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Proceedings of the Inaugural Fiji Islands Conservation Science Forum 2009

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Mabualau Island – Posa Skelton
Fiji Crested Iguana (*Brachylophus vitiensis*) – Posa Skelton
Kula (*Phygys solitarius*) – Posa Skelton
Goby (*Sicopterus lagocephalus*) – Aaron Jenkins
Red-footed Booby (*Sula sula*) – Posa Skelton

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Acknowledgement

prepared by Aaron P. Jenkins

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A special 'thank you' is given to our chief guest and opening speaker Mr. Epeli Nasome, Director of Environment, for taking time out of his busy schedule and attending this important multi-sectoral event. A big *vinaka vaka levu* goes out to Mr. Robin Yarrow, keynote speaker, a champion advocate of biodiversity conservation in Fiji. A special 'thank you' is also extended to Professor Bob Pressey of the Australian Research Council Centre of Excellence for Coral Reef Studies, James Cook University in Townsville, Australia for agreeing to participate at this event although he could not attend due to medical reasons.

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[1] EBM – Ecosystem-based Management

Preface

prepared by Aaron P. Jenkins

The Fiji Islands are recognized as a hub for the Western Pacific region, lying strategically central to this huge expanse of ocean and reflecting the heterogeneous cultural and biological diversity of this unique part of the world. As a strategic intersection point for the region and home to one of (The University of the South Pacific) only two regional universities in the world, Fiji has attracted and established a plethora of conservation and development organizations. These organizations have, over many years, conducted research in a diverse range of fields related to conservation of natural systems within Fiji and through the region.

Fiji, like many Pacific island countries, possesses a unique natural heritage with very high levels of endemism across many taxa and a multitude of tropical ecosystem types ranging from tropical cloud forests to mangrove forests and vast coral reef systems. The economy of the nation and the well-being of its people rely heavily on ecologically functioning, naturally beautiful systems for tourism and for the local subsistence derived from these systems. The threats to these natural supporting systems are many and increasing with extractive pressures, population growth, habitat loss, invasive species introductions and climate change among primary drivers of species extinction and loss of ecosystem services. The responsible Government agencies, non-government organizations and other development agencies have been pursuing a range of research projects to address these threats and to further document the unique biodiversity and ecosystems of Fiji. As such, Fiji has emerged in the last decade or so as a world leader in tropical island conservation science.

Recognizing the contribution to national development and conservation science that these organizations or individuals have made throughout the years, the partners of the Fiji Ecosystem-Based Management (EBM) Project (Wildlife Conservation Society, World Wildlife Fund, Wetlands International – Oceania, Fiji Department of Fisheries and The University of the South Pacific) and Fiji Locally Managed Marine Area (FLMMA) Network) convened the historic Inaugural Fiji Islands Conservation Science Forum in Suva from August 5th to 7th, 2009. This forum was extremely well-received by the local conservation and development community and was the first country-wide event to consolidate and synthesize the science that is being done in-country to assist holistic and multi-disciplinary conservation and development decision-making. Following a stirring opening by the Fiji Director of Environment, Mr. Epeli Nasome, and a thought-provoking keynote address by Mr. Robin Yarrow, the three days of the forum saw 58 oral and several poster presentations made by leading conservation scientists and practitioners, with at least 115 people from eight countries in attendance. Vigorous discussion and debate surrounded the eight session themes of: Ecosystem-Based Management and Conservation Planning, Habitat Mapping, Species Conservation, Taxonomy, Community-Based Adaptive Management and Socio-Economics, Terrestrial Ecology, Marine Ecology and Marine Protected Areas.

For the first time, this vast array of science for conservation and development has been captured in this First Proceedings of the Fiji Islands Conservation Science Forum and should prove useful to scientists and decision-makers in the fields of conservation and development to gain a more holistic view of the high level of conservation science being undertaken in Fiji. It is our sincere intention that this forum will become a national annual or bi-annual event so that it continues to be a catalyst for innovative and multi-disciplinary research that meets the sustainable development needs of Fiji and its people.

Opening Speech

Mr. Epeli Nasome – Director, Department of Environment

Invited Guests, Organizers of the Fiji Islands Conservation Science Forum (Wetlands International Oceania (WI-O), Wildlife Conservation Society (WCS), Wildlife Fund for Nature (WWF), Ladies and Gentlemen

It was indeed a great pleasure for me to have been approached by Aaron to deliver some opening remarks at the beginning of this very important occasion, the inaugural Fiji Islands Conservation Science Forum. I was made to believe that this is the first forum of this type for Fiji, and that it had been a big challenge to have organized for it, and now having the full satisfaction when seeing its fruition as we witness here today. I thank the organizers for a vision that could be a milestone for conservation in Fiji and the Pacific. There have been many discussions, and planning, for gatherings such as this, as a way to bring together the many stakeholders in Fiji that focus on protecting and conserving Fiji's natural resources and in turn, attempting to ensure a safe and healthy environment for all the people of Fiji.

Today is a milestone reached — the inauguration of such a gathering — and we should all congratulate the organizers and all those who would be giving their time to participate here for the next three days.

It has been the notion that such forums would bring all conservation stakeholders together, bring them closer together, strengthen their working ties, understand better the various areas of responsibilities, share strengths and weaknesses, sort out areas of duplication, and find ways of preventing wastages of resources, etc. In some instances, there has been concerns raised about overlapping project areas and duplication of work which have resulted in resource owners becoming somewhat harassed with many visits by various organizations, and many times they are requested to provide the same information of their land over and over again, with little or even no benefits being yet realized. This has caused many instances of untimely disruptions to the work of organizations amongst the landowners and their resources, resulting in incomplete projects or low quality data being collected. It is always important to note at all times that the owners of resources being researched should have ownership also over the work being carried out. It is sincerely hopeful that the outcome of this forum would enhance holistic and multidisciplinary conservation and development decision-making processes.

The various Government departments have started to mainstream into their initial policies and legislation the conservation strategies for sustainable development. Wide consultations have been conducted when reviewing long-established policies and legislation. All these would set the platform for Government to facilitate the work of NGOs or individual conservationists working in Fiji and assist by overcoming the challenges being faced today, some of which I have highlighted earlier.

The Department of Environment was mandated in 1993 by the Fiji Government to be responsible for the protection and conservation for Fiji's natural environment. It has

formulated various policy documents to set the direction for Government and NGOs to work together towards the conservation of natural resources. Extensive and comprehensive studies have taken place back then for a baseline or inventory of all natural resources, however I must admit that these reports need to be reviewed for updating as required by the Environment Management Act 2005. So what a better time to discuss and do these sorts of work than at this forum. All I am saying here is, the situation we are in now (i.e. the need for conservation sciences) would be a demand on the outcomes of this forum. Apologies!!! Fiji has come a long way from the days when the Department of Environment alone within Government, together with a few individuals, took challenges together to promote conservation. Today, there are many Government departments and organizations that are attempting to work together on this conservation drive. The need is greater now for the many organizations to work together towards the consolidation and the synthesisation [*sic*] of the sciences, for 'holistic and multi-disciplinary conservation and development decision-making'. This need, I am sure, would be provided by the outcome of this forum. And again, I express the appreciation, and congratulations, from this Government department that was mandated to protect and conserve Fiji's natural environment, and on behalf of Government, to the organizers of the Fiji Islands Conservation Science Forum, for this initiative, and a work very well done!!

I wish the forum all the success!!

Thank you for your attention

I now declare the inaugural Fiji Islands Conservation Science Forum open!!

Keynote Address

Mr. Robin Yarrow – Vice-Chair, National Trust of Fiji

Introduction

I am delighted to be here today amongst so many like-minded friends in conservation, as well as over the next two days, for such a worthy cause. While I cannot claim any special qualifications or credentials in conservation science, this matter is so very close to my heart! In fact I am happy to be described as being passionate about the subject because this is simply the reality! Although I have lived and worked in Fiji virtually all of my life and therefore have some reasonable 'institutional memory' of this fascinating island country, I continue to find it a place of wonder and amazement in a biodiversity sense – there is still much to learn and understand about Fiji's unique living resources and ecosystems and how to better mitigate the expanding impacts of us humans.

The findings for example, of the joint Rapid Biological Assessment Mission into the legendary Nakauvadra Range in Ra Province last November and the re-discovery of both the Long Legged Warbler on Viti Levu and the 'Mirimiri' bat on Taveuni, are examples of recent 'good news' conservation science stories. In addition, there have been significant recent discoveries of new fish species in our freshwater habitats, a subject very close to my heart. These cases show why such work and our first-ever Forum are both so important.

In terms of my coverage, I will commence with a brief global overview after which I will move on to islands as a land mass category, including specifically here in the vast Pacific Ocean region. I will then focus on Fiji, initially in terms of some recent conservation development, in order to assist with a sense of context and stage-setting. Next I will spend some time on Fiji's Biodiversity Strategy and Action Plan [BSAP] before referring to what I consider are some of the key issues, approaches and questions. I will then touch on some conclusions.

I have spoken to a selected number of knowledgeable and authoritative 'conservation' friends over the past few weeks in order to gain a range of perspectives and input for my presentation because, as they say, 'no man/or more correctly, no one is an island.' I am most grateful to these special colleagues for the experience, knowledge and views which each has shared so willingly with me. I might add that I have also done a substantial amount of reading of relevant documents and papers. I will endeavor to reflect these valuable views and insights together with my own in a balanced and hopefully meaningful way.

Our world

That we are living in unprecedented times is an absolute understatement. Some have gone as far as calling the present situation an environmental emergency. While there is much new technology to marvel at and also use, the pressures we humans are placing on our natural resources, and in particular on our biodiversity, is a great worry. This is not only in terms of our demands for natural raw materials but also as a consequence of the impacts of our wider activities, including pollution and greenhouse gas emissions, on both ecosystems and climate. Biodiversity is being lost at an alarming rate, in spite of many good and

worthwhile initiatives at a range of levels. If one were to take a pessimistic view, it might be said we really appear to be losing the overall battle to ensure we preserve and manage these precious natural assets which include what are often called our living treasures, in a sustainable manner.

Islands

Almost a quarter of the world's nations are island states or archipelagos. Some 175,000 islands with a land area each exceeding 0.1 sq. km exist. While these collectively comprise only 2% of the total land area of our planet, they are home to 10% of the population. Therefore while many islands have small numbers of humans, population density is on average higher than that in the continental land masses. When ocean area is considered, island people are stewards for more than 17% of the Earth's total area, including many of the most unique and vulnerable animals, plants and ecosystems. Population increases are often substantial on islands and these two factors are placing great pressure on natural resources in many island situations. It is believed that more than half of all known extinctions have taken place on islands!

Small islands are said to possess significantly greater biodiversity on a *pro rata* basis than the larger land masses. In fact, both the terrestrial and marine biodiversity of our Pacific islands are considered as globally significant, even to the extent of possessing some of the 'hottest' conservation hotspots in the world. At the same time it is recognized that they are also most vulnerable to negative impacts of human habitation. The Pacific islands in particular, are believed to hold more rare and threatened species per capita than any other region. Already a significant loss of endemic species has taken place in our region. One view is that species on islands are in a sense more 'naïve' in that they are less able to withstand impacts because they evolved in the absence of most predators, grazing herbivores and many of the pests and diseases found on larger land masses.

Collectively islands are facing a host of critical environment issues which include the destruction of coral reefs and mangrove, invasive species and climate change and sea level rise. In spite of relatively high population densities, many islands have small critical masses of people and this presents another category of challenge from a human resource and skills perspective.

Fiji

In the Pacific islands setting, Fiji is one of the larger states. In addition to a sizable land area and considerable diversity in terms of landscapes, Fiji is considered to have one of the most outstanding tropical marine environments — this also exhibits great diversity. Fiji is said to have over 1,000 coral reefs and The Great Sea Reef to the north of Vanua Levu is rated the third longest barrier reef in the world. In fact, Fiji's reefs cover an area of around 10,000 sq. km. and represent some 4% of the world's coral reefs. Around 80% of the population live on the coast and rely heavily on marine resources for food. However, it is on the land where the greatest endemic biodiversity exits. The close interface and connection between the land and the sea resources and the great majority of Fiji's human and animal population, should be recognized.

As a developing country with many competing demands for enhanced infrastructure and services, the current trend of down and 'rightsizing' of Government will require even more activities to be undertaken and provided by non-state actors, as some development entities

like to call non-governmental as well as commercial organizations. That so many NGOs and *quasi*-government entities are doing so much good work in an environmental sense here in Fiji, is a matter of great pride — this can only serve as a model and inspiration to many other Pacific island states. However, the imperative for the Government, especially through the Department of Environment, to work closely with the various players and provide vision, direction and encouragement, will be clear to all. The responsibility to ensure that the work of NGOs is not only effectively discharged but also is in accordance with priorities and needs is a critical one which can not rest solely with the State. There is considerable scope for the various entities concerned to both coordinate and collaborate more closely and this Forum is a major step in this direction. I therefore commend our host organizations for their initiative as well as all of you presenters and participants for being part of this Forum.

It is always helpful as well as advisable to take account of recent relevant and competent reviews in a particular field, in order to help gain a sense of context and understanding — of course that conducted by the Austral Foundation in 2007 by Suliana Siwatibau and Annette Lees, readily springs to mind. This highly consultative and somewhat sobering exercise concluded that Fiji is facing a biodiversity crisis. The reviewers singled out the degradation of forests and adjacent land as the major issue effecting terrestrial biodiversity. Poor agricultural land use and indiscriminant burning were also cited as significant contributing factors. In the marine sector, the consequences of poor land use and erosion in particular, coupled with the unsustainable harvesting of species, and pollution, have had severe negative impacts on ecosystems and species.

The Austral Foundation study found that many conservation initiatives in Fiji have not achieved the progress expected of them despite considerable effort and expenditure. Interestingly, it suggested that a number of common assumptions about the causes of the crisis, and I quote, 'a lack of awareness, inadequate policies, a shortage of information and science, a lack of models or a lack of resources are not underlying causes nor even in some cases, contributors' to the disappointing situation.

The review proposed four key solutions to the crisis. The building of greater local ownership of the responses and initiatives, as well as leadership both within and beyond Government, is considered fundamental. This would help support talented local people within the organizations in question and also encourage greater accountability.

Secondly, it stressed the importance of having sound strategy behind the design and implementation of biodiversity programs in Fiji. Each organization should clearly understand its role and pursue a transparent work program with benchmarks and indicators for monitoring, with a built-in process to incorporate lessons learned. The importance of the BSAP as the guiding document was emphasized, with a qualification about the need for an accompanying strategy, which would prioritize core actions needed and specify a framework for enhanced collaboration between Government, NGOs, donors and other agencies.

Thirdly, the need to build the capacity of Government departments and related institutions is strongly advocated. A major thrust of this action is that Government would be able to secure more resources for conservation if it possesses greater capacity.

Fourthly, the review recommends a program of 'conservation campaigning' within the national biodiversity strategy, whereby conservation groups and Government agencies working on selected priority responses to conservation problems, collaborate closely to solve these. Sustainable forest management is quoted as a prime example for such an

approach. It should be noted that considerable success has been achieved in parts of Fiji, such in Drawa in Vanua Levu, with sustainable forest management under the SPC/GTZ Pacific-German Regional Forestry Project.

The establishment recently of two important new players within our Fiji biodiversity 'land and seascapes' are also very worth noting — I refer of course to the Oceania Regional Office of the IUCN [or World Conservation Union] and to the Fiji Nature Conservation Trust, located within a short distance of each other in 'evergreen' and pleasant Muanikau.

The ORO is a response to a real need for an IUCN/World Conservation Union presence in Oceania, which was felt over 10 years ago and was then subsequently the subject of a Resolution adopted at the World Conservation Congress in October, 2000. The Office was formally established in Ma'afu Street in 2008 and Fiji became a state member this year. The National Trust however, has been a member of IUCN since the early 1970s and as many will know, worked hard to facilitate the establishment of this fine new Office. Oceania is one of eight statutory regions of IUCN and includes Australia and New Zealand, in addition to the Pacific islands region.

As a membership-based organization, the IUCN's goal is to provide scientific advice and support to conservation and development of sustainable livelihoods. This involves adding value to many ongoing efforts and activities and to developing and implementing its own complementary Program of Work. The IUCN's expert Commissions and huge inventory of over 10,000 volunteer scientists, which constitute the world's largest environment network, back up the four key areas of the Regional Program and the three special Pacific initiatives. In particular, IUCN supports and develops 'cutting-edge' conservation science. Limitations of time restrict me from expanding further but may I close my IUCN references by simply saying how fortunate we are to host the ORO and its dedicated team here in Fiji. What a captive biodiversity human resource to have on our doorstep! They have achieved a great deal in a relatively short time and have a number of exciting initiatives in progress — among the many benefits of the IUCN's presence has been getting us all to talk to each other more than ever before.

Of course the visit in June by the Director-General of the World Conservation Union, Julia Marton-Lefevre, has been a real highlight for our entire conservation movement. Julia's sheer commitment, energy and vitality will have deeply impressed all who were fortunate to have met her.

Fiji's terrestrial biodiversity is recognized as being of global importance. There is a high degree of endemism as illustrated by the fact that some 56% of some 1,594 known plant species fall into this category, including 24 of 25 palms. Over 40% of 59 terrestrial breeding species of birds and 35% of 26 reptile species are also endemic — the latter include the iconic Fiji iguanas. The invertebrate fauna have received very little attention and yet over 90% of Fiji's cicadas, for example, are endemic. Many bird species are threatened and eight are considered Critically Endangered. Although Fiji's flora is relatively well-researched, many localities have been never or only lightly collected.

In addition to an accelerating loss of forest, a range of invasives are very real threats to our forests and endemic species. Diminishing Government resources and weak capacity are impacting on Fiji's ability to address obligations to a raft of environmental-conservation treaties to which it is signatory. Moreover, our 'protected areas system' is not yet

developed sufficiently and awareness in the general population about natural heritage is low.

At least six international conservation NGOs [INGOs] are now operating in Fiji and all are providing considerable benefits. However, the case for a local NGO which has Fiji's interests as its fundamental driver, to serve also as an adjunct, complement and partner for these very committed INGOs, is clear. Some are perhaps not aware that Fiji did have such an NGO in the 1980s in SPACHEE — unfortunately it did not make the transition to the new millennium after performing a useful initial role. Of course it must be recognized that the Award-winning Fiji Locally Managed Marine Areas [FLMMA] initiative, had evolved into an independent network just prior to NatureFiji's establishment.

While the National Trust of Fiji performs an increasingly important role as a 'centre' for natural and built heritage protection and as a manager of a modest network of protected land areas and buildings, it is still essentially a State entity, although in many respects it operates like an NGO. Significantly, the Trust is now sourcing an increasing proportion of its funding from outside Government. It works very closely with a major U.S. biodiversity NGO, Conservation International, which is co-located with the Trust in Ma'afu Street, in a very symbiotic arrangement.

NatureFiji [or MareqetiViti] is the operational arm of the Fiji Nature Conservation Trust, which was launched only two years ago last month at the Sigatoka Sand Dunes property of the Fiji National Trust. NatureFiji was born out of a long-standing clear need for natural heritage conservation NGO which is fully local, or indigenous!

That NatureFiji has been able to attract substantial funding and commence a number of very relevant initiatives in two short years, is a testimony to its leadership and dedicated staff team as well as a clear vindication of its creation. The Fiji Nature Conservation Trust of course has much more to do in the future and this includes, for example, developing nature clubs through which greater engagement and participation of young people can be achieved. May I recognize the inspiration as well as the immense effort and commitment which Dr Dick Watling has devoted to this mission of establishing MareqetiViti?

A recent event of significance was the 12th meeting of the Pacific Islands Roundtable for Nature Conservation which took place in the Solomon Islands last month, chaired by Taholo Kami, the IUCN ORO Director. I have looked closely at both the Roundtable Communiqué and the Agreed follow-up framework and must agree that these cover and state all the right things. Central amongst the nine principles from the recent Roundtable in my view, is the need for donors and partners to align with national priorities, including with NBSAPs.

The Roundtable for Nature Conservation, the largest cross-sectoral coalition of nature conservation and development organizations, governments, inter-government, donor agencies and community groups, was established under the auspices of SPREP in 1997. In 2002 it developed the Action Strategy for Nature Conservation in the Pacific Islands Region, the Mission of which is 'protecting and conserving the rich natural and cultural heritage of the Pacific Islands forever for the benefit of the Pacific and the world.' It aims to provide guidance to a wide range of actors in the Pacific community, including governments, in the development of their plans for nature conservation. The revised Strategy was developed for and approved by the 8th Conference on Nature Conservation and Protected Areas held in Alotau in PNG, in 2007.

This Strategy has taken considerable guidance from the objectives and aims of the National Biodiversity Strategies and Action Plans [NBSAPs] formulated under the Convention on Biological Diversity, or CBD. Some 14 Pacific Island States are members of the CBD.

Amongst a range of Resolutions, the recent Honiara Roundtable agreed to focus considerable assistance toward PNG, Solomon Islands and Fiji and to possibly work toward national Roundtables in each country. Another key principle from the Roundtable communiqué, 'Banking on Biodiversity,' which I wish to repeat, is the need to 'build capacity for leadership, direction and ownership within Pacific governments to enable long-term sustainable management and conservation of biodiversity and bio-capital.'

In addition, there are a number of other relevant regional initiatives and plans. Paramount amongst these is the over-arching Pacific Plan, which arose out of a Leaders Meeting in Auckland in 2004. While management of the natural environment or biodiversity are not central themes of this Plan, there is overt reference to 'Improved Natural Resources Management and Environment Management' within its Strategic Objective No. 5. Several initiatives with a direct bearing on biodiversity and the environment have been promoted under the Pacific Plan. More specific regional actions include the Pacific Invasive Initiative, the Pacific Invasive Learning Network, the Coral Reefs Initiative for the Pacific and the Pacific Biodiversity Information Forum. Furthermore, there are some sub-regional initiatives such as the Micronesia Challenge and the Coral Triangle.

NBSAPs

The call for NBSAPs emerged as a key issue at the Earth Summit in Rio in 1992 and was then addressed in the formulation of Convention on Biodiversity [CBD]. The importance of 'mainstreaming' nature conservation and the sustainable use of biological resources across all sectors were recognized as being a complex challenge at the very heart of the CBD. Globally, there have been numerous recommendations and guidelines to support individual nations in the development of their NBSAPs and these have included the use of measurable targets, the incorporation of themes, the reflection of cross-cutting issues and most importantly, the inclusion of information relating to the values of biodiversity.

The first NBSAPs to be produced in the Pacific region were in the late 1990s, with significant support from the Global Environment Facility. A Pacific NBSAP Working Group and e-mail network was established through the Roundtable to facilitate information sharing and cooperation between Plan coordinators. A major objective of the Working Group has been to improve the monitoring and evaluation of NBSAPs across the region. A number of regional-level reviews of one or more components of the NBSAPs have been undertaken and in 2007 an in-depth analysis of Plan status was commenced on a regional basis, examining key issues of implementation planning and processes. A total of 11 NBSAPs were reviewed out of some 14 countries which had produced such Plans. The key challenges and obstacles to NBSAP implementation in the Pacific were identified and the areas in which support is required was also established. Important amongst these were fund-raising, a lack of available capacity, burdensome obligations under environment agreements, the matter of scale plus the limited numbers of available personnel and socio-economic factors such as poverty.

The issue of capacity-building is being addressed through the 'National Capacity Self Assessment' [NCSA] process under the CBD, which is designed to assist government agencies identify where gaps exist, including in terms of needs in climate change and land

degradation. The NCSA process also focuses facilitating initiatives aimed at linking national issues with the multilateral environment objectives. However, it is important to recognize that once needs are identified there must be adequate follow-through in addressing these.

The review noted that a key challenge faced by many nations, including beyond the Pacific region, is in monitoring and collating critical biodiversity data collected in the field by researchers from universities, NGOs and other institutions. Information flows to relevant government departments are minimal and research is undertaken at many sites by a cross-section of groups. It was felt that an opportunity exists in the Pacific to develop clear and manageable reporting requirements with academic institutions and NGOs to ensure that research undertaken is appropriately copied to the relevant government departments and associated regional data banks such as SPREP.

The review suggested that systems could be established [noting some were already in existence] through developing MOUs, which would not only cover the submission of research findings but also include reporting on the progress of biodiversity conservation activities being undertaken by a range of agencies.

A common omission from most NBSAPs is a monitoring and evaluation protocol with appropriate targets, indicators, timescales and prioritization. However, it is important to note that these plans are not static documents — these should constitute a dynamic and responsive process which accepts changes and addenda as the need arises. As objectives are met the NBSAPs can be re-assessed and adjusted in order to address both unfinished and new challenges. The importance of the conservation of biological diversity in any State being domestically driven can not be over-emphasized — ownership of the plan is therefore is critical. However, regional support entities and international organizations have key roles to play in providing assistance and guidance as well as in sharing experience and lessons.

On the more positive side, compared to larger countries, it was found that Pacific Island States have achieved higher levels of stakeholder consultation. Overall, the results indicated that the status of NBSAP development and implementation varied considerably.

Fiji BSAP

Work commenced on this plan in 1997, initially with assistance and guidance from WWF, followed by consultancy and other input from Environmental Consultants [Fiji] Ltd and then SPACHEE, which provided a coordinator. A representative National Biodiversity Steering Committee, chaired by the Department of Environment, then oversaw the completion of the Fiji NBSAP, using six Technical Groups. A working draft was finalized in 1999 at a national consultative workshop, following which it was endorsed by Cabinet — however, this did not take place until 2003 as a consequence mainly of political difficulties. Two revisions were subsequently undertaken and the Plan was then launched in September, 2007 at a 'stakeholders consultation forum' by the then Minister for the Environment, Bernadette Rounds-Ganilau. I wish to pay tribute to Bernadette for her role in bringing this document into the public domain. Some of us felt that it was almost destined to remain on the shelf, being the finished output of a process, so that other more important work could be attended to! However, we all know how important process can be.

The current initiative, assisted by IUCN on behalf of the Roundtable, to develop a 'roadmap for the implementation of the Fiji BSAP' to cover the next several years, is a very positive move. This will include a stock take of all related work being undertaken, including by

various ministries. In addition, a clearer prioritized and achievable results framework will be developed together with strategies to address each priority outcome. A transparent set of coordination, monitoring and evaluation arrangements will also be drawn up with the strategies being linked directly to ongoing initiatives. I understand that three of the six Focal Areas for Action of the BSAP, namely Protected Areas, Species Conservation and Invasive Species, will be focused on and an action planning meeting is scheduled as part of this process later this month.

No doubt thought will also be given to how greater public awareness of the BSAP could be generated using the output of this exercise, given that the Plan is still not well-known outside conservation circles. One possibility might be to develop condensed, well-illustrated versions in the three languages as well as posters, aimed at schools in particular. This could be undertaken in 2010 as part of activities to celebrate the Year of Biodiversity.

I know all of you will agree that it is most desirable that research on biodiversity and conservation in Fiji is undertaken in accordance with our priorities and needs, whether the funding is derived from within or beyond this country. There would appear to be merit in basing the research on the specific scientific conservation outcomes being sought in the national interest. Such an approach would assist with focusing on re-defined or new priorities in line with our Fiji BSAP and in the process, ensure that gaps are addressed in an integrated and effective manner. There would be greater transparency in terms of who is doing what and progress could be more easily monitored. A facilitating mechanism might be to consider developing a conservation/biodiversity research strategy and framework through a consultative process and to then endeavor to base the ongoing research on this framework. Such a research strategy would not be set in stone and should be updated periodically to take account of changing circumstances. Moreover, this strategy could logically be considered as an annex to the BSAP. [It should be noted that in October, 2008 a Fiji National Research Council was established under the Ministry of Education. Obviously, a link to this body would need to be considered in the event that a framework such as that suggested is developed]

A framework of this kind would also assist to utilize the knowledge and skills in different organizations in a more integrated and coherent way through collaboration and even pooling — the expertise does not need to all be in one or two entities, nor can we expect it to be.

An example in my view of a possible major gap in research is regarding the invasive creeper, *Meremia* — I am not aware of any such work being undertaken and yet it is such a major problem. Moreover, there are several networks and initiatives within the region which focus on invasive species. Is this because it is not perceived as a real threat or is it just too large and complex a matter or is it simply not sexy enough, in a research sense? There are other examples such as African Tulip and the Giant Sensitive Grass, both of which have expanded their coverage greatly in my lifetime.

Collectively, invasives are considered the biggest threat to ecosystems and species and yet it seems that coordinated work on this subject is limited. There appears to be a real need for an inventory of invasives in Fiji, covering historical aspects, distribution and impacts, trends over time, control initiatives/efforts to date, to mention only some of the issues. In fact, a National Inventory of Invasive Species has been proposed this year through UNDP, under the National Capacity Self Assessment initiative but progress is unclear. Similarly, the development of a Fiji Invasive Species Management Strategy has also been proposed under

the same provision. The current BSAP contains two very similar project briefs which have not advanced since they were originally formulated in 1999. An interesting additional project formulated this year by the same Consultant is one on the propagation of Sandalwood or 'yasi' as a sustainable income source.

The original BSAP also carries additional project briefs, including one on the establishment of a 'biodiversity management information system' and another on a 'bibliography and checklist of Fijian flora and fauna.' I believe many would consider the need for such projects to be undertaken greater now than ever. A benefit of the delay is the possibility of taking advantage of new Information Technology advances, such as web portals, which would make access and application much easier.

The need for the science to be better 'connected' to the various stakeholders is also very important — if not, there is a real risk that it will remain as just that, science in isolation.

The resource-owning communities are the most central of stakeholders and must be effectively 'engaged.' There is a need for greater understanding and awareness about the importance of biodiversity in sustaining life. Linkage with Fijian institutions would be an essential part of this objective. Involvement at the *tikina* level will be very desirable and the fact that many Fijian communities have animals and plants as totems should be taken advantage of.

Experience tells us that it is risky to talk biodiversity conservation to communities without a clear benefit being apparent to, and realized by them. It is therefore important to endeavor to ascertain the needs and goals of a community in this process and to try to assist to meet some of these while also achieving conservation goals, usually somewhat later. The community benefits need not only be cash and include enhanced food production and living conditions and also pride. Of course, special care must be taken not to mislead resource-owners and to always work to ensure that expectations are not raised unduly. Relevant experience from the successful FLMMA model should be studied and used where applicable.

In addition, the issue of capacity-building of our own researchers cannot be under-stated. While the numbers overall are still small these are increasing, importantly from the indigenous community. Much good work in this sense is being done within the individual NGOs, at the National Trust in its partnership with Conservation International and also at the USP, thorough the post-graduate program. More and more NatureFiji will play a role in this regard. It will be so important for our young researchers to be kept challenged, engaged and involved. Opportunities should exist for specialization and scholarships need to continue to be provided, especially by the very supportive Foundations which have been involved for some years. It goes almost without saying that overseas researchers, particularly those who are visiting, must always link and work with suitable locals, as is strictly enforced by the Institute of Applied Sciences of USP.

The need to factor Fiji's biodiversity and conservation more into the educational curriculum for future generations must also be kept to the forefront. A strategy should be developed, ensuring 'buy in' by the key decision-makers and then setting out activities and steps as well as assigning responsibilities, as far as this is possible. This would include having teachers adequately trained. The excellent 'Green Book' produced in the early 1970s by Margaret Knox, might be revised, updated and made more colorful with modern technology, for this purpose.

All will agree that the private sector needs to be more involved and supportive. Fiji Water is such a good example of participation and there is opportunity to sign up more Fiji companies as supporters, in the spirit of good corporate responsibility. Entities which are involved directly in the natural resources sector are logical targets as are those engaged in tourism. This will further assist with convincing the rank and file, including their staff that conservation is in everyone's business and in all our interests. Many other organizations spring to mind as potential supporters including both mobile phone companies — some innovative thought might be given to incorporating biodiversity awareness and conservation into their marketing. I am reminded of the World Conservation Union Director's address here at USP recently, when she strongly urged us all to invest in nature!

Most donors recognize that the priorities must be ours and that a partnership approach helps greatly with coordination and with more effective activities. The data collected and the associated research findings also need to be shared and should not become the exclusive property of the donor or agency, as we know can sometimes happen. We also know that research findings need to be well-analyzed and interpreted and that working the results and conclusions through into possible policy and draft legislation can be a difficult process — there appears to be a need for strengthening capacity in this endeavor and donors might be able to offer specialist support for this purpose. It is also apparent that a significant number of NGO workers have good basic conservation knowledge and strong people skills but are weaker in terms of capacity in the science of conservation action.

Last but certainly not least, the Government is a key stakeholder, in particular through the Department of Environment, which has a prime function in 'promoting the sustainable use and development of Fiji's natural resources' to quote from the Ministry's impressive 2008 Annual Report. This overall responsibility, which includes important obligations under several Conventions to which Fiji is a party, as well as our own Environment Management Act, is both challenging and daunting. These duties are made much more complex and difficult by the current financial and economic circumstances. The need for the Department to play a central leadership, ownership and directional role, is now greater then ever — this will need to include making the BSAP a more visible and operational mechanism for conserving and managing our biodiversity. However, the fact that there is only a single sentence reference to the BSAP in the latest Ministry Annual Report, will only serve to lend weight to those who say it is a well-kept secret!

We also regularly hear the cliché that conservation must be mainstreamed. This is a huge challenge because some decision-makers feel that conservation can either wait or continue to stay out on the margins or sidelines. The importance of appraising policy-makers much more with the concept of 'Ecosystem Services' should be recognized. While this is well-covered in the Fiji BSAP, based on Sisto's 1994 study, these figures are now in need of updating. The value of Fiji's ecosystem services was calculated then to be worth over $970 million per year and equivalent to approximately 42% of our GDP. The value in today's terms would be significantly higher but how many leaders and senior Government administrators would be aware of this? How can we collectively better 'sell' this most important concept and thereby use it more to our advantage?

Fiji's forests are the home of just about all of Fiji's endemic biodiversity. The conservation of these forests is the single most important responsibility Fiji has encumbered itself with by becoming a signatory of the Convention on Biological Diversity. Yet their conservation will remain a distant dream if we are unable to interest the forest landowners. Not surprisingly, at this point in Fiji's economic development, landowners' interests are determined largely by

income requirements. And it is a great wrong that forest conservation, either formal or informal, is not a recognized and economically rewarding land use.

In the past and currently, the only forest land uses which are beneficial for landowners are inherently destructive — poorly controlled short-term logging and conversion to the likes of mahogany, coconut, cocoa or other farming enterprises. Forest owners are denied any rewards from the environmental services their forests supply. We need to be far more innovative in devising practical cooperative arrangements with forest landowners to enable them to benefit from forest conservation rather than be passive witnesses, or actually penalized.

It is incongruous that generous subsidies are paid in the 'developed' world in all sorts of forms, to those who put aside or try to restore mere vestiges of forest remnants, while in Fiji and elsewhere in developing countries, landowners are effectively penalized if they should leave their forests intact. Forest custodianship should be a recognized land use and those landowners who are willing to maintain quality forest should be rewarded as such — paying for environmental services from forests is only one of the possible mechanisms. Making appropriate valuation is no longer guesswork: the methodology is well-developed and it is time that it is carefully considered for implementation here in Fiji.

Time prevents me from covering other important issues, some of which were mentioned by colleagues during my talks with them. These include the subject of social science in engaging with resource-owners on the better understanding of the value, as well as of the sustainable management, of their natural assets. An element of conservation learning would be a desirable flow-on from conservation science in this context.

The science of good leadership, particularly at community level as well as in Government, was also raised as a subject of relevance. Other matters which should not be lost sight of include carbon storage, land degradation and pollution.

Summary

I believe that the initiative to convene this Forum is a very desirable and timely one. There is a real need to work more closely and to collaborate more smartly for several reasons. First and foremost, it is imperative that research addresses Fiji's biodiversity conservation and management priorities as effectively as possible, whatever the source of the funding and other resources. We still have much to learn about our biodiversity and lack of information makes many decisions about managing this resource uncertain. The benchmarking of progress and sharing of information as well as the possible 'pooling' of expertise and other resources, as a result of closer partnership, can only be beneficial. This should also assist to counter some of the likely difficulties in obtaining adequate financial resources in the future. New opportunities for working together as well as synergies should emerge and these will further support this orientation. If a proposed Conservation Science Strategy and Framework gains favor, this would help to ensure that the work being undertaken is clearer and more transparent. Gaps and threats, in terms of research needs, will also become more evident and a more integrated approach to these should be facilitated.

The enhanced capacity of Fiji nationals must also underpin all that is being done. Much good work is taking place but we should avoid being complacent as this is an ongoing process. Scholarships and internship positions should continue to be offered as should mentoring and other support.

I believe that Fiji's BSAP should be central to this entire effort. In fact it should be the vehicle and enabling means to all our efforts to protect and conserve our biodiversity. Much effort, consultation and resource was put into the Plan and I personally feel it has not received the attention which it deserves. This is a principle reason why I have dwelt at some length on Fiji's BSAP.

NGOs have been playing a most valuable role as an auxiliary to Government, particularly to the Environment Department and this must be recognized and commended. Fiji is indeed fortunate to have such a group of supportive and committed civil societies.

A revision and updating of the value and benefits of Fiji's ecosystem services should be undertaken but this should be backed up with a targeted media campaign, building on the Year of Biodiversity in 2008, aimed at policy-makers, with an additional focus on our younger generation. This update could well be jointly published with the revised Roadmap for the implementation of the BSAP which is currently being developed.

Conclusion

This Forum will mean different things to each of the various categories of participants. To researchers it is a great opportunity to present their findings and to receive professional feedback and input. For post-graduate students, it is a wonderful opportunity to learn and network. In fact, I have heard on good authority that one excited USP student went as far as stating 'it is one of the best things since I have been here.' For those working in academic institutions like USP, it is a chance to ascertain more clearly as to what the conservation sector expects of their entity as well as to break out of their respective ivory towers, where these exist! Importantly also, the involvement with USP enables presentations which have relevant content to extend beyond Fiji into the region. In the case of Government participants, the Forum allows them to be reminded of the capacity and enthusiasm that exists within NGOs to work on biodiversity conservation issues of national importance. For all of us it represents a chance to meet and network with many like-minded individuals over several days of thematic scientific presentations, under the umbrella of the Ecosystems-based Management approach. I do hope that some of the thoughts and suggestions I have provided assist with the conduct of this Forum.

We will all agree that one of our major challenges is to 'mainstream' biodiversity conservation much more — this is of course, music to my ears, as a freshwater ecosystems person from as far back as I can remember! We have to reach out and embrace more of our people from policy and decision-makers to youth and to resource-owners in the rural sector. Hopefully we can also deliberate a little on how we might do better in this regard. It is noteworthy that considerable success has now been achieved in regard to 'mainstreaming' climate change — what are the useful lessons from this experience?

It will also be important to recognize that acquiring greater knowledge about Fiji's biodiversity will also need to be matched by enhanced skills in developing and proposing possible policy interventions, as well as in designing and implementing appropriate field conservation programs and other related activities.

We cannot change the past but we can all resolve to work more closely and better in the future, in our shared endeavor to promote biodiversity conservation through scientific research, taking full account of past lessons. We know this is an imperative and time is not

on our side. The window of opportunity is progressively closing and a number of species are 'on the edge' of extinction — the current worrying state of Fiji Peregrine Falcon population is an example which has had little recent mention. Currently only four adult Peregrines remain at the Kula-Ecopark captive breeding centre (another important stakeholder) and there have been no hatchings for over two years.

Whether this Forum serves as a once-up event or becomes a regular item will of course depend on the feeling and outcome of this inaugural gathering. There is an expectation of 'National Roundtables for Nature Conservation' in several regional States, including Fiji — could the proposed Fiji Roundtable and a possible follow-up Conservation Science Forum be merged or be held back-to-back?

In closing, I wish to thank the sponsors and donors for their initiative and support and also the organizing team for the 'hard yards' they have put in mounting this important inaugural Forum. I also re-iterate my appreciation for the honor accorded to me as Keynote Speaker. It is now my real pleasure and privilege to declare this first Fiji Conservation Science Forum [FICSF] open and to wish it a most successful outcome.

Suva.
5th August, 2009

Session 1. Ecosystem Based Management and Conservation Planning

Chaired by Stacy Jupiter and James Comley

SUMMARY

prepared by Aaron P. Jenkins and Stacy Jupiter

Ecosystem Based Management (EBM) is a developing field of conservation science that emphasizes ecosystem structure, function and key processes while recognizing the central role of humans as ecological actors. EBM works through integration of ecological, social, economic and institutional perspectives, recognizing their interconnectedness. Conservation planning at the scale at which these processes and perspectives are operating is also crucial for EBM to be implemented effectively.

Seven papers were delivered during this theme session, their topics ranging from conservation planning and the issues of scale to seasonality in migratory ichthyofauna. The talks fell into two major sub-themes: i) applied ecosystem scale science for implementing community managed areas; and ii) using EBM modeling tools for optimizing marine protected area (MPA) network design. Key messages emerging from this theme were:

1. ninety-eight percent of fishes from fresh and estuarine environments in Fiji are linked to marine environments during their lives for feeding, breeding and/or ontogeny. Eighty percent of Fiji's endemic fishes are moving across five habitat types during their lives. Percentage forest cover and presence/absence of introduced species (e.g. tilapia) were found to be highly important in determining in-stream community structure;
2. our emerging knowledge on ecological connectivity between habitats from 'ridge-to-reef' is being applied on a national scale to prioritize linked areas of forest, rivers, mangroves and reef for both conservation and restoration;
3. there is a clear mis-match between ecological optimization in MPA network design using EBM tools and socio-cultural realities at the ground level. Socio-economic considerations at the community level are likely to be the most important local determinants of MPA success with ecological processes and biodiversity considerations often locally perceived as of lesser importance. Greater emphasis is needed to bring the on-the-ground ecological and socio-economic insights into the emerging EBM modeling tools; and
4. although tropical systems are recognized as having only two seasons (wet and dry), seasonal variation is very important in structuring riverine faunal assemblages. Seasonality in faunal assemblages needs proper consideration when designing and implementing management of aquatic fauna.

Presentation 1. Tackling the mismatch of scales between regional planning and local implementation in Fiji

Mills, M.[1,3], Jupiter, S.[2] and Pressey, R. L.[1]

The mismatch of scales between regional conservation planning and local implementation frequently prevents the translation of even the best conservation plans into effective conservation actions. This mismatch results from a number of scale-related decisions taken during the planning process. These decisions include the extent and delineation of the planning region, the choice of data, the delineation of the planning units (the geographical units that are assessed and compared for conservation priority), the configuration of the conservation plan on paper or in Geographic Information Systems, and the changes that must be made to the plan before actions are finally implemented.

Using conservation planning decision-support software, we are creating scenarios for marine protected area networks in a part of Fiji using different constraints on these decisions of scale. For example, to investigate the constraints related to the choice of socio-economic data, we will create two marine protected area network scenarios of fishing effort — one based on a global, coarse-resolution model and one based on fine-resolution data. We will then use these scenarios to investigate how the use of fine-resolution versus broad-resolution socio-economic data affects the design and implementation of marine protected areas in Fiji. The results of this modeling will help us to identify the value of obtaining data on fishing effort at fine-resolution for systematic conservation planning, and also provide directions for future research to diminish the mismatch of scales between planning and implementation of conservation actions in Fiji. By integrating the factors that influence success of locally managed marine areas into regional conservation planning designs, our study also will increase our understanding on how regional goals can be achieved through local-scale implementation in Fiji. This understanding can be used by agencies creating networks of interacting marine protected areas or implementing single marine protected areas intended to interact with established neighboring marine protected areas to help reach regional conservation goals.

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Presentation 2. Marine opportunity costs: a method for calculating opportunity costs to multiple stakeholders groups

Adams, V.[1]

The objective of systematic conservation planning is to maximize conservation benefits while minimizing socio-economic costs. When designing marine protected areas, most studies have assumed homogenous costs. Methods of creating heterogeneous cost layers for marine planning have included mapping current use by surveys of fishing activities. These methods have typically been biased to a single fishing sector and might not give sufficient information on the trade-offs of using costs representing different stakeholder groups (e.g. trolling versus net fishing). I expand upon current approaches by presenting a novel method for calculating the opportunity costs of conservation actions to multiple stakeholder groups, defined by catch of key species for consumption and revenue. My method builds upon those applied in land conservation in which the probability of conversion of land to alternate uses is used to estimate opportunity costs to multiple stakeholder groups. This method differs from previous approaches by providing information about costs of currently unused areas that may be of potential future benefit to stakeholders.

Using presence/absence data and predictor variables we develop spatial distribution models for the key species harvested in Fiji. These distribution models were then used to calculate expected revenue from catches. In the revenue estimates costs of fishing based on gear type, fuel prices and distance traveled from port are included. By incorporating this information I can identify areas that have high abundance of key species and are within fishermen's spatial mobility. I compare costs to different stakeholder groups when only one key species is considered, as well as the summed costs of all species, and validate the marine cost layer used against an existing cost layer developed from traditional survey methods. This method gives an unbiased estimate of opportunity costs to multiple stakeholders in a marine environment that can be applied to any region with existing species data. The opportunity costs to stakeholder groups in Kubulau (Vanua Levu island) was used to assess the costs of currently established marine protected areas as well as costs of potential future marine protected areas. I compare the cost to different groups as well as the aggregate cost and make recommendations for conservation strategies which minimize effects on all stakeholder groups considered.

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Presentation 3. Ecosystem based management (EBM) is essential for conserving migratory high island ichthyofauna: a case study from Fiji

Jenkins, A. P. [1,3] **and Jupiter, S.** [2]

The freshwater and estuarine ichthyofauna of tropical high island ecosystems are highly migratory and comprise a high proportion of endemic, amphidromous gobiid fishes. Based on extensive field surveys and literature review, this study presents the current state of knowledge on cross-habitat connectivity in fresh and estuarine ichthyofauna of the Fiji Archipelago.

Our analysis of life history patterns within this fauna show amphidromous gobiid and obligate catadromous fauna displaying the greatest extent of cross-habitat migration. The prevalence of invasive fish species in Fiji's catchments is also quantified, showing that all major catchments have been invaded primarily by *Oreochromis mossambica* and *Gambusia affinis*. We present data from 20 catchments along a gradient of catchment disturbance, showing significant correlation between the decline in diversity of migratory fauna and the decline in the extent of natural forest cover compounded by the presence of invasive species. Our data also suggests that the invertivore specialist feeding guild is most affected by this decline in catchment integrity. Our data strongly suggests that an ecosystem–based management approach that considers how multiple disturbances interrupt habitat connectivity is needed to conserve ichthyofaunal diversity and productivity in tropical high island systems.

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Presentation 4. Priority connectivity regions for conservation and restoration in Fiji

Jupiter, S.[1,3], Jenkins, A. P.[2] and Qauqau, I.[1]

The presence or absence of migratory fish in the Fiji Islands is strongly influenced in areas with high anthropogenic disturbance — from forest clearing and/or non-native species introductions. Based on these relationships, spatial data were combined into a Geographic Information System to identify priority areas for conservation in Fiji that preserved the connection between terrestrial catchments, hydrologic networks, mangroves and coral reefs. To identify priority areas of Viti Levu, Vanua Levu and Taveuni, a set of decision rules was used that considered habitat intactness and complexity, hydrology, and sensitivity to erosion. Each combined catchment-fishing ground mapping unit (n = 76) was scored for relative erosion potential, extent of road network, number of creek crossings, presence/absence of non-native freshwater fish, mangrove area relative to catchment size, mangrove habitat complexity, reef area relative to fishing ground size, and reef habitat complexity.

Results revealed that the mapping units with the highest scores included remote, largely undeveloped regions in Cakadrove, Macuata (Udu Point, Qelewara, Natewa) and Bua provinces (Kubulau, Wainunu, Dama) of Vanua Levu, and the northern and eastern aspects of Taveuni. Two smaller mapping units of Viti Levu (Naikorokoro and Sawakasa) scored 9th and 10th respectively due to there being fewer roads and creek crossings and reasonably extensive areas of mangroves and reefs. In contrast, all of the mapping units with the lowest scores (zero or below) were situated around the highly agricultural centres of Nadi, Ba, and Labasa, all of which have high urban population density, considerable forest clearing, extensive road networks for agriculture and logging, and many records of introduced fish species. The Yarawa and combined Kolovisilou-Nubulotulotu catchments on the central Coral Coast of south Viti Levu also had low scores due to high relative erosion potential, many records of introduced fish and fewer areas or complexity of mangroves and coral reefs.

Conservation and restoration of priority conservation areas in Fiji require large-scale efforts across multiple habitats using ecosystem-based management principles.

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Presentation 5. Applying ecosystems based management tools to strengthen the design of a community - based network of marine protected areas in Kadavu, Fiji

Wendt, H. K.[1,2], Aalbersberg, W.[1], Comley, J.[1] and Grober-Dunsmore, R.[1]

The residents of the Southern Island Province of Kadavu are leading Fiji's efforts to protect natural and cultural resources by establishing 52 locally-managed marine areas. These 'no take' (*tabu*) areas were selected through a community-based adaptive management process aimed at meeting local-scale conservation and fisheries needs. While many of the management interventions of individual marine protected areas demonstrate well-defined success by ensuring food security at the individual community level, they potentially lack the coordinated island-wide outcomes desired for the wider area (or province) and the biodiversity conservation benefits associated with an integrated network of marine protected areas.

To evaluate the trade-offs of different approaches, ecosystem-based management tools are being used to examine how well the existing collection of locally-designed marine protected areas addresses island-scale conservation and fisheries objectives. Local ecological, governance and socio-economic knowledge collected using participatory approaches are being spatially-integrated to evaluate the present design and assess whether or not the existing network in Kadavu has can achieve protection for a province-wide marine protected areas network. Findings are crucial as Fiji strives to achieve bold conservation targets to effectively manage 30% of nearshore waters in a network of marine protected areas. Furthermore, results will be invaluable for developing marine protected area network design approaches that combine traditional knowledge with ecosystem-based management tools in a manner appropriate to a Melanesian context.

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Presentation 6. Integrating Ecosystem-based Management science to provide recommendations for redesigning a marine protected area network in Fiji

Jupiter, S.[1,3], Tui, T.[1], Cakacaka, A.[1], Moy, W.[1], Naisilisili, W.[1], Yakub, N.[1], Dulunaqio, S.[1], Patrick, A.[1], Callow, M.[1] and Shah, S.[2]

There are 20 community-managed marine protected areas within the fishing grounds of the Kubulau district on Vanua Levu. Seventeen of these marine protected areas are traditional closures (*tabu*), managed by individual villages and the remaining three are large, district-wide, no-take areas co-managed by a committee composed of representatives from each of the ten villages in Kubulau. Namena, the largest of the district-wide marine protected area, has been protected since about 1997, while the other two – Nasue and Namuri – were designated in 2005; their locations are based on baseline underwater visual count surveys, resource mapping assessments, and community consensus. Monitoring in 2007 showed a strong and moderately positive response to protection in fish biomass (Namena) and fish abundance (Namuri), but that fish were more abundant, and larger, at control sites outside of the Nasue marine protected area than within it. Integrated results from coral core records, interviews with fishers and underwater visual census surveys indicate several reasons for the lack of performance by the Nasue marine protected area. Firstly, coral cores from massive *Porites* sp. collected near Nasue are heavily enriched with trace metals related to run-off from the Yanawai River and Mt. Kasi gold mine that operated until 1998, and there are anecdotal reports that excessive run-off of mine tailings caused mass mortality of fish and corals that year. Secondly, community members have complained of a high level of poaching within the Nasue marine protected area: 83% of respondents (total n = 30) from household surveys in villages in the north-eastern part of Kubulau district, closest to the Nasue reserve, reported encounters with poachers, 60% of the respondents reporting that poachers exclusively come from outside of the traditional fishing area boundaries. Results were presented to the Kubulau Resource Management Committee and village leaders at a three-day workshop in February 2009. Community members identified that most poaching is done by traditional resource owners living in adjacent district and members devised strategies to increase awareness of marine protected area rules among that group of fishers. Suggestions were made to modify the boundaries of the Nasue marine protected area to maximize fisheries benefits and biodiversity protection across the entire fishing grounds.

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3 Presenter: Stacy Jupiter; sjupiter@wcs.org

Presentation 7. Seasonality in freshwater and estuarine ichthyofauna in Macuata, Vanua Levu

Mailautoka, K.[1, 2]

Wetlands International — Oceania has undertaken freshwater surveys in the Province of Macuata on the island of Vanua Levu for the last three years. It began its surveying in 2006 when dry season data were collected. Wetlands International – Oceania followed up this survey in 2009 by collecting wet-season data at the same sites sampled during the dry-season.

In this presentation, Wetlands International — Oceania presents the data which was collected and makes comparisons of both the wet and dry seasons for all the sites surveyed. It will also reveal the different species that were found in both the seasons and the numbers caught from the various sites, and how seasonal changes affect the migration of fish in freshwater system. Finally Wetlands International — Oceania hopes to work out the differences found in the river system and compare fish complements in large and small rivers, and make recommendations on how the health and ecological functions of these river systems can be improved.

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Session 2. Habitat Mapping

Chaired by Daniel Egli and Jens Kruger

SUMMARY

prepared by Daniel Egli and Jens Kruger

Marine benthic habitats are the crucial framework for all marine ecosystems. Their importance lies in allowing an understanding of processes at various scales from local influence on reef fish assemblages to effects of coastal developments and large scale oceanographic processes.

The availability of suitable habitat maps and improved understanding of marine systems allow managers to make better decisions. Ecologically detrimental developments can be avoided while key areas can be included in conservation plans.

Rapid advances in new technology and data processing techniques have helped to advance the field of underwater habitat mapping greatly. Large areas (from 10s to 100 square kilometres) can be rapidly mapped with improved accuracy from satellite and ship-borne remote sensing instruments. However, many of such projects are resource intensive in terms of technical expertise and the cost of data acquisition, field surveys and software requirements. Therefore it is worth pursuing alternative approaches that can include use of traditional ecological knowledge, expert mapping techniques, and low cost approaches using available off-the-shelf side scan and single beam sonar in combination with specifically developed 'freeware'.

Independent of the approach taken and the available budget, two key factors needed to develop a marine habitat map that can practically assist the achievement of coastal management objectives have been identified. First, it is crucial to engage the end users of the mapping product early in the planning stage to determine what the specific objectives of the map should be. This engagement should largely determine the choice of the method, approach for habitat classifications, and level of accuracy. Ground truthing was identified as a second key factor which should preferably involve key stakeholders such as members of the local community. This step is vital for two reasons: firstly, ground truthing will improve the overall accuracy of the map and also dictate for what purpose it can be utilized; second, involving local experts enhances community ownership of the data and improves the acceptance of coastal management decisions based on marine habitat maps.

Presentation 1. Evaluating eight field and remote sensing approaches for mapping benthic habitats on three different coral reef environments in Fiji

Roelfsema, C.[1,2] and Phinn, S.[1]

Monitoring and management of tropical benthic habitats require accurate and timely information on their composition. Tropical benthic habitats are challenging to map due to their frequent remoteness, extent, heterogeneity of benthic cover, and variable water clarities.

This work evaluated the accuracy, cost and relevance of eight commonly-used benthic cover mapping techniques for three different tropical benthic habitats in Fiji. For each habitat eight mapping techniques were applied which integrated field and satellite data. Three of these used manual delineation and five used supervised classification techniques. The field data were obtained from local fishermen, local resource management expert knowledge, 'spot check' surveys or geo-referenced photo transects. The images used were multi-spectral Quickbird (2.4 m pixels) and Landsat Thematic Mapper (TM, 30 m pixels). The eight mapping techniques were evaluated in terms of their output map, accuracy, cost of the mapping process, and production time. Qualitative assessment was carried out by map users representing the local marine monitoring agencies. Results showed that the basic map produced from manual delineation on a Landsat TM image using fishermen's local knowledge, had the lowest cost, fastest production and lowest accuracy and contrasted with the complex map produced from a field survey-guided, supervised classification of an atmospherically corrected Quickbird image that had higher cost and accuracy and slower production. For some users the map produced from the basic mapping process was sufficient for answering their needs.

The findings from this work demonstrate how effectively and accurately benthic cover information can be created through a range of techniques which vary in cost, time and accuracy, while still providing sufficient information for different users.

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Presentation 2. A low-tech and low-cost approach to marine resource mapping of inshore areas

Egli, D.[1, 2]

To study the importance of habitat to reef fish assemblages it is crucial to have access to good quality habitat maps. The complexity of the topography is one of the most important criteria influencing fish assemblages. Topographic and habitat information provide a vital decision tool to improve the selection process of effective marine protected areas or 'tabu' areas.

Traditionally, habitat maps have been produced with expensive survey gear by highly specialized professionals. However, decision makers at the local level in Pacific islands rarely have the resources necessary to prepare detailed maps, nor do they require maps with a high degree of accuracy. Here we propose a low-tech and low-cost approach to creating basic habitat maps of inshore reef areas. In this study an affordable, boat-mounted side scan sonar and easily available 'freeware' were used to collect sonar recordings in the Kubulau 'qoliqoli', Fiji Islands. These recordings were later processed and digitized in 'Q-GIS' (free Geographic Information Systems software) to create habitat maps. The main goal was to map the occurrence and structure of different habitat types at an adequate level for management decision making in data poor environments. This approach can be replicated in other areas of Fiji and the Pacific region without the need for expensive investments and highly specialized training to produce practical habitat maps for local resource management.

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Presentation 3. Habitat mapping of coral reefs at various spatial scales in Fiji and other Pacific Islands, using object-based classification

Roelfsema, C.[1,5], Phinn, S.[1], Jupiter, S.[2], Comley, J.[3], Wendt, H.[3], Kruger, J.[4], Kumar, S.[4] and Sharma, A.[4]

Coral reef habitat maps at geomorphic and benthic community spatial scales are needed for monitoring and management purposes in Fiji and throughout the South Pacific. High spatial resolution satellite imagery, with pixels less than 5m and integrated with field survey data, can provide these maps through pixel- or object-based image analysis. This presentation outlines methods and results from coral reef habitat mapping using remote sensing for local monitoring and management agencies in Fiji and the Cook Islands.

The reefs mapped are Navakavu, Kadavu and Kubalo in Fiji, and Aitutaki Reef in the Cook Islands. For each case study reef, high spatial resolution 'Quickbird' imagery (2.4m pixels) and georeferenced photo transects were acquired. The satellite image data were corrected for radiometric and atmospheric distortions to at-surface reflectance. For the Fijian reef sites, coarse spatial scale mapping was completed first, using object-based segmentation and manual labeling to define geomorphic zones. Each geomorphic zone was sub-segmented in finer spatial scale segments, which were then assigned a benthic community category. Rules to assign benthic community categories to each image segment were developed based on analysis of the field and image data. For reef mapping conducted by SOPAC at Aitutaki reef, a supervised per-pixel classification approach was applied as part of a capacity building project. For the study areas, accurate benthic habitat maps were, or will be, produced at geomorphic and/or benthic community scales using the two different sets of methods. The Geographic Information System layers of these maps will be used by the co-author organizations for: assessing commercial fish resources, determining marine park boundaries and looking at benthic changes due to coastal development. Additionally, the study provides an organization with the ability to further develop its own capacity in creating habitat maps from field and remote sensing image data.

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Presentation 4. Habitat mapping in Aitutaki, Cook Islands

Sharma, A.[1], Kruger, J.[1], Kumar, S.[1], Roelfsema, C.[2], Leiper, I.[2], Phinn, S.[2], George , N.[3] and Story, J.[3]

A habitat is the place where a particular species lives or biotic community is normally found, and is often characterized by a dominant life form (e.g. seagrass bed habitat) or physical characteristics (e.g. sandy intertidal habitat). Benthic habitat maps are designed to understand and predict moderate depth (20m – 150m) benthic habitats used by the different organisms that inhabit coral reef ecosystems.

Marine habitats are investigated by snorkelling, diving, and foot transects using a digital camera and hand-held Geographic Positioning System receiver to record the actual track of the swimmer. Once analyzed for biotic and abiotic characteristics, the geotagged photos provide the necessary 'ground-truth' information to thematically map the marine habitats using the multispectral information of the high-resolution satellite imagery. The thematically rich marine habitat maps capture the present characteristics of the marine ecosystem.

When combined and overlaid with other Geographic Information Systems layers (such as bathymetry, backscatter data, hydrodynamic models, and *in situ* biological and physical samples of the substratum) habitat maps are the ideal ecosystem-based management tools for conservation purposes. These maps provide stakeholders and decision makers with accurate spatial and functional information to better manage and develop resources as associated land comes under increasing pressure, primarily in response to socio-economic aspirations and climate change.

The Pacific Islands Applied Geosciences Commission surveyed and created a benthic habitat map of the Aitutaki Reef in Cook Islands to use as a base map to determine the possible effects of changes in reef hydrodynamics resulting from increasing the size and depth of the major boating channel. Ultimately, this Habitat Mapping Project furthers progress in ecosystem-based management through operational coral reef remote sensing mapping approaches for use in all forms of coral reef environments.

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Session 3. Species Conservation

Chaired by Don Stewart

SUMMARY

prepared by Aaron P. Jenkins and Posa A. Skelton

Conservation of species is an important component of the Ecosystem Based Management approach. Knowledge about species gained through scientific research (and traditional knowledge) and their interaction with the environment provides us with a piece of the picture that is critical for local and national development aspirations. While we have a fair idea of the numbers and identities of the prominent species (e.g. birds, fishes, and corals) in Fiji, there remains a swathe of other species that are yet to be discovered. These species, their roles and their effects on the environment, communities and current and future challenges therefore are unknown. The need to conserve and protect these organisms relies on sound scientific information that can only be garnered through supporting researchers and research institutions. With this in mind, the Fiji Islands Conservation Science Forum held a special session on the theme of species conservation to discuss a range of issues including research on Fiji's largest endemic butterfly (*Papilio schmeltzii*), native and introduced land snails, post-nesting migration of hawksbill turtles (*Eretmochelys imbricata*), and marine reserves for sharks. Chaired by Dr Don Steward (Birdlife International) and Dr Taholo Kami (International Union for the Conservation of Nature – Oceania), the key messages discussed include:

1. A high proportion of Fiji's fauna and flora comprises endemic species, and many of them are endangered or threatened. Our knowledge of the ecology and life-histories of Fiji's biota also is insufficient, thus compromising species conservation initiatives in the nation. There is a great need to give high priority to research (including scholarships for students, engaging communities, and more research funding) that will enhance our knowledge of Fiji's endemic species and so enable informed management actions.

2. Protection of native species begins by building local capacity to identify species, and through this enhanced capacity we are in a better position to detect introduced and potentially invasive species. Early detection will protect our native species and ensure the integrity of our ecosystem is maintained.

3. An intact ecosystem, which included conservation of species, has a bearing on the health of our communities. A healthy ecosystem provides more opportunities — such as better access to diverse food species, medicines and recreation.

4. The need to utilize new technology (such as the use of satellite tagging for turtles and bull sharks, *Carchahinus leucas*) to assist with the protection of species. In the case of mobile species (e.g. turtles, sharks), engaging other communities and countries is a necessary component for species conservation.

5. Traditional knowledge provides a stream of information on native species that should be utilized for the conservation of species.

Presentation 1. A study on the ecology of *Papilio schmeltzii* of Fiji Islands

Chandra, V.[1,2]

The butterfly family Papilionidae contains about 600 species and is distributed worldwide. In the western Pacific it is represented by few species, from 14 in Papua New Guinea to one each in Vanuatu, Fiji and Samoa.

Fiji's endemic swallowtail butterfly, *Papilio schmeltzii*, prefers forested and isolated areas and is found near the edges of forests. It is Fiji's largest butterfly. Available literature has only a few notes on *P. schmeltzii*; hence because very little is known about its ecology it is much in need of study – also because of its endemic status. This study was carried out in the Vatukarasa area, Sigatoka. The study investigated the biology, behavior and distribution of *P. schmeltzii* in detail.

Swallowtail butterflies mainly visit (feed on) Blue Rat's Tail (*Stachytarpheta urticifolia*) flowers, although they also visit pentas, lantana and ixoria flowers. Females prefer to lay their eggs on *Micromelum minitum* plant, but will lay on *Citrus* plants in the absence of *Micromelum*. Eggs, larvae, pupae and adults are described.

P. schmeltzii occurs in limited numbers in their natural habitat, and it has been officially recorded from few localities; this study reports new records of the species for Taveuni, Beqa and Kadavu. With continuing habitat loss due to increasing urbanization, agriculture and deforestation, the outlook for this endemic species is far from bright as many populations will be inevitably pushed to near or actual extinction. Finally, this paper looks at the conservation needs of *P. schmeltzii* based on the information gained from this research.

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Presentation 2. Conservation of Fiji's land snails: biodiversity, agriculture and human health perspectives

Brodie, G.[1, 2]

Fiji's land snail fauna is unique, highly diverse and poorly documented. One hundred and sixty endemic species and at least 15 introduced land snail and slug species are listed as present. However, information to easily identify these species is totally lacking. To address this knowledge gap, existing and new data on Fiji's land snail and slug fauna is being collated. This information is urgently required so that introduced and invasive species can be detected and managed, and critically threatened endemic fauna can be identified.

Case studies from other Pacific Island countries already show substantial endemic land snail biodiversity loss, particularly from high profile invasive snail species that are not yet present in Fiji. Currently we are unable to monitor or manage any potential native species loss because we have little baseline information or reference material that allows us to identify even the most common snails. This lack of identification information also has strong implications for agriculture, quarantine, trade and human health issues because exotic species already introduced are spreading unacknowledged despite the fact that several species are known to be disease vectors and agricultural pests elsewhere. This project is designed to provide immediate and direct invasive snail identification assistance to government units, such as the Agriculture, Quarantine, Forestry and Environment. It is also the beginning of the larger task of documenting the native and endemic snail and slug species present, the better to understand how human-related development and invasive species may be affecting these valuable invertebrate resources in the Fiji Islands.

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Presentation 3. Post-nesting migration of hawksbill (*Eretmochelys imbrata*) turtles in the Fiji islands

Laveti, M.[1,4], Niukula, .[2], Navuku, S.[1], Nagatalevu, D.[3] and Solomona, P.[1]

Fiji's first satellite tagging of a post-nesting hawksbill turtle (*Eretmochelys imbricata*) (known locally as *Marama ni Yadu*) took place on 13 January 2008. The turtle was released from Denimanu village in Yadua Island, Fiji; it was monitored in the Bua waters of Vanua Levu. The second satellite tagging of another post-nesting hawksbill turtle, referred to as *Adi Mamanuca*, commenced in March 2008 when it was released from Treasure Island in the Mamanuca Group; it was last recorded in November 2008, in Lomaiviti waters.

The turtles' migratory routes were tracked by the Secretariat of the Pacific Regional Environment Programme until transmissions stopped. *Marama ni Yadua* measured 88 cm curved carapace length when released, and transmitted for 235 days whereas *Adi Mamanuca* measured 79 cm curved carapace length when released and transmissions lasted for 261 days. Both the turtles migrated within Fiji's waters utilising a few coastal areas as residential foraging sites; their migrations consisted of both trans-oceanic and coastal legs. Results indicate that Fiji's post-nesting turtles are residential which signifies the extent of the conservation effort needed to recover our local declining turtle rookeries.

In our presentation we also provide background information on the turtle species inhabiting Fiji waters, and an overview of turtle tagging results from the Secretariat of the Pacific Regional Environment Program and the United States National Oceanic and Atmospheric Administration of other tagged turtles in the western Pacific.

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Presentation 4. Shark Reef Marine Reserve: a marine tourism project in Fiji involving local communities

Brunnschweiler, J. M.[1] and Rasalato, E.[2,3]

Shark Reef Marine Reserve, on the southern coast of Viti Levu, is an example of an ecotourism project designed to protect a small reef patch and its fauna while preserving the livelihood of local communities. This project, that involves the local communities, uses a participatory business planning approach to marine protected areas management, generating income through a diving user-fee for the local villages that have sold their traditional fishing rights in the marine reserve.

Shark Reef Marine Reserve is a self-sustaining and profitable project, and is an example of a privately initiated, 'bottom-up' approach which includes all relevant stakeholders, in an area where marine rights are finely subdivided.

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Session 4. Taxonomy

Chaired by Robin South and Dick Watling

SUMMARY

prepared by Posa A. Skelton, Robin South and Aaron P. Jenkins

Taxonomy is an important component of Biodiversity Systematics: it is the study of biological diversity. More specifically, it is the science that discovers, describes and classifies all organisms. Taxonomy looks at taxa at any rank, e.g. kingdom, division/phylum, class, order, family, genus and species, among others. 'Nomenclature' determines the naming of organisms based on agreed-to principles, and 'phylogeny' is how taxa are organized in genetically related groups.

Twelve presentations were given for this theme covering taxonomic groups from the terrestrial, freshwater and marine environments. A unique aspect of this theme is the recognition of the importance of indigenous knowledge (ethno-taxonomy) to biodiversity conservation. The key messages from this theme are listed below.

1. Whilst taxonomic knowledge is advanced in a few groups (e.g. freshwater fishes, freshwater snails, seagrasses, algae and corals), for others it remains rudimentary and requires resources (including scholarships, training and taxonomic tools) to advance it.
2. The biodiversity of Fiji and other Pacific Islands is poorly documented, although threats from human activities (land-use practices, invasive species) and climate change are causing serious declines in populations of some species leading to extirpation.
3. Ethno-taxonomy is an integral part of indigenous knowledge. It is suffering from the passing away of knowledge holders, the lack of initiatives and efforts to document this knowledge, the indifference of the younger generation to indigenous knowledge and perhaps the perception that ethno-taxonomy is not as important as scientific taxonomy.
4. Taxonomy in Fiji needs to be broadened (regional and international) to allow Fiji researchers to benefit from global advancements in taxonomic tools and technologies (e.g. genetics research) as many taxonomic groups in the tropics are complex.
5. Taxonomy is important in national development and planning such as trade (e.g. setting quotas for coral harvesting), agriculture (choosing fast growing crop species), aquaculture (food security/enhancement), biosecurity (biocontrol) and adaptation to climate change (drought tolerant species). A multi-prong/partnership approach needs to be adopted therefore (as in, e.g., the Pacific Island Network in Taxonomy) to ensure that taxonomic research is focused and prioritized for the benefit of Fiji and other Pacific Island countries.

Presentation 1. Ethno-biodiversity and taxonomy of marine organisms in Fiji: towards a synthesis of indigenous and modern knowledge as a basis for the conservation and sustainable use of coral reef and marine biodiversity in Fiji

Thaman, R.R.[1,3], Fong, Teddy[1] and Balawa, Asakaia[2]

Ethno-biodiversity (the knowledge, uses, beliefs, management systems, taxonomies and languages that different cultures or societies – including modern scientists – have for their biodiversity) constitutes a critical foundation for the conservation and sustainable use of coral reef and marine biodiversity. A synthesis of indigenous and modern scientific taxonomies for some 1200 coral reef-related finfishes, corals and other vertebrates and invertebrates in Fiji is presented. It is based on over 16 years of studies conducted with local communities, master fishers and fishmongers on the conservation status, uses, local names, behavior, ecology and taxonomies of marine biodiversity in Fiji. The studies have been a collaborative effort between The University of the South Pacific and local Fijian communities; they have been funded by the MacArthur Foundation, the Total Foundation, the Coral Reef Initiative for the Pacific Islands and the Worldwide Fund for Nature. Emphasis is placed on the need for methodologies to record, conserve and promote the use of indigenous ethnobiodiversity and taxonomy and make them integral components of all biodiversity surveys and conservation initiatives. Such efforts will make our research more useful to local communities, enrich our bio-cultural understanding of reef- and marine-dependent societies, and underpin our conservation efforts with better understanding of the organisms and ecosystems that we wish to protect as well as protecting and conserving priceless, centuries-old ethnobiodiversity, without which our conservation efforts may ultimately fail . To do so requires a strong synthesis between indigenous Fijian and modern marine ethnobiodiversity, in particular the emerging body of up-to-date knowledge on the status of coral reef and marine ecosystems, ecological and biological processes, taxa and interlinkages with other ecosystems. Without such an approach, there may be no future for 'marine life', both human and non-human, as we know it today in Fiji . . . or as our elders remember it from the past!

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Presentation 2. Boring sponges from Fiji – their status, diversity and future prospect

Pohler, S.[1] and Rashni, B.[2,3]

Sponges belong to the phylum Porifera which has three classes. Most excavating sponges belong in the class Demospongiae, Order Hadromerida and within it, are the families Clionaidae and Alectonidae. Boring (or excavating) sponges have the capacity to bore into limestone substrates.

Boring sponges play an important role in the marine environment, as they break down hard limestone. Some Caribbean Ocean species are known as nuisances as they weaken reef structures and dislodge coral polyps which lead to coral die-off.

Knowledge of boring sponge diversity and ecology in Fiji remains in its infancy since the first record of Ole Tenda published in 1969. Our research has unearthed interesting diversity and distribution of boring sponges in Fiji, including high diversity in Suva Barrier Reef and Laucala Bay. This diversity includes a number of introduced and invasive species, such as *Cliona varians*, a European/Caribbean species. Kadavu contains the highest diversity of endemic, new species. Boring sponge infestation is considerable in Suva Barrier Reef (90%) compared to the Coral Coast (10%).

Boring sponges weaken reef framework from the interior and thus have a big influence on reef stability. Weakened substratum may also accelerate the activity of secondary borers. Live corals have few boring sponges and the presence of algae, especially coralline algae, plays a major role in limiting the presence of boring sponges. In contrast, high levels of sponge infestation can be linked to abundance of 'free' substrate available for settlement of boring sponge larvae. Areas with large amounts of coarse and very coarse coral rubble with soft algal cover are the most favored sites. Hence a link can be established to recent bleaching events and storms or tropical depressions which dislodged and killed many corals providing abundant settling sites for boring sponges.

Four main problems have emerged hampering rapid assessment: 1), many species descriptions date back to the last century, are incomplete or vague, and often type specimens are lost or not available; 2) modern work on sponges in the region is limited, making comparisons difficult; 3) the reliability of using spicule morphology in sponge taxonomy is paradoxical; and 4) whereas sponges may be cryptic, there is no consensus on the effect of ship ballast disposal on sponge distribution – i.e. are bioeroding sponge species mainly cosmopolitan or are morphologically similar species from widely separated areas complexes of sibling species? Molecular tools should be an integral tool for resolving these problems.

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Presentation 3. A study of the benthic Foraminifera of Laucala Bay, with special focus on *Marginopora vertebralis*

Sharma, A.[1,2]

Foraminifera (often abbreviated to 'forams') are acellular organisms (protists) that form shells (tests) of calcium carbonate or cemented grains of sand or other material which, when the animals die, may form calcareous sand. The Order Foraminiferida (informally 'foraminifera') belongs to the Kingdom Protista, Subkingdom Protozoa, Phylum Sarcomastigophora, Subphylum Sarcodina, Superclass Rhizopoda and Class Granuloreticulosea.

Living benthic and fossil foraminifera species can aid in understanding temporal and spatial variability as well as the implications of positive and negative anthropogenic effects on the environment. The purpose of the study was to identify and determine the different benthic foraminifera within Laucala Bay, Suva, Fiji, as well as identifying the locations where these species are present. Broad patterns of distribution of foraminifera within the bay were established.

Sixty-eight different species from 48 different genera were identified from the 13 sites sampled and the species' classification and taxonomy were determined. Synonyms for each species were found and recorded and plates were made showing the photographs and the species' details. It was assumed that the species live close to where their tests were found and so were mapped accordingly. The abundance of the different species of foraminifera tests in sediments, their wide distribution and their sensitivity to changes in environmental conditions can be used as valuable indicators of environmental change.

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Presentation 4. Soft corals of Fiji

Feussner, K-D.[1,2]

The science of bio-discovery or bio-prospecting refers to the process of collecting and analyzing biological resources in the search for new, active compounds that can be developed into useful products.

The Natural Products Group of the Institute of Applied Sciences, The University of the South Pacific, in collaboration with international partners, carries out a bio-prospecting program in Fiji in order to identify novel compounds for pharmaceutical use. Essential to this research is the need to correlate chemical data (bio-activity) with the identity of the organisms at the lowest taxonomic level (species or genus). The lack of local experts means that we have to rely on overseas experts — currently a retired taxonomist in Australia — to assist us with identification. This requirement also means that chemists and biochemists increasingly need to learn taxonomy.

One of the groups of organisms that we are working on is soft corals. Not much is known about the soft-corals of Fiji, including their diversity and distribution. In this presentation, I discuss my current research on the diversity of soft-corals, Alcyonacea, including the challenges of their identification. Special reference is made to the genus *Sarcophyton*, family Alcyoniidae. I also suggest future research needs in order to fully understand the functions of soft corals to the coral reefs of Fiji.

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Presentation 5. Biodiversity and abundance of hard corals in the central Southwest Pacific and their suitability as a sustainable fishery

Lovell, E. [1,2]

Information on the occurrence of hard coral species has been collated for the central southwest Pacific. For some sites, abundance data is also available. This is of particular relevance in Fiji where the export of live coral for the aquarium fishery has proved to be a valuable coastal resource. Resource assessment indicates that the fishery is under-utilized in terms of sustainable exploitation. The recent findings on species presence and abundance are presented, as are management efforts for the aquarium fishery.

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Presentation 6. Status of the marine macroalgal flora of the Fiji Islands

South, R.G.[1,3] and Skelton, P.A. [2]

The benthic marine macroalgae (seaweeds) of Fiji belong to three main groups of algae: the Chlorophyta (Green algae), Phaeophyceae (Brown algae) and Rhodophyta (Red Algae). More than 450 species have been recorded to date. They are an important component of coral reef habitats, and indicators of reef health. The earliest reports are those of Grunow in 1874, following which there was a gap of more than a century before more recent reports on the flora began with those of VJ Chapman in the 1970s, followed by DF Kapraun and WA Bowden, S Enomoto, S Ajisaka, H Itono, H Kasahara and DJ Garbary. Since the arrival of GR South in Fiji in 1990, there has been a continuous stream of publications on the Fijian seaweed flora, and knowledge of the flora is now comparable to or better than that of most other Pacific islands. The research highlights include the establishment of the Phycological Herbarium at the USP, now comprising some 8,000 specimens, publication of comprehensive checklists of the flora, descriptions of new taxa, monographs on several genera [*Caulerpa* (GR South, PA Skelton, ADR N'Yeurt)*; Ceramium* (GR South, PA Skelton)*,* Corallinales (DW Keats)], and detailed studies of important sites such as Rotuma, the Suva Barrier Reef (ADR N'Yeurt), the Great Astrolabe Reef (DS & MM Littler) and the Great Sea Reef (PA Skelton). Applied aspects include publication of surveys of edible seaweeds in Fiji (GR South) and of seaweed aquaculture (GR South & T Pickering). There are substantial areas within Fiji not yet explored for seaweeds (Yasawas, Lau Group, much of Vanua Levu) and deeper sampling, especially on reef faces, will certainly yield many new records. There is a need for monographic studies of important genera, and for molecular genetics to sort out some of the most difficult taxonomic problems. Seaweeds are useful bio-indicators for heavy metal pollution; they should also be surveyed for potentially useful bio-products.

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Presentation 7. Seagrass species of the Fiji Islands

Skelton, P.A.[1,2]

Seagrasses are unique flowering plants adapted to living in saline environment. They belong to the Division Magnoliophyta, Class Liliopsida, orders Hydrocharitales and Potamogetonales, and families Hydrocharitaceae, Cymodaceae, Zosteraceae. Eight seagrass genera are known of which three are found in Fiji waters: *Syringodium, Halodule* and *Halophila*.

Knowledge on seagrass diversity of Fiji began with the report by the Wilke's expedition in 1878, of which three species were known. Other itinerant visitors made collections of seagrasses and these are scattered in herbaria in Europe and America. During the 1980s Japanese researchers undertook research on seagrass beds on Dravuni, Kadavu resulting in a workshop with proceedings published in 1994. Research by graduates and scientists from The University of the South Pacific continues to focus on the importance of seagrasses to the coastal ecosystem. In the 2004 survey of the Cakaulevu (Great Sea Reef) in northern Vanua Levu another new record of seagrass species was found at minimum depth of 10 metres. This record brings the known seagrass species to five – excluding a subspecies that is endemic to Fiji, Tonga and Samoa.

Seagrasses of Fiji are of regional significance in that they are the foraging fields for Hawksbill and Green turtles. Unfortunately, the distribution of seagrass species in Fiji remains poorly known thus identifying it as one of the areas for future research. Given their regional significance, communities and managers should consider protecting some seagrass beds to ensure the survival of turtles and economically important fish stocks.

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Presentation 8. The ecological importance and ethnobiodiversity of parrotfishes (Scaridae): Vanua Navakavu Perspective

Fong, Teddy[1], Thaman, R.R. [1, 3] and Balawa, Asakaia[2]

Parrotfishes (Scaridae), of which there are about 30 species reported in Fiji's waters, are among the most common, diverse and prolific of Fiji's important food fishes and have important ecological roles to play in coral reef and marine ecosystems. Some species are also under threat. These mainly shallow water and coral reef-associated species are renowned for their sexual dimorphism and distinct color forms for males and females and different growth stages, most of which have distinct vernacular Fijian names. Parrotfishes may also be among the best indicator species of the health and future sustainability of our lagoons, reefs, beaches and the success of associated conservation efforts. This paper looks at the taxonomic and morphological diversity, ecological roles, conservation status and depth of local knowledge of parrotfishes in Fiji, and the fishes' role as indicator species of the health of our coral reef and nearshore marine and coastal ecosystems.

Parrotfishes have a major effect on coral reefs through intensive grazing and associated bioerosion. Grazing patterns of large schools of parrotfish prevent algae from choking out corals. Many parrotfishes feed on calcareous algae contributing significantly to the process of bioerosion and the creation of sediment and sand in lagoons and on reefs and beaches. Parrotfishes are able to utilize the last stubble of algae on reefs that is no longer available to other grazing herbivores. For example, a single *Bolbometapon muricatum* (bump-head parrotfish) consumes, and turns into fine sediment, approximately one cubic metre of coral skeletons per year. In this way large schools of bump-head parrotfish, and the multitude of other parrotfishes, play very dominant roles in determining the fine-scale topography and the health of coral reefs, lagoons and beaches.

Indigenous knowledge (referred to as ethnobiodiversity) —when combined with the most up-to-date modern knowledge about parrotfishes, the health of our lagoons and the benefits of marine protected areas — can provide a basis for better understanding of this ecologically and culturally important fish family, and how this knowledge can be applied to the conservation and sustainable use of marine biodiversity and coastal ecosystems. In our presentation we stress also, that the richness, depth and complexity of local indigenous knowledge and the taxonomies used for parrotfishes in Fiji — which can serve as an important input to community based conservation — is, like many of our more important marine species themselves, seriously threatened and unknown to the current generation of fishers. There is thus a critical need to conserve this ethnobiodiversity heritage alongside our conservation efforts to conserve the more tangible biodiversity itself: if we do not, we may be 'throwing the baby out with the bathwater'.

The results of this research are based on community-based surveys and market studies over the past five years in the Fiji Islands. The studies have been a collaborative effort between The University of the South Pacific and local Fijian communities funded and supported by the MacArthur Foundation, the Total Foundation, the Coral Reef Initiative for the Pacific Islands, the Foundation for the Peoples of the South Pacific, the Worldwide Fund for Nature, the World Fish Center, ReefBase and FishBase. It is hoped that knowledge gained and experiences learned from local taxonomists will provide a basis for a marriage of traditional ethnobiodiversity and modern science as a foundation for ecological sustainability and improved management of marine and coral reef ecosystems and fisheries.

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Presentation 9. Freshwater and estuarine fishes of Fiji: current taxonomic knowledge and priorities for conservation

Jenkins, A.P.[1,2]

Our knowledge on the taxonomy and composition of Fijian freshwater and estuarine fishes builds upon sporadic work in the late 1920s, 1950s and 1980s. During the past decade, beginning in 2001, use of new electrofishing technology and increased surveying and taxonomic effort by the author and students has resulted in a rapid increase in knowledge of Fijian fish species composition and ecology. We currently recognize 166 species (belonging to 47 families) from tidal reaches upwards of which 156 species (43 families) are indigenous to Fiji, 10 species (four families) are established invasive or non-indigenous populations, and at least 13 species (four families; 8.3%) are considered to be Fijian endemics. Faunal composition is dominated by species of marine ancestry and in native diversity and abundance by Gobiidae (Gobies), Eleotridae (Gudgeons), Kuhliidae (Flagtails), Mugilidae (Mullet), Sygnathidae (Pipefishes, Seahorses) and Anguillidae (Freshwater eels).

Fiji was recently recognized as a global priority for freshwater conservation based on endemics per unit land area. Major threats and issues for freshwater fish conservation are dominated by a rapid loss of habitat and connectivity. The fresh, estuarine, ocean habitat continuum is interrupted by 1) loss of forested catchments (logging, farming, degraded buffers); 2) invasive predation and water quality alteration; 3) gravel extraction, dam building, road construction, culvert building; 4) industrial scale pollution (e.g. sugar cane waste, mine waste), and 5) destructive fishing practices (derris root, pesticides). This issue is compounded by a general lack of cross sectoral awareness of food and water security implications of loss of habitat, cross habitat connectivity and the effects of invasive species.

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Presentation 10. Freshwater gastropods of the Fiji Islands

Haynes, A.[1,2]

Gastropods (snails) belong to the invertebrate Phylum Mollusca and Class Gastropoda. The freshwater gastropods in Fiji are distributed among seven families: Neritidae, Thiaridae, Hydrobiidae, Planorbidae, Ancylidae, Acochlidacea and Viviparidae. The most important are the Neritidae with 26 and Thiaridae with 10 species. The Neritidae in Fiji is divided into the genera *Clithon, Neritina, Neritilia, Neritodryas* and *Septaria* while the Thiaridae are placed in the genera *Melanoides, Thiara* and *Fijidoma.* In total there are 52 freshwater snail species in Fiji.

Albert Mousson described the freshwater snails collected by Dr Edward Graeffe from Fiji and Samoa in 1864. However, most of his species are considered invalid because if a gastropod had a shell slightly different in color, pattern or shape from the 'norm', he placed it in a new species. More recently, in 1975 Starmühlner sampled the streams in Viti Levu for gastropods and found 26 species. Since 1982, I have investigated the distribution of gastropods in the streams and rivers of Viti Levu, Vanua Levu, Taveuni, Ovalau, Kadavu and Waya. I have re-evaluated the two neritid genera *Clithon* and *Neritina* using their reproductive anatomy and have completely revised all of the neritid limpet species of *Septaria.* I have also studied the population biology of the endemic species *Fijidoma maculata* and with the late Dr Kenchington described a new endemic species, *Acochlidium fijiense* (Acochlidacea).

More work needs to be done on the reproductive strategies, behavior, DNA analysis and ecology of the freshwater gastropods. The effect the introduced species *Cipangopatudina chinensis* (Chinese Apple Snail) is having on stream ecology and on other gastropod populations should be investigated also.

Gastropods are a major part of freshwater ecosystems. They have the greatest biomass of any of the invertebrates in many streams and they are food for prawns and fishes. Their absence indicates either past or present pollution. Poor agricultural practice and deforestation cause mud and grit to be washed into streams where it accumulates on the stream bottom. This mud covers the film of algae growing on the rocks and stones. Algae is the food on which the gastropods graze so that they are smothered or die from starvation.

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Presentation 11. Weevil diversity in the Fiji Islands (Coleoptera, Curculionoidea)

Brown, S.D.J. [1,2]

The weevils (superfamily Curculionoidea) are represented in Fiji by more than 320 species in seven families. These species include effective biological control agents such as the water hyacinth weevil *Neochetina eichhorniae* (Erirhinidae); economically important pest species such as the banana borer *Cosmopolites sordidus* (Curculionidae), sweet potato weevil *Cylas formicarius* (Brentidae) and red palm weevil *Rhynchophorus ferrugineus* (Curculionidae); and aesthetically interesting species such as *Cerambyrhynchus schoenherri* (Anthribidae), *Rhinoscapha lagopyga* (Curculionidae) and *Bulbogaster ctenostomoides* (Brentidae).

Weevils comprise the largest group of organisms in the world, their success due in part to their ability to utilize plants in nearly every capacity and display remarkable host specificity. The weevils of Fiji are poorly known both in their taxonomy and their life histories. Accurate identification is essential to control emerging pests and invasive species and knowledge of life history is essential for accurately estimating conservation priorities and ecological function.

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Presentation 12. Invasive ants in Fiji

Latchman, R.[1,2]

Invasive species are among the most significant threats to biodiversity. Recent research has focused on the distribution and effects of invasive ant species, and 67 invasive ant species have been reported to have established in the Pacific region. Many of these species have been present and widespread in the region from as long ago as the mid-1800s and the early 1900s. Several of these invasive species are widespread: 15 species are recorded from ten or more island groups.

Given the relatively small number of the Pacific Island ant fauna, there has been a disproportionate amount of interest and study on the ant species of the region. However, the ant fauna of Fiji has received relatively little attention. An updated checklist of the ants of Fiji (2006) includes 138 valid species and subspecies: 91 are Fijian endemics, 22 are wide-ranging Pacific natives, and 25 are invasive species. During a survey of Viti Levu conducted in 2004, five invasive ant species were reported that had not previously been reported from Fiji; *Monomorium destructor, M. sechellerise, Platythyrea parallela*, *Tetramorium lanuginosum* and *Cardiocondyla obscurior*.

The endemic Fijian fauna probably descends from migrants from the Papuan and Western Melanesian regions, with subsequent radiation in several genera, particularly *Camponotus, Cerapachys*, *Leptogenys*, *Lordomyrma, Pheidole*, and *Strumigenys*. The ever-increasing number of invasive ant species in Fiji and across the broader Pacific region has potential long-term negative effects for the conservation of the region's unique biota.

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Session 5. Community-based Adaptive Management and Socio-economics

Chaired by Joeli Veitayaki and Kesaia Tabukanawai

SUMMARY

prepared by Posa A. Skelton

Ten presentations were given in this session.

The session began with a review of scientific knowledge and its effects on community-based management; the review highlighted the need for scientific information to be fully understood — especially by the local community — to ensure that it is fully utilized in coastal management policies.

The role of culture in coastal management has not been explored to the same level as have the ecological, economic and social factors influencing management. Because culture is an important component of Pacific Islands existence, it must be factored into management initiatives. The effects of various management initiatives have remained unexplored until a recent assessment was undertaken on locally managed marine areas. The assessment found positive responses by community to this approach driven by community empowerment, active community participation, alternative livelihood opportunities and engagement with outside agencies. Thus, the community engagement either through the development and implementation of management initiatives was highlighted as critical. It was noted that economic benefits can accrue by taking certain actions such as establishing *tabu* ('no take') areas.

Apart from the reports on studies investigating those four factors for effective management, there were two important highlights of the session. One was the report of an assessment of Fiji's fishery resources state: the report revealed that a big proportion (70%) of landed fishes and invertebrates are sold. Of concern was the high proportion of fish being sold by unlicensed fishers, something that may have contributed to the reported reduced catch per unit effort since the 1990s. The other was a presentation on the conservation and sustainable use of agro-biodiversity and associated ethno-biodiversity which together constitute vital preconditions for food and subsistence security and sustainable living, especially in island environments. Outer island 'cool-spots' have equally important conservation status as have the better focused-upon 'hot-spots' and charismatic species; agro-ecosystems and agro-biodiversity also are often the most seriously affect by invasive alien species, one of the most serious emerging threats to biodiversity conservation worldwide.

Presentation 1. Evaluating the role of science in community based adaptive management of coastal resources in Fiji

Seidel, H.[1,2]

Community-based adaptive management in Fiji is coordinated by the Fiji Locally-Managed Marine Area , a network which aims to apply modern scientific knowledge to traditional management and governance systems for improved coastal area management. The use and degree of modern science required to support community-based adaptive management however, is not properly defined and viewpoints vary between stakeholders.

This presentation is a review of the actual and potential use of the natural sciences as an integral part of community-based adaptive management where they can support resource management at various levels of governance. Existing approaches such as participatory community-based biological monitoring are discussed. Alternative approaches including modelling with available biophysical data and monitoring and evaluation methods are examined.

The findings suggest that the supporting function of existing scientific knowledge has not been fully exploited to date. Current procedures to generate site-based scientific knowledge tend to be limited in their scope, and appear to have little direct influence on management of coastal resources. Specifically, the degree and capacity to which communities can effectively benefit from the collection and interpretation of data based on scientific methodologies without continuous external input, need to be revised. Recommendations are provided for more effective integration of modern science into the community-based adaptive management process.

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Presentation 2. A nation-wide survey of village-based fishing pressure in Fiji

Institute of Applied Sciences[1,2]

While commercial and village-based fisheries are crucial to the economic needs and cultural livelihoods of Fiji's coastal communities, the status of these fisheries and the resources on which they depend are largely unknown.

To complement the Fiji Department of Fisheries' efforts to quantify catches from recognized commercial landing sites, in 2008 Fiji's Locally Managed Marine Areas Network embarked on an ambitious national project to quantify catch per unit effort from village-based fishing. Based on responses to questionnaires distributed across the country, more than 11,300 catch records have been reported from 46 villages across 10 provinces. Data analysis of Institute of Applied Sciences' partner sites reveals trends in catch landings by geographic region, household, fishing gear, and end users of the catch, enabling a better understanding of the economic drivers and demographic composition of the subsistence fishery. Preliminary analysis suggests that more than 70% of the fishes and invertebrates landed in villages are sold, the remainder of catches consumed at home or donated to village functions. Overall, catches were dominated by emperors (Lethrinidae), surgeonfishes (Acanthuridae) and snappers (Lutjanidae), and handlining, spearfishing and netting are the primary methods of fishing. Data are evaluated to 1) provide insights into the status and condition of Fiji's subsistence fishery, and 2) serve as a baseline for monitoring change in landings and fishing effort over time, especially where communities are implementing management plans under the Fiji Locally Managed Marine Areas Network. This ongoing study will help us better understand the sustainability of nearshore fisheries and assess the effectiveness of community-based management in Fiji.

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Presentation 3. Cultural roles and marine resources management in Fiji

Veitayaki, J.[1,2]

Even though customary practices are the basis of the community-based marine resource management activities now spreading throughout Fiji and other parts of Oceania, little study has been undertaken on the influence of the cultural roles on the effectiveness of marine management areas. Moreover, the challenges that are now facing community-based marine resources management make it critical that the influence of cultural roles be better understood and addressed so that areas that are weak and incapable of performing can be identified. For this reason cultural roles must join the ecological, economic, and social factors as the parameters to be better understood for the effective management of marine resources at community level.

In Fiji, a dual system of coastal resource management exists — an informal management system devised and implemented by a community of resource users coexisting with a formal government management system. This customary system, that is based on traditional practices that are handed down through the generations, has been the cornerstone of the community-based resource management now undertaken across the Pacific Islands. Although the customary system reflects the ethnic, clan, kin, class and gender situations and responsibilities, there has been little consideration of cultural factors. In other words, the assumption has been made that the system works and that all of the community members are adhering to the decisions made by the community.

A quick review of the reports published by some of the community groups undertaking conservation shows little study of how the people involved in community-based resource management have perceived the imposition of customary resource management arrangements. There are therefore questions on whether the people are happy with the arrangements and what their perception is in relation to the management arrangements: what is the effect of the resource management activity on the people?; were the people's views solicited before the management decision was made?; how was the decision made in the first place?; is the customary system able to function in the present day?; why is poaching now the biggest threat to community-based resources management?; can there be a better arrangement to 'deliver' on the objective of resources management? These questions relate to the cultural roles that we will examine in this study. Ways to answer some of those questions are identified in this presentation: they include improved village governance, livelihood considerations, enhanced support by Government and Church, and appropriate conflict management and planning.

The existence of customary marine tenure and rules that include the unwritten, informal (customary and traditional) practices through which people gain use rights, and define specifically which acts are required, permitted and forbidden by resource users with respect to their coastal activities makes this study important and timely.

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Presentation 4. Socio-economic and governance impacts of marine managed areas on local communities in Fiji

Fong, P.S.[1,2]

One of the major challenges faced by the conservation world is that of understanding the effects of management programs on the livelihoods of the local people — the group that is directly affected by the implementation of these programs. Recently, a collaborative study coordinated by Conservation International and The University of the South Pacific was conducted in Fiji to assess the effects of locally managed marine areas on the social and economic levels of the local people. The study also examined the critical determining factors that contributed to the achievement of those effects.

Preliminary findings suggested that overall adoption of the locally managed marine area system has had notably positive effects on the local people and has created better outcomes now than did outcomes from the former system and period. For instance, social cohesion has increased amongst community members, the governance system has become effective, there is increased environmental awareness and also income levels have increased. However, there are also challenges, such as conflicts and equitable sharing of benefits; they need to be addressed.

The critical determining conditions for the achievement of the positive outcomes are political support through the recognition of the rights of the community to make decisions regarding the fishing ground, availability of alternative sources of income, active participation by the community in project coordination, and continuous support from outside agencies. Findings from this study can provide the basis for the design of effective marine resource management strategies in Fiji and also can provide lessons for the conservation world.

[Author acknowledges the assistance of Giselle SamonteTan (Center for Applied Biodiversity Science, Conservation International, USA), Professor Bill Aalbersberg, (Institute of Applied Science, The University of the South Pacific, Fiji Islands) and Loraini Sivo (Conservational International- Fiji Program, Fiji Islands)].

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Presentation 5. Gross financial valuation of a Fijian customary fishing ground

Ratuniata, R.[1,2]

This study quantifies the increase in gross monetary value of marine resources within a traditional fishing area (*i-qoliqoli*) that can be attributed to the implementation of community-based marine management initiatives — such as establishing *tabu* areas. The research estimated the population of marine resources within Namada's *i-qoliqoli* on southern-western Viti Levu, using data collected from biological surveys prior to, during, and after management.

Gross financial valuation was calculated based on market surveys for all edible marine resources including targeted finfishes and invertebrates. Results demonstrate positive economic benefits accruing from community-based management.

It is hoped that this research methodology can be further developed to a standardized form and used to demonstrate the financial sustainability of locally-managed marine areas.

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Presentation 6. Traditional indigenous knowledge and community-based environmental management

Nainoca, W.U.[1,2]

About 80% of the land in Fiji and 410 *qoliqolis* (traditional fishing areas) are native owned. There is an obligation to ensure the sustainable use of natural resources and environmental conservation as the resources in those *qoliqolis* and land are exploited and environmental degradation increases.

Community-based environmental management initiatives commenced in Fiji in the early 1990s and continue to gain momentum with new conservation sites added annually. Research at these sites has been mainly scientific and ecological in nature.

This paper explores the role of Fijian traditional indigenous knowledge in implementing community-based environmental management in Fiji. A qualitative research strategy with case studies and a research design using methods that include interviews (key informants and focus groups) and participants' observations was used; traditional skills and roles are described. Findings will help in developing an understanding about the role that Fijian traditional indigenous knowledge does, should and could play in community-based environmental management in Fiji. The wider implications and further research potential include exploring the application of lessons learned and insights gained from Fiji to community-based environmental management in general.

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Presentation 7. Integrating ecosystem-based management principles into the Fijian context: a case study from Kubulau, Vanua Levu

Tui,T.[1,3] Kolikata, P.[2], Dulunaqio, S.[1] and Jupiter, S.[1]

The term ecosystem-based management has recently come into vogue to describe a holistic style of resource management that integrates humans into the environment and considers cumulative effects from different activities. Specific applications of ecosystem-based management principles, however, will vary according to location and conservation goals.

We present a case study from the Kubulau district of Vanua Levu, Fiji, where traditional resource owners are working in partnership with local non-government organisations to establish a network of protected areas to improve fisheries management. In response to perceived declines in important food fish and invertebrate catches from increased commercial landings, leaders from the 11 villages within Kubulau called for assistance in 2004 to develop a management plan for their 260 square kilometre traditional fishing ground (*qoliqoli*). A workshop held in 2005 to identify threats and management objectives resulted in the community-led protection of 14 traditional (*tabu*) estuarine and reef areas, three district-wide, no-take fisheries areas, and one forest reserve. Draft management plans for the reef and forest areas were produced and are currently being adapted to form a single document integrated under the existing Fijian legislative framework, with regulations and best practices for management of terrestrial, riparian, estuarine, and marine habitats. The effectiveness of management is being assessed through surveys of fish and invertebrate size and abundance in protected versus control sites, and catch per unit effort data on fish landings. By November 2009, results of these surveys will be reported to the communities along with key ecosystem-based management messages to produce a refined protected area network.

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[2] Kubulau Resource Management Committee, Vanua Levu
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Presentation 8. Fiji's agrobiodiversity: foundation for conservation success and energy, health and livelihood security

Thaman, R.R.[1,2]

The conservation and sustainable use of 'agro-biodiversity' and associated 'ethno-biodiversity' (the cultural link with biodiversity) constitute one of the most important preconditions for food and subsistence security and sustainable living in Fiji: they should be seen as an integral component in ALL community-based conservation initiatives. This is particularly true for the smaller 'biodiversity cool spot' outer island communities in Fiji which, compared with the larger islands, have more limited and highly threatened terrestrial biodiversity inheritances and fewer options for modern market-orientated development and large-scale conservation initiatives that tend to focus on endemic species and 'biodiversity hotspots'. All Fiji's islands, regardless of their size, are like arks with limited and fragile biodiversity inheritances, and most island communities have an obligate dependence on their limited biodiversity inheritances for their livelihood, as well as the nation's development. Prominent among this inheritance is agro-biodiversity, as many small islands and agricultural areas (e.g. the sugarcane belt) have little or no remaining truly wild land and natural forest. Agro-biodiversity, in this context, includes all agro-ecosystems (including associated fallow and protected areas) in both rural and urban areas; species and genetic diversity of both domestic and wild organisms within these ecosystems; and agricultural ethno-biodiversity — the knowledge, uses, beliefs, management systems, taxonomies and language that a given society, including western scientific society, has for agricultural biodiversity. This paper describes this rich, life-giving bio-inheritance, its conservation status, and why it should be an increasingly important focus of all conservation initiatives, if we are really serious about addressing all three pillars of the U.N. Convention on Biological Diversity: conservation, sustainable use and equitable access to the benefits of genetic diversity—the latter two being of particular relevance to agro-biodiversity.

Unfortunately, island agro-biodiversity inheritances, including associated ethno-biodiversity, are being rapidly eroded because of increasing monoculture, monetization and urbanization, and because mainstream biodiversity conservation initiatives concentrate largely on endemic or charismatic native organisms, intact terrestrial and marine ecosystems and 'species survival'. This concentration is despite most culturally useful, well-known and highly threatened biodiversity being commonly found within the fabric of permanent and shifting agricultural land-use systems. Most endemic plants and animals are not known to local communities and do not have local (vernacular) names. Agro-ecosystems and agro-biodiversity are also often the most seriously affect by invasive alien species, one of the most serious emerging threats to biodiversity conservation worldwide. The result of a failure to conserve, enrich and sustainably use island agro-biodiversity will be the abject poverty, food insecurity and nutritional and health deterioration that we associate

with the world's most destitute societies, a trend already reaching serious proportions in many small island developing states.

Fortunately, there are exciting international and national initiatives that underline the critical importance of agro-biodiversity and emphasize that it can not be separated from 'wild biodiversity'. One of the major work programs under the Convention on Biological Diversity, along with the new Work Program on Island Biodiversity, is the Work Plan on Agro-biodiversity. In Fiji, the Koroyanitu Conservation Area development with its agricultural 'buffer zone' and the 'ridge to reef' approach to biodiversity research and conservation adhered to by the Pacific-Asia Biodiversity Transect Network and Conservation International in their 'Fiji Water'-supported project in Ra Province are excellent examples of the recognitions of the importance of focusing some conservation effort on agricultural ecosystems and agro-biodiversity. The South Pacific Regional Initiative on Forest Genetic Resources and the efforts of the Secretariat of the Pacific Community's Trees and Forests Programme—which both have components on agro-forestry, agro-biodiversity and tree improvement within agro-ecosystems—, and the efforts of the World Wildlife Fund for Nature to replant *vesi* (*Intsia bijuga*) on Kabara are other excellent examples. Finally, the overarching Fijian concept of *vanua* (land) does not separate the *veikau loa* (true forest)*, wai* (water, including rivers, other freshwater bodies and the ocean) and *vanua teitei* (garden lands) from each other: they are clearly interlinked ecosystems, all with biodiversity inheritance worthy of the attention of 'biodiversity conservationists'.

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Presentation 9. Wetlands, human health and food security in Pacific Islands: a new project for Fiji and PNG

Waqaniburotukula, S.[1,2]

From global to local scales, the health and environment sectors in International Water Resource Management funding, policy and planning is not integrated. For example, there is lack of co-ordination and applied understanding between those agencies addressing Millennium Development Goals numbers One (poverty and hunger) and Seven (environmental sustainability). In the Pacific Islands, the need for synergy in these sectors is particularly relevant to the management of water-borne diseases in populations adjacent to island river basins and to the security of human food resources from coral reefs. Evidence-based case studies are needed to form the basis for dialogue and shared vision building between the major regional health, environmental and development agencies.

This demonstration project builds on past and ongoing initiatives in Fiji (Ecosystem-Based Management project) and Papua New Guinea (Locally Managed Marine Area Network) to ascertain the links between particular aspects of human health and the ecological integrity of these two major wetland types. It will help identify overlapping areas and create greater integration between health and environment organisations in those countries, with the purpose of encouraging development and food security. These aims are to be achieved partially by producing case studies on the interrelationships between the ecology of reef and river systems with water borne diseases and protein availability, developing a comprehensive database of health, environment and development agencies operating in the Pacific Islands region, and establishing a protocol for ongoing dialogue between organisations having mandates in health and development, and interest in maintaining the ecological integrity of rivers and reefs.

Major stakeholders in both countries will include the World Health Organization, Food and Agriculture Organization, South Pacific Regional Environment Program, United Nations Development Program, international conservation non-government organisations and national health and environment-related institutions.

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Presentation 10. Community messaging: an Ecosystem-based Management tool for securing community ownership through effective information dissemination

Navuku, S.[1,2] and Tokece, A.V.B.M.[1] and Tabuanakawai, K.[1]

Communities reminisce about the changes in the ecosystem — be it the less abundance of fish, or presence of smaller fish, or the decline in habitat integrity.

This paper describes the World Wildlife Fund for Nature's experiences in the Ecosystem-Based Management project community at Macuata on Vanua Levu Island. The facilitated process of awareness education via the community messaging approach carried out there aims at enhancing knowledge transfer and information exchange, and allows the voices of all community members to be heard without their overstepping the boundaries of Fijian customary protocol. Learning from elders and addressing the concerns of youth have been adopted in Macuata as a means of facilitating better resource management by all thus indirectly influencing decision-making.

There is no definition of the concept of community messaging; we define it as an aid tool for the transfer of knowledge from the older to the younger generation. In the process, an exchange of information is generated and conservation actions taken. This concept is effective in Macuata Province where it is complemented with the opportunity of tracing historical uses of natural resources. As part of the project, information sheets summarising individual issues were distributed to households, the returned queries providing openings for discussions and clarifications. In the process, individuals of all ages got to express their opinions on particular topics of interest. A shift in community perceptions of the environment, and a pro-active response to protected area management are some results of the community messaging program.

Traditional knowledge combined with scientific findings is perhaps a way forward for community-based conservation efforts in Fiji.

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Session 6: Terrestrial Ecology

Chaired by Marika Tuiwawa and Dick Watling

SUMMARY

prepared by Posa A. Sketon

Nine presentations were given in the session and they spanned a range of topics including basic research on Fiji fauna, assessing the state of Fiji's forests using birds as environmental indicators, invasive ant species in Fiji and the Solomon Islands, fruit flies, freshwater macro-fauna, and seabird colonies.

Although birds are important environmental indicators, it is not known whether they could be used as a measure of the health of a forest. An assessment concluded that having a diverse bird species assemblage that included threatened species is the best indicator of forest health.

Our knowledge on the insects of Fiji remains rudimentary; however, recent surveys are revealing unusual information. A survey of beetles (Coleoptera) found that ecological niches of beetles at different elevations appear to be discreet. The survey recommended that proposed conservation areas take into account the beetles' elevation range and give priority for conservation over agriculture developments in the mid-altitude elevation.

Fruit flies are serious economic pests to agriculture. Routine surveys undertaken by the Ministry of Agriculture identified seven fruit fly species in Fiji, most of them favoring economically important crops such as guava and breadfruit.

Invasive species are a serious threat to biodiversity as they alter ecosystem structures and compete with native ant species. Ants, including the ghost ant (*Tapinoma melanocephalum*) from Africa and Asia, and the little fire ant (*Wasmannia auropunctata*) were assessed for their behavior and effect on Fijian and Solomon Island animal communities.

Two studies on the freshwater environment (an area often under-studied) were conducted to identify the macro-faunal assemblages and determine what effect, if any, has development on that fauna. The conclusion from both studies provided a timely reminder of the need to maintain the integrity of our environment to ensure that our biodiversity is conserved.

Finally, the importance of undertaking research on our biodiversity can sometimes have unexpected consequences — such as the survey in Fiji for sites of global and national importance for seabird colonies that led to the eradication of invasive species and rehabilitation of islands.

Presentation 1. Monitoring of forests and the potential to use indicator species

Valu, M.[1,5], Shankaran, N.[2], Markwell, T.[3], Khurma, U.[2] and Millett, J.[4]

Birds are frequently used as environmental indicators because they are well known, easy to identify and survey and tend to be relatively sensitive to environmental change. The global criteria for identifying Important Bird Areas was used to identify 14 sites of international importance in Fiji using birds as indicators of biodiversity importance. However, the assessment of the total number of birds alone may not give a good indication of forest quality. Our study examined bird populations in mature secondary forest and recently-logged forest in the Viti Levu Southern Highlands Important Bird Area. The study used point counts to look at species assemblages, total numbers of birds, and potential indicator species for high quality forest. The study also attempted to quantify what stratum of the forest was used by different species.

Overall the study indicated that numbers of individual birds was not a good indicator of forest quality because of the high density of a few generalist species; species assemblage was probably a better indicator. The results of the study did not reveal strong indicator species for old-growth forest and indicated that most species could adapt to the forest habitats they utilize. We conclude that species assemblages plus the presence of threatened species are probably the best indicators for monitoring forest bird populations.

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Presentation 2. Addressing the imminent threat of extinction to Fiji's unique botanical diversity

Tuiwawa, M.[1,2]

Fiji's botanical diversity is of global significance for conservation owing to the extremely high levels of endemism and rarity found in the country.

In this presentation several examples are highlighted of extremely rare and endemic plants found in Fiji and the threats to their continued existence. Some examples given are of the shrub *Antiaris toxicaria* var. *macrophylla*, which was last recorded in 1860 and has cultural significance as it produces poisonous latex used on spears and arrows during warfare, and *Parkia parrii*, a tree endemic to Bua and Rewa, which was last recorded in 1878.

Main concern for conservation and protection must be given to the natural remnant forest blocks remaining in the country; they now represent less than 30% of the terrestrial vegetative cover.

Priority areas for conservation are highlighted by the Key Biodiversity Area approach. These areas include the Nakauvadra Range on Viti Levu and the interior forests of Gau Island. Recent biodiversity surveys in some of these last remaining forest blocks have revealed several new species and range extensions of known species, and many species thought to have become extinct (such as *Neoalsomitra integrifoliola*, a relative of the melon and cucumber species, and last seen in 1868).

Innovative approaches to conservation such as conservation trust funds (as used in Sovi Basin) in conjunction with community management are needed to secure the future of the largest intact forest blocks in Fiji.

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Presentation 3. Taxonomy, diversity, and distribution of canopy Coleoptera (beetles) along elevational gradients on Eastern Viti Levu, Fiji

Sakiti, H.W.[1,2]

Ecological gradients (e.g. habitat types, climate, altitude, and seasonality) are known to be important factors in regulating the diversity and distribution of insect taxa. Knowledge of the distribution of insects is essential baseline information for proper conservation measures to be implemented. In Fiji, virtually no research of this type has been done.

In this study, canopy coleopteran communities were surveyed along a landscape transect on selected undisturbed rainforest areas in eastern Viti Levu, Fiji, from lowland Nakobalevu (200m) through upland Waisoi, to a cloud montane forest in Monasavu (1000m). Dominant beetle families sampled from the canopy included Curculionidae, Chrysomelidae and Staphylinidae and their dominance reflects their generalist feeding habits and ability to exploit rainforest habitats. Diversity was highest at mid-to-high altitudes (800-1000m in Monasavu). Along the landscape transect, Multidimensional Scaling Ordination revealed a clear division in the canopy beetle communities between the three habitat types (lowland forest less than 400m, upland forest less than 600m and cloud montane forests less than 1000m) suggesting that taxa were restricted within an elevational range due to preferred altitude, climatic conditions and, possibly, plant-host associations. Therefore, for the proper conservation of Fiji's insect fauna, conservation measures should ensure (1) that a span of elevational range within intact tracts of tropical forests be protected for the conservation of a wide range of taxa, (2) that altitude be a criterion used for selecting conservation areas, and (3) that within intact forests, conservation of biodiversity be given higher priority at mid-altitudes (800m) over agricultural purposes or human habitation.

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Presentation 4. The distribution of fruit-flies in the Fiji Islands

Leweniqila, L.[1,2], Ralulu, L.[1], Caucau, A.[1] and Wise, F.[1]

Fruit fly trapping and host surveys are conducted by the Ministry of Agriculture and Primary Industries. Fruit fly trapping confirms the presence of different species of fruit flies while host surveys confirm the fruit fly fauna, geographical distribution, host fruit range, host susceptibility, levels of damage and parasitism and seasonal abundance.

In Fiji, these two activities have confirmed the presence of seven species of fruit flies. These are *Bactrocera passiflorae* (Froggatt), a light-coloured *B. passiflorae* (Drew & Hancock), *B. xanthodes* (Broun), *B .distincta* (Malloch), *B. gnetum* (Drew & Hancock), *B. obscura* (Malloch) and *B. kirki* (Froggatt). Only *Bactrocera gnetum* is endemic to Fiji.

Commonly known as the Fijian Fruit Fly, *B. passiflorae* is the most widely distributed species in Fiji; it is found from coastal areas to the rainforest-clad mountainous areas. The Pacific Fruit Fly, *B. xanthodes* however, is found only in coastal areas. *B. distincta* has been found on all of the islands. The light-colored *B. passiflorae* has been found in the interior of Viti Levu at Nadarivatu and on the islands of the Lau Group. *B. gnetum* has been found only on Vanua Levu while *B. obscura* and *B. kirki* are present only on the island of Rotuma.

Fruit flies utilize a range of hosts. The 'best' economically important fruits preferred are guava (by *B. passiflorae*) and breadfruit (by *B. xanthodes*).

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Presentation 5. Unicolonial aggression within and among the local population of the invasive ant *Tapinoma melanocephalum* in Viti Levu, Fiji

Latchman, R. [1,2]

Invasive species are among the most significant threats to biodiversity, especially in insular areas. These species drastically alter ecosystem structures and functioning and may cause local extinctions. Among them, structure-infesting ants represent a subset of major pest problems in urban environments where they represent violation of aesthetic and economic thresholds and have potential influences on human health.

Some invasive ants exhibit an extraordinary form of social organization, called unicoloniality, whereby individuals mix freely among physically separated nests. This form of social organization has been highly attributed to their success.

Among these ants and spreading world-wide, *Tapinoma melanocephalum* (ghost ant) represents an understudied model. This is a 'tramp' ant of African or Oriental origin, which appears to be a disturbance specialist and in many locations is absent from undisturbed natural habitats. Interestingly therefore, this species is widely distributed all around Fiji, especially on the main island of Viti Levu. In this context, I tested the pattern of aggression and genetic structure within nests and among nests of seven distant populations of *T. melanocephalum* on Viti Levu. I found that ants within and among populations do not exhibit aggressive interactions. This pattern led to an assumption that there may have been only one introduction of *T. melanocephalum* which in turn led to the existence of one 'supercolony'.

This study has provided evidence that unicoloniality can be maintained in invasive ants with very little genetic differentiation which enables them to discriminate between nest mates and non-nest mates through cuticular hydrocarbons.

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Presentation 6. Invasive ants in the Solomon Islands: a threat to biodiversity

Fasi, J.[1,2]

Invasive ant species pose a challenge for the conservation of unique island biota. The vulnerability of Pacific Islands to the invasion of some of the worst exotic ant species is a concern for conservation of biodiversity.

This presentation reports on invasive ants in the Solomon Islands. A current list of invasive ant species in the Solomon Islands was compiled by carrying out field work and searching archival records. Baiting and hand collecting methods in garden sites were used to determine the effect of the invasive Little Fire Ant, *Wasmannia auropunctata*, on other ant species in the Solomon Islands is discussed. Information collected from villages was used to assess the effect of *W. auropunctata* on domesticated vertebrates, particularly cats, dogs and birds.

Results confirmed firstly, the presence of 19 invasive ant species in the Solomon Islands. Secondly, *W. auropunctata* is responsible for the decline of other ant species; and thirdly, *W. auropunctata* can inflict eye damage on domesticated animals. Given the negative effect of *W. auropunctata* on other ant species and domestic animals, we propose here that failure to take measures to address the issue of invasive ant species runs counter to efforts made in conserving our unique biota. This presentation concludes with recommendations on what can be done to contain established populations of invasive ants: create buffer zones from gardens, educate and raise awareness in communities; and eradicate populations in some forests, so that native ant communities can re-establish.

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Presentation 7. Effect of urbanization on freshwater macro-invertebrates

Chand, N.[1,2]

Urbanization is one of the dominant patterns of land use change in developed countries. Disturbance associated with urbanization leads to increased storm water run-off, higher inputs of pollutants from human activities within catchments, altered hydrological regimes, and changes to riparian and in-stream habitats. These changes can have significant effects on the ability of a stream to support macro-invertebrate diversity.

From 2006 to 2008, I studied four streams in Suva and the Nasinu area. Three of the study streams, Samabula, Vatuwaqa and Wainibuku, had urbanized catchments comprising residential housing and industry whereas Savura stream catchment was native reserve forest. At each study site macro-invertebrates were collected from pool, riffle and run habitats using kick-nets. Environmental parameters such conductivity, temperature, pH, clarity and substrates types were measured.

The macro-invertebrate richness, diversity and abundance did not differ significantly in Vatuwaqa, Samabula and Wainibuku streams; however, there was significant difference found in Savura stream when compared with the other three streams. Oligochaetes and chironomids were the dominant taxa in Vatuwaqa, Samabula and Wainibuku stream whereas caddisfly, Trichoptera and Ephemeroptera were dominant in Savura stream. The results of this study suggest that urbanization is associated with reduced stream macro-invertebrate richness and diversity.

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Presentation 8. Freshwater invertebrate assemblages in Fiji's Nakauvadra Range streams

Finau, I.[1,3] and Brodie, G.[2]

Freshwater ecosystems in Pacific Island countries like Fiji are under substantial threat from anthropogenic modification of surrounding land. There is a strong and immediate need to raise awareness of the long-term consequences of such actions, and to provide local government agencies with the support and information necessary to enforce regulations and work collaboratively in partnership with local communities.

The current project involved an initial survey of three streams within Fiji's Nakauvadra Range, north-western Viti Levu, to examine freshwater invertebrate assemblages. Data was collected utilizing methods recommended by a Fijian Stream Health Monitoring and Assessment Kit developed by the National Institute of Water and Atmospheric Research in New Zealand. Thirty-five different species of freshwater invertebrates from across seven higher taxon categories were found and the abundance of these taxa was highly variable. The nature of the species assemblages suggests a relatively healthy and productive freshwater stream system, a result likely to be linked directly to the nature of the surrounding vegetative cover and the overall land use.

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Presentation 9. Identifying and ecologically rehabilitating nationally and internationally important seabirds islands in Fiji

Seniloli, E.[1,2]. Tuamoto, T.[1] and Cranwell, S.[1]

During an assessment of Important Bird Areas undertaken in Fiji between 2002 and 2005, five Important Bird Areas were identified that were wholly or in part of seabird interest. These are Kadavu East, Nabukulevu, Gau Highlands, Taveuni and Vatu-i-ra. Even though Vatu-i-ra was the only small island identified on the basis of large colonies of seabirds with populations that exceed regional or global population thresholds, it was suspected that other seabird islands of global importance remained undetected. Research undertaken between 2007 and 2009 has located a further 51 sites of global importance for seabirds in Fiji.

Following identification of Vatu-i-ra as an Important Bird Area, the island was subjected to a rat eradication project in 2006 that removed this major invasive predator of seabirds from the island. This operation was a success and in 2008 it was followed by eradication of rodents on seven of the Ringgold Islands and Mabalau Island.

Here we have shown how research into sites of global and national importance for seabird colonies has guided the priorities for a programme of island rehabilitation in Fiji.

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Session 7. Marine Ecology

Chaired by Bill Aalbersberg and Akuila Cakacaka

SUMMARY

prepared by Sunil Raj Prasad

Marine ecology is an integrative science that studies the basic structural and functional relationships within and among living populations and their physical environment. Recently, major focus has been given to understanding ecological processes that control short and long term events such as population growth and survival, primary and secondary productivity, and community dynamics and stability. These processes are vital to maintaining persistent communities and coupling of communities to form viable ecosystems.

Three talks looking at regional genetic connectivity and national reef health assessment and status were given during the Marine Ecology session. A common major message derived from these talks was that resilience and biodiversity in the Pacific is underestimated. Some of the other major highlights and recommendations are:

- island endemism has been identified despite the potential for long distance dispersal with little genetic difference within island system communities;
- reefs in remote areas of Fiji may be vital reservoirs of resilient coral and other habitats and therefore should be given priority in protecting global reef health;
- butterflyfish numbers are high in most areas in Fiji, however:
  - although most volunteer surveys revealed an accurate species spread, more careful identification training is needed; and
  - it is important to scientifically survey some areas to identify likely species identification mistakes;

  and
- more studies should be done in eastern Fiji to assess the (if any) relationship between tectonic events on fish diversity in Fiji and neighboring areas (e.g. Tonga).

Presentation 1: Population connectivity in south-west Pacific reef fishes

Barber, P.H.[1] and Drew, J.A.[2]

Our work with coral reef fishes in Fiji has identified that there are substantial barriers to gene flow between Fijian populations and putative conspecific populations in the Solomon Islands, Papua New Guinea and Indonesia. The reciprocally monophyletic nature of these populations, coupled with demonstrable morphological and color variations has led us to believe that Fijian populations are regional endemics and in some cases new species. This work has thus highlighted the unique biodiversity of this region and has essentially identified the far Western boundary of these unique populations.

Understanding the range over which populations are effectively exchanging genes is critical not only in highlighting the alpha biodiversity of the region, but also in parameterising the spatial scale of protected areas throughout the region. In order to address the extent to which the 'Fiji' genotypes are represented throughout the rest of the region studies have also been conducted in the reefs north of Fiji, in Tuvalu and the reefs directly south of Fiji in the Niuas and Vava'u Groups of Tonga.

The aim of our goal was to estimate levels of genetic connectivity of coral reef fishes within the major archipelago of Fiji. Specifically I wanted to see if the Bligh Waters / Vatu-i-Ra channel served as a barrier to dispersal due to its fast currents. These results will be useful in scaling marine conservation within that particular area and Fiji in general, as they highlight the degree to which individual reefs are interconnected over long time scales.

Our sampling was focused on seven sights within Fiji, three north of the Bligh Waters (Navatu, Naigigi and Naselesele), three south (Ocean Pacific, Naigani and Nannanu-i-Ra) and one within the waters (Koro). This would then give us estimates of gene flow across and along the putative genetic break. At each of these sites we focused on five species, *Pomacentrus moluccensis, Chrysiptera talboti, Amphiprion melanopus* (Pomacentridae) *Halichoeres hortulanus* (Labridae) and *Ctenochaetus striatus* (Acanthuridae). These species represent common members of Fijian reef fanua, yet possess biological characteristics (pelagic spawning, site fidelity as adults) which make them characteristic of many other reef species – thus increasing the applicability of our results.

Our sequences were placed in a phylogenetic context using standard software which allowed us to calculate the genetic diversity, and then to see if this diversity had any geographic pattern. If we saw that geography did a good job of explaining genetic diversity then we would infer that the reefs north and south of the Bligh Waters were largely independent. However we found that despite large amounts of genetic variation, geography did not explain this pattern and therefore we infer that these populations are interbreeding throughout the sampled areas.

Since we know that these fish are largely site attached as adults, we can therefore assume that the majority of mixing between reefs occurs during the larval phase. In other words, the larvae are not necessarily settling on the reefs of their parents. This therefore implies that these reefs are linked through demographic processes and for a single cohesive management unit.

These findings have several conservation implications when applied to the placement and design of a no-take reserve system. First, our results indicate that if protected areas were established or augmented within the sampled areas that they would function as a network. Second, no-take reserves have the potential to seed other areas through the continued export of larvae from protected to non-protected areas, thus providing a mechanism for fisheries augmentation over long terms. Similarly, should a site undergo a catastrophic loss of reef habitat (i.e. localized bleaching, ship strike, oil spill etc.) it would be possible for the surviving reefs to provide propagules to the area and facilitate restoration.

However these linkages between sites are bi-directional and therefore our findings also suggest that protected areas draw propagules from non-protected areas as well. Thus unless the size and number of protected areas within Fiji is increased the existing systems of protected areas will be insufficient for long-term conservation. Current research suggests that anywhere from .66 to .50 of larvae settling on a reef are produced elsewhere, thus the matrix within which protected areas is placed is an important consideration for the long term viability of the system. A network of no-take reserves would augment local fisheries, but a scenario of complete exploitation in the matrix would probably result in both extermination of populations within and outside the protected areas, albeit at different rates.

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Presentation 2. Status of Fiji's reef health 1999 - 2008: the Fiji Coral Reef Monitoring Network

Sykes ,H.R.[1], Lovell, E.[2] and Reddy, C.[1,3]

The Fiji Coral Reef Monitoring Network is a node of the Global Coral Reef Monitoring Network. It comprises scientists from a variety of organisations, tourism operators, and community members, and for nine years has carried out long-term monitoring of reefs across the Fiji Islands.

Over this period, coral cover fell between 1998 and 2000 due to crown-of-thorns (*Acanthaster plancii*) seastar outbreaks, then dramatically between 2000 and 2002 due to mass temperature-related coral bleaching events, but coral cover recovered to pre-bleaching levels by 2005. Cyclones affected localized coral health in shallow waters (2001, 2004) but caused no large scale or permanent damage and in some cases served coral recovery by lowering water temperatures and clearing new substrate for settlement.

While short-term monitoring can identify immediate results of stressing events, long-term monitoring is essential to accurately represent actual cycles of coral reef health.

Overall, Fiji's reefs appear to be remarkably resilient to acute catastrophic events, and that is a cause for optimism. Reefs in remote areas of the western Pacific — such as Fiji — may be vital reservoirs of resilient coral and habitats and therefore should be given priority in protecting global reef health.

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Presentation 3. The Great Fiji Butterflyfish Count: a Fiji-wide biodiversity assessment

Sykes, H.R.[1], Reddy, C.[1,4], Jenkins, A.P.[2] and McKay. K.[3]

To mark the International Year of the Reef, organisations across the Fiji Islands took part in a one-week count of butterflyfish species (Chaetodontidae) between 2nd and 8th of November 2008. Online and in-water identification materials were provided to assist non-scientists. Results were compared with fish counts made by scientific researchers and data on reef characteristics gathered by the Fiji Coral Reef Monitoring Network.

The event received overwhelming support and participation from resorts, dive operations, youth groups, village groups, non-government organisations, conservation organisations and individuals. Two hundred and seventy seven counts were recorded by 200 volunteers in ten regions: Beqa, the Coral Coast, Kadavu, Kubulau, the Mamanuca Islands, Savusavu, Suva, Taveuni, Vatu-i-Ra and the Yasawa Islands.

Volunteers in the Mamanuca region reported the highest numbers of butterflyfish and, along with Beqa and Taveuni, representatives of all 27 species found in Fiji waters were recorded there. Reef type related to species distribution; 90% of Fiji's butterflyfish are distributed through the island; some species have confined distributions.

The positives and negatives of volunteer surveying were identifed. On the one hand, the 'Great Butterflyfish Count' event raised awareness of Fiji's biodiversity and reef health; on the other hand, biomass assessments were limited, and sometimes identifications were confused. Overall however, the Great Butterfly Fish Count project demonstrated that volunteer data, when supported by solid scientific data, can be used to provide information over a large area.

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Presentation 4. The bull shark tagging programme: an integrated approach to study bull shark behavior and ecology in Fiji

Brunnschweiler, J.M.[1, 2]

Bull sharks (*Carcharhinus leucas*) are widespread along the continental coasts of all tropical and subtropical seas but also occur around remote island states far away from continental waters. Because they are often found close inshore in shallow water, bull sharks are accessible to scientific study.

In Fiji, bull sharks may be observed year-round on Shark Reef and surrounding reefs off the southern coast of Viti Levu. The number of bull sharks decreases over the course of a calendar year with fewer sightings between October and December. A likely explanation for the sharks' seasonal departure is reproductive activity.

Bull shark behavior and ecology have been investigated on Shark Reef and surrounding reefs since 2004 with the aid of direct and indirect observation techniques. To date, more than 60 individual male and female bull sharks have been identified visually, using each shark's unique external markings. Indirect observation techniques include acoustic and satellite telemetry. Up to the present, more than 50 acoustic tags have been attached to bull sharks (either by including them in bait, or externally attaching them) to monitor presence/absence of sharks and gain insight into the sharks' small-scale movement patterns on Shark Reef and between neighboring reefs. Fourteen 'pop-up' satellite archival tags also were deployed between 2004 and 2009 to monitor vertical habitat use by bull sharks and the sharks' movements away from Shark Reef.

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Session 8. Marine Protected Areas

Chaired by: Rikki Grober-Dunsmore and Stacy Jupiter

SUMMARY

prepared by Rikki Grober-Dunsmore

While traditional, participatory approaches to conserving marine ecosystems has a long history in Fiji, the science of developing functionally connected, representative and resilient networks of marine protected areas (MPAs) is relatively young and progressing rapidly. As 'grassroots', community-based marine conservation initiatives have been revitalized within the country, an increasing number of studies are documenting the costs and benefits of MPAs within Fiji. In this session, eight studies have demonstrated the economic, ecological, and fisheries benefits offered by 'no take' (or *tabu*) areas.

By seeking to maintain the intrinsic biodiversity and natural processes of marine ecosystems, MPAs thereby provide a variety of conservation benefits (e.g. increased abundance of fished species). Several studies documented differences in abundance, biomass, and diversity of targeted species between marine protected (*tabu*) and open access (*tara*) areas. Several studies provided evidence that species diversity of reef fishes and invertebrates can be higher within MPAs compared to unprotected areas. In talks by Naushad Yaku, Ron Simpson, Chinnamma Reddy, and Rikki Grober-Dunsmore, higher abundance of targeted reef fishes and invertebrates (e.g. giant clams, sea cucumbers) was documented inside MPAs compared to outside of them. In several cases, biodiversity was also higher 'inside' compared to 'outside'. Daniel Egli and colleagues found similar results, but they also pointed out the importance of protection duration: their data shows that MPAs that had been closed for extended periods of time may perform better with higher abundances of targeted reef fishes within older protected areas. Not surprisingly, the benefits of MPAs (in the form of resources) can be harvested easily, and often within a short period of time. In a study by the Wildlife Conservation Society (Jupiter et al.), the positive effects from protection were removed in a single opening event: the MPA was opened to raise funds for school and provincial fees and although the villagers' target was reached on the first day, the area remained open for a five-week period. Controlled openings and closings could help retain MPA benefits while allowing for traditional customs regarding opening and closing of *tabu* areas.

MPAs also offer a range of benefits for fisheries, providing safe havens for depleted fish stocks to recover. Several presentations demonstrated potential fisheries benefits of MPAs in small, locally managed *tabu* areas. In the presentation by Akuila Cakacaka, total fish abundance and the abundance of several key targeted fish species increased within the boundaries of the *tabu* area. With time, 'spill-over' is predicted to occur and be detected outside of the boundaries of the *tabu* area, though these effects typically take several years of protection. One presentation revealed that fish catches were considerably higher for targeted fishes compared to catches outside *tabu* areas, reiterating the importance of *tabu* areas for fisheries. In addition, fishes inside the *tabu* areas were reaching reproductive sizes, whereas

fishes outside of *tabu* areas were generally too small to reproduce. Such evidence suggests that MPAs are providing crucial breeding stock for depleted fisheries.

Monitoring the effectiveness of MPAs is challenging and requires consideration of local economic, logistical, and cultural constraints. Ron Simpson provided an interesting examination of various community-based indicators: his study revealed that simple measures of abundance of coral cover and targeted species can be used by local communities to evaluate MPA management and detect gross changes in ecological condition within MPAs over time. Innovative technologies can also provide invaluable and compelling data for understanding the effectiveness of such areas: Daniel Egli and colleagues presented videos from baited underwater traps located inside MPAs, the films capturing images of elusive reef fishes that are often missed in visual surveys. In addition, acoustic tags inserted in targeted reef fishes along the Coral Coast (presentation by Grober-Dunsmore et al.) provide the first real-time movement data for determining the optimal size required of MPAs to ensure protection of different species.

In summary, it is clear that MPAs in Fiji can provide conservation and fisheries benefits to local communities, although several challenges to effective management have been identified. Of these, poaching, economic incentives and governance are the most particular, and were frequently discussed as obstacles for successful community-based management. Our challenge will be to document the conditions under which valuable marine resources can be protected while at the same time, offer long-term solutions for protecting the livelihoods and cultural traditions of local communities within Fiji.

Presentation 1. The effects of *tabu* on fish and invertebrate abundance in a Marine Protected Area: a case study of *Navakavu,* Suva, Fiji

Cakacaka, A.[1,2]

Demonstrating fisheries benefits of community-based marine protected areas or *tabus* (traditional closed areas) is challenging, particularly as few sites have access to 'before and after' data. Here, the effects of closing a traditional fishing ground (at Navakavu near Suva in south-eastern Viti Levu, Fiji) was examined using 'before and after' data to evaluate changes in fish and invertebrate abundance and benthic substrate cover.

After a single year of closure, the study revealed that there was a significant increase in total fish abundance inside of the marine protected area compared to fish abundance in the unprotected control sites. Six commercially important fish genera (*Chaetodon, Ctenochaetus, Siganus, Chlorurus, Lethrinus* and *Epinephelus*) significantly increased in abundance. No significant changes in total abundance of invertebrates and substrate composition was detected, however.

The study confirms that establishing the *tabu* area as a replenishment and refuge zone significantly increased fishery resources within its boundaries over a short time period.

The results suggest that the *tabu* area may lead to increased fish production. With continual, effective protection of fish and invertebrate populations within the *tabu* area over time, fisheries resources within it are expected to continue increasing. As the density of targeted fish populations increases, 'spill-over' to adjacent areas is predicted to increase—although typically it takes several years of protection for these effects to be realized in maximized fisheries benefits for surrounding local communities.

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Presentation 2. Evaluation and enhancement of marine conservation efforts in Tikina Komave and Navosa Province: CPUE and fish tagging study

Grober-Dunsmore, R.[1,3], Bonito, V.[1], Aalbersberg, W.[1], Bogiva, A.[1,2] and Comley, J.[1]

To investigate whether community-based *tabus* (traditional closed areas) are (1) protecting spawning stock, and (2) providing fisheries benefits through export or movement outside of the *tabu*, catch-per-unit-effort and external fish tagging studies were conducted in the villages of Namada, Votua, Komave and Namatakula within the Korolevu-i-wai traditional fishing grounds of Navosa Province on south-western Viti Levu.

Analysis of data from Namada, an effectively managed site, indicates that catch-per-unit-effort (total fish catch, lethrinids, epinephelids) is significantly higher within the *tabu* compared to outside of the *tabu*. Importantly, fishes may only reach sexual maturity within the *tabu*, as outside Namada *tabu* the average size of fishes captured with hook-and-line of targeted species (e.g. *Lethrinus harak* and *Epinephelus merra*) was below length at maturity.

These results suggest that *tabus* may play a critical role in providing spawning stock for fished areas. The study is continuing to monitor whether the *tabus* provide fisheries benefits by examining movement patterns of tagged fishes, including movements among marine protected areas and to potential spawning aggregations. Community support and involvement in all aspects of this project promise to help build awareness of *tabu* area benefits to fisheries and build community capacity for effective management of local marine resources.

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Presentation 3. Effects of protection and depth on reef fish assemblages structure in Kubulau, Fiji Islands

Egli, D.[1,3], Goetze, J.[2], Langloise, T.[2] and Harvey, E.[2]

The use of Marine Protected Areas or *tabu* areas (traditional closed areas) has become increasingly common as part of marine resource management in the Fiji Islands and the wider Pacific. Fishing in these areas generally uses low technology vessels and gears with a limited spatial and depth range. Effective protection of designated areas from fishing generally results in an increase in abundance and biomass of exploited marine species. However, to date there is limited data available to show such effects conclusively in the Pacific. Demonstrating effects of fishing, which occur first at higher trophic levels, is very challenging with conventional dive surveys. To test the effects of fishing on reef fish assemblages, biomass and potential depth refuge, we used Stereo Baited Remote Underwater Video to survey areas inside and outside marine protected areas in the Kubulau *qoliqoli* (traditional fishing area) off Vanua Levu, Fiji Islands, at three different depths. This technique has the advantage of producing permanent records and allows highly accurate length measurements of fish recorded during the deployment. This allows us to compare in detail the fish assemblage composition and size structure of open and closed areas. We can also determine if the difference between the two areas decreases in deeper areas, providing a natural depth refuge from fishing effects.

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Presentation 4. Characterizing and comparing coral reef fish assemblage inside and outside of a marine protected area

Yakub, N.[1,2]

Coral reefs are a dynamic and diverse ecosystem that provides shelter and food for marine plants and animals.

The main aim of the present study is to characterize and compare coral reef fish assemblages inside and outside of a marine protected area in Kubulau *qoliqoli* (traditional fishing area). The term 'fish assemblage' includes abundance and biomass, species richness, and diversity and it is influenced by different habitat characteristics. Point intercept transect and Underwater Visual Census techniques were used to sample 71 sites for substrate and fish, respectively. The sampling effort was stratified by depth and reef zones.

Based on Shapiro-Wilk and Kruskal Wallis Rank Sun tests, fish assemblage characteristics were generally higher in marine protected area shallow and deep reef zones compared to those in control areas. The control backreef zone showed significant difference ($p<0.05$) in fish assemblages compared to marine protected area backreef zone. When compared with all other reef zones in the two management regimes, corallivore ($p=0.03$), herbivore ($p=0.003$), omnivore ($p=0.001$) and piscivore ($p=0.02$) assemblages were higher only in the control backreef zone. Piscivore assemblages were significantly higher in marine protected area shallow reef ($p=0.005$) and deep reef ($p=0.0007$) zones compared with those in control reef zones; however the composition of the piscivore assemblage in the control backreef zone was significantly different to that of the marine protected area backreef zone. Even so, control backreef zones have greater fish abundance and biomass compared to that in the same reef zones in the marine protected area. Fish abundance and biomass in that zone corresponds to the high percentage of live coral and reef matrix cover, less algae and less unconsolidated substrate cover.

This study supports previous conclusions that marine reserves can increase fish abundance and biomass to serve as a potential source of fish populations in adjacent, non-reserve areas.

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Presentation 5. Findings from acoustic tagging reveal community-based MPA in Fiji affords reasonable protection to lethrinids

Grober-Dunsmore, R.[1,3], Bonito, V.[1], Aalbersberg, W.[1], Bogiva, A.[1,2] and Comley, J.[1]

To investigate whether community-based *tabus* are: 1) protecting spawning stock and 2) providing fisheries benefits through export or movement, catch per unit effort and external fish tagging studies were conducted in the villages of Namada, Votua, Komave, and Namatakula within the Korolevu-i-wai traditional fishing grounds. Analysis on data from Namada, an effectively managed site, indicates that catch per unit effort (total fish catch, Lethrinids, Epinephelids) is significantly higher within the *tabu* compared to outside. Importantly, fishes may only reach sexual maturity within the *tabu,* as outside Namada *tabu* the average size of fishes captured with hook and line of several targeted species (*Lethrinus harak* and *Epinephelus merra*) was below length at maturity. These results suggest that *tabu* areas may play a critical role in providing spawning stock for fished areas. The study is continuing to monitor whether the *tabus* provide fisheries benefits through movement of tagged adult fishes. Community support and involvement in all aspects of this project promise to help build awareness of *tabu* benefits to fisheries and build capacity for effectively managing local marine resources.

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Presentation 6. Impacts of an intensive harvest on reef fish communities of Cakaulevu Reef Macuata Province

Jupiter, S.[1,3], Egli, D.[1], Cakacaka, A.[1] and Jenkins, A.P.[2]

During September-October 2008, community members from three villages on Kia Island, Macuata Province, engaged in an intensive harvest of their *tabu* ('no take') area as a fundraiser for school and church fees. Underwater visual count surveys of reef fish size and abundance were conducted on shallow (5-8 m) and deep (12-15 m) forereef sites within and adjacent to the *tabu* area, both before and after four weeks of fishing.

Prior to the harvest, natural gradients in fish abundance and size existed within the *tabu* area: a steep wall in the northern part of the *tabu* area had greater productivity than did the southern section with a more moderate slope. The steep wall with high currents and upwelling supported considerable populations of large planktivores (e.g. *Naso* species) and their predators. The ratio of fish longer than 25 cm (miminum size limit for many species) to fish less than 25 cm in length was greatest in the north of the *tabu* area and declined to the control area, which had significantly fewer and smaller fish than did sites within the *tabu* area.

Following intensive fishing, the ratio evened out across all of the sites, suggesting a depletion of large fish from deep areas inside of the *tabu* area. Grade B (Scombridae, Carangidae, Lutjanidae, Sphyraenidae) and grade C food fish (Acanthuridae) were most strongly affected. Mean fish abundance (± Standard Error) per transect (250 m^2) slightly increased in the north of the *tabu* area (from 251 ± 39 fish to 280 ± 32) due to greater numbers of smaller fish, particularly grade D food fish (parrotfish, triggerfish, *Lutjanus bohar*, all undersized fish). However, this change was not significant. Mean food fish biomass (± Standard Error) per transect increased more than six-fold in the control (from 775.7 ± 141.7 kg/hectare to 5245.1 ± 2140.7 kg/hectare), likely caused by the outward migration of preyed-upon fish from the *tabu* area.

Repeat surveys will be conducted in September 2009 to assess fish population recovery and determine whether periodic openings are a viable strategy for the communities of Kia.

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Presentation 7. Assessing MPA effectiveness using community-selected Indicators, over time

Simpson, R.[1,2]

The effectiveness of community-based marine protected areas in the Korolevu-i-wai District in south-western Viti Levu, Fiji, was assessed using community-selected indicator species. The indicators (targeted reef fish and invertebrates and benthic substrate cover) were selected by local community members because of the indicators' subsistence, commercial and ecological value. Abundance of these indicators was measured in 2004 and 2007 at fixed sampling locations. Among the indicators, common food fishes such as emperors (Lethrinidae), snappers (Lutjanidae) and groupers (Serranidae) significantly increased in numbers within the marine protected areas over the three-year study period, and herbivorous fishes such as rabbitfishes (Siganidae) and surgeonfishes (Ancanthuridae) increased in both the marine protected areas and the non-marine protected areas — a phenomenon resulting in significant reduction in algal cover and a corresponding increase in live coral cover.

Results have encouraged local communities to increase their efforts to develop management plans and strengthen village governance related to fisheries management. Furthermore, findings demonstrate that community-selected biological indicators can be sensitive and robust enough to reflect change and so enable us to evaluate the effectiveness of marine protected areas. These findings suggest that community monitoring can provide adequate qualitative and quantitative information to allow evaluation and response to the ecological changes taking place in different *qoliqoli* (traditional fishing areas).

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Presentation 8. Comparison of key invertebrate species abundance within a community managed marine protected area versus its fishing grounds: Waitabu Marine Park, Fiji Islands

Reddy, C.[1,2] and Sykes, H.R.[1]

Annual biological monitoring was used to assess the effects of more than ten years of community-managed conservation for key invertebrate species population in a village-based 'no-take' marine protected area in the Fiji Islands.

Surveys were carried out by a team of marine scientists and community members and the results compared with results from surveys of neighboring reefs used for subsistence fishing. Invertebrate species populations were assessed using Manta Tows, Catch Per Unit Effort and Belt Transect methods over those years.

Numbers of key invertebrate species (giant clams (Tridacnidae), sea cucumbers (holothurians), trochus (*Trochus niloticus*)) have increased within the marine protected areas during the five years in which the area has been protected. In addition, giant clam and trochus in the marine protected area were considerably larger than were those collected in the subsistence fishing grounds. These ecologically significant species were the fastest to re-populate the marine protected area and they contributed considerably to reef heath by removing macroalgae and creating favorable coral growth conditions in the marine protected area and adjacent reefs.

Whilst the recovery of giant clams and trochus was much slower in the subsistence fishing grounds, sea cucumber populations increased in both the subsistence fishing grounds and the marine protected area.

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