

# RESILIENCE SOURCEBOOK

INSPIRED BY THE 2013 MILSTEIN SCIENCE SYMPOSIUM  
*UNDERSTANDING SOCIAL AND ECOLOGICAL RESILIENCE IN ISLAND SYSTEMS*  
*INFORMING POLICY AND SHARING LESSONS FOR MANAGEMENT*



## CASE STUDIES OF SOCIAL-ECOLOGICAL RESILIENCE IN ISLAND SYSTEMS

 AMERICAN MUSEUM OF NATURAL HISTORY

**CENTER FOR BIODIVERSITY  
AND CONSERVATION**

# A WELL-DEVELOPED COMMUNITY-BASED MARINE PROTECTED AREA PROVES RESILIENT TO A CROWN-OF-THORNS SEA STAR OUTBREAK

NIMPAL CHANNEL MARINE CONSERVATION AREA,  
YAP

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## THE SETTING

Yap State is situated in the westernmost region of the Federated States of Micronesia (FSM). Yap proper, the main island of Yap State, is located at 9° 32' N, 138° 07' E, within the Indo-Pacific center of biodiversity. The island is approximately 100 square kilometers, with a densely vegetated and hilly landscape. It is home to 7400 residents spread over 10 municipalities, a relatively small population compared to the other states of Micronesia. The population and urban center are slowly growing, placing increasing pressure on the islands' natural resources for subsistence and economic gain.

Yap, like many islands in Micronesia, has an extensive history of western colonization and Japanese occupation. The Spanish colonized Yap in the 1700s. Germany controlled Yap in the beginning of the 20th Century until it passed to Japan following World War I. The Japanese military used Yap during World War II but the US forced them out in 1944. The United States then held Yap and other Micronesian islands as a trusteeship until 1986, when the Federated States of Micronesia became a sovereign nation. The islands still have ties with the United States government through a signed agreement called the Compact of Free Association.

Micronesia's tumultuous history and strong ties to the United States have affected traditional natural resource management through out the Micronesian islands. Yap, however, has largely maintained traditional customs and management systems that differ from most other Micronesian states. Still,



over the past two decades, increasing westernization and the move towards a cash-based economy have challenged Yap's traditional customs and management systems. Development within Yap's watersheds, in addition to these changes in resource use, places growing pressure on the harvest and sale of fishery resources.

Though the cash economy has infiltrated Yap, many residents maintain a largely subsistence-based livelihood. The state government is mandated to manage and conserve natural resources and has instituted laws on resource management. However, in Yap, village chiefs have the final say on local resource use; they embody the collective voice and authority of the community through the various traditional estates. The Yap Constitution recognizes traditional tenure of land and the near-shore waters. The villages own natural resources on their land, as well as the reefs and marine spaces that are tied or linked to their traditional lands. Because each community has jurisdiction over their own reef, chiefs are able to listen to villagers' concerns and desires for site-based management, and

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establish rules. For over a decade, communities in Yap have created reserves or conservation areas on their lands or in their near-shore environments by making public declarations. Traditional chiefs and other traditional landowners endorse these declarations. While the legal status (in a formal western sense) of these conservation areas is still evolving, precedent has been set that the government recognizes and upholds the legitimacy of community-managed areas. As community-managed areas progress and modernize, formal management plans are being developed to aid in ensuring sustainable management policies with corresponding enforcement mandates.

The Nimpal Channel is located off the central-western coast of Yap. Both Okaw and Kaday villages have their fishing grounds associated with Nimpal Channel. The villages are within the municipality of Weloy, home to approximately 1000 residents. In 2005, a men's village meeting was called to address the ongoing problem of overfishing in their channel, and decided to seek help and information from outside their community. In 2006, a rapid ecological assessment (REA) was conducted across Yap Proper, including the Nimpal region, so that stakeholders could get a better sense of the current status of their resources. The coral-reef monitoring and assessment team for the REA process consisted of many knowledgeable fishermen from Okaw and Kaday villages, as well as regional scientists with local and global expertise. Following data collection and reporting efforts, and realizing that Nimpal's resources were not as well off as many



*A crown-of-thorns starfish on a reef in Yap outside of Nimpal MCA. Photo credit: Peter Houk*

other places in Yap due to both natural causes and local fishing pressures, these two villages began discussing their desire to set aside part of their reefs as no-take fishing areas. While Nimpal Channel is very narrow (approximately 0.5 kilometers in width) and has only a limited mangrove stand associated with it, the two communities proposed to make it a Marine Conservation Area (MCA). Through the REA process, marine scientists recommended areas for protection that were larger, deeper, and had more extensive connections with nearshore mangrove habitats known to nourish juvenile fish populations. To marine scientists, the area that Okaw and Kaday proposed to set aside was clearly influential for the locally-owned marine resources, yet was smaller in size and harbored less biological diversity in comparison to other larger and more extensive channels systems nearby. In short, this was not the most ideal area to bolster fishery resources based upon ecological criteria alone. However, the timing was right, and the two communities strongly supported management in that area. Shortly after, in May 2008, Okaw and Kaday, in partnership, publicly declared the Nimpal Channel as a Marine Conservation Area with technical support from the Yap Community Action Program.

Within only 1-2 years, monitoring results began to document improved fishery resources in the conservation area. These positive results were an immediate testament to strong community support for management, and dedicated local enforcement. Four years after formalizing the Nimpal Channel Marine Conservation Area, in



*Monitoring seagrass beds. Photo credit: Nimpal Channel MCA*



*Acropora* coral showing feeding scars from crown-of-thorns starfish on a reef outside of Nimpal MCA in Yap.  
Photo credit: Peter Houk

2012, a more formal scientific assessment of the channel reefs highlighted that the reef's condition is second-highest among other MCAs in the region despite having one of the smallest extents. The MCA exceeded the expectations of many marine scientists and changed the way they thought about establishing new marine protected areas going forward. In this case, strong social acceptance and enforcement was more important than ecological criteria.

### THE DISTURBANCE

In late spring 2009, *Acanthaster planci*, commonly known as the crown-of-thorns sea star (COTS), began populating the coral reefs around Micronesia (from Pohnpei westward to Yap). *A. planci* is a carnivorous species of starfish that preferentially preys upon hard corals such as *Acropora* spp. and *Montipora* spp. *A. planci* were first quantified in monitoring programs off the southwest coast of Yap, and anecdotal reports from fishermen and data suggested a northward migration up the west coast of the island.

Healthy coral reef systems with high levels of fishery resources have been shown to be resistant to the threat of an *A. planci* outbreak based upon recent evidence from places like the Great Barrier Reef and Fiji. While the exact mechanism remains elusive, there appears to be some added resistance to these natural disturbance events from healthy fish populations through predation and/or other biological interactions. On the flip side of things, reefs that have already been stressed by increased sedimentation, reefs with low numbers of predators due to overfishing, and reefs with low

coral diversity have proven most vulnerable to *A. planci* predation.

This outbreak of *A. planci* was not a new threat for Yap. *A. planci* outbreaks have been described as natural, cyclical events. There are a few theories on why the outbreaks occur. Some experts theorize that COTS outbreaks occur when the sea stars 'sense' oceanic conditions are most conducive for their larval offspring to successfully develop, and hence the initial outbreaks may be triggered by some form of nutrient enrichment in the surface waters near coral reefs. Following spawning from initial population outbreaks, it has also been hypothesized that larvae may get caught in ocean currents and somehow influence secondary starfish outbreaks downstream. In Yap, the single most significant COTS event was documented in the early 1970s, although there is local knowledge of smaller outbreaks over the years.

To the local community, the sea stars are well known, but their lifecycles remain mysterious. Locals understand the origins of threats to the reefs like bleaching, sedimentation, and overfishing; however outbreaks of the crown-of-thorns sea stars just suddenly occur without any obvious proximal cause.

### THE RESPONSE

During the 2009 *A. planci* outbreak there was no official attempt on Yap to remove the sea stars from their reefs, but fishermen noted their presence. In the case of the Nimpal MCA, the communities did not choose to remove starfish because of adherence to the established no-take MCA policy.

### THE RECOVERY

The recovery of the coral reefs to the *A. planci* outbreak in Yap varied. A recent study revisited the study sites where coral populations were monitored as part of the 2006 REA survey and found interesting results. Many reefs along the western coast of Yap showed an expected decline in coral colony sizes and diversity, yet there was one unique exception. The Nimpal Channel MCA appeared to be more resilient to the disturbance event compared with sites to the north and south of this channel. Remarkably, no sea stars were

found in the protected area during surveys shortly after the COTS event. In fact, monitoring of the area during the disturbance revealed an increase in coral colony sizes, no significant change in diversity within coral groups, and consistently high fish biomass. Reefs in the protected area showed high abundances of *Porites* spp. (the less desired coral for *A. planci*) but *Acropora* spp. also remained throughout the disturbance period. The area's resistance to COTS is hypothesized to be due to an intact predator fish population and high coral diversity.

In contrast, formerly diverse reefs with extensive coral growth, such as off the southwestern tip of Yap, had the greatest coral reef damage after the sea star outbreak, with little recovery reported as of 2013. Other coral reefs to the north of the Nimpal Channel MCA started to recover in 2012, but recovery has been a slow process and remains ongoing. These findings suggest that the establishment of the locally-managed MCA may have benefitted the resilience of Nimpal's reefs, and might be supporting recovery along adjacent reefs.

This case study highlights the importance of well-managed marine protected areas for weathering disturbance events. Nimpal Channel MCA appeared to provide added resistance to the COTS disturbance through a series of highly influential, but still poorly understood, ecological processes.

While the Nimpal Channel MCA was initially established to aid fish stock recovery, it was later found to have added benefits of enhanced



Installing monitoring equipment. Photo credit: Nimpal Channel MCA

resistance to COTS. The success of the Nimpal Channel Marine Conservation Area in both enhancing fish populations and mitigating the damage done by the 2009 disturbance continues to be a very popular and productive discussion at regional management meetings across Micronesia. This example shows that marine protected areas have additional benefits that we are only beginning to understand. Certainly the list of benefits will grow into the future.

#### LESSONS LEARNED AND RECOMMENDATIONS

- *People, rather than biology and science, are most important to think about when establishing a marine protected area.* Without the community's dedication to protecting their channel, the Nimpal Channel Marine Conservation Area would never have been established. Based on biological considerations and the small size of the managed area, scientists felt other areas were better suited to set aside as a protected area; it was only through the community's will and support that their protected area was established. Science is used to drive management recommendations, but other factors might be more relevant for successful management.
- *The success of a marine protected area is dependent on community involvement and knowledge.* The success of the Nimpal Channel MCA is due to community-based decisions based in traditional ecological knowledge and supported by scientific measures. Consequently,



Community participants in a planning workshop. Photo credit: Nimpal Channel MCA

the Nimpal Channel MCA is one of the few functioning protected areas in Yap.

- *Quantitative monitoring is essential for responding to increased frequency and intensity of disturbances.* Identify critical biological thresholds in your management area. Reef ecosystems are complex systems that can behave in a non-linear manner (for instance, the decline of a predator fish population might not have the effect of reducing a reef's resistance to *A. planci* outbreak until the predator fish population declines past a critical threshold). Part of this non-linear behavior is related to trophic interactions (interactions between predators and prey, for example). Science has not fully explained trophic interactions and thresholds in coral reef systems. Disturbances are becoming more and more frequent; there might be a COTS outbreak one year and a bleaching event the next year. Because of the increasing frequency and severity of threats to coral reefs, it is important to collect quantifiable data to be able to perceive rates of change. For example, monitoring fish biomass in your area can be a good starting point to understanding how fish biomass is related to reef resilience. The relative level of biomass within different trophic levels may be related to the maintenance of coral reefs through time.

- Marine Laboratory, University of Guam  
<http://www.guammarinelab.com>
- Water and Environmental Resource Institute of the Western Pacific, University of Guam  
<http://www.weriguam.org>
- Palau International Coral Reef Center (PICRC)  
<http://www.picrc.org>
- The Nature Conservancy Micronesia Program  
<http://www.nature.org/ourinitiatives/regions/asiaandthepacific/micronesia/index.htm>
- Micronesia Conservation Trust  
<http://www.ourmicronesia.org>
- Seacology  
<http://www.seacology.org>
- Conservation International's Pacific Islands Program  
<http://www.conservation.org/where/pages/pacific-oceanscape.aspx>
- Pacific Development & Conservation Trust  
<http://www.communitymatters.govt.nz/Funding-and-grants---Trust-and-fellowship-Grants---Pacific-Development-and-Conservation-Trust>
- Onereef Micronesia  
<http://www.onereef.org/index.htm>

*As told to Alexandra Donargo.*

#### **PARTNERS AND FUNDING SUMMARY**

- Kaday Community and Cultural Development Organization
- Pacific Marine Resources Initiative  
<http://www.pacmares.com/Home.html>
- Yap Community Action Program  
<http://www.facebook.com/yapcap.NGO>

## THE MILSTEIN SCIENCE SYMPOSIUM

The collection of this case study and others like it results from the April 2013 Milstein Science Symposium, Understanding Ecological and Social Resilience in Island Systems: Informing Policy and Sharing Lessons for Management. Held at the American Museum of Natural History, the Milstein Science Symposium convened local resource managers, researchers, educators, island leaders, policy makers, and other leading conservation practitioners to examine characteristics, qualities, and processes that may foster resilience for coastal and marine systems as well as explore interactions, linkages, and feedback loops in complex social-ecological systems and what this means for management. The Milstein Science Symposium was organized in collaboration with The Nature Conservancy, the Gordon and Betty Moore Foundation, the National Science Foundation, The Christensen Fund, the Coral Reef Alliance (CORAL), the Scripps Institution of Oceanography at the University of California San Diego, the University of California Santa Barbara, the United Nations Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries, and Small Island Developing States (UN-OHRLS), and the Wildlife Conservation Society.

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<http://tinyurl.cbc-resilience-cases>

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