Coastal Management, 30:401–418, 2002

0892-0753/02 $12.00 + .00
DOI: 10.1080/08920750290028 2

The Reimplementation of the Ra'ui: Coral Reef Management in Rarotonga, Cook Islands

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*This research focuses on coral reef health in the South Pacific region, an area of high global coral diversity. Coral reef health surrounding two study sites in Rarotonga, Cook Islands, has been assessed in areas that have not been previously surveyed. Each study site has distinct differences based upon marine management practices. Marine management practices are identified and described and some historical reasons as why they exist are discussed. Data are also presented on the ecological condition (coral coverage, number of coral species, clonal condition, disease, and presence and absence of bioindicators). This interdisciplinary research methodology includes both ecological and social data collection to further understand human–environment interactions. In comparing the reefs with different management practices, I argue that the implementation of traditional marine social institutions as exemplified in this case study of the Ra'ui in Rarotonga, Cook Islands, is an effective conservation management tool and is improving coral reef health. The Ra'ui site has significantly higher species diversity/Mortality Index (*F = *2.63).*

Keywords community-based conservation, coral reef, marine resource management

Introduction

> Ra'ui has no fishing and collecting, and it is helping the ecosystem. Herbivorous and carnivorous fish [are] getting back into balance. (Interview #1, Rarotonga)

In the past two years the local communities on Rarotonga, Cook Islands, have tried to stop islanders from fishing in some coral reefs areas by creating traditional no-fishing zones, known to the locals as Ra'ui. The Ra'ui primarily protects the reef from many people walking and collecting shellfish, octopus, and other organisms, and therefore helps restock the lagoon fish. Locals want to maintain the restricted areas for conservation purposes.

Received 20 October 2001.
The United States Environmental Protection Agency Star Fellow # U915636 and the University of California Pacific Rim Research Program provided financial support to conduct this research. I would like to thank my professors Jere Lipps, David Stoddart, and Michael Watts for their guidance and the reviewers for their comments. For more information on this project see Tegan Churcher Hoffmann's Ph.D. dissertation, *Reefs of Life to Reefs of Death: The Political Ecology of Coral Reef Health in Fiji and the Cook Islands*, 2001, University of California Berkeley, Department of Geography. This article does not necessarily represent the views of CORAL.
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This island case study of Rarotonga documents an alternative model of the property institutions in place, which changes access to resources and regulation of marine areas. Rarotonga has heavy development of marine resources. The local people and the government have simultaneously reinvented traditional marine institutions to regulate access and harvesting of the reef.

In this article I will review the history of the Ra'ui, discuss the process of its reintroduction in 1998, and investigate whether or not the Ra'ui around Nikao Beach has changed any aspect of the basic reef ecology. I will show that the reintroduction of "traditional" marine social institutions, as exemplified in this case study, has increased the diversity of corals. Other researchers show that it has increased marine invertebrates and fish species diversity and evenness (Ponia et al., 1999, 1998; Raumea et al., 2000).

Methods

This research contributes to baseline monitoring in the Pacific, where a small amount of research has been done to assess coral reef health in comparison to the Caribbean (Cornell, et al. 1997; Salvat, 2001; Wilkinson, 2000). The research questions require an interdisciplinary approach and set of methodologies. I asked in-depth questions that were open-ended[1] with local people who live and work in coastal communities, secondary data sources, and my own fieldwork to determine coral reef health as well as to document baseline data on basic ecology of the reef. Three methods are used to obtain these data, and they are:

1. *Local knowledge*: data obtained from local people who have knowledge of the reef and from local reports to examine the local history of the environment and Ra'ui system;
2. *Qualitative ecological data*: to assess large-scale patterns of reef health between the two study sites;
3. *Quantitative ecological data*: by site-specific sampling.

All ecological data were collected in December 1999. Additional interview data were collected in June 2001. A research assistant, Lisa Wedding, was employed to help with data collection and I also collaborated with and employed people on the islands.

The research results presented in this article are part of a larger Ph.D. study related to human and environmental effects of economic development and different property regimes in the Cook Islands and Fiji. The project took an overall political ecology approach to analyze the human–environment interactions. The social science research methods were comprised of interviewing people and collecting secondary sources. Census data appeared accurate and up-to-date. Cook Island interviewees were selected who were well informed about their community and the recent history of the marine environment and the Ra'ui. Oral histories were elicited from 23 informants to document their perceptions on changes on Rarotonga to contribute to a longitudinal understanding of the impacts of development. They were asked open-ended questions on coral reef health, changes on the reef in their lifetime, fishing practices, coastal development, the Ra'ui, and history of the Ra'ui. Informants included 12 government officials, 4 community leaders, 4 dive and tour operators, 2 researchers, and 1 representative from a nongovernmental organization.

By carrying out ecological assessments around each island I have been able to make observations and acquire baseline data coral reef health.

Field Analysis of Transects

25 m × 1 m transects with three replicates were done to determine the state of the reef. Within each contiguous quadrat the following factors were determined:

- percentage live and dead cover of hard corals and soft corals;
- number of hard coral and soft species;
- the number of corals affected by predators, parasites, and pathogens,[2] determined by examining potential biotic factors. Examples of these factors are coral diseases, such as black band disease, parasitic organisms such as *Plagioporus* spp., or bleaching. In addition, a coralline algae disease, coralline lethal orange disease (CLOD), was documented;
- the genus of coral affected by the biotic factors when known;
- clonal condition of the coral polyps. This qualitatively documents the appearance of the coral tissues. Comments were documented describing the coloration of the tissue and the appearance of mucus;
- presence and absence of coral disease and filamentous algae and Cyanophyta.

Data were collected on indicator species, coral affected by parasites and disease, and clonal condition using methods recommended by Santavy and Peters (1997). The criteria above suggest that a significant difference in prevalence of one or more of the following factors indicates a threat to coral reef health: predators such as the Crown of Thorn Starfish, parasites such *Plagioporus* spp., tissue loss and discoloration, mucus production, and the presence of certain bioindicators such as filamentous algae and certain Cyanophyta (Naranjo, Carballo, & Garcia Gomez, 1996)

Ecological Data Collection Study Sites

There have been no studies of coral growth on the reef flat or differences inside and outside the Ra'ui. I selected the Nikao Ra'ui site to survey and compare with a second study area within 500 meters. This study compares two sites, one inside and one outside a protected area. In Nikao Reef, Site #1 and Site #2, all reefs were fringing reefs (see Figure 1). Transect locations were nonadjacent, nonoverlapping, and dispersed at least 100 m laterally along each reef. Therefore, the reef areas sampled incorporate variation. Three transects of 25 m were measured, with counts being taken each meter with a 1 m × 1 m quadrat for a total of 75 quadrats at each site.

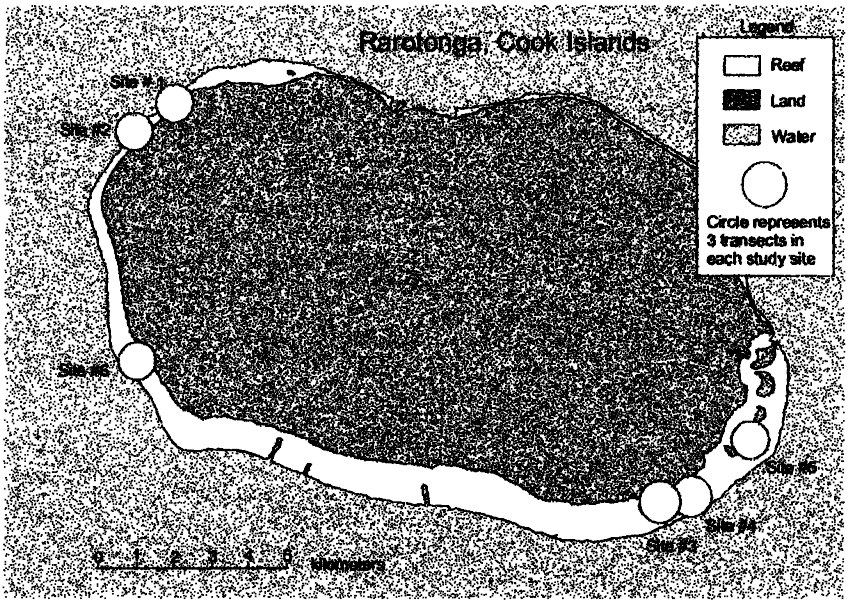

Figure 1. Rarotonga study sites, Cook Islands.

Site #1 Descriptive Data of Nikao, Ra'ui: W159.49.376 S21.12.474. The Ra'ui covers 25 ha, including 800 meters of beach. The beach is public and easily accessed by locals and tourists. Two habitats are found within the study site, reef and sand substrate. Reefs dominate the habitat. The Ra'ui began in 1998 and was lifted for one month starting February 1, 2000, and then reinstated. According to the Ministry of Marine Resources, large increases in invertebrates have been recorded in the Nikao Ra'ui (Ponia et al., 1999, 1998; Raumea et al., 2000).

Site #2 Descriptive Data of Nikao, no Ra'ui: W159 49.3R8 S21.12.470. Site #2 is southwest of Site #1 in the Nikao community.

Cook Island Customary Marine Tenure and the Ra'ui

In many Pacific countries, laws and customary practices relating to conservation and use of natural resources are an essential component in policy making. In the past century, as legislative systems have begun to incorporate environmental laws, the question of integrating customary concepts and practices into the Western legal framework has come to the attention of many researchers and resource managers (Pulea, 1984). Customary law has been found throughout the Pacific in written and unwritten form (Boer, 1996). These types of laws can be a social contract, such as marriage, or have an economic incentive, such as the numerous customary practices of traditional fishing that economically benefited a chief or the community. Pacific people abide by such laws or the social laws which may be considered ritual, or process by which society conforms, and, if violated, will invoke coercive procedures (Boer, 1996). According to Reti (1993), the incorporation of customary law has been effective concerning the protection of the Pacific Islands' environment:

> Custom and traditional law have in the past had some success in the protection of the natural resources and environment of countries in the Pacific. However, some customs and laws have lost the degree of respect they use to command and are not as effective today as they were some years ago. . . . Both the written and unwritten laws can contribute positively to the protection of the environment of the Pacific. The unwritten law which has its basis in the traditional customs and practices can bring together local communities to observe and to pay respect to policies and principles set under the written law for the protection of the environment. The legal system must also respect the local traditions and practices if it is to gain support and cooperation of the local people. (Reti, 1993, pp. 59–60)

The customary laws and practices, i.e., patterns of behavior and social norms that have developed in the Cook Islands are based upon a system originating from Eastern Polynesia. These practices have been modified over the years, especially since European contact. Since 1965, the Cook Islands has been a self-governing state in free association with New Zealand. The formal ties to New Zealand beginning in 1901 significantly influenced the Cook Islands legal system. Laws written at this time are still in practice. For example, on issues related to land rights and ownership, the following law is still in place. The Cook Islands Act of 1915 gives recognition to native customs and makes the following provision in relation to land: "Every title to and interest in customary land shall be determined according to ancient custom and usage of the Natives of the Cook Islands" (Boer, 1996, p. 30).

However, all land lying below the high water mark was declared by The Cook Islands Act of 1915 to be Crown Land, thus annulling the indigenous pattern of rights to reef and lagoon waters (Boer, 1996, p. 30). Furthermore, the 1986/87 Conservation Act declares all foreshores and soil under the water to be owned by the Crown (Boer, 1996). This Act further protects the foreshore by prohibiting the removals of silt, sand, gravel, coral, cobble, and boulders from foreshore and coastal waters without permission from

the Conservation Council. These three laws are crucial to the issue surrounding reef health and the reimplementation of the Ra'ui.

Prior to European contact, rights to the lagoon, like land, were controlled by the dominant social lineages. According to Crocombe (1964) "rights to the lagoon and its products were generally exercised by the *matakeinanga* occupying the *tapere*."[3] Although demarcation of the areas as often unclear, court cases documented people referring to coral rocks as boundary marks (Crocombe, 1964, p. 41). In addition to reef access, reef passages from the lagoon to the open ocean were associated with the senior title of the major lineage of the *tapere* in which they were found. In the past, it was the right of the title-holder to be given a part of the catch by any fisherman using the passage (Crocombe, 1964, p. 41).

Access to land, preservation of supplies of certain crops, protection of lagoon fish, and even a walking path could be controlled by the use of a Ra'ui, or customary prohibition, enforced by the appropriate chief. The Cook Islands Maori Dictionary defines a Ra'ui as: "1. A sign, *usu*, leaves on a branch set in place by the owner of a piece of land or water reserving it or its produce for his own or some special use; a prohibition. 2. Erect a ra'ui restricting the picking of fruit etc."

The Ra'ui would be marked with a sign, such as a coconut leaf tied around a tree bordering the prohibited area. This prohibition was not permanent and would usually last for a season to restock food sources for a celebration or feast, or to protect a species while spawning (Interview #15, Rarotonga). The area was patrolled and no one was allowed to enter the demarcated area (Interview #14, Rarotonga). This area had supernatural power, *tapu*. If a person were to break the Ra'ui he/she would be punished with both secular and supernatural sanctions: "Ra'ui areas are policed by *mana*, power—traditional leadership, king, and social pressure. And hurt person if disobey" (Interview, #3, Rarotonga). The Ra'ui had spiritual significance. Prior to colonization, not only would poaching cause a person harm through supernatural forces, but the person would be punished by the village. Forms of punishment included being beaten, fined, or perhaps even chased out of the village (Interview #18, Rarotonga).

In the 19th century when European missionaries arrived, and in 1888 when the Cook Islands was officially declared a British Protectorate, the Ra'ui was used as an important technique to control the export of cash crops. A person could not harvest any coconuts until the Ra'ui was lifted. In order for the Ra'ui to be lifted, the *ariki* would negotiate with a trader the best price for the crop for the entire district. The system was "used to reduce theft and ensure the best possible price for produce" (Crocombe, 1964, p. 93). However, an unfair chief could take advantage of this power. A principal function of the subsistence economy had been to ensure food supplies, but since the resources were perishable, and thus rapidly consumed, all the people enjoyed the fruits of their labor. The chief would not take a larger share than anyone else, just perhaps the best piece. But, as the export agricultural market developed, the chief could use a Ra'ui to increase his cash income.

As land laws changed under The Cook Islands Act of 1915, land and sea ownership became segmented and clans' control and ownership of the land and sea was slowly being extinguished. By the 1970s, the Ra'ui system was not being used on the island of Rarotonga. If an elder placed a coconut leaf on a stake to protect the coconuts for feast, people would just rip off the leaves (Interview #12, Rarotonga). Local people were becoming less and less dependent upon the land and, in addition, had less access to it (Interview #12, Rarotonga). Prior to the reimplementation of the Ra'ui in 1998, the last time one community leader remembers a Ra'ui was in the early 1970s. "My grandmother or other elder, put a Ra'ui on in the 1970s during the time period the Rock Cod was spawning. No fishing and she would tie a coconut leaf on a stick and place it in the water and this would mean do not fish there" (Interview #12, Rarotonga).

In the Northern Group of Islands, the major lineages demarcated and created claims and ownership of the lagoon, and these traditional claims have persisted. For example, local people still respect traditional ownership of the reef if the family owns beach front property and there is no alternative way to access the waters except through the family's land (Interview #19, Rarotonga). Presently, on the remote islands and atolls, beach front access and ownership is of great importance, especially as the cultivation of pearls is becoming a more developed industry (Boer, 1996). In one of the southern islands, Rarotonga, the Ra'ui system was re-instated by the local communities with the government's approval in 1998, and other islands such as Aitutaki reimplemented the Ra'ui in 2000. Koutu Nui is suggesting the Ra'ui system to the other islands. Although the Ra'ui are technically common property areas, the Cook Islanders have decided to implement the traditional system of the Ra'ui with the support of the government.

Access and Control over Marine Resources and the Reintroduction of the Ra'ui

On the island of Rarotonga the Ra'ui was re-instated by the traditional leaders in 1998 in five different community lagoon areas surrounding the island:

> The Ra'ui has been declared to assist in the protection of the marine environment, to contribute towards an increase in the numbers of fish and shellfish available for present and future generations. It may provide the additional benefit of promoting the area as a tourist attraction, bringing opportunities for additional revenue to the people. (Passfield & Tiraa, 1998c, p. 3)

The Ra'ui is a complete ban on fishing or collecting of all marine life. However, the restricted area remains open to recreational users for nonmotorized activities such as snorkeling and surfing. The demarcated areas extend from the high water mark to the reef slope to a depth of 30 m. Community wardens of all ages are appointed to enforce the prohibition against killing and taking of marine life. The duration of the Ra'ui varies from community to community, but is not seasonal. Instead. communities are assessing the marine resource stocks to determine their rate of recovery with the aid of the Ministry of Marine Resources.

Why was the Ra'ui reinstated in Rarotonga after so many years? The idea emerged in the 1970s when Gare (1975) and later Dahl (1981) suggested creating marine reserves around the island. Soon after, the traditional chiefs, *Koutu Nui*,[4] in 1989 requested the Ministry of Marine Resources to survey the marine resources in the lagoon. The chiefs were once again thinking of creating marine reserves and wanted some biological data to support this proposal. By 1991, the Cook Island Tourism Master Plan suggested creating a marine reserve, as did the Asian Development Bank in 1995 (Barrett Consulting Group, 1985; Darby, 1991). The 1991 Tourism Master Plan suggested organizing and standardizing tourist cultural sites as well as coastal areas (Darby, 1991). The plans also recommended ways to better manage limited water resources and disposal of waste on the tiny islands. The creation of a marine reserve was thought to attract tourists and create revenue. In 1997, the idea was again brought to the attention of the Cook Island Tourism Master Plan Implementation Assistance Programme (TMPIAP). This NZ$2.8 million program funded by the New Zealand Overseas Development Agency (NZODA) and Cook Island government had the goal to develop, promote, and strengthen tourism. One report was carried out, by the request of the *Koutu Nui*, under the TMPIAP, which proposed the establishment of marine protected areas using the Ra'ui concept (Passfield & Tiraa, 1998c). This crucial report, "Parks, Reserves, and Ra'ui on Rarotonga: A Proposal for Establishment of Protected Areas in Partnership between Landowners, the Community

and Government," instigated discussions with the communities on establishing the marine reserves, Ra'ui (King, 1997). After the completion of the report, the World Wide Fund for Nature (WWF) decided to support the concept, but only if it was community based. By September 1997, the feasibility study was presented at a stakeholders' meeting for commentary by the government, NGO, business, fishers, and chiefs to discuss. At this point the President of the *Koutu Nui*, Dorice Reid, said that the *Koutu Nui* should promote and support the Ra'ui and convey this agenda to the communities. Furthermore, to truly accomplish and implement the Ra'ui, all the groups agreed that the *Koutu Nui* had to be the ones establishing the Ra'ui. The advantage of using the traditional system in the modern context is that it is community based and managed. Furthermore, over the years the Cook Island government has been perceived as oppressive; as one local person stated, the "government involvement in restricting fishing is seen as politically incorrect" and "the government is not trusted. In the past [the government] did not deliver promises and the communities have not always been consulted on various projects" (Interview #12, Rarotonga; Interview #14, Rarotonga). Native inhabitants trust and respect their community leaders. Furthermore, it would be expensive to enforce the regulation. Peer pressure and the *mana* of traditional leaders was often all that was required to prevent a violation in the past, and people thought it would work again today. In order for it to be established and successful, once implemented, the entire community's support was and is essential for continual success.

Members of the community from many different groups came together to share the responsibility of accomplishing tasks and supporting financial aspects of the project. The *Koutu Nui* gathered support from WWF to help prepare the management plans for four of the five selected sites. The Ministry of Marine Resources agreed to survey the Ra'ui and advise on appropriate times to open the Ra'ui for harvesting or move the Ra'ui to another location. NZODA, through the Tourism Master Plan, provided funds and created awareness campaigns and activities. They paid for the Ra'ui signs, boundary markers, leaflets, and flyers educating tourists and the community (see Figure 2). Businesses, schools, and the church supported the initiative with money, educational programs, and material.

Figure 2. Nikao Ra'ui sign, Rarotonga, Cook Islands.

Community Establishment of the Ra'ui

Implementation of the Ra'ui has resulted in 14% of the lagoon being demarcated as a Ra'ui (Ponia et al., 1998, p. 30). These temporary reserves allow fish stocks, corals, and other marine resources to rejuvenate. Five sites were initiated in February 1, 1998, by the traditional chief, *Koutu Nui*. The first five Ra'ui were declared by the groups of traditional chiefs and the communities of Rarotonga. This was the first step to improve the inshore marine environment surrounding Rarotonga. The five Ra'ui are in the communities of Aroko/Nukupure Ra'ui, Nikao Ra'ui, Kavera Ra'ui, Tikioki Ra'ui, and Matavera/Pouara Ra'ui: "Four of the Ra'ui declared in 1998 (Tikioki, Nikao, Aroko and Pouara) were in place for two years" (WWF, personal communication, 1/5/01).

After the *Koutu Nui* decided to support and implement the Ra'ui, they went to each of their respective villages for discussion:

> Each community is unique and the chiefs of each area called [a] meeting with their community. They told the communities that they wanted [the] Ra'ui. And, asked the community, and discussed the boundaries and how long it should be in place for, as well as what species to protect for certain Ra'ui like Avana/Nukopure/Aroko, which has restricted species. (Interview #14, Rarotonga)

Each village held a meeting deciding whether to establish a Ra'ui. There was discussion until overall consensus was achieved. Other meetings were held at each village so that the community could decide upon the location and period of time that the Ra'ui would be in place. It was determined that toward the end of the Ra'ui another community meeting would be held to discuss whether the Ra'ui should continue. Each village held a different number of meetings and made different decisions about whether to establish a Ra'ui, the size of the Ra'ui, the period of time the Ra'ui should be in place, and the restrictions. Once the communities decided on the establishment of the Ra'ui, they agreed to implement them all on the same day. The Ra'ui was declared in the traditional manner by the *Koutu Nui*, with a special church service blessing the formation of the Ra'ui.

Nikao

Nikao Beach, Black Rock, is one of the most popular beaches on the island. The Nikao community decided to place a Ra'ui on the popular site to protect the reef and lagoon from harvesting and trampling. Most of the community supported the establishment of the Ra'ui: "The community decides about the Ra'ui and I chair the village, but the people decide. I put a map up and people decide. Not a lot of debate. . . . All communities have a similar process . . . in the village everyone is the same . . . we are all equal" (Interview #18, Rarotonga).

When the meeting was held to review the Ra'ui in 1999 all the people of the community wanted the Ra'ui because they saw higher density and diversity of marine species in the waters (Interview #18, Rarotonga). The community decided to establish another Ra'ui:

> There are two in the village. The second is by the parliament and it is in place for five years. It is their land, of the family. Little Clams in the sand were gone and [the family] want[s] to bring them back. This second Ra'ui is a reef owned by the family. There is no access to the beach except through this family's yard and they look after the beach, which is not Crown Land. (Interview #19, Rarotonga)

The Nikao community has been continually advised by the Ministry of Marine Resources to determine the optimal times to harvest trochus in the area. The Ministry of

Marine Resources suggested brief periods of time when only the trochus could be harvested (Interview #16, Rarotonga). The community profited greatly from the Ra'ui. They decided after the two-year Ra'ui from 1998–2000 to open the area for one month and allow spearfishing and harvesting of trochus:

> On Aitutaki NZ$400,000 was made harvesting the trochus. Our village first harvest of trochus benefits our village and we gave it two years and then we took it out. We collected five tons last year and it was NZ$41,000 for village projects and we only opened the Ra'ui for one month and allowed spearfishing and trochus, no net fishing. (Interview #18, Rarotonga)

People in the Nikao community believe that the Ra'ui system has respect from most of the community members. If a person does not abide by the Ra'ui he/she will be embarrassed in front of the community, and it is considered to be a bad omen. "Nothing happens except warnings from the elders if you poach . . . but you will get hurt accidentally if you fish in the Ra'ui and this is true. Two boys were caught fishing and were warned by the minister and the next day they were smashed against the sea wall" (Interview #18, Rarotonga).

Tikioki

Tikioki reported an initial meeting of 60 people from the community to decide upon the creation of the Ra'ui. The creation of the Ra'ui was well received. The community decided to have a two-year Ra'ui that restricted all taking and killing of marine life. The area remains open for recreation use, although no jet skiing or water skiing is permitted. Wardens were appointed from the Rangatira family. Toward the end of the Ra'ui period a review committee was appointed by the *Mataiapo* in 1999 (Passfield & Tiraa, 1998d): "The Tikioki Ra'ui was lifted on 1st February 2000 and moved west to Akapuao on the same day. This Ra'ui will be in place for five years. Again on the same day, a smaller area of the old Tikioki Ratui was declared a permanent marine sanctuary" (WWF, personal communication, 1/5/01).

The Tikioki private sector has been benefiting from the Ra'ui. In the past few years more ecotourism tours and activities are available to tourists. The Ra'ui around Tikioki is becoming a tourist stop and popular snorkel and dive site. "[The] commercial sector benefit[s] from the Ra'ui. Hotels, cruises for viewing coral have improved [business]. Small shops have popped up and more people are snorkeling. The bus stops now at [the] Ra'ui. Night dives [have been] organized and [there is] much opportunity" (Interview #16, Rarotonga).

Avana/Aroko/Nukupure

The traditional leaders called a meeting and the location of the Ra'ui was determined. The community decided to place a ban on the harvesting of all marine plants and animals. Three species, however, are allowed to be harvested when in season: *patito* (sea slug), *matu rori* (sea cucumber), and *ature* (fin fish) (Passfield & Tiraa, 1998a). Recreational activities are allowed in the Ra'ui, but no jet skiing or water skiing.

Traditional landowners and the *Mataiapo* will appoint wardens, but all community members are encouraged to enforce the restrictions. A review process began in 1999 to decide on whether or not to keep the Ra'ui in place after February 2, 2000. The Aroko Ra'ui was lifted on 16 February and replaced on 2 March (WWF, personal communication, 1/5/01).

Matavera/Pouara

The initial discussion meeting comprised 30 people (Passfield & Tiraa, 1998b). The community agreed to have a complete ban on the harvesting and killing of all marine life. The area remains open to recreational activities. The *Mataiapo* will select a review committee toward the end of the Ra'ui period, and the Rangatira will enforce the Ra'ui. One-third of the Pouara Ra'ui was lifted (or harvesting) on 2 February 2000 and replaced the next day, on 3 February (WWF personal communication, 1/5/01).

According to one community member it was not the community deciding upon the establishment of the first Ra'ui; it was the traditional families who owned the coastal land.

> [The] community decides and for Matavera there were four consultations and they could not agree and did not want the Ra'ui. [The] Tapere was owned by [his] family—reef to hills—and it is still seen as that today. Matavera could not decide and [his] family decided to post Ra'ui. . . . Matavera community was bullied into it and now they see the benefit. (Interview #12, Rarotonga)

The traditional property rights are still respected in the Matavera community. The families that own coastal property also are seen as the owners of the reefs.

Since access to the reef is through the families' property, most people respected the Ra'ui: "Some poachers over the last three years . . . overall the Ra'ui helped a lot, otherwise ten–fifteen people collecting everyday. No laws, if caught just embarrassed" (Interview #12, Rarotonga).

The Ra'ui beginning in 2000 will be in place until 2005. The entire community supported and agreed to create a more permanent Ra'ui. Since the Ra'ui was strategically placed in the middle of two passages, there is "spillage" of marine life on both sides of the reef into over 1 km of village reef (Interview #12, Rarotonga). Furthermore, people are reporting that they are seeing clams, seaweed, and baby parrotfish that they had not seen for decades (Interview #12, Rarotonga): "Matavera [will be in place for] five years . . . Tikioki [is] permanent and will be renamed Ra'ui Motukore (forever) and it is only a section of the patch reef" (Interview #16, Rarotonga).

Rutaki

The seven traditional leaders, seven Mataiapo, decided to place a six-month Ra'ui starting February 2, 1998, and then lift the Ra'ui and place another Ra'ui for six months in a different location. This was done four times. They decided to totally ban the killing and taking of marine life and not allow any recreational activities or access inside the Ra'ui. People are allowed to access the ocean only through the reef passages. The community did not want to appoint wardens. They felt that the *mana* and *tapu* of the Ra'ui will be respected and, if otherwise, they will take other measures. The review process began at the end of 1999 (Passfield & Tiraa, 1998c).

> Rutaki the fifth Ra'ui declared in 1998 (Rutaki) was in place for ten months. Fishing was intensive when it was lifted for Christmas in November 1998. Unfortunately, an assessment of marine resources was not done immediately before or after the lifting. Later, the Rutaki Ra'ui managers shifted the Ra'ui about two kilometres west to Kavera to be in place for ten months from 1st March 1999. This was lifted on December 31st 1999 and moved one kilometre east to Aroa on 1st March 2000. This Ra'ui, immediately adjacent to the Rarotongan Beach Resort will be in place for two years. (WWF, personal communication, 1/5/01)

The Rutaki Ra'ui, according to the Ministry of Marine Resources, was not very effective in protecting the marine resources because once the Ra'ui was lifted and the reef

open for harvesting, the community overexploited the resources: "One Ra'ui lesson we learned was in Rutaki. For 6 months they placed a Ra'ui and when opened [the community] raped [the] reef and [there is] nothing now" (Interview #16, Rarotonga).

The Ministry of Marine Resources recommends to the communities that they have the Ra'ui for a longer period of time with limited harvesting periods in between the Ra'ui. This prevents overexploitation and also allows communities to benefit from the Ra'ui.

A Model of Success

The acceptance of the Ra'ui by the local people was a result of a number of factors. The emergence of the fish disease ciguatera and the decline in the state of the lagoon health were the primary reasons for such overwhelming community support. In the early 1990s a fish toxin called ciguatera appeared in the lagoon fish. Some studies have shown that ciguatera is correlated with an increase in nutrients in the water column, which are a result of reef disturbance or destruction, construction, or agricultural pollutants, but this is still being debated (Lewis, 1981).

> *Ciguatera* came out five to six years ago and local[s] stopped eating [the] fish. This was an opportunity to impose conservation in the lagoon areas and improve lagoon areas with [the] Ra'ui system. Now [the] lagoon [is] re-stocked and the locals want to fish and eat again . . . Ra'ui is a traditional system—traditionally a stocking exercise for a feast and only lasts up to a year. (Interview #3, Rarotonga)

Ciguatera derives from a toxin accumulated in some fish in the tropical seas. The production of the toxic agent, a dinoflagelette algae *Gambierdiscus toxicus*, occurs when there are too many nutrients in the water column. The outbreaks tend to occur following environmental disturbances caused by cyclones, dredging, the use of underwater explosives, or increased sedimentation. The dinoflagellate, *Gambierdiscus toxicus*, colonizes the disturbed area in large numbers a few months after the disturbance. They are consumed and concentrated in the food chain, and the toxin intensifies as it moves up the food chain. As a result, when humans consume species of fish containing the toxin, the result can be fatal (Lewis, 1981). Fish in Rarotonga that may be poisonous include *Maito*, black surgeonfish; *A'a pata*, moray eel; *Anga mea*, red snapper; *Maratea*, Napolean wrasse, *A'a manga*, snake mackerel; *Ku pa*, bullseye; *Ume*, unicorn fish; *Ono*, barracuda; *Tongua*, large snapper; *Titiara*, jacks; *Iroa*, emperors; and *Kokiri tua*, triggerfish.

On Rarotonga the number of cases has varied over the years, but has been fairly considerable (see Table 1). The fishers in the communities were ready to accept a Ra'ui system to protect the people from eating toxic fish. In addition, "the local people were complaining to the chiefs during the monthly meetings. People were dissatisfied with the state of the lagoon" (Interview #12, Rarotonga). According to a Technical Report prepared for the South Pacific Applied Geoscience Commission (SOPAC), fish populations around Rarotonga have declined over the past few decades and there has been a "continuing problem in the use of vegetable poisons, pesticides and explosives to kill fish" (Holden & South Pacific Applied Geoscience Commission, 1992, p. 27). Furthermore, Holden (1992) mentions that the water quality is essentially the same quality as the ocean surrounding Rarotonga. The researchers claim that the real cause of fish decline is due to the use of nets, poisons such as *Ora*,[5] explosives used for fishing, and loss of mangrove habitat and other breeding grounds as a result of coastal development (Holden & South Pacific Applied Geoscience Commission, 1992). Therefore, the idea of protecting an area from destructive fishing practices is crucial to increase the fish populations. The Ra'ui is one way for communities to increase fish populations for

Table 1
Ciguatera outbreaks in Rarotonga

Year	Number of cases
1989	158
1990	109
1991	81
1992	148
1993	55
1994	216
1995	281
1996	304

Sources: Losacker (1992), Munokoa, Boaza, and Iorangi (1997).

subsistence, for tourists, and also to prevent people from eating fish that may have ciguatera.

The third reason why the communities accepted the Ra'ui is because the majority of people respect the traditional chiefs and this traditional marine institution: "In general, chiefs have great support, and people trust their leaders in the community. The Cook Island government has control of marine resources, but the chiefs have customary right to manage it" (Interview #14, Rarotonga). People also trust their community leaders because they know that the community leaders are volunteering their time to make the community a better place for everyone: "The community members tell chiefs what they want and the chiefs do not dictate. The *Koutu Nui* have a powerful mandate and respect started way back" (Interview #16, Rarotonga).

WWF has supported the establishment of Ra'ui with the development of management plans. In addition, it has provided funding, coordination of all the stakeholders, and an education campaign. In a recent newspaper article in the *Cook Island News*, WWF employee Jacqui Evans discussed the importance of the communities "coming up with the ideas themselves and take ownership of the problem" and states that outside agencies like WWF can play an advisory role to help village communities "do what they feel needs to be done to manage their natural resources" (LW, 1999). However, the Ministry of Marine Resources, WWF, and other conservation organizations would like to see the Ra'ui be permanent and also develop into a management plan that integrates land use practices and more restrictions on fish net sizes. Not everyone in the communities wants this: "Locals want to stop [the Ra'ui] because [they are] ready to eat and Cook Islanders from New Zealand returning home tend to break the rules, not respecting the system" (Interview #3, Rarotonga).

The Environment Department on the island asked locals to not leave nets in the water. However, many have been found in the Ra'ui. Furthermore, when Cook Islanders return to Rarotonga from New Zealand for the holidays there is an increase in illegal fishing. The increase in visitors is not good for the reef and the reef fish (Environment Department, 1999).

The local people and government are interested in protecting the reef not only for health reasons. In the 1970s, Rarotonga primarily exported citrus fruits, but the growth and export of these products has ceased. Tourism is now the main industry on the island, with approximately 55,000 tourists visiting The Cook Islands each year. Tourists

like to snorkel inside the reef and see a diverse reef with a large variety of tropical fish. Communities are benefiting from the Ra'ui tourism and also benefiting from harvesting the trochus.

The Ra'ui is seen by all community groups as a success. New ecotourism businesses have developed around the Ra'ui as they become a point of interest for tourists. Many communities throughout the world have begun to successfully combine sustainable tourism and protected area management. Bunaken National Park in Sulawesi, Indonesia, and Bonaire Marine Park in the Caribbean are models of how successful planned tourism can be to sustain the biodiversity and create revenue for the private and public sector (Dixon, Scura, & Van't Hof, 1993; Erdmann, 2000). In the Pacific, Australia and New Zealand led these efforts. Wilderness has become a main attraction in the Tasmanian Wilderness World Heritage Site as well as in the Great Barrier Reef and Kakadu National Park. This growth in some places, like Tasmania for the aboriginal communities in Kakadu, has revitalized the depressed area as well as encouraged the government to successfully manage the area (Kirkpatrick, 2001; Mark, 2001).

In the Cook Islands, community-based marine protected areas are helping some of the communities benefit from a monitored trochus fishery. All groups have participated in the formation of the success and continue to support the Ra'ui. New Ra'ui have been created on the island of Rarotonga since this research was done in 1999. The *Koutu Nui* is trying to promote and establish Ra'ui not just on Rarotonga, but also on other islands. Aitutaki established three Ra'ui in 2000 and Mangaia has started the process to create Ra'ui. Furthermore, community members notice a change in the diversity and density of marine species, in particular mollusks and fish.

Ecological Data: Trends and Patterns of Coral Reef Health and the Nikao Ra'ui

The next portion of this article examines whether the Ra'ui is improving the ecological habitat. I examine two sites in the Nikao community.

Presenting the Quantitative Data and Discussion

The average mortality index[6] (MI) is higher in the Ra'ui Site #1 0.871 than in Site #2 0.827 (see Table 2). The difference is not significant using a Wicoxon test. The number of affected corals and the presence of algae are all higher in Site #1, but again this result was not significant at the percentage level. The presence of cyanophyta were higher in Site #2. The difference in the number of coral species present in each quadrat was higher in Site #1, though the means are similar: 3.69 at Site #1 and 3.25 at Site #2 (see Table 2). As discussed in Hoffmann (2001), when you have a higher MI, the species diversity is usually lower.

Other indicators of the difference between these two species data sets are shown in

Table 2
Ecological data means

Means	MI	% Dead	% Live	# Affected	Clonal condition	Fil. algae	Cyanophyta	Spp. diversity
Ra'ui site #1	0.871	73.667	11.173	0.04	0.133	0.12	0.067	3.693
Site #2	0.827	70.2	14.307	0	0.133	0.067	0.133	3.253

Table 3
Descriptive statistics

Descriptive statistics	Species diversity Ra'ui Site #1	Species diversity Site #2
Mean	3.693	3.253
Standard error	0.265	0.163
Median	3	3
Mode	3	3
Standard deviation	2.296	1.415
Sample variance	5.270	2.002
Kurtosis	–0.119	0.984
Skewness	0.574	0.711
Confidence level (95.0%)	0.528	0.326

the variance. The variance at Site #1 is 5.270 and considerably higher than Site #2, where it is 2.003 (see Table 3). This illustrates that the data in Site #1 has a higher number of species present in some of the quadrats. Figures 3 and 4 show the frequency of the number of species present in the 75 quadrats for each site.

The higher and greater slope in the data for Site #1 indicates a higher mean and higher variance than Site #2. Furthermore, in Site # 1, 90% of the 75 data points have under 7 species, and in Site #2, 90% of the 75 data points under 5 (see Figures 3 and 4). This again highlights the long tail of the data in Site #1, which has eight, nine, or even ten different species of coral accounted for in the quadrats. By contrast, in Site #2 the maximum number of different species found in a quadrat was eight.

To further highlight the differences between the two sites the data were normalized by taking the number of different species present divided by the mortality index in each quadrat. An F-test was used to measure the difference in the variance between the two sites (see Table 4). In an F-test the bigger the value is for F, the more significant the result. There is a significant difference in the two sites. The implications of this great difference shows that the reintroduction of the Ra'ui as a conservation tool has increased biodiversity and abundance in Site #1.

Conclusion

The recovery of the coral reef Ra'ui at Nikao is illustrated by the number of different species in each quadrat. The Ministry of Marine Resources has been monitoring inverte-

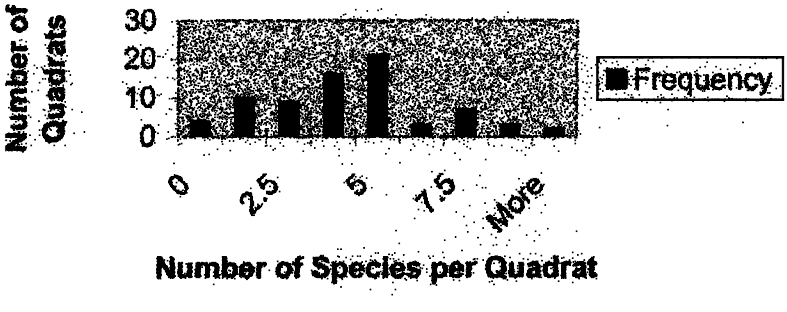

Figure 3. Species diversity histogram Ra'ui: Site #1.

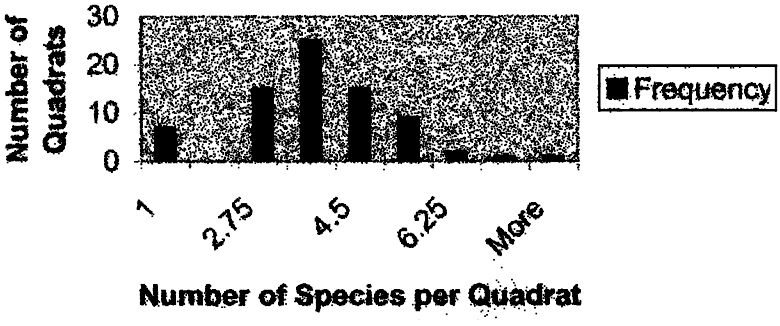

Figure 4. Species diversity histogram Site #2.

brates and fish density inside the Ra'ui. Their data show that marine invertebrates have increased in species diversity and evenness in all of the Ra'ui that they are monitoring (Ponia et al., 1999, 1998; Raumea et al., 2000). Furthermore, their study in Tikioki found that there were more fish species inside the Ra'ui than outside (Ponia et al., 1999, 1998; Raumea et al., 2000). Fewer people are collecting and fishing in this area, and this is what is most likely contributing to the difference between these two study sites' species abundance. This allows for the coral to settle and grow instead of having people walking all over the reef. The sites are similar in all other environmental factors due to their close proximity. The only difference between the two sites is the fact that Site #1 is in a protected Ra'ui and Site #2 is not. Further research should be done on coral growth and recruitment.

Customary Marine Tenure and traditional systems of resource management for the ocean are found in numerous fishing communities throughout the world. Researchers have only recently begun to realize the biological, economic, and social significance of these practices. A number of researchers have also seen how they may play a vital role in future marine management (Cordell, 1989; Hviding & Baines, 1992). Key lessons learned from the Ra'ui and a World Bank (2000) study on community-based marine conservation in the South Pacific point out that local support is essential for conservation of marine resources. The best conservation programs provide simple management rules. Marine sanctuaries and areas closed for seasons, like the Ra'ui, are generally followed and understood by coastal communities (World Bank, 2000). Open access sites lacking community rules to manage the resources make communities feel like they are

Table 4
F-test two-sample for variances Ra'ui Site #1 and Site #2, species diversity

	Ra'ui Site #1	Site #2
Mean	3.693	3.253
Variance	5.270	2.003
Observations	75	75
df	74	74
F	2.631	
P(F <=f) one-tail	2.342	
F critical one-tail	1.469	

incapable of managing the sites properly (World Bank, 2000). Creating a marine sanctuary or a restricted area based upon a traditional system of resource management helps create community awareness (World Bank, 2000). Furthermore, creating local-level socioeconomic incentives, such as harvesting trochus and increasing ecotourism revenues, in conjunction with simple ecological research to manage the resources is essential for community support of the reserve area (World Bank, 2000). The external partnership of WWF and the support from the Ministry of Marine Resources appears to be extremely effective where the external partner solely provides technical expertise and aids in the building infrastructure (World Bank, 2000). But, there are limitations to community-based management (World Bank, 2000). Enforcement of customary laws can be difficult, and some traditional leaders feel that if traditional authority is eroding it is easier to enforce national laws (World Bank, 2000). Although this is not the exact situation in Rarotonga because the Ra'ui has not been made into a national law, often compliance with rules is more likely when they are national laws and when they are relevant to the communities and adapted by the village leaders (World Bank, 2000). In addition, communities may find it difficult to restrict their own harvesting, and it is more effective if an external partner is aiding the process (World Bank, 2000). Finally, local communities cannot necessarily address all of the threats impacting coastal resources such as inland activities like logging and road building, and national laws using an integrated coastal zone management approach need to address these issues (World Bank, 2000).

Traditional systems like the Ra'ui can provide a successful model for conservation. This type of system can control access to resources and it can also provide culturally sanctioned rules for managing resources that can reduce administrative costs by not incorporating government officials in the management process. Finally, traditional systems of management can be more flexible to changes in both biological and socioeconomic conditions affecting marine resources. At the same time, researchers often report the friction associated with access and control of resources. For example, certain fisher groups abide by local rules and traditions, and outsiders exploit resources with additional capital and expertise (Johannes, 1981; Ruddle, Johannes, & UNESCO, 1985). The case of Rarotonga documents another community-based marine conservation effort established by the local communities and supported by the government and commercial sector. Both government and some local people fear that the Ra'ui will only be in place temporarily.

As I have shown in this case study, due to the various histories of development on the islands even in the same country, the individual islands have different present-day systems of property rights and social norms based upon the embedded historical context, which in turn influences reef health. The reintroduction of the Ra'ui is a unique model of a traditional marine social institution improving coral reef health.

Notes

1. List of interviews can be found in the appendix of Hoffmann (2001).

2. Identification of predators, parasites, and pathogens is based upon my knowledge and identification keys.

3. *Matakeinanga* is the local group occupying a *tapere*, and composed of the residential core of a major lineage and other permitted members. *Tapere* is a subdistrict, normally headed by a *Mataiapo*, a chief of a major lineage. Each *mataiao* was titular head of a *tapere* of land and the people who resided thereon, and occupied by *mataakeinanga* (see Crocombe, 1964).

4. The *Koutu Nui* is a formal group of traditional leaders. They comprise the Lower House of Traditional Chiefs (Passfield & Tiraa, 1998c).

5. *Ora* is a Maori word for *Derris* spp.

6. Mortality Index = dead coral coverage/(live coral coverage + dead coral coverage) (Gomez, 1994).

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