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### Editor

Kenneth Ruddle  
Asahigaoka-cho 7-22-511  
Ashiya-shi  
Hyogo-ken  
Japan 659-0012  
Email: mb5k-rddl@asahi-net.or.jp

### Production

Information Section,  
Marine Resources Division  
SPC, BP D5, 98848 Noumea Cedex  
New Caledonia  
Fax: +687 263818  
Email: cfpinfo@spc.int  
www.spc.int/coastfish

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## Editor's note

In this issue we present two contributions that examine complex and important, yet neglected, topics. I sincerely hope that both will stimulate comment, additional research and practical application.

In the first article, "The sea turtle wars: Culture, war and sea turtles in The Republic of the Marshall Islands", Regina Woodrom Rudrud, Julie Walsh Kroeker, Heather Young Leslie, and Suzanne S. Finney provide comprehensive documentation of an ongoing research project to examine human-sea turtle ecology from the perspective of environmental anthropology. The Republic of the Marshall Islands has the horrific distinction of having experienced close to a century of war and weapons testing, including 12 years of nuclear weapons testing. In that appalling historical and contemporary context the authors will conduct, cooperatively with the College of the Marshall Islands, an interdisciplinary project on human health risks and hazards and the impact of environmental toxicants, such as those related to war and weapons testing, on the viability of the sea turtle population. The cultural significance of sea turtles and their value as a continuing source of food for atoll populations is to be examined, as will traditional and contemporary Marshallese cultural, ecological and health knowledge regarding sea turtles, and sea turtle "flows" through marine and human ecosystems. Contemporary knowledge of sea turtle ecology, natural history and usage will be compared with historical and ethnographic accounts. (Further aspects of this comprehensive project are summarised in the "Abstract" to the article.)

In the second article, "Traditional authority and community leadership: Key factors in community-based marine resource management and conservation" based on research conducted in the outer islands of Fiji, Annette Muehlig-Hofmann looks at a subject that common sense tells us is critical, yet that has basically been ignored in the academic literature and overlooked in practical development. Community-based marine resource management projects are now commonplace in the Pacific and elsewhere. Yet the approach must contend with complex and varied challenges that include such rapid change in local social conditions as patterns of resource ownership, and such external pressures as outsider and foreign fishers, who place increasing pressure on resources. Muehlig-Hofmann documents changes over space and time as perceived by Fijian villagers in their natural and social environment, and that require adaptations by the community members. The author stresses that such changes are not considered in many community management plans, which assume the continued existence of a traditional communal hierarchy and order. This requires urgent reconsideration to overcome the challenge of adapting to ongoing and possible future changes while still supporting local livelihoods.

**Kenneth Ruddle**

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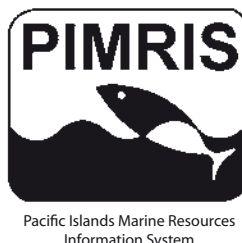
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Secretariat of the Pacific Community, Marine Resources Division, Information Section  
BP D5, 98848 Noumea Cedex, New Caledonia  
Telephone: +687 262000; Fax: +687 263818; [cfpinfo@spc.int](mailto:cfpinfo@spc.int); <http://www.spc.int/coastfish>

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PIMRIS is a joint project of five international organisations concerned with fisheries and marine resource development in the Pacific Islands region. The project is executed by the Secretariat of the Pacific Community (SPC), the Pacific Islands Forum Fisheries Agency (FFA), the University of the South Pacific (USP), the Pacific Islands Applied Geoscience Commission (SOPAC), and the Pacific Regional Environment Programme (SPREP). This bulletin is produced by SPC as part of its commitment to PIMRIS. The aim of PIMRIS is to improve the



availability of information on marine resources to users in the region, so as to support their rational development and management. PIMRIS activities include: the active collection, cataloguing and archiving of technical documents, especially ephemera ("grey literature"); evaluation, repackaging and dissemination of information; provision of literature searches, question-and-answer services and bibliographic support; and assistance with the development of in-country reference collections and databases on marine resources.

## The sea turtle wars: Culture, war and sea turtles in The Republic of the Marshall Islands

*Regina Woodrom Rudrud<sup>1\*</sup>, Julie Walsh Kroeker<sup>\*\*</sup>, Heather Young Leslie<sup>\*\*</sup>, Suzanne S. Finney<sup>\*</sup>*

### Abstract

This document considers human-sea turtle ecology in the Republic of the Marshall Islands (RMI) from the perspective of environmental anthropology and outlines the background and rationale for an upcoming project to be conducted by the authors and the College of the Marshall Islands. In particular, the project will examine the:

1. possible use of sea turtles as proxies of human health risks and hazards,
2. potential for sea turtle bone and tissue contaminant levels to back-calculate the initial amounts of toxicants introduced to the area,
3. feasibility of using chromosomal changes resulting from contamination to determine home ranges in areas impacted by nuclear activities, and
4. impact of environmental toxicants such as those related to war and weapons testing on the viability of the sea turtle population, its cultural significance, and its value as a continuing source of food for atoll populations.

The project will also take into account how this cultural valuation can be used to contribute to a sea turtle monitoring programme and population baseline assessment for the RMI. Additionally, in keeping with the concept of *je ilo bok*, literally “write in the book”, researchers will document traditional and contemporary Marshallese cultural, ecological and health knowledge regarding sea turtles, describe sea turtle “flows” through marine and human ecosystems (including markets and bartering systems), compare contemporary knowledge of sea turtle ecology, natural history and usage with historical and ethnographic accounts, and put that combined knowledge into preservable formats (in both English and Marshallese) for the use of current and future generations.

By focusing on a culturally, traditionally and nutritionally important species and by investigating potential hazards to these species as well as the human populations that rely on them, this project will allow local participants to help identify and mitigate these hazards as well as gain experience in a wide array of research and investigative techniques that comprise the holistic approach of environmental anthropology.

From ethnographic field techniques to sea turtle biology to maritime archaeology, the long-term benefits of this project will serve to decrease the dependence of the RMI on outside experts and provide potential and creative career skills for a future generation of Marshallese. The success of this project relies on the continual monitoring and testing of sea turtle health and population numbers. This cannot be done without trained experts within the Marshallese community to continue the project beyond what is described here.

This project will result in real knowledge about the risks and hazards to sea turtles in the RMI environment, and real help on how to maintain cultural traditions in ways that support rather than undermine health. Results cannot be predicted, which is why this research is necessary. Possible outcomes include the finding that some portions of turtle cannot be safely consumed, but others can, consumption reserved for only the most special (and rare) occasions is not a risk (in terms of broader whole-system exposures), or that all edible tissues must be avoided. Regardless of the result, this project will develop significant methodologies and establish the capacity and infrastructure for Marshallese-controlled testing/monitoring of native foods.

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1. Maritime and Fisheries Anthropologist, Ecological Anthropology Program (Marine) specializing in sea turtle conservation biology, University of Hawai'i at Mānoa, 2424 Maile Way, Saunders Hall 346, Honolulu, Hawai'i 96822-2223.  
Email: ReginalL@hawaii.edu

\* PhD Candidate, ABD

\*\* PhD

## Introduction

One defining characteristic of the RMI is its involvement throughout the 20<sup>th</sup> century, and continuing on to today, with war and weapons testing by the US, including 12 years of nuclear weapons testing.

Aquatic organisms inhabiting an environment contaminated with radioactivity receive alpha, beta, and gamma irradiation from external and internal sources; external radiation from radionuclides in water, sediment, and from other organisms in the environment, internal radiation ingested via food and water and from radionuclides absorbed through the skin and respiratory organs. Although most radiation impact studies have evaluated effects at the organism level, assessments of ecological risk are usually concerned with the viability and success of populations. Unlike the case for humans, there is usually no similar concern about the survival of individual organisms in nature. An exception exists for threatened or endangered species such as sea turtles, where the survival of an individual could influence the success of the population (Biayiock et al. 1993).

The sea turtles' longevity, site fidelity and ability to survive extreme injury may make them particularly vulnerable to both acute and chronic exposure to marine contaminants. In addition, because of their position in the food chain, turtles are sensitive to long-term, low-dose contamination (Meyers-Shone and Watson 1990). Slider turtles inhabiting a radioactive reservoir were shown to have genetic damage (mutations) due to long-term exposure to low concentrations of long-lived radionuclides, including cesium-137 (<sup>137</sup>Cs) and strontium-90 (<sup>90</sup>Sr) (Lamb et al. 1991). Freshwater turtles in riverine environments contaminated with chemicals and heavy minerals such as strontium-90, <sup>137</sup>Cs, cobalt-60 (<sup>60</sup>Co), and mercury demonstrated single stranded DNA breaks (mutations) (Meyers-Shone and Watson 1990).

Further studies have demonstrated the impacts to sea turtle populations through contamination from heavy metals including: bioaccumulation of heavy metals as the sea turtle ages (Sakai et al. 2000b), mutation in hatchlings related to <sup>137</sup>Cs in algae and seagrasses (Vanda et al. 2006), and chemicals have

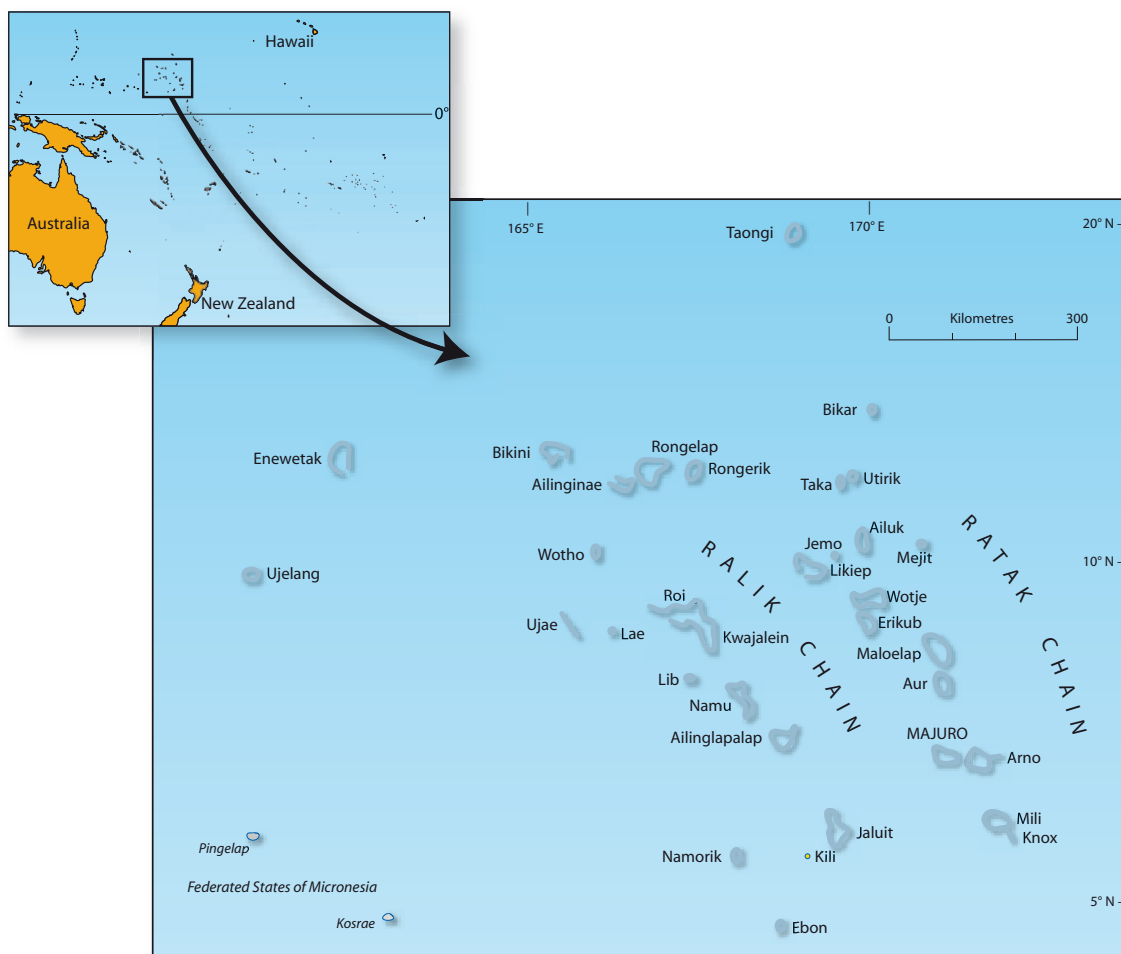


Figure 1. The Republic of the Marshall Islands (RMI)

been demonstrated to affect the sexual differentiation of reptiles such as marine turtles, which demonstrate temperature-dependent sex determination (Keller and McClennan-Green 2004). Metals tend to concentrate in the liver, kidney and muscle (Sakai et al. 2000b) and have also been detected in the blood and carapace tissue, which mimic the levels found in the internal organs and tissues (Wang 2005; Presti et al. 1999). Additionally, a recent study found that in many areas where contaminants are present, “levels of heavy metals and organochlorine compounds measured in sea turtle edible tissues exceed international food safety standards and could result in toxic effects including neurotoxicity, kidney disease, liver cancer and developmental effects in fetuses and children” (Aguirre et al. 2006).

Reports regarding WWII and weapons testing contamination in the Marshalls often discuss estimated fallout levels, expected doses, and cleanup/restoration efforts. But none of the reports, including the biological opinion written for the current Kwajalein missile testing, considered impacts to species that live as long as sea turtles (50–75+ years), that can survive grave injury (even the loss of a limb), and that show strong site fidelity to their nesting, foraging and resting sites (often living in the same area for the majority of their lives). Preliminary research into the types and amounts of contaminants that were (and are) deposited into the marine environment suggests that the amount may indeed have been at least, if not greater, than terrestrial contaminants, particularly when the final deposition of the actual equipment is considered; the majority of which went into the lagoons and ocean areas.

### War and weapons testing in the RMI

Before considering just how much marine contamination there may have been (or is), it is useful to look first at exactly what took place in the Marshalls as well as statements made by some of the servicemen involved in the testing and cleanup efforts.

### World War II

During WWII, the battles to take the Marshall Islands from the Japanese left the islands a “wasteland” of nothing but bombed-out land and debris. The Japanese had military installations on 12 atolls and all of those installations were heavily bombed by US forces. On the main fortifications of Mili (*Mile*), Wotje (*Wōjjā*, *Wūjae*, *Ujae*), Jaluit (*Jālooj*, *Jalwoj*) and

Maloelap (*Maļoeļap*), 15,288.70 tons of US bombs and naval shells were delivered. “A US intelligence report following the US capture of Kwajalein Atoll, Marshall Islands, indicates that approximately 50% of the naval shells failed to detonate on impact, an observation reinforced by a statement by the commander of the Japanese garrison made after surrender of Taroa” (Kamada 1947 cited in Spennemann 2006). In addition several of the Japanese-held atolls, once stripped of anti-aircraft capabilities, were used as training grounds for new pilots on their way to other areas and as testing grounds for the effectiveness of new types of weapons: napalm (tested from late 1944 onward), rocket trials (started in mid 1945), and equipment (the fighter-bomber was first developed there), all of which further contributed to the unexploded ordnance load. “Despite initial clean up and a number of subsequent ordnance removal missions there is still an abundance of ammunition located on the islands” (Spennemann 2006:235). The compilers of this document can find no documentation regarding the fate of unexploded ordnance in the lagoons and coastal seas, although we can infer from the island record discussed above that remaining amounts of these materials may be quite large.

By the end of the war, the US had driven Japan out of the Marshall Islands by a series of air, sea and land battles, but the environmental damage continued (ADB 2001). The war left tanks, weapons, ordnance, abandoned fuel and other hazardous materials as well as the wrecks and cargoes of vessels and downed aircraft. “The oil, chemicals and unexploded ordinances still on board many of these vessels pose a grave and imminent danger to the people, marine and coastal environments and fisheries of the region” (SPREP 2002:5). The range of oil impacts includes lethal and sub-lethal toxic effects on fauna and flora and the tainting of edible species (SPREP 2002).

### Post WWII, nuclear testing<sup>2</sup>

On 2 March 1944<sup>3</sup>, Enewetak (*Ānewetak*, Eniwetak, Eniwetok) was sold by the US Trust Territory of the Pacific (see paragraph below for Trust Territory description) to the US government for the sum of USD 10 (GTTP 1944). On 6 August 1945 the US dropped the first nuclear weapon used in warfare on the Japanese city of Hiroshima; three days later they dropped the second bomb on Nagasaki. These events led to dramatic changes in the Marshall Islands. In November of 1945, the US began to plan operation CROSSROADS<sup>4</sup>, a campaign to determine

2. The material in the following section, unless otherwise noted, is from: US Department of Energy (DOE). 1982. Marshall Islands: A Chronology 1944-1981. Department of Energy Document 2UF890.m35 c.1. Available online at: <http://worf.eh.doe.gov/ihp/chron/A27.PDF>
3. This date probably refers to the first agreement between the Marshallese and the military as there is a handwritten note on the agreement that states: “recorded June 20th 1957 9am”.
4. See declassified film clips for all nuclear testing operations at: The Internet Archive: Universal Access to Human Knowledge: [http://www.archive.org/search.php?query=%22marshall islands%22](http://www.archive.org/search.php?query=%22marshall%20islands%22)

how US troops, vessels and other military hardware would survive a nuclear attack, and to search for a test site. In January 1946, the US Navy announced that Bikini Atoll (*Pikinni*) fulfilled their requirements. The Bikini chief gave permission, saying “If the United States government and the scientists of the world want to use our island and atoll for furthering development, which with God’s blessing will result in kindness and benefit to all mankind, my people will be pleased to go elsewhere” (Mason 1954).

As a result of CROSSROADS, and the Navy’s inability to decontaminate the targeted vessels, 23 shipwrecks, contaminated with radioactivity, were added to the waters of Bikini Atoll and 41 radioactive shipwrecks to the waters of Kwajalein (*Kuwajleen*) (Carrell et al. 1991; Delgado et al. 1991; Weitz et al. 1982; USGAO 1985). The underwater Baker shot resulted in about half of the fission products of the bomb remaining in the waters of the lagoon (LANL 1946; Fee 1946; Schubert and Lapp 1957). “Large amounts of radioactive material” were found on the lagoon bottom at Bikini (Berkhouse et al. 1984:159). Further study determined that some marine organisms can concentrate fission products by a factor of 100,000 times the background level in their environment (Hacker 1987 cited in Weisgall 1994). Fission products were found in fish, clams, snails, oysters, corals, sponges, octopus, crabs, sea urchins, sea cucumbers, spiny lobsters, shrimp and algae in the lagoon. Many of the fish in the northwest corner of the lagoon were killed by the explosions (Berkhouse et al. 1984).

“They called me to go help fight a fire on the aircraft carrier Independence, which was one of the target ships. We went up there three times. . . Right after that, we all went swimming in the lagoon there. . . There were dead fish around there, lots of them . . .” (Smitherman 1983).

On 18 July 1947, the Marshalls became a strategic area trusteeship administered by the US in accordance with a trusteeship agreement with the UN Security Council and the islands were placed under the administration of the US Navy (USDOE 1982). At the end of that year, the move to open Enewetak Atoll as the second test site began.

“When we first arrived [at Enewetak], we toured the main island and found a number of spent cartridges and shell casings left over from the battle to take the atoll; even at that late date. Also, the island was loaded with construction equipment of every kind . . . bulldozers, cranes, road scrapers, etc. Shortly after, they were all gone; they had been dumped into the ocean. We were told that it was too expensive to ship the stuff back to Hawaii or mainland” (Oakes 2002).

In April of 1948, Operation SANDSTONE — conducted to perform weapon improvements studies — began at Enewetak. Three more atomic weapons were detonated.

“The Admiral directed that cargo from a previous ship sitting just off the ramp/roadway area be bulldozed into the water and covered over with cement bags and coral rock and sand. I saw at least two brand new 75KW diesel motor-generator sets destroyed in that move” (Johnson 2004). “When we abandoned Eniwetok [at the end of SANDSTONE] . . . we dumped many dollars worth of equipment into the lagoon” (Scott 2001).

“Practically all of the iron scattered about the islands is radioactive due to neutron capture and/or contamination with fission products. This iron will be collected and dumped on the reef on the oceanside of the Atoll” (Snapp 1949).

This series was followed by Operation GREENHOUSE; completed to test weapon effects and weapon improvements. Three more weapons were tested along with GEORGE — a device to test thermonuclear capabilities of hydrogen isotopes.

“We were warned by Headquarters, 7th Engineer Brigade, Task Group 3.2 before we arrived at Eniwetok that: “At certain times, many of the fish in our area are highly poisonous. The poison is tasteless and there is no way of telling which fish are poisoned.” From the time we arrived at Eniwetok the men were not allowed in the water, not even to wade. . . there was still danger of nuclear poisoning in the water from earlier Atomic bomb testing done in the area in 1946-48” (Ingram 2001).

“I also checked the drone planes that flew through the radiation atomic blast clouds . . . The planes were extremely radiated as they had just returned from the atomic bomb blast . . . Also a B-17 drone letter ‘M’ (initials were painted on the tail of the bombers) crashed on the island . . . I followed this plane from the point of touch down to its crash site. I stayed with this plane for three hours and allowed only authorized personnel at the site. Specimens were salvaged from the wreckage and the plane was then pushed into the ocean” (McMurtry 1995 cited in Campbell undated)

Once GREENHOUSE ended, the US Atomic Energy Commission (AEC) attempted to reduce residual radioactivity at Enewetak by bulldozing surface dirt away from shot areas into the ocean. “I often think of . . . the equipment, vehicles, planes, steel

runway matting all bulldozed off the ocean side” (Palmer 2001). At the end of 1952, the AEC reported that Bikini “is in all probability quite uninhabitable from a radiological point of view” (Dean 1952).

In November 1952, Operation IVY began at Enewetak. IVY included the test of MIKE, the first thermonuclear device — 750 times the strength of that dropped on Hiroshima, more energy than all previous tests combined, including the USSR’s. MIKE vaporized the islet of Flora (Elugelab, *Bokombako*) and left a crater a mile in diameter and 175’ deep in the coral (Noshkin 1978). Ujelang (*Wūjlañ*, Ujla) was contaminated with fallout from KING (USDOE 1982). Each of these tests sent surges of contaminated water over the adjacent islets (Noshkin 1978).

From 1–15 March 1954, Operation CASTLE took place on Enewetak and Bikini Atolls. CASTLE included the detonation of six hydrogen bombs including BRAVO, an experimental 15-megaton hydrogen bomb that resulted in the single worst radiation fallout incident of the US testing programme (USDOE 1982). “A recently declassified 1955 Atomic Energy Commission Report documented high radiation levels on ALL [atolls and islands of] the Marshall Islands after the Bravo test and others in its series” (Breslin and Cassidy 1955 cited in Watkins et al. 2006:5). The current dose limit and clean-up criteria specified by the US Environmental Protection Agency (EPA) and adopted by the Nuclear Claims Tribunal is 15 mrem<sup>5</sup> year<sup>-1</sup> — a number that was exceeded on every atoll by the CASTLE series alone (Watkins et al. 2006).

Testing on 6 March for gamma doses on Rongelap (*Roñlap*) resulted in dose estimates of 37,500,000 mrem h<sup>-1</sup>. On Utirik: 4,000,000 mrem h<sup>-1</sup>, and at unpopulated Bikar (*Pikaar*): 16,000,000 mrem h<sup>-1</sup>. In addition, plutonium (see endnote i) was found in urinalysis of the Rongelapese and 90Sr (see endnote ii) was detected on Rongelap.

“What was a problem was that in just minutes fallout from the blast covered the ship. There was sand, coral and seaweed all over the flight deck, catwalks, gun tubs and every exposed area” (Summers 2002). “. . . there appeared on the surface of the water various debris as well as dead fish and a whitish scum, most likely pulverized coral” (Bass 2003). “My most vivid memory was . . . the way the sea looked after detonation. The sea had a chalky, milky, simmering kind of appearance, especially one of the detonations that was close to an atoll, we went in pretty soon after the shot

and that scene always stuck in my mind, kind of like the sea was boiling” (Williams 2000). “A short while after the explosion we made [an aerial] pass over ground zero at around 10,000 I think. . . the water was still boiling for several miles diameter” (Hasty 2004). “. . . the ocean was covered with leaves, chips of wood, and bark. The ocean was just littered with this stuff, for miles around” (Long 2001). “Whole palm trees were blasted apart, lying and floating everywhere, dead fish everywhere and debris everywhere. It was really unbelievable and what a tremendous sight to all of us” (Kosted and Kosted 1997).

“Two days later when we returned to our control island [Eneu], the radiation level was still much too high for personnel to remain any length of time. Bulldozers were brought in to scrape off the top soil containing most of the radiation and push it into the ocean” (Clark 1957).

On 26 April 1954, UNION was detonated and Bikini, Ailinginae (*Aelōñinae*, Ailiginae), Rongelap (*Roñlap*), and Rongerik (*Roñdik*) received heavy fallout; on 5 May 1954; the YANKEE test and heavy fallout was again measured at Bikini, Ailinginae, Bikar (*Pikaar*), Rongelap and Rongerik.

In June 1954, contamination at Bikini was found to be 130 times normal 312 miles away from the lagoon, and a Japanese team found contaminants in ocean water and marine life 3000 miles to the west (USDOE 1982). On 14 September 1954, fish in Bikini and Enewetak lagoons were reported to be too radioactive for human consumption, and by 30 January, unsafe amounts of radioactivity were found in shellfish and crabs in Rongelap.

By March 1955, one year after BRAVO, a survey by the US Naval Radiological Defense Laboratory (NRDL) and the US Applied Fisheries Laboratory (AFL) showed that “significant amounts of radioactive contamination,” were found in the animals, food plants, water and soil. The highest concentrations were in the marine specimens, which were found to contain: zirconium-95 (95Zr) (see endnote iii), niobium-95m (95mNb), ruthenium-106 (106Ru), and rhodium-106 (106Rh).

“Profound alterations of the Bikini Lagoon fauna have, of course, already occurred and shortly after March, highly contaminated fish specimens were taken in the Rongelap Lagoon” (Nichols 1944).

5. A millirem is a unit of radiation dose equivalent to one-thousandth of a rem (which stand for Roentgen equivalent man). It measures the amount of damage to human tissue from a dose of ionizing radiation. The biological risk of exposure to radiation is measured using the conventional unit rem or the SI unit sievert (Sv) (CDC 2003).

Operation REDWING, consisting of 17 nuclear weapons tests, was conducted between 4 May and 21 July 1956. Further contamination of the reef fish at Rongelap and Ailinginae were found from operation REDWING. In addition, radiation was found in plankton, water and fish near Bikini and Enwetak and fallout was recorded on Parry Island and on Enewetak.

“11 July [1956] 1300 hours: Entered into the center of the blast area, really a sight around Bikini; palm trees, leaves, plants, dead fish, birds were all over the water and the blast was nine miles from any land. It was set off on a barge by remote control, they say. We weren’t allowed ashore because of the radioactivity. Sharks and barracuda were cleaning up the dead fish . . . 12 July 1956 Bikini: Went ashore in Enyu and what a mess! The blast was 20 miles from the atoll and many of the trees were down and a ship sunk in an Atomic blast in 1947 was on the shore; marines guarded it and it had coral and gunk all over it. Fish and sharks were all over the place. 13 July: Fished all day and didn’t catch a thing. The bomb really messed things up” (Mead 2000). “I remember swimming in the lagoon and the water was crystal clear and you could look down and see giant clams of which most were dead. Their shells were open” (Long 1998). “The coconuts and the fish were not safe to eat, as they were contaminated from the exposure to the atomic and hydrogen bomb testing. The coconuts were mutated — shaped like bananas, but hard shelled like coconuts” (Francis 1999).

1957 July: Rongelap trees and plants were described as “mutants” because of their extra flowers and limbs and their stem abnormalities — atrophied, or “thickened, swollen” stems covered with cancerous warts (Held 1959:43 cited in Johnston and Barker 2001:33). “People got fish poisoning from types of fish that never caused poisoning in the past, such as *iol* (mullet), and *malok*. Before the tests, only the *jujukop* (barracuda) fish caused fish poisoning” (Johnston and Barker 2001:34). Clams were found to be concentrating high levels of  $^{60}\text{Co}$  (see endnote iv).

In May of 1958, Operation HARDTACK I began to develop the weapons themselves and to measure the explosive and radiation effects. This series of 35 weapons tests included the underwater tests WAHOO and UMBRELLA. WAHOO was detonated in the deep open ocean southwest of Boken Island, and UMBRELLA inside the western end of the lagoon at Enewetak.

The MAGNOLIA test further contaminated Ujelang. MAPLE at Bikini further contaminated Ailinginae and Wothe (*Wötto*). During the QUINCE test on Runit, only the high explosive component of the device was detonated. This resulted in scattering the plutonium nuclear fuel over a large area of the island (Noshkin 1978). To prepare for the FIG event, scheduled 12 days later in the same location, three to five inches of this plutonium contaminated soil was bulldozed from the site and disposed of in the lagoon immediately offshore the center of the island (US DNA 1981 cited in Noshkin 1997; US DOE 1982 cited in Noshkin and Robinson 1997).

“When OAK detonated . . . when I turned to see the column of water rising out of the lagoon, it was so tremendous that no one spoke. After fifteen or twenty minutes, the water in the lagoon began to recede until the lagoon bottom lay exposed for about two hundred yards from shore . . . The bomb had created a column which sucked up all the lagoon water for fifteen miles around . . . Then it started coming back and I got a sick feeling . . . the lagoon water turned an ugly milk chocolate brown . . .” (Mace 2003). “Rising up off the lagoon floor was a large funnel of water, sand and coral rock. Out at the edges of the cloud you could see large chunks of burning coral rock falling back to the water below” (Hampton 2004). “Very soon after we moved into ground zero and retrieved what the Scientist called “Corpsuals “ they were fiberglass buoys with antennas on top. We were amazed to see cooked fish floating as we got close to the target area retrieving the corpsuals” (Wixon 1999). “There were nets set up so if we wanted to swim we didn’t have to worry about sharks, although I never saw a fish, except for dead ones floating after a bomb went off and jelly fish everywhere” (Clayton 2007).

### Radiation

The end of nuclear testing by no means meant the end of its effects on the marine environment. In 1994, the US Geological Service (USGS) put out a synthesis of the technical literature on radionuclides in the environment and their effects on notably fish, wildlife, invertebrates and other natural resources (Eisler 1994). Several aspects of that report are relevant here.

“Fallout can occur years after an explosion injected material into the atmosphere . . . high acute doses of ionizing radiation produce adverse biological effects at the molecule, cell, tissue-organ, whole animal, population, community, and ecosystem levels



. . . Typical adverse effects of ionizing radiation include cell death, decreased life expectancy, increased frequency of malignant tumors, inhibited reproduction, increased frequency of gene mutations, leukemia, altered blood-brain barrier function, and reduced growth and altered behavior . . . Overall, the lowest dose rate at which harmful effects of chronic irradiation have been reliably observed in sensitive species is about  $1.0 \text{ Gy}^6 \text{ year}^{-1}$ ; this value for acute radiation exposures is about  $0.01 \text{ Gy}$  . . . Ionizing radiation can harm marine organisms directly through death to the irradiated organism as well as through reduced vigor, shortened life span, and diminished reproductive rate as well as by the genetic transmission of radiation-altered genes “that are most commonly recessive and almost always disadvantageous to their carriers” (Bowen et al. 1971 cited in Eisler 1994). Eisler (1994) also found that gross radiation injury to marine organisms has never been studied.

In 1961 fish with “black spots” on their abdomens were discovered at Rongelap. By February 1962, additions to the known radioisotope load included  $^{95}\text{Zr}$ - $^{95}\text{Nb}$ ,  $^{103}\text{Ru}$  and  $^{106}$ - $^{103}\text{Rh}$  and  $^{106}$ , Tungsten-181 and 185 ( $^{181}\text{W}$  and  $^{185}\text{W}$ ),  $^{65}\text{Zr}$ , and  $^{137}\text{Cs}$  (see endnote v). Increased concentrations of radioactive Iron-55 ( $^{55}\text{Fe}$ ) were found in goatfish liver (Beasley et al. 1970 cited in Johnston and Barker 2001).

A survey in August 1964 found  $^{60}\text{Co}$  in all samples of marine invertebrates and it was determined to be the major radionuclide in the marine environment. Radioactive manganese-54 ( $^{54}\text{Mn}$ ) was also found in all samples, and  $^{106}\text{Ru}$  and antimony-125 ( $^{125}\text{Sb}$ ) were found in groundwater, soil, animals and plants. Bismuth-207 ( $^{207}\text{Bi}$ ) ( $T_{1/2}=38\text{y}$ ) and cerium-144 ( $^{144}\text{Ce}$ ) were detected in marine algae, soils, and land plants. Iron-55 was comparatively high in vertebrates, and plutonium-239 ( $^{239}\text{Pu}$ ) was found in the soil and in the skin of rats and birds (Welandar 1969 cited in Eisler 1994). In 1965, testing showed that the long-lived gamma-emitter  $^{137}\text{Cs}$  had moved down into the soil on all exposed atolls and was considered the limiting factor in repopulating the atolls.

A 1969 study by Held revealed there was still no measurable difference between the 1967 and 1969 values of radionuclides for edible marine animals and those values were not expected to change. In addition, Held found an increasing concentration of some radionuclides with increasing age of fish and clams and an increase as they move up the food

chain. Where the animal fed was also determined to be a factor, the tissues of bottom feeders contained 10 times more  $^{60}\text{Co}$  than herbivores or plankton feeders. For the first time, the gamma emitter silver-108m ( $^{108m}\text{Ag}$ ) ( $T_{1/2} = 418 \text{ y}$ ) (see endnote vi) was found associated with fallout, in the hepatopancreas of the spiny lobster (Held 1969).

In October of that year, the AEC released an aerial radiation survey of Enewetak. Runit Island, the site of 18 nuclear tests — and contaminated with high concentrations of unexploded plutonium — was quarantined for 140,000 years. The AEC located surface plutonium contamination on Runit that included a plutonium-bearing sand layer outcropping on the ocean side of the mid-island area, plutonium fragment sand grains on the island surface, and contaminated scrap metal throughout the island. Most disturbingly they found high alpha contamination as well: alpha, when internalized, is the most damaging of the three types of radiation (alpha, beta and gamma). The next year, the US proposed dumping radioactive soil and debris from the other islands in Enewetak into an atomic bomb crater on Runit Island. The radioactive material would then be mixed with cement to form a massive concrete dome. In response the EPA stated, “The fact that crater entombment is only a semi-permanent solution should be recognized” (USDOE 1982: 25).

“Minute amounts of plutonium are expected to be released through the geological formation (dome on Runit Island). These, however, will be small and insignificant compared to the amounts already in the lagoon” Defense Nuclear Agency, EIS, April, 1975 (USDOE 1982: 34).

Almost 20 years after testing stopped, radioisotope levels at Bikini were found to be higher than ever previously recorded. Plutonium 239 and 240 measured highest by a factor of five. By 1976,  $^{239}\text{Pu}$  and  $^{240}\text{Pu}$  levels were higher than in 1971 by a factor of two on Rongelap, Rongerik, Ailuk (*Aelok*), Wotje and Utrik (*Utrök*).

In May 1977, the US began its proposed cleanup of Enewetak. The cleanup removed an estimated 125,000 cubic yards of “non-contaminated” debris, which was dumped into the ocean, and about 100,000 cubic yards of soil and debris contaminated with plutonium and other radionuclides — placed in the bomb crater on Runit Island and sealed with a cement cap.

6. When a person is exposed to radiation, energy is deposited in the tissues of the body. The amount of energy deposited per unit of weight of human tissue is called the absorbed dose. Absorbed dose is measured using the conventional rad or the SI Gy. The rad, which stands for radiation absorbed dose, was the conventional unit of measurement, but it has been replaced by the Gy. One Gy is equal to 100 rad (CDC 2003).

“I remember some of the ideas our superiors would come up with on transporting these tons of radiated soil to another Island so we could cap them off in a large pit, and also to our surprise we would have a large barge in the middle of the lagoon to dump these soils into the lagoon after we had cleared a large portion of earth from a contaminated Island” (Celestial 2000).

“We would take all the metal debris either back to Medren and put it in a huge pile that Japanese ships would come and pick up or we would dump it into the lagoon at its deepest part, which we thought was counter productive, but what did we know, we just did what we were told. One job we had which was one of the most tedious and infuriating was to pick up metal chips from the beaches of one small island. We would go out all day and fill sand bags with these quarter to half dollar size chips of metal then load these bags on the LARC 60 which was this big amphibious army vehicle, then drop them over the side on our way back to the main island. After the waves would wash over the beach during the night and expose more chips you just wanted to scream because you would do it all over again” (Jackson 2005).

“Then I was moved to Eniwetok to work on Medrain with the [Navy] seals removing the remnants of the trucks and other equipment that had been run into the channels between the islands. This metal was loaded on maggies (LMUs) to be taken to Reunit or to the deep water in the center of the lagoon and deep sixed” (Savage 2001).

During this time, wells on Bikini were found to contain 90Sr and, according to Lawrence Livermore Labs, Enewetak Lagoon was determined to be the largest reservoir of transurenic (see endnote vii) in the atoll, and little alteration should be expected over the next few decades.

A survey of Enewetak Atoll conducted during the mid 1970s concluded that measures designed to reduce plutonium contamination in the marine food-chain would have little impact due to its long half-life — plutonium would remain in the marine environment long after the other major radionuclides had decayed (Wilson et al. 1975).

Fish specimens from Ailinginae, Rongerik and Utirik were found to have radionuclides in their tissues (Nelson 1977). Cobalt-60 and 55Fe were found to be predominant in the Rongelap marine environment (USDOE 1977). Noshkin (1978) found

that due to the high level of radioisotope deposition in the marine environment, Enewetak had become its own transuranic source as radioisotopes are continually remobilized, suspended, assimilated, and transferred through the environment by physical, chemical and biological processes. A further report during that year found very high concentrations of plutonium in the bone, viscera and gills of fish (Robinson et al. 1978).

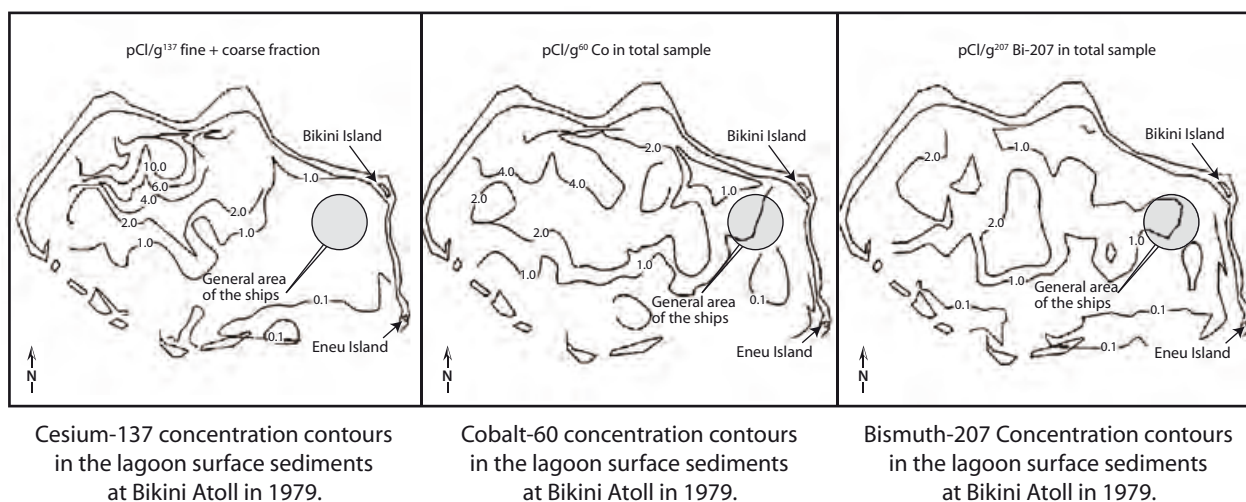
Twenty years after nuclear testing stopped (August 1978), the US admitted that another 10 atolls — Ailinginae, Ailuk, Bikar, Jemo (*Jāmō*), Likiep, Mejit (*Mājeej*), Rongerik, Taka (*Tōke*, Tōkā), Ujelang, and Wothe — received intermediate fallout. One year later, the DOI states, “...The new data reaffirmed that Bikini Island could not be used by the people of Bikini for at least the next 30 years and possibly the next 60 years ...The Island of Eneu must be placed off limits...for at least another 20–25 years.” That same year the Runit Island dome was completed and determined to be extremely radioactive and dangerous for at least the next 24,000 years (Rowa 2006).

“I had the pleasure of swimming in one of the large bomb craters, I think it was the one that was filled in, the size sounds the same, 30 feet deep and 350 feet wide, there was a smaller crater near by but we saw a very hungry shark in it. The crater we swam in had mutated sea creatures, by this I mean much larger than the ones in the lagoon, spiny sea urchins in the lagoon would be about the size of a baseball with spines about 6 inches long, but in the crater these same urchins were the size of a volley ball and had spines over a foot long, the same with sea anemone, they were much larger in the crater” (Ingram 2002).

“Vegetation grew on Runit just like on other islands, but near the twin craters, some of the vines were orange. . . .” (Collins 2000).

By 1979 the radioactivity levels of americium-241 (241Am) (see endnote viii) in Enewetak Lagoon were determined to be 20–25% higher than determined by previous measurements. In 1985 it was discovered that the lower levels of sediment in the lagoon (>20 cm down) contained elevated radioisotope levels that were being redistributing into the lagoon waters by the burrowing activities of ghost shrimp (Crustacea: Thalassinidea) (McMurtry et al. 1985).

In 1991, a study by the US National Park Service, Submerged Cultural Resources Unit, looked at the radioisotope levels remaining on the sunken vessels in Bikini Atoll from Operation CROSSROADS in order to determine any hazards that the opening of



**Figure 2.**  $^{137}\text{Cs}$ ,  $^{60}\text{Co}$ , and  $^{207}\text{Bi}$  concentrations in Bikini Lagoon sediments in 1979 (Source: Delgado et al. 1991:191-193).

the area to recreational diving might impose — 44 years after CROSSROADS and 32 years after the last test at Bikini (Delgado et al. 1991).

The radionuclides described as present in the lagoon sediments and on the islands were:  $^{137}\text{Cs}$ ,  $^{90}\text{Sr}$ ,  $^{60}\text{Co}$ ,  $^{239}\text{Pu}$ ,  $^{240}\text{Pu}$  and  $^{241}\text{Am}$ . Additionally, europium-155 ( $^{155}\text{Eu}$ ) (see endnote ix), and  $^{207}\text{Bi}$  were reported as common in lagoon sediments but not on the islands (Delgado et al. 1991; Jernström et al. 2005; Unterweger 2002).

The  $^{137}\text{Cs}$  concentrations ranged from 100  $\text{pCi kg}^{-1}$  in the southern end of the lagoon to 10,000  $\text{pCi kg}^{-1}$  in the northwest portion of the lagoon.<sup>7</sup> Cobalt-60 concentrations ranged from 100–4,000  $\text{pCi kg}^{-1}$  and  $^{207}\text{Bi}$  concentrations ranged from 100–2,000  $\text{pCi kg}^{-1}$  (Fig. 2) (Delgado et al. 1991).

The levels in the area of the target ships were deemed non-hazardous to divers because the gamma rays they emit would dilute as they moved through the water and would be negligible by the time they reached recreational diving depth. No determinations regarding the alpha or beta particle emissions were included in the report.

Further study of Enewetak in 1997 found that the inventory of plutonium in the lagoon was constantly replenished by remobilization of sediments and seepage from the Runit crater and currently “overshadows by orders of magnitude” the total amounts of radioactivity buried under the dome. In addition, concentrations of transuranics in fish were found to be no different than they were at pre-cleanup levels 20 years earlier (Noshkin et al. 1997).

Robinson et al. (1998) looked specifically at the radioactive fission and particle activated products, and unspent radioactive nuclear fuel that entered the marine environment and found that in 1998 the sediments and waters in the Bikini and Enewetak lagoons were still reservoirs for 100s of trillions of Becquerels (Bq) of radionuclides.

Johnston and Barker (2001:35–37) present additional information regarding the radioactive contamination of the marine environment with emphasis on Rongelap:

. . . University of Washington researchers involved in the radiation ecology studies at Rongelap determined that the highest con-

7. Different units of measure are used depending on what aspect of radiation is being measured. For example, the amount of radiation being given off, or emitted, by a radioactive material is measured using the conventional unit curie (Ci), named for the famed scientist Marie Curie. When the amount of radiation being emitted or given off is discussed, the unit of measure used is the conventional unit Ci or the SI unit Bq.

A radioactive atom gives off or emits radioactivity because the nucleus has too many particles, too much energy, or too much mass to be stable. The nucleus breaks down, or disintegrates, in an attempt to reach a nonradioactive (stable) state. As the nucleus disintegrates, energy is released in the form of radiation.

The Ci or Bq is used to express the number of disintegrations of radioactive atoms in a radioactive material over a period of time. For example, one Ci is equal to 37 billion ( $37 \times 10^9$ ) disintegrations per second. The Ci is being replaced by the Bq. Since one Bq is equal to one disintegration per second, one Ci is equal to 37 billion ( $37 \times 10^9$ ) Bq. Ci or Bq may be used to refer to the amount of radioactive materials released into the environment” (CDC 2003).

centrations of radiation were found in the herbivore and omnivore species of fish, such as the parrotfish (Donaldson 1950 DOE #340:145). Increases in gross beta radioactivity in fish were measured on Rongelap between 1954 and March 1958 (Palumbo 1959 DOE #292; UW 1958 DOE #312) . . .

From radiation levels monitored in the bird populations, United States government researchers concluded that the fishing area in southern Rongelap where the people were resettled had higher radiation concentrations than fish in the restricted northern islands . . . The birds from southern Rongelap also had higher levels of radiation than birds from the north of Rongelap (AFL 1955 DOE #342). According to researchers, this “unexpected” finding of “higher levels of radioactivity in the tissues of the southern birds suggest the availability of a supply of food fish with a higher average radioactive content in the southern area compared with that of northern Rongelap” (AFL 1955 DOE #342:43) . . .

United States researchers monitored open sea marine plankton and its role in transporting fallout in the marine food chain (University of California undated DOE #34:17). Researchers observed that plankton was “the most sensitive indicator of radioactivity in the sea” (Seymour et al. 1957 DOE #332:55). Radiation readings in plankton were considered “representative of that available to marine food chains” (Palumbo and Lowman 1958 DOE #348:64). In a 3300 mile survey area in the Pacific Ocean, “radioactive materials were found in the plankton samples from every station” (Seymour et al. 1957 DOE #332:9).

By 1958, university researchers discovered that fish may be concentrating radioactivity by as much as “a thousand fold” because of the radioactive plankton they consume (Palumbo and Lowman 1958 DOE #348:59) . . . Researchers also observed that “the lagoon would tend to hold radiation within its system of circulation” (Author not available 1961 DOE #380:85) and that radiation would concentrate in the lower levels of the lagoon where fish, such as the sturgeon fish . . . would concentrate high levels of cesium (author not available 1961 DOE #380:118).

. . . As late as 1962, “the highest levels of gross beta radioactivity were found in samples of algae, fish liver and muscles, and sea cucumber muscle” at Rongerik (Donaldson 1962 DOE #299:11)

The Rongelapese observed that many species of fish that did not cause fish poisoning before the nuclear tests became poisonous afterwards, and some species were poisonous in some locations, but not in others. Some scientists have suggested a relationship between fish poisoning and nuclear testing with damaged reefs supporting abnormally high numbers of the plankton *Gambierdiscus toxicus*, a dinoflagellate that produces ciguatera toxin. Fish feeding on the reefs absorb this plankton, ciguatera toxins accumulate in the fish, which in turn are eaten by larger fish that concentrate the ciguatera toxin in their flesh. Humans who eat these fish suffer from vomiting, diarrhea, loss of balance, and rarely, death. The Marshall Islands and French Polynesia (the area where the French test nuclear weapons) have the highest incidence of fish poisoning in the Pacific (Ruff 1989 cited in May 1989:249).

In the mid-1990s the RMI Nationwide Radiological Survey tested thousands of soil, plant, and occasionally marine samples collected throughout the nation and confirmed the existence of unsafe levels of radiation at dozens of islands.

Just last year (2006) terrestrial radiological survey values were adjusted for 2005 and showed dangerous levels of radioactive <sup>137</sup>Cs still contaminating as many as 20 islands (Table 1) (Watkins et al. 2006). Recall the current dose limit and clean-up criteria specified by the USEPA and adopted by the Nuclear Claims Tribunal of 15 mrem year<sup>-1</sup> for all radioisotopes. In 2005 this number was exceeded on every island by <sup>137</sup>Cs alone.

The preparers of this document can find no current information on remaining marine contamination but due to the long-lived nature of the transuretics with half-lives in the hundreds and thousands of years such as <sup>108</sup>mAg, <sup>238+239</sup>Pu and <sup>241</sup>Am, which have been identified in the marine environment, we argue that much of it remains to this day.

### **Testing after the nuclear period**

Operation HARDTACK ended the nuclear test period, but not weapons testing by the US. In 1959, Kwajalein was chosen as the test site for the NIKE-ZEUS anti-missile tests and Roi Namu Island was selected as a center to study missile re-entry characteristics. In the 1960s, Enewetak’s lagoon was the target and impact area for tests of Intercontinental Ballistic Missiles (ICBMs) fired from Vandenberg Air Force Base in California (Rowa 2006). In 1964, the testing of a system for shooting down Soviet satellites began.

**Table 1.** 2005 Radiocesium ( $^{137}\text{Cs}$ ) levels in mrem per day  
(Source: Watkins et al. 2006)\* [322: (Simon and Graham 1994); 323: (Mauro et al. 2002)].

Source	1994 nationwide Radiological Study <sup>322</sup>				2002 SC&A Report <sup>323</sup>	
	2484 kcal day <sup>-1</sup> diet 75% local food		2484 kcal day <sup>-1</sup> diet 18% local food		3208 kcal day <sup>-1</sup> diet 100% local food	
Predicted exposure range	Low	High	Low	High	Low	High
Bikini-Bikini	16	1600	80	400		
Northern Rongelap	120	800	40	240		
Enewetak-Enjebi	63	400	16	160		
Rongelap	40	240	12	80		
Bikini	40	240	12	80		
Rongerik	40	240	12	80		
Southern Rongelap	40	240	12	80		
Northern Enewetak	32	200	12	60		
Enewetak-Aoman	24	160	7.9	40		
Enewetak	16	120	6.3	40		
Bikini-Eneu	16	120	6.3	40		
Enewetak-Bijiri	12	90	5.6	32		
Enewetak-Lojwa	12	90	5.6	32		
Ailinginae	7	60	1.6	16		
Utrik	5	50	1.6	12		
Enewetak-Runit	5	50	1.6	12		
Ailuk	2	16	1.6	8	5	22
Mejit	1.6	12	0.6	5	5	21
Likiep	0.2	2	0.2	2	5	21
Wotje	0.2	2	0.2	2	4	18

\* Values adjusted for 2005 by using the cesium-137 half-life of 30 years.

“In the summer of 1968, the Deseret Test Center conducted a series of tests known as DTC 68-50 from the USS Granville S. Hall, anchored off Eniwetok Atoll. This test series involved the atmospheric dissemination of “PG” — *Staphylococcal enterotoxin* Type B — a toxin that causes incapacitating food poisoning that causes flu-like symptoms that can be fatal to the very young, the elderly, and people weakened by long term illness. *Staphylococcal enterotoxin* B was disseminated over a 40–50 km downwind grid, and according to the Final Report, a single weapon was calculated to have covered 2400 square km, an area equal to 926.5 square miles” (Johnston and Barker 2001:31).

Also in 1968, the US Air Force experienced a high order explosion while testing a high-energy upper stage (HEUS) rocket motor at Enewetak. The explosion contaminated Engebi with a significant amount of the highly toxic substance, dispersed Beryllium (see endnote x) (Dickman 1972).

The Pacific Cratering Experiments (PACE), which began on Enewetak in September 1971, included more than 220 tons of explosives brought to the atoll to simulate nuclear bomb blasts. In April 1972, the US announced it would end its use of Enewetak by the end of 1973 — after completion of certain unspecified tests, which included 190 holes drilled into reefs and land for explosive charges in 86 trenches as well as the detonation of six tons of explosives. Ongoing US weapons testing is also part of the current military impact on the Marshall Islands. Testing of the US National Missile Defense System sometimes called Star Wars or Son of Star Wars at the US Army’s Ronald Reagan Ballistic Missile Defense Test Site on Kwajalein Atoll continues to this day. Over 113 missiles have been fired and over 66 rockets have been launched from Kwajalein since its designation in 1959 (Parsch 2002-2004, Wade 1997-2007).

“Back in the days when we had no television, our entertainment sometimes included sitting

out on the north sand spit . . . This area was the best place to watch the incoming ICBM missile payload section from Vandenberg Air Force Base as it reentered the Earth's atmosphere . . . In pre-1996 days, the Army Zeus interceptor rocket would take off from Launch Hill down at the south end of Kwajalein . . . The display was a brilliant cataclysmic array of light unlike any Fourth of July celebration I have ever seen. Sometimes the display was bright enough to photograph and even get a colored film time exposure. We were not supposed to be outside our concrete houses, just in case something might fall out of the sky. The rule was never enforced, and you could always count on around 500 people out on the sand spit whenever a Vandenberg Special came down the pike" (Sims 1999-2007).

WWII, the nuclear testing program, chemical and biological weapons testing, missile testing, rocket test firings, and the cratering experiments program caused and continue to cause serious environmental damage to the marine environment of the Marshall Islands. This is most clearly demonstrated at Enewetak Atoll, where five islands — Bokombako (Elugelab), Louj (Lidilbut), Bokaidrik, Boken (including a small unnamed islet to the west of Boken) and Eleleron — were completely or partially vaporized (Rowa 2006).

"A few days later we returned to the site to find that part of the atoll was gone and in its place was a very large crater. They say the size of the bomb was 10 megatons. I would never want to go through that again" (Guido 2001).

"After the explosion, the islands where the bomb was detonated disappeared, they were gone, no more, nada" (Marquez 2007).

"When I rotated back to Hickam, we flew over the test site I'd seen earlier when they were building the 100 foot tower. Around the barrier reef was the deep purple coloring of the ocean. Inside of the reef was the pale green coloring of the shallow water. Where the 100 foot tower had been placed on this small island there was no tower, there was no island! Instead there was a hole the same color as the deep ocean surrounding the reef! All of us on the plane sat there staring at that hole" (Sapp 2000).

These activities have all resulted in a large amount of submerged cultural materials, such as military equipment, unexploded ordnance, shipwrecks and sunken aircraft, as well as radioactive debris, which remain largely undocumented to this day.

## Sea turtles

Let us now consider why sea turtles may be particularly susceptible to these contaminants. Sea turtles, particularly green sea turtles (the most populous species in the RMI), rely on certain foods (such as algae and seagrass) that bioaccumulate metals and radiogenic contaminants. This may pose a special risk given the unexploded ordnance load, the sheer number of wrecks and other submerged materials, the archipelago-wide fallout from nuclear weapons testing and the historic and current environmental threats posed by ongoing testing at Kwajalein and related Kwajalein base activity (especially contaminants in the reef and marine food chain like perchlorate, the primary ingredient of solid rocket propellant), and radiogenic deposition in the lagoon sediments.

In 1952, US scientists first published reports that perchlorate inhibited the uptake of iodine in Marshallese research subjects. The 1953 test series studies documented bioaccumulation in biological organisms (Atkins undated cited in Johnston 2003; Atkins et al. 1974 cited in Johnston 2003). In 2001 perchlorate contamination was documented by the US Department of Defense in the water supply and coral reef/lagoon ecosystem in and around Kwajalein (USAF et al. 2001 cited in Johnston 2003).

"One of the many shocking aspects of reviewing US research in the Marshall Islands was finding evidence that the US DOD [Department of Defense] has produced scattered yet substantive documentation of non-radiogenic toxic hazards introduced by military testing, and yet to the best of my knowledge no comprehensive environmental impact assessment has ever been undertaken. The toxins are many, and their effects, especially on radiologically exposed and immune-system compromised populations, are serious" (Johnston 2003).

Samples of algae were taken from several of the sunken target ships by a Navy dive team in 1989 (Delgado et al. 1991) and were analyzed for radioisotopes (Table 2).

Levels of all contaminants, including the extremely high levels of <sup>241</sup>Am and <sup>239+240</sup>Pu were dismissed as a human diving hazard because the emanating radiation is totally absorbed in a few millimeters or less of water, which was suggested to be closer than a diver would approach. This limitation would not exist for sea turtles that regularly eat organisms growing directly on shipwrecks such as algae and sponges. Plutonium-<sup>239+240</sup> and <sup>241</sup>Am are described as containing the highest risk of inhalation exposure in disturbed lagoon sediments (Del-

**Table 2.** Radioisotope concentrations in algae samples taken from sunken ships at Bikini Lagoon in pCi kg<sup>-1</sup> (Delgado et al. 1991).

Ship	60Co	137Cs	90Sr	155Eu	270Bi	241Am	239+240Pu
<i>Gilliam</i>	<10	<10	11	<190	<10	3450	4140
<i>Pilot Fish</i>	360	110	121	90	420	90	108
<i>EOD Collection Pilot Fish</i>	240	140	154	150	500	2300	2760
<i>Carlisle</i>	490	80	88	<40	470	1400	1680
<i>Saratoga</i>	200	470	517	<290	180	<400	480
<i>Arkansas</i>	380	140	154	170	490	1700	2040
<i>Nagato</i>	410	260	286	170	290	3300	3960

Note: For 238+239Pu + 241Am combined, the DIL for all components of the diet is 54 pCi kg<sup>-1</sup>.  
DIL = US Nuclear Regulatory Commission Recommended Derived Intervention Level.

gado et al. 1991). This pathway may be important for turtles when feeding on benthic organisms such as invertebrates, shellfish and sea grasses.

The radioisotope levels in the area of the target ships in Bikini Lagoon were deemed nonhazardous to divers because the gamma rays they emit would dilute as they moved through the water and would be negligible by the time they reached recreational diving depths. Such depth restrictions, as well as location restrictions (the shipwrecks off Bikini Islet) would not be observed in the sea turtle population as normal resting behavior makes the cracks and crevices of wrecks and other submerged materials ideal resting locations, and neither their foraging nor resting habitats would be restricted to the southern end of the lagoon.

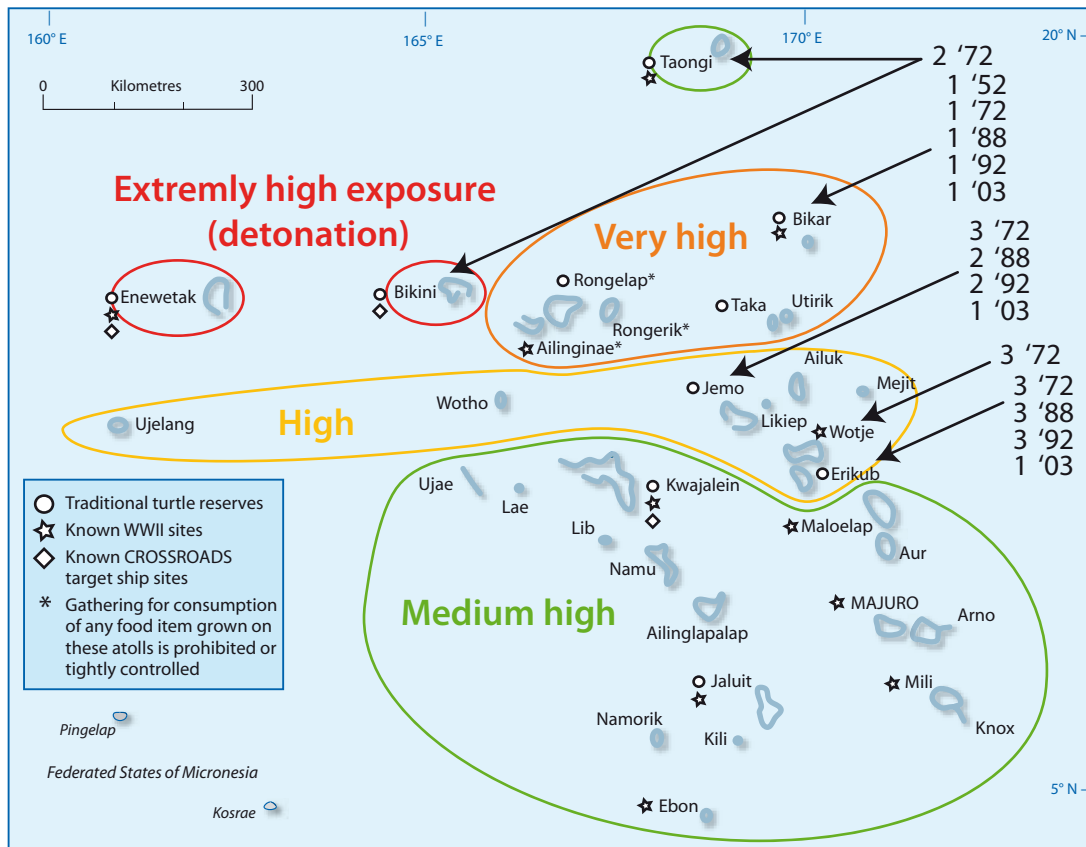
It is important to note that sea turtles show site fidelity to both their resting and foraging sites (i.e. remain in or return to the same location over and over), so those resting or feeding off of toxic materials may have been doing so every day for many decades (depending upon the age of the turtle).

As discussed previously in this document, the limiting factor for both occupation and consumption of terrestrial foods due to radioisotope levels is the continued presence of high levels of the long-lived radionuclide, 137Cs in the soil of the atolls and "there is a continuing inventory of 137Cs and 90Sr in the fresh water portion of the groundwater at all contaminated atolls" (Robinson et al. 2003). Due to this factor, the consumption of food grown in the soil of the most highly contaminated islets has been vastly restricted and several atolls (Rongelap, Rongerik, and Ailinganae) have been categorized as "no-gathering" sites. Again it must be pointed out that sea turtles would not abide by these restrictions. Nesting sea turtles as they dig a few feet down into the sand in order to lay their eggs and as air breathers expending considerable amounts

of energy as they do so, may take in large amounts of resuspended particles. All of the sites previously reported as first, second, or third for number of sea turtle nests are contaminated with these radioactive elements, some at extremely high levels (Fig. 3).

This is also significant because sea turtle eggs have been shown to take up contaminants found in the nest environment, which is generally located a few feet down into the sand above the high tide mark, with some turtle species, such as hawksbills, nesting as far up as the vegetative areas (Acuna et al. 1999; Campos et al. 1996).

In addition, several northern islets of the atolls with the high levels of contamination were previously set aside by the chiefs as sea turtle reserves due to the high number of turtles in these locations; these included Taongi (*Bok-ak*, Bokak, Pokak, Pokaakku), Bikar, Taka, Erikub (*Adkup*, Erikup), and Ailinginae atolls, Jemo Island, Wönwöt (*Wönoot*) and Pekram (*Pekdam*) islets of Kwajalein Atoll, Lijeron Islet (*Ledjiok*) of Jaluit, and several uninhabited northern islets of Enewetak (Tobin 1952; Lessa 1984; Fosberg 1990). When the National Resources Assessment Survey team surveyed Rongelap Atoll (*Ronlap*) in 2003, "the reefs surveyed were found in mostly pristine conditions, with a large number of fish, coral, algae and other species present and abundant. The team found abundant and large size fisheries target fishes, and recorded abundant mega-fauna such as sea turtles, whales, and rays" (NRAS 2003). Due to their unique ability to survive tremendous injuries that would result in death to humans, such as loss of limb and even portions of their torso, an abundant population of large size turtles would not mean they suffered no impacts from WWII and the weapons tests. It is entirely possible that the turtles that were alive during these periods are still alive today having experienced both the high levels of acute exposure as well as chronic exposure at lower levels as dilution and decay take effect. Should



**Figure 3.** Atoll rankings by number of sea turtle nests in previous studies.

Diagram compiled from the following sources: Tobin 1952; Thomas 1989; Maragos 1988; Fosberg 1990; Puleloa and Kilma 1992; McCoy 2004; dose figures extracted from Table 2 above.

similar abundances also be found for the remainder of the aforementioned contaminated areas with historically high sea turtle numbers, it could have far-reaching consequences should it be determined that the contamination at those atolls is contaminating the tissues of sea turtles born, foraging and resting in those locations and migrating throughout the country and the region.

The environmental contamination of sea turtle flesh and eggs as well as the human health risks associated with their consumption has been well documented. Yasumoto (1998) reports on the fatal intoxication from the consumption of a green sea turtle that caused by the turtle feeding on contaminated blue-green algae. Human poisoning from consuming hawksbill, green, leatherback, loggerhead and olive ridley turtles over a 65-year period was determined to be due to the toxicity of the food consumed by the turtles (Robinson 1999 cited in Strainchamps 2000). Ranaivoson et al. (1994) reported that six people died within five days from eating a sea turtle that was in ill health. "Observers reported that the turtle, when caught, was weak; upon being butchered, it was reported to have gut contents smaller than usual; there was a strong smell of urea/urine

in the gut, and the meat was unusually soft" (Ranaivoson et al. 1994:1).

It is important to remember the quarantine of Runit Islet and the tremendous load of transuranics in Enewetak Lagoon as well as the quarantine of the northern islets of many atolls. Contaminant levels in these locations were not determined to limit consumption of marine species due to what surveyors described as the non-migratory nature of the species tested as well as dose estimates using their "edible" tissues. Our doubts about the validity of this conclusion are too many to be considered here, but it must be pointed out that the migratory nature of sea turtles and the fact that the Marshallese reportedly eat all rather than only some of their parts, with women even sucking the marrow out of their bones, would again make such determination irrelevant. Neither location of, nor the short life span of, nor the edible tissues tested in marine species to date, would apply to sea turtles that may well be nesting, foraging and resting, perhaps living 98% of their very long lives, in these highly contaminated areas.

Also important to note are determinations of what level of contaminant remains in the environment



today as well as the half-lives of the radioisotopes. Neither of these determinations would be relevant to the sea turtle population as it is entirely possible that some of the current stock of reproductive adults were present during the actual nuclear testing events (ended 50 years ago) and even as far back as WWII (65 years ago) as frequently estimates of sea turtle longevity are 50-75+ years — the Hawaiian green sea turtle population for example is not estimated to even reach the age of first reproduction for 30 or more years (Zug et al. 2002).

## Conclusion

We argue that research into this situation is essential as we have found a high probability that there are toxicants remaining in the RMI environment and that due to the long life (50+ years receiving low-dose radiation and other contaminants) and normal habits of sea turtles, such as site fidelity to certain resting areas and resting in submerged resources such as irradiated shipwrecks (among others), site fidelity to certain foraging areas and several species eating organisms that may be growing directly on toxic surfaces (such as algae and sponges), and embryo development and metamorphosis taking place a few feet down in contaminated sand, their contamination from those products is highly probable. In addition, we suggest that due to the migratory nature and reproductive patterns of sea turtles, which often have nesting areas thousands of miles away from their feeding and developing areas, the possible threat to sea turtle populations may be regional rather than strictly limited to the RMI environment. Finally, we assert that as the non-human animal most likely to have experienced the same war and weapons testing events as the human population, if not more so, sea turtles may be viable candidates for determining with accuracy the initial, subsequent, and long-term contaminants that existed and still exist today. The results of this research will be important not only to the Marshallese but to all nations whose sea turtle habitats are subject to the impacts of war and weapons testing, including but not limited to the nation-states of Kiribati (testing by UK and US) and Australia (testing by the UK), and the territory of French Polynesia (testing by France).

## Project summary: Phase I

The essential first step to the development of this project is the collection of local indigenous knowledge in order to gain an understanding of the complex array of cultural, ecological, historical and economic elements that form the present state of affairs and inform attempts at mitigation. We intend to identify priority research areas within the country with high sea turtle activity and submerged cultural resources through the collection of local knowledge.

Furthermore, a good understanding of human interests, practices and aspirations is also critical to effective conservation and resource management. Presently, despite national and international protections as endangered species, sea turtles remain prestigious, desirable and ceremonially important food sources for atoll populations; the relatively new and international science of sea turtle conservation does not counter Marshallese traditional valuation and uses of sea turtles. As locally available and prestigious meat with huge cultural significance, as a valuable exchange item (meat and handicrafts), and as an activity that helps people “feel native,” sea turtles are very special to the Marshallese; yet sea turtles are also risky, subject to caution (potential contamination), legal conservation-oriented measures, and at risk of extirpation.

Some ethnographic information regarding sea turtles' importance has been documented in the RMI. Information is fragmentary but hints at complex cultural elaboration and acute ecological knowledge that has ramifications for Marshallese health and social identity even today: Tobin (2002) describes numerous legends collected in the 1950s that document the high cultural value placed on turtles; Erdland (1914) reported that among the Marshallese “tortoise shell was a prominent magical charm, and in fact the neck plate of the upper shell had greater magical power than the tail plate.”

This symbolism is related to Lijebake (*Jebake*) (a giant turtle who once was a goddess) who features in two common Marshallese legends regarding sea turtles. In one legend Lijebake (adored and respected female hawksbill turtle) then living at Bikar, is visited by her two sons, also gods. They receive power from her in the form of pieces of her turtle shell: a shoulder piece to her preferred son and a tailpiece for the other (McCoy 2004). In other legends (see Downing et al. 1992 and Spennemann 1998), Lijebake rescued her granddaughter from mistreatment in Kiribati and swam with her to Jemo Island, thereby becoming the “Great Mother Turtle,” and causing turtles to prefer Jemo Island from thereafter. Other versions of the legend have the girl turning into a seabird and flying away above her grandmother to Bikar (Tobin undated), and the grandfather turning into a frigate bird and along with Lijebake fleeing with their granddaughter to Jemo (Kane 1995). Lijebake's feat is so well integrated into Marshallese identity that in 1995, the RMI government issued a USD 0.32 stamp depicting Lijebake with her granddaughter on her back.

The sea turtle was such an important cultural resource to the Marshallese that as mentioned above, until the mid-20<sup>th</sup> century, several islands and atolls were set aside by the chiefs as traditional sea turtle reserves, protected by the Marshallese concept of “*mo*” or taboo areas. In order to obtain turtles from

these islands strict rituals were observed. Earlier reports describe such visits to the *mo* (Staff Anthropologist [Jack Tobin] 1957:8–9; Johannes 1986:24–25).

In 1978 when the green turtle was listed as threatened and endangered under the US Endangered Species Act (ESA) of 1973, USFWS and NMFS adopted a special rule containing a provision for the continued subsistence taking of green turtles (*Chelonia mydas*) from below the low water mark for nutritional reasons by residents of the Trust Territory, “. . . if such taking is customary, traditional, and necessary for the sustenance of such resident and his immediate family” (Balazs 1983). The Trust Territory was the sole area to receive an exemption for subsistence use as defined above. The rationale for this action was that many of the inhabitants follow a traditional way of life in villages on small remote islands that are limited in natural food resources; therefore, the risk to the turtles’ survival from subsistence use had to be balanced against the nutritional and cultural needs of the people (Balazs 1983).

After internal self-government was established under a constitution in 1979, the RMI promulgated their own Endangered Species Act for protection of endangered and threatened species. However, only the hawksbill and the leatherback were specifically covered by the Act. The RMI gained independence linked to a Compact of Free Association with the United States in 1986. In 1988 they instituted the Marshall Islands Marine Resources Authority Act: “An Act to regulate fishing and protect endangered species in the Republic and for matters connected therewith” (FFA undated). This new act contained the following:

§ 3. Limitations on taking of turtles.

(1) No hawksbill turtles or sea turtles shall be taken or intentionally killed while on shore, nor shall their eggs be taken.

(2) No hawksbill turtle shall be taken or killed except whose shell is at least twenty-seven (27) inches (68.6 cm) when measured over the top of the carapace shell lengthwise; no green turtle shall be taken or killed except whose shell is at least thirty-four (34) inches (86.4 cm) when measured over the top of the carapace shell lengthwise.

(3) No sea turtle of any size shall be taken or killed from the first day of June to the thirty-first day of August inclusive, nor from the first day of December to the thirty-first day of January inclusive.

(4) Notwithstanding any provisions of this Section to the contrary, taking of sea turtles and their eggs shall be allowed for scientific purposes when specifically authorized by the Cabinet.

§ 6. Penalties for violation. A person violating any of the provisions of this Chapter for which a different penalty is not otherwise provided shall be guilty of an offense and shall upon conviction be liable to a fine not exceeding \$100 or to a term of imprisonment not exceeding six (6) months, or both.

In 1997, the act was amended as follows (FFA undated);

§ 3(2) on size restrictions was amended to add an exception for subsistence fishing,

§ 3(3) on seasonal limits was deleted,

§ 3(4) which gave permitting authority to the Cabinet was changed to make the Marshall Islands Marine Resource Authority (MIMRA) the permitting authority for scientific taking.

It also added a new provision to § 3: “no turtles or turtle products may be sold, purchased, displayed for sale, offered for sale or otherwise marketed,”

In addition, it increased the penalties for violation: to a fine of not more than \$10,000 or imprisonment of up to six months, or both.

The actual level of cultural take is unknown, although there are a few reports that give us some indications (McCoy 2004, Eckert 1992, Thomas 1989, Maragos 1988, Fosberg 1951).

1951 There is no sea turtle fishery on Arno, although the natives frequently catch turtles in the stone fish traps.

1988 The nesting turtles and their eggs of Erikub appear to be subject to heavy harvesting pressure. “Recent human footprints were found along all beaches where turtle tracks were reported. Numerous nest marker sticks, temporary camps, and the remains of sea turtles and their eggs were also conspicuous.”

1989 “The Wotho islanders harvest the turtles only infrequently for special or ceremonial occasions, usually during the summer months off the beaches of uninhabited islands. The villagers seem very conscious of “*ine* vulnerability of the nesting turtle population and limit this harvesting practice accordingly” (Thomas 1989).

1992 A rough estimate of annual take was around 100 turtles from the reefs around Wotje islet.

One inhabitant of Wotje estimated that roughly 1000 turtles were captured annually on Wotje and Erikub.

Hunting trips to Erikub to collect turtles for a large “liberation day” feast resulted in 20–30 turtles (nesting females as well as “several males” caught in shallow water). It was estimated that more than fifty sea turtles would be eaten during the course of the celebrations.

A family spent the better part of the summer on Erikub and captured 13 turtles, estimating that two escaped for each one captured. All were large, mature turtles, 9 males and 4 females. Ten were to be sold in Majuro, three to be eaten.

2003 Approximately 40 turtles per year were captured on Wotje consisting mostly of the larger sizes and captured in the lagoon and while nesting

Those interviewed agreed that more turtles are taken in the eastern and southern portions of Ailinglaplap Atoll where seagrasses and mangroves are present and where a majority of the population resides.

A compilation of responses from various informants resulted in an estimate of the average annual take to be around 30–50 green turtles for the entire atoll: Katiej and north-western islets 1–2; from Buoj to Airok 10–15; from Jeh and Eastern islets 10–15; from Woja and western islets 10–15; from uninhabited islets 2–5 nesting females (Total 33–52).

Because of the significance of the sea turtle to the Marshallese, a major portion of this research will be aimed at documenting, from a Marshallese perspective, the cultural knowledge and everyday importance of sea turtles in order to determine the possible ramifications of project findings (such as finding that all or some parts of sea turtles cannot be safely consumed), including:

- the importance of non-commercial, non-imported foods (sea turtles, marine foods, other foods) in regular and preferred diet;
- specific cultural knowledge regarding sea turtles’ protection and conservation;
- specific cultural knowledge regarding sea turtles as culturally significant (including mythic) beings;
- specific cultural knowledge regarding sea turtles as food and medicine;
- specific cultural knowledge regarding techniques for protecting and conserving sea turtles and their locations;
- specific cultural knowledge regarding finding, and harvesting sea turtles and eggs; and
- cultural importance of sea turtles to the Marshallese peoples’ sense of identity and place.

A second aspect of this research segment will be aimed at documenting the potential impact on mar-

ket forces from a change to non-consumptive sea turtle uses (by Marshallese and others). Surveys will be conducted to understand:

- content of local foods markets;
- locals’ food preferences (and fears); and
- importance of sea turtles to tourists and tourism operators.

A third, interconnected aspect of this research segment will use GPS mapping to augment cultural and ecological documentation of key sites. We will:

- record local ecographies;
- draft verbal snapshots of sea turtle and other places significant to the Marshallese; and
- map sea turtle locations and ecographies to GPS coordinates

Including the collection of local knowledge as a big part of the project will provide insight into the broad social context that frames the challenge of effectively managing the sea turtle resources in the RMI. Studying the cultural and historic development of the different economic activities that were established in the region by the indigenous settlers, their culture and social aspects will help us to analyze the types of social problems and cultural issues that relate to sea turtles in the region. We will study and assess the methods being used for harvesting and processing of sea turtles for food and income and will study the ethical issues regarding the interplay of sea turtles as important cultural resources and their possible contamination with war and weapons testing. We will also examine the consequences and implications of different models of resource distribution and will explore the impact on sea turtle and human health.

Combined methods (quantitative and qualitative) data will be collected and analysed (see methods outlined below). Participatory ethnographic methods, drawing on a combination of phenomenological and social interactionist techniques, and survey instruments created for this project will be employed. Basic ethnographic and qualitative information about local perceptions of sea turtles will be collected. The methods will include semi-structured interviews, group discussions, participant observation, verbal snapshot and GPS mapping of sea turtle locations, ecographic and cognitive mapping, active listening, observing and analyzing the landscape, tourist surveys, market and local foods study, life history interviews, time allocation studies, food preference surveys, and the collection of turtle recipes for food and medicine, among others. The population target will be different social and age groups to have a comprehensive vision about local perceptions. Researchers will interact with and among atoll householders, elders, cultural spe-

cialists, turtle harvesters, market vendors, food preparers, and other local experts as identified by the community. We will rely on partnership with local Marshallese as well as cultural competency, active listening, photo-documentation and unstructured interviews with community groups and key individuals, to gather information in the most naturalistic, culturally sensitive methods possible.

We intend our research to include involvement of local participants at every step of the process and in order to accomplish this, the ultimate utility, relevance, and meaning to the local community must be taken into account. Doing so will ensure that the proposed research is not solely of “external” value. Of course this also implies a willingness to bend toward community interests, the involvement of the community in initial discussions, an exchange of resources during the research period, and full disclosure regarding the benefits and requests to be made of the local community.

Fully integrated into the research process will be careful consideration, in conjunction with community members, of the possible uses and impacts of research results — since no outsider can fully judge or predict how information may be damaging to local research participants. Of course, all participation must be voluntary and anonymous, as spelled out in the federal regulations regarding research on human “subjects”.

The collaborative nature of the proposed fieldwork will be emphasised and made public. Training, mentoring, and compensating assistants are examples of the type of reciprocal exchange of knowledge and skills we have planned. Committing oneself to such work during the research period is a critical collaborative activity. The relationships that develop through work in meaningful local contexts, rather than detract from research, enhance it tremendously. Local work enables community members to value individual researcher’s contributions, and allows researchers to know them in ordinary environments. Participants contribute their time, effort, and knowledge. That offering must be respected, acknowledged, and returned with a commitment in kind.

This exchange of information and resources allows the researchers to be better known by community members, makes them more accessible and more understandable. As this exchange takes place, personality, desires, and interests grow more transparent. Viewing this contribution as obligatory rather than supplementary is a challenge we hope to have met through our research design. Building in a time commitment to research participants makes us accountable not only through our research, but also as individuals. We commit our time to their self-

defined needs, and their livelihoods, as they do to ours. We come to know them as whole beings, not just interviewees. We open ourselves to being known and making our strengths and weaknesses obvious. We pledge to be professionally and ethically accountable by protecting the anonymity of participants, and by being as accurate as possible. Once field research is completed, the final results will be presented in accessible and meaningful ways to the local communities with limited use of technical jargon and discipline specific terminology.

The value of sharing research outcomes in a community-accessible product is immeasurable. Eliminating academic terminology and clearly stating theoretical interests is not only an opportunity to give back, but to show how valuable the participation of the community is to a deeper understanding of the research topic. It provides an opportunity for the researcher to be responsible to the community for praise, criticism, and further discussion. Once local audiences have access — in the local languages, idioms, and images — to works written about them, they are sure to comment and to be recognized as co-creators and collaborators.

*“We see a future where generations of Pacific Island people will have choices about how they use and interact with sea turtles. This dream will come true if we take action now to ensure that sea turtle populations recover to become healthy, robust and stable. Sea turtles will be fulfilling their ecological role and be harvested by Pacific Islander people on a sustainable basis to meet their cultural, economic and nutritional needs.”*

-- The Vision Statement of the Strategic Plan for Marine Turtles of the South Pacific, drafted by participants of the Strategic Planning Meeting of the Regional Marine Turtle Conservation Project, June 1996, Apia, Western Samoa

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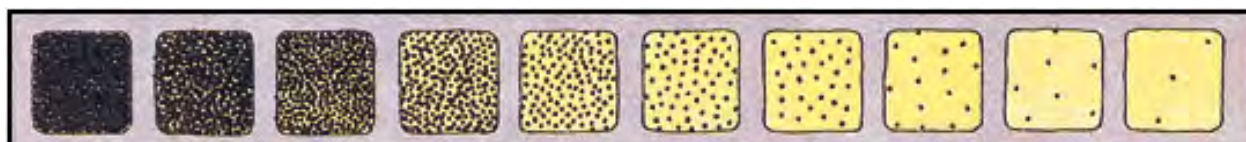
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## Endnotes

- i The time in which half the atoms of a radioactive substance disintegrate to another nuclear form is known as the half-life ( $T_{1/2}$ ). As a general rule of thumb, 7–10 half-lives can indicate how long an isotope could be expected to remain radioactive as it decays into its daughter isotope, which also remains radioactive for 7–10 half-lives as it decays into its daughter isotope and on and on until it decays to a stable isotope (ANV and USDOE 2007). In hazard assessments, all radioactive members of a decay series must be considered. This concept of half life is illustrated below (from the Uranium Information Center, Melbourne, Australia, [www.uic.com.au/ral.htm](http://www.uic.com.au/ral.htm)):

Decay rate of radioactivity: After 10 half-lives, the level of radiation is reduced to one thousandth



Time:      One half-life   two      three      four      five      six      seven      eight      nine

$^{238}\text{Pu}$ ,  $^{239}\text{Pu}$ , and  $^{240}\text{Pu}$  are isotopes of plutonium, and have half-lives of 87 years, 24,065 years, and 6,537 years, respectively. As plutonium decays, it releases radiation and forms decay products. For example, the decay products of  $^{238}\text{Pu}$  and  $^{239}\text{Pu}$  are uranium-234 ( $^{234}\text{U}$ ) and uranium-235 ( $^{235}\text{U}$ ), respectively. The half-life for  $^{235}\text{U}$  is 710 million years and is 250,000 years for  $^{234}\text{U}$ . Radiation is released during the decay process in the form of alpha and beta particles, and gamma radiation. When mixed in soil on the ground these plutonium isotopes have a potential risk that is predominantly from the inhalation and ingestion pathways. Plutonium may remain in the lungs or move into the bones, liver, or other body organs. The plutonium that is not readily extracted stays in the body for decades and continues to expose the surrounding tissue to radiation. Plutonium inhaled or ingested will increase a person's chance of developing cancer, but such cancer effects may not become apparent for several years (US EPA 2006). When uranium gets inside the body, radiation and chemical damage can lead to cancer or other health problems, the major target organ of uranium's chemical toxicity is the kidney (US EPA 2006).

- ii. Strontium-90 ( $^{90}\text{Sr}$ ) has a half-life of 29 years and emits beta particles of relatively low energy as it decays. Strontium-90 decays to yttrium-90 ( $^{90}\text{Y}$ ). The isotopes of yttrium emit beta particles as they decay. Beta particles can pass through skin, but they cannot pass through the entire body.  $^{90}\text{Y}$  has a shorter half-life (64 hours) than  $^{90}\text{Sr}$ , but it emits beta particles of higher energy. Strontium in the environment can become part of the food chain. After  $^{90}\text{Sr}$  is ingested, 20–30% of it is absorbed from the gastrointestinal tract, while the rest is excreted. Of the portion absorbed, virtually all (99%) of the  $^{90}\text{Sr}$  is deposited in the bone volume or skeleton. The balance is distributed among the blood stream, extracellular fluid, soft tissue, and bone surface, where it may stay and decay or be metabolized and excreted in urine and fecal matter. Strontium-90 behaves like calcium in the human body and tends to deposit in bone and bone-forming tissue (bone marrow). Thus,  $^{90}\text{Sr}$  is referred to as a "bone seeker" and exposure to it will increase the risk for several diseases including bone cancer, cancer of the soft tissue near the bone, and leukemia (US EPA 2006).
- iii. Zirconium 95 ( $^{95}\text{Zr}$ ) is among the long-lived radionuclides with a physical half-life of 65 days. It decays to niobium-95 ( $^{95}\text{Nb}$ ), which has a physical half-life of 35 days (aquatic plants have a rapid uptake of soluble zirconium) (KAERI 2000). Zirconium can be taken into the body by eating food, drinking water, or breathing air. Gastrointestinal absorption from food or water is the principal source of internally deposited zirconium in the general population. Of the zirconium that reaches the blood, half deposits in the skeleton with a biological half-life of 8000 days and the other half deposits in all other organs and tissues of the body where it is retained with a biological half-life of seven days (per simplified models that do not reflect intermediate redistribution). Since zirconium is not a major constituent of mineral bone, the amount deposited in the skeleton is assumed to remain on the bone surfaces and not be absorbed into the volume of bone. While inside the body, zirconium presents a health hazard from the beta particles and gamma radiation, and the main concern is associated with the increased likelihood of inducing cancer (ANV and USDOE 2007).
- iv. Most of the radiation from the decay of cobalt-60 ( $^{60}\text{Co}$ ) is in the form of gamma emissions; some is in the form of beta particles. Beta particles are generally absorbed in the skin and do not pass through the

entire body. Gamma radiation penetrates the body. The half-life of  $^{60}\text{Co}$  is about 5.2 years. Cobalt-60 can be swallowed with food or inhaled in dust. Once in the body, some of it is quickly eliminated in the feces. The rest is absorbed into the blood and tissues, mainly the liver, kidney, and bones. This cobalt leaves the body slowly, mainly in the urine. Because  $^{60}\text{Co}$  releases gamma rays, it can affect health even if not ingested or inhaled. Exposure to low levels of gamma radiation over an extended period of time can cause cancer (US EPA 2006).

- v. Cesium-137 ( $^{137}\text{Cs}$ ) is significant because of its prevalence, long half-life (30 years), and its potential effects on health. After  $^{137}\text{Cs}$  is ingested, it is distributed fairly uniformly throughout the body's soft tissues. Slightly higher concentrations are found in muscle; slightly lower concentrations are found in bone and fat. Exposure to radiation from  $^{137}\text{Cs}$  can result in malignant tumors and shortening of life. Cesium-137 emits beta particles as it decays to the barium isotope, barium-137m (half-life = 2.6 minutes), which emits gamma radiation of moderate energy. Gamma photons emitted from the  $^{137}\text{mBa}$ , are a form of ionizing radiation that can pass through the body, delivering doses to internal tissue and organs (US EPA 2006).
- vi. In fish and amphibian toxicity tests with 22 metals and metalloids, Silver was the most toxic tested element as judged by acute LC50 values (dose at which 50% mortality occurs). In solution, ionic Silver is extremely toxic to aquatic plants and animals. Among all tested species, the most sensitive individuals to silver were the poorly nourished and young and those exposed to low water hardness or salinity. It is emphasized that silver-induced stress syndromes vary widely among animal classes. Silver, as ionic  $\text{Ag}^+$ , is one of the most toxic metals known to aquatic organisms in laboratory testing. Signs of chronic silver intoxication in tested birds and mammals included cardiac enlargement, vascular hypertension, hepatic necrosis, anemia, lowered immunological activity, altered membrane permeability, kidney pathology, enzyme inhibition, growth retardation, and a shortened life span. Repeated exposure of animals to silver may produce anemia, cardiac enlargement, growth retardation, and degenerative changes in the liver.
- vii. Transuranics are "elements of a higher atomic number than uranium (92), most transuranic isotopes are highly toxic alpha-emitting radionuclides with great biological significance which do not occur naturally in any significant quantities, but which are an artificial product of the fission process and emit radiation having much higher energy than other radionuclides. The transuranic nuclides of the greatest significance are neptunium-237, plutonium-238, 239, 241, americium-241, and curium-242, 244" (RADNET 2007). Alpha radiation is difficult to detect and its effect is lasting for years. It has a range of only a few inches in the air, however is a primary hazard when absorbed internally.
- viii. The half-life of americium-241 ( $^{241}\text{Am}$ ) is about 432 years. As americium decays, it releases radiation and forms "daughter" elements. The first decay product of  $^{241}\text{Am}$  is neptunium-237 ( $^{237}\text{Np}$   $T_{1/2}=2,144,000$  years), which also decays and forms other daughter elements. The radiation from the decay of  $^{241}\text{Am}$  and its daughters is in the form of alpha particles, beta particles, and gamma rays. Because  $^{241}\text{Am}$  emits alpha particles, it poses a significant risk if swallowed or inhaled. Once in the body,  $^{241}\text{Am}$  tends to concentrate primarily in the skeleton, liver, and muscle. It generally stays in the body for decades and continues to expose the surrounding tissues to radiation. This may eventually increase a person's chance of developing cancer, but such cancer effects may not become apparent for several years. Americium, however, also can pose a risk from direct external exposure (US EPA 2006). Neptunium-237 is generally more mobile than other transuranic elements and it can move down with percolating water to underlying layers of soil. Neptunium preferentially adheres to soil particles, with the concentration associated with sandy soil particles estimated to be about five times higher than in interstitial water (water in pore spaces between the soil particles). Neptunium is readily taken up by plants, and plant concentrations are typically similar to soil concentrations. Neptunium can be taken into the body by eating food, drinking water, or breathing air. Gastrointestinal absorption from food or water is a likely source of internally deposited neptunium in the general population. After ingestion or inhalation, most neptunium is excreted from the body within a few days and never enters the bloodstream; only about 0.05% of the amount taken into the body by ingestion is absorbed into the blood. After leaving the intestine or lung, about 50% of the neptunium that does enter the bloodstream deposits in the skeleton, about 10% deposits in the liver, about 5% deposits in other soft tissues, and the rest is excreted, primarily in urine. The biological half-lives in the skeleton and liver are about 50 and 20 years, respectively. (This information is per simplified models that do not reflect intermediate redistribution.) The amount deposited in the liver and skeleton depends on the age of the individual, with fractional uptake in the liver increasing with age. Neptunium in the skeleton is deposited on bone

surfaces and slowly redistributes throughout the bone volume over time. Neptunium is generally a health hazard only if it is taken into the body, although there is an external risk associated with the gamma rays emitted by  $^{237}\text{Np}$  and its short-lived decay product protactinium-233. The major health concern is cancer resulting from the ionizing radiation emitted by neptunium isotopes deposited on bone surfaces and in the liver (ANL and USDOV 2007).

- ix. The half-life of europium-155 ( $^{155}\text{Eu}$ ) is about five years. Europium isotopes decay by emitting beta and gamma particles. Europium can be taken into the body by eating food, drinking water, or breathing air. Gastrointestinal absorption from food or water is the principal source of internally deposited  $^{155}\text{Eu}$  in the general population. Europium is not well absorbed into the body after intake, with only about 0.05% of the amount ingested being absorbed into the bloodstream through the digestive tract. Of the  $^{155}\text{Eu}$  that reaches the blood, 40% is deposited in the liver, and another 40% is deposited on the surface of the bone, where it can irradiate the bone-forming cells; this deposited  $^{155}\text{Eu}$  is retained in the body with a biological half-life of almost 10 years (3500 days); an additional 6% of the absorbed  $^{155}\text{Eu}$  is deposited in the kidneys, where it is retained with a short biological half-life of 10 days (per simplified models that do not reflect intermediate redistribution). The remainder of the absorbed  $^{155}\text{Eu}$  is excreted. While in the body, europium poses a health hazard from both the beta particles and gamma rays, and the main health concern is associated with the increased likelihood of inducing cancer in the liver and bone (ANV and USDOE 2007).
- x. Because it is an element, beryllium does not degrade nor can it be destroyed. Inhalation of beryllium can result in two types of respiratory disease, acute beryllium disease and chronic beryllium disease (also referred to as berylliosis). Both forms can be fatal. The acute disease usually occurs after exposure to high levels (more than  $1 \text{ mg m}^{-3}$ ) of the relatively soluble forms of beryllium, with symptoms ranging from inflammation of the nasal passages to severe chemical pneumonia. Some people can get chronic beryllium disease from breathing low levels, occurring in less than 15% of those exposed to more than  $0.0005 \text{ mg m}^{-3}$ . This disease is a type of immune response only observed in sensitized individuals, and it involves the formation of granuloma and development of fibrosis of the lung. There can be a protracted latency period (up to 25 years) before the onset of any symptoms following exposure. The USEPA describes beryllium as a probable human carcinogen (ANV and USDOE 2007).



# Traditional authority and community leadership: Key factors in community-based marine resource management and conservation

Annette Muehlig-Hofmann<sup>1</sup>

## Abstract

Community-based marine resource management (CBMRM) is more widespread in Oceania than in other tropical region. In this article, I examine the relationship between community leadership and CBMRM, based on a Fijian example. During 2004, sociological community surveys were conducted in five communities on two remote islands, to investigate the status of local traditional authority, with strong leadership being deemed as a critical foundation for successful local marine resource management. Findings show that local traditional customs, for example around the instalment of chiefs, are eroding and one result is that village leadership generally weakens. This local foundation therefore requires more careful attention — without it, implemented management measures may be impractical and unsustainable.

## Introduction

Devolution of resource management via a system of community-based marine resource management (CBMRM) may have much to contribute to small-scale fisheries management worldwide (Hviding and Ruddle 1991; Ruddle 1987, 1998; Fa'asili and Kelekolio 1999; Johannes 1978, 2002; UNESCO 2004). The main anticipated hypothesised results are improved sustainability, efficiency and equity of resource use.

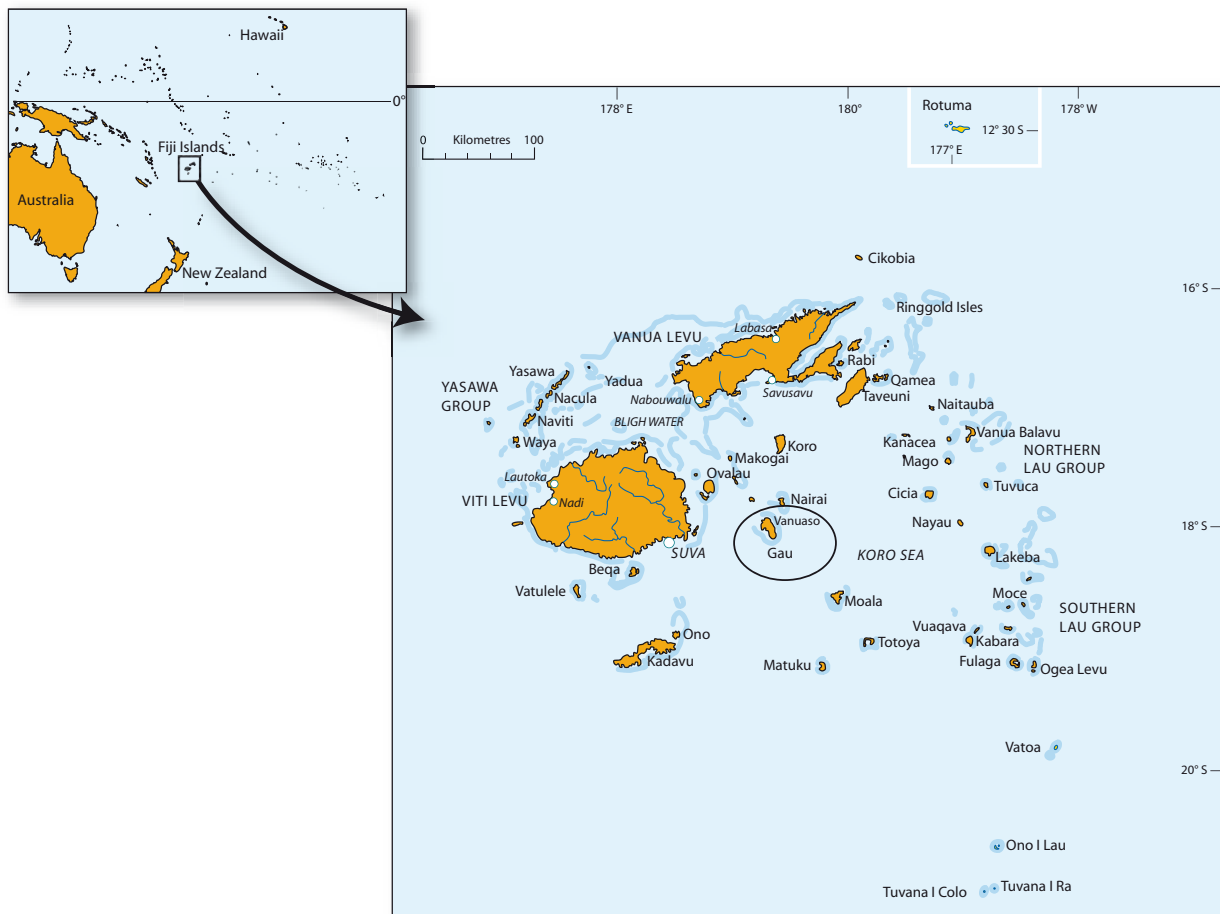
However, it is not always apparent how those results might be achieved and sustained in practice (Ruddle 1987, 1988; Jentoft and McCay 1995; Bolido and White 1997; Berkes et al. 2000; White and Vogt 2000; Christie et al. 2002; Johannes 2002; Pauly et al. 2002), because many social and ecological characteristics are not well understood. This is a major constraint because resource management not uncommonly requires restrictions on the exploitation of resources, and CBMRM, in particular, demands difficult decisions that must be based more on social values than on technical merits (Amos 1993; Jentoft 1998; Johannes 2002; UNESCO 2004). Further, it is a dynamic process of social inventions, shaped by local experience, and influenced by external forces (Bailey and Zerner 1992), such that attempts to create or strengthen existing systems therefore demand a realistic assessment of the motives, ethics, interests, and cultural conceptions driving local stakeholders (Bailey and Zerner 1992; McGoodwin 2001; Johannes 2002). In other words, CBMRM is more about the resource users (the community) than the resources; it is about the management of human activities in relation to the resources (McGoodwin

1994; Jentoft 1998). As a consequence of this appreciation, managers and researchers are increasingly focusing on local communities as webs of social interaction tied to place, history and identity (Jentoft et al. 1998).

Management and conservation activities are driven by various mutually linked forces, for example support by contacts (e.g. to government officials), knowledge and education, religion, community dynamics and hierarchy, or perceptions. Social issues of a general nature, such as justice, power and equity, penetrate local resource management systems in ways that may distort their functioning (McGoodwin 1994; Jentoft 1998). A respected village leadership is noted as a key factor for successful CBMRM; changing leadership and community instability can have a distorting effect on CBMRM and conservation efforts and need to be better understood (Fong 1994; McGoodwin 1994; Jentoft 1998; Veitayaki 1998; Robertson and Lawes 2005). It can also be noted that a widespread constraint is ineffective information exchange between authorities (e.g. fisheries officials and local village chiefs), including the transmission of knowledge and perceptions of resource status and management regimes already implemented (Ruddle 1987; Cooke and Moce 1995). In addition, participation in management can be especially problematical in isolated locations.

In this article, I examine these issues in five communities on two islands in eastern Fiji (Fig. 1). Two topics were chosen for this examination: CBMRM in progress, and the role of traditions and traditional authority in CBMRM. In the concluding section, I summarise and evaluate the recent status of tradi-

1. School of Marine Science and Technology, Newcastle University, UK Email: mhannette@hotmail.com



**Figure 1.** Overview of Fiji and the location of Vanuaso District on Gau Island (18°00'S, 179°20'E).

tional authority and leadership in the communities I studied. I discuss how one can define the status quo of the communities during their balancing act between development and traditions, new and old, and also whether or not rural Fijian communities can still be described as traditional (having already moved too far beyond their traditional ways of living to “turn back”), and whether or not the latter would still be desirable.

During 2003–2004, I conducted research in the eastern part of Gau Island in the four coastal communities of Malawai, Vanuaso, Naovuka (Fig. 2) and Lamiti (Fig. 3), which share the same fishing ground (*qoliqoli*) and belong to the district of Vanuaso, and in Natauloa Village on Nairai Island. Gau and Nairai form part of the Lomaiviti Islands, the central eastern islands of the Fiji Group. The population of the five villages studied ranged from 100 to approximately 200 people. Women predominate in Fiji’s inshore fisheries and also form the main fishing force on Gau, in terms of both time spent fishing and resources harvested (Rawlinson et al. 1993; Vunisea 2005). On Gau, recent community work-

shops on conservation issues and development of management plans concerning the *qoliqoli* and coast in general (e.g. protected marine areas, gear restrictions, mangrove rehabilitation, waste management) offered access to the communities.

Face-to-face life history interviews, focus groups, and participant and non-participant observations were employed to investigate people’s perceptions of change in their complex social environment. Research was conducted over a period of 14 months, with 10 weeks spent in the communities. For the life history interviews, one older woman and one older man (> 60 years) were interviewed in each village. The interviewees had lived in their communities for most of their lives. Towards the end of the interviews, the older people were asked how they saw the future of their respective village and its people, what their fears or hopes were, what perspectives the future would hold. Because of the personal and time-consuming character of this interview type (1–2 hours), only one female and one male was selected per village. Information derived from five female focus group meetings complemented the in-





**Figure 2.**  
Naovuka seafront, Vanuaso District,  
Gau Island. [Photo: A. Lanting]



**Figure 3.**  
View from the east coast of Gau Island of  
*qoliqoli* with fringing reef in the background  
and Lamiti in the foreground.  
[Photo: A. Lanting]

formation gained through the individual interviews. In each community, a focus group meeting was conducted with four women, using guiding questions on subjects concerning family life and perspectives on the future of the villages. In addition, participant and non-participant observation was conducted during each visit to the communities. This involved participating in and observing the daily activities in the communities studied, and immersion in the research subjects' lives. All direct statements quoted here were taken directly from the 24 people interviewed (hence the use of the vernacular), and thus were specific to their villages and their *tikina* (district).

### The context of leadership in Oceania

Variety is a predominant characteristic of Oceania, since there exists considerable ecological, cultural, social and political variation both among and within the countries of the region. Nevertheless, the region shares a broadly similar history (Dahl 1980; Feinberg and Watson-Gegeo 1996; Kolig and Mückler 2002; Novaczek et al. 2005).

In pre-colonial Oceania, the various forms of chieftainship and community leadership were based on matrilineal or patrilineal systems, were either inher-

ited and/or merit-based, and some were ritual and spiritual (Gustafsson 1992; Feinberg and Watson-Gegeo 1996; Hooper 1996; Shuster et al. 1998; Leckie 2002; Tarisesei and Novaczek 2005). During the 19<sup>th</sup> century, various colonial authorities came, often in power for more than a century, and established new types of leaders and power centres that competed with the islanders' traditional systems (Feinberg and Watson-Gegeo 1996). Traditional political leadership of the countries of Oceania was thus challenged and undermined by powerful new structures, with Christian missions further severely challenging the notions of spiritual power that had often signified precedence in the old systems (Gustafsson 1992; Feinberg and Watson-Gegeo 1996).

The complex co-existence of new governments and traditional structures during the colonial period did not vanish with independence in the 1970-1980s; new ways paralleled old traditional ways, although the latter had often been rendered invisible for decades. As a consequence, the countries of Oceania entered into independence in a variety of ways and conditions. Problems persist where countries try to combine both old colonial and old traditional systems into something modern (Churney 1998). Political disorder was a hallmark of independence in

many South Pacific countries because of the co-existence of two separate systems, one based on traditional (genealogically) acquired authority, and the other on democratic election and the institutions of a modern nation state (Besnier 1996). After independence from centralised colonial governments, and under increased decentralisation efforts of many island nations within this political disorder, reliance on communal and village levels of governance gained a new focus.

In most South Pacific countries, traditional leadership had remained important throughout the colonial period. Thus it survived and still continues to shape people's identity (Shuster et al. 1998). However, traditional leadership has now acquired a new importance, not least because of natural resource issues. In many nations, changing definitions, functions and expectations of leaders followed political independence, in the wake of accelerating social and economic change (Feinberg and Watson-Gegeo 1996; Churney 1998). As they experiment with leadership arrangements at varying levels of socio-political inclusion and authority, Pacific Islanders are reworking leadership offices (e.g. splitting titles in Samoa; Shore 1996), synthesising traditional and Western models, and drawing on indigenous values and symbols to validate the result (Watson-Gegeo and Feinberg 1996).

"Leadership" therefore remains a fuzzy category that requires specification and description in given cases. However, it is not only in the theoretical literature that leadership lacks clear definition (Watson-Gegeo and Feinberg 1996), because in many contemporary Pacific societies, islanders themselves are debating the meaning of leadership in response to a variety of political and socioeconomic factors (Besnier 1996; Hooper 1996; Lutkehaus 1996). Through most of the Pacific, authority was formerly based on spiritually derived potency combined with a commitment to promote the common good. The introduction of money, commodity production and market exchange, however, have worked to undermine communal spirit by promoting individual competition and accumulation (Shuster et al. 1998).

Under such conditions, traditional leaders are often tempted to use their privileged access to economic resources to benefit themselves and their immediate families, thereby establishing themselves as an exploiting class, alienating themselves from their followers, and damaging their own legitimacy (Howard 1996; Lutkehaus 1996). In other cases, chiefs maintain commitment to the older, more communal economic values, and find themselves attacked by those preferring the more individualistic, competitive, and, in a sense, egalitarian system provided by the new political and economic order

(Feinberg and Watson-Gegeo 1996). At the same time, they usually lack the skills and worldly experience to be effective leaders in a modern context, and may thus become increasingly defensive and self-centred, further isolating themselves, compromising their authority, and creating a vacuum to be filled by new leaders of a variety of types (Feinberg and Watson-Gegeo 1996).

### The Fijian context

As in other Pacific Island nations, marine fisheries are one of Fiji's major industries, with estimated annual landings of about 35,000 mt, valued in excess of USD 108 million (1995). Further, an estimated 50% of all rural households are involved in some form of subsistence fishing, landing between 15,000 and 20,000 t yr<sup>-1</sup> (<http://www.spc.int/coastfish/Sections/Community/fiji.htm> 18 August 2007).

Not unusual for the region (Crocombe 1994; Hunt 1997; Johannes 2002; Novaczek et al. 2005), Fiji has a customary marine tenure (CMT) system based on local autonomy and self-reliance, its potential function being to control invasion of local marine space, use by groups within the community, and use of specific resources and fishing gears (South and Veitayaki 1998). CMT divides the inshore fishing areas into 410 registered customary fishing rights areas (*qoliqoli*), which provide most of the catch for subsistence fishers. *Qoliqoli* are an integral part of a tribal land-sea "estate" (*vanua*) or *tikina* that extends from the watershed seawards, generally to the outer margin of the seaward slope of the fringing reef. The chief of a *vanua* (Paramount Chief of an area), together with his/her clan (*mataqali*), is traditionally regarded as the owner or, in the case of the chief, as supreme guardian of its land, waters, resources and resident indigenous people. This kind of kin group tenure system also occurs elsewhere in the Pacific (Sudo 1984; South et al. 1994; King and Fa'asili 1998; Johannes 2002; Kolig and Mückler 2002; Foale and Manele 2003; Caillaud et al. 2004; Novaczek et al. 2005).

In the heavily exploited *qoliqoli*, CBMRM is becoming increasingly important as pressure from local users increases and is no longer considered sustainable. In addition to the rapid exogenous change, the *qoliqoli* may thus not be capable of fulfilling the role in marine resource management that many anticipate (Anderson and Mees 1999). This is magnified as the marine environment becomes increasingly vulnerable, through previous exploitation and such environmental stresses as coral bleaching events or soil erosion. Subsistence lifestyles are still prevalent and are respected, but not sufficiently supported at government level, although departments seem to rely heavily on the general autonomy of the communities (UNESCAP

2003), being already overwhelmed with their responsibilities in urban areas.

Prior to colonisation, Fijian society, like many other Pacific societies, was strongly hierarchical (Kelly and Kaplan 2001). Indigenous Fijians lived in villages in well-defined social units that were the basis of all social groupings and activities (Veitayaki 2002). As in other island groups in Oceania, community leadership was intimately bound to the idea of *mana* (mystical or spiritual potency), kinship obligations, and responsibility for preserving community welfare (Hooper 1996). *Kerekere*, a system of gaining things by begging for them from a member of one's own group, ensured that surpluses were shared, thereby preventing the accumulation of wealth (Nayacakalou 1978; Capell 1991). This social kinship system, also known from other parts of the western Pacific, was the safety net that enabled people to meet their needs (Davis 1984; Novaczek et al. 2005).

Since independence, in 1979, chiefly succession disputes and pre-colonial rivalries were revived and had an impact on national political as well as communal issues (Kelly and Kaplan 2001; Leckie 2002). Thus, the political role of chiefs in a modern democracy remains a key political issue in post-colonial Fiji (Toren 1990). Debates include the desirability and viability of the state remaining neutral from traditional politics, and the limitations of traditional and chiefly authority (Kelly and Kaplan 2001). Colonial rule strengthened chiefly power and also enabled many chiefs to have preferential access to education and employment opportunities (e.g. as legal holders of company titles), notably within the bureaucracy. Dr Bavadra (elected Prime Minister in 1987 for a month prior to the coup) repeatedly questioned the abuse of chiefly power and the entanglement of tradition with modernity that, in the extreme, had become embedded in corrupt practices (also called "communal capitalism"; Leckie 2002). Grievances were directed at development projects, scholarships and state expenditure being unfairly allocated to the traditional seats of power, showing both that traditional status still bears heavily on participation in the monetised economy, and that poverty is not constrained by ethnicity (Leckie 2002).

As in many British colonies, the state implemented a dual administrative structure, with regulations and institutions pertaining to indigenous Fijians and those for the general population (Leckie 2002). The Republic of Fiji has a parliamentary government system while retaining traditional chiefly rights. The *Bose Levu Vakaturaga* (Great Council of Chiefs; GCC), composed of the 14 paramount chiefs of all provinces (the highest ranking members of the traditional chief system), brought to life under the Deed of Cession in 1874, still has political power and

sets policy for general Fijian affairs on matters relating to the indigenous community (Ruddle 1995; Lal 2003). Many Fijians feel that the GCC should play a more active role in national politics (e.g. Madraiwiwi 2002; <http://newspad-pacific.info> 2005). Its role and authority are an important political as well as constitutional fact, and, perhaps more importantly, seen to be beyond dispute or debate — at least until the most recent coup, after which the interim Prime Minister Bainimarama dismissed the GCC of its function for an unknown period (Lal 2003; [www.pireport.org](http://www.pireport.org) 2007).

Thus, in contemporary Fiji as a whole, traditional authority and the economic power of chiefs appears to remain intact, and in many traditional villages the installed chief of a *vanua* is still regarded as the guardian of its land, resources and people. Yet, although the respect paid to a chief depends on many factors, such as strength of his/her character, knowledge and authority, this traditional respect seems to be declining, its relevance for daily decision-making, including CBMRM, questioned, and the chief's roles and positions are increasingly of a ritualistic nature (Ravuvu 1988; Cooke and Moce 1995; Ruddle 1995; Feinberg and Watson-Gege 1996; Vunisea 2002). Lal (2003) even goes further in stating that the era of dominance of paramount chiefs, with overarching influence across the whole spectrum of indigenous Fijian society, has ended.

For traditionally owned resources, as is the case in large parts of Oceania, the planning of CBMRM must therefore consider the social structures of the communities involved, including the issue of leadership. The specific situation and circumstances under which a community exists must be considered before CBMRM can be successfully implemented. This correlation between the existing leadership and authority setting and CBMRM efforts has not hitherto been examined in Fiji, yet it is essential to understand how those management systems work and the manner in which they are linked to the status of traditional authority and village leadership.

### CBMRM in progress

Having focused and scaled-down community-based research work to examine specific settings for CBMRM and community perceptions, how might general conclusions be drawn from a very specific small island study? And is it valid to extrapolate conclusions from these communities to other settings?

Perhaps the main valid generalisation is that CBMR managers and researchers should examine the ordinary, everyday life of people before beginning ambitious projects. This requires a focus on a specifically developed research methodology (e.g.

including various social groups), specific environmental conditions (e.g. fishing or deforestation activities), specific combinations and characteristics of people involved (e.g. community structures and hierarchies), and on specific perceptions.

Natural resource management varies throughout the South Pacific. Owing mainly to the existing CMT system, the Fijian government takes a “cooperative” co-management approach (Sen and Raakjaer Nielsen 1996), in which government and users cooperate as partners in decision-making. Fiji has never had a formal, uniform national co-management arrangement. Like other studies (Cooke and Moce 1995; Tawake and Aalbersberg 2002), my research verified that management strategies and the level of government involvement vary greatly, and depend solely on individual fisheries officers, chiefs and communities. This causes problems and conflict where people feel they are treated unequally or with disrespect. Such a situation is not confined to Fiji and the South Pacific; a greater focus on core individuals, their respective influence, knowledge and character may be most useful for coastal zone management research elsewhere, where governments try to decentralise natural resource management (UNESCAP 2000; Courtney et al. 2002).

Therefore, decentralised responsibility in Fiji cannot be classified as co-management; rather, it is a parallel arrangement between government and rural communities, the latter having principal responsibility for their resources. Owing mainly to a lack of funds and personnel, the government relies on the local governance and self-regulation skills of coastal fishing communities. Were this approach not taken, the government’s problems would be much greater. However, given their present structure, skills and resources, the communities alone could not establish the management needed to mitigate the increasing pressure on their resources. Knowledge of different management options is scarce, and resource owners, like government officials, often lack the ability to quantify impacts on the fishery (Cooke et al. 2000). Hence, they require external assistance in the form of biological, environmental and conservation education together with help in planning, monitoring, evaluation and enforcement.

Some Fijian communities have already established close bonds with local NGOs and official institutions (e.g. University of the South Pacific–USP and Secretariat of the Pacific Community–SPC). Ways have been found to facilitate management activities, such as through communication with Suva officials and academics (e.g. the Mositi Vanuaso project; Veitayaki et al. 2007), follow-up of NGO workshops, or hearsay from other communities or relatives. A privileged connection to official institutions is often positively related to a higher degree of manage-

ment and awareness (Cooke et al. 2000), not only in Fiji (Beger et al. 2005). However, activities always depend on the ambitions of the communities and individuals involved.

In many places, marine protected areas (MPAs) have afforded the first chance for local communities and outside agencies to work together (Polunin et al. 1983; Riedmiller and Carter 2001; Kunzmann 2002). MPAs can play an important role in the decentralisation movement and establishment of local management authorities. Seasonal or temporary *tabu* areas (traditional area closures), an ancient concept in Fiji, are used often for ceremonial reasons (e.g. the place where the chief took a bath was not to be fished) (Veitayaki 1998). However, since 2000 these areas have been increasingly used as a management tool through the Fiji Locally Managed Marine Area (FLMMA) network (Caillaud et al. 2004). The FLMMA network was established by people involved in community-based fisheries management, including government departments, other conservation agencies, and individuals from the private sector. FLMMA has formed new partnerships with communities throughout the developing world, and used pilot management areas and those involved in the projects to facilitate continuing community management work (IAS 2002; Tawake and Aalbersberg 2002; Vunisea 2002). Promoting the idea that healthy living standards and additional income can be obtained from properly managed marine environments and fisheries resources, the network has become the main factor changing the face and driving the process of CBMRM in Fiji. However, although a more sustainable approach to exploitation has been pursued over the last decade, the varying degrees of success in Fiji are a reminder of people’s general inability to organise themselves (Veitayaki 1998; Zann and Vuki 1998).

Attempts are still being made everywhere to modernise methods of exploitation and management, especially for coastal and marine fisheries. However, in heavily exploited fisheries, where little knowledge exists of the sustainability of the resources, the wisdom of making fishing techniques efficient must be questioned (Jennings and Polunin 1996; Bavinck 1997). Because a resource could easily be exploited beyond sustainable levels, potentially beyond recovery, the precautionary approach to fisheries should be implemented at the village level.

These challenges can be met only through a good bond between communities and official agents, based on continuity, community consensus and trust. For example, every community or district could have at least one experienced fisheries manager working closely with respected community members. Ideally, this would permit acceptance of conservation measures and general compliance,

communication and networking, and data collection and analysis. Under a system of extension workers similar to that established for teachers and nurses, these “marine advisors” could monitor projects, make marine conservation and education matters of everyday life for the communities, and thus support long-term thinking. Such a system already exists in other places, for example in the form of park rangers (e.g. in Tanzania and Tonga; Malm 2001; Riedmiller and Carter 2001), and would greatly strengthen Fiji’s capacity for monitoring and managing its marine biodiversity in coastal waters through the traditional users’ rights. Without such a system, underpinned by the skills of academics, NGOs, and regional agencies, CBMRM in Fiji may remain unorganised and too dependent on local authorities to achieve reliable and sustainable marine resource use and conservation. Each community practicing CBMRM should be in the position to take responsibility for the enforcement of management measures and locally developed regulations and rules (Crawford et al. 2004). But for this, people first must understand and be involved in developing these measures, which in turn depends on a good community sense and leadership. Marine resource management, at least in its initial phases, requires sacrifices, not only by the fishers but also by the entire community (Veitayaki 1998).

### What role do traditions and traditional authority play in CBMRM?

#### One voice

All 10 interviewees in the life history surveys agreed that important decisions in the village were easier if the chief was respected and just “one person talks”. In three of the villages, people said that “before” the situation in the villages was better and that nowadays there were “plenty people who can’t listen to what the chief says”. Before, “either the *turaga ni koro* [village headman] or the *turaga ni vanua* [chief of the village or area] decided and told people what to do; it was good, easy to follow better; now it is very hard, now there are so many people, that’s different today”. This meant there were not only more people in terms of quantity but also that more people were giving their opinion and going their own way without much effort to integrate these into the community. “*E na koro sega e na lala* [there will be nothing in the village, nothing will be done], before they listen to one command, with respect for the chief, now not anymore”.

Interviewees also said that generally, the atmosphere in the village had changed and even worsened. “The people were good, now they are bad; before they respected the chief, the village, but now ...” Some village customs such as respectful behaviour were not adhered to anymore: “before we can’t shout from

there to here [pointing down the hill to other houses], and now we can call, anywhere you stand you can call”; similarly with sharing (*kerekere*): “today, if you want something, we can ask for it, but have to give some money; you have to pay, you can’t give it just like that to relatives, we have to pay all the things today”. “*Sa sega na loloma*” [there is no love/pity/kind-heartedness], “*sa sega na vakarokoroko*” [there is no respect and politeness]. “The way of life changes; the situation in the village is different now, there are plenty problems, it’s like Fiji now — independent; and there are plenty of different things coming in, church *solu* (fees/donation), education in the village, etc.” “There are major changes, compared to the olden times, especially the behaviour of the younger generation, they seem to clash with the traditional people and ways of life.” The “rules and guidelines that were used by the people” have also changed. Not always have they become less adhered to, but “now with all the changes that come nowadays, different decisions are made to suit the environment; before we could feel free to go around, but now we have to take a [fishing] license”.

Only one village (Naovuka), the smallest and youngest in the *tikina*, was content with their village and its decision-making, “decisions are made in the same way as before, one speaks, one talks, because [we are] only one family here, not like in the [other] villages where there are many families”. Consensus and compliance existed in this community and were facilitated by an educated and charismatic character, the last of a chiefly line of brothers. “He is a good leader because people like him”, one interviewee said. They have had some problems in the village they come from (Lamiti), after which they moved down the coast in the 1980s to re-settle on their family land. Their new chief said “it was very hard, now it’s good, now those elders died, it’s easier now for us; before it was different you know, different-minded people, and the children, the boys, the elders had different opinions”, and another one adds, “but he can bring them together now, because he always laughs, people like and respect him.”

#### Chiefly death

During the period of this study, a traditional chief of one of the villages died in Suva. Traditionally, the corpse would have been transferred back to his village to be buried there with major ceremony. On this occasion, however, there was not enough money for the transfer, and too much discussion between family members. So he was buried in Suva, where some of his family lived.

When asked what had changed about customs surrounding the death of a chief, presumably symbolising changes in traditional authority, all interviewees but one (who said everything stayed the same) said

there had been changes in that less and less respect was paid by the villagers. A chiefly death could now be more or less “just like that of some other person”. A few decades ago, when a chief died, the children of the village were kept in one house until the funeral was over. No children were supposed to be seen around the village and outside the house; no playing or noise should disrupt the respect towards the deceased. Men and women were “standing back cooking for the children, that’s the time they respected the chief”. “Before as kids, we just hide inside the house, but now kids just come right to the coffin, onto the grave, now they can run up to right beside the coffin and look in.” Again it was mentioned “before, when he [the chief] said something, people took part in the decision, but now, when the chief says something, people go on doing their own work, they don’t care what he says”. It was also said that the policy within the community was “very strict” before, but “now we have to open up, to go along with time and changes; time has changed, and you must change according to time, if not, you become stagnant.”

For example, a “temporary *tabu* area [*tabu ni wai*] was often established when a chief died, and opened again later with the *tara* [relaxing of *tabu*]” and fished for the accompanying ceremonial feast. However, in *Tikina* Vanuaso, no new *tabu* area was established in addition to the already existing permanent ones, but people “go and catch the [present] *tabu* area; after that, the area is *tabu* again”.

Hopes for the future of the villages and their people mostly concerned the importance of a respected leader. Some were summarised and can be elucidated by the following direct quotes:

“It’s up to the elders, it’s up to the church elders, or the family elders, to tell the children how to keep the village and the life for tomorrow; it’s up to the family, [they] got to teach their children, [they have to] see the future of Lamiti, and make a good Lamiti next time.”

“[There is] no chief here now, the one that died in February was not a real chief, [he] was not installed to be a chief, the Fijian way. We have to make a chief, and [then] he can speak, one talks and the others listen; at the moment there is none [no chief] but if we have one next year, we will see the change.”

“They will become good, the people in the village, and there will be more people in the village in the future.”

“It will be better next time [in the future], more people to come to the village, good for

the *tikina* and the school, many school kids would be good.”

“I am praying for a good chief, [a] good village, one talks, [people] respect each other, that’s what I hope.”

Stagnating development on Gau and Nairai, and the often-passive attitude of villagers towards this trend, may be a link to the worsening traditional village functioning and loss of traditional chiefly authority. Both reflect a general feeling among villagers of loss of power, observed also elsewhere in Fiji (Tomlinson 2004). The last paragraphs suggest that for CBMRM in these villages, the feeling of powerlessness is reflected mostly in aspects such as decision-making, distribution of management responsibilities, evaluation of management plans and measures, enforcement of regulations against outside fishers, but also in terms of income generating possibilities. In addition, both stagnation in development and decreasing community function may mutually enhance their effects towards this feeling of loss. The fact that some communities feel increasingly powerless is likely to have an impact on any CBMRM regime, as consensus in issues concerning the entire community and traditional respect accorded to the chiefs are declining everywhere in Fiji (Ravuvu 1988; Cooke and Moce 1995; Ruddle 1995; Vunisea 2002; Tomlinson 2004; Toren 2004).

Findings also show that this lack of respect is dividing the villages, in addition to increasingly different economical status and religious beliefs among families (Tomlinson 2004). Those who cope with a “modern” individualistic self-determined life independent of *kerekere* have tended to separate from those that still respect the traditional social structure and deem this as a precondition for community function and leadership. The notion of having “too many people who talk”, meaning the lack of and inability to find a consensus on village level was emphasised in the villages of this study. In another study on another Fijian island (Kadavu), people also lamented that “commoners who earn money think they are chiefly too, and begin to act — inappropriately — like chiefs” (Tomlinson 2004).

The chiefly person’s death, traditionally embedded in highly respectful ceremonies and traditional activities (Toren 2004), provided a good example of what changes have taken place in terms of respect and traditional authority. The ceremonial activities and behaviours around this event have loosened. In addition, the period after the burial and prior to the ceremonial instalment of a new chief, seemed to be critical to a village’s function and stability. Some of the villages went for more than a year without a traditionally installed leader, although there were still members of the same chiefly family living in

the village. In the *tikina* Tomlinson studied the chiefs had not been formally installed within living memory (Tomlinson 2004), exacerbating the sense of lost power. Without a formal installation, chiefs were considered ineffective, and in *Tikina* Vanuaso people actually felt during this period as if the community was without a leader altogether, supporting not only the feeling of lost power but also lost identity. Tomlinson's observation (2004) "that people and society in the past were unified, proper, and powerful; the present is fragmented, improper, and relatively powerless by contrast" is corroborated by the present study. With communities being fragmented, unstable or unaware of their power, future CBMRM plans for *Tikina* Vanuaso may become difficult to develop and implement in a useful and sustainable way.

How can an indigenous community recover its social strength and function that have been lost over decades but now are needed for implementation of CBMRM, and assume responsibility for conserving the local environment? As discussed above, the reasons for decline in traditional authority, respect and hence traditional community function have been the subject of wide speculation. They could also be several and complex. One reason is increased adoption of westernised standards from the urban centres (and abroad). Almost every family in the communities investigated had relatives living in urban areas; in the towns, chiefs were increasingly sharing the same problems and rights as any person of non-chiefly origin, and this tendency was reflected through relatives back to the island.

In parallel are more complex changes in the characters of the people and their behaviour. To cope with the effects of change and re-establish a firm basis for community function, crucial for CBMRM, each community will need to independently make its own decisions. Whether or not CBMRM on Gau and Nairai succeeds in the future will depend on the education and character of individual persons, as well as on finding an educated and respected leadership, while preventing long gaps between periods of leadership. This process of re-establishing strong community leadership and stability will be highly complex and variable among communities and *tikina* and thus difficult to predict. The research reported on here, shows that a path cannot be found simply by looking back. To make CBMRM work, every individual community must find a way to establish a stable community structure. If this is not possible in the future by following the traditional way of installing a chief owing to long inter-installment periods, for example, a new type of leadership, including non-traditional leaders, might be needed.

However, whereas that has occurred elsewhere in the Pacific Islands, for example Palau (Shuster et al.

1998), it is uncommon and might not work on Gau or in other parts of Fiji. And again, a strong and continuous connection to the government officials as well as other agents, supported by improved transport and communication technologies, might help the rural communities on Gau to find their responsibilities and strengths in terms of CBMRM in modern Fiji, and to rebuild community structure. Although traditional roles and resource use systems within the communities of this study were still more or less defined, leadership structures, protocol, respect and beliefs were undergoing change and cannot be neglected on the background that a supported community leadership is necessary for sustainable management of natural resources in these regions (Fong 1994; World Bank 2000).

Findings during this study therefore indicated that greater compliance of villagers — needed to strengthen and stabilise local management regimes — can be achieved only through strong and respected leadership, increased environmental education at all social levels, and greater support of basic family needs. All of these again require better correspondence of the remote islands with authorities on the main island Viti Levu. A neglect of management and conservation necessities and possibilities was, in the communities in this study, not so much caused by misunderstanding over resource user rights and rules, but rather by a general loss of "community" perception and identity, coupled with lack of knowledge of the surrounding environment. The resources were declining; therefore community members bought larger nets, spearguns and smashed coral heads to get even smaller fish hiding in them. An accepted, and not necessarily traditional, leadership could support the revitalization of identity and responsibility for the environment, resources and their management, which is crucial for the compliance with measures and thus stabilization of management.

Smooth chiefly succession and general "community peace", suggested to have positive influence on good management level (Vunisea 2002), no longer exist in many places on these islands. The village-based authority of the islands can be revitalised only by reversing the general feeling of loss of community perception and identity. Better control over fishing activities by outsiders and their interference with the community has occurred on Gau and Nairai through the decision of the communities (facilitated by management workshops) to not grant new fishing licenses to outsiders, as well as through the appointment of fishwardens since 2002. One main objective of Fiji regarding CBMRM should be to enforce financially and legally those measures with the "marine advisor" scheme. But only in a few cases will the communities and districts be able to address this issue by themselves.

Independence is the “hope and hurdle” of outer islands such as Gau and Nairai, unwanted but accepted at the same time, where true long-term independence in terms of sustainable resource use will work only with government reforms that result in improved communication, information and transport services to enable the people to make their own wise choices. Believing that the situation on the islands (including social and environmental changes and hazards) could be ignored for many more years, while financial and natural resources can be used for “pressing” urban issues, may eventually backfire. The role of the rural communities will become more important since they will be crucial for enabling the government to achieve a balance between developing the country and safe-guarding it.

### Concluding remarks

Marine inshore resources are today endangered even on remote islands in the South Pacific, where subsistence lifestyles persist. When centralised government services cannot reach the remote islands spread over vast distances, Pacific Island states such as Fiji require a CBMRM system. Although CBMRM is springing up on many Pacific Islands, it faces many challenges as the environment changes quickly, and inside (e.g. resource ownership) and outside (e.g. foreign fishers) pressures increase. In this study I have documented changes over space and time as perceived by Fijian villagers in their natural and social environment, including traditional authority and village leadership, which requires adaptations by the community members. However, such changes are not considered in many community management plans, for which it was still assumed that a traditional communal hierarchy and order exists.

To face the challenge of adapting to these and future changes while still supporting the livelihoods of island communities, villagers’ need for strong and knowledgeable leadership must be acknowledged. Such leadership is critical to successful marine resource management and of direct consequence to community welfare and function, the distribution of responsibilities, transfer of knowledge and acceptance of management measures, and thus needs to be prevented from further erosion.

The rural communities reported on here are in danger of becoming simultaneously decreasingly traditional and increasingly undeveloped in relation to the urban areas of Fiji. Although villagers hope for an improved quality of life, better access to information, improved infrastructure and reinforced community leadership, attempts have been slow and often not successful. This study therefore gives an example on how villages can be caught between needing development and wanting adaptation and

improvement (e.g. for their children and grandchildren), and their former traditions, which they lose but still mourn. People were becoming less dependent on the traditional cultures, a situation which a few decades ago they could never imagine. Similarly, many people who had made their way to towns or abroad could not imagine coming back to the villages. Another very old and very complex traditional system is losing its efficiency and complexity over time. What remains are societies that are no longer traditional but still “developing”, versus the “old” traditional but undeveloped ones. The wide perception that the traditional system is becoming eroded is thus a reality, but have these rural communities already moved too far from their traditional lifestyles to be able to turn back (re-establish pre-colonial status) or to adapt these lifestyles to the changing circumstances of life in modern Oceania, a region that is barely comparable to its pre-colonial status and identity? The people interviewed in this study felt that turning back was not the best option for community welfare, nor for the management and conservation of their resources, as the communities did not want to stand back while the world developed around them. How then could CBMRM work successfully in these communities? One way to lighten the dilemma of being caught between past and future without direction for the present would be by an enforcement of the village leadership, for example through faster re-installments of new chiefs, under the responsibility of each individual community.

These trends and findings are based on CBMRM research in Fiji; however, considering the importance of village leadership and local marine resources in the region, some generalisations may be made for the wider Pacific Island region. It remains uncertain, whether the present traditional chiefly systems can survive the changes in the region and regain the ability to fulfil their duty of leading and sustaining the communities, or whether they will be replaced by new types of leadership, for example by including non-traditional leaders into the nomination process. Obviously, the latter would be an even greater departure from tradition in some ways; and even with a locally elected leader having the blessings of the community elders, this way would not be accepted in all communities. Nevertheless, if the traditional chiefly system can no longer convey the necessary kind of leadership, for example owing to a lack of competent people of chiefly descent — electing an educated and charismatic leader of non-chiefly descent would mean a boost for some communities in terms of identification, welfare and development. Respect and support for community leadership, and with it social capital and collective action, may be rebuilt, essential for future community existence and the environment, islander’s “bank and insurance”. The necessity of consider-



ing these community aspects towards improved local resource management and conservation with a view to wise decisions must be supported more widely and merged into funding opportunities and policy-making processes. In this way, a more holistic approach to the management in this area could make management measures more meaningful, sustainable and hence successful in the future.

Nevertheless, CBMRM efforts in Oceania will have to remain case-specific regardless that generalisations are required, such as, for example, the regional and national management plans. The changes in the villagers' everyday lives influencing management regimes are not the same in all villages, and one cannot generalise community concerns because of the actions highly depend on the individuals involved. Although traditional respect and social ties are loosening, they do so with varying speed and manner. Hence, the aspects of community leadership mentioned in this article cannot be considered independently; they form a complex network that differs among communities and islands. For deeper insights, understanding and generalisation of statements, larger-scale follow-up research is needed to unequivocally address the issues raised by this study. Further, deeply focused studies are needed on the specific aspects of social environment of the communities themselves and the development history of each island. Such long-term research and assistance would best be based in the communities themselves, to detect the specific community concerns and integrate them in the management planning process.

Finally, paralleling any CBMRM efforts, and before any clarification of leadership status can take place, other pressing issues of development in the region should first be attended. Principal among such issues is communication between remote and main islands and capitals. Rural communities generally need and want a closer relationship with their urban and official counterparts, and decentralisation must be used for good (co-)management and not just to release pressure and responsibility from overwhelmed government departments, or to look back and ignore the enormous changes these countries have undergone in the past century.

The key challenges for CBMRM in rural archipelagic Fiji (and likely beyond) can be summarised in a somewhat idealised way as being to:

- maintain or re-establish strong community leadership;
- increase knowledge on everyday life of people, including information on the social and natural history dimensions of the island;
- increase focus on core individuals, their respective influence, knowledge and character to increase effectiveness of management responsibility delegation;
- identify ways for greater input from outside agencies in the form of biological, environmental and conservation education as well as help in planning, monitoring, evaluation and enforcement (such as marine advisers); and
- thus find ways to (re-)establish and maintain a strong bond among and between communities and official agents, based on continuity, community consensus and trust.

Many small and remote islands in developing states such as Fiji are still far from achieving their full growth potential in terms of sustainability of resource use and livelihood, not least because of political instability. Nonetheless, by supporting a more balanced situation between rural and urban areas, with continuous local leadership appropriate for all aspects of community reality, the communities could connect to the government, other facilitating agents and their information resources. A possibly triangular (co-) management scheme might thus become possible in the region as one choice for successful resource stewardship and CBMRM. Otherwise, the traditional independent island life is likely to become further eroded and the small islands and villages even further detached from the general way in which their countries try to represent or identify themselves.

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