



WILDLIFE CONSERVATION SOCIETY  
FIJI COUNTRY PROGRAM 2017

## FROM THE DIRECTOR



**2017** has been an eventful year that has placed Fiji in the international spotlight as it co-hosted the United Nations Ocean Conference (UNOC) in New York, and COP23 on Climate Change in Bonn. The UNOC provided a unique opportunity for Pacific Island countries like Fiji to unite and find a strong voice to advocate for our ocean. A total of 17 commitments were made by Fiji alone, 9 of which WCS is committed to implementing with the Government and partners. We were proud to witness the Fiji Government state its intention to gazette two large marine managed areas in the Vatu-i-Ra Seascape.

2017 saw us re-engaging more fully with our communities, as they opened their homes to us, post-Cyclone Winston. Working closely with the Bua Provincial Office, representatives from each of the nine districts and stakeholders from the province, we finalized the content for an Integrated Coastal Management Plan for Bua Province which will be launched in early 2018. Our gender and fisheries has expanded and is starting to make real traction at the local and national level. We proudly partnered the Women in Fisheries Network-Fiji and Fiji Locally-Managed Marine Area network to host the first national “Women in Fisheries Forum” on International Women’s Day. Women fishers from Bua and Ba drafted management plans for their mud crab fishery and learnt methods from the private sector on fattening and good handling of mud crabs to increase their profit margins.

In July, we celebrated the signing of a conservation lease with the *iTaukei* Land Trust Board to protect 402 ha of Kilaka Forest in Kubulau District. The conservation lease is a win for *mataqali* Nadicake who have been protecting the forest for 10 years, but wanted an alternative to logging their forest. Working with the Ra Provincial Office, local communities and tourism operators, completed a management plan and marine conservation agreement for the Vatu-i-Ra Conservation Park in Nakorotubu District. A Trust Deed has been drafted and we expect the first education grants for tertiary level students to be issued in early 2018.

As we end 2017, we are saddened to lose two leaders who were a great source of inspiration to their people and all those that met them. The WCS staff feel honoured to have known and worked with Ratu Apenisa Vuki the Tui Kubulau, and Atunaisa Kaloumaira the Chairman of the Lomaiviti Provincial Council, who both passed away just before Christmas. They will be sorely missed, but they leave a legacy for all of us to follow.

On behalf of the WCS Fiji team, we look forward to continuing to work with our partners in Fiji, regionally and nationally. As we end 2017, let us together take our international and national commitments, and make a real difference on the ground for all Fijians and the global community we share this beautiful planet with.

A handwritten signature in black ink that reads "Sangeeta Mangubhai".

Sangeeta Mangubhai  
WCS Fiji Director

## IN MEMORIUM – RATU APENISA VUKI, TUI KUBULAU



I was deeply saddened to learn of the passing of Ratu Apenisa Vuki, the Tui Kubulau, in December 2017. I had worked closely with the Tui Kubulau since his father passed away in 2008, shortly after I arrived in Fiji.

After being installed as high chief, Ratu Apenisa quickly followed in his father's footsteps in becoming a champion for conservation in Kubulau District. He oversaw the development of a district-

level, ridge-to-reef management plan, a first for Fiji, and led its endorsement in 2009. The management plan linked together the various conservation activities happening in the district, from forest conservation in the highlands to a growing network of marine protected areas over the reef, including Kubulau's crown jewel, the Namena Marine Reserve.

Many of the divers visiting the Namena Marine Reserve on liveaboards like the *Nai'a* had the opportunity to stop by Kiobo village for a visit, where Ratu Apenisa was always there to greet them with a warm welcome and musical hits from the 1960s and '70s played on his guitar. In fact, every time I visited Kiobo I was instructed to sing-along to "your song", and we always did a raucous rendition of Hotel California by the Eagles.

Ratu Apenisa was very concerned about the loss of traditional knowledge and stories among the people of Kubulau. He was hugely supportive of the WCS's efforts to capture some of the traditional knowledge around marine and coastal species that we published in our *EcoTales* from Kubulau book.

I am very privileged to have been able to know Ratu Apenisa and observe how he led his people with quiet grace. I was also fortunate enough to be able to attend the funeral with some of our Fiji program staff, which was a fitting tribute to a leader who will be much missed.

A handwritten signature in black ink that reads "Stacy Jupiter". The signature is fluid and cursive.

Stacy Jupiter  
WCS Melanesia Regional Director

## THE WCS TEAM

### Sangeeta Mangubhai, Director – Fiji Program



Dr. Sangeeta Mangubhai joined WCS-Fiji in 2014. She has worked on marine science and conservation in Australia, East Africa, Indonesia and the South Pacific. She completed her Ph.D. in 2007 through Southern Cross University in Lismore, Australia, looking at reproduction and recruitment of corals in Kenya. Since then she has been working on designing marine protected areas, marine spatial planning, coral reef and invertebrate fisheries, environmental policy, and climate change. She is a specialist in designing monitoring programs to understand impacts of disturbances on coral reef communities, and the return of investment of conservation strategies. She recently served as the Co-Chair for the Executive Committee for the Women in Fisheries Network-Fiji, and sits on numerous government committees. She is an editor for the journal *Pacific Conservation Biology*, an adjunct scientist with the New England Aquarium and adjunct Associate Professor with Southern Cross University in Australia.

### Stacy Jupiter, Director – Melanesia Program



Dr. Stacy Jupiter has been working with WCS since 2008, first as the Fiji Country Director and since 2014 as the Melanesia Director. As Melanesia Director, she oversees country programs in Fiji, Papua New Guinea and Solomon Islands, and is initiating work in Vanuatu. Her Ph.D. research through the University of California, Santa Cruz focused on linkages between land use and downstream impacts to water quality and nearshore coral reefs, topics which she continued to develop as a postdoctoral fellow with the ARC Centre of Excellence for Coral Reef Studies in Australia. Her work continues to focus on integrated catchment-to-reef management, though this has taken various forms, including: evaluating effectiveness of locally-managed marine areas and integrated island management projects; undertaking spatial planning to achieve biodiversity and livelihoods outcomes; assessing downstream impacts of catchment modification on biodiversity and human health; and understanding drivers of resilience in Pacific coastal communities.

### Nischal Narain, Melanesia Regional Budget Manager



Nischal Narain joined WCS-Fiji in 2008 as Finance Manager and became the Melanesia Regional Budget Manager in 2016. He holds a Masters degree in Business Administration (MBA) with University of the South Pacific. He previously worked with Pacific Theological College as Director of Finance and Administration and WWF South Pacific as Finance Manager. His primary responsibilities are to oversee the regional budget and assist country programs with budget and grants management.

Upashna Prakash, Finance and Administration Officer



Upashna joined WCS in 2016 as Finance and Admin Officer, and supports the finance, administration and operations of the Fiji Country Program. She has a Post Graduate Diploma in Commerce from the University of the South Pacific (USP). She completed studies in Professional Development from the University of Southern Queensland, a Bachelor of Arts majoring in Accounting and Information Systems from USP and is currently pursuing her Masters in Commerce. She is a provisional member of the Fiji Institute of Accountants.

Ruci Lumelume, Policy Advisor



Ruci Lumelume joined WCS-Fiji in 2015 as our Policy Advisor. Ruci is WCS' government liaison for WCS-Fiji, supporting the Fiji government in its international commitments and the development of new legislation and policies that address conservation and fisheries issues. Ruci has a Bachelor of Arts in geography, population studies and demography, and postgraduate degree in development studies from the University of the South Pacific. She worked previously for IUCN focusing on wetlands, and the Fiji Islands Trade and Investment Bureau.

Akanisi Caginitoba, Community Engagement Coordinator



Akanisi Caginitoba joined WCS-Fiji in 2002 as an administration officer and is currently the Community Engagement Coordinator. Akanisi led a livelihood project to build the capacity of women in Vanua Levu to run small businesses to produce *kuta* weaving, honey and virgin coconut oil. She is a specialist in community ecosystem based management planning, community leadership and assists communities identify and develop community projects.

Margaret Fox, Conservation Officer



Margaret Fox joined the WCS-Fiji marine team in March 2010 as a conservation officer. She completed her Bachelor of Science degree in Marine Biology and Chemistry at the University of the South Pacific in 2002. Previously she has worked as a Marine Biologist with Turtle Island Resort to help set up marine protected areas. Margaret's expertise includes coral identification, invertebrate identification, socioeconomic surveys, and community engagement and consultation. Margaret is overseeing WCS' women in fisheries programme.

Watisoni Lalavanua, Fisheries Officer



Watisoni joined WCS in 2016 as a Fisheries Officer. He has a Bachelor of Applied Science in Environmental Studies from Auckland University of Technology. Previously he worked with Partners in Community Development Fiji on climate change adaptation and disaster risk management, rural water security, food security and fisheries management. He was a junior fisheries scientist with the Pacific Community, supporting national fisheries in Tuvalu, Kiribati, Federated States of Micronesia and Papua New Guinea. He has experience in assessing status of fish, invertebrate and corals, socioeconomic survey and post-harvesting training.

Yashika Nand, Marine Scientist



Yashika Nand joined WCS-Fiji in 2010 as a Marine Scientist. She has graduated with her Post-graduate Diploma in Marine Science specializing in coral reef ecology from the University of the South Pacific in 2008. Previously she worked for Fiji’s Department of Fisheries as the lead coral researcher. Yashika manages all data from WCS’ biological monitoring program, and helps integrate this into conservation planning in Fiji. Her

expertise includes coral identification, coral health assessments, the aquarium trade fishery and more recently value chain analyses of coastal fisheries. She is currently completing a Masters in coral reef ecology, focusing on coral disease at the University of the South Pacific.

Waisea Naisilisili, Field Officer



Waisea Naisilisili joined WCS-Fiji in 2003 as a field collector and now works as a project officer and is part of the biological survey team. Waisea has previously worked at the Fiji Mineral Resources as a research assistant collecting mineral samples. Waisea specializes in coral reef fish surveys and community catch monitoring. He is also a specialist in community engagement and is currently

leading WCS’ island planning process and community engagement in the Lomaiviti Province.

Epeli Manu Loganimoce, Community Engagement Officer



Epeli joined WCS in 2017 as a Community Engagement Officer. He has a Masters in Marine Biology and Ecology from the University of Porto, Portugal. In addition to working with communities to help them plan and manage their natural resources, he has implemented socioeconomic surveys in Fijian villages to assess conservation impact and establish baselines for new payment for ecosystem service initiatives.

Sirilo Dulunaqio, Community Liaison Officer



Sirilo Dulunaqio (Didi) joined WCS as a Community Liaison Officer in 2005. Originally from Kubulau, trained as a dive instructor, Didi provides a critical link between WCS activities and management implementation with the communities of Kubulau and adjacent districts, and provides technical and logistical support on biological surveys. Didi is now working with communities and dive operators in Ra Province to establish a marine protected area and a

voluntary contribution to conservation scheme.

Jone Tamanitoakula, Fisheries Officer



Jone joined WCS in 2017 as a Fisheries Officer. He has a Bachelor of Applied Science from Auckland University of Technology (AUT) and worked for the Ministry of Fisheries as a Project Officer and Fisheries Assistance Officer for 5 years before joining WCS. He has extensive experience marine surveys, socioeconomic monitoring, conducting CITES “Non-Detrimental Findings” and Fisheries Impact Assessments throughout Fiji. He has a keen interest in conservation and management of fisheries resources and ecosystems.

#### Sahar Noor Kirmani, Technical Support Officer



Sahar joined WCS in 2017 as an Australian Volunteer International to provide technical support across two marine projects. She has a BSc with first class honours in Biology and Marine Science from the University of Sydney, a certification in Spatial Information Systems from the National Environment Institute, New South Wales, and studied Development and Management from Lund University in Sweden. She has worked in species conservation and ecological monitoring around Australia, Indonesia and India, and is experienced in spatial analysis, cartography and project management.

#### Ingrid Qauqau, GIS Officer



Ingrid Qauqau has been working with WCS-Fiji as a GIS officer since 2003. She graduated with a Bachelor's Degree in environmental science in 2002 from the University of the South Pacific. She specializes in general mapping, image analysis, remote sensing, spatial analysis, and habitat mapping. Ingrid is also a member of the GIS user forum of Fiji.

#### Kelera Varawa, Communication Officer



Kelera Serelini-Varawa joined WCS in 2016 as Communications Coordinator bringing with her wealth of experience in the media industry, public relations and strategic communications. She has undergone professional training in communication pertaining to human rights issues, environment journalism and strategic communications. Kelera is responsible for the coordination of WCS internal and external communications as well as the promotion of the Vatu-i-Ra Seascape, a campaign to build public support for the protection of land and sea between Fiji's two main islands.

#### Jonah Vadiga



Jonah Vadiga joined WCS in 2016 as an Administration and Logistics Assistant. He has a Certificate in Business (General) and a Diploma in Business (Economics) from the Fiji Institute of Technology. Previously he worked with Musket Cove Island Resort and Marina Fiji as Human Resources Coordinator, and as a Technical Officer for the Chief Executive Officer of Investment Fiji. He has experience in human resources, administration and logistics.

## COLLABORATING STUDENTS

### Rachel Dacks



Rachel is in the final year of her PhD at University of Hawaii. Her thesis is titled “Investigating the complexities of coral reef social-ecological resilience in Fiji”. She has conducted household and fisher interviews across Fiji to better understand how marine resource use varies across a gradient of social, economic, and ecological conditions. She is supervised by Dr. Cynthia Hunter and advised by Dr. Stacy Jupiter.

### Krystelle Danford



Krystelle is in the final year of her Master of Science at the University of the South Pacific on “Life history characteristics of two coral reef fish species in Fiji, *Naso unicornis* and *Siganus vermiculatus*.” She is also trying to understand geographic different in life history traits between reefs, and its implications for setting revised size limits in Fiji. She is supervised by Drs. Susanna Piovano and Sangeeta Mangubhai.

### Jade Deleveux



Jade recently completed her PhD in Natural Resources and Environmental Management at University of Hawai’i. Her thesis is titled “Data and tools to operationalize ridge-to-reef management in high oceanic islands”. She developed the first land-sea linked modeling framework at fine spatial scale for Kubulau District. She applied this framework with scenario planning to evaluate the effect of forest conservation on coral reefs under different climate change scenarios. Her findings highlighted the benefits of local forest conservation in the face of climate change. She was supervised by Dr. Tamara Ticktin and advised by Dr. Stacy Jupiter.

### Nicole Fraser



Nicola is in the first year of her PhD at the National Marine Science Centre, Southern Cross University, Australia. She has been awarded an Endeavour Fellowship to examine sea anemones in the marine aquarium trade, with a focus on Fiji. The overarching goal of this work is to address knowledge gaps to enable effective fisheries management, and establish aquaculture techniques for sea anemones to provide sustainable livelihoods for local communities and promote environmental stewardship. Her supervisors are Drs. Anna Scott, Sangeeta Mangubhai, and Karina Hall.



## WCS INTERNS AND FELLOWS

### Cadie Artuso



Cadie has a bachelor of Marine Science and Management from the University of New England in Australia. Since graduating, she has been working in Australia at the Department of Agriculture and Water Resources and at the Australian Fisheries Management Authority. She completed an internship with WCS-Fiji assisting with the development of Community-Based Management Plans for the sea cucumber and mud crab fisheries on Fiji's northern island of Vanua Levu.

### Mosese Naleba



Mosese Naleba has a Bachelor of Science in Environmental Studies from Fiji National University. He was an intern with WCS, during his studies. Mosese assisted with studies on coral reef fish and their size at maturity and socioeconomic surveys on women in fisheries. He continues to assist with data collection and data entry, and supports WCS with the preparation of workshops and meetings with partners.

### Alyssa Thomas



Dr. Alyssa Thomas started working with WCS in February 2017 initially as a volunteer and then as a consultant. She has a PhD in environmental studies from Victoria University of Wellington, New Zealand. Her PhD thesis was on the attitude and behaviour of fishers in a popular New Zealand recreational fishery. Alyssa's research interests revolve around the human dimensions of wildlife conservation.

### Luke Uluiburotu



Luke has a Bachelor of Arts majoring in Geography and Marine Affairs from the University of the South Pacific. He joined WCS Fiji program as an intern in July 2016 and has been involved in multiple projects assisting with socioeconomic data collection, data entry and supporting logistics for field surveys. He supported WCS with the preparation of workshops and meetings with partners.

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## EXECUTIVE SUMMARY

The Vatu-i-Ra Seascape is an area of unique ecological value located between Fiji's two main islands that incorporate the four provinces of Bua, Ra, Lomaiviti, and Tailevu, their associated traditional fishing grounds and offshore channels. The Wildlife Conservation Society (WCS) is working with a diversity of partners to preserve the functional integrity of Fiji's Vatu-i-Ra Seascape to sustain biodiversity, fisheries, and intact linkages between adjacent systems from land to sea, thereby enhancing social-ecological resilience to disturbance, and improving quality and abundance of marine resources for Fiji's people and economy.

This report highlights WCS Fiji Country Program's achievements from January to December 2017, under our three main themes of Science, Management and Communication. We also highlight our engagement with national and regional policy and planning, and the links to Fiji's national priority strategies under the National Biodiversity Strategy Action Plan (NBSAP), National Climate Change Policy, Green Growth Framework and National Gender Policy, to enable governments and partners to assess progress towards national targets.

In 2017, WCS Fiji's scientific studies included:

- A value chain analysis of the mud crab fishery in Bua Province, and grouper fishery in Vanua Levu;
- Fiji's sea cucumber fishery: advances in science for improved management;
- Socioeconomic surveys of Fijian women in the inshore fisheries sector;
- Biological survey of the northern Lau group;
- Assessment of coral reefs around Koro Island, post-cyclone Winston;
- Size of maturity in coral reef fish;
- An evaluation of Marine Conservation Agreements in Fiji; and
- Understanding the links between local ecological knowledge, ecosystem services, and resilience to climate change in Pacific Islands.

In our efforts to help strengthen community-based natural resource management in the Vatu-i-Ra Seascape WCS:

- Supported the five districts Lekutu, Nadi, Navakasiga, Solevu and Vuya to implement their ecosystem-based management (EBM) plans that take a ridge-to-reef approach;
- Finalised the strategies and content for the Bua Province Integrated Coastal Management (ICM) plan that builds on the provinces nine district management plans;
- Continued to provide technical advice and support to the Ministry of Fisheries to improve of inshore coastal fisheries focusing on sea cucumbers, mud crabs and coral reef fish;
- Assisted women crab fishers fatten and improve the quality of handling mud crabs;

- Supported local communities and tourism operators set up a voluntary contribution to conservation scheme around dive tourism in Ra Province;
- Completed marine spatial planning with stakeholders in the Vatu-i-Ra Seascape and submitted regulations to gazette the Bligh Waters and Central Viti Marine Managed Areas (MMAs); and
- Participated in the United Nations (UN) Ocean Conference as a Fiji Government delegate, and supported 10 of the 18 voluntary commitments to the global ocean.

Highlights from our communication work included:

- Continuing our Vatu-i-Ra Seascape campaign to support both inshore and offshore marine managed areas;
- Sponsoring a sailing voyage through the Vatu-i-Ra Seascape with a traditional Fijian *vaka* (canoe), the Uto-ni-Yalo, to raise awareness on the importance of the entire ridge-to-reef ecosystem;
- WCS featuring in over 60 articles on the environment, which has helped raise the profile of the work we do in the Vatu-i-Ra Seascape; and
- Producing 15 new scientific publications and 8 reports, on a range of topics including sea cucumbers, mud crabs, periodic harvested closures, land-sea island management, and conservation planning.

Lastly, WCS Fiji continued to maintain a strong presence on national committees and steering groups like the Protected Area Committee (PAC), the Integrated Coastal Management Committee (ICMC), the Fiji Locally-Managed Marine Area (FLMMA) Network, the Marine Protected Area (MPA) Technical Advisory Committee, and the Particularly Sensitive Sea Areas (PSSA) Task Force to help achieve national objectives in biodiversity protection, conservation planning, coastal management, sustainable fisheries and climate change preparedness.

## SCIENCE

The following sections present a synthesis of completed and ongoing science projects by WCS and partners for 2017. All reports are available online at <https://fiji.wcs.org/Resources.aspx>

### *A value chain analysis of the mud crab fishery in Bua Province*

**STATUS:** Completed

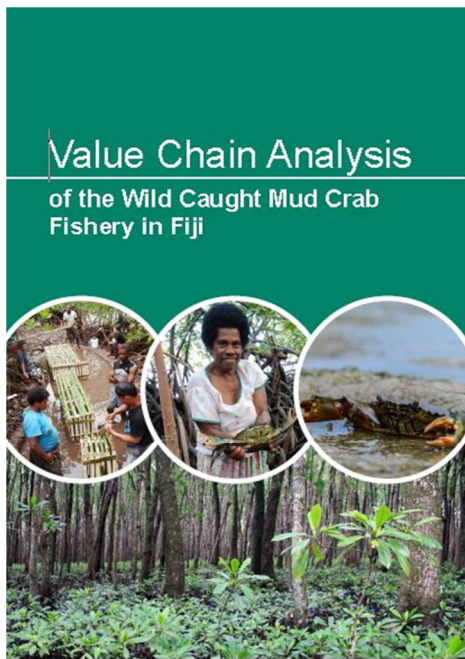
**FUNDING:** Flora Family Foundation (Grant #2016-2908) and the David and Lucille Packard Foundation (Grant #2015-41007)

**PARTNER ORGANISATIONS:** Ministry of Fisheries, FLMMA

#### **OUTPUTS:**

- *Report:* Mangubhai S, Fox M, Nand Y (2017) Value chain analysis of the wild caught mud crab fishery in Fiji. Wildlife Conservation Society. Report No. 03/17. Suva, Fiji. 100 pp.
- *Factsheet:* WCS Fiji (2017) Taking stock: Mud Crabs in Bua Province

#### **RESEARCH HIGHLIGHTS AND RECOMMENDATIONS:**



WCS, Ministry of Fisheries and FLMMA led Fiji's first comprehensive value chain analysis (VCA) of the wild caught mud crab (*Scylla serata*) fishery in November 2015. A total of 240 people were interviewed, including mud crab fishers, boat owners, middlemen, seafood shops/retailers, resorts, hotels, restaurants, exporters and consumers. This was the first VCA conducted for this fishery in Fiji and the wider Pacific Region. Understanding the commercial aspects of the fishery is critical to implementing sound sustainable management approaches, and for supporting community fisheries.

Briefly, this research found of the fishers interviewed, 88% were women with most earning \$8–17/kg, compared to middlemen and exporters who earned \$17–25/kg and \$40/kg. Most fishers have a poor understanding of market needs (e.g. size, shell to meat ratio). Geography, availability of transport, quality of roads, cost of travel, and historic social and business links, were all factors influencing whether fishers sold their mud crabs, and if they sold them, where they sold them, and to whom. Little to no gear is needed for harvesting mud crabs, and therefore there are low barriers to entry in the fishery other than access to mangrove forests. Fishers largely sell their crabs at markets or along the roadside, with most having limited connections to larger-scale traders, restaurants, and exporters. There is no processing (i.e.

value-adding) done by fishers and crabs can be held live for a few days compared to other seafood items that have a shorter sale window (e.g. fresh fish, sea cucumbers).

The income received by fishers from the sale of mud crabs did not vary during the year, with almost all fishers reporting no peaks or troughs in pricing. Prices also increased in early to mid-2016, shortly after Tropical Cyclone Winston<sup>1</sup>. Interviews with traders, restaurants, seafood retailers and exporters, revealed there were wider markets in Fiji with insufficient supplies to meet the demand. Because fishers operate independently or with their immediate family the supply can be variable and not consistent. This is particularly an issue for restaurants that do not have the time and resources to invest in fishers if there is not a consistent supply. The formation of fisher cooperatives may address this issue if well-established and managed. Size and weight were important for all players purchasing mud crabs, including consumers purchasing from municipal markets in Suva, Labasa and Savusavu. However, very few customers knew the legal size limit for mud crabs in Fiji. A high proportion of customers stated they would pay a higher price for crabs that came from more sustainable sources.

Overall, there were three main challenges and constraints faced by different players in the wild caught mud crab fishery in Fiji: (a) supply and demand; (b) capacity to add value is low; (c) insufficient data on catches or earnings, volumes of mud crabs being harvested and how much income the fishery generates annually for households and contributes to the local economy. There were seven recommendation from the VCA study: (i) improved inclusion of women in fisheries management; (ii) adherence to minimum sizes; (iii) improved mud crab post-harvesting techniques; (iv) formation of women cooperatives; (v) diversification of markets; (vi) development of a national mud crab management plan; (vii) gazettement of Fiji's national mangrove management plan.

#### **NEXT STEPS:**

Work with the Ministry of Fisheries to develop a national management plan for the mud crab fishery in Fiji.

#### **LINKS TO NATIONAL PRIORITIES:**

**NBSAP Implementation Plan Thematic Area 3 (Inshore Fisheries), Action 3.2b:** Monitor core set of existing MPAs for biodiversity and fisheries resources compared with unmanaged sites; **Action 8.2a:** Perform stock assessment of inshore marine resources. **Green Growth Framework Thematic Area 3 (Sustainable Island and Ocean Resources):** (i) develop a natural resource management system which is inclusive and integrated, and continue capacity building and awareness programmes with all communities, emphasizing supporting resource owners on the importance of proper environmental stewardship. **Thematic Area 4 (Inclusive Social Development):** increase women's capacity to participate in decision making and leadership at all levels to development (from village to national government) by 2018. **Fiji National Gender Policy:** 5.7 Gender Statistics and Research, 5.19 Leadership, Training and Development.

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<sup>1</sup> Vandervord C, Fox M, Yashika Nand, Unaisi Nalasi, Tarusila Veibi, Mangubhai S (2016) Impact of Cyclone Winston on Mud Crab Fishers in Fiji. Wildlife Conservation Society. Report No. 04/16. Suva, Fiji. 23pp.

## *Fiji's sea cucumber fishery: Advances in science for improved management*

**STATUS:** Completed

**FUNDING:** David and Lucile Packard Foundation (Grant #2015-41007)

**PARTNER ORGANISATIONS:** Ministry of Fisheries, the Pacific Community (SPC)

### **OUTPUTS:**

- *Report:* Mangubhai S, Lalavanua W, and Purcell SW (eds.) (2017). Fiji's Sea Cucumber Fishery: Advances in Science for Improved Management. Wildlife Conservation Society. Report No. 01/17. Suva, Fiji. 72 pp.
- *SPC Bulletin:* Lalavanua W, Mangubhai S Purcell SW (2017) New Report urges management reforms to save Fiji's sea cucumber fishery. SPC Bulletin 152: 22–26

### **RESEARCH HIGHLIGHTS AND RECOMMENDATIONS:**



FIJI'S SEA CUCUMBER FISHERY

Advances in Science for  
Improved Management



The sea cucumber fishery in Fiji has been operating intermittently for 200 years and has incurred intense fishing pressure in the past two decades. A recent change in government policy means the issuance of exemptions for the use of underwater breathing apparatus (UBA) for collecting sea cucumbers is prohibited. Ecological, socioeconomic, genetic, and trade studies undertaken in Fiji over the past five years by WCS and the Ministry of Fisheries revealed new insights for decisions to further improve management of the fishery.

Data collected on products for export, underwater population surveys and socioeconomic surveys corroborate previous reports that sea cucumber populations in Fiji are seriously over-exploited. Abundances are very low for many species (with potential local species extinctions), the body sizes of wild stocks and harvested animals are below legal size

limits and reproductive age, and fishers believe they are collecting much less per day than they did decades ago. Serious accidents of UBA divers have come at a high cost to rural communities and the national health system. Sea cucumbers were shown to be beneficial to reef sediments, and their removal appears to diminish ecosystem health. Gene flow for one species appears to be in an east-to-west direction, so conservation of populations in the eastern island will likely benefit genetic diversity across the fishery.

Overall, the recent studies validate the new ban on UBA in the fishery, but urge for further reforms to management. The studies provide evidence for the introduction of better minimum

legal size limits, shortlists of permissible species, and limited entry requirements to reduce the number of fishers permitted to collect sea cucumbers. At the same time, management actions are needed to strengthen enforcement of the regulations, support better postharvest processing and value chains, and develop nation-wide standards for pricing of raw and dried sea cucumbers. Prompt action on these management needs will give hope to reversing the perilous status of the fishery. Inaction will likely result in loss of biodiversity and some local species extinctions, erosion of ecosystem benefits of sea cucumbers, diminished long-term performance of the fishery, and a long-term loss of a valuable livelihood resource for current and future generations of Fijians.

**NEXT STEPS:**

In partnership with SPC, support the Ministry of Fisheries finalise a national management plan for Fiji’s sea cucumber fishery.

**LINKS TO NATIONAL PRIORITIES:**

**NBSAP Implementation Plan Thematic Area 3 (Inshore Fisheries), Action 8.2a:** Perform stock assessments of inshore fisheries. **Fiji Climate Change Policy Objective 5 (Adaptation), Strategy 5:** Support the ecosystem-based approach throughout Fiji, recognising that ecosystem services, such as food security, natural hazard mitigation and physical coastal buffer zones, increase resilience. **Green Growth Framework Thematic Area 3 (Sustainable Island and Ocean Resources):** (i) develop a natural resource management system which is inclusive and integrated, and (ii) implement a framework for inshore fisheries valuation.



*Sea cucumbers harvested at Sawani village (left, © Margaret Fox/WCS), and Vanua Balavu (right ©Watisoni Lalavanua/WCS)*



## *A value chain analysis of the grouper fishery in Vanua Levu*

**STATUS:** In progress

**FUNDING:** David and Lucille Packard Foundation (Grant #2015-62920)

**PARTNER ORGANISATIONS:** Science and Conservation of Fish Aggregations (SCRFA), Ministry of Fisheries

### **RESEARCH HIGHLIGHTS:**



*Groupers from Vanua Levu being sold at Bailey Bridge in Suva.  
©Sangeeta Mangubhai/WCS*

Over the three years, there have been concerted efforts in Fiji to improve the management of grouper spawning aggregations. However, there is very little data on the supply chain, and what is driving exploitation of this fishery. WCS provided training and technical support to SCRFFA and the Ministry of Fisheries to design and implement a comprehensive VCA of the grouper fishery in Vanua Levu, with a focus on *Plectropomus (donu)* and *Epinephelus (kawakawa)* species. The VCA aims to answer a number of key questions about the fishery:

- a) What is the structure of Fiji's grouper fishery and value chain?
- b) What is the revenue distribution, and comparative financial costs versus benefits, of different actors along the seafood value chain?
- c) What are the key challenges to value creation, and key areas of waste along the chain?
- d) How do different value chain actors perceive the state of grouper resources in Fiji?
- e) In which ways can higher values be garnered from grouper for value chain actors (particularly fishers) in Fiji?
- f) Which recommendations can be put forward from this VCA with regards to managing grouper exports from Fiji, particularly in relation to: (i) current resource condition and its biological sustainability (ii) economic benefits to the Fijian economy?

### **LINKS TO NATIONAL PRIORITIES:**

**NBSAP Implementation Plan Thematic Area 3 (Inshore Fisheries), Action 3.2b:** Monitor core set of existing MPAs for biodiversity and fisheries resources compared with unmanaged sites; **Action 8.2a:** Perform stock assessment of inshore marine resources. **Green Growth Framework Thematic Area 3 (Sustainable Island and Ocean Resources):** (i) develop a natural resource management system which is inclusive and integrated, and continue capacity building and awareness programmes with all communities, emphasizing supporting resource owners on the importance of proper environmental stewardship.

## Size of maturity in coral reef fish

**STATUS:** In progress

**FUNDING:** David and Lucile Packard Foundation (Grant #2015-41007, #2017-66580)

**PARTNER ORGANISATIONS:** Biospherics, Ministry of Fisheries, World Wide Fund for Nature (WWF), University of the South Pacific (USP)

### RESEARCH HIGHLIGHTS:

Length-Based Spawning Potential Ratios (LB-SPR) is a new methodology for determining if exploited marine populations have sustainable levels of reproduction or “spawning potential”. The need for this kind of data is imperative in the Pacific, especially Fiji, given the high levels of non-compliance by fishermen and middlemen to the current fish and invertebrate size limits, and the increasingly high demand of fish as a source of protein. The current size limits for Fiji were developed based on limited knowledge in the 1940s on the life history characteristics of fish species. Moreover, the size limits are categorized by fish families rather than by individual species, which is the recommended approach.

WCS, Ministry of Fisheries and World Wide Fund for Nature (WWF) are collecting data on fish size maturity for targeted species to review and improve the existing fish size limits under the Fisheries Act. The study adopts a robust methodology to assess SPR, developed by Dr. Jeremy Prince of Biospherics and gathers data on: (i) the length of the fish and its maturity phase; (ii) the sex of the species; and (iii) the SPR of the targeted species for specific fishing grounds.

Data are being collected through two sources: (i) village fisheries; and (ii) fish being sold at municipal markets. Fishermen from four villages from the Districts of Bua (Dalomo, Tiliva and Bua village) and Navakasiga (Nasau village) have been trained to collect the specific size of maturity data of targeted species. The targeted species includes *Acanthurus xanthopterus*, *Naso unicornis*, *Lethrinus nebulosus*, *L. harak*, *Lutjanus argentimaculatus* and *Siganus vermiculatus*. Concurrently, data were collected from Bailey Bridge and Labasa fish markets and included the following additional species: *Chlorurus microrhinos*, *Crenimugil crenilabis*, *L. atkinsoni*, *L. olivaceus*, *L. xanthochilus*, *Lutjanus gibbus*, *Plectropomus areolatus*, *Epinephelus polyphekadion*, *E. fuscoguttatus*, *Scarus rivilatus*, *S. rubroviolaceus*, *Hipposcarus longiceps*, *Caranx melampygus* and *Scomberomorus commerson*.

### LINKS TO NATIONAL PRIORITIES:

**NBSAP Implementation Plan Thematic Area 3 (Inshore Fisheries), Action 3.2b:** Monitor core set of existing MPAs for biodiversity and fisheries resources compared with unmanaged sites; **Action 8.2a:** Perform stock assessment of inshore marine resources. **Green Growth Framework Thematic Area 3 (Sustainable Island and Ocean Resources):** (i) develop a natural resource management system which is inclusive and integrated, and continue capacity building and awareness programmes with all communities, emphasizing supporting resource owners on the importance of proper environmental stewardship.

## *Socioeconomic surveys of Fijian women in the inshore fisheries sector*

**STATUS:** In progress

**FUNDING:** Flora Family Foundation (Grant #2017-3026), David and Lucile Packard Foundation (Grant #2017-66580), SPC

**PARTNER ORGANISATIONS:** FLMMA, Women in Fisheries Network – Fiji (WIFN-Fiji), World Wide Fund for Nature (WWF), Ministry of Fisheries

### **RESEARCH HIGHLIGHTS:**



*Women fishing on Koro Island reefs. © WCS*

Women fishers significantly contribute to household protein requirements and/or income; but these contributions are often overlooked, underestimated, and/or undervalued. In order to address these knowledge gaps, a national socioeconomic survey commenced in October 2017 across eight provinces in order to capture the diversity of the different fisheries targeted by Fijian women. Information will be gathered on fishing effort in the different habitats fished, types of seafood both caught and sold, and the quantities. Another portion aims to gather more details about the sale of seafood by women, including

what is caught by other people. Other sections focus on dependency on fisheries and involvement in the post-processing of seafood.

Expected outcomes of this study include:

- 1) a better understanding of the role these women play in providing food and income for households and contribution to the national economy;
- 2) information to assist with sustainable fisheries management by providing village, district and provincial scale information;
- 3) data that might help women fishers request necessary support (technical or funding);
- 4) information that will assist policy makers in creating policy that is aligned with the needs of women fishers.

### **LINKS TO NATIONAL PRIORITIES:**

**NBSAP Implementation Plan Thematic Area 3 (Inshore Fisheries), Action 8.2a:** Perform stock assessment of inshore marine resources. **Green Growth Framework Thematic Area 3 (Sustainable Island and Ocean Resources):** (i) develop a natural resource management system which is inclusive and integrated, and continue capacity building and awareness programmes with all communities, emphasizing supporting resource owners on the importance of proper environmental stewardship. **Thematic Area 4 (Inclusive Social Development):** increase women's capacity to participate in decision making and leadership at all levels to development (from village to national government) by 2018. **Fiji National Gender Policy:** 5.7 Gender Statistics and Research, 5.19 Leadership, Training and Development.

## Fisheries profiles for Fiji

**STATUS:** Completed

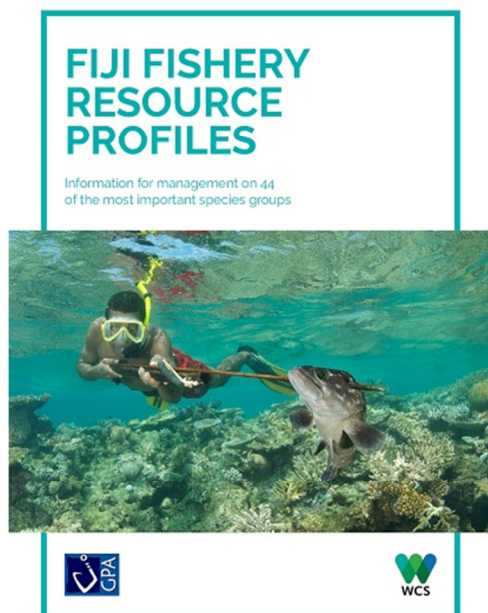
**FUNDING:** David and Lucile Packard Foundation (Grants #2016-63286, #2017-66580)

**PARTNER ORGANISATIONS:** Gillett, Preston and Associates

### OUTPUT:

- *Report:* Lee S, Lewis A, Gillett R, Fox M, Tuqiri N, Sadovy Y, Batibasaga A, Lalavanua W, Lovell W (in press) Fiji Fishery Resource Profiles. Information for Management on 44 of the Most Important Species Groups. Gillett, Preston and Associates and the Wildlife Conservation Society, Suva. 240pp.

### RESEARCH HIGHLIGHTS:



The earlier Forum Fisheries Agency report “Fiji Fisheries Resources Profiles”<sup>2</sup> provided summary information on different categories of fish, invertebrate and plant fishery resources to staff of the Fisheries Division, NGOs, students, communities, researchers, and others, and informed government policy on natural resource management for some years. The Fiji Fishery Resource Profiles was updated in 2017, and summarises information on 44 of Fiji’s main fisheries.

Where information is available, profiles have sub-sections on: (a) the resource (i.e. species present, distribution, biology and ecology) (b) the fishery (i.e. utilization, production and marketing; (iii) stock status; and (iv) management (i.e. current legislation/policy; recommended legislation/policy). The updated Fiji Fishery Resource Profiles will be published in early 2018.

### LINKS TO NATIONAL PRIORITIES:

**NBSAP Implementation Plan Thematic Area 3 (Inshore Fisheries), Action 3.2b:** Monitor core set of existing MPAs for biodiversity and fisheries resources compared with unmanaged sites; **Action 8.2a:** Perform stock assessment of inshore marine resources. **Green Growth Framework Thematic Area 3 (Sustainable Island and Ocean Resources):** (i) develop a natural resource management system which is inclusive and integrated, and continue capacity building and awareness programmes with all communities, emphasizing supporting resource owners on the importance of proper environmental stewardship.

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<sup>2</sup> Richards A, Lagibalavu M, Sharma S, Swamy K (1994) Fiji Fisheries Resources Profiles. Report 94/4, Forum Fisheries Agency, Honiara. 205pp.

## Marine biological surveys of the northern Lau group

**STATUS:** Completed

**FUNDING:** Vatuvara Private Islands, Vatuvara Foundation, WCS

**PARTNER ORGANISATIONS:** Vatuvara Foundation, Marine Ecology Consulting

### OUTPUTS:

- *Report:* Miller K, Nand Y, Mangubhai S, Lee S, Naisilisili W, Sykes H (in press) Marine Biological Surveys of the Northern Lau Group. Report No. 01/18. Vatuvara Foundation and Wildlife Conservation Society, Suva, Fiji. 46pp.

### RESEARCH HIGHLIGHTS AND RECOMMENDATIONS:



*Turbinaria coral formation in a community tabu area. ©Sangeeta Mangubhai/WCS*

The Lau Group comprises of 60 islands and islets scattered over 114,000 km<sup>2</sup> of the relatively pristine ocean. In 2016, Tropical Cyclone Winston caused widespread damage across Fiji affecting 540,400 people and the livelihoods of 62% of the population.

In May 2017, WCS partnered with the Vatuvara Foundation to undertake baseline surveys on the health, abundance and diversity of corals, reef fish and invertebrate species to establish a baseline for long-term monitoring, document the damage caused by Cyclone Winston to community fishing grounds and provide recommendations on better management of fisheries resources to support food security and sustain livelihoods.

Coral reefs were surveyed around the five islands of Kaibu, Yacata, Vatuvara, Kanacea and Adavaci in the northern Lau group. A total of 33 sites of varying habitats were surveyed, including lagoon patch reefs, channels, and leeward and windward island fringing reefs. Profiles of each site were made to describe the reef type, current(s), exposure, reef structure and relief, habitat complexity and general observations. Results showed that hard corals and consolidated reef matrix dominated all islands except Adavaci, which had high cover of sand, silt and rubble.

A total of 47 coral genera were found across the sites, including massive and submassive corals of *Porites*, *Platygyra*, *Favites* and *Acanthastrea*; and branching, plates, tabular and encrusting coral forms of *Pocillopora*, *Stylophora*, *Turbinaria*, and *Acropora*. The effect of Cyclone Winston was apparent on more than half the reefs sites surveyed. Reef systems in northern Lau appeared to show a high degree of resilience to natural disturbances, likely a result of their exposure to extreme wave action and weather conditions. Thus, continuing to build for future cyclones and other disturbances.

Overall, fish populations showed high diversity with the families Labridae, Pomacentridae, Acanthuridae, Chaetodontidae, Scaridae and others. Mean fish biomass across all sites was remarkably high (1143.5 kg ha<sup>-1</sup>), with Vatuvara island supporting the highest abundance (2203.2 kg ha<sup>-1</sup>).

All islands had very low abundances of invertebrates such as sea cucumbers and giant clams. A number of recommendations were made from the study: (i) minimize human-stresses to coral reefs, especially areas that were heavily impacted; (ii) protect reef areas that had minimal damage or were undamaged, which may play a critical role in the recovery of adjacent impacted reefs; (iii) identify areas that are diverse, unique and provide refuge for threatened species and can be easily enforceable and establish marine protected areas; (iv) Assist in developing alternative livelihood programs for communities that support sustainable futures in order to relieve pressures from marine resources; and (vi) extend monitoring programs to measure the recovery of coral reefs over the next 2–5 years, and ensure they are linked to management actions.

#### **NEXT STEPS:**

Support the Vatuvara Foundation set up their long-term monitoring sites.

#### **LINKS TO NATIONAL PRIORITIES:**

**NBSAP Implementation Plan Thematic Area 3 (Inshore Fisheries), Action 3.2b:** Monitor core set of existing MPAs for biodiversity and fisheries resources compared with unmanaged sites; **Action 8.2a:** Perform stock assessment of inshore marine resources. **Fiji Climate Change Policy Objective 5 (Adaptation), Strategy 5:** Support the ecosystem-based approach throughout Fiji, recognising that ecosystem services, such as food security, natural hazard mitigation and physical coastal buffer zones, increase resilience; and **Green Growth Framework Thematic Area 3 (Sustainable Island and Ocean Resources):** (i) develop a natural resource management system which is inclusive and integrated, and continue capacity building and awareness programmes with all communities, emphasizing supporting resource owners on the importance of proper environmental stewardship, (ii) government to continue to work with community and civil society on initiatives such as the establishment of marine protected areas and community based fish wardens.



*Examples of healthy coral reefs in northern Lau group. @Sangeeta Mangubhai/WCS*

## Assessment of coral reefs around Koro Island, post-cyclone Winston

**STATUS:** In progress

**FUNDING:** John D. and Catherine T. MacArthur Foundation (Grant #16-1608-151132-CSD)

### RESEARCH HIGHLIGHTS:



*Land-sea ecosystems on Koro Island.*  
©Sanaeeta Manubhaa/WCS

Koro Island is a volcanic island located 75 nautical miles north of Suva in the Lomaiviti Archipelago and is the sixth largest island in Fiji with a land area of 105.3 km<sup>2</sup>. Koro Island has 14 traditional fishing grounds, one for each village covering an area of 75.1 km<sup>2</sup>, including 6 *tabu* (*temporary no-take*) areas. A diverse system of corals and marine organisms support the reef habitats around Koro Island including reef flats, forereef, fringing reefs, and deep and shallow terraces and lagoonal reefs, mangroves and seagrass meadows.

On 20 February 2016, one of the largest cyclones on record in the Southern Hemisphere passed through Fiji, with winds up to 185 mph, and gusts of 225 mph. Category 5 Cyclone Winston left a trail of destruction, with some of the most impacted landscape and communities located in the Vatu-i-Ra Seascape. Prior to Cyclone Winston, there were 19 *tabu* areas, 13 of which were harvested to support community needs. A detailed assessment of community fishing grounds (*qoliqoli*) around Koro Island in the

Lomaiviti Province was conducted from 6–12 September 2017. The objectives of these surveys were to: (a) assess impact and recovery of coral reefs within community fishing grounds 18 months after Cyclone Winston; and (b) provide recommendations to communities on the management of their traditional fishing grounds to maximize post-cyclone recovery, and support ridge-to-reef planning for Koro Island. Data were collected on the benthic cover, habitat structure, coral genera, and fish size and abundance. Surveys were done both inside and outside *tabu* areas within community fishing grounds.

The surveys documented high variability in coral, algae and substrate cover around Koro Island. The hard coral cover was significantly different between leeward (sheltered) and exposure sides of the island. There was also a significant difference in intact reef and unconsolidated substrate

(rubble, sand) between sites that were managed and open to fishing. We also found a significant difference in fish biomass between managed and open reefs. When compared to the pre-cyclone data in Tuatua and Nakodo, our results showed a significant difference in hard coral cover and fish biomass ( $\text{kg ha}^{-1}$ ) between different survey years for both fishing grounds. Given the findings of this assessment, a number of general recommendations are made.

- i. Actions should be taken to minimize human-stresses to coral reefs, especially areas that are heavily impacted. This includes the control of gravel extraction and the clearing of forests and other vegetation on steep slopes.
- ii. Maintaining the network *tabu* areas around the island for another 5 years to support reef recovery.
- iii. Monitoring programs are extended to measure the recovery of coral reefs over the next 2-5 years and ensure they are linked to management actions.

#### **NEXT STEPS:**

- A full report of the survey will be available in 2018.
- All results from the surveys will inform the development of an island-scale ecosystem-based management (EBM) plan for Koro Island.

#### **LINKS TO NATIONAL PRIORITIES:**

**NBSAP Implementation Plan Thematic Area 3 (Inshore Fisheries), Action 3.2b:** Monitor core set of existing MPAs for biodiversity and fisheries resources compared with unmanaged sites; **Action 8.2a:** Perform stock assessment of inshore marine resources. **Fiji Climate Change Policy Objective 5 (Adaptation), Strategy 5:** Support the ecosystem-based approach throughout Fiji, recognising that ecosystem services, such as food security, natural hazard mitigation and physical coastal buffer zones, increase resilience; and **Green Growth Framework Thematic Area 3 (Sustainable Island and Ocean Resources):** (i) develop a natural resource management system which is inclusive and integrated, and continue capacity building and awareness programmes with all communities, emphasizing supporting resource owners on the importance of proper environmental stewardship, (ii) government to continue to work with community and civil society on initiatives such as the establishment of marine protected areas and community based fish wardens.



*Laying transects, counting fish and assessing coral reefs around Koro Island © Alyssa Thomas/WCS*



## *National Study of Marine Conservation Agreements in Fiji*

**STATUS:** In progress

**FUNDING:** John D. and Catherine T. MacArthur Foundation (Grant #16-1608-151132-CSD)

**OUTPUT:**

- *SPC Bulletin:* Mangubhai S, Billé R (2017) Marine conservation agreements as innovative financial mechanisms for biodiversity conservation and sustainable fisheries in the Pacific: The Vatu-i-Ra Conservation Park in Fiji. *SPC Fisheries Bulletin* 151: 12–14

**RESEARCH HIGHLIGHTS:**

Marine Conservation Agreements (MCAs) are *“any formal or informal understanding in which one or more parties commit to delivering explicit economic incentives in exchange for one or more other parties committing to take certain actions, refrain from certain actions, or transfer certain rights and responsibilities to achieve agreed-upon ocean or coastal conservation goals”* ([www.mcatools.org](http://www.mcatools.org)). MCAs can be entered into by governments, local communities, indigenous groups, private sector and NGOs, and there are increasing examples globally of MCAs making positive impacts, ecologically and socioeconomically. Because of the strong tenure system in Fiji, there are likely to be many examples in country of partnerships between the private sector and local communities, particularly relating to the tourism industry which contributes to positive environmental outcomes.

However, there is limited public information on (i) to what extent MCAs are being used in Fiji, (ii) what are the best practices being applied, (iii) how effective they are, and (iv) if MCAs are achieving ecological and socioeconomic outcomes. There is also no documentation of best practices that can be shared with existing or new tourism operators in Fiji, or with local communities engaging or negotiating private sector partnerships.

WCS conducted a national study in 2017 to document the degree and scale to which MCAs contribute to biodiversity conservation, fisheries and sustainable financing in coastal waters in Fiji. The study focused on MCAs involving local communities with land-sea tenure rights and the tourism sector.

Key outcomes of this study focused on:

- i. Key characteristics and scope of MCAs, and their potential role in achieving conservation outcomes;
- ii. Identifying the enabling conditions for MCAs in Fiji that result in both positive ecological and socioeconomic outcomes and understanding the conditions under which MCAs do not work, or are likely to fail;
- iii. Identifying the laws, policies or mechanisms under which MCAs are established;
- iv. Identify organizations and agencies responsible for and capable of implementing project-specific MCAs;

- v. Identify the costs, incentives and sustainable financing for MCAs;
- vi. Identify key lessons learned and best practices for MCAs in Fiji that result in biodiversity conservation and/or fisheries management, with benefits both for tourism and for local resource owners;
- vii. Produce a series of studies, showcasing the range of MCAs that operate in Fiji; and
- viii. Obtain coordinates and produce a map (or series of maps) of MCAs that can be added to Fiji's national database.

**NEXT STEPS:**

A report will be released in 2018, along with guidelines to assist tourism operators and local communities apply best practice for establishing and implementing MCAs in the long-term.

**LINKS TO NATIONAL PRIORITIES:**

**Implementation Plan Thematic Area 6 (Protected Areas), Strategy 2:** Expand protected area network in priority sites at the national level and provincial level to achieve national targets, **Objective 2.2:** By 2014, develop management structures and implement paths to gazettal at highest priority sites, **Actions 2.2b-c;** and **NBSAP Implementation Plan Thematic Area 3 (Inshore Fisheries), Strategy 4:** Design new ecologically relevant inshore MPAs, **Objective 4.6:** By mid-2014, 25% of the communities will have established new management structures for new MPAs, **Action 4.6a:** Consult with communities at priority regions outside of existing MMAs to establish new MPA management structures. **Green Growth Framework Thematic Area 3 (Sustainable Island and Ocean Resources):** (i) develop a natural resource management system which is inclusive and integrated, and continue capacity building and awareness programmes with all communities, emphasizing supporting resource owners on the importance of proper environmental stewardship, (ii) government to continue to work with community and civil society on initiatives such as the establishment of marine protected areas and community based fish wardens.



*Vatu-i-Ra Conservation Park in Ra Province. ©Stacy Jupiter/WCS*

## *Biocultural indicators of Pacific Island resilience*

**STATUS:** Ongoing

**FUNDING:** Science for Nature and People Partnership (SNAPP), National Science Foundation Coastal SEES grants (1325874 and 1427091)

**PARTNER ORGANISATIONS:** American Museum of Natural History, University of Hawaii, The Nature Conservancy

### **OUTPUTS:**

- *Journal article:* Sterling EJ, Filardi C, Newell J, Albert S, Alvira D, Bergamini N, Betley E, Blair M, Boseto D, Burrows K, Bynum N, Caillon S, Caselle JE, Claudet J, Cullman G, Dacks R, Eyzaguirre PB, Gazit N, Gray S, Herrera J, Kenilorea P, Kinney K, Kurashima N, Macey S, Mauli S, McCarter J, McMillen H, Pascua P, Pikacha P, Porzecanski AL, de Robert P, Salpeteur M, Sigouin A, Sirikolo M, Stege M, Stege K, Ticktin T, Toomey A, Vave R, Wali A, West P, Winter KB, Jupiter SD (2017) Biocultural approaches to well-being and sustainability indicators across scales. *Nature: Ecology & Evolution* 1: 1798–1806
- *Journal article:* Sterling E, Ticktin T, Morgan K, Cullman G, Alvira D, Andrade P, Bergamini N, Betley E, Burrows K, Caillon S, Claudet J, Dacks R, Eyzaguirre P, Filardi C, Gazit N, Giardina C, Jupiter S, Kinney K, McCarter J, Mejia M, Morishige K, Newell J, Noori L, Parks J, Pascua P, Ravvikumar A, Tanguay J, Sigouin A, Stege T, Stege M, Wali A (2017) Culturally grounded indicators of resilience in social-ecological systems. *Environment & Society: Advances in Research* 8:63-95
- *Conference presentation:* Jupiter S, Dacks R, Sterling E, Ticktin T, Mejia M (2017) Developing biocultural indicators to assess capacity to recover from disasters and adapt to climate change. Symposium on Building resilience using traditional knowledge, culture and arts. Joint Pacific Platform for Disaster Risk Management and Pacific Climate Change Roundtable. Suva, Fiji, Oct 5.

### **RESEARCH HIGHLIGHTS:**



*Participants of SNAPP working group on Biocultural Indicators at meeting in Santa Barbara in February 2017. @Stacy Jupiter/WCS*

Pacific Island communities face unprecedented challenges in conserving natural resources and maintaining human well-being. Gaining a better understanding of the factors driving community resilience and the supportive management practices and policies is urgent. Biocultural feedbacks are widely believed to play a critical role in fostering resilience of both human and ecological communities, but they are poorly understood. Understanding biocultural linkages and feedbacks requires overcoming two challenges: (1) development of consistent methodologies to identify and measure them; and (2) development of appropriate models to explore their benefits are affected by social and

environmental pressures.

Through synthesis of the literature and comparative data analyses from on-going projects across a wide range of Pacific Island communities, WCS and our collaborators are working together to identify: (i) what makes a good biocultural indicator and how can it be measured?; (ii) how can we translate local to global indicators and which have relevance across Pacific Island sites?; and (iii) what is the relationship between pressures, 'biocultural state', benefits and management responses in Pacific Island communities? Our aim is to provide guidance on how to better articulate the complex connections between people and nature through a series of outputs, which include: (1) compiled case studies of biocultural approaches to inspire and empower local communities for a UN toolkit; (2) guidelines for national agencies on reporting biocultural indicators to international conventions; and (3) guidance for inclusion of biocultural indicators into multilateral conventions (e.g., CBD Strategic Plan, Sustainable Development Goals).

To date we have published two papers that: (1) provide an overview of what makes biocultural approaches unique and advocates for their use; and (2) discusses issues related to translating indicators across different scales. We have also identified a draft list of 8 overarching domains of resilience and 99 underlying sub-elements that characterize what it means to be resilient in the Pacific context. These domains include things like environmental state, access to natural and cultural resources, connectedness to people and place and access to financial resources and infrastructure. We are in the processes of consultation with researchers, managers, decision-makers and indigenous groups across the Pacific to ensure consensus across the domains and sub-elements and then we will proceed to do a cross-walk of these areas across international frameworks that support human well-being targets (e.g., Sustainable Development Goal indicators) in order to point out relevant gaps.

#### **NEXT STEPS:**

- Finalize consensus for domains of resilience that characterize Pacific Island communities and their associated sub-elements.
- Conduct gap assessment of how well domains of Pacific resilience are picked up in indicators found in multi-lateral conventions and provide guidance for alternative indicators to fill gaps.
- Assess pressures, 'biocultural state', benefits and management responses in Pacific Island communities in order to provide guidance on best practice management strategies to improve resilience.

#### **LINKS TO NATIONAL PRIORITIES:**

*Draft Climate Change Policy 2017* objective to mainstream climate change issues in all environmental, social, and economic processes including enactment and amending of current legislations. Indicators against targets for development under Fiji's *5-Year and 20-Year National Development Plan*, including access to clean and safe water in adequate quantities, food sourced domestically compared to total food available, incidence of poverty, establishment of marine protected areas and forest areas under long-term conservation.

## *Understanding the links between local ecological knowledge, ecosystem services, and resilience to climate change in Pacific Islands*

**STATUS:** In progress

**FUNDING:** U.S. National Science Foundation (Coastal SEES # 1325874)

**PARTNER ORGANISATIONS:** University of Hawaii, Natural Capital Project - Stanford University, USP

### **OUTPUTS:**

- *Conference presentation:* Jupiter S, Dacks R, Sterling E, Ticktin T, Mejia M (2017) Developing biocultural indicators to assess capacity to recover from disasters and adapt to climate change. Symposium on Building resilience using traditional knowledge, culture and arts. Joint Pacific Platform for Disaster Risk Management and Pacific Climate Change Roundtable. Suva, Fiji, Oct 5
- *Conference presentation:* Delevaux J.M.S., Jupiter S, Stamoulis K.A., Bremer L.L., Wenger A., Falinski KA, Dacks R, Ticktin T (2017) Managing for island resilience through scenario planning with linked land-sea models Island Arks Symposium 2017

### **RESEARCH HIGHLIGHTS:**

This collaborative project with University of Hawaii focuses on social-ecological systems and how to promote resilience through integrated land-sea planning. The project modeled and tested the relationships between local ecological knowledge (LEK) systems and indicators of social-ecological resilience to climate change on land and sea in coastal Fijian communities. This study identified key social drivers of biodiversity conservation and ecological resilience in agroforests and on coral reefs not previously reported, with important implications both for understanding social-ecological system functioning and for increasing resilience and sustainability in Pacific Island communities. For example, using structural equation modeling the study showed that LEK is the strongest driver of native plant richness and several indicators of ecological resilience in Fijian agroforests. They showed also that contrary to the literature, proximity to markets does not drive fishing pressure. On the contrary, households further from markets are fishing at higher levels than those closer to markets. This highlighted the important role of middlemen and the need to further investigate their involvement in understanding and fostering sustainability of small-scale fisheries.

The project also developed linked land-sea models at fine spatial resolution, through nutrient enriched groundwater and stream sedimentation, to revive the integration of traditional ridge-to-reef management practices into climate change management. These frameworks were applied to explore the effects of different land/ocean use (i.e., forest conservation, coastal development, and marine closures) and climate change scenarios on coral reef indicators of resilience in three Hawaiian watersheds and the Bua District in Fiji. This analysis revealed coral reef areas vulnerable to land-based activities under projected climate change impacts across the Kubulau seascape (see Fig. A-C for land-sea linkages and coral reef area impacted). Using

the linked land-sea frameworks to identify place-based conservation actions on land (see Fig. D for priority areas for forest conservation and restoration).

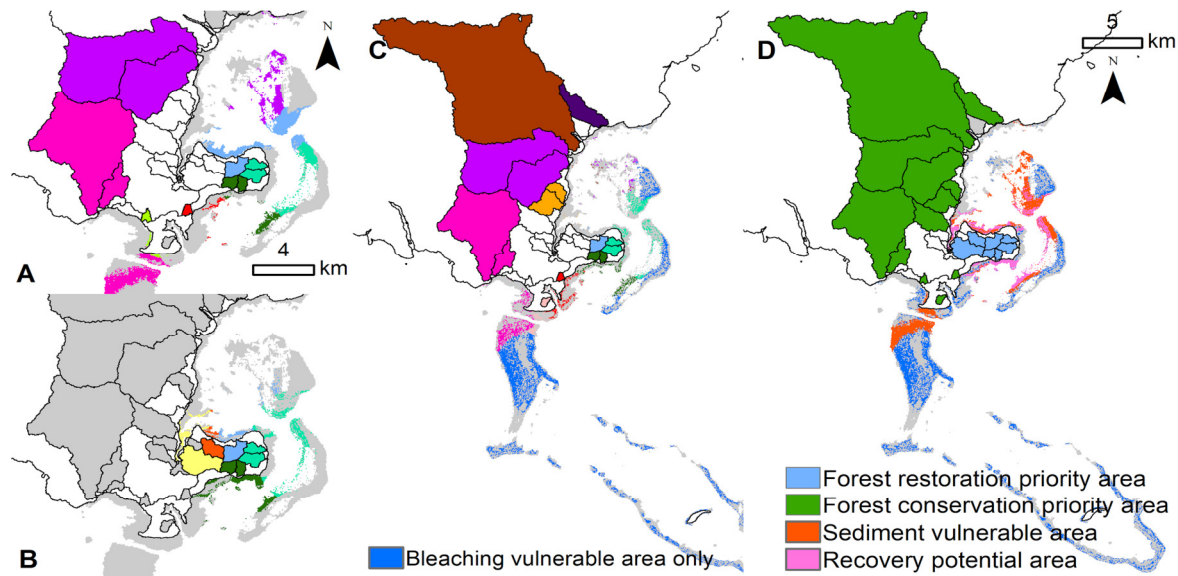


Figure. (A) Coral reef areas likely to be impacted by deforestation from specific watersheds. (B) Coral reef areas likely to recover by restoration in specific watersheds. (C) Coral reef areas susceptible to current sediment runoff under projected climate change scenarios. (D) Priority watershed for forest conservation and/or restoration. Land-sea links are color-coded in A, B, C, thus watersheds are colored to match the coral reef areas that they impact.

An interactive coloring book for school children about local ecological knowledge and its importance for communities was produced in partnership with WCS, and distributed in September 2016 to schools in the districts of Suva and Nakorotubu. Results of this research were also shared to government and NGO staff in Fiji, through oral presentations and discussions in multiple meetings.

#### LINKS TO NATIONAL PRIORITIES:

**National Climate Change Policy, Objective 5 (Adaptation) Strategy 2:** Include vulnerability assessment and climate change impact projections into resource management planning, such as integrated coastal and watershed management plans; **Strategy 4:** Develop adaptation technologies that take traditional knowledge into account and are culturally acceptable; and **Strategy 5:** Support the ecosystem-based approach throughout Fiji, recognising that ecosystem services, such as food security, natural hazard mitigation and physical coastal buffer zones, increase resilience. **NBSAP Implementation Plan Thematic Area 1 (Forest Conversion), Action 3.1b:** Integrate appropriate traditional knowledge and skills into training courses, **Action 3.2m:** Encourage and assist landowning and TFRO communities to document their traditional knowledge of biodiversity and its uses and develop their own local strategies. **NBSAP Implementation Plan Thematic Area 3 (Inshore Fisheries), Action 6.1a:** Collate marine traditional and local knowledge and make available upon request to traditional owners for management and educators to aid in curriculum development.

## MANAGEMENT

The following sections present a synthesis of completed and ongoing activities that have strengthened and supported community-based natural resource management in Fiji in 2017.

### *Spreading District-Scale Ecosystem-Based Management in Bua Province*

**STATUS:** Ongoing

**FUNDING:** John D. and Catherine T. MacArthur Foundation (Grant #16-1608-151132-CSD)

**PARTNER ORGANISATIONS:** Bua Provincial Council Office, *iTaukei* Affairs Board (iTAB), *iTaukei* Lands and Fisheries Commission (TLFC), c-Change, Bua Yaubula Management Support Team (BYMST), FLMMA

#### **HIGHLIGHTS:**

Six of the nine districts in Bua Province develop 5 year implementation plans for their district EBM plans, to help prioritise actions. Each resource management committee (RMC) identified their capacity needs for overseeing and implementing the plans. WCS worked with key government ministries to provide training and answer questions on the laws and regulations relating to the use and management of forests, mining (especially gravel extraction) and fisheries. The Bua Province Resource Center was established in Nabouwalu to provide information on the natural resources of the province, and conservation initiatives being implemented by different districts. WCS helped the Navakasiga RMC submit an \$80,000 proposal to the UN Development Programme Small Grants Programme to focus on building resilience to future cyclone events. The proposal includes documenting traditional knowledge of cyclone resistant crops, diversifying fruit, vegetables and produce for food and livelihoods and switching to organic farming.

#### **LINKS TO NATIONAL PRIORITIES:**

**Implementation Plan Thematic Area 6 (Protected Areas), Strategy 2:** Expand protected area network in priority sites at the national level and provincial level to achieve national targets, **Objective 2.2:** By 2014, develop management structures and implement paths to gazettal at highest priority sites, **Actions 2.2b-c;** and **NBSAP Implementation Plan Thematic Area 3 (Inshore Fisheries), Strategy 4:** Design new ecologically relevant inshore MPAs, **Objective 4.6:** By mid-2014, 25% of the communities will have established new management structures for new MPAs, **Action 4.6a:** Consult with communities at priority regions outside of existing MMAs to establish new MPA management structures. **Climate Change Policy Adaptation Strategy 5:** Support the ecosystem based management approach throughout Fiji, recognizing that ecosystem services, such as food security, natural hazard mitigation and physical coastal buffer zones, increase resilience. **Green Growth Framework Thematic Area 3 (Sustainable Island and Ocean Resources):** (i) develop a natural resource management system which is inclusive and integrated, and continue capacity building and awareness programmes with all communities, emphasizing supporting resource owners on the importance of proper environmental stewardship, (ii) government to continue to work with community and civil society on initiatives such as the establishment of marine protected areas and community based fish wardens.

## Provincial-scale engagement in Bua Province

**STATUS:** Ongoing

**FUNDING:** John D. and Catherine T. MacArthur Foundation (Grant #16-1608-151132-CSD), SNAPP, Australian Research Council (ARC) Linkage grant (LP150100934)

**PARTNER ORGANISATIONS:** Bua Provincial Council Office, Commissioner Northern Office, iTAB, Ministry of Fisheries, Ministry of Forestry, Ministry of Environment, Department of Agriculture, BYMST

### OUTPUTS:

- *Journal Article:* Tulloch VJ, Klein CJ, Jupiter SD, Tulloch AIT, Roelfsema C, Possingham HP (2017) Trade-offs between data resolution, accuracy, and cost when choosing information to plan reserves for coral reef ecosystems. *Journal of Environmental Management* 188:108-119
- *Journal Article:* Brown CJ, Jupiter SD, Simon A, Klein CJ, Mangubhai S, Maina JM, Mumby PJ, Olley J, Stewart-Koster B, Tulloch V, Wenger A (2017) Tracing the influence of land-use change on water quality and coral reefs using a Bayesian model. *Scientific Reports*. DOI:10.1038/s41598-017-05031-7
- *Journal Article:* Jupiter S, Epstein G, Ban NC, Mangubhai S, Fox M, Cox M (2017) A social-ecological approach to assessing conservation and fisheries outcomes from Fijian locally managed marine areas. *Society and Natural Resources*.
- *Journal Article:* Brown CJ, Jupiter S, Lin H-Y, Albert S, Klein C, Mbui M, Tulloch V, Wenger A, Mumby PJ (2017) Habitat change mediates the response of coral reef fish populations to terrestrial run-off. *Marine Ecology Progress Series* 576:55-68
- *Journal Article:* Lin H-Y, Jupiter S, Jenkins A, Brown C (2017) Impact of anthropogenic disturbances on a diverse riverine fish assemblage predicted by functional traits. *Freshwater Biology* 62:1422-1432
- *Journal Article:* Jupiter SD, Wenger A, Klein CJ, Albert S, Mangubhai S, Nelson J, Teneva L, Tulloch JV, White AT, Watson J.M (2017) Opportunities and constraints for implementing integrated land-sea management on islands. *Environmental Conservation*, 1-13. doi:10.1017/S0376892917000091



Participants of the third workshop for the Bua Province IICM Plan. © WCS



## HIGHLIGHTS AND NEXT STEPS:

With the completion of eight of the nine district EBM plans for Bua Province in 2016, WCS has been working with the Bua Provincial Office and partners in Bua Province to integrate and synthesize these into a single ICM plan for the province. The third ICM workshop was held in November 2017, in Nabouwalu with representatives from Bua Provincial Office, each of the 9 districts in Bua, and relevant ministries, to review and finalize the content for the Bua Province ICM Plan that was drafted with the assistance of WCS. Participants reviewed the priority catchments for protection, activities, timelines, roles and responsibilities for implementing management strategies for threats that need to be addressed at the provincial level, and finalized developments strategies for communication, enforcement compliance, financing and monitoring and evaluation of the ICM plan.

There was a continued commitment to protecting at least one intact catchment per district, to maintain key ecosystem service like clean water, and healthy river and coastal fisheries, and building resilience to future natural disasters (e.g. cyclones) and climate change. Networks of forest, freshwater and marine *tabu* areas are an important strategy in the ICM plan, as well as strategies to address threats. Participants also recognized the need for improved decisions around the cutting and use of forest areas, and learned about the recent conservation lease established for the Kilaka Forest Conservation Area (see page 41).

All content for the Bua Province ICM Plan has now been reviewed and updated, and the final version of the plan will be available in early 2018 for endorsement. A Bua ICM Task Force has been established with representatives from Bua Provincial Office (Roko Tui, Provincial Assistant), Ministries of Agriculture, Environment, Fisheries, Forests, Health, *iTaukei* Affairs, Water Authority of Fiji and National Disaster Management Office (NDMO) to oversee the implementation of the plan. A 5 year implementation plan has been drafted and will be shared with the Task Force for their finalisation. It will be critical for the Taskforce coordinates with the National ICM Committee and gets the endorsement and support of the Ministry of Environment.

## LINKS TO NATIONAL PRIORITIES:

**NBSAP Implementation Plan Thematic Area 4 (Coastal Development) Strategy 1:** Strengthen national guidelines for inter-sectoral coastal development, **Objective 1.3:** By 2014, a national coastal development plan to be developed to regulate/monitor coastal development activities; **Adaptation Strategy 5:** Support the ecosystem based management approach throughout Fiji, recognizing that ecosystem services, such as food security, natural hazard mitigation and physical coastal buffer zones, increase resilience. **Green Growth Framework Thematic Area 3 (Sustainable Island and Ocean Resources):** (i) develop a natural resource management system which is inclusive and integrated.

## *Island-scale ecosystem-based management planning for Koro Island, Lomaiviti Province*

**STATUS:** Ongoing

**FUNDING:** John D. and Catherine T. MacArthur Foundation (Grant #16-1608-151132-CSD)

**PARTNER ORGANISATIONS:** Lomaiviti Provincial Council Office, Lomaiviti YMST, Koro YMStT, Ministry of Forests, NatureFiji-Mareqeti Viti (NFMV), United States Geological Service (USGS)

### **HIGHLIGHTS and NEXT STEPS:**



The Banded Iguana *Brachylophus bulabula* near Tuatua village. © Ben Landis

More than a year after Cyclone Winston devastated Koro, WCS was invited back by the local communities to continue island-scale EBM management planning for the entire island. With the support of local communities WCS led marine surveys of Koro Island in September 2017, to assess the impact the cyclone had on coral reefs. At the same time, a team of terrestrial scientists from NFMV, USGS and Ministry of Forests did herpetofauna surveys of the islands forests. Both teams may have found species new to science! All results were presented back to the local communities a month later.

A workshop was held in November 2017 on Vatulele village with village leaders, clan leaders and other community representatives, the Village Yaubula Management Committees (VYMC), Roko Koro, NFMV and government representatives. Participants reviewed and reflected on the EBM planning process they had started in 2015, and forged an inspiring vision for the sustainable use and management of the island's valuable natural resources. Traditional knowledge on the islands natural resources and potential terrestrial protected areas were mapped out during group discussions. The communities went on to form the Koro Island YMST and revived each of the VYMCs. In addition, communities reviewed *tabu* areas and got the support of village elders to re-establish *tabu* areas within each village's LMMA. WCS worked closely with the Ministry of Forests on their "Reforestation of Degraded Forest Program" with the primary aim of replanting native tree species on Koro Island, to replace those lost during Cyclone Winston.

Over the next 4–5 months, WCS will be working with each of the communities on Koro Island and other interested stakeholders to: (i) draft the island EBM plan; (ii) complete village-per-village consultations on the content of the island EBM plan; and (iii) finalizing and endorse the

plan. Critical to this work is close coordinating with all government agencies supporting the rehabilitation process on Koro Island.

**NEXT STEPS:**

All results from the surveys will inform the development of an island-scale EBM plan for Koro Island.

**LINKS TO NATIONAL PRIORITIES:**

**NBSAP Implementation Plan Thematic Area 6 (Protected Areas), Strategy 2:** Expand protected area network in priority sites at the national level and provincial level to achieve national targets, **Objective 2.2:** By 2014, develop management structures and implement paths to gazettal at highest priority sites, **Actions 2.2b-c;** and **NBSAP Implementation Plan Thematic Area 3 (Inshore Fisheries), Strategy 4:** Design new ecologically relevant inshore MPAs, **Objective 4.6:** By mid-2014, 25% of the communities will have established new management structures for new MPAs, **Action 4.6a:** Consult with communities at priority regions outside of existing MMAs to establish new MPA management structures. **Climate Change Policy Adaptation Strategy 5:** Support the ecosystem based management approach throughout Fiji, recognizing that ecosystem services, such as food security, natural hazard mitigation and physical coastal buffer zones, increase resilience. **Green Growth Framework Thematic Area 3 (Sustainable Island and Ocean Resources):** (i) develop a natural resource management system which is inclusive and integrated, and continue capacity building and awareness programmes with all communities, emphasizing supporting resource owners on the importance of proper environmental stewardship, (ii) government to continue to work with community and civil society on initiatives such as the establishment of marine protected areas and community based fish wardens.



*A sticky trap recovered along the proposed Koro reserve. © Ben Landis*

## *Improving Effectiveness of Inshore Fisheries Management Systems in Fiji to Achieve Sustainable Ecological, Social and Economic Outcomes*

**STATUS:** Ongoing

**FUNDING:** David and Lucille Packard Foundation (#2015-41007), Flora Family Foundation (#2015-2694), John D. and Catherine T. MacArthur Foundation (Grant #16-1608-151132-CSD)

**PARTNER ORGANISATIONS:** Ministry of Fisheries, Fiji Environmental Law Association (FELA), Biospherics, WWF, FLMMA, WiFN-Fiji, James Cook University (JCU)

### **OUTPUTS:**

- *Journal Article:* Purcell WP, Beatrice IC, Lalavanua W, Eriksson H (2017) Distribution of economic returns in small-scale fisheries for international markets: A value chain analysis. *Marine Policy*. 86: 9-16.
- *Journal Article:* Goetze JS, Januchowski-Hartley FA, Claudet J, Langlois TJ, Wilson SK, Jupiter SD (2017) Fish wariness is a more sensitive indicator to changes in fishing pressure than abundance, length or biomass. *Ecological Applications*. DOI:10.1002/eap.1511
- *Report:* Mangubhai S, Lalavanua W, and Purcell SW (eds.) (2017). *Fiji's Sea Cucumber Fishery: Advances in Science for Improved Management*. Wildlife Conservation Society. Report No. 01/17. Suva, Fiji. 72 pp.
- *Report:* Mangubhai S, Fox M, Nand Y (2017) Value chain analysis of the wild caught mud crab fishery in Fiji. Wildlife Conservation Society. Report No. 03/17. Suva, Fiji. 100 pp.

### **HIGHLIGHTS AND NEXT STEPS:**

Our fisheries work focuses around three key objectives: (1) improving fisheries management systems; (2) developing effective legislative, policy, and management frameworks; and (3) strengthening governance of inshore fisheries. Despite the challenges communities continue to face in the aftermath of tropical Cyclone Winston, key highlights for 2017 are summarized below.

Sea cucumber fishery: In partnership with the Ministry of Fisheries, WCS co-hosted a national sea cucumber forum to launch two technical reports on the fishery (i.e. VCA and summary on new advances in science on Fiji's sea cucumber fishery), and discuss management actions for the fishery. The villages of Saolo and Natuvu have drafted management plans for their sea cucumber fishery, and fishers received post-harvest processing training in June, 2017. Both communities have decided not to open their fishery until stocks have improved, and to maximize the income they can earn. These decisions were made prior to the Ministry of Fisheries decision to close the fishery to enable stocks to recover nationally. Saolo and Natuvu villages will be finalising their sea cucumber fishery management plan in 2018.

Coral reef fish fisheries: WCS staff have been working with local fish sellers at Bailey Bridge in Suva and the Labasa market to collect additional size at maturity data on species that are not easily recognized by local communities (e.g. parrotfish, emperors) or are more vulnerable to

overfishing (e.g. groupers). Dr. Jeremy Prince conducted a data analysis workshop from July 25-27, 2017 with WCS, Ministry of Fisheries, and WWF to build local capacity to: (1) assess size at maturity; and (2) calculate SPR for fishing grounds. The workshop provided an opportunity to analyse what data had been collected to date and to identify gaps. Representatives from each of the organisations met with the Minister, Deputy Permanent Secretary, and Director for Ministry of Fisheries to brief on them on this work, and the proposed timeline for reviewing the size limits for Fiji.

A full analysis of the data is now scheduled for February/March 2018. The analysis will include maturity and catch per unit effort data collected by women mud crab fishers in Bua Province. Preliminary analysis of the data on mud crabs suggests the current size limit for mud crabs in Fiji may not be adequate to protect breeding populations of the species. This information will be critical for developing a national management plan for the fishery.

Fisheries Curriculum: Dr. Rebecca Weeks (JCU) worked closely with WCS Melanesia Director Dr. Stacy Jupiter to develop the fisheries training module. An outline of the curriculum was developed with inputs from local stakeholders (e.g. Ministry of Fisheries, iTAB, FLMMMA, WWF, USP) and includes modules on: (i) objectives and tools for community based fisheries management; (ii) managing the broader LMMA; (iii) community-based monitoring for adaptive management; (iv) size limits and spawning aggregations; (v) MPA and *tabu* area design; (vi) *tabu* area management; (vi) sustainable fish choices; and (vii) ecosystem-based management planning.

National Enforcement Forum: The Ministry of Fisheries hosted Fiji's first Enforcement Forum on Inshore Fisheries with support from WCS, FELA, and law firm Siwatibau and Sloan in August, 2017. It was a closed forum to enable representatives from key enforcement agencies (e.g. police, Customs Authority, navy, city councils, Maritime Safety Authority of Fiji) and members of the judiciary (e.g. Department of Public Prosecution) to have open discussions about the challenges and solutions to addressing enforcement issues in Fiji. The forum highlighted key areas that needed work: (1) monitoring and surveillance; (2) investigation; and (3) prosecution. All participants supported an annual enforcement forum to enable this type of open and frank dialogue.

#### **LINKS TO NATIONAL PRIORITIES:**

**NBSAP Implementation Plan Thematic Area 3 (Inshore Fisheries), Action 8.2a:** Perform stock assessments of inshore fisheries. **Green Growth Framework Thematic Area 3 (Sustainable Island and Ocean Resources):** (i) develop a natural resource management system which is inclusive and integrated, and continue capacity building and awareness programmes with all communities, emphasizing supporting resource owners on the importance of proper environmental stewardship.

## *Supporting women in fisheries as a strategy to strengthen and expand marine conservation in Fiji*

**STATUS:** Ongoing

**FUNDING:** Flora Family Foundation (#2015-2694), David and Lucille Packard Foundation (#2015-41007)

**PARTNER ORGANISATIONS:** Ministry of Fisheries, FLMMA, WIFN-Fiji

### **HIGHLIGHTS AND NEXT STEPS:**



*The Crab Company (Fiji) teaching fishers to build enclosures for fattening mud crabs.  
© Margaret Fox/WCS*

WCS continued to support mud crab fishers as part of its Women in Fisheries Programme. Mud crabs were selected because: (i) of growing concern about the number of undersize crabs being sold in markets; (ii) they are a high value commodity largely targeted by women in coastal areas; (iii) they provide an opportunity to highlight the importance of mangrove habitats for fisheries; and (iv) almost no work has been done on the mud crab fishery in Fiji. Despite the challenges women fishers continue to face in the aftermath of tropical Cyclone Winston, the project continued to move forward, and key highlights for 2017 are summarized below.

**Catch-per-unit-effort (CPUE) logbook:** A weekly CPUE logbook has been implemented for 12 months with women fishers from 10 villages across Bua Province. Given there are almost no studies of this kind globally, a manuscript will be prepared for submission to an international journal. The results will be presented at a national workshop in February 2018 to review the size limits for selected fish and invertebrate species (including mud crabs) in Fiji.

**Value-adding:** WCS and FLMMA partnered with The Crab Company (Fiji), which has a farm on Viti Levu and rears mud crabs for the domestic market. Over the last three months mud crab collectors have been trained on mud crab fattening techniques and fattening pens have been established in mangrove areas in four community fishing grounds in Bua and Ba Provinces. The pens are established in natural clearings that will not impact on the mangroves. To date, 22 mud crab collectors in Bua Province and 43 in Ba Province have now been trained on post-harvest handling methods, to meet national health and safety standards.

**Management plan:** A template for community-based fisheries management plans has been developed for piloting with mud crab fishers, and management planning has commenced in 2 districts: Bua (Waitabu and Tacilevu villages); and Tavua (Tavua and Votua villages). Most of

the women requested more time to develop their management plans, hold discussions with the men in their villages to get broader community support, and to implement the training they had received on crab fattening. In Waitabu and Tacilevu villages, the women are now working with a local middleman who is providing them a stable source of income, and they are receiving a higher price than if they sold in a local market, without the additional cost of transport.



National forum: Fiji’s first national Women in Fisheries Forum was held on March 8, 2017, on International Women’s Day, co-hosted by the WiFN-Fiji, WCS, FLMMA and the Ministry of Fisheries to raise the profile of women in Fiji’s subsistence and commercial fisheries, develop a deeper understanding of the diversity of projects and partners working on gender and fisheries in Fiji and improve networking between partners. The forum included an afternoon session with women fishers to learn about their fisheries, and the challenges they face.

TEDxSuva: Dr. Sangeeta Mangubhai participated in the TEDxSuva event on May 6, 2017. Her TEDx talk on ***Rethinking Fisheries Management to include Fisher Women*** was well-received by the audience and has had over 580 views online. Her talk emphasized that we can no longer ignore the importance of including both genders in fisheries management. <https://www.youtube.com/watch?v=ZOvuHkbu8DU>

Improving Gender Inclusion in Fisheries: The WiFN-Fiji, in partnership with the Ministry of Fisheries, WCS, FLMMA and other partners, made a voluntary commitment on “Promoting Gender Equality in Sustainable Fisheries Management and Development in Fiji” at the UNOC in New York, June 5–9, 2017. The objective of this voluntary commitment is to afford equal opportunity in training and other forms of capacity building for women in the fisheries sector, including mud crab fishers. This commitment also seeks to recognize the full contribution of women to the fisheries sector and better involve women in the decision-making on the protection, use and management of fisheries resources. This commitment sets a strong foundation for working towards better inclusion of gender in fisheries management and development. <https://oceanconference.un.org/commitments/?id=19964>

#### **LINKS TO NATIONAL PRIORITIES:**

**NBSAP Implementation Plan Thematic Area 3 (Inshore Fisheries), Action 3.2b**: Monitor core set of existing MPAs for biodiversity and fisheries resources compared with unmanaged sites; **Action 8.2a**: Perform stock assessment of inshore marine resources. **Green Growth Framework Thematic Area 3 (Sustainable Island and Ocean Resources)**: (i) develop a natural resource management system which is inclusive and integrated, and continue capacity building and awareness programmes with all communities, emphasizing supporting resource owners on the importance of proper environmental stewardship. **Thematic Area 4 (Inclusive Social Development)**: increase women’s capacity to participate in decision making and leadership at all levels to development (from village to national government) by 2018. **Fiji National Gender Policy**: 5.7 Gender Statistics and Research, 5.19 Leadership, Training and Development.

## *Sustainable financing for local community protected areas*

**STATUS:** Ongoing

**FUNDING:** John D. and Catherine T. MacArthur Foundation (Grant #16-1608-151132-CSD), RESCCUE Project funded by the French Development Agency (AFD) and the French Global Environment facility (FFEM) and implemented by SPC

**PARTNER ORGANISATIONS:** Ra Provincial Council, USP, Volivoli Resort, Wananavu Resort, Nai'a Cruises, SPC, FELA, BirdLife International, Ministry of Environment

### **OUTPUT:**

- *Management Plan:* Wildlife Conservation Society (2017) Vatu-i-Ra Conservation Park Management Plan. Wildlife Conservation Society, Suva, Fiji. 25 pp.
- *Report:* Nand Y, Loganimoce EM, Mangubhai S, Fox M, Uluiburotu L, Naisilisili W, Dulunaqio S, Lalavanua W, Gurney G, Teneva L (2017) Baseline ecological and socioeconomic surveys of the Vatu-i-Ra Conservation Park. Wildlife Conservation Society. Report No. 02/17. Suva, Fiji. 52 pp.

### **HIGHLIGHTS:**

A management plan was finalised for the Vatu-i-Ra Conservation Area Park, and encompasses an existing conservation area established by communities since 2011, within the Nakorotubu District and covers an area of 105.3 km<sup>2</sup>. The Park includes highly diverse coral reefs that are popular amongst international divers, and a regionally significant population of seabirds on Vatu-i-Ra Island that is free from rats and other invasive species. The Management Plan establishes the vision, strategies and framework for sustainably managing Vatu Island, the surrounding customary fishing grounds *i qoliqoli* Cokovata Nakorotubu, and adjacent deeper waters. The objectives of the Vatu-i-Ra Conservation Park are to:

- (i) protect the unique biodiversity of the island and the surrounding reefs;
- (ii) protect the unique cultural history of the area;
- (iii) protecting critical breeding grounds for fish so that the 'spillover' from this Conservation Park supports community fisheries in the adjacent *qoliqoli* Cokovata Nakorotubu area;
- (iv) to establish a voluntary mechanism through sustainable tourism, that will ensure the sustainable financing of the Conservation Park while supporting the sustainable development of resource owners; and
- (v) to establish the Vatu-i-Ra as the leading Conservation Park for the Fiji and the wider South Pacific.

A Trust Deed was developed in partnership with the FELA and has received the endorsement of the Ra Provincial Office, tourism operators and leaders and representatives from Nakorotubu District. The Trust will be overseen by one representative each from the local community, from WCS and from the tourism sector. The Trust Deed sets out the rules, roles and responsibilities



of the Board of Trustees and the Management Committee that will oversee the day-to-day management of the Park. The Trust Deed will be registered by FELA in early 2018.

To ensure the Conservation Park achieves its ecological and socioeconomic objectives, a monitoring and evaluation framework was developed by WCS, in consultation with experts from Conservation International and JCU.<sup>3</sup> A rigorous monitoring and evaluation framework is necessary to track the success of Conservation Park towards the specific biophysical and socioeconomic goals and objectives. Specifically, monitoring and evaluation enables the tourism industry (i.e., buyers) and local communities (i.e., sellers) to track interventions or activities, achievements and milestones towards goals, so that the Conservation Park can be adaptively managed to meet the goals in original agreement. A report was produced that summarises the results of the ecological and socioeconomic surveys in the Vatu-i-Ra Conservation Park. The report highlighted the importance of improving the engagement of women to better understand the Conservation Park and voluntary contribution to conservation scheme.

#### **NEXT STEPS:**

- Set up the education fund and issue the first scholarships to school children from Nakorotubu District.
- Establish the management committee for the Vatu-i-Ra Conservation Park, and develop a workplan for 2018, with budgets.
- Develop and implement a communication strategy for Conservation Park, to build support from visitors to the Park.

#### **LINKS TO NATIONAL PRIORITIES:**

By providing means to alternate revenue streams, this activity in principle supports **NBSAP Implementation Plan Thematic Area 3 (Inshore Fisheries), Strategy 9**: Reduce demand for marine natural resources and biodiversity products. However, monitoring will be required to evaluate whether revenue is additive or alternative. **Thematic Area 3 (Protected Areas), Strategy 3**: Develop sustainable finance mechanisms for new and existing protected areas. **Action 3.1d**: Ensure meaningful participation and provide equitable incentives and remuneration to resource owners for Protected Area establishment and management.

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<sup>3</sup> Teneva L, Mangubhai S (2016) Monitoring and Evaluation Framework for Marine Conservation Agreements in Fiji. Wildlife Conservation Society. Report No. 06/16. Suva, Fiji. 17 pp.

## *Offshore Marine Managed Areas: Campaigning for the Vatu-i-Ra Seascape*

**STATUS:** Ongoing

**FUNDING:** Waitt Foundation

**PARTNER ORGANISATIONS:** Ministry of Fisheries, Ministry of Environment, IUCN, WWF, Conservation International

**OUTPUT:**

- *Management Plan:* Ministry of Fisheries (*in press*) Management Plan for the Bligh Waters and Central Viti Marine Managed Areas 2017-2027. Wildlife Conservation Society, Suva, Fiji. 40 pp.
- *Policy Brief:* Protected Area Financing in Fiji. For Discussion. (draft) Policy Brief of the national Protected Areas Committee.

**HIGHLIGHTS:**

WCS worked with key government ministries, most notably the Ministry of Fisheries, the private sector (i.e., fishing, tourism, mining, and shipping) and provincial offices, to identify and establish deeper water MMAs in the Vatu-i-Ra Seascape. The two proposed multiple use MMAs supports the Government of Fiji's international commitment to protect 30 percent of its seas by 2020 and its voluntary commitment of expanding MMAs in Fiji, as part of Sustainable Development Goal 14, which aims to "conserve and sustainably use the oceans, seas, and marine resources for sustainable development." WCS has undertaken consultations on the two MMAs, Central Viti MMA and Bligh Waters MMA, including the numbers and types of zones within each MMA, and a management plan has been finalized. The proposed gazettal of the Central Viti and Bligh Waters MMA was announced by the Fiji Government at the UNOC in New York, 5-9 June, 2017. The finalization of the zones will be determined by the MPA Technical Committee, with support from the Marine Working Group of the PAC.

At the same time, in partnership with IUCN and the MACBIO Project and with the support of PAC, technical expert workshops were held to help identify "Special and Unique Marine Areas" in Fiji and bioregions. New information was collated from expeditions conducted by WCS, Vatuvara Foundation and Conservation International in May 2017 to document the state of coral reefs in the Lau Province. Maps have been produced from this work, which will be used for country-scale marine spatial planning to identify marine areas of national priority. This work makes significant progress towards Fiji meeting its obligations under the Convention on Biological Diversity, especially Aichi Target 11 on the establishment of representative networks of MPAs.

A policy brief on sustainable financing options for marine and terrestrial protected areas in Fiji was drafted and discussed at the PAC meeting in 2017. The brief provides a summary of the financing options recommended in a report, commissioned by WCS and conducted by Nimmo Bell & Company Ltd., looking at sustainable financing options for marine and terrestrial protected areas in Fiji. The brief focuses on the establishment, capitalization and

operationalization of a National Protected Area Trust Fund for formally recognized protected areas. The brief will be used to sell the financing options to key stakeholders including government.

**LINKS TO NATIONAL PRIORITIES:**

**NBSAP Implementation Plan Thematic Area 6 (Protected Areas), Strategy 1:** Identify gaps in biodiversity protection against national targets. **Strategy 2:** Expand protected area network in priority sites at the national level and provincial level to achieve national targets. **Green Growth Framework Thematic Area 3 (Sustainable Island and Ocean Resources):** (i) develop a natural resource management system which is inclusive and integrated, and continue capacity building; (ii) establish deepwater MPAs targeting 30% of offshore areas by 2020.



*Fiji government delegation at the UN Ocean Conference celebrating Fiji's achievements at a Fiji event (left). Dr. Sangeeta Mangubhai with the Honourable Prime Minister for Fiji (right).*



*Consultations with local fishermen from Levuka and Moturiki in the Vatu-i-Ra Seascape © WCS*

## Kilaka Forest Conservation Area

**STATUS:** Ongoing

**FUNDING:** Harvey and Heidi Bookman, John D. and Catherine T. MacArthur Foundation (13-104090-000-INP)

**PARTNER ORGANISATIONS:** Nadicake *mataqali*, iTaukei Land Trust Board (TLTB), Ministry of Forests, Ministry of Environment, Kubulau RMC

### HIGHLIGHTS:



*Formal ceremony in Suva to handover the conservation lease agreement to WCS. © Kelera*

WCS has worked with the communities of Kubulau District, Bua Province, for over 10 years and has developed a strong working relationship with the Nadicake *mataqali* (clan) from Kilaka village that holds land tenure over the Kilaka forest. The Kilaka Forest Conservation Areas (KFCA) is also thought to be home to a wide variety of other bird species, as well as endemic freshwater fish species whose threat status is not yet determined. The KFCA is also home to essential populations of many of Fiji's threatened bat and frog species. Finally, Kilaka's heavily forested watersheds also protect adjacent thriving coral reefs from the

major threat of land-based silt runoff.

In 2006, the clan made a commitment to protect the forest on the land parcel over which they hold tenure for at least 10 years. Although not legally binding, this commitment included a promise not to lease the land for logging. In 2009 the management of this community-managed forest park was incorporated into the Kubulau District EBM plan. Although the forest area is a national priority for conservation, there is considerable and growing pressure to log the forest. Given the level of commitment the community has shown to date to protect Kilaka Forest, WCS worked closely the Nadicake clan from 2015 to 2017, to secure a 99 year conservation lease for the forest through the TLTB. The TLTB was set up in 1940 to secure, protect and manage land ownership rights assigned to the *iTaukei* (indigenous Fijian) landowners and to facilitate the commercial transactions that revolve around the use of the land. This is currently the only feasible mechanism to establish forest protected areas in Fiji.

The conservation lease for KFCA is the second of its kind for Fiji, and has resulted in the protection of this nationally significant forest for 99 years (2017–2116). The lease was signed on June 22, 2017 and was formally handed over to WCS in a ceremony at TLTB office on August 1, 2017. Present at the ceremony were the head of the clan and two other members, and the General Manager for TLTB and all his senior staff. Fiji Country Director expressed her gratitude

to the members of the Nadicake clan, stating “*this is a historic occasion today as we recognise the incredible commitment mataqali (clan) Nadicake has made to themselves and their children, and the gift they have given Fiji as a nation. The protection of these forests will ensure communities have continued access to clean water, protect important catchments in Kubulau District, while contributing to their own development needs and aspirations.*”

Fiji’s National PAC has also given its full endorsement and support, and recognises KFCFA contributes to Fiji’s international commitment to Aichi Target 11 under the Convention on Biological Diversity, to protect 17 percent of its terrestrial areas by 2020. KFCFA is a gift to the nation of Fiji.

**LINKS TO NATIONAL PRIORITIES:**

**NBSAP Implementation Plan Thematic Area 6 (Protected Areas), Strategy 1:** Identify gaps in biodiversity protection against national targets. **Strategy 2:** Expand protected area network in priority sites at the national level and provincial level to achieve national targets. **Green Growth Framework Thematic Area 6 (Freshwater Resources and Sanitation Management):** Adoption of watershed management plans using integrated water resources management principles for major rivers, waterways and drainage systems.



*Landowners from Nadicake clan in Kilaka Forest (top). One of many clear freshwater streams flow through Kilaka Forest supporting fish and invertebrate life (bottom, left). Looking up into the canopy of Kilaka Forest (bottom right)*  
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## COMMUNICATIONS: CAMPAIGNING FOR THE VATU-I-RA SEASCAPE

**STATUS:** Ongoing

**FUNDING:** Waitt Foundation, WCS

### **HIGHLIGHTS:**

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

*In the media:* The public and the media were actively involved and aware of the campaign this year, with a 20% increase in articles and quotes in the local and international media, compared to last year. Over the last 12 months, WCS has featured in over 60 articles on the environment. With 2, 062 followers on Twitter and 3, 666 people following our Vatu-i-Ra Facebook page, our social media presence engaged the public through live updates from the field, conferences, and on current publications, which has helped raise the profile of the work we do in the Vatu-i-Ra Seascape.

*Public campaigns:* In September 2017, WCS partnered the Uto Ni Yalo, a Fijian canoe or *vaka* that “sails to advance sustainable sea transportation by rejuvenating traditional boat building, navigation and voyaging”. The Uto ni Yalo sailed through the Vatu-i-Ra Seascape for seven days, raising awareness, engaging with coastal communities and celebrating achievements towards sustainable fisheries. At each village, discussions were held on the unique biodiversity and important fisheries in the Vatu-i-Ra Seascape, the role of MMAs in maintaining connectivity between inshore reefs and offshore areas, and the benefits of managing oceans holistically.

*New blog site:* In November 2017, WCS launched its new blog focussing on the work we do in Fiji. The site will feature live blogs and personal accounts from the field, including stories from communities that live in the Vatu-i-Ra Seascape. <http://wcsfiji.org.fj/>

### **LINKS TO NATIONAL PRIORITIES:**

This work supports **NBSAP Implementation Plan Thematic Area 5 (Species Conservation), Strategy 5:** Improved communication amongst stakeholders (including communities) on threatened and endangered species; **Strategy 4:** Share best practices and lessons learned to improve management effectiveness and governance.

## ENGAGING WITH NATIONAL AND REGIONAL POLICY AND PLANNING

The following sections present a synthesis of ways that WCS Fiji has participated in development of national and regional conservation and resource management policies and planning in 2017.

### *Protected Area Committee*

WCS participated in three meetings of the national PAC under the Ministry of Environment, established under the Environmental Management Act (2005). WCS-Fiji Director, Dr. Sangeeta Mangubhai continued to chair the Marine Working Group for PAC. Discussions in 2017 focused largely around the Fiji Government commitment to protect 30% of its seas by 2020, and the participation of Fiji in the UNOC in New York, 4–9 June, 2017.

### *Marine Protected Areas Advisory Committee*

WCS participated and provided secretarial support to the national MPA Technical Advisory Committee chaired by the Ministry of Fisheries, established under the Offshore Fisheries Management Decree (2012). A workplan was developed for 2018 to help focus and guide the Committee.

### *CITES Management Authority*

WCS became a member of the Fiji CITES Management Authority in 2017 managed by the Ministry of Environment. Part 4 of the Act established the Authority and Part 6 outlines the functions. This body regulates CITES and Endangered and Protected Species Act-listed species through a licensing and quota system. The Authority is required to meet four times per year to discuss issues pertaining to the training of CITES and EPS-listed species.

### *BIOFIN Initiative Technical Advisory Committee*

WCS is a member of the Biodiversity Finance Initiative Technical Working Committee, under the Department of Environment. BIOFIN is a global project launched in October 2012 as a partnership seeking to address the biodiversity finance challenge in a comprehensive manner, to define finance needs and gaps with greater precision through detailed national assessments, to determine challenges and opportunities for resource mobilization and build a sound case for increased biodiversity investment. BIOFIN will support the government of Fiji review its policies and institutions relevant for biodiversity finance, determining baseline investment and assess the cost of implement NBSAP, and quantifying the biodiversity finance gap.

### *Particularly Sensitive Sea Areas Task Force*

WCS was invited to be a member of the national Particularly Sensitive Sea Areas (PSSA) Task Force, coordinated by the Maritime Safety Authority of Fiji (MSAF). A PSSA is an “area that requires special protection through action by the International Maritime Organization (IMO) because of its significance for recognized ecological, socio-economic or scientific reasons and which is vulnerable to damage by international maritime activities”. As Fiji is a member state of the IMO, the body that declares PSSAs, the national PSSA Task Force has had a number of

meetings and workshops in 2017 pertaining to Fiji's submission to declare the Beqa Channel as a PSSA. Additionally, WCS sits on the Ecological, Socio-economic and Scientific Sub-committee of the task force, providing data and technical advice on the submission of the Beqa Channel PSSA to the Marine Environment Protection Committee under the IMO for approval.

### ***United Nations Ocean Conference, New York***

Many of the members helped develop the voluntary commitments made by the Fiji Government and partners on marine managed areas, integrated coastal management, coastal fisheries, gender and fisheries, cetaceans, turtles, groupers and sharks. The 10 Voluntary Commitments signed by WCS are listed below:

- 1) #OceanAction19929: Delivering Improved Coastal Fisheries Management Services in Fiji
- 2) #OceanAction19964: Promoting Gender Equality in Sustainable Fisheries Management and Development in Fiji
- 3) #OceanAction14327: Protection of Groupers and Coral Trouts Spawning Aggregation Sites across Fijian Reef Systems
- 4) #OceanAction19984: Integrated Coastal Management to Preserve Ecosystems Services, Improve Climate Resilience and Sustain Livelihoods in Fiji
- 5) #OceanAction19904: Expansion of Large Scale Marine Managed Areas in Fiji
- 6) #OceanAction19959: Protection and Management of All Marine Mammal Species in Fiji
- 7) #OceanAction19909: The Conservation and Management of Sea Turtles within Fijian Waters
- 8) #OceanAction16006: Protecting, conserving, and restoring whale populations in the Pacific Islands
- 9) #OceanAction19999: Conservation and Management of all Species of Sharks and Rays and their Critical Habitats within Fijian Waters
- 10) #OceanAction21668: Gift to Our Children! Scaling up locally managed marine areas to 100% of Fiji's customary marine areas.



## 2017 PUBLICATIONS

### *Journal Articles*

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- Barnes M, Fox HE, Ahmadi GN, Kao G, Haisfield K, Glew L, Hidayat NI, Huffard C, Katz L, Mangubhai S, Purwanto. (2017) Generating actionable data for evidence-based conservation in the global center of marine biodiversity. *Biological Conservation*. 210:299–309.
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- Brown CJ, Jupiter SD, Simon A, Klein CJ, Mangubhai S, Maina JM, Mumby PJ, Olley J, Stewart-Koster B, Tulloch V, Wenger A (2017) Tracing the influence of land-use change on water quality and coral reefs using a Bayesian model. *Scientific Reports*. 7:4740. DOI:4710.1038/s41598-41017-05031-41597
- Ford AK, Eich A, McAndrews R, Mangubhai S, Nugues MM, Bejarano S, Wild C, Moore BR, Rico C, Ferse SCA (2017) Evaluation of coral reef management effectiveness using conventional versus newly developed monitoring metrics. *Ecological Indicators*. 85: 308–317.
- Goetze J, Claudet J, Januchowski-Hartley F, Langlois T, Wilson S, White C, Weeks R, Jupiter S (accepted) Demonstrating multiple benefits from periodically harvested fisheries closures. *Journal of Applied Ecology* Accepted October 9, 2017.
- Goetze JS, Januchowski-Hartley FA, Claudet J, Langlois TJ, Wilson SK, Jupiter SD (2017) Fish wariness is a more sensitive indicator to changes in fishing pressure than abundance, length or biomass. *Ecological Applications* 27:1178-1189. DOI:10.1002/eap.1511.
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- Jupiter SD (2017) Culture, kastom and conservation in Melanesia: what happens when worldviews collide? *Pacific Conservation Biology* 23:139-145.
- Jupiter SD, Epstein G, Ban NC, Mangubhai S, Fox M, Cox M (2017) A social-ecological approach to assessing conservation and fisheries outcomes from Fijian locally managed marine areas. *Society and Natural Resources* 30:1096-1111.
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- Purcell SW, Ngaluafé P, Lalavanua W, Ceccarelli DM (2017) Market price trends of Latin American and Caribbean sea cucumbers inform fisheries management. *Regional Studies in Marine Science* 17: 127-132.
- Purcell WP, Beatrice IC, Lalavanua W, Eriksson H (2017) Distribution of economic returns in small-scale fisheries for international markets: A value chain analysis. *Marine Policy* 86: 9-16.
- Sterling EJ, Filardi C, Newell J, Albert S, Alvira D, Bergamini N, Betley E, Blair M, Boseto D, Burrows K, Bynum N, Caillon S, Caselle JE, Claudet J, Cullman G, Dacks R, Eyzaguirre PB, Gazit N, Gray S, Herrera J, Kenilorea P, Kinney K, Kurashima N, Macey S, Mauli S, McCarter J, McMillen H, Pascua P, Pikacha P, Porzecanski AL, de Robert P, Salpeteur M, Sigouin A, Sirikolo M, Stege M, Stege K, Ticktin T, Toomey A, Vave R, Wali A, West P, Winter KB, Jupiter SD (2017) Biocultural approaches to well-being

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### **Book Chapters**

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[Lumelume R](#), [Mangubhai S](#), [Dulunagio S](#) (2017) Achieving forest conservation in Fiji through Payment for Ecosystem Services schemes: A case study from Kilaka Forest. Paper presented at the Island Arks Symposium V, 23-27<sup>th</sup> October 2017, Nadi, Fiji.

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