish biomass and abundance were significantly greater inside the Namena MPA than outside ($p < 0.01$ and $p < 0.05$, respectively), whereas fish biomass was not significantly different in Nasue MPA and abundance was significantly lower ($p < 0.05$; Figure 7c,d). These results suggest real differences in MPA effectiveness that may be do to the following

factors: (1) land-based disturbance; (2) longevity of protection; and (3) extent of poaching.

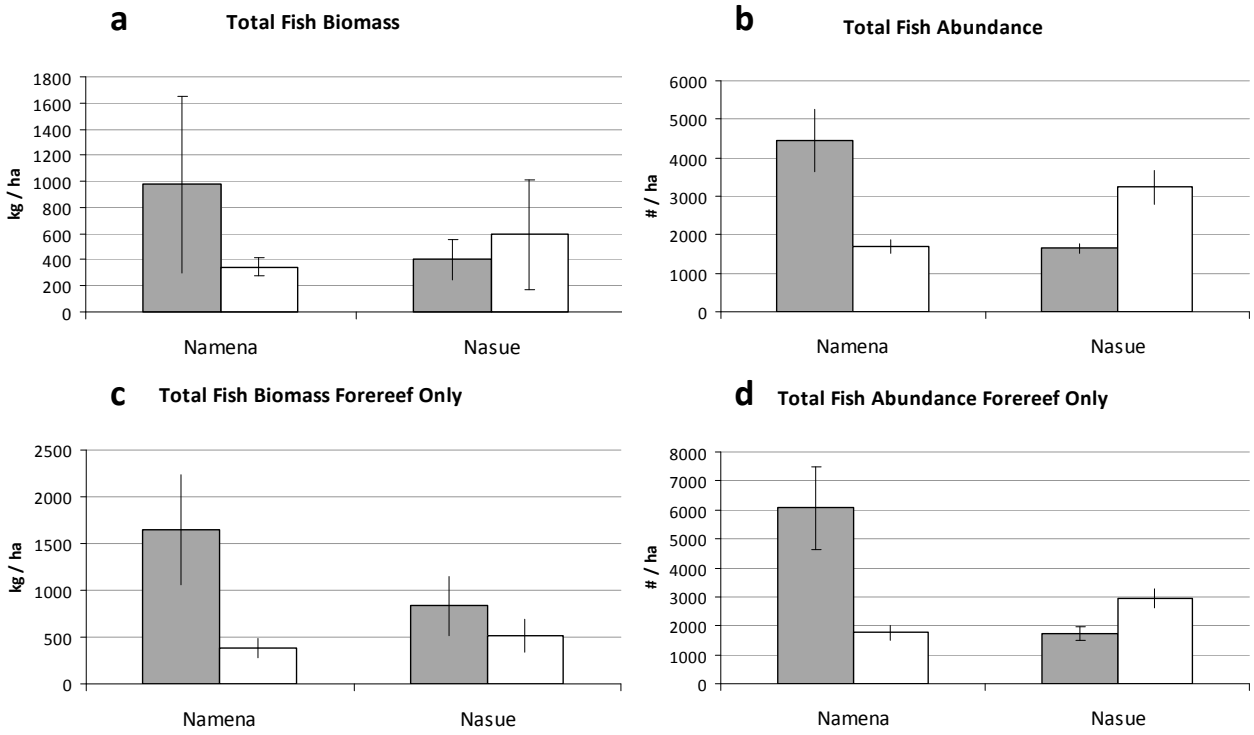


Figure 7. Total reef fish (a) biomass (kg/ha) and (b) abundance (#/ha) inside (grey) and outside (white) district MPAs. (c-d) Total Total reef fish (a) biomass (kg/ha) and (b) abundance (#/ha) inside (grey) and outside (white) district MPAs for forereef sites only. Error bars are ± 1 standard error.

Variation in benthic habitat

Benthic community structure was also recorded along the same 50 m transects at 0.5 m intervals. All life form classes were consolidated into 7 strata: live hard coral (LC); macroalgae (MA, including cyanobacteria); turf algae (TA); reef matrix (RM, including crustose coralline algae, pavement and dead coral framework);

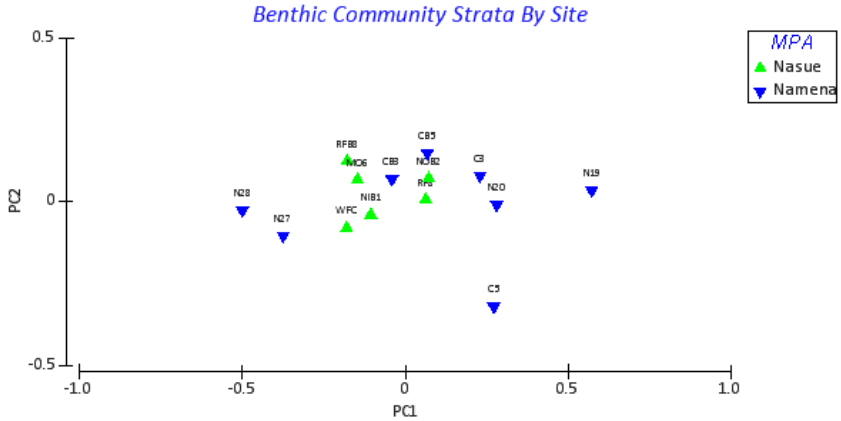


Figure 8. Principal components analysis of 7 main benthic strata from all sites surveyed inside and adjacent to the Nasue (green) and Namena (blue) MPAs. Negative values on PC1 are most related to unconsolidated substrate, while positive values are more related to live coral and other.

unconsolidated substrate (US, including sand and rubble); upright coralline algae (UC, including Halimeda); and other (OT, including soft corals, sponges and other soft reef dwelling organisms). Although live coral cover was significantly greater in and around Namena compared with the reefs around Nasue (Mann Whitney U-test; p = 0.01), ordination of the mean percent cover of each benthic strata (arcsine-squareroot transformed) of each site surveyed in 2007 showed no holistic differences between Nasue and Namena sites, whether inside or adjacent to the MPAs (Figure 8). In addition, at the transect level, sampling locations within the Nasue MPA did not appear to have marked habitat differences to transect locations outside the MPA (Figure 9).

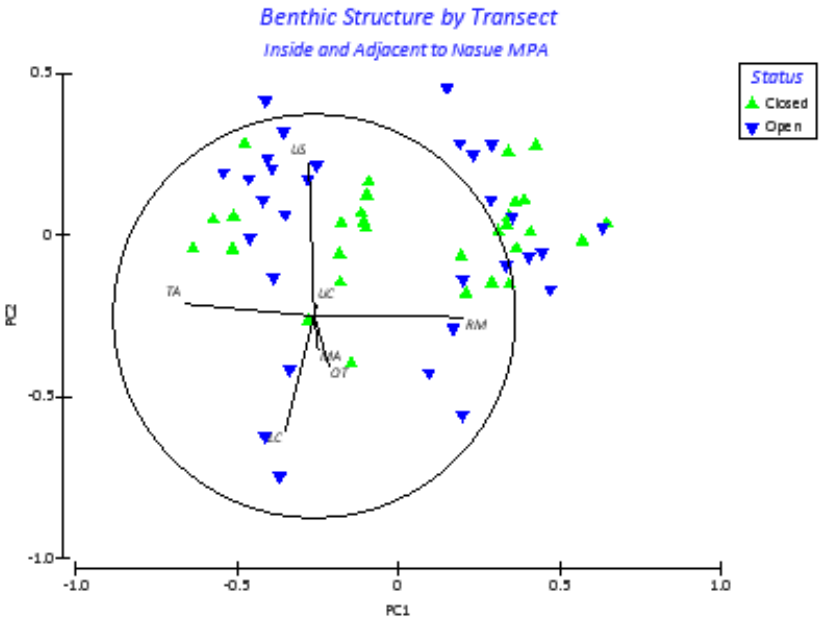


Figure 9. Principal components analysis of 7 main benthic strata from all transects surveyed inside (green) and adjacent (blue) to the Nasue MPA. Negative values on PC1 are most related to turf alae, while positive values are more related to reef matrix. Negative values on PC 2 are most related to live coral while positive values are related to unconsolidated substrate.

Repeat surveys at forereef only sites in 2009 found slightly higher amounts of rubble inside the Nasue MPA and slightly higher coverage of fast growing *Acropora* and *Pocillopora* corals that tend to recovery quickly from disturbance, but these abundances were not significantly greater and the coverage of macroalgae was fairly constant. In addition, measures of reef complexity were statistically similar both inside and outside the Nasue MPAs. These results suggest that if the reef habitat was indeed disturbed from flood runoff during mining activity, it has substantially recovered and the reef structure itself is not likely to be the main driver of differences in reef fish community composition and abundance. Other factors more likely to play a major role include longevity of protection and extent of poaching within the MPAs.

Longevity of protection

Many previous studies assessing the effectiveness of MPAs have shown that recovery of reef fish populations often takes many years, depending on the life history of the target species. For example, large-bodied, long-lived species such as grouper may take decades to recover. Recovery in Namena MPA, which has been informally protected since the mid-1990s has been strong, while little recovery has

been observed in Nasue MPA which has only been protected since 2005 (see *MPA Effectiveness within Kubulau and Macuata Qoliqolis*),.

Extent of poaching

Data from 2008 household socioeconomic surveys in Kubulau indicate a high degree of poaching from inside Nasue, both from people living outside of Kubulau and local residents. From the villages surveyed closest to Nasue, 83% of respondents reported seeing poaching, while 60% of these respondents said that they poachers came from the adjacent fisheries management area to the north (Wailevu district).

Additionally, catch per unit effort (CPUE) surveys recorded by trained community volunteers who asked fishers to map locations of their catch showed that local fishers are fishing within the Nasue tabu (Figure 10), likely because they are unaware of management rules and MPA boundaries. Most of the poaching in Nasue likely occurs because the fishers cannot be seen from any of the villages. This is in contrast to Namena where there is a resort on the island and the staff are very vigilant at enforcement.

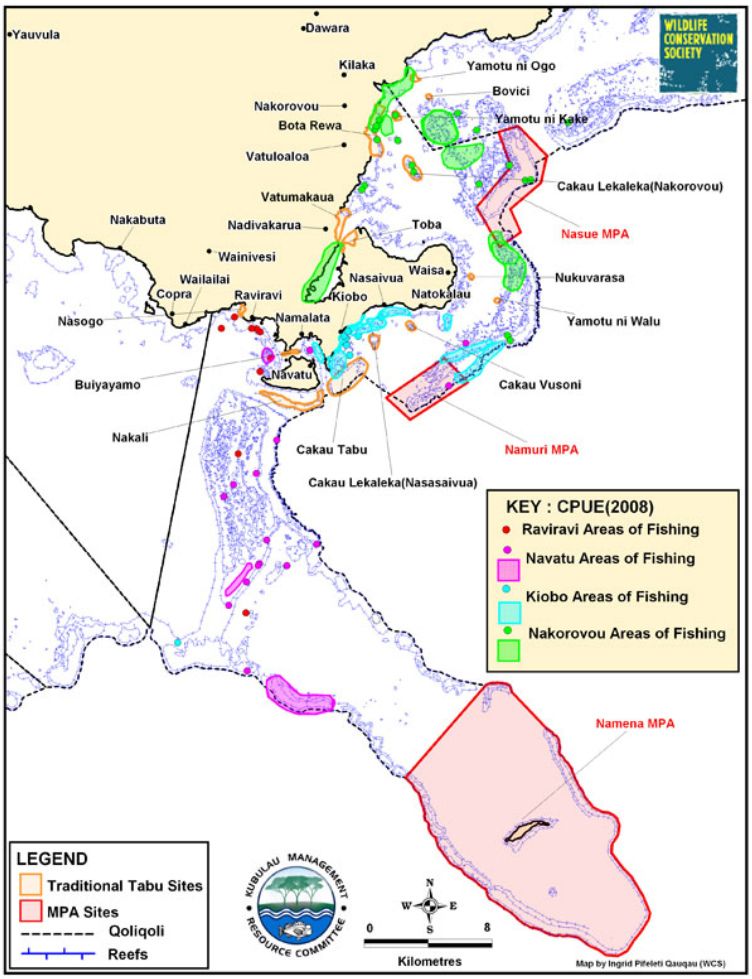


Figure 10. Locations of catch recorded by fishers from four villages (Raviravi: red; Navatu: purple; Kiobo: blue; Nakorovou: green) during catch per unit effort surveys between May 2008 and February 2009. Local fishers were given blank maps to record their catch locations.

In conclusion, while coral core records indicate past histories of land-based disturbance around the Nasue MPA, the combination of current UVC monitoring and

socioeconomic data suggests that the differences in MPA effectiveness in terms of increasing fish biomass and abundance may be more driven by longevity of protection and degree of poaching than actual differences in benthic community structure.

LINKS TO NATIONAL PRIORITIES:

Fiji's first national communication under the framework Convention on Climate Change 2005 stresses the importance of appropriately managing upland forest resources in order to mitigate effects to the coastal zone in a changing climate. While mining activity was mentioned only in its relation to gross domestic product, recommendations for adaptation response strategies include: *Water-catchment management and soil-conservation measures to reduce erosion and sedimentation* and *Controls on pollution from residential, tourism, commercial and industrial areas*.

The current revised NBSAP implementation plan also does not explicitly mention impact from mines, but does include an action in the forest conversion section to *Enact regulations or codes of practice which ensure environmental impact assessments of new logging areas and plantation establishment sites*. These regulations under the *Environment Management Act* should be equally enforced for the development or redevelopment of mining areas such as at Mt. Kasi mine in order to prevent downstream degradation of freshwater, coastal and marine habitats.

MPA Effectiveness within Kubulau and Macuata Qoliqolis

STATUS: Ongoing through 31 January 2010

FUNDING: David and Lucile Packard Foundation (2007-31847), Gordon and Betty Moore Foundation (540.01), National Oceanic and Atmospheric Administration (NA07NOS4630035)

PARTNER ORGANISATIONS: Wetlands International-Oceania, WWF

OUTPUTS:

- *Technical report*: in prep for submission to the Packard and Moore Foundations
- *Final grant report*: in prep for submission to NOAA

RESEARCH HIGHLIGHTS:

WCS has been conducting surveys of reef community condition inside and outside the marine protected areas (MPAs) within Kubulau and Macuata qoliqolis since the MPA networks were established in 2005. Here we report on survey results from the past 15 months to evaluate the current effectiveness of the networks. A full technical report on the changes in MPA effectiveness is currently being prepared for submission to the donors.

Macuata MPA network

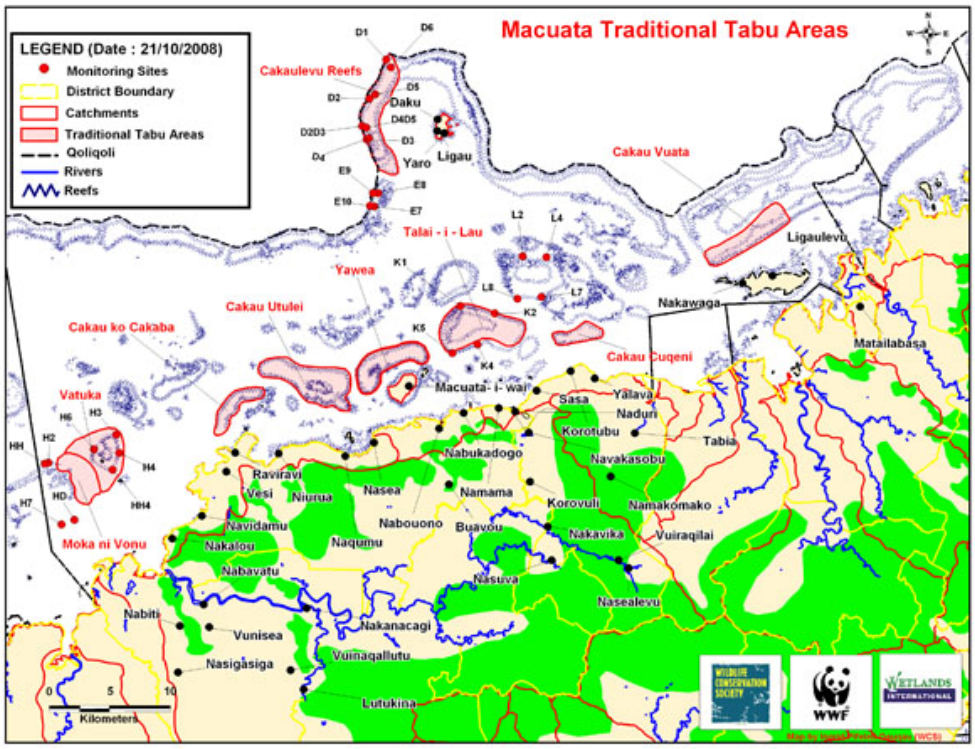


Figure 11. Location of 2008 survey sites within and adjacent to community-managed MPAs (outlined in red) in Macuata qoliqoli.

In September-October 2008, underwater visual census (UVC) monitoring of fish size and abundance was carried out along 50 m transects at sites inside and outside the community-managed MPAs of Cakaulevu (n = 12 sites total), Talai-i-Lau (n = 8 sites total) and Vatuka (n= 8 sites total; Figure 11) to measure fish abundance and size of the following families: Acanthuridae, Balistidae, Carangidae, Carcharhinidae, Chaetodontidae, Haemulidae, Kyphosidae, Labridae, Lethrinidae, Lutjanidae, Mullidae, Nemipteridae, Pomacanthidae, Scaridae, Scombridae, Serranidae (groupers only), Siganidae, and Zanclidae. Biomass was calculated from size class estimates of length (L_T) in 5 cm classes and existing published values from Fishbase (http://www.fishbase.org) used in the standard weight-length expression $M = aL_T^b$. Length-length conversions were used to convert total length field estimates to fork length values when a and b values were reported in Fishbase for fork length.

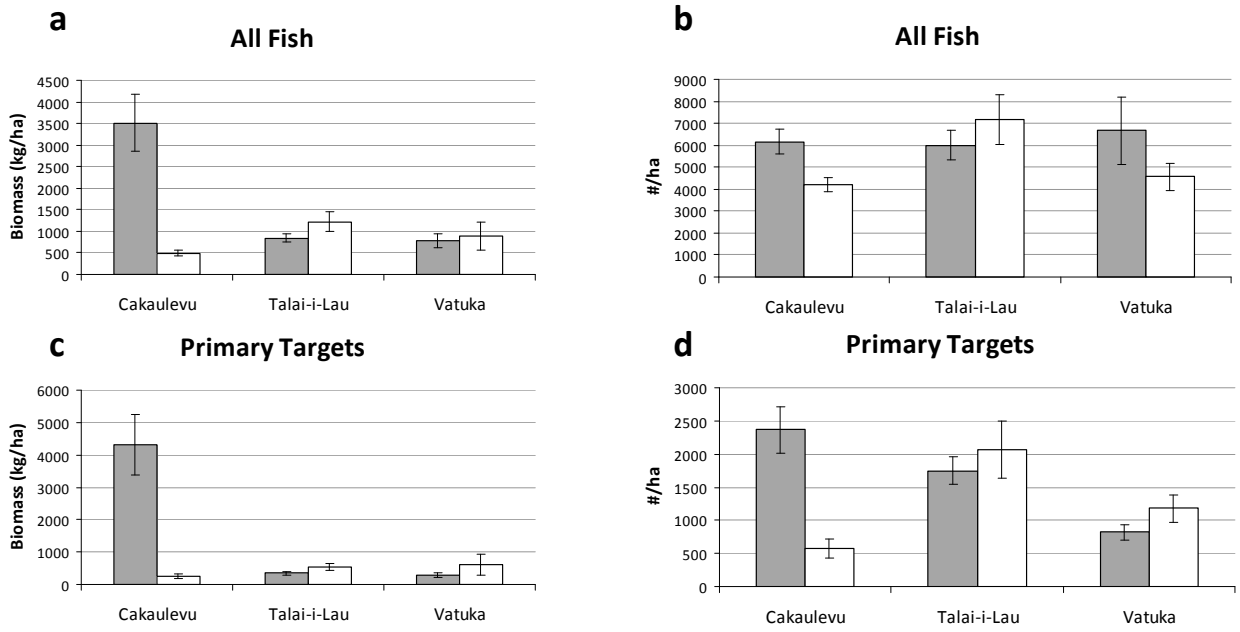


Figure 12. Differences from 2008 Macuata fish survey data between MPAs (grey) and adjacent open fishing grounds (white) in: (a) total fish biomass (kg/ha); (b) total fish abundance (#/ha); (c) primary target fish biomass (kg/ha); and primary target fish abundance (#/ha). Error bars are ± 1 standard error. The majority of Cakaulevu sites were measured prior to fishing harvest in October (see *Intensive Harvest of a Community-Managed Tabu, Cakaulevu Reef*).

Of the 3 MPAs surveyed, only Cakaulevu had significantly greater total fish biomass (kg/ha) than at sites surveyed in adjacent open fishing grounds (Mann Whitney U-test; p = 0.003; Figure 12a), and in no MPAs were fish significantly more abundant (Figure 12b). There were also significantly more and larger primary target food fish inside the Cakaulevu MPA compared with its control sites (Figures 12c,d), but no significant differences in food fish abundance or size in Talai-i-Lau or Vatuka reef.

Although Vatuka MPA is the longest established MPA in Macuata qoliqoli, there appears to be high incidents of poaching which is limiting the effectiveness of the reserve. WCs observed fishing boats within the tabu boundaries during our surveys. Residents of Macuata-i-wai noted that many poachers hide out within the channels

of the mangrove islands of Talai-i-Lau and Vatuka during the day and come out to poach at night when they are not seen. By contrast, the Cakaulevu MPA is far away from mainland villages, yet directly visible from the villages of Daku and Ligau on Kia Island. In addition, the steep wall and high currents are favourable for reef fish production: the biomass values reported from transects in the northern part of the tabu area range to 25 tonnes per hectare due to the presence of: large trevally; large, planktivorous, schooling surgeonfish; and large reef sharks. The consequences to reef fish communities of an intensive harvest directly following these surveys are discussed in the next section.

Kubulau MPA network

In April-May 2009, WCS surveyed 33 forereef sites inside and outside of the three district MPAs (Nasue, Namuri, Namena) and a community-managed tabu (Nakali; Figure 13). As data from backreef sites surveyed in 2007 and 2008 were highly variable, only forereef sites were surveyed on this trip in order to improve statistical power to detect differences in fish community composition related to management.

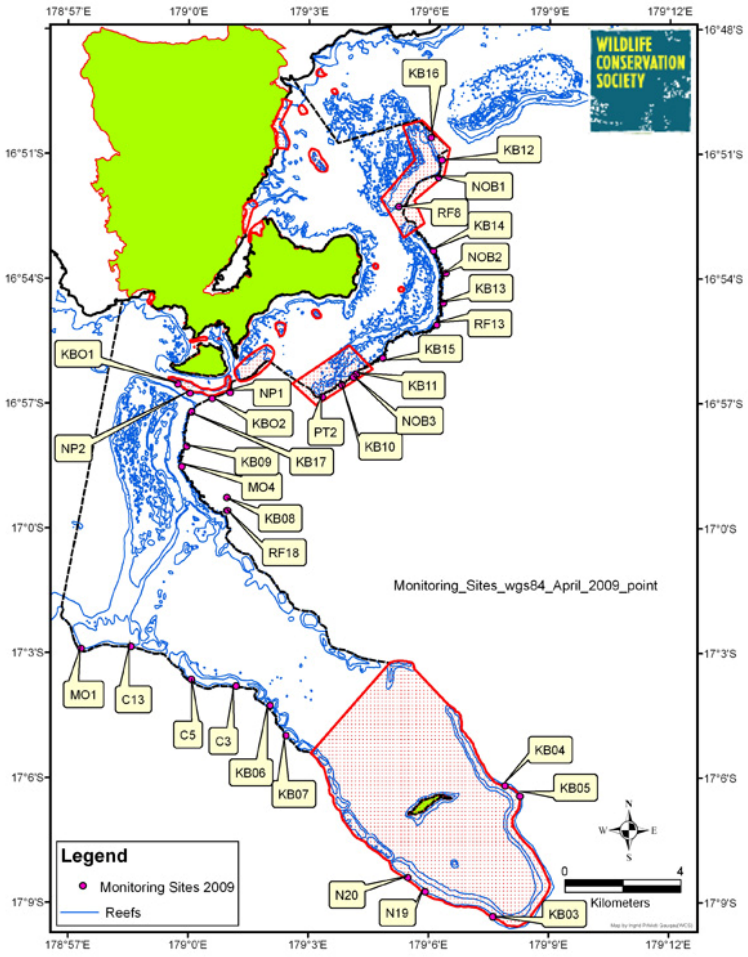


Figure 13. Location of 2009 survey sites within and adjacent to community-managed tabus and district MPAs (outlined in red) in Kubulau qoliqoli.

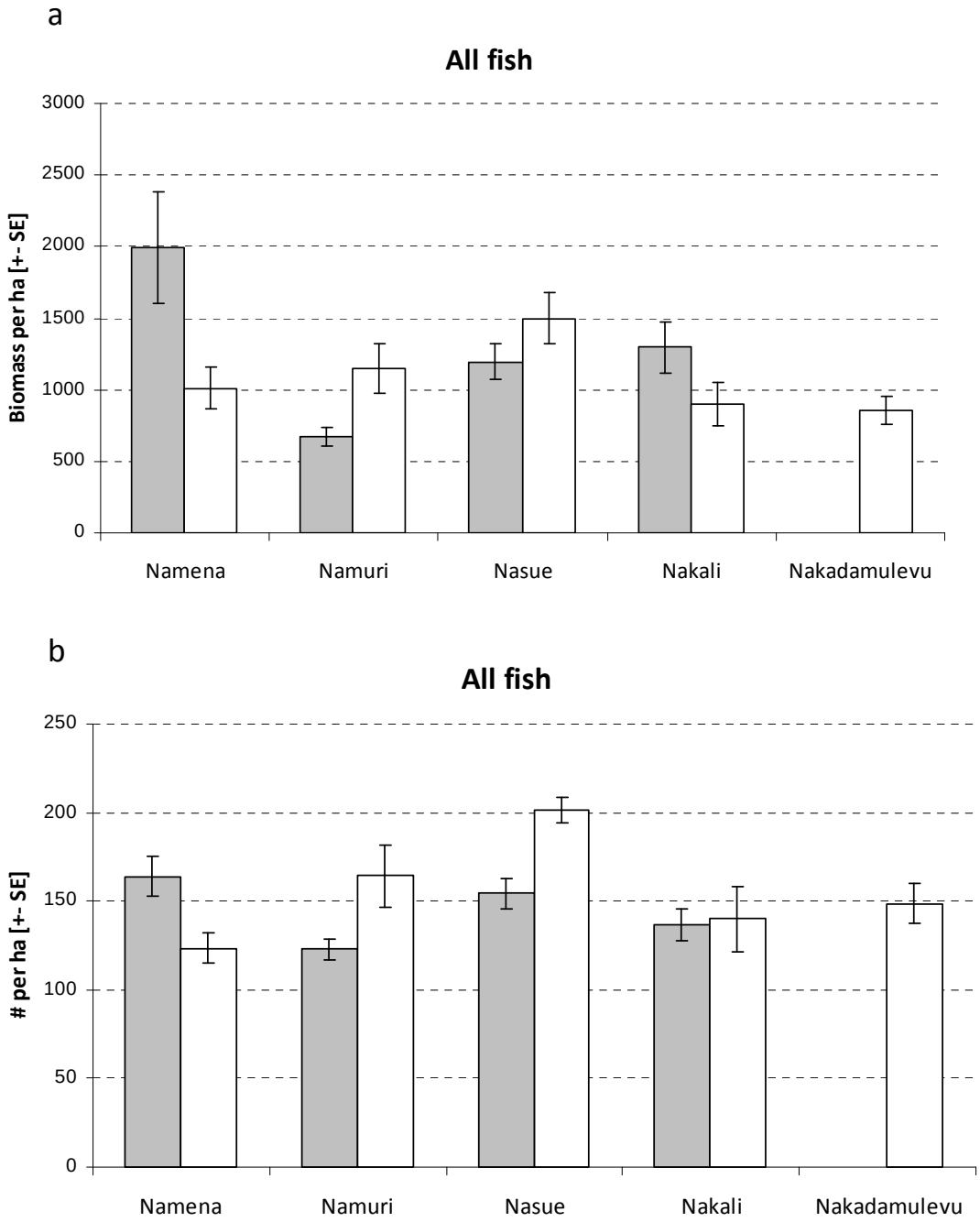


Figure 14. Differences from 2009 Kubulau fish survey data between MPAs (grey) and adjacent open fishing grounds (white) in: (a) total fish biomass (kg/ha); (b) total fish abundance (#/ha). Error bars Error bars are ± 1 standard error.

Biomass (kg/ha) of all fish surveyed was significantly higher in the Namena district MPA ($p = 0.007$; Figure 14a,b). Namena MPA has had consistently higher biomass and abundance, particularly of targeted food fish (Figure 15a,b), since surveys were initiated in 2005 (though the greater abundance and biomass observed in 2008 were not significant). The success of Namena MPA is likely due to a combination of its distance away from villages, the vigilance of the owners of Moody's Namena Resort in chasing poachers, and a strong desire by the majority of the community to respect the management rules in order to maintain the economic benefits of dive tag revenue.

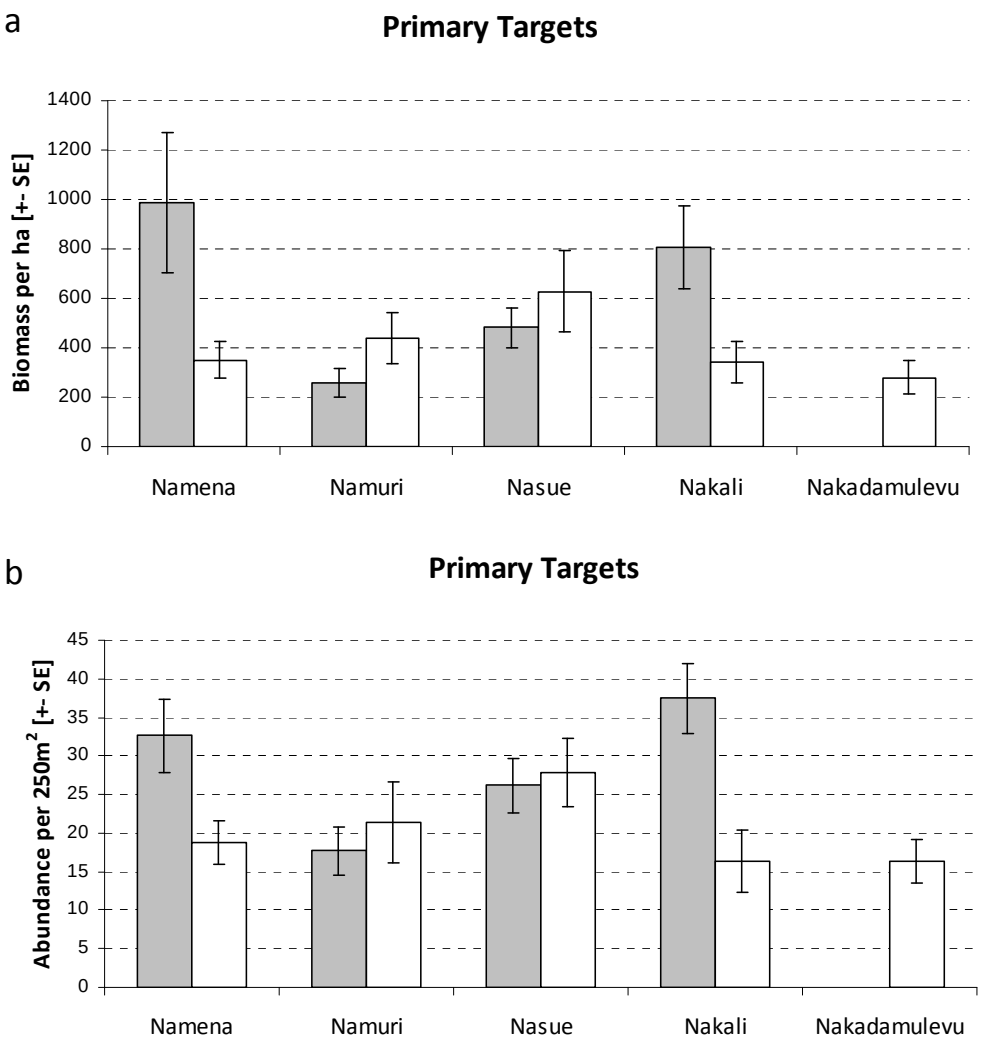


Figure 15. Differences from 2009 Kubulau fish survey data between MPAs (grey) and adjacent open fishing grounds (white) in: (a) primary target fish biomass (kg/ha); (b) primary target abundance (#/ha). Error bars Error bars are ± 1 standard error.

The Nakali community-managed tabu area has clearly recovered from its 2008 levels: in 2007, abundance and biomass of all fish were significantly greater inside versus outside the tabu, but it was harvested 3 times between the succeeding survey in 2008 where the opposite pattern was observed. This frequency of harvest is within the community regulations for the tabu, which state that the tabu "May only be opened up to three times per year, preferably in January, June and November." By 2009, biomass and abundance of primary target food fish ($p < 0.001$), plus the biomass of all fish ($p = 0.005$), was significantly greater inside Nakali tabu than at adjacent reef sites open to fishing. The rapid recovery of fish populations is likely to be enhanced by the high productivity of the system that is well flushed with high current waters from the Naisonisoni passage. The tabu is located within visual distance from land and fishers from the village have other preferential spots for fishing, leading to high compliance with MPA rules.

There is still significantly more fish outside the Nasue MPA in 2009 ($p < 0.001$), which was also observed in 2007. It is likely that the MPA is still being influenced by poaching both from Kubulau residents and from those outside the district (see *Assessments of Land Based Impacts from Long-term Coral Records*).

While the Namuri district MPA had previously shown significantly ($p < 0.001$) greater fish biomass and abundance in 2008, in 2009 there was significantly more biomass outside the MPA. This may be due to regular poaching incidents, as this MPA is located close to the greatest number of villages. Secondly, the pattern may be influenced by the large abundance of spawning parrotfish seen on Drokana Reef outside the MPA (Figure 16), which was not previously observed in other surveys. This finding highlights the importance of surveying at the same time each year in order to avoid potential confounding effects of seasonal differences (e.g. spawning cycles).

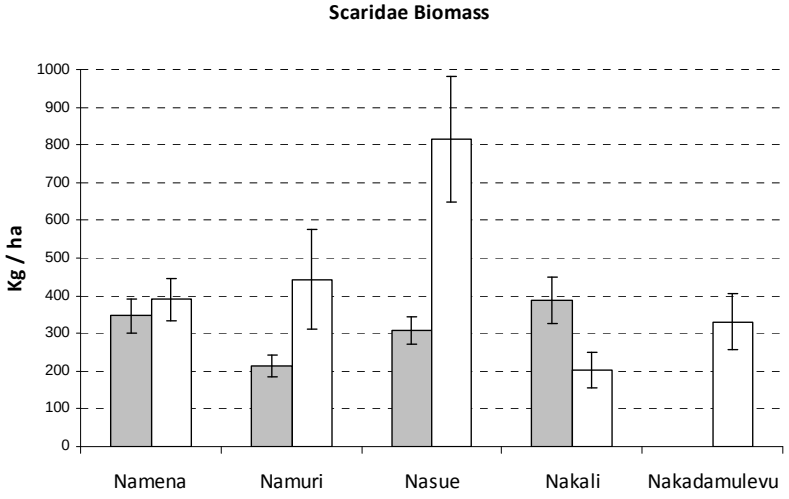


Figure 16. Parrotfish (family Scaridae) biomass (kg/ha) inside (grey) and outside (white) the Kubulau MPAs surveyed in 2009.

LINKS TO NATIONAL PRIORITIES:

The marine protected area networks established in both Kubulau and Macuata qoliqolis help support NBSAP's inshore fisheries thematic section through strategy 4.3 *Maintain existing protected areas* and strategy 4.4 *Design new, ecologically relevant inshore marine protected areas*. The Macuata MPA network has maintained its original 9 MPAs, while WWF has helped facilitate adding an additional 14 protected areas. The overall network consists of 20 MPAs, 3 coastal beach protected areas for turtle nesting sites, 2 estuarine mangrove protected areas, plus 2 terrestrial forest protected areas.

The reefs, mangrove and seagrass within protected areas of Kubulau and Macuata form a large proportion of the total amount of no-take inshore marine protected areas in Fiji. Their protection is assisting the country to meet its national targets for marine conservation under the Programme of Work on Protected Areas. Protecting these vulnerable coastal and marine areas has also been highlighted as an

adaptation strategy in Fiji's first communication to the framework Convention on Climate Change.

Due to the length since establishment and the rigorous scientific monitoring that has been conducted nearly annually at sites in both Kubulau and Macuata, both locations have potential as learning sites for the FLMMA network and continued, periodic monitoring is recommended to gauge long-term success to improve fisheries and conserve biodiversity.

Intensive Harvest of Community-Managed Tabu, Cakaulevu Reef

STATUS: Ongoing through 31 January 2010

FUNDING: David and Lucile Packard Foundation (2007-31847), Gordon and Betty Moore Foundation (540.01)

PARTNER ORGANISATIONS: Wetlands International-Oceania, WWF

OUTPUTS:

- *Journal publication*: in prep

RESEARCH HIGHLIGHTS:

South Pacific islands widely use community-based adaptive management (CBAM) approach to address the increasing pressures on their marine resources. A strong focus is being laid on integrating traditional with contemporary approaches. For nearshore marine areas, one of the main management tools is establishment of traditional tabu areas. The majority of tabu areas are temporary no-take areas with village/area specific harvest regulations: these can be restricted to particular species or limited regular or irregular openings. While it is important for the existing approach successfully being promoted mainly under Fiji Locally Managed Marine Areas (FLMMA), there have thus far been no attempts to empirically investigate the potential impact of regular or even irregular openings on the recovery of marine species in such tabu areas in Fiji. This is particularly important given that ongoing biological monitoring has often struggled to demonstrate positive effects on exploited species due to a combination of poor sampling design and poor reserve design.

For long-term survival of marine biodiversity, “bigger is better” as larger reserves contain: (1) greater proportions of critical habitats and ecological processes needed to sustain multiple species; and (2) larger populations with higher genetic diversity. Yet for the majority of cases in the tropical Western Pacific, socio-political considerations demand smaller MPAs. Additionally, the foremost objective of MPAs for many Pacific Island communities is not biodiversity conservation but rather maximizing the export of adults and larval supply for fisheries benefits. Many small reserves can, in fact, maximize fisheries yields. Yet it is important to be aware that these benefits will be outweighed by negative edge effects as reserve sizes shrink: skilled fishers may concentrate their efforts at MPA boundaries and may overexploit stock if the reserves are smaller than the foraging ranges of mobile, target species.

Furthermore, MPAs will only yield positive fisheries benefits insofar fishers comply with their no-take status. It has been found that even small amount of fishing pressure (period opening, partial reserves, poaching) can offset long-term benefits of protection on exploited species. To gain a better understanding of harvesting impact on fish assemblages in protected areas, we used an opportunistic pre- & post-

harvest sampling to examine direct effects of harvesting on coral reef fish assemblages.

The main sampling design compared underwater visual census (UVC) surveys at two different depths on the forereef inside and outside the Cakaulevy tabu area off Kia Island (Vanua Levu, Macuata Province). UVC surveys were carried out using standard scuba equipment. Given strong differences in reef geomorphology, the Cakaulevu tabu was divided into a northern and southern area with a control area located south of the tabu (Figure 17). Two sites were sampled in each of the three areas and two depths within each site. All sites were sampled prior to the opening event (September 2008) and again after four weeks of intensive harvesting within the Cakaulevu tabu for a community fundraiser (October 2008). The unforeseen opening of the Cakaulevu tabu restricted the pre-opening sampling to three days and two sites within each of the sampling areas. All sites were chosen based on a baseline survey conducted in the study area in 2006.

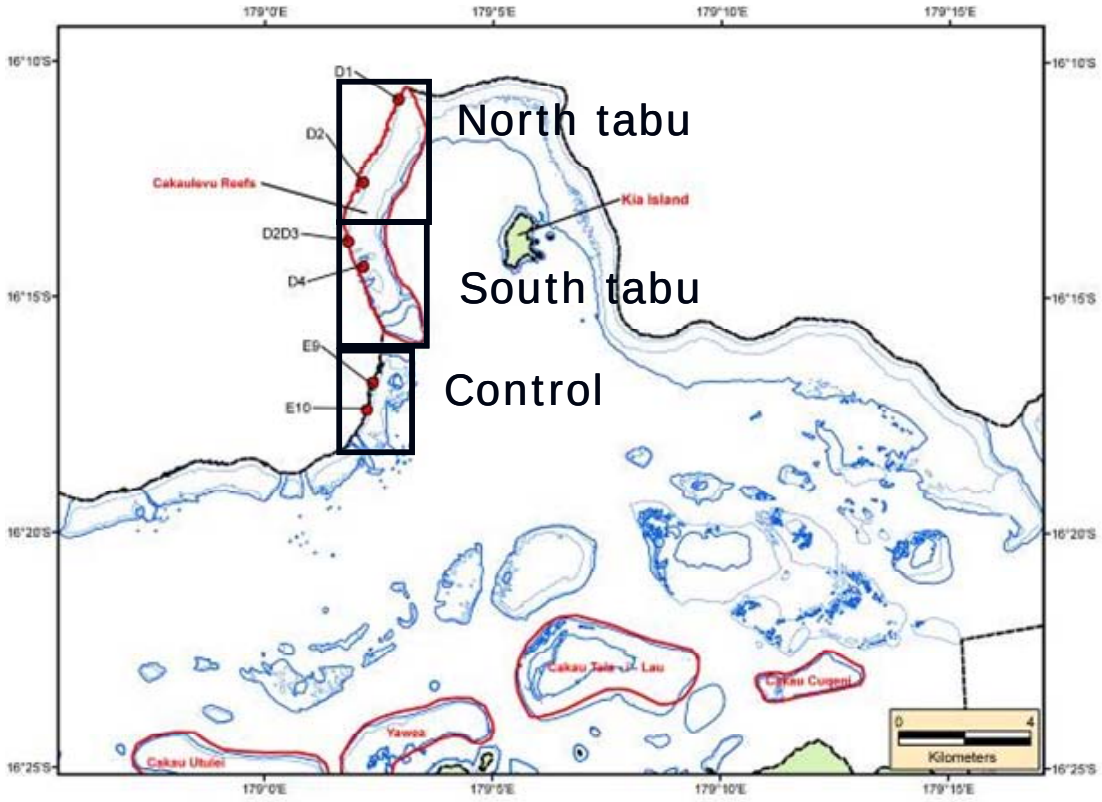


Figure 17. Map of Kia Island and Cakaulevu tabu (outlined in red) in Macuata Province, Vanau Levu, Fiji Islands. The study area is divided in north tabu, south tabu, and control area.

Prior to the harvest event there was a clear increasing gradient from the control to southern and northern tabu area for: abundance, biomass, ratio of large (>25 cm) to small fish (<25 cm), and primary target fish (Figure 18a-d). The protected area harboured more and bigger fish (and primary target fish) with even larger and more abundant fish in the northern tabu area, likely due to the steep reef wall and high currents supporting high natural reef productivity. This gradient breaks down after the harvesting event and even reverses in the case of biomass of primary target fish (Figure 18d).

The northern tabu area is statistically significantly greater then the control area for all four measures pre-harvest and remains only just higher in biomass post-harvest. Following the harvest, the biomass of primary target fish in the control area increases significantly to levels well above the protected area ones (even though the difference between the areas is not statistically significant; Figure 18d).

The breakdown of the natural gradient (north > south > control) is most obvious in the ratio between fish >25 cm (fork length) to fish ≤25cm, where there are statistically significant pre-harvest differences between both protected areas (north and south) and the control area (Figure 18c). After the harvest, the ratios area very similar in all three areas and no statistical difference area observed. This is also reflected in the large increase in biomass in the control area (where there was little or no fishing during this period.

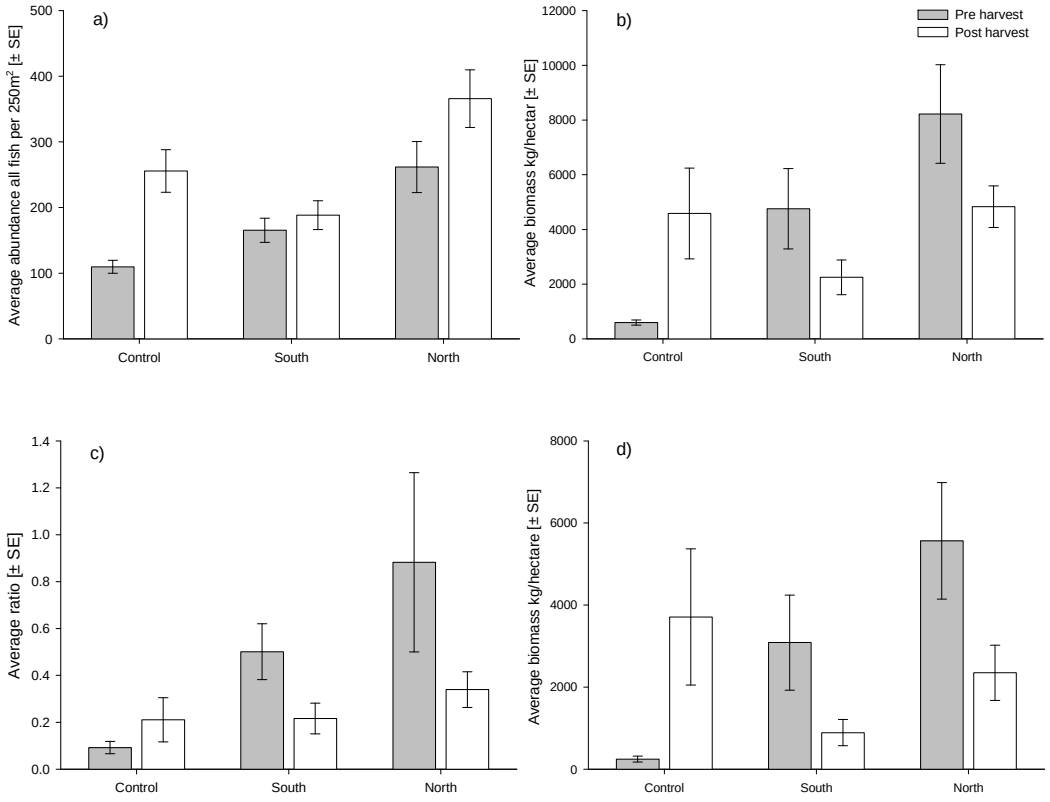


Figure 18. Differences before (grey) and after (white) a four week intensive harvest of Cakaulevu tabu in: (a) total fish abundance (# per transect); (b) biomass (kg/ha); (c) ratio of large fish >25 cm to small fish < 25 cm; and (d) biomass of primary target fish (kg/ha).

The breakdown of changes in biomass of primary target fish by area and families shows which families are particularly affected by the harvesting event (Figure 19). In the northern area, the biomass of Acanthuridae and Carangidae were heavily reduced by the fishing (Figure 19c). In the southern portion of the tabu area, Lethrinidae, Lutjanidae and Scaridae that were strongly affect by the harvesting (Figure 19b). In the control areas, there was an increase in biomass following the harvest in all but one (Carangidae) of the families that declined during the harvesting event in the southern and northern tabu area (Figure 19a).

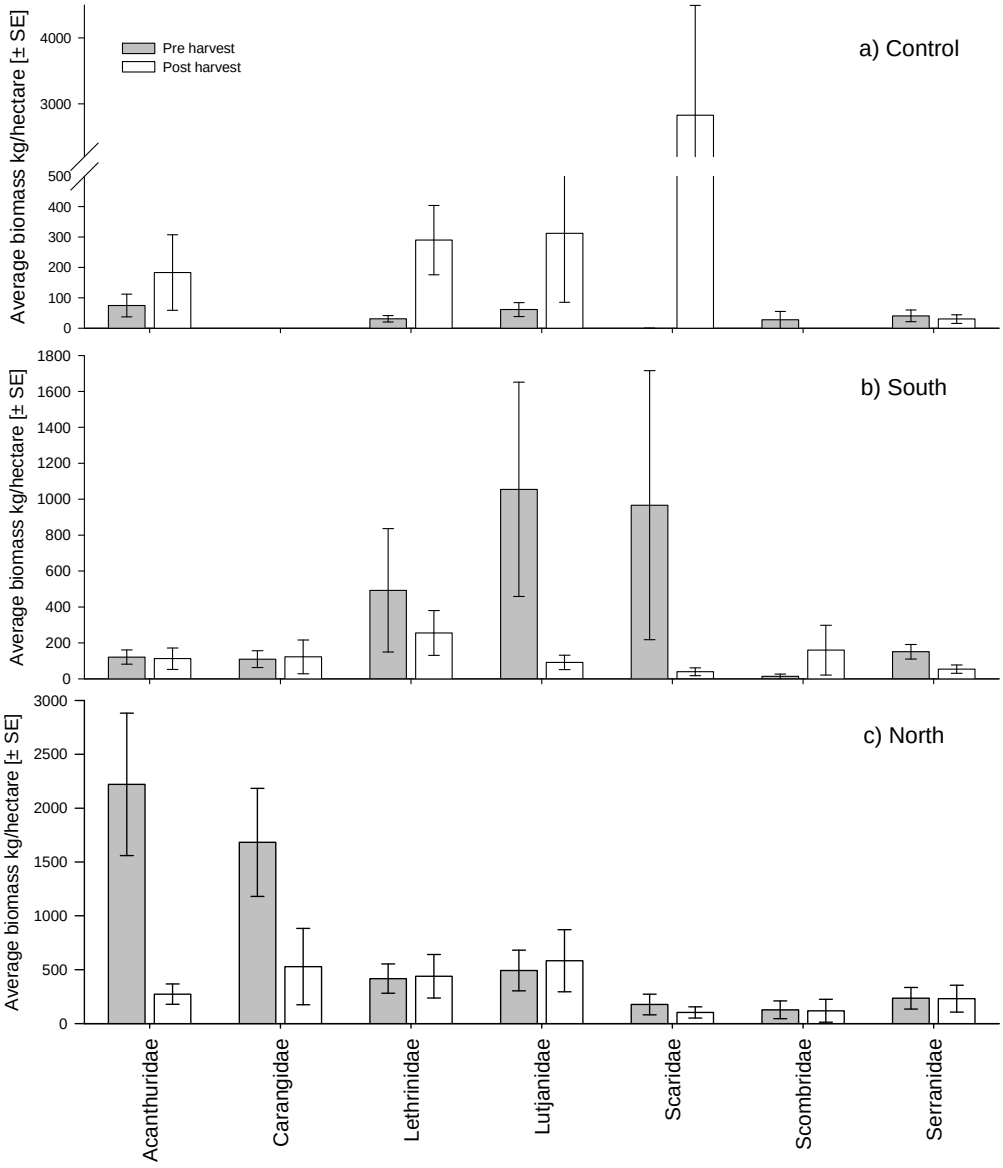


Figure 19. Differences in pre- (grey) and post- (white) harvest biomass (kg/ha) of major targeted food fish families in the (a) control areas; (b) southern part of Cakaulevu tabu; and (c) northern part of Cakaulevu tabu.

The results of this study demonstrate clearly that a single intensive harvest event can remove all positive effects of protection in tabu areas. The main effect of the harvest event was seen in primary target fish, which suggests that fishing was the main cause of the dramatic reduction in biomass observed in the protected area. In addition, it was demonstrated that results from surveys using abundance alone (with no size estimates) need to be interpreted cautiously. The observed increase in numbers in the northern part of the tabu does not reflect the true impact of the harvesting event on the fish assemblage: fishing resulted in a population of more abundant, smaller fish when the larger, targeted species were removed. An increase in abundance of fish could have lead to the false conclusion that harvesting a protected area can be beneficial.

Given these results, it is important to advocate that future coastal marine management strategies to include permanent no take areas (marine reserves) in the

management. Furthermore, closer examination of effects at the population level should be considered to assess the impacts of the various management strategies for traditional tabu areas which have been established in Fiji.

LINKS TO NATIONAL PRIORITIES:

The FLMMA network has an objective in its 5 year draft Stategic Plan to *complement community learning with partner learning at 25 sites*. One of the main priorities for learning through the FLMMA network is how frequently and how often tabu areas can be harvested without long-term damage to the ecosystem. FLMMA has set a goal through its RARE pride campaign to issue guidelines to community members on whether and how tabu areas should be harvested and this research will support development of those guidelines. These guidelines will help facilitate the Department of Environment 2010 priority for the inshore fisheries thematic section to *Identify community capacity building needs to help better manage inshore resources*.

Fish Assemblage Characteristics at Different Depths Using Stereo Baited Underwater Remote Video (sBRUV) Surveys

STATUS: Ongoing through 31 January 2010

FUNDING: Niarchos Fellowship (to D. Egli, WCS)

PARTNER ORGANISATIONS: University of Western Australia (Australia)

OUTPUTS:

- *Honours thesis*: Goetze J (2009) Evidence of artisanal fishing impacts and depth refuge in assemblages of reef fish of a Fijian Island. University of Western Australia, Perth.
- *Journal publication*: in prep

RESEARCH HIGHLIGHTS:

Spatial and/or temporal protection from fishing generally results in an increase in the abundance and biomass of targeted fishes within Marine Protected Area (MPA) boundaries. In Fiji, many traditional tabus and MPAs have been set up recently as measures to help ensure sustainable management of coastal inshore marine resources. In addition, within areas open to fishing, targeted fish may also find natural refuges in deeper areas where fishers cannot access, yet few studies have looked at the potential effects of depth simultaneously with spatial closures. To date, there has been limited empirical research into the effects of protection on assemblages of coral reef fish in developing countries where fishing is mostly small-scale and artisanal. The effects of protection and depth on assemblages of reef fish in the Kubulua district off Vanua Levu Island, Fiji were studied using novel stereo Baited Remote Underwater Video (sBRUV) systems.

In contrast to conventional underwater visual census (UVC) on scuba, the sBRUV system is stationary and records fish assemblages near the sea bed for 1h periods, with the bait placed in front of the video cameras attracting additional predatory fish. The video footage is afterwards used to identify species and measure the length of individuals. Stereo BRUVs consist of a trestle shaped, galvanized frame, with a base bar running horizontally within, holding two water proof camera housings (Figure 20). Each of these housings are inwardly converged at 7° to enable a three dimensional calibration used to estimate the size of fish. Sony Mini-DV HandiCams (Model HC15) with wide-angle lens adapters (0.6×) situated inside of the aluminium housings were used to record the fish populations. Bait arms with a plastic coated mesh canister containing 1 kg of pilchards as bait were attached to the front of the frame and lie just off the seabed in plain view of the cameras. A diode is attached to the bait arm to enable the synchronisation of the stereo images. Ropes with 2 surface floats were attached to the stereo BRUVs for deployment, re-location and retrieval.

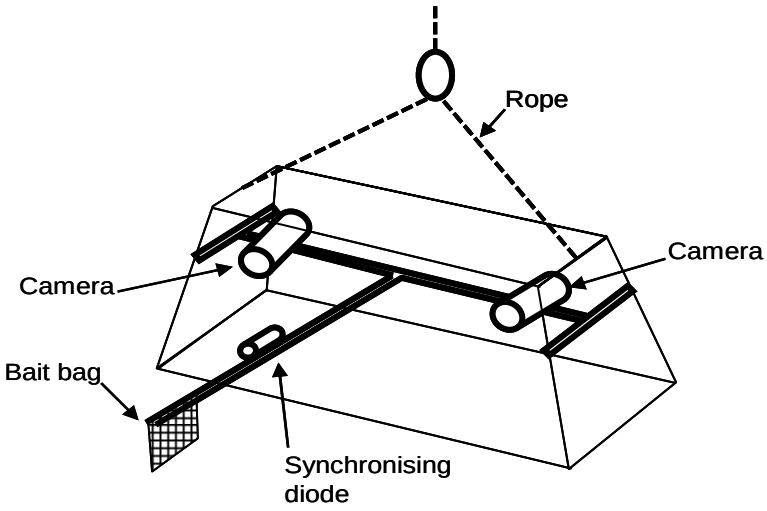


Figure 20. Diagram of a stereo Baited Remote Underwater Video system (Courtesy of Dr Timothy Langlois).

Video recordings were collected from shallow (5-8 m) and deep (25-30 m) sites inside and outside of the Namena reserve (60.6 km^2, 13 years old) and Namuri reserve (4.25 km^2, 4 years old). The relative abundances of 341 species and biomass of 258 species was recorded. In the shallow waters of the Namena reserve, species richness was 34% greater than surrounding fished areas, while in deep waters of the reserve, species richness was only 9% greater than comparable fished areas (Figure 21). This indicates a potential depth refuge, meaning that the fishing in open areas has an impact only in shallow areas. However, in the younger and smaller Namuri reserve there were no differences found in species richness between fished and protected areas. The lack of higher species richness in the shallow areas may be due to regular poaching and openings for invertebrate collection.

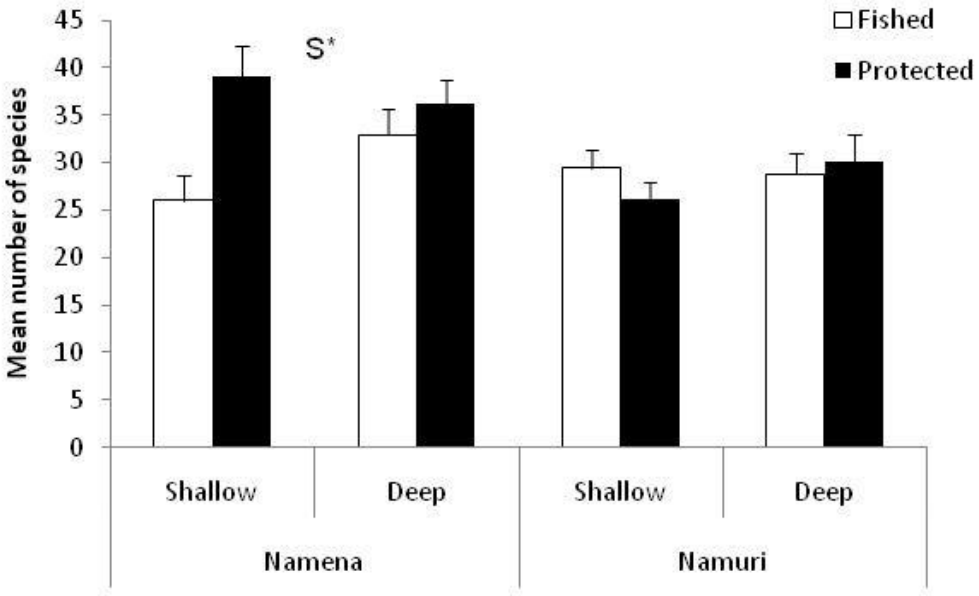


Figure 21. The mean (+ 1SE) number of species per stereo BRUV drop is shown for deep and shallow sites inside and outside of the Namuri and Namena reserves. The symbol S* represents a significant difference between status, and the absence of a symbol indicates no significant difference was found.

There was no statistically significant difference in the average number of all individuals per drop between deep and shallow sites or protected and fished sites for the Namena or Namuri reserve ($p > 0.05$). There were, however, more individuals in the shallow protected sites than the shallow fished sites for the Namena reserve (Figure 22).

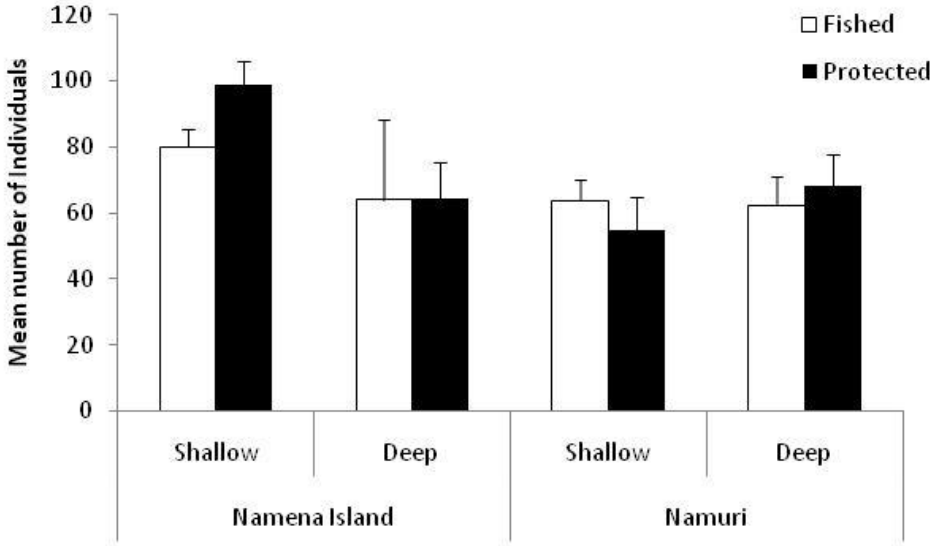


Figure 22. Total number of individuals per stereo BRUV drop is shown for deep and shallow sites in the Namuri and Namena reserves.

There was a significant difference with between protected and fished areas (status) for the targeted fish species by food fish grade (A-C), with greater abundance in the protected areas than for both shallow and deep sites in the Namena reserve (Figure 23). In contrast, the species included in the non-targeted category showed no significant difference between protected and fished sites for the Namena reserve. There was a significant difference between the abundance of non-targeted species between deep and shallow sites. The generally more pronounced differences in the shallow areas indicate that the fishing impact in shallower depths is more pronounced.

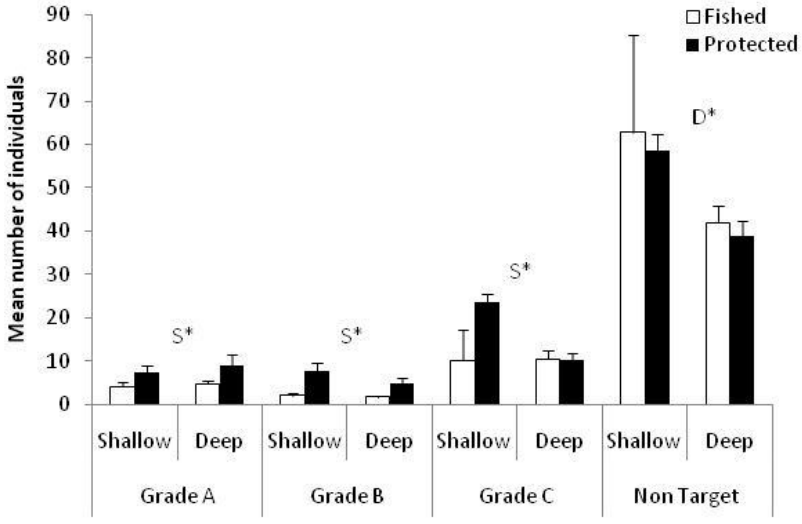


Figure 23. The mean abundance for each food fish grade A-C and Non-target species is shown for deep and shallow sites in the Namena reserve. Error bars = +SE. The symbol D* represents a significant difference between depths, S* a significant difference between status, and the absence of a symbol indicates no significant difference was found.

There was no significant difference with the abundance of grade A, B and C targeted species or non-targeted species between deep and shallow sites or protected and fished sites for the Namuri reserve (Figure 24). The lack of any recovery of target fish in either depth supports the observations of regular poaching that can easily prevent recovery.

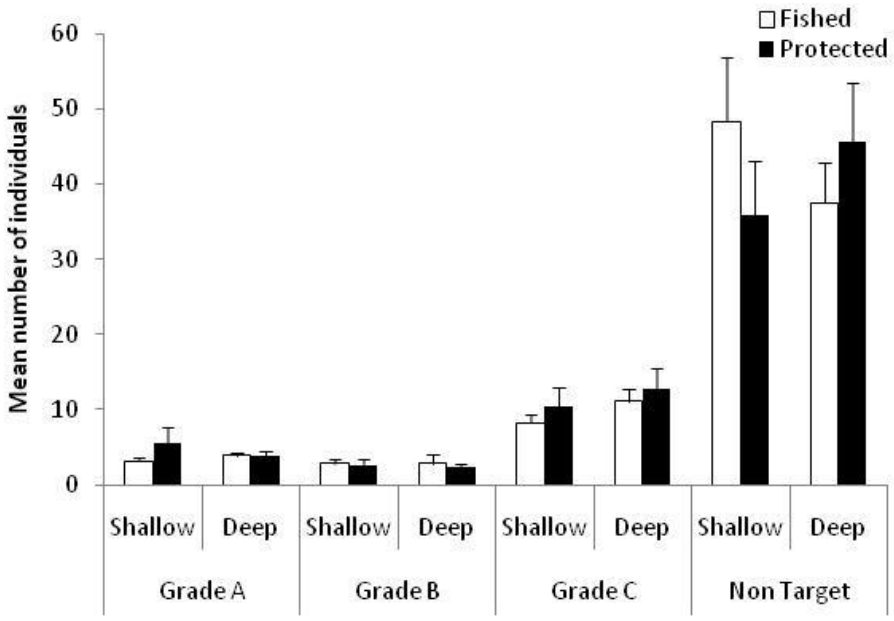


Figure 24. The mean abundance for each food fish grade A, B, C and non-target species is shown for deep and shallow sites in the Namuri reserve. Error bars = +SE. The absence of a symbol indicates no significant difference was found.

This study suggests that artisanal fishing in Fijian inshore marine areas significantly impacts on the structure of fish assemblages and abundance. Furthermore, the results indicate that recovery from fishing effects may only be detected in large reserves that have been established for a long period of time. This effect of protection also appears to vary with depth, highlighting the importance of incorporating multiple depth strata in the design of MPAs and sampling over this full depth range when monitoring. The lack of differences in abundance and species richness at deeper depth suggests that there is likely a depth refuge to some degree from fishing effects in areas deeper than 25 m at present. It is vital to keep in mind though that the species assemblages vary between shallow and deep sites and even a strong depth refuge would not provide any protection to some important species that are normally found in shallower areas. With the likely development and sophistication of fishing methods and technology any existing depth refuge is going to be temporary. As a long term approach it would be necessary to incorporate large areas of protection that not only cover representative habitats but also large depth ranges.

LINKS TO NATIONAL PRIORITIES:

The FLMMA network has an objective in its 5 year draft Strategic Plan to *complement community learning with partner learning at 25 sites*. Results from this study will inform future monitoring designs at the learning sites.

Spatial Predictions of Fish Assemblages from Satellite Mapping Data

STATUS: Ongoing through 31 January 2010

FUNDING: David and Lucile Packard Foundation (2006-30719; 2007-31847), Gordon and Betty Moore Foundation (540.01)

PARTNER ORGANISATIONS: University of Queensland (Australia), University of Waterloo (Canada)

OUTPUTS:

- *Journal publication*: in prep

RESEARCH HIGHLIGHTS:

On a national scale, there is fairly little accurate, quantitative information about the amount and variety of marine and coastal habitats in Fiji. While the Fiji Department of Lands has digitized both exposed and submerged reefs from 1994 and 1996 aerial photographs, and the Fiji Department of Forestry has digitized mangroves from 2001 Landsat satellite data, the coverage is not comprehensive for Kubulau, which limits the utility of these datasets for management applications.

WCS purchased multispectral satellite imagery in May 2009 which covers the entire Kubulau *qoliqoli*. In collaboration with researchers from the University of Queensland in Australia and the University of Waterloo in Canada, field data was collected in September 2009 from a variety of marine and coastal habitats to be used to validate geomorphic classifications of reef habitats and spatial models of fish assemblages. Predictive maps of relative differences in fish biodiversity and biomass will represent a new innovation in remote sensing science that has never been used for direct management applications to try to identify optimum areas to add new marine protected areas (MPAs) to the Kubulau network.

Geomorphic classifications have been mapped, reviewed and edited (Figure 25). Over 9,500 photographs were taken and analysed for benthic substrate and reef complexity: they are currently being used to divide the geomorphic classifications into more specific benthic community classes (e.g. live coral dominant; Figure 26). Spatial models trialled with the field data from underwater visual count surveys of fish and benthic structure suggest that depth, coral cover and reef complexity explain high amounts of variation in reef fish assemblages. Since all of these variables can be derived from the remote sensing data, we have high confidence that we should be able to use the mapped classifications to predict spatial distributions in fish diversity and biomass on Kubulau's reefs.

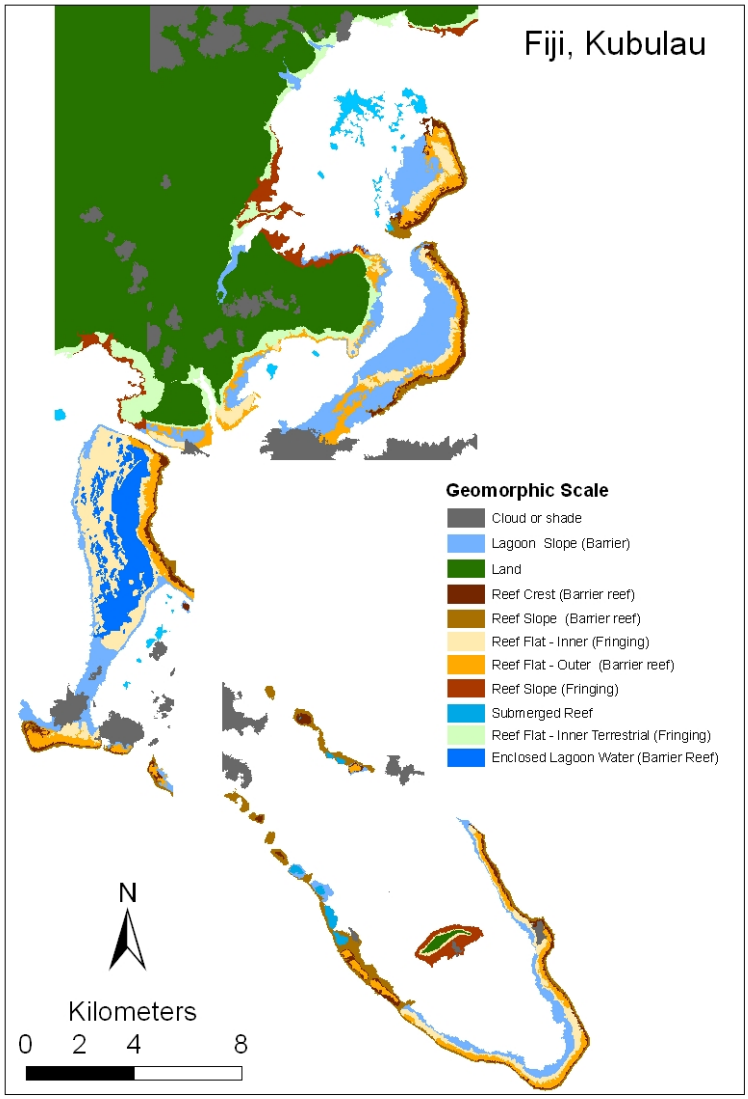


Figure 25. Draft geomorphic classification of marine habitats in Kubulau *qoliqoli*. Broad classes include: land, cloud, lagoon slope, reef crest, reef slope (fringing and barrier), reef flat (inner and outer), submerged reef, reef flat and enclosed lagoon water.

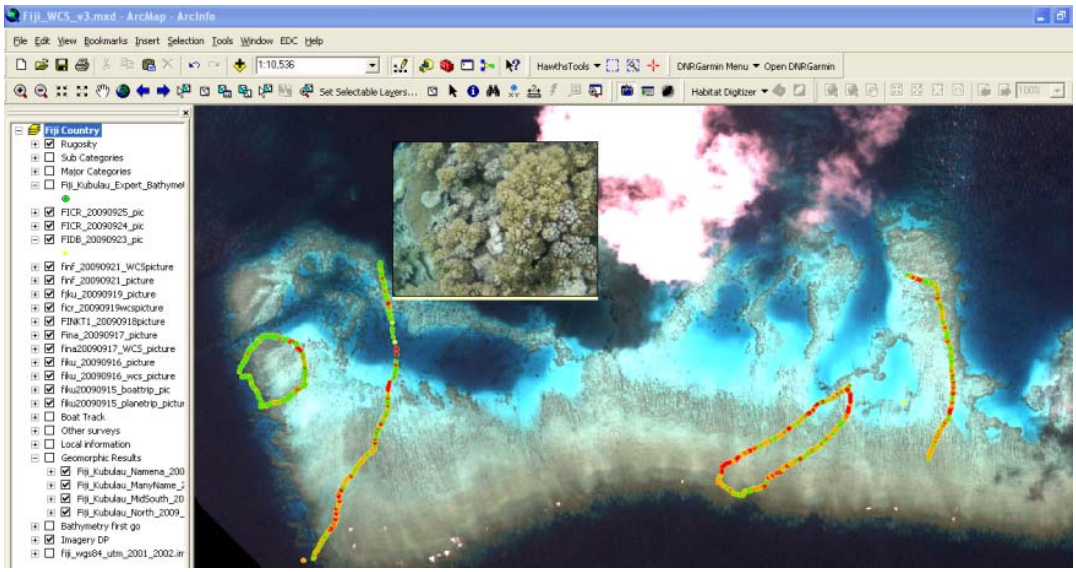


Figure 26. GIS display of classified photographs according to benthic substrate category.

LINKS TO NATIONAL PRIORITIES:

The national Protected Area Committee has been tasked with carrying out a national ecological gap assessment for Fiji. WCS has taken the lead on the marine component of the gap analysis and is working to scale up learning from the site to the national level. Millenium Coral Reef maps are currently being produced for all of Fiji's reefs through a collaboration between the Institute for Marine Remote Sensing (IMaRS) at the University of Southern Florida and NASA. Once these geomorphic classifications become available, WCS can examine the extent to which the coarse geomorphic classes are able to represent relative differences in fish diversity and biomass in Kubulau in order to scale up across the entire country's reef systems. This exercise will aid in the process to prioritize areas for protection under the Programme of Work on Protected Areas to help identify regions that are potentially rich in biodiversity for which there is no field data available.

Marine Opportunity Costs: Maximizing Fisheries Benefits from MPAs while Minimizing Costs to Fishers

STATUS: Ongoing through 31 January 2010

FUNDING: David and Lucile Packard Foundation (2007-31847), Gordon and Betty Moore Foundation (540.01)

PARTNER ORGANISATIONS: James Cook University (Australia)

OUTPUTS:

- *Technical report*: in prep
- *Journal publication*: in prep
- *Local conference presentation*: Adams VM, Mills M, Jupiter S, Pressey B (2009) Opportunity costs: a method for marine systems. Presented at the 1st Fiji Islands Conservation Science Forum, Suva, Fiji, 5-7 August 2009.

RESEARCH HIGHLIGHTS:

There has been considerable discussion on differences in design criteria for reserves and reserve networks with explicit goals of biodiversity conservation versus fisheries production: optimum designs to meet both objectives may ultimately require trade-offs between size, spacing and representation. Systematic conservation planning can account for these trade-offs during the selection of areas for conservation and is currently the preferred approach to designing MPA networks in developed countries. Historically driven by biological goals and data, the technical ability to design effective protected area networks has evolved rapidly. Despite this progress, recent research highlights the need to include socio-economic data in conservation planning as it will influence the likely outcomes of plans.

Use of socio-economic criteria is especially important in the context of developing countries where social acceptance is a critical factor in determining MPA success and data is generally limited. While inclusion of socio-economic factors in the design of MPAs has increased in the last decade, the spatial variation in costs to stakeholder groups needs to be better understood and incorporated into conservation plans. This is especially important in Pacific Island countries where: communities are highly dependent on marine resources for subsistence; fishers have limited spatial and occupational mobility; and customary marine tenure institutions set social and governance constraints on MPA network design For example, research from the Western Province of the Solomon Islands suggests that success of MPA networks relies on their placement within secure sea tenure regimes and the perception of equitable distribution of biological and social costs and benefits by resource users. Any type of conservation planning approach to MPA network design for the Western Pacific needs to be particularly sensitive to these cultural needs.

The most prevalent type of socio-economic data included in conservation planning is fisheries catch data. Catch per unit effort (CPUE) data included are typically derived

from socio-economic survey questions such as fishing location, gear used and the type and amount of fish caught. These data both enable assessment of the spatial distribution of fishing effort and can be combined with ecological surveys to examine the effects of fishing effort on reef fish community composition. However, as access to motor boats increases, it is reasonable to expect that fishing effort will change and move further offshore to areas currently not fished. Therefore, a method for estimating opportunity costs of areas currently not fished is needed so that conservation plans take into account the heterogeneous opportunity costs to fishers. A method for calculating opportunity costs in transitional landscapes has been developed, however an analogous method is not currently described for marine environments. In response to this need, we report on a novel method for calculating the opportunity costs to multiple stakeholder groups arising from fisher displacement due to the establishment of marine protected areas and apply the method to a region in Fiji. We then demonstrate an application of using the opportunity cost layer within a conservation planning software framework to present recommendations for reconfiguring an existing community-managed MPA network in Kubulau District, Fiji Islands, to improve its social acceptance.

Through this study, we seek to address 3 main questions:

(1) Where are the preferred target species located and what spatial models serve as the best predictors of species abundance;
(2) Where in Kubulau is current fishing effort focused and how does it vary by gear; and
(3) Where would be the best areas to modify the current MPA network to reduce conflict and improve fisheries benefits and which users would be most affected by these changes?

Preliminary modelling exercises have been based on baseline underwater visual count surveys collected in 2005 at 99 sites across reef areas in Kubulau qoliqoli to assess target fish size and abundance, plus spatially-referenced CPUE data (in kg person^{-1} hr^{-1} m^{2}) collected between May 2008 and February 2009 from four villages (Raviravi, Navatu, Kiobo, Nakorovou) within Kubulau District. Trained community volunteers recorded information once a week from all fish landings in the village during a 24 hour period. Fishers were asked for information on the total number fish caught, the number of fishers who went out fishing, the time spent fishing, the gear used for fishing and the transport used for fishing.

In order to model opportunity costs of fishing sites we considered the stakeholder groups in the region. We define stakeholder groups by the type of fishing gear used. In Kubulau there are seven stakeholder groups identified by the types of fishing gear (gill net, hand spear, speargun, hand line, trolling, diving, Hawaiian sling). For each stakeholder group we identify key species, *i.* We define the opportunity cost to stakeholder group *j* to be c_j

$$c_j = \sum_{i=1}^{n} p_{ji} w_i b_{ji} m_i$$

Where p_{ji} is the percentage catch for gear type j of species i, a_i is the abundance of species i, b_i is the expected biomass of species i and m_i is the market value of species i.

The opportunity cost, c, of a fishing site is the sum of opportunity costs to all stakeholder groups weighted by the current proportion , w_j, of the total fleet of gear types and fishers currently in the fishery:

$$c = \sum_{j=1}^{J} w_j c_j$$

We calculated the opportunity cost as a weighted sum to capture the current distribution of gear types in the fleet. Additionally, a fishing site was not exclusively available for fishing by any one gear type, therefore calculating the opportunity cost to be equal to the most profitable gear type at that site is not accurate for marine environments. We calculated the opportunity costs to each stakeholder group as well as the full opportunity cost of each fishing site. The abundance and percentage catch components were modeled separately. Biomass was estimated based on average size of fish by species from the UVC data. Market value, or sales price, was obtained by the closest Fiji Department of Fisheries district office in Savusavu.

Acanthuridae, Lutjanidae and Scaridae were the most abundant families in the qoliqoli in terms of numbers of their targeted food fish sighted (Figure 27). Species abundance model results indicate that abundance of fish within these three families varies spatially with highest abundance occurring in different habitats for each. Acanthurids have the highest abundance on inshore fringing and patch reef (Figure 27a); lutjanids have the highest abundance on barrier (Figure 27b); while scarids have the highest abundance on fringing reef (Figure 27c).

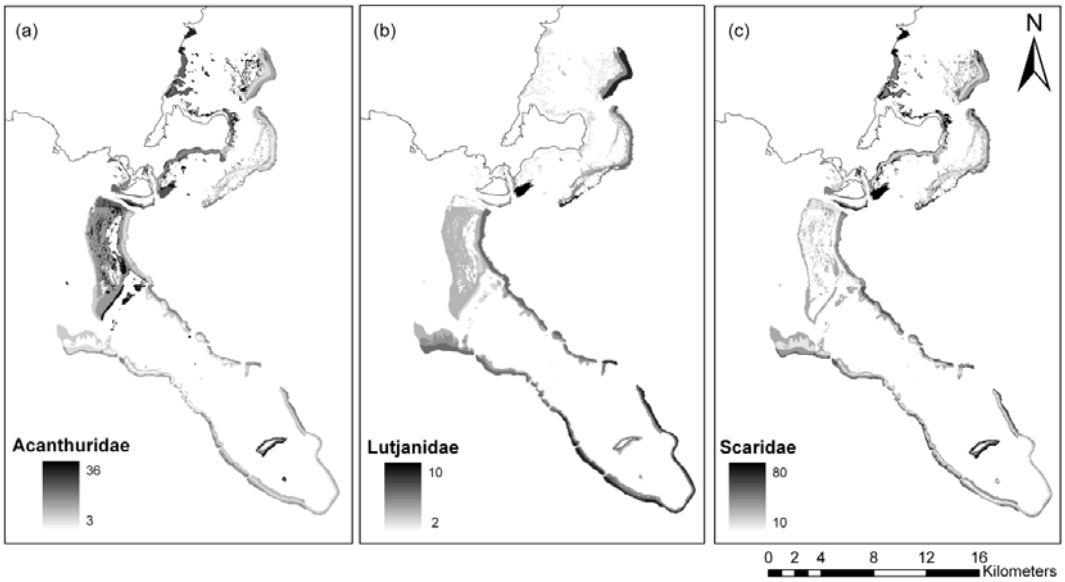


Figure 27. Modeled abundance for the three most abundant families: Acanthuridae, Lutjanidae, Scaridae. (a) Acanthuridae abundance (b) Lutjanidae abundance (c) Scaridae abundance.

CPUE, as indicated by fisher survey records, was relatively uniform across all inshore reefs with the highest effort occurring on fringing reef near villages, particularly near areas where multiple villages are in close proximity. (Figure 28a). CPUE values ranged from 0.02 kg person^{-1} hr^{-1} m^{2} to 11.25 kg person^{-1} hr^{-1} m^{2}. The modeled opportunity cost was highest for inshore fringing and patch reefs, with one section of high value fringing reefs occurring offshore in the Namena MPA (Figure 28b).

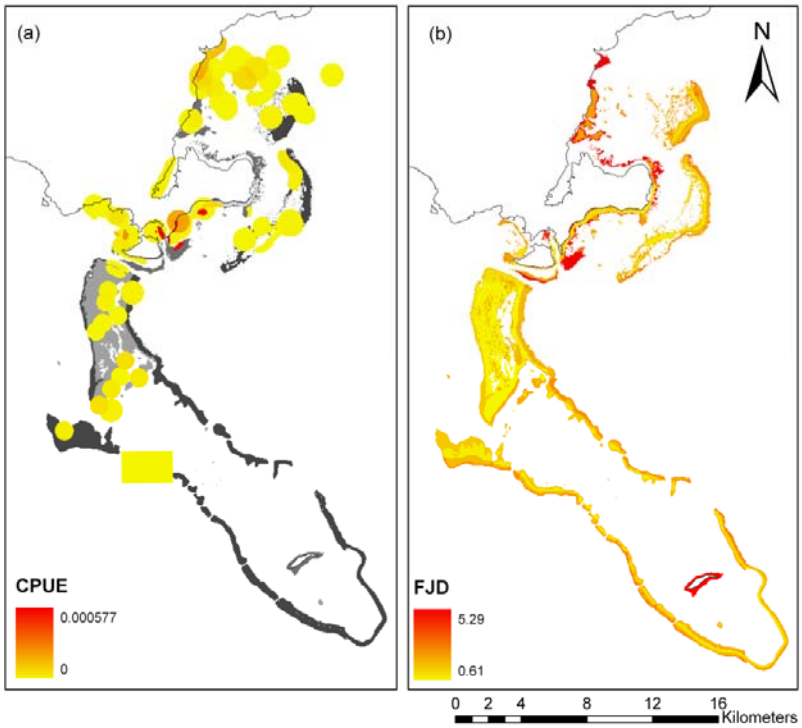


Figure 28. Total CPUE and modelled Opportunity Cost for all gear types in Kubulau district. (a) Catch per unit effort (CPUE) calculated as catch person^{-1} hour^{-1} m^{-2}. (b) Opportunity cost to all gear types in Fiji Dollars (FJD) per 2,500 m^{2}.

We used MARXAN software to explore options for design and re-configuration of a cost-effective MPA network for Kubulau that met the conservation targets for all habitat types (a minimum of 30% representation of: barrier reefs, patch reefs, and fringing reefs with intertidal seagrass). We considered four scenarios:

Scenario 1- We use CPUE as the cost layer and do not require that current tabu areas and MPAs be included in the selection of representative areas (***clean slate #1***).

Scenario 2 – We use CPUE as the cost layer and require that current tabu areas and MPAs be included in the selection of representative areas (***locked in #1*).**

Scenario 3- We use opportunity cost as the cost layer and do not require that current tabu areas and MPAs be included in the selection of representative areas (***clean slate #2***).

Scenario 4 – We use opportunity cost as the cost layer and require that current tabu areas and MPAs be included in the selection of representative areas (***locked in #2*).**

The current network of tabu and MPAs in Kubulau qoliqoli cover 40% of all barrier reefs, 36% of fringing reefs and 2% of patch reefs. For the reconfiguration scenarios 2 and 4 with the protected area network locked in, new areas selected by the best MARXAN analyses were predominantly the patch reefs within Cakaunivuaka Reef (Figures 29b,d). Best solutions from the clean slate MARXAN analyses indicated that Namuri MPA plus some of the inshore community tabu could possibly be eliminated, while adding protection to Nakadamalevu and Cakaunivuaka reefs (Figures 29a,c). The locked in model also indicates possible additions to the network from the northwest, central, and southwest portions of Cakaunivuaka reefs.

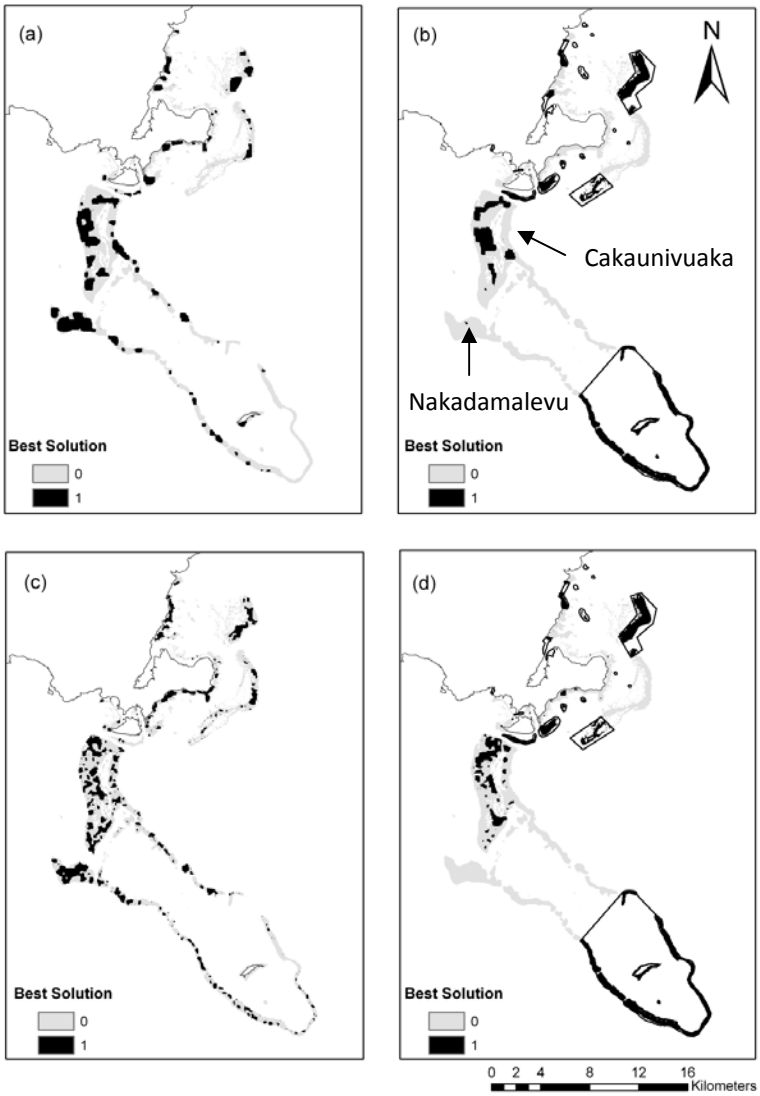


Figure 29. Marxan best solutions for (a) Scenario 1: current MPAs were not locked in and CPUE was used as the cost layer. (b) Scenario 2: current MPAs were locked in and the boundaries are shown in black. CPUE was used as the cost layer. (c) Scenario 3: current MPAs were not locked in and opportunity cost was used as the cost layer. (d) Scenario 4: current MPAs were locked in and the boundaries are shown in black. Opportunity cost was used as the cost layer.

These modelling results will be taken back to the communities of Kubulau to provide recommendations to adding or reconfiguring the MPA network to a more socially acceptable design with minimal economic costs to fishers, thereby ideally reducing conflict among Kubulau residents.

LINKS TO NATIONAL PRIORITIES:

The national Protected Area Committee has been tasked with carrying out a national ecological gap assessment for Fiji, which requires selection of different types of conservation planning tools. This study has developed a new tool to assess opportunity costs to fishers, which could be applied more broadly across Fiji with access to the national CPUE dataset collected by the Institute of Applied Science at USP. These data could help optimize expansion of protection within the existing FLMMA network and placement of new sites while minimizing costs to fishers. This would help achieve the inshore fisheries strategy to *Design new, ecologically relevant inshore, marine protected areas* while at the same time fulfilling Department of Environment's 2010 priority to for the thematic section to *Identify community capacity building needs to help better manage inshore resources*.

Mangrove Change in Kubulau Qoliqoli

STATUS: Completed

FUNDING: GEF Climate Vulnerability Assessment (8C00065.10)

PARTNER ORGANISATIONS: WWF (lead), University of the South Pacific-Institute of Applied Sciences

OUTPUTS:

- *Technical report*: to WWF
- *MSc Thesis*: in prep by USP student Simita Singh

RESEARCH HIGHLIGHTS:

Due a recent global decline in mangrove area, there is growing concern about loss of important mangrove services (e.g. shoreline stabilization) in the face of global climate change. Mangroves, which inhabit coastal, intertidal zones, are one of the first ecosystems affected by sea-level rise. Mapping mangrove change over time, in combination with field data on stand structure and condition, is therefore critical for assessing responses to local and regional environmental change.

In the Pacific Island region, Fiji has the third highest area of mangroves (517 km^2), composed of eight species and one hybrid. Given the diverse tectonics of the region, Fiji mangrove areas are likely to exhibit differential responses to sea-level rise depending on whether the coastline is actively uplifting or subsiding and the rate of the movements. For example, both the northern coast and southeastern Cakaudrove peninsula of Vanua Levu have experienced tens of metres of uplift during the Quaternary, however it is not known whether current rates of uplift will keep pace with current estimates of global sea-level rise of 1.29 to 2.97 cm per decade to 2100.

In order to discriminate short-term, local affects from long-term regional drivers of mangrove change, we mapped mangrove distributions between 1954 and 1994 from aerial photographs of the Kubulau region on the southern Vanua Levu coast. We compare these distributions with more recent mapping from 2001 satellite imagery completed by the Fiji Department of Forestry.

Table 1. Differences in Total Mangrove Area between 1954 and 2001

Year	Mangrove area (ha)
1954	812.1
1978	734.8
1994	612.5
2001	744.0

Between 1954 and 1994, there was a net decline in mangrove area of approximately 200 ha (Table 1). There was a slight decline in total mangrove area between 1954 and 1978 (Figure 30). The thin, fringing mangrove regions adjacent to coastal areas are likely to have existed in 1954 as well, but were not able to be

distinguished due to poor contrast of the aerial photographs. Between 1978 and 1994, mangroves were lost from upper intertidal areas (Figure 31). The causes for mangrove decline are currently being investigated through a masters project by USP student Simita Singh, titled, “A Study of the Relationship between the Wetland Ecosystem Services and Human Well-being in the Coastal Villages of the Kubulau *Tikina* in Vanua Levu, Fiji”.

Figure 30. 1954 (red) and 1978 (yellow) mangrove distributions overlaid on 1994 aerial photomosaic.

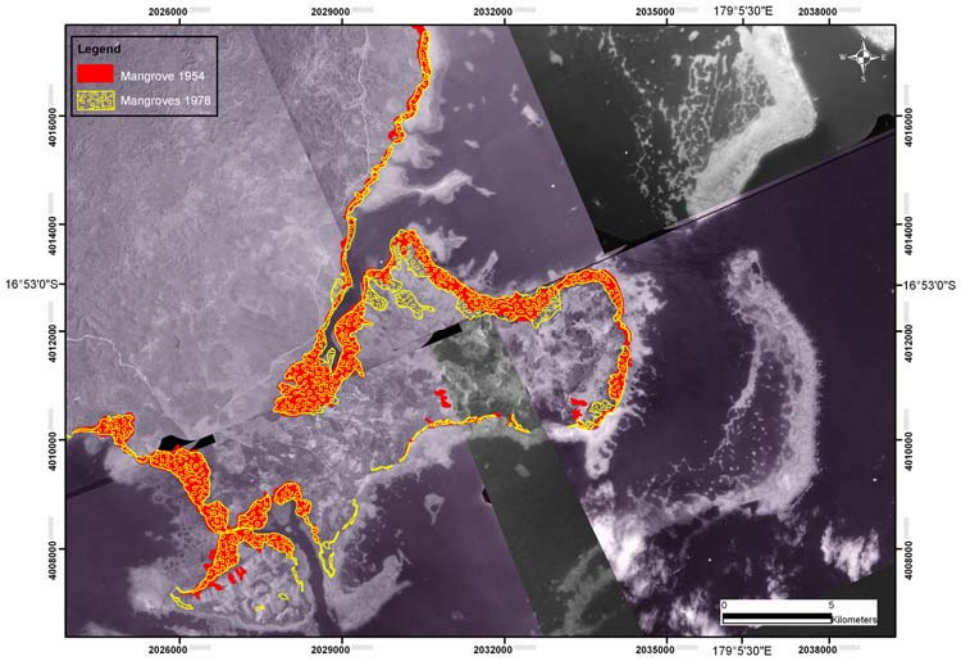


Figure 31. 1978 (yellow) and 1994 (pink) mangrove distributions overlaid on 1994 aerial photomosaic.

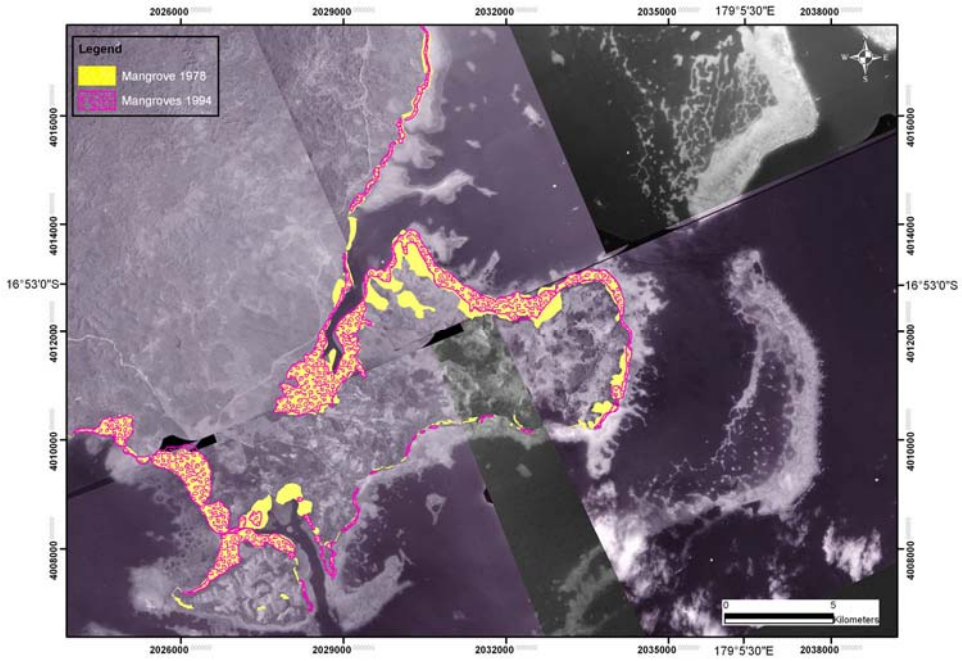
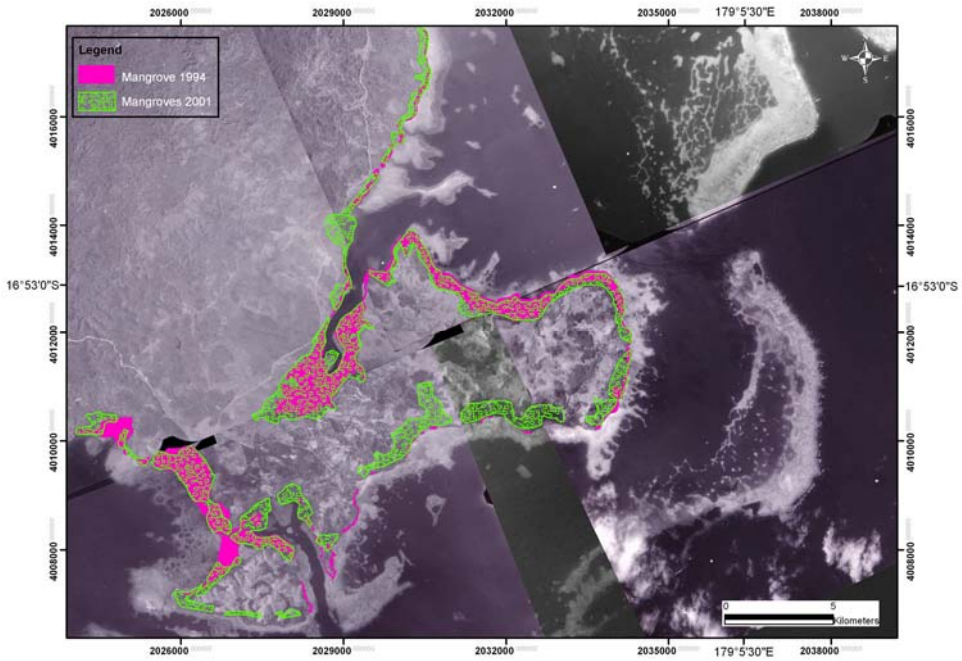


Figure 32. 1994 (pink) and 2001 (green) mangrove distributions overlaid on 1994 aerial photomosaic.



The area of mangroves mapped by the Department of Lands from 2001 Landsat imagery included 131.5 ha more mangroves than the distributions mapped from 1994 aerial photographs (Figure 32). While it is possible that some of the previously cleared mangroves may have expanded within their natural range, it is likely that narrow areas of mangroves were either overestimated or missed altogether using visual interpretation from the coarser (28.5 m) Landsat pixels. Contraction and expansion of mangroves within estuarine areas was unlikely to be related to cycles of dry or wet periods, as there were no consistently wet or dry periods between 1977 and 2006

LINKS TO NATIONAL PRIORITIES:

The Integrated Coastal Management Committee has set a priority to map all of Fiji's coastal areas and evaluate change over time in order to evaluate vulnerability to climate change disturbance. This study supports this national objective and also provides some of the technical methodology to scale-up the mapping across the rest of Fiji. Detailed mapping of Fiji's coastal areas will also facilitate development of a zoning scheme for improved management and regulation, to be included in the framework for Fiji's Coastal Management Plan (slated for 2010).

MANAGEMENT

The following sub-sections present a synthesis of completed activities that have strengthened and supported community-based natural resource management in Fiji.

Process for Developing Kubulau Ecosystem-Based Management Plan

STATUS: Completed

FUNDING: David and Lucile Packard Foundation (2007-31847), Gordon and Betty Moore Foundation (540.01), National Oceanic and Atmospheric Administration (NA07NOS4630035)

PARTNER ORGANISATIONS: Wetlands International-Oceania, WWF, The Coral Reef Alliance

OUTPUTS:

- *Kubulau EBM Plan*: WCS (2009) Ecosystem-Based Management Plan: Kubulau District, Vanua Levu, Fiji. Wildlife Conservation Society, Suva, Fiji, 121 pp.
- *Process*: Description of process of plan development distributed in Fijian at FLMMA annual training meeting, 9 Dec 2009.

PROCESS:

Step one: Kubulau Community EBM workshop

The first step to collate existing and new information for the Kubulau ridge-to-reef EBM plan was held in Namalata village, where the chairman of the Kubulau Resource Management Committee (KRMC) resides and centrally located within Kubulau District. A community workshop was held with a wide range of internal and external stakeholders who included: KRMC members; *Bose Vanua* representatives; Kubulau fishers and farmers; representatives from women and youth groups from each of the 10 villages; representatives from Macuata Qoliqoli Management Committee; representatives from government (Culture & Heritage, Native Land Trust Board (NLTB), Native Land Commission (NLC), Department of Fisheries, Department of Forestry, Department of Environment); and representatives from a range of NGOs (Kubulau Resource Management Committee (KRMC), Partnership in Community Development of Fiji (PCDF), Environmental Law Association (ELA), Wetlands International–Oceania (WI-O), WWF, Ecumenical Centre for Research Education and Advocacy (ECREA), Coral Reef Alliance (CORAL), Greenforce, Kubulau Soqosoqo Vakamarama, Qoliqoli Macuata Cokovata (QMC)).

The main goals of the workshop were to:

1) Present to communities the recommendations from the emerging scientific results;
2) Agree on EBM ridge-to-reef management plan structure;
3) Stage conceptual modeling exercises to identify management targets, threats, strategies to mitigate those threats (Figure 33);
4) Draft community action plans based on management strategies;

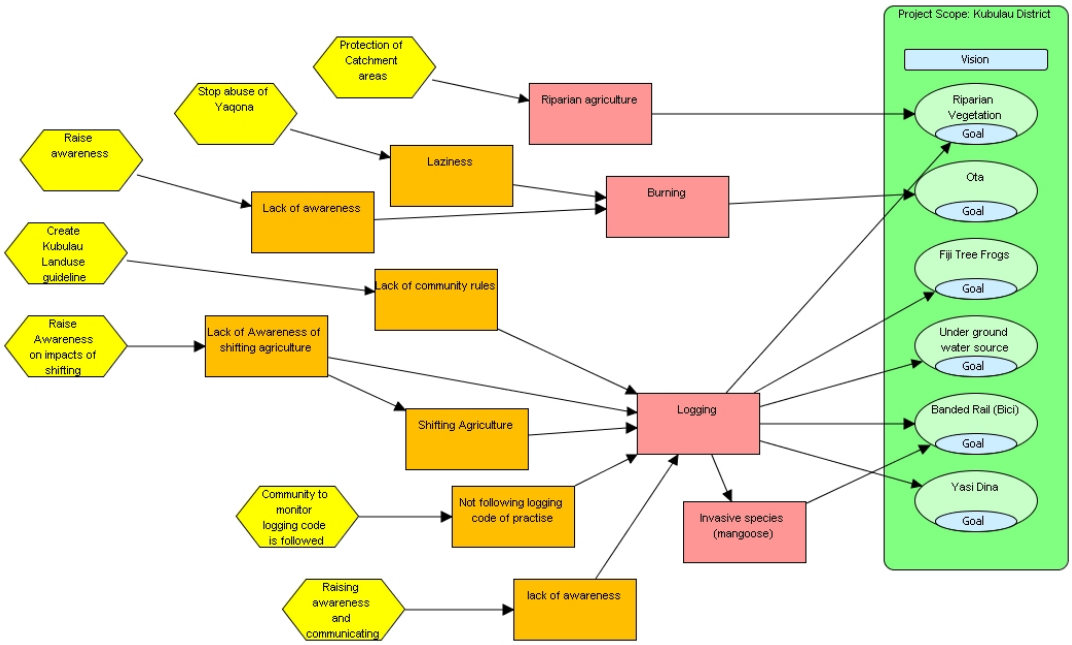


Figure 33. Conceptual diagram illustrating the management targets (green), direct threats (pink), indirect threats (orange), and management strategies (yellow) for the terrestrial habitats of Kubulau District.

5) Identify *who* is responsible for carrying out the management actions and *when* they will be carried out;
6) Confirm the boundaries and management rules of existing marine ad forest protected areas;
7) Agree on changes/additions to existing management plans; and
8) Reach consensus on which protected areas should be proposed for gazettal areas and clarify the process for progressing..

Step two: Draft EBM ridge-to-reef plan development

A consultant, Mr. Pepe Clarke, was hired for the development of the EBM ridge-to-reef plan based on the recommendations from the Kubulau management planning workshop. The consultant was responsible for:
1) Consolidating content of the existing plans under the agreed ridge-to-reef structure; 2) Making necessary updates to management rules, regulations and protected area boundaries to the content of existing draft plans based on recommendations arising from Step One.;
3) Classifying the agreed management rules under community or national legal and policy frameworks;
4) Compiling a best practices section for each of the terrestrial, freshwater, coastal/estuarine, and marine ecosystems; and
5) Providing additional rule tables from national laws to strengthen the ridge-to-reef plan (such as a list of species protected under the Fiji Endangered and Protected

Species Act and a table of minimum size limits for collection of marine species from the Fiji Fisheries Act).

Step three: Consultation on the draft EBM ridge-to-reef plan
The draft EBM plan was presented to the Kubulau Resource Management Committee (KRMC), *turaqa-ni-yavusa*, and community representatives in Raviravi village. The participants were consulted and endorsement was sought for:
1) A reconfigured protected area network for Kubulau;
2) Management rules for the protected areas;
3) A process for adapting and amending the plan; and
3) Roles and responsibilities for the subcommittees of KRMC.
Then the KRMC, on behalf of the EBM-Fiji partnership, presented the draft and their recommendations to the *Bose Vanua* who provided feedback for subsequent incorporation into the final plan.

The draft plan was also presented to external stakeholdera (government departments and NGOs) over two half day meetings in Suva. Invitations were sent to Wetlands International-Oceania, CORAL, SPC-GTZ, National Trust, Conservational International, WWF, International Union for Conservation of Nature, Partners in Community Development, Environmental Law Association, Fisheries Department, Tourism Department, Ministry of Health, Native Lands and Fisheries Commission, Culture & Heritage, Native Land Trust Board (NLTB), Fijian Affairs Board, Department of Forestry, and Department of Environment to comment on the plan and discuss its potential to be adapted to other sites and projects across Fiji. The presentations to the external stakeholders included:
1) An overview of the draft management plan;
2) A discussion of proposed management activities, including potential government roles; and
3) A discussion of management rules, including compliance and enforcement issues.

Step four: Endorsement of the finalized EBM ridge-to-reef plan
The outcomes of the KRMC and external stakeholders consultations were used to refine the draft plan. The refined plan was then presented back to the Tui Kubulau, *turaga-ni-yavusas*, and KRMC for final approval and endorsement. The refined plan was presented to these groups with special focus on management rules of the protected areas and community action plans. Once consensus was reached that the plan was reflective of the agreed outcomes of the consultation meetings, the Tui Kubulau and *turaga-ni-yavusas* endorsed the plan with their signatures and copies were distributed to each village in Kubulau.

Step five: Management support training of resource management committee
The final draft of the EBM ridge-to-reef plan was further strengthened through a management support workshop with members of the KRMC where:
1) Roles and membership of KRMC sub-committees were confirmed;
2) Management actions identified in the management plan were reviewed;
3) Responsibility for management actions were allocated to relevant sub-committees;

4) Start times were identified and agreed upon for implementation of management actions by sub-committees;
5) Knowledge, skills and resources required for implementation of management actions were identified; and
6) Training was provided on selected skills necessary for effective resource management including, internal and external communication, gazettal of marine protected areas, and compliance and enforcement.

Step six: Roadshow of the endorsed ridge-to-reef plan
A travelling 'roadshow' was conducted at the 10 villages of Kubulau to raise community awareness of the agreed and endorsed management rules and community actions contained in the Kubulau EBM plan. Large format posters with management rules and community actions posters were also distributed to all villages to be posted in each village community hall and in the two schools in the district. During the roadshow, communities were also given an opportunity to ask questions and receive clarification on resource management in Kubulau.

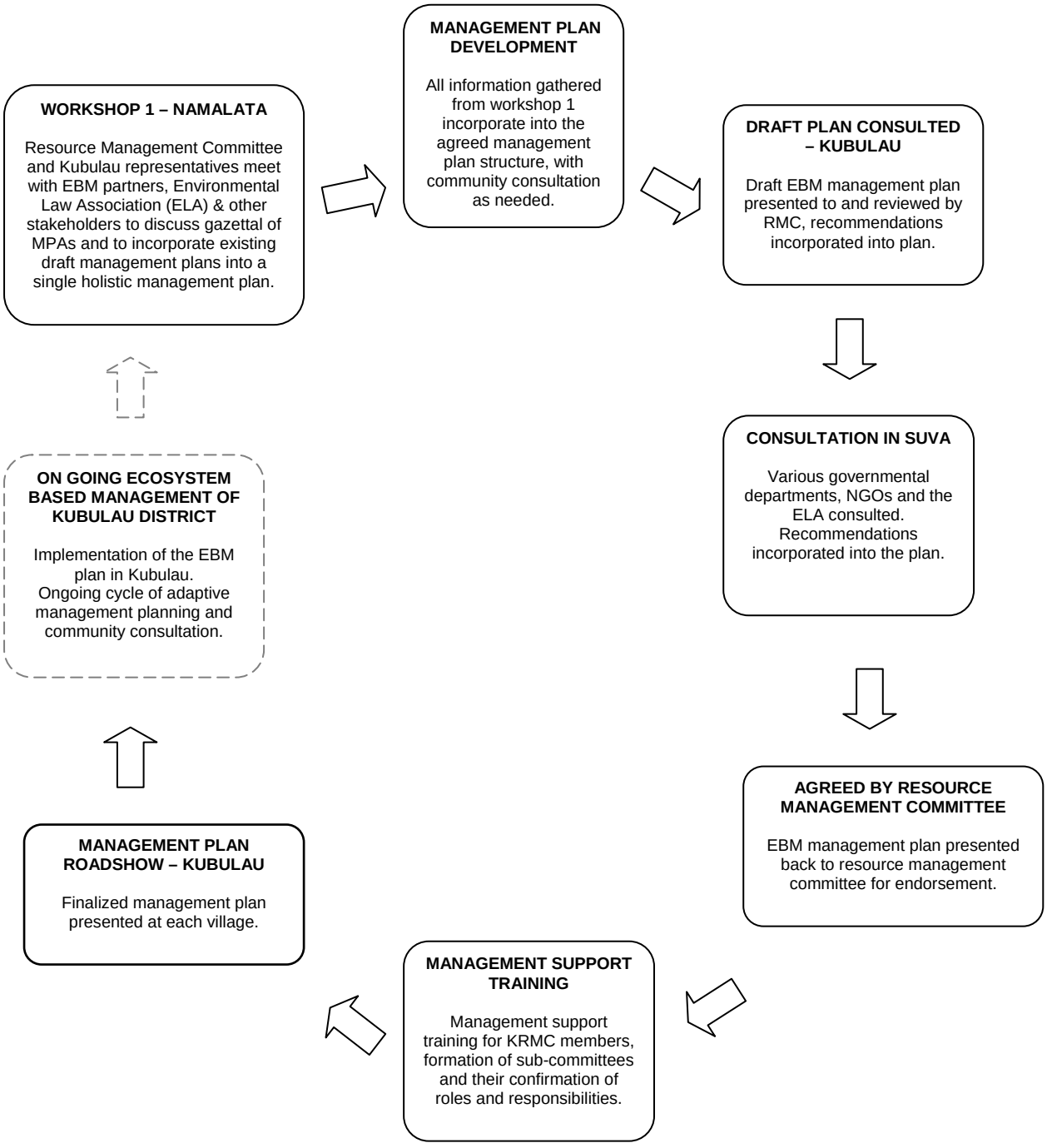
All six steps are illustrated in the schematic in Figure 34.

LINKS TO NATIONAL PRIORITIES:
The development of the generalized EBM planning process directly supports the NBSAP's inshore fisheries thematic section strategy to *Strengthen natural resource leadership, management and governance* through the action to: 'Provide all MMA sites with a management plan template and assistance developing management actions.'

The process also directly supports the NBSAP's logging and forestry thematic section strategy to *Put in place government policies, legislation, guidelines and management plans* through the action to: 'Prepare management plans for existing biodiversity PAs, nature reserves and community-based ecotourism sites.'

The process has been translated in Fijian and distributed through the FLMMA network.

Figure 34. Process for developing an adaptive Ecosystem Based Management (EBM) plan for Kubulau



Development of Generalized EBM Management Plan Template

STATUS: Ongoing through 31 March 2010

FUNDING: David and Lucile Packard Foundation (2007-31847), Gordon and Betty Moore Foundation (540.01), National Oceanic and Atmospheric Administration (NA07NOS4630035), National Trust of Fiji (sub-grant from Early Action GEF and UNDP PoWPA funding)

PARTNER ORGANISATIONS: Wetlands International-Oceania, WWF, Protected Area Committee

OUTPUTS:

- *EBM Plan Template*: disseminated at FLMMA annual training meeting in December 2009 and to other external stakeholder in Fiji in January-February 2010
- *Local workshop presentation*: WCS (2009) Scaling up to an ecosystem-based management plan: lessons learned. Presented at the FLMMA Annual Training Meeting, Nadave, Fiji, 9 December 2009.

TEMPLATE OUTLINE:

I. Introduction
   a. Statement of objective
II. EBM Principles
   a. Definition of an ecosystem
   b. EBM objectives and targets
   c. Key messages for EBM specific to the region/project
III. Site Description
   a. Site boundaries
   b. Demographics of resource users
   c. Resource tenure (by habitat)
   d. Resource use patterns
   e. Protected area locations and sizes
IV. Legal Mechanisms for Establishing Protected Areas (under current legislation)
   a. Terrestrial
   b. Marine
V. Management Institutions
   a. Government institutions
   b. Community institutions
   c. Sub-committees
VI. External Stakeholders
   a. Government
   b. Non-government
   c. Private sector
VII. Management Roles and Processes

a. Statement of where management rules derived
b. Statement of where management actions were proposed
c. Statement of who has responsibility for implementing the plan
d. Process for amending the plan
e. Time period for review of the plan

VIII. Compliance and Enforcement
a. Mechanisms to raise awareness of management rules
b. Statement of who is responsible for monitoring and surveillance
c. Enforcement protocol for breaches of national laws
d. Enforcement protocol for breaches of community rules (and/or provincial by-laws)

IX. Habitat Description(s)
a. Conservation value of management targets
b. Threats to species/habitats
c. Socioeconomic and cultural importance

X. Best Practice(s)
a. Management activities to promote environmental health, though not enforceable by national or community laws

XI. Management Rules and Action Tables
a. Rules
b. Exceptions
c. Designator of rule (national law/policy; community)
d. Management actions, with responsible parties and timelines
e. Source of each rule noted

XII. Sustainable Financing (*NOTE: This should complement a separate Business Plan*)
a. Methods for generating income
b. Activities on which income will be spent
c. Methods to ensure transparency and accountability

XIII. Contact Details

LINKS TO NATIONAL PRIORITIES:

The development of the generalized EBM management plan template directly supports the NBSAP's inshore fisheries thematic section strategy to *Strengthen natural resource leadership, management and governance* through the action to: 'Provide all MMA sites with a management plan template and assistance developing management actions.'

The template also directly supports the NBSAP's logging and forestry thematic section strategy to *Put in place government policies, legislation, guidelines and management plans* through the action to: 'Prepare management plans for existing biodiversity PAs, nature reserves and community-based ecotourism sites.'

Intersection of Law and Custom for Community-Based Natural Resource Management

STATUS: Completed

FUNDING: David and Lucile Packard Foundation (2007-31847), Gordon and Betty Moore Foundation (540.01), National Oceanic and Atmospheric Administration (NA07NOS4630035), National Trust of Fiji (sub-grant from Early Action GEF and UNDP PoWPA funding)

PARTNER ORGANISATIONS: N/A

OUTPUTS:

- *Journal publication*: Clarke P, Jupiter SD (in press) Law, custom and community-based natural resource management in Kubulau District, Republic of Fiji Islands. Environmental Conservation
- *Local workshop presentation*: WCS (2009) Law, Custom and Community-Based Management of Natural Resources in Fiji. Presented at the FLMMA Annual Training Meeting, Nadave, Fiji, 10 December 2009.

HIGHLIGHTS:

Community-level governance systems have regulated natural resource use and management in the Pacific islands for centuries. While the effectiveness of these systems was variable and context dependent, they nonetheless played an important role in maintaining resource availability in many communities throughout the region. These traditional governance systems were modified and eroded during the colonial era, and the contemporary legal systems of Pacific island states and territories vary in the extent to which they recognise customary law and traditional resource tenure.

National legislation in most Pacific island countries recognises and protects indigenous land tenure, and the large majority of land in the region is held under customary communal title. Recognition of customary marine tenure has been more uneven, reflecting a historical conflict between Pacific marine tenure systems and the 'open access' traditions of colonising European states. Influenced by developments in international law and policy, Pacific island countries have developed national environmental policies and passed environmental legislation. However, the capacity of Pacific island governments to develop, implement and enforce environmental legislation has been constrained by a lack of financial, technical and human resources, professional training, and public awareness of environmental laws.

In practice, traditional governance systems remain the primary mechanism for regulating the use of terrestrial and marine resources in many contemporary Pacific societies. Respect for customary law and institutions are an integral feature of most rural communities, where the overwhelming majority of disputes are resolved by customary means. In remote areas, daily life is almost entirely governed by custom

and customary processes, and even where state institutions do exist at the local level, they co-exist with customary institutions, resulting in 'legal pluralism', or the existence of multiple legal systems within one geographic area.

Site-based conservation provides insights into practical compliance and enforcement barriers, and opportunities for engaging with relevant government institutions to resolve these issues. Here we present a case study from the district of Kubulau in Bua Province, Fiji, to illustrate the challenges and successes of integrating traditional CBNRM within the Fijian legislative context. We identify a range of lessons for conservation practitioners, both at the site-specific level and in relation to broader legal and institutional reform. More specifically, we ask:

- Under which circumstances do custom and law complement one another for governing and managing natural resources in Kubulau?

- Under which situations does conflict arise between custom and law in Kubulau and what are the management implications of the discord?

- What type of legal and institutional reform in Fiji would help improve sustainable resource management while minimizing internal and external conflict?

First, we identified the legal context in Fiji under which community-based management institutions of terrestrial (Table 2) and marine (Table 3) resources are obliged to operate. We then established the management context in Kubulau by describing customary management institutions and the development of an ecosystem-based management plan to locally manage resources (see previous sections on *Process for Developing Kubulau Ecosystem-Based Management Plan* and *Development of Generalized EBM Management Plan Template*). Lastly, we used specific examples from Kubulau to illustrate the synergies between law and custom in promoting community-based management of natural resources (CBNRM), as well as the potential for conflict (Table 4).

Example 1. Namenalala Island Conservation Lease

In 1983, a lease was brokered by the National Land Trust Board (NLTB) to Moody's Namena Resort under the condition that 90% of the island be managed as a strict nature reserve. This has resulted in successful protection of the islands forest and coastlines for several reasons:

(1) The lease did not displace local landowners since they were not living on the island;
(2) The resort owners provide permanent employment and regular lease payments to the landowning mataqali which are deemed acceptable compensation for the loss of access to their terrestrial lands; and
(3) Additional revenue from dive tag sales to guests provides benefits to the entire Kubulau district in the form of money available for scholarships and management.

Table 2. Selected national legislation relevant to terrestrial natural resource management in Kubulau District.

Legislation	Key Features	Responsible Agency
***Native Lands Act* [Cap 134]**	Recognises and maintains communal ownership of native lands.	Native Lands and Fisheries Commission
***Native Land Trust Act*[Cap 134]**	Empowers NLTB to enter into land leases on behalf of native landowners	Native Lands Trust Board
Forestry Decree 1992	Prohibits felling or extraction of timber without a licence. Exempts certain customary uses (e.g. firewood, village houses). Empowers forestry licensing officers to issue logging licences. Empowers the Minister for Forests to declare strict nature reserves.	Department of Forests
***Mining Act* [Cap 146]**	Vests ownership of mineral resources in the state. Empowers Director of Mines to grant mining permits and leases. Mining leases may be granted over native land without landowners consent. Mining restricted under certain sensitive areas, including villages, burial grounds, water catchment areas and nature reserves.	Department of Mineral Resources
***Land Conservation and Improvement Act* [Cap 141]**	Empowers the Land Conservation Board to issue orders prohibiting clearing, grazing, burning or cultivation of an area for conservation purposes.	Land Conservation Board
***Water Supply Act* [Cap 144]**	Minister may declare any area to be a water supply catchment area. Pollution of water within a declared catchment area is an offence.	Department of Water Supply
***Bird and Game Protection Act* [Cap 170]**	Prohibits killing, wounding or taking of native bird species, and regulates hunting of listed game bird species.	Department of Primary Industries
***National Trust for Fiji Act* [Cap 265]**	Empowers National Trust to enter into binding conservation covenants with landowners, purchase land for conservation purposes, adopt by-laws for trust properties and maintain a register of nationally significant areas.	National Trust of Fiji
Endangered and Protected Species Act 2002	Regulates international and domestic trade in listed protected species. Prohibits unauthorised possession or sale of listed protected species.	Department of Environment
Environment Management Act 2005	Environmental impact assessment (EIA) and approval required for development proposals that are likely to have a significant impact on the environment. Traditional or customary structures exempt from EIA process.	Department of Environment Various 'approving authorities'

Example 2. Proposed Kilaka Forest Reserve

From 2005, WCS began consultations with landowning mataqali to set up a forest reserve in the upper catchments of the Kilaka River. A 2005 survey by Gunnar Keppel found the forests to be highly pristine, with 126 endemic plant species, 15 of which were restricted to Vanua Levu. To date, no progress has been made to gazette the Kilaka forest reserve, likely for several reasons:

(1) The tangible, short-term benefits of logging to community landowners outweigh the diffuse, longer-term benefits of protection;
(2) The forests are unlikely to attract significant international tourism in their own right;
(3) There is a high opportunity cost to the landowning mataqali, while the benefits of maintained ecosystem services would be shared by all in Kubulau; and
(4) There are real fears that formal reservation will constrain future development options.

Table 3. Selected national legislation relevant to marine natural resource management in Kubulau District.

Legislation	Key Features	Responsible Agency
Fisheries Act	Provides for registration of traditional fishing grounds (*qoliqoli*). Recognises resource owners' subsistence fishing rights. Prohibits fishing for 'trade or business' without a licence. Empowers Minister to establish restricted areas and adopt management measures. Empowers the Permanent Secretary to appoint honorary fish wardens.	Department of Fisheries
Crown Lands Act	Vests ownership of land below the high water mark in the state. Empowers the Department of Lands to issue leases and licences over this land.	Department of Lands
***Bird and Game Protection Act* [Cap 170]**	Prohibits killing, wounding or taking of native bird species, including sea birds.	Department of Primary Industries
Endangered and Protected Species Act 2002	Prohibits unauthorised possession or sale of listed protected species, including marine species	Department of Environment
Environment Management Act 2005	Environmental impact assessment (EIA) and approval required for development proposals that are likely to have a significant impact on the environment.	Department of Environment Various 'approving authorities'

Example 3. Namena Marine Reserve as a District MPA

The establishment and management of the Namena Marine Reserve (65.6 km^2), located in the southeastern part of the *qoliqoli* present an instructive example of the interaction of CBNRM with the national legal system. The reserve is home to exceptional marine biodiversity and attracts international dive tourism. Since 1998, divers have paid a goodwill fee to use the marine reserve, now $25 per person per year. Fees are paid into a community-managed fund, and divided between scholarships and resource management activities.

Because Namena Marine Reserve is not legally gazetted, its success as a district MPA has relied on several factors, including:

(1) A misconception that the reserve is protected under national legislation;
(2) Assistance with enforcement by the vigilant owners of Moody's Namena Island Resort;
(3) Respect for the traditional authority of the Tui Kubulau's wishes expressed in conditional letters of consent for commercial fishing vessels owned by traditional resources owners that expressly prohibit with Namena and the other district MPAs; and
(4) That the conditions in the permits directly reflect community management decisions and, because licenses expire at the end of each year, these conditions can be amended relatively quickly.

Yet despite these opportunities for successful CBNRM, there have been persistent breaches of the permit conditions and community rules, particularly by a single mataqali whose i kanakana falls within the Namena MPA boundaries. Even after the Tui Kubulau and other village chiefs staged a formal blessing of all of the district MPAs, members to the mataqali were found fishing in Namena the following week. Their refusal to obey community rules likely stems from both discord between national legislative framework which grants open access to marine areas and community management decisions to close off Namena as a no-take zone (Table 4), and other reasons including:

(1) Some members of the mataqali do not believe that they have received adequate compensation for loss of access to their traditional fishing grounds;
(2) There may be a loss of respect for traditional authority due to their increasing access to markets (i.e. a middleman regularly buys fish off fishers from this village); and
(3) Imposition of effective sanctions for breaching community rules is contrained by the Fiji legal system.

Some recommendations for legal and institutional reform in the fisheries sector include:

- Improved training and resources for community fish wardens;
- Fisheries enforcement training for police and magistrates;
- Increased penalties for infringements;
- Powers for the Department of Fisheries to revoke fishing licenses for breaches under the *Fisheries Act*; and

- Formalised management powers for community resource management committees.

Specific recommendations for legal and institutional reform in the terrestrial sectors include:

- Allocation of adequate resources by national government to promote awareness and lawful enforcement of the *Environment Management Act*;
- Rigorous enforcement of logging code of practice;
- Increased penalties for infringements;
- Legal obligation to reforest logged or cleared areas; and
- Use of environmental bonds.

Table 4. Comparison of property and resource management rights for land and sea under custom and national legislation. Areas of synergy between custom and law are likely to lead to successful implementation of community-based resource management measures, whereas areas of discord are likely to lead to conflict.

	Land		**Sea**	
	Custom	*Law*	*Custom*	*Law*
Property Rights				
Ownership	Clan (*mataqali*)	Clan (*mataqali*)	Tribe (*yavusa*)	State
Occupation	Clan (*mataqali*)	Clan (*mataqali*)	-	-
Right to exclude others	Clan (*mataqali*)	Clan (*mataqali*)	Tribe (*yavusa*)	Open access.
Resource Management				
Resource use rights (traditional resource owners)	Land use decisions by chief (*turaga ni mataqali*).	Land use decisions by clan, subject to state regulation.	Resource use decisions by chief (*turaga ni yavusa*)	Subsistence fishing rights recognised. Commercial fishing requires state approval.
Resource use rights (non-resource owners)	Use rights granted by chief (*turaga ni mataqali*).	Use rights granted by state, with consent of majority of resource owners.	Use rights granted by chief (*turaga ni yavusa*).	Fishing rights granted by state, following consultation with resource owners.
Protected areas	Traditional *tabu* areas, declared by chief (*turaga ni mataqali*).	*Conservation leases:* granted by NLTB with consent of majority of resource owners. *Nature reserves, catchment areas:* may be declared unilaterally by state.	Traditional *tabu* areas, declared by chief (*turaga ni yavusa*).	*Restricted fishing areas:* may be declared unilaterally by state. *Fishing licence conditions:* set by state, following consultation with resource owners.

General recommendations for legal and institutional reform should involve:

- New legislation or modifications to existing legislation to all for community-managed no-take areas without loopholes;
- Mechanisms for equitable distribution of market-based compensation for the use of resources acquired from traditional owners;
- Oversight to ensure that there is appropriate stakeholder involvement, particularly from resource and resource-rights owners; and
- Development of institutional rules of engagement between the State and communities.

LINKS TO NATIONAL PRIORITIES:

The review of natural resource legislation to support this analysis directly addresses the NBSAP implementation strategies *Reform fisheries legislation and management institutions* and *Improved coordination of government policies, legislation and management guidelines to ensure protection of Fiji's biodiversity* through recommendations for legal and institutional reform. Some of these recommendations have been taken up through FLMMA's submission to Department of Fisheries for their review of the *Fisheries Act*.

COMMUNICATIONS

The following sub-sections present a synthesis of completed and ongoing activities that WCS has undertaken to improve communication between our organization, community partners and external stakeholders.

Community Bulletins

STATUS: Ongoing

FUNDING: David and Lucile Packard Foundation (2007-31847), Gordon and Betty Moore Foundation (540.01)

PARTNER ORGANISATIONS: Wetlands International-Oceania, WWF, The Coral Reef Alliance

OUTPUTS:

- *EBM Kubulau Bulletin*: Bi-monthly newsletters distributed to all 10 villages in Kubulau District to update community members on WCS and EBM activities plus new research findings.

EXAMPLE:
The EBM Kubulau bulletin is released every two months in English and Fijian and distributed to all the 10 villages via communication focal points (Figure 35). The communication focal points are volunteers who are responsible for distribution of the bulletin in their specific villages after being dispatched from the chairman of the Kubulau Resource Management Committee.

The articles in the bulletin cover: updates of recent WCS and EBM activities; emerging findings of the scientific team; management planning updates; and upcoming activities. The bulletin is aimed mainly for community members, however, it is also used to update key external stakeholders of the ongoing EBM activities in Kubulau, specifically: 1) Provincial Officer-Bua; 2) Assistant Roko-Kubulau; 3) Environmental officer-Fijian Affairs Board; 4) Fisheries officer-Bua; and 5) Forestry officer-Dreketi.

LINKS TO NATIONAL PRIORITIES:
Recent consultation meetings have identified several implementation priorities for the inshore fisheries thematic section of the NBSAP, which include *Identify community capacity needs to manage inshore fisheries*. External stakeholders attending this workshop suggested that implementation of this priority should be addressed by the FLMMA Strategic Plan. The Kubulau EBM bulletins support two communication strategies within the FLMMA Strategic Plan to: (1) *Share information about current implementation strategies between partners*; and 2) *Define and use appropriate media to communicate with sites*.

FIJI ECOSYSTEM BASED MANAGEMENT (EBM) = HEALTHY PEOPLE, PROCESSES AND SYSTEMS

EBM KUBULAU BULLETIN

Ni sa bula vinaka! Oqo nai ka tini ni volaitukutuku me baleta na vei tavi eso sa qaravi keina kena e vakarau mena qaravi ka okati talega kina e so na macala ni vakadidike eso sa qaravi taumada.

VOL. 10. SEVITEBA 2009

KEY EBM MESSAGES:

Na kena kauwataki na vakaveivakotaki ni noda yaubula eso

- *Na daumoku ni veiqaravi ni EBM eba vakatau mai na noda veimaliwasi vakatamata kei ira nai yaubula eso*
- *E dredrea mera kauwataka na veitikotiko mai ulunivasi ka cava ki wattui na vakayagataki vakamatau ni noda yaubula*
- *Na EBM e taqomaka na veivanua kei na daidai ni veika era bula kina*
- *Na lewai vakamatau ni vakayagataki ni qele kei nai qolipoli ena vuku na noda taqomaki na noda yaubula eso*
- *Na I tavaki ni noda tiko bulabula e na vakatau tiko mai na noda taqomaka nanodai yaubula.*

NA VUNAUTAKI NI TUVATUVA NI VEIQARAVI

Enai ka tolu ni siga ni vula o Seviteba, 2009 eratou qarava kina nai vakaitlesilesi ni WCS nai tavi ni keina vunautaki nai tuvatuva ni veiqaravi e na loma ni tikina, ena yavu ni kena maroroi nai yaubula ena loma ni tikina me tekivu mai na ulunivanua ka cava sara yani ki waitui.

Na veisiko siga tini oqo e qaravi e na veikoro kece sara ena loma ni tikina meera kila na bibi ni maroroi ni noda yaubula eso. E vakaraitaka o Thomas Tui na kena bibi ni noda vakadewataka vakamatata yani vei ira na lewenivanua na bibi ni tuvatuva ni veiqaravi me baleta na yaubula eso e na loma ni tikina.

E vakamatatataki vei ira na lewe ni tikina na veilawa eso vakarautaki enai tuvatuva ni veiqaravi oqo, ka vakatalega kina na kena soli e yadua nai lavelave kina veikoro kece sara ena nodratou veivakadonui na Turaga ni Yavusa.

E veisoliyaki ena veikoro kece sara nai lavelave ni veilawa eso vakarautaki tu enai tuvatuva ni veiqaravi me ra biuta ena nodra dui valenibose vakakoro, me rawa ni ra dau taleva lesu ena veigauna era loma tarotaro kina me baleta na kena maroroi na nodrai yaubula eso. E vakaraitaka talega o Ravulolo Vasukibau ni oqo e dua na i tuvatuva e rawa ni na vakalesuya tale mai e na loma ni tikina na veika eso sa yali, ka vukei ira vakalevu me ra maroroya ka vakayagataka vakamatau na veiyaubula eso.

E qaravi nai tavi oqo, me vakavure vakasama, vakabibi na kena saumi na veivakatataro eso e tu vei ira na lewenivanua me baleta nai tuvatuva ni veiqaravi oqo. E vakaraitaka o Apisai Naulu ni sa kalawa sara tiko vakatotolo ko Kubulau kina dua na vanua vinaka ka rawa ni ra na vakayagataka nai tuvatuva ni veiqaravi oqo me nodrai vola diasidusi me baleta na veigauna muri mai..

"Oqo e dua na gauna vinaka vei iratou na vakaitlesilesi ni WCS, baleta ni rawa ni ratou sota kina kei ira na lewenivanua, ka ra veivuke taumada ena kena biu vata e dua nai tuvatuva ni veiqaravi ena loma ni 5 na yabaki sa oti, ka vakatalega kina na veitalanoa lasa eso", vakaraitaka o Thomas Tui.

Oqo e rua na vakaitlesilesi o Thomas Tui kei Akanisi Caginitulua e na kena vunautaki tiko nai tuvatuva ni veiqaravi oqo.

Figure 35. Front page of volume 10, September 2009 edition of the EBM Kubulau bulletin.

EBM Partnership Newsletter

STATUS: Ongoing

FUNDING: David and Lucile Packard Foundation (2007-31847), Gordon and Betty Moore Foundation (540.01)

PARTNER ORGANISATIONS: Wetlands International-Oceania, WWF, The Coral Reef Alliance, Birdlife International, International Union for the Conservation of Nature, University of the South Pacific's Institute of Applied Sciences, United States Geological Survey, Laje Rotuma, University of Queensland, Shark Reef Fiji

OUTPUTS:

- *EBM Newsletter*: Quarterly newsletters distributed to external stakeholders to promote projects within Fiji and regionally that are using ecosystem-based management principles

EXAMPLE:
The EBM partnership newsletter was released at the end of 2008 with aspirations to advocate to our non-community based stakeholders the adoption and practice of the EBM approach in Fiji and the region (Figure 36).

Since its release, articles have covered topics such as: integrated coastal zone management; water catchment management; habitat and faunal connectivity; and multi sectoral approach towards conservation. This newsletter is heavy with technical jargons and is aimed at external stakeholders, electronically sent to various government departments, NGOs, academic institutions, donors, and regional agencies such as SPREP, SOPAC, and SPC.

LINKS TO NATIONAL PRIORITIES:
Recent consultation meetings have identified several implementation priorities for the coastal development thematic section of the NBSAP, which include collating information on coastal development and threat related issues. The EBM quarterly newsletter provides one mechanism for raising awareness of ongoing projects and synthesizing information into a format easily distributed among all external stakeholders.

Fiji Ecosystem Based Management (EBM) = Healthy People, Processes and Systems

Key EBM Messages:

Preservation of functional integrity of Fiji's eco-scapes through multiple stakeholder management.

- Successful EBM relies on cross sectoral planning and management
- Inland and lowland communities need to manage resources together
- EBM protects habitat for all stages of life
- Improving land and fishing practices helps protect natural resources
- Public health and livelihoods depend on environmental health

Inside this issue:

FIJI EBM PARTNERSHIP NEWSLETTER

Volume 1, Issue 4 October 2009

Roadshow of Fiji's first 'ridge-to-reef' plan

Starting from the 3rd of September 2009 for two weeks, Wildlife Conservation Society-Fiji (WCS-Fiji) conducted a roadshow in Kubulau for Fiji's first ridge-to-reef management plan.

The roadshow of the ridge-to-reef plan was conducted to raise community awareness among the ten villages of the district. During the roadshow, the Kubulau communities were also made aware of the management rules for the protected areas and community actions that are listed in the plan.

Every village was given a ridge-to-reef management plan that was signed by the various Turaga ni Yavusas from Kubulau to show their support and endorsement towards protecting and managing their natural resources.

Management rules and community actions posters were also distributed to all villages and a copy was put up at each village community hall. "It is important for every member of the community to be aware of the management rules and actions. This will contribute to greater returns and better management of resources", said Ravulolo Vasukibau, chair of the protected area and resource management sub-committee.

In addition, in August the Kubulau Resource Management committee (KRMC) members gathered in Namalata to attend the implementation training conducted by WCS team. This training was designed to: confirm roles and membership of KRMC sub-committees; review management actions identified in the ridge-to-reef plan; allocate responsibility for the management actions to various KRMC sub-committees;

(top left) KRMC and Bose Vanua during the blessing ceremony held in July, (top right) community members during roadshow, (bottom right), (bottom left) KRMC participants during the implementation workshop held in August.

prioritize and develop start times for the actions; identify knowledge, skills, and resources needed to implement the actions.

Apart from this, internal and external communication within Kubulau, gazettal of marine protected areas, and compliance and monitoring were also discussed.

"We will seek endorsement of the sub-committees from the *Bose Vanua* and the first task after endorsement will be to schedule a meeting of the different sub-committees to set in place a structure for reporting" said Paulo Kolikata, chairman of the KRMC.

Figure 36. Front cover of October 2009 issue of the EBM partnership newsletter.

Management Rules Posters

STATUS: Completed

FUNDING: David and Lucile Packard Foundation (2007-31847), Gordon and Betty Moore Foundation (540.01)

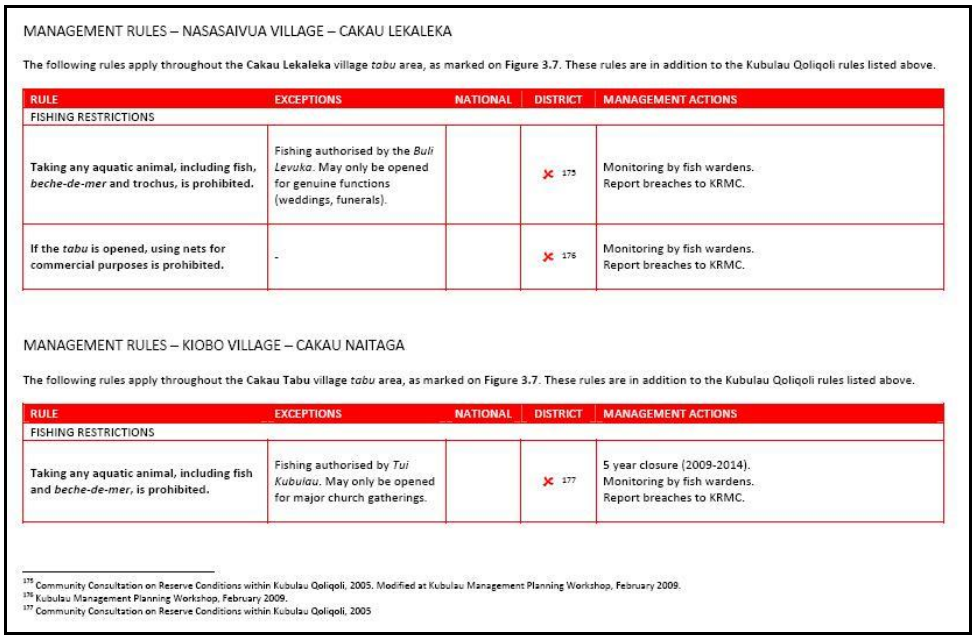
PARTNER ORGANISATIONS: Wetlands International-Oceania, WWF

OUTPUTS:

- *Posters for community halls*: Large format posters with management rules and actions from Kubulau EBM plan distributed and displayed in 10 community halls in Kubulau and Kubulau district schools.

EXAMPLE:
The Kubulau ridge-to-reef plan was developed this year which has a list of community management actions and rules (*see Management section*). To have greater outreach of the community actions and the various management rules, management actions and rules posters were developed (Figure 37). These were distributed to all villages and a copy was put up at each village community hall to ensure accessibility to all the village members.

LINKS TO NATIONAL PRIORITIES:
The production of management rules posters support the NBSAP inshore fisheries implementation strategy to *Maintain existing protected areas* by providing resources that boost community awareness of management rules and actions to support compliance.



MANAGEMENT RULES – NASASAIVUA VILLAGE – CAKAU LEKALEKA

The following rules apply throughout the **Cakau Lekaleka** village *tabu* area, as marked on **Figure 3.7**. These rules are in addition to the Kubulau Qoliqoli rules listed above.

RULE	EXCEPTIONS	NATIONAL	DISTRICT	MANAGEMENT ACTIONS
FISHING RESTRICTIONS				
Taking any aquatic animal, including fish, *beche-de-mer* and trochus, is prohibited.	Fishing authorised by the *Buli Levuka*. May only be opened for genuine functions (weddings, funerals).		✕ [175]	Monitoring by fish wardens. Report breaches to KRMC.
If the *tabu* is opened, using nets for commercial purposes is prohibited.	-		✕ [176]	Monitoring by fish wardens. Report breaches to KRMC.

MANAGEMENT RULES – KIOBO VILLAGE – CAKAU NAITAGA

The following rules apply throughout the **Cakau Tabu** village *tabu* area, as marked on **Figure 3.7**. These rules are in addition to the Kubulau Qoliqoli rules listed above.

RULE	EXCEPTIONS	NATIONAL	DISTRICT	MANAGEMENT ACTIONS
FISHING RESTRICTIONS				
Taking any aquatic animal, including fish and *beche-de-mer*, is prohibited.	Fishing authorised by *Tui Kubulau*. May only be opened for major church gatherings.		✕ [177]	5 year closure (2009-2014). Monitoring by fish wardens. Report breaches to KRMC.

[175] Community Consultation on Reserve Conditions within Kubulau Qoliqoli, 2005. Modified at Kubulau Management Planning Workshop, February 2009.
[176] Kubulau Management Planning Workshop, February 2009.
[177] Community Consultation on Reserve Conditions within Kubulau Qoliqoli, 2005

Figure 37. Example of management rules (red) poster.

Feature Documentary on Community-Based Management

STATUS: Completed

FUNDING: David and Lucile Packard Foundation (2007-31847), Gordon and Betty Moore Foundation (540.01)

PARTNER ORGANISATIONS: Wetlands International-Oceania, WWF

OUTPUTS:

- *DVD documentary*: "Paulo's Triumph: Lessons from Community Conservation in Fiji". Launched at FLMMA Annual Training Meeting, 9 December 2009.

EXAMPLE:
The EBM DVD was launched on 9 December at the FLMMA annual training meeting in Nadave, Viti Levu. A follow-up launch will be held in Kubulau, with 3 separate screenings for all community members between 14-16 December. The documentary was produced with an aim to present to other communities and stakeholders in Fiji how the communities of Kubulau have benefitted from the EBM project. The documentary's main focus is on the threats of unsustainable resources management and securing community livelihoods through an EBM approach, leading to the development of the ridge-to-reef plan. WCS hopes to air the documentary on Fiji TV in 2010.

LINKS TO NATIONAL PRIORITIES:
The documentary can be used to support the Department of Environment's awareness campaign for the 2010 International Year of Biodiversity. The documentary could be featured during Environment Week in June 2010.

Inaugural Fiji Islands Conservation Science Forum

STATUS: Completed

FUNDING: David and Lucile Packard Foundation (2007-31847), Gordon and Betty Moore Foundation (540.01)

PARTNER ORGANISATIONS: Wetlands International-Oceania, WWF, University of the South Pacific, Fiji Locally Managed Marine Area Network

OUTPUTS:

- *Conference Proceedings*: 1st Fiji Islands Conservation Science Forum Proceedings are currently being printed and distributed to all participants.

EVENT SUMMARY:

The inaugural Fiji Islands Conservation Science Forum (FICSF) was convened from 5th-7th August, in Suva's Studio 6 conference centre. The main aim for this forum was to provide a platform to consolidate and synthesize the science that has been conducted in-country and to support holistic and multi-disciplinary conservation and development decision making.

Dr. Robin Yarrow, vice chair for the National Trust of Fiji and the key note speaker, described this event by stating, "T*o researchers it is a great opportunity to present their findings and to receive professional feedback and input. For post-graduate students, it is a wonderful opportunity to learn and network. In fact, I have heard on good authority that one excited USP student went as far as stating 'it is one of the best things since I have been here.' For those working in academic institutions like USP, it is a chance to ascertain more clearly as to what the conservation sector expects of their entity as well as to break out of their respective ivory towers…In the case of government participants, the Forum allows them to be reminded of the capacity and enthusiasm that exists within NGOs to work on biodiversity conservation issues of national importance. For all of us it represents a chance to meet and network with many like-minded individuals over several days of thematic scientific presentations, under the umbrella of the Ecosystem-based Management approach*".

The forum was attended by 115 participants from various national, regional and international organizations, including participants and visitors from Australia, New Zealand, Solomon Islands, Indonesia, Palau, Papua New Guinea, Madagascar, and the United States. Organizations represented included:

- NGOS (Wildlife Conservation Society, World Wide Fund for Nature, Wetlands International-Oceania, Birdlife-Pacific, International Union of

Conservation for Nature, Nature Fiji, The Nature Conservancy-Indonesia, Conservation International-Indonesia, Palau Conservation Society, SeaWeb)

- Government Departments (Ministry of Primary Industries, Department of Environment, Ministry of National Planning, Ministry of Health)
- Regional and local post-graduate students from academic institutions (University of the South Pacific, Fiji Institute of Technology, James Cook University, Lincoln University)
- Media agencies (Fiji Times, Fiji Sun, Fiji Television, *Wonsolwara*-USP student newspaper)
- Other partners (Fiji Locally Managed Marine Areas, Pacific islands Applied Geoscience Commission, Beqa Adventure Divers, Ridge to Reef Consulting, Resort Support, Blue Ventures, National Trust of Fiji, Japan International Cooperation Agency)

We received and accepted 58 abstracts which were divided into eight presentation themes: Ecosystem Based Management and Conservation Planning; Habitat Mapping; Species conservation; Community-based Adaptive Management and Socioeconomics; Marine Protected Areas and Fisheries; Marine ecology; Terrestrial ecology; and Taxonomy. These presentations reflected a widespread range of leading conservation and scientific organizations. The Forum received both local and international media coverage, with over 8 printed stories, plus features on Radio Australia, Radio New Zealand and Fiji One television.

The Forum's proceedings are now complete. They will be shortly released to participants and will also be publicly available from libraries. The proceedings include the annotated abstracts from the three days of presentations, PDFs of PowerPoint presentations, and a synthesis of major discussion points during the Forum.




LINKS TO NATIONAL PRIORITIES:

The Fiji Islands Conservation Science Forum has, for the first time in Fiji, enabled a 'true multi-sectoral' platform for conservation scientists and stakeholders to convene as a single body to present their work, highlighting challenges, outcomes and future conservation priorities. There have been many calls by participants to make this into an annual event in order to provide local conservationists a platform for dialogue. Before this Forum, the only avenue for this dialogue existed during the

annual Pacific Science Inter-congress (PCI), which is hosted regionally throughout the Pacific. However, PCI lacks participation by many local and regional students, local government departments, and other local conservation scientists due to financial constraints. Therefore, the Conservation Science Forum, under the Ecosystem Based Management (EBM) umbrella, has filled an important yet empty niche that is crucial for strengthening the conservation work in Fiji and the Region. The Forum was also an important step in improving the multi-sectoral relationship by synergizing the major conservation players and will hopefully assist emerging recommendations to be incorporated into national legislature.

ENGAGING WITH NATIONAL AND REGIONAL PROCESSES AND PLANNING

The following sub-sections present a synthesis of ways that WCS has participated in development of national conservation and resource management planning and policies.

Protected Area Committee

The Fiji Protected Area Committee has received funding through the Convention on Biological Diversity through the United Nations to initiate a Programme of Work on Protected Areas. Initial seed funding was granted to conduct an ecological gap assessment and to review legislative and institutional barriers to implementing a national network of protected areas in Fiji. The Protected Area Committee (PAC), as a technical advisor to the National Environment Council, has initiated the process of gathering information from relevant stakeholders to help set Fiji's conservation targets at a national scale for terrestrial, freshwater and marine systems.

On behalf of the Protected Area Committee, WCS hosted a workshop in Suva on Monday, 22 June 2009 to review and refine preliminary marine conservation targets for Fiji. Invited stakeholders and experts included representatives from Fiji government, non-governmental organizations, the University of the South Pacific and private-sector.

The workshop findings indicated that although some diversity surveys and prioritization exercises have been performed for certain taxa (e.g. seabirds), data on aquatic habitat condition and species distributions are currently too deficient to: (a) determine quantitative targets for protection; (b) establish gaps in current aquatic conservation efforts; and (c) prioritize regions for protection to maximize biodiversity conservation. Furthermore, most currently available data is decentralized and not spatially located within a geographic information system (GIS) for ready analysis.

While preliminary marine conservation targets for Fiji have been suggested (Table 5), WCS has recommended application for further funding to collate new and existing biodiversity and biogeographic data into a spatial database to first determine the extent of important habitats and corridors used by marine species. Once this information becomes available, WCS advises the PAC to set quantitative targets for protection for 5 years (consistent with implementation of the NBSAP) and 20 years.

Table 5. Preliminary targets for an ecological gap assessment of Fiji's marine regions through the Programme of Work on Protected Areas.

Habitat	Target Protection	Comments
Coastal beaches and scrub vegetation	100% of priority nesting ground for marine turtles and seabirds	Based on known priority locations from 2009
Coastal littoral forests	100% of those in near-pristine conditions	
Intertidal mud flats	100% known to be important feeding grounds for waders	Based on known priority locations from 2009
Estuaries	50% from high priority connectivity areas where rivers meet the sea	Areas defined by Jenkins et al. (in press)
Mangroves	??% of mangrove area, with highest protection and enforcement around mangrove islands and intact riverine mangrove habitats	Percentages to be extracted from zoning scheme in Watling. A Mangrove Management Plan for Fiji
Seagrass beds	30% of all seagrass areas, with priority to seagrass habitats adjacent to mangroves and coral reefs. 100% of highest quality feeding ground for marine turtles (subtidal bed <5 m)	Based on known habitats from 2009
Permanent sandy cays	50%	Based on known locations from 2009
Soft-bottomed lagoons	10% of all, particularly connecting seagrass and reefs	
Coral reef habitat	30% of all, ensuring that protection is equitably distributed among offshore as well as nearshore areas, with special focus on pristine, resilient and/or remote areas	Definition of coral reef geomorphic zones will be aided by release of Millenium Coral Reef Mapping data
Seamounts	25% under management	Based on known location from 2009. Consider other management measures in addition to no-take zones: (1) gear restrictions (e.g. bans on bottom-fishing, trawling & mining); (2) seasonal closures; and (3) closures when CPUE falls below a certain threshold or catches fall below a certain size.
Deep trenches	100% under management	Based on known locations from 2009. Consider gear restrictions or closures during seasonal migrations in additional to no-take zones.
Deep passages	50%	
Spawning aggregation sites	100% of known sites closed during spawning periods	Based on known locations from 2009

Integrated Coastal Management Committee

WCS holds a seat on the newly established Integrated Coastal Management Committee, a second technical advisory arm of the National Environment Council tasked with developing a framework for a coastal management plan for Fiji. WCS has been requested to sit on a working group to develop the objectives and terms for a planning workshop slated for early 2010 to engage stakeholders to conceptualize a management framework for Fiji's coastal zones.

NBSAP Consultative Group

WCS sits on the national steering committee for revising implementation strategies for the National Biodiversity Strategy and Action Plan (NBSAP). In August 2009, WCS helped facilitate conceptual modelling exercises for the Inshore Fisheries section of the NBSAP implementation plan, which included identification of threats to the marine conservation targets defined through the Protected Area Committee, as well as strategies and specific actions to mitigate those threats. A results chain of the final conceptual model for sustainable inshore fisheries is depicted in Figure 38.

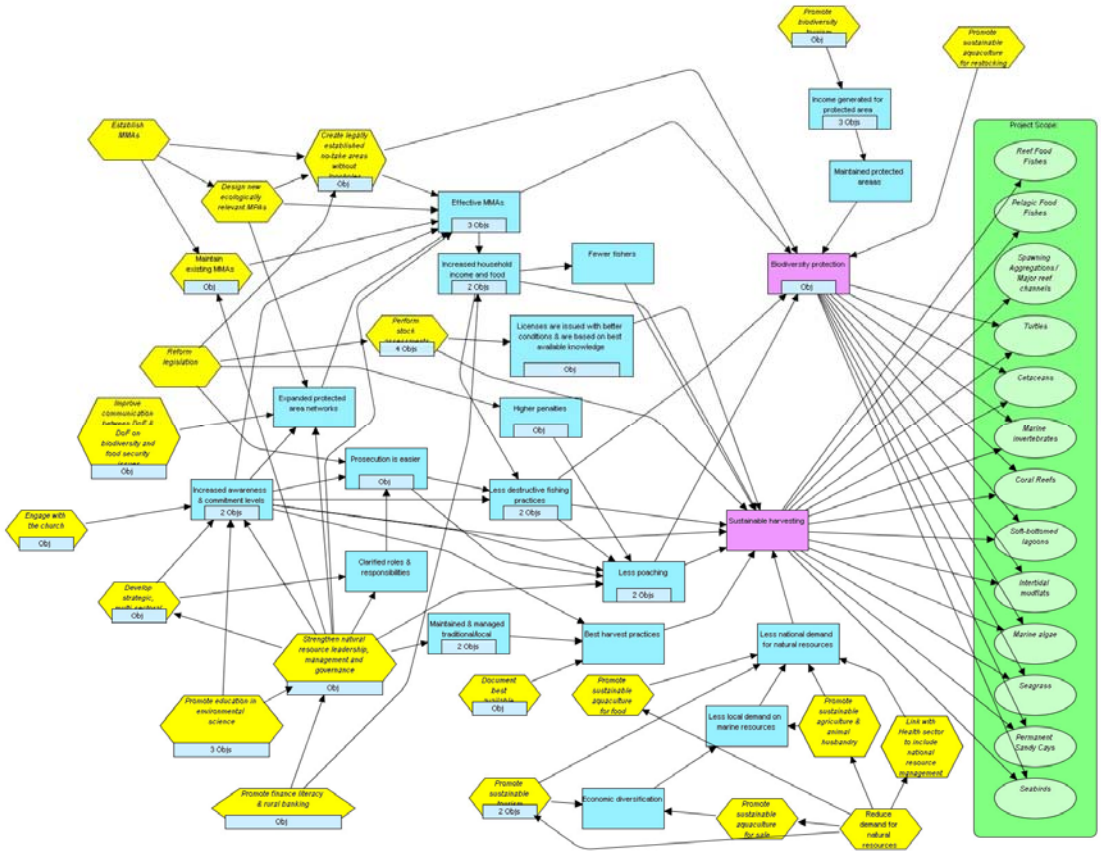


Figure 38. Results chain for the Inshore Fisheries thematic section of the NBSAP implementation plan 2009. Purple boxes represent the desired outcomes: (1) Sustainable harvesting of marine resources; and (2) Biodiversity protection. Yellow hexagons represent strategies to achieve these outcomes and blue rectangles are objectives used to measure success of each strategy. Schematic was produced using Miradi software for conservation planning, monitoring and evaluation.

WCS has refined the conceptual model into 9 broad strategies designed to yield sustainable harvesting of marine resources and biodiversity protection, if properly implemented with measurable objectives. These 9 strategies include:

(1) Promote sustainable aquaculture for restocking;
(2) Promote biodiversity tourism;
(3) Maintain existing protected areas;
(4) Design new, ecologically relevant, marine inshore protected areas;
(5) Strengthen natural resources leadership, management and governance;
(6) Promote education and awareness in environmental science;
(7) Improve communication between Department of Environment and Department of Fisheries on relevant biodiversity and food security issues;
(8) Reform fisheries legislation and management institutions; and
(9) Reduce demand for marine natural resources and biodiversity products.

WCS is working with Department of Environment to ensure that actions falling under each strategy are achievable and can be monitored against measurable objectives.

Fiji Locally Managed Marine Area Network

WCS has been actively involved through the Fiji Locally Managed Marine Area (FLMMA) network through participation on the Executive Committee and technical working groups (Biological Monitoring, Socioeconomic Monitoring, Compliance & Enforcement, DAM, Communications). WCS sent representatives to attend the Bua provincial FLMMA workshop to collate information for Strategic Plan design and participated in the FLMMA partners workshop to organize the agenda for the full Strategic Planning meeting in September 2009. At the Strategic Planning meeting, WCS assisted to facilitate discussions with community members, provincial representatives and partner organizations on some of the 6 priority focal areas identified by FLMMA for action:

(1) Monitoring and learning;
(2) Communication;
(3) Legislation and regulatory mechanisms;
(4) Best practice and sustainability;
(5) Governance; and
(6) National, regional and international engagement.

In particular, WCS helped to ensure complementarity between the FLMMA Strategic Planning process and other national initiatives (e.g. NBSAP implementation, PoWPA) by assisting to align strategies and actions.

For the FLMMA annual training meeting in December 2009, WCS is organizing a session to share lessons learned from the EBM projects. Presentations are slated to include:

(1) Managing for connectivity between terrestrial, freshwater and marine systems;

(2) Generalized EBM management plan template;
(3) Sustainable financing and business planning (led by The Coral Reef Alliance);
(4) Small grant proposal development (led by WWF);
(5) Launch of EBM documentary; and
(6) The intersection of law and custom for community-based natural resource management in Fiji.

With regards to promoting partner communities in the FLMMA network, to date in 2009 WCS has assisted 3 villages of Kubulau District become full FLMMA members. WCS is working towards enabling full membership status for 5 of the remaining 7 villages in the district.

Round Table for Nature Conservation

In July 2009, WCS attended the Pacific Round Table for Nature Conservation meeting in Honiara, Solomon Islands. The main objectives of the meeting were to:

(1) Share partner organisation objectives and alignment to the Action Strategy four objectives;
(2) Enable effective engagement of Roundtable Working Groups and clarification of processes and coordination;
(3) Improve linkages and coordination with regional initiatives and opportunities such as CTI, Pacific 2020, Global Environment Facility and others; and
(4) Secure Roundtable support to countries in regard to the implementation and coordination of their nature conservation strategies and approaches.

The director of WCS's Fiji program presented strategies and measurable indicators from both WCS's Fiji and Papua New Guinea programs to demonstrate their alignment with Round Table objectives. These strategies include:

Objective 1. Ensure conservation has a development context that recognises, respects and supports sustainable livelihoods and community development aspirations
WCS Fiji Strategy 1: Establish managed, no-take protected areas to maintain and increase fisheries resources
WCS Fiji Strategy 2: Develop links to microfinance options
WCS PNG Strategy 1: Conduct gap analysis to determine where Traditional Ecological Knowledge (TEK) is no longer adequate to ensure sustainability and where WCS science can be used to improve sustainability

Objective 2: Identify, conserve and sustainably manage priority sites, habitats and ecosystems
WCS Fiji and PNG Strategy 1: Engage communities in establishing networks of locally-managed protected areas through an ecosystem approach

Objective 3: Protect and recover threatened species and species of ecological, cultural and economic significance
WCS Fiji Strategy 1: Engage communities in social marketing campaigns to decrease pressure on select iconic species that represent important ecosystem processes

WCS PNG Strategy 1: Build scientific capacity to conduct research on focal species selected using the WCS species selection criteria

Objective 4: Manage threats to biodiversity, especially climate change impacts and invasive species
WCS Fiji Strategy 1: Help resolve major conservation challenges related to climate change adaptation by raising community awareness, developing community action plans and integrating protocols to assess ecosystem resilience into monitoring
WCS Fiji Strategy 2: Help resolve major conservation challenges related to invasive species by campaining, in partnership with Wetlands International-Oceania, to prevent the spread of tilapia
WCS PNG Strategy 1: Help resolve major conservation challenges related to climate change adaptation by developing and applying models for impacts of climate change and socio-cultural and ecosystem resilience

EBM Pacific Regional Workshop

WCS convened the premier Pacific Ecosystem Based Management (EBM) networking workshop on 10th-11th August, 2009 in Suva, Fiji, to provide a forum for Pacific EBM practitioners to: discuss specific successes of implementing EBM projects in the Pacific region; brainstorm on solutions to challenges to implementing EBM; and open discussions on the potential benefits of a Pacific EBM network. The workshop directly followed the inaugural Fiji Islands Conservation Science Forum, hosted by the Fiji EBM partnership, to capitalize on the presence of regional representatives and to build on relevant discussions that emerged from new scientific findings presented. A further critical component of the workshop was to review and edit the first draft of a guide for implementation of EBM (*Principles and Practice of Ecosystem-Based Management: A Guide for Conservation Practitioners in the Western Tropical Pacific*).

This workshop was attended by various regional partners involved in practicing, implementing and advocating EBM in the Pacific:

- **Fiji:** WCS-Fiji, WWF, University of the South Pacific/Institute of Applied Sciences**,** International Union for the Conservation of Nature
- **Palau:** Palau Conservation Society
- **Indonesia:** The Nature Conservancy-Indonesia, Conservation International-Indonesia
- **Other collaborators:** James Cook University (Australia), U.S. Peace Corps

Brief project overview presentations were given by Fiji, Palau, and Indonesian delegates. This was followed by four focused break-out sessions through the two days to generate discussions and assist exchange of lesson learnt between groups. Break-out groups included a mix of participants from different projects and participants changed groups throughout the workshop to diversify our interactions on four main themes: (1) Connectivity Science/EBM Tools; (2) Translating Science to Adaptive Management; (3) Communicating EBM; and (4) Cross-Sectoral Engagement.

PROJECTED ACTIVITIES FOR 2010

The following sub-sections present a brief list of confirmed and pending projects for 2010 and their link to National Priorities.

Ecosystem-Based Science in Fiji: Closing the Knowledge Gaps

STATUS: Confirmed

NATIONAL PRIORITIES:

- NBSAP Inshore Fisheries Priority: Mechanism for FLMMA to address biodiversity
- NBSAP Coastal Development Priority: Evaluate upstream impacts on coastal/marine environment

OUTPUTS:

- MPA network reconfigured to take into account coral reef areas with greatest resilience to climate disturbance
- Assessment of links between upstream riparian stream condition and downstream community health

LOCATION: Kubulau District and Macuata Province, Vanua Levu

PARTNERS: Wetlands International-Oceania

DONOR: David and Lucile Packard Foundation

TIMELINE: February 2010 – January 2012

INVESTMENT: USD$200,000

Ecosystem-Scale Impacts of Changing Climate and Intensive Land Use on Fiji Catchments and Downstream Habitats

STATUS: Pending

NATIONAL PRIORITIES:

- NBSAP Coastal Development Priority: Evaluate upstream impacts on coastal/marine environment
- Fiji's First National Communication under the Framework Convention on Climate Change to build local capacity to reduce vulnerability to climate change risks

OUTPUTS:

- Land cover, riparian condition and landslide maps from Ba catchments
- Estimated sediment supply to Ba nearshore from landslides

- Identification of vulnerable upstream and downstream areas that community and government managers can target for restoration and protection
- Long-term monitoring protocols to determine the effectiveness of catchment mitigation measures.

LOCATION: Ba catchments, Viti Levu

PARTNERS: U.S. Geological Survey

DONOR: U.S. National Aeronautics and Space Administration (NASA)

TIMELINE: March 2010 – March 2013

INVESTMENT: ~USD$994,000

Developing a Community Ecosystem-Based Adaptation Approach to Increase Ecological and Social Resilience to Climate Change Disturbance in Fiji

STATUS: Pending

NATIONAL PRIORITIES:

- Fiji's First National Communication under the Framework Convention on Climate Change to build local capacity to reduce vulnerability to climate change risks
- NBSAP Inshore Fisheries Priority: Identify community capacity needs to manage inshore fisheries

OUTPUTS:

- Vulnerability assessments of community capacity to respond to climate disturbance
- Ecosystem-based adaptation plans to mitigate effects of climate disturbabce and protect ecosystem functions
- Ecosystem-based adaptation toolkit that can be applied throughout Fiji and the region.

LOCATION: Wainunu and Kubulau Districts of Bua Province, Wailevu District of Cakaudrove Province, Vanua Levu

PARTNERS: University of British Columbia (Canada), Kubulau Resource Management Committee

DONOR: U.S. National Oceanic and Atmospheric Administration (NOAA) Sectoral Applications Research Program (SARP)

TIMELINE: May 2010 – April 2012

INVESTMENT: USD$300,000

Incorporating Reef Resilience to Climate Change in Ecosystem-Based MPA Management Plans for Two Fijian Traditional Fishing Grounds

STATUS: Pending

NATIONAL PRIORITIES:

- Fiji's First National Communication under the Framework Convention on Climate Change to build local capacity to reduce vulnerability to climate change risks
- NBSAP Inshore Fisheries Priority: Mechanism for FLMMA to address biodiversity
- NBSAP Inshore Fisheries Priority: Identify community capacity needs to manage inshore fisheries

OUTPUTS:

- Adaptation to the Kubulau MPA network and existing ecosystem-based management plan to improve reef resilience to increasing frequency and severity of disturbance due to climate change
- New, resilient, linked networks of MPAs in Wainunu district qoliqoli guided by an ecosystem-based MPA plan

LOCATION: Wainunu and Kubulau Districts of Bua Province, Vanua Levu

PARTNERS: Kubulau Resource Management Committee

DONOR: U.S. National Oceanic and Atmospheric Administration (NOAA) International Coral Reef Conservation Program

TIMELINE: October 2010 – March 2012

INVESTMENT: USD$80,000

An Ecosystem Approach to Fiji's Vatu-i-Ra Seascape: Integrating Science into Site Management and National Planning Processes

STATUS: In preparation

NATIONAL PRIORITIES:

- Fiji's First National Communication under the Framework Convention on Climate Change to build local capacity to reduce vulnerability to climate change risks
- NBSAP Inshore Fisheries Priority: Mechanism for FLMMA to address biodiversity

OUTPUTS:

- Effective management of Vatu-i-Ra's unique biodiversity and natural resources via community-based management of resilient protected area networks across Kubulau, Wainunu and Wailevu districts and adjacent fishing grounds
- Expansion of national network of marine protected areas through increased capacity for sound conservation planning

LOCATION: Wainunu and Kubulau Districts of Bua Province, Wailevu District of Cakaudrove Province, Vanua Levu

PARTNERS: Kubulau Resource Management Committee, FLMMA, PAC

DONOR: MacArthur Foundation

TIMELINE: July 2010 – June 2012

INVESTMENT: USD$250,000