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**CRISP**



Coral Reef InitiativeS for the Pacific  
Initiatives Corail pour le Pacifique

## WORKSHOP REPORT

**REEFS**

**AT RISK**

Authors: Katie Reytar, Lauretta Burke, Mark Spalding, Allison Perry, Robin South and Cherie Morris.

### *Reefs at Risk Revisited: Pacific Regional Workshop*

Institute of Applied Science, University of the South Pacific

Suva, Fiji – March 16-18, 2009



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# CRISP



Coral Reef InitiativeS for the Pacific  
Initiatives Corail pour le Pacifique



The CRISP programme is implemented as part of the policy developed by the Secretariat of the Pacific Regional Environment Programme for a contribution to conservation and sustainable development of coral reefs in the Pacific

The Initiative for the Protection and Management of Coral Reefs in the Pacific (CRISP), sponsored by France and prepared by the French Development Agency (AFD) as part of an inter-ministerial project from 2002 onwards, aims to develop a vision for the future of these unique ecosystems and the communities that depend on them and to introduce strategies and projects to conserve their biodiversity, while developing the economic and environmental services that they provide both locally and globally. Also, it is designed as a factor for integration between developed countries (Australia, New Zealand, Japan and USA), French overseas territories and Pacific Island developing countries.

The initiative follows a specific approach designed to:

- associate network activities and fieldwork projects;
- bring together research, management and development endeavours;
- combine the contributions of a range of scientific disciplines, including biology, ecology, economics, law and social sciences;
- address the various land and marine factors affecting coral reefs (including watershed rehabilitation and management);
- avoid setting up any new body but supply financial resources to already operational partners wishing to develop their activities in a spirit of regional cooperation. This is why the initiative was prepared on the basis of a call for proposals to all institutions and networks.

The CRISP Programme comprises three major components, which are:

**Component 1A:** Integrated Coastal Management and Watershed Management

- 1A1: Marine biodiversity conservation planning
- 1A2: Marine Protected Areas
- 1A3: Institutional strengthening and networking
- 1A4: Integrated coastal reef zone and watershed management

**Component 2:** Development of Coral Ecosystems

- 2A: Knowledge, beneficial use and management of coral ecosystems
- 2B: Reef rehabilitation
- 2C: Development of active marine substances
- 2D: Development of regional data base (ReefBase Pacific)

**Component 3:** Programme Coordination and Development

- 3A: Capitalisation, value-adding and dissemination of CRISP results
- 3B: Coordination, promotion and development of CRISP Programme

CRISP Coordination Unit (CCU)  
Programme Manager : Eric CLUA  
SPC - PO Box D5 - 98848 Noumea Cedex  
New Caledonia  
Tel/Fax : (687) 26 54 71  
E-mail : [ericc@spc.int](mailto:ericc@spc.int)  
[www.crisponline.net](http://www.crisponline.net)



**SPC**  
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CRISP is funded by the following partners :



## **Reefs at Risk Revisited Pacific Workshop Summary**

### **University of the South Pacific, Suva, Fiji on March 16-18, 2009**

The World Resources Institute (WRI), in collaboration with the International Coral Reef Action Network (ICRAN), University of the South Pacific (USP), Coral Reef Initiatives for the South Pacific (CRISP), WorldFish Center, and ReefBase Pacific, hosted a three-day workshop on the *Reefs at Risk Revisited* project at USP in Suva, Fiji on March 16-18, 2009.

The workshop brought together representatives from 20 local and regional organizations in the Pacific. These organizations included government agencies, non-governmental organizations, regional organizations, universities, trade associations, and consulting companies. A total of 32 participants attended the workshop. Attachment 1 provides a complete list of participants and their representative organizations. Attachment 2 includes the workshop agenda.

**The goals** of the three-day workshop were to:

- Inform a range of organizations in the Pacific of the breadth, components, and complexity of the Reefs at Risk Revisited (R@R) project;
- Gather additional information from experts specifically on threats facing reefs in the Pacific region;
- Collect and verify data points on maps of various threats to reefs and observations of reef condition;
- Present preliminary modeling results for local threats to reefs (land pollution, marine pollution, overfishing, and coastal development) and verify them against local observations;
- Discuss ways to improve modeling methods to better capture local threats to reefs;
- Present preliminary results for modeling climate-related threats and discuss ways to improve indicators of these threats;
- Discuss the inclusion of marine managed areas (MMAs) and other types of management into the analysis as factors mitigating threat;
- Collect data on the locations and level of effectiveness of Pacific MMAs;
- Obtain input on main messages and policy recommendations for the report;
- Discuss ideas for reef stories-- both threatened reefs and “signs of promise”-- as part of the project products; and
- Review and discuss ideas for the vulnerability study of reef-dependent communities.

**Main conclusions** from the workshop are:

- The **significant threats to reefs in the Pacific region** include: fishing-related threats, land-based threats, marine pollution, coastal development, invasive species, climate change, overpopulation, disease, predation, military activities, and loss of traditional management practices.
- The Pacific region has a **unique geomorphology** that should factor more prominently in the threat models, particularly the significant differences between volcanic islands and atolls; variations in soil type; and the open/closed nature of atolls.
- **Climate-related threats** are an important component of the report. However, the preliminary model results for past and future thermal stress events should be further refined to account for both frequency and severity, as well as adjusted for past temperature variability.
- The **coastal development** threat indicator could be improved to include hotels as a proxy indicator for tourism centers, mangrove loss, and refined data on airport size/usage.
- The **marine-based threat** indicator could be improved with additional data on port size/volume; refined data on commercial shipping intensity; and inclusion of data on cruise ship visitation intensity.

- The **land-based threat** indicator could be improved if it included data on mining activities; included more detailed data on soil type; and modified to give more significant weight to land cover type. Dams should be included if data are available.
- The **overfishing threat** indicator could be improved if the population pressure were adjusted to account for reef and lagoon area, wealth, and/or unemployment.
- The **social vulnerability analysis** is an important component of the project that will address the human impact of reef degradation as well as other factors not captured in the models, such as sea level rise.
- Participants had mixed reactions as to whether R@R should include an **economic valuation** component.
- **Storms and natural geohazards** are significant threats to reefs in the Pacific region that should be addressed in the report.
- The R@R project will follow up on the many suggested **data sources for model input and calibration**. Of particular note are coral reef data for Fiji, land pollution studies for several islands, and data on location and effectiveness of marine managed areas.
- The R@R project will incorporate all of the **map annotations** that workshop participants provided to us to improve our preliminary model results for local threats and other observational data.
- The R@R project will follow up with individuals about their suggestions for **Reef Stories**.

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## **MAJOR THREATS TO REEFS IN THE PACIFIC**

A primary objective of the R@R Pacific Workshop was to acquire information from experts on the major threats to coral reefs in the Pacific. Attachment 3 contains a complete list of the major threats identified during the workshop brainstorming session.

## **CORAL REEF MAPPING**

It is important that the R@R project use the best available and highest-resolution data on coral reef locations in the threat analyses. In earlier R@R projects, we have used coral reef maps from the United Nations Environment Programme - World Conservation Monitoring Centre (UNEP-WCMC), with project partners reviewing and improving these data. The Institut de Recherche pour le Développement (IRD)/Institute for Marine Remote Sensing (IMaRS), University of South Florida Millennium Coral Reef Mapping Project (MM) reflects a significant improvement in coral map resolution, but this mapping is not complete for the globe. As such, UNEP-WCMC is currently working with the WorldFish Center and IRD to develop the best possible map of the world's coral reefs from currently available sources. We are still looking for additional sources of reef data to replace areas of low-resolution data.

- *Comments and Recommendations:*
  - The Fiji Lands Department has mapped and produced shape files of reefs for Fiji. The Wildlife Conservation Society has these reef data. (Contact: Stacy Jupiter, WCS).
  - IUCN is currently working on mapping sea mounts and that work will be released in the near future.
  - It is important to define a maximum depth for mapping coral reefs.
  - R@R should include the names of islands, not just countries, in the detailed (sub-regional) maps and as a digital layer in final products, if possible.

## **REVIEW OF PRELIMINARY LOCAL-THREAT MODELING RESULTS**

Local threats to reefs are those that are caused by direct pressure from human activities, such as coastal development, land-based pollution, marine-based pollution, and overfishing. Since data on these threats are not explicitly available, we perform GIS modeling using proxy indicators and the integration of data on various activities to paint a picture of threat. Additional details on the modeling approach for each type of threat and feedback from workshop participants are provided below.

### **1) Coastal Development**

The purpose of the coastal development indicator is to capture the impact of activities near the coast and runoff from areas along the coast, such as dredging, land filling/reclamation, runoff from roads and construction sites, sewage discharge, mining of sand and coral, removal of mangroves, and impacts from tourism.

The preliminary modeling results integrate data on cities/settlements, airports, ship ports, coastal population density (2007), population growth (2000 - 2005), and tourism growth since 2000 to develop a proxy indicator of threat from coastal development. We are still exploring options for including data on tourism centers to further refine the model.

- *Comments and Recommendations:*
  - Dive centers are not a good proxy for tourism centers since they are not necessarily near the areas where tourist numbers, and therefore impacts to reefs, are greatest. Almost all tourists use two dive centers in Fiji, and neither are near major tourism centers. In Fiji and elsewhere in the South Pacific, this may be a skewed proxy.

- Hotels would be a good indicator of tourism centers. Google Earth may have good data sets on hotel size and location. Otherwise, focusing on the location and size of major hotel chains may be a useful proxy.
- If possible, try to incorporate wave action into the modeling. Some reefs are washed substantially such that the impact from coastal sources is dampened.
- Review closely the airport data. Exclude ones that are very small and infrequently used so that they do not skew the threat. Perhaps in the Pacific, only use international airports or only include airports that are located within 10 km of an area with a population density of 500 or greater.
- Include locations of military development.
- If data are available, include mangrove loss as an indicator.
- Improve and refine the data points for ship ports.
- Evaluate impacts from population density based on a set proximity (i.e., 5 or 10 km) from the reef.

## 2) Land-Based Pollution

The purpose of this indicator is to capture increased threat from pollutant and sediment delivery due to land cover change, particularly agricultural activities in watersheds discharging near reefs. During the workshop we explored the use of watersheds derived from both 1km and 300 m resolution elevation data. The higher resolution data improves results for small islands.

The preliminary modeling results focus on sediment delivery and use this as a proxy indicator for both sediment and organic/inorganic pollutant delivery. The modeling of erosion and sediment delivery relies on elevation, slope, land cover, soils (porosity), and precipitation using a simplified version of the Revised Universal Soil Loss Equation (RUSLE). The preliminary results were not calibrated, but the final results will be adjusted based on estimates of river discharge and sediment delivery at river mouths, sediment plumes visible from satellite imagery, and local observations of impacted reefs.

- *Comments and Recommendations:*
  - Differentiate between the soil types on islands (e.g., volcanic vs. limestone).
  - Livestock (especially piggeries) and lack of management regulations or enforcement are a significant source of pollution.
  - The waste from one pig is equivalent to that from six humans.
  - Land cover change is probably more important than just land cover type.
  - Need to apply a weight factor for land cover that is higher than slope. Land cover is often more important than slope on the islands, in that some steep forested areas do not deliver as much sediment as flat agricultural areas.
  - Dams are rare in the Pacific islands, but are important in other regions..
  - Include data on mining and mineral extraction, specifically mine location and type (if possible).
  - Model sediment plumes to account for barriers, such as atolls.
  - Currents are probably not worth including in the plume modeling. Currents in the Pacific are often more wave-driven than tide-driven and not usually significant around islands except in El Niño years.
  - Include mangroves as an adjustment factor, since mangroves have significant capacity to filter and decrease sediment loadings.
  - If possible, include vegetation buffer around rivers as an adjustment factor, since less sediment is delivered to vegetated rivers.
  - Deforestation, both from logging and wildfires, is a major issue in the Pacific and a major source of sediment influx.

- Do not need to include basins and model land pollution on atolls.
- Feral ungulates contribute to vegetation destruction in Hawaii and other small Pacific islands.
- Vanuatu, Fiji, and the Solomon Islands have sediment delivery data that can be used to calibrate the R@R results. (Contacts: Caroline Vieux, SPREP and Jens Kruger, SOPAC).

### 3) Marine-Based Pollution

The purpose of this indicator is to capture physical impact from shipping (anchor damage and groundings), discharge from ships (pollutants and invasive species in ballast water), and oil leaks and spills.

The preliminary model results are based on data for port size, commercial shipping intensity, and oil and gas infrastructure. We are still exploring the inclusion of cruise ship visitation intensity to further refine the model.

- *Comments and Recommendations:*
  - Marine debris (e.g., discarded fishing gear, solid waste) is a major threat in the Pacific. If it can't be captured in the model, then include it as a text box in the report.
  - Explore using port volume in the model instead of port size. This may improve results where very small ports have a high volume of traffic.
  - Refine the data on shipping lanes. Increase the volume threshold for the inclusion of shipping lanes to alleviate the problem of the disappearance of lanes near shore. If this doesn't work, then buffer the layer to capture shipping intensity near shore.
  - If available, include data on cruise ship ports and frequency/intensity.
  - Data may exist for ship groundings on a regional level. SPREP has data on groundings of war vessels. NOAA may also have a record of groundings and/or anchorages for the Pacific region. If data are not adequate to include in the model, then include groundings as a text box in the report.
  - We will investigate whether groundings are a major issue in the Pacific before we include these data in the model (i.e., consult the Scientific Consensus Statement of Threats in the Pacific Ocean).
  - Iron pollution from shipwrecks can cause phase shifts and outbreaks of normally iron-limited organisms like corallimorphs.
  - Private yachts are a major issue in spreading invasive species. However, GIS data on yacht numbers and anchorages are probably not available (though some might be available through tourism data sets).
  - Military and nuclear testing waste is a problem
  - SPREP has a marine pollution advisor who may have data to calibrate the model results. (Contact: Caroline Vieux, SPREP).

### 4) Overfishing and Destructive Fishing

This indicator focuses on artisanal, recreational, and commercial overfishing of reefs and on destructive fishing (fishing with dynamite and poisons). Overfishing is one of the most important factors affecting reef health, but unfortunately little data exist to capture the threat.

The preliminary results are based on overfishing pressure within 20 km of a reef location, adjusted by the area of shelf (shallow area up to 30 m depth) within 20 km of the reef location (derived from bathymetry). The results were calibrated using observations of overfishing pressure from Reef Check surveys. The results could also be adjusted using management effectiveness of marine managed areas, but this adjustment was not included in the preliminary model. The destructive fishing component includes information on occurrences of blast fishing and poison fishing from Reef Check data and supplemental observations.

- *Comments and Recommendations:*
  - Participants suggested not using the term “shelf” to describe areas of shallow sea, since this term seems to refer to continental shelf, which does not apply to most Pacific islands. Using the term “shallow area” (or similar) was recommended.
  - Participants agreed that the FAO data for fish catches were not accurate and should not be used in the model or to calibrate the model.
  - The preliminary model result, that 17 percent of reefs in the Pacific are overfished, seemed low to participants.
  - The distance buffer should be adjusted to account for land masses, shallow water and/or reef areas – in some cases 20 km is too far, but in others 20 km may not be far enough. Most local fishermen would not venture out 20 km if it is into open ocean, but may venture out 20 km or more into areas with uninhabited land masses or shallow water. Also, fishermen stop catching reef fish when they are a few km away from reefs, so inclusion of too much open ocean may skew the effect on reefs.
  - Reef area was suggested as an adjustment factor. More reef area attracts more fishermen.
  - Several ideas for adjusting the population data to more accurately reflect overfishing pressure were suggested. The suggestions included: 1) adjust by wealth (GDP); 2) use unemployment statistics (higher unemployment usually leads to more fishing); and 3) adjust by importance of fish in diet.
  - It was suggested to treat urban centers as a market by creating a large buffer around highly populated urban centers, thereby capturing the increased threat from urban market demand.
  - Uninhabited islands should not be overlooked in terms of overfishing pressure. Fishermen move toward uninhabited islands once nearby populated islands are depleted.
  - The Pacific may have low human population pressure, but the large and growing market for fish in Asia is causing increased fishing activity in the Pacific.
  - Evaluate using airports as a pressure indicator, since significant quantities of fish are exported by air.
  - It was suggested to include population growth as an indicator since overpopulation leads to more fishing.
  - Suggested data to use for calibrating the overfishing model were: import/exports, LMMA database, and local/regional observations.
  - Participants raised concerns about the destructive fishing data, including their geographic coverage and the lack of differentiation between the larger-scale impacts of blast fishing and cyanide fishing in Southeast Asia versus the more localized impacts of traditional poisons in the Pacific region.
  - If it is not possible to include data about the Live Reef Food Fish Trade in the modeling, it should be included as a text box in the report (see map and text from Sadovy et al. (2003)—While Stocks Last).

## **MARINE MANAGED AREAS**

Areas that are designated as marine managed areas (MMAs) or locally marine managed areas (LMMAs), if effective, can reduce the impact of local threats such as overfishing and coastal development. However, it is often difficult to distinguish between effectively managed areas and “paper parks.” The data that we currently have is from the World Database of Protected Areas (WDPA) and supplemented with a few country-specific data points. We are looking for data on the level of effectiveness of these areas to use as an adjustment factor such that threats to reefs inside well-managed areas can be diminished. The scoring system ranges from 1 (effective), 2 (partially effective), and 3 (ineffective).

- *Comments and Recommendations:*
  - SPREP, WWF, and the WorldFish Center are producing a study of MMA effectiveness in the Pacific that includes a CD and GIS Data. It should be available in May. (Contact: Caroline Vieux, SPREP).
  - The WDPA includes many areas that are not active; these should be removed, or at least categorized as inactive.
  - American Samoa has many village MMAs established in 2002 that are not included in the WDPA. (Contact: Fatima Sauafea-Leau, NOAA).
  - The MPAs, MMAs, and LMMAs in the Cook Islands have equivalent effectiveness.

## **SOCIAL VULNERABILITY ANALYSIS**

An important component of the new R@R report is a global study on the vulnerability of reef-dependent communities to reef loss and degradation. Building upon the R@R threat analysis, the study will determine where these threats are likely to result in the most adverse impacts upon livelihoods and human well-being. The study will include a spatial index of social vulnerability to help quantify levels of community dependence on reefs and identify areas of particular vulnerability. The index will integrate the following three key components: exposure of reefs to threats, sensitivity of reef-dependent people to reef loss, and adaptive capacity of people facing potential reef loss.

- *Comments and Recommendations:*
  - If possible, the study should incorporate the cultural community and the traditional usage of reefs.
  - Island type and geography are important factors in influencing the vulnerability of communities.
  - It would be important to disaggregate different classes of economic data so that the economy of an entire country doesn't overwhelm the fraction of population at the coast. Similarly, care is needed in combining data at different spatial scales.
  - It makes sense to include measures of formal employment within the analysis, as an indicator of reef dependence.
  - IUCN Oceania's Pacific Program has several initiatives that may be of relevance: the Pacific Ocean Challenge 2020 is an initiative that focuses on developing global attention, building new partnerships, and generating necessary commitments to address the threats to the world's largest natural resource, the Pacific Ocean, by 2020 (including coral reefs). One of the outputs of this initiative will be an economics report, *Pacific Ocean Report: Cost of Inaction*, which will include a broad overview of the economic values to Pacific Island countries. (Contact: Padma Narsey Lal, IUCN Oceania).
  - Participants had mixed reactions to the inclusion of an economic valuation study in the R@R report. On one hand, economic information can help to influence politicians. For instance, by converting scientific information about the threats to reefs into economic terms, a better advocacy could be developed. On the other hand, an economic study may take focus away from the main point of the report: examining the threats to reefs.
  - A very targeted economic valuation could help to highlight the value of losing a reef and define the impact of the loss. It could also increase the receptiveness of key decision-makers to actions that would reverse the trend..
  - It would be important to include remittances in the social vulnerability study. In a Pacific context, these are an important resource during time of hardship, and so would be a useful indicator of adaptive capacity.
  - Tourism, such as diving, should be included in the study, since it is another form of reef dependence.

## CLIMATE-RELATED THREATS

Threats due to climate change are the most pervasive to reefs globally, yet among the most difficult to capture in models due to the synergies of many different environmental conditions. This R@R report will be the first to include the modeling of climate-related threats, including thermal stress and ocean acidification. If possible, we will look at indicators of resistance to coral bleaching and resilience of coral reefs (ability to cope). The timeframe for the projections will be 30 and 50 years into the future. Observations of bleaching and disease will also be included, as in past R@R reports.

The types of climate-related threats that will be addressed in the report include past thermal stress, future thermal stress, and ocean acidification. Preliminary model results for the past thermal stress indicator are based on satellite sea surface temperature (SST) data from the past 20 years (1985 to 2005). Indicators reflecting degree heat weeks (DHW) and Thermal Stress Anomalies (TSA) were presented. The data and results were provided by NOAA Coral Reef Watch, NOAA Oceanographic Data Center's Coral Reef Thermal Anomaly Database (CoRTAD), and Conservation International.

Preliminary model results for the future thermal stress indicator are based on outputs from the Geophysical Fluid Dynamics Laboratory (GFDL) general circulation models CM2.0 and CM2.1 forced with IPCC Scenario A1B (business as usual). The indicator is degree heat months (DHM). The data and results were provided by Simon Donner at the University of British Columbia.

The model results for the ocean acidification indicator were provided by Long Cao and Ken Caldeira at Stanford University. The indicator that they used is aragonite saturation state (compound in seawater that corals and other calcified marine organisms use to build skeletons) at various CO<sub>2</sub> stabilization levels that correspond to future atmospheric conditions. A CO<sub>2</sub> level of 450 ppm corresponds with the year 2030 and 550 ppm with 2050 under the IPCC A1B (business as usual) scenario.

- *Comments and Recommendations:*
  - In general, Pacific reefs have recovered well from bleaching events except where they are under higher stress from local threats.
  - Eliminate all areas outside of the tropics from the climate change maps. This will adjust the scale so that it is more relevant to reef areas (and not skewed by any significant changes in high latitudes).
  - Adjust the timeframe for the past thermal stress data so that it only goes back ten years - to the mid 1990s, not 1985. A more recent timeframe will make the data more relevant to current conditions.
  - Weight the thermal stress indicators for frequency and severity and adjust for natural variability in temperature.
  - Connectivity of reefs is very important for recovery after a bleaching event. Try to include the distance between reefs (connectivity) as a resilience factor.
  - Include human population projections out to 2030 and 2050, since increased population greatly impacts reef condition, through increasing pressure and reducing resilience.
  - Overlay the data on bleaching observations with the past thermal stress data to look at the correlation between "bleaching-level stress" and actual bleaching occurrence.
  - Evaluate data sets that model future storm frequency and intensity due to climate change for potential inclusion.
  - Coral disease is a problem in the Pacific and often follows thermal stress.

## OTHER THREATS

After presentation of the local and climate-related threats to coral reefs, participants were asked to provide feedback on any other threats to reefs that were not captured in the previous sessions and should be either included in the models or featured as topics (text boxes) in the report.

- *Comments and Recommendations:*
  - Sea level rise
    - Sea level rise should be included in the social vulnerability study, since it is not detrimental to coral health but can impact coral-dependent communities.
    - It does not need to be included in modeled threats.
  - Storm frequency and intensity
    - Storms can be an exacerbating factor to reefs that are already under stress from other threats.
    - Storms cause mechanical damage to reefs both from wave action and contact with debris. They can also cause significant increases in sediment runoff from land.
    - Data from historical storm/cyclone tracks over the past 50 years are sufficient to capture the areas of threat from storms. Data can be used as an adjustment factor to compound past stresses.
    - Investigate the predictive models of storm tracks and future increases in frequency/intensity for potential inclusion in R@R modeling.
  - Natural geohazards
    - Earthquakes and tsunamis can cause mechanical damage to reefs and reduce reefs' ability to recover from other stresses.
    - This element does not need to be included in the model, but data on historical occurrences might be useful for showing threat areas.

## REEF STORIES

The R@R report will feature some interesting stories of both healthy and threatened reefs. The threatened reef stories can help to bring home points and provide memorable examples. The signs of promise are important to show that some reefs are doing well and many are resilient. Participants were asked to provide ideas for reef stories based on their experiences working in the Pacific.

- *Suggestions for Healthy Reef Stories:*
  - **Suva Barrier Reef.** Reef has survived population growth and has shown resilience despite a lack of officially-designated protection. (Contact: Robin South, USP).
  - **Palolo Deep Marine Reserve near Apia, Samoa.** First national marine protected area in Samoa (est. 1974) and located near the Apia harbor. It is managed by a family with support from the Department of Conservation. (Contacts: Posa Skelton, USP and Caroline Vieux, SPREP).
  - **Kimbe Bay, Papua New Guinea.** Local communities are engaged in the management. (Contact: Mark Spalding, TNC).
  - **Tetepare Island in Solomon Islands.** Largest uninhabited island in the Pacific and locally managed. The western side is protected by a no-take zone. Conservation International provides funding for management. (Contact: Jens Kruger, SOPAC).
  - **Lagoons of New Caledonia.** Site was recently designated as a UNESCO World Heritage Site. A local NGO in New Caledonia first came up with the idea for the designation a few years ago. Two years ago a campaign was started by the French government (IFRECOR), the local authorities (Provinces of New Caledonia), scientific organizations (IRD and UNC), and NGOs (WWF, CI) to achieve the designation. (Contact: Laurent Wantiez, University of New Caledonia).
  - **Tsunami-Affected Reefs in Solomon Islands.** Reef sites were surveyed three years before the December 2004 tsunami and again within months after the tsunami to study the recruitment of

corals, fish, and invertebrates. WorldFish Center prepared a report on the findings. (Contact: Peter Ramohia, TNC).

- **Manu'a Islands in American Samoa.** Marine areas are managed by communities with training from the government. (Contact: Caroline Vieux, SPREP).
  - **Atolls in French Polynesia.** A volunteer program reviews sites at 30 uninhabited atolls yearly. The program has established a record of data going back 20 years. The volunteers are currently working on solutions for mitigating a COTS outbreak. (Contact: Elodie Lagouy, Reef Check Polynesia).
  - **Great Sea Reef in Fiji.** It is the focus of a WWF ecosystem-based management project. WWF is working with local communities to develop an MPA around the reef and also protect inland areas from watershed effects. (Contact: Louise Heaps, WWF).
  - **Fisheries Management in American Samoa.** Villages have council meetings to determine how to manage their local fisheries in concert with guidance from NOAA Fisheries. The program was started in 2002 and recently adopted in Western Samoa. (Contact: Fatima Sauafea-Leau, NOAA).
  - **Reefs in Palau.** The 1998 bleaching event caused bleaching of 50 to 80% of some reefs in Palau with up to 30% mortality in areas. Some reefs showed good recovery five years after the event and some have almost completely recovered by now. However, reefs that are exposed to land-based pollution have not recovered. This example shows how pristine areas can recover more easily than stressed areas. (Contact: Steven Victor, PICRC).
  - **Micronesia Challenge.** The story focuses on gaining political will to effect change and improve conservation in the region. It was signed in 2006. (Contact: Mike Gawel, Guam EPA).
  - **U.S. Marine National Monuments.** The United States established four large, fully protected marine national monuments in the Pacific that include uninhabited volcanic islands, reef islands, and atolls. (Contact: Jim Maragos, USFWS).
  - **Other Sources for Stories.** Check the archives of SPC bulletins, such as the Traditional Marine Resource Management and Knowledge Information Bulletin. (Contact: Franck Magron, SPC). Also refer to the ReefBase Pacific website.
- *Suggestions for Threatened Reef Stories:*
    - **Phoenix Islands.** Many species have disappeared including giant clams and sharks. (Contact: Robin South, USP).
    - **Over-Water Hotels.** A hotel was recently built on top of a fringing reef in Nauru. (Contact: Elodie Lagouy, Reef Check Polynesia and Cherie Morris, USP).
    - **Sand Mining in Kiribati.** (Contact: Louise Heaps, WWF).
    - **Aggregate Mining in Nauru.** Remaining coral pinnacles may be blasted to mine for aggregate. (Contact: Jens Kruger, SOPAC).
    - **Samoa Turtle Feeding Grounds.** Government has not adequately regulated the construction of a wharf and its encroachment on turtle feeding grounds. (Contact: Caroline Vieux, SPREP).
    - **Reefs at Risk 10-year Follow-up.** Revisit the reefs that were profiled in the 1998 edition of *Reefs at Risk* and report on their status.

## MAIN MESSAGES

The proposed take-home messages for the global R@R report are as follows: a) most coral reefs are threatened; b) things have gotten worse in many areas and improved in a few over the past 10 years; c) do not abandon hope; d) some reefs will fare better; and e) management can help, but it is not a panacea. Participants were asked to provide ideas for take-home messages that they would like featured in the Pacific section of the report.

- *Comments and Recommendations:*

- Highlight the stewards in the region who are working to manage reefs and exemplary management from communities.
- Note the increase in the number of projects and reef-focused studies over the last 10 years (both scientific and traditional).
- Pacific island countries need increased capacity to handle threats on the horizon.
- Need increased management to prevent overexploitation of resources and better enforcement of existing managed areas.
- Need to protect entire/inter-connected ecosystems, not just reefs (e.g. ridge-to-reef approach). Increase the size of managed areas and increase the diversity in types, geography, and biodiversity within those areas.
- Reef-dependent communities need to be supported in developing alternative livelihoods.
- Encourage development of more partnerships and networks among Pacific countries to help improve the exchange of data and unify management goals.

We welcome your comments, reactions, and ideas about the project and the points brought up at the workshop. Please send them to Katie Reytar at [kreytar@wri.org](mailto:kreytar@wri.org) and +1-202-729-7653 or Laretta Burke at [lauretta@wri.org](mailto:lauretta@wri.org) and +1-202-729-7774.

**ATTACHMENT 1: PARTICIPANTS**

**Reefs at Risk Pacific Regional Workshop, March 16-18  
University of the South Pacific - Suva, Fiji**

	<b>First Name</b>	<b>Last Name</b>	<b>Organization</b>	<b>Country</b>	<b>Email Address</b>
1	Lauretta	Burke	World Resources Institute	USA	<a href="mailto:Lauretta@wri.org">Lauretta@wri.org</a>
2	Monifa	Fiu	World Wildlife Fund - South Pacific	Fiji	<a href="mailto:mfiu@wwfpacific.org.fj">mfiu@wwfpacific.org.fj</a>
3	Mike	Gawel	Guam Environmental Protection Agency	Guam	<a href="mailto:Mike.Gawel@epa.guam.gov">Mike.Gawel@epa.guam.gov</a>
4	Philippe	Gerbeaux	International Union for the Conservation of Nature - Oceania	Fiji	<a href="mailto:Philippe.Gerbeaux@iucn.org">Philippe.Gerbeaux@iucn.org</a>
5	Stuart	Gow	Fiji Islands Hotel and Tourism Association	Fiji	<a href="mailto:Stuart@Matava.com">Stuart@Matava.com</a>
6	Louise	Heaps	World Wildlife Fund - Fiji	Fiji	<a href="mailto:lheaps@wwfpacific.org.fj">lheaps@wwfpacific.org.fj</a>
7	Stacy	Jupiter	Wildlife Conservation Society - Fiji	Fiji	<a href="mailto:sjupiter@wcs.org">sjupiter@wcs.org</a>
8	Jens	Kruger	Pacific Islands Applied Geoscience Commission (SOPAC)	Fiji	<a href="mailto:jkruger@sopac.org">jkruger@sopac.org</a>
9	Elodie	Lagouy	Reef Check Polynesia	French Polynesia	<a href="mailto:elodie_lagouy@hotmail.com">elodie_lagouy@hotmail.com</a>
10	Ed	Lovell	University of the South Pacific / IAS	Fiji	<a href="mailto:lovell_e@usp.ac.fj">lovell_e@usp.ac.fj</a>
11	Franck	Magron	Secretariat of the Pacific Community	New Caledonia	<a href="mailto:franckm@spc.int">franckm@spc.int</a>
12	Jim	Maragos	US Fish and Wildlife Service	USA (Hawaii)	<a href="mailto:jim_maragos@fws.gov">jim_maragos@fws.gov</a>
13	Semisi	Meo	University of the South Pacific	Fiji	<a href="mailto:meo_s@usp.ac.fj">meo_s@usp.ac.fj</a>
14	Cherie	Morris	University of the South Pacific	Fiji	<a href="mailto:morris_c@usp.ac.fj">morris_c@usp.ac.fj</a>
15	Padma	Narsey Lal	International Union for the Conservation of Nature - Oceania	Fiji	<a href="mailto:padma.lal@iucn.org">padma.lal@iucn.org</a>
16	Kelvin	Passfield	International Union for the Conservation of Nature - Oceania	Fiji	<a href="mailto:kelvin.passfield@iucn.org">kelvin.passfield@iucn.org</a>
17	Allison	Perry	WorldFish Center	Malaysia	<a href="mailto:A.Perry@cgiar.org">A.Perry@cgiar.org</a>
18	Peter	Ramohia	The Nature Conservancy	Solomon Islands	<a href="mailto:pramohia@tnc.org">pramohia@tnc.org</a>
19	Chinnamma	Reddy	Resort Support	Fiji	<a href="mailto:CReddy@marineecologyfiji.com">CReddy@marineecologyfiji.com</a>
20	Katie	Reytar	World Resources Institute	USA	<a href="mailto:kreytar@wri.org">kreytar@wri.org</a>
21	Fatima	Sauafea-Leau	US National Oceanic and Atmospheric Administration (NOAA)	American Samoa	<a href="mailto:Fatima.Sauafea-Leau@noaa.gov">Fatima.Sauafea-Leau@noaa.gov</a>
22	Posa	Skelton	Pacinet / University of the South Pacific	Fiji	<a href="mailto:skelton_p@usp.ac.fj">skelton_p@usp.ac.fj</a>
23	Robin	South	University of the South Pacific	Fiji	<a href="mailto:robin.south@orda.com.au">robin.south@orda.com.au</a>
24	Mark	Spalding	The Nature Conservancy	United Kingdom	<a href="mailto:mspalding@tnc.org">mspalding@tnc.org</a>
25	Helen	Sykes	Resort Support	Fiji	<a href="mailto:helen@resortsupportfiji.com">helen@resortsupportfiji.com</a>
26	Randy	Thaman	University of the South Pacific	Fiji	<a href="mailto:thaman_r@usp.ac.fj">thaman_r@usp.ac.fj</a>
27	Ron	Vave	LMMA Network	Fiji	<a href="mailto:vave_r@usp.ac.fj">vave_r@usp.ac.fj</a>
28	Joeli	Veitayaki	University of the South Pacific	Fiji	<a href="mailto:veitayaki_j@usp.ac.fj">veitayaki_j@usp.ac.fj</a>
29	Steven	Victor	Palau International Coral Reef Center	Palau	<a href="mailto:svictor@picrc.org">svictor@picrc.org</a>
30	Caroline	Vieux	South Pacific Regional Environment Programme (SPREP)	Samoa	<a href="mailto:carolinev@sprep.org">carolinev@sprep.org</a>
31	Laurent	Wantiez	University of New Caledonia	New Caledonia	<a href="mailto:wantiez@univ-nc.nc">wantiez@univ-nc.nc</a>
32	Naushad	Yakub	Wildlife Conservation Society - Fiji	Fiji	<a href="mailto:nyakub@wcs.org">nyakub@wcs.org</a>

**ATTACHMENT 1: PARTICIPANTS (CONTINUED)**



**Reefs at Risk Revisited Pacific Workshop Participants.** *Front and middle rows (left to right):* Laretta Burke, Louise Heaps, Caroline Vieux, Allison Perry, Chinnama Reddy, Robin South, Steven Victor, Laurent Wantiez, Fatima Sauafea-Leau, Naushab Yakub, and Jim Maragos. *Back row (left to right):* Peter Ramohia, Mike Gawel, Semisi Meo, Joeli Veitayaki, Mark Spalding, Franck Magron, Kelvin Passfield, and Katie Reytar.

## **ATTACHMENT 2: AGENDA**

*Reefs at Risk Revisited: Pacific Regional Workshop*  
Institute of Applied Science Conference Room, University of the South Pacific  
Suva, Fiji – March 16-18, 2009

**Workshop will run from 9 AM to 5 PM each day.**

### **Monday, March 16, 2009**

#### **Morning    Opening and Overview**

- Opening (Prof. Patrick Nunn)
- Welcome (Prof. Robin South)
- Introductions by participants
- Workshop Purpose (Lauretta Burke)
- *Tea Time*
- Overview of Project / Components (Lauretta Burke)
- Status of Coral Reefs in the Pacific (Cherie Morris)
- Discussion of main threats in region (Mark Spalding facilitating)
- Coral Reef Locations / Mapping (Mark)
- *Lunch*

#### **Afternoon    Reef Mapping / Part 1 of Threat Modeling – Land-based Threats to Coral Reefs**

- Discussion / Feedback on Coral Reef Maps
- Threat Model Overview (Lauretta)
- Coastal Development and Tourism
- *Tea Time*
- Watershed-based Pollution and Sedimentation
- Map review and discussion

### **Tuesday, March 17, 2009**

#### **Morning    Part 2 of Threat Modeling – Marine-based Threats and Overfishing**

- Recap of Day 1
- Any overflow from Day 1
- Marine-based Pollution (Lauretta)
- Map review and discussion
- *Tea Time*
- Modeling Overfishing pressure (Lauretta)
  - Map review and discussion
  - Mapping Destructive Fishing events (expert based) (Katie Reytar)
- *Lunch*

#### **Afternoon    Management, Social and Economic Issues**

- MPAs, LMMAs and Management Effectiveness (an adjustment factor) (Mark)
- Map review and discussion
- *Tea Time*
- Social Vulnerability and Coral Reefs (Allison Perry)
- Potential for Economic Valuation (Lauretta)
- Discussion
- Break-out sessions in small groups for in-depth discussion of local threats.

## ATTACHMENT 2: AGENDA (CONTINUED)

Wednesday, March 18, 2009

### **Morning      Reporting from Break-Out Sessions and Global / Climate-related Threats**

- Reporting of outcomes from the small-group breakout sessions (coastal development, overfishing, marine-based threats, and land-based threats).
- Overview of approach for climate-related threats (Katie)
- Basic description of indicators for past and future threats (Katie)
  - Past Thermal Stress
  - Future Warming
  - Ocean Acidification
- Maps for review and editing and discussion (Katie)
  - Observations of Coral Bleaching (for review / edit)
  - Past Thermal Stress
  - Projected Warming
  - Projected Aragonite Saturation State
  - Observations of Coral Disease (for review / edit)
- *Tea Time*
- Other threats / other factors (Mark)
  - Disease, COTS, storms and other threats.
  - Should we / could we adjust by natural vulnerability?
- Open Discussion – comments on modeling; data for calibration
- *Lunch*

### **Afternoon      Review and Discussion**

- Main Messages
- Key Solutions
- Case Studies / Reef Stories
- *Tea Time*
- Concept and Model Improvements
- Products
- Next Steps
- Closing

**ATTACHMENT 3: MAJOR THREATS TO CORAL REEFS IN THE PACIFIC  
AS IDENTIFIED AT THE REEFS AT RISK WORKSHOP**

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|---|---|
| <ul style="list-style-type: none"> <li>• Fishing-Related Threats             <ul style="list-style-type: none"> <li>- Overfishing</li> <li>- Illegal</li> <li>- Unmanaged</li> <li>- Recreational</li> <li>- Destructive                 <ul style="list-style-type: none"> <li>o Blast</li> <li>o Damaging gear (e.g., nets)</li> <li>o Night SCUBA spear fishing</li> <li>o Poison</li> </ul> </li> </ul> </li> <li>• Aquaculture</li> <li>• Harvesting for export and aquarium trade             <ul style="list-style-type: none"> <li>- Corals</li> <li>- Fish</li> <li>- Inverts (e.g., bêche-de-mer, clams)</li> </ul> </li> <li>• Land-Based Threats             <ul style="list-style-type: none"> <li>- Agriculture</li> <li>- Livestock</li> <li>- Sewage</li> <li>- Industrial/point source</li> <li>- Logging</li> <li>- Mining</li> <li>- Nuclear waste</li> <li>- Urban development</li> <li>- Sedimentation</li> </ul> </li> <li>• Marine-Based Threats             <ul style="list-style-type: none"> <li>- Dumping at sea</li> <li>- Anti-fouling</li> <li>- Sand and aggregates mining</li> <li>- Solid waste</li> <li>- Ship wrecks</li> <li>- Dredging</li> </ul> </li> <li>• Coastal Development             <ul style="list-style-type: none"> <li>- Tourism (e.g., pollution, diver damage, overwater hotels)</li> <li>- Urban growth</li> <li>- Land reclamation</li> <li>- Coastal engineering/modification</li> </ul> </li> <li>• Physical damage             <ul style="list-style-type: none"> <li>- Trampling of reefs</li> </ul> </li> </ul> | <ul style="list-style-type: none"> <li>• Natural Impacts             <ul style="list-style-type: none"> <li>- Cyclones, storms</li> <li>- Tectonic impacts (e.g., tsunamis, earthquakes)</li> </ul> </li> <li>• Adjacent habitat impacts             <ul style="list-style-type: none"> <li>- Mangroves</li> <li>- Seagrasses/algal beds</li> <li>- Wetlands</li> <li>- Estuaries</li> <li>- Rivers</li> </ul> </li> <li>• Invasive species             <ul style="list-style-type: none"> <li>- Alien species</li> <li>- Non-alien species outbreaks</li> <li>- Algae</li> <li>- Aquaculture escapes</li> </ul> </li> <li>• Coral Predation             <ul style="list-style-type: none"> <li>- COTS, others</li> </ul> </li> <li>• Coral Disease</li> <li>• Climate Change and Variability             <ul style="list-style-type: none"> <li>- Acidification</li> <li>- Bleaching</li> <li>- Sea level rise</li> <li>- UV exposure</li> </ul> </li> <li>• Overpopulation</li> <li>• Lack of Awareness/Apathy</li> <li>• Lack of Capacity             <ul style="list-style-type: none"> <li>- Legislation</li> <li>- Enforcement</li> <li>- Science</li> </ul> </li> <li>• Military Activities</li> <li>• Loss of Local Knowledge             <ul style="list-style-type: none"> <li>- Disappearance of traditional management</li> </ul> </li> <li>• Ecosystem-Wide Decline</li> <li>• Isolation/Lack of Connectivity</li> </ul> |
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