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I-KIRIBATI KNOWLEDGE AND MANAGEMENT OF TARAWA'S LAGOON RESOURCES

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ABSTRACT

Knowledge of the fishermen of Tarawa Atoll, Kiribati concerning some key food fish in their waters is described and shown to be highly relevant to the management of these fish. The bonefish, *Albula glossodonta*, has been the most important shallow-water finfish in Tarawa catches. However, all but one of its known spawning runs has been eliminated according to fishermen and this last remaining run is showing signs of severe depletion. Traditional marine resources management measures, some conservation-driven and others with different objectives, were diverse. But they have largely disappeared due, in part at least, to the impacts of British colonial rule. Reestablishing some form of local marine tenure seems essential to sound marine resource management, although the difficulties that would be encountered in doing so are not trivial.

INTRODUCTION

This report describes the results of an investigation of local knowledge concerning Tarawa's marine resources, as well as local customs relating to their exploitation and management. The study was part of a United States Agency for International Development (USAID)-funded project designed to assist in formulating a contemporary marine resource management plan for Tarawa Atoll. The study involved interviews with fishermen and other knowledgeable I-Kiribati throughout the atoll over a total period of three weeks between February, 1992 and October, 1993.

Informants deliberately were not randomly selected and we sought out individuals with high reputations in their villages for fishing expertise. For the most part these were people between 42 and 79 years of age. Some of them no longer fished because of physical infirmity, but all maintained an active interest in fishing and in the changes in fishing conditions occurring over the years. The attitudes and knowledge revealed by these interviews should not be assumed to be representative of Tarawa's fishing communities as a whole, but of their most experienced fishermen.

Our questions concerned the distribution, abundance and behavior of living marine resources observed by fishermen, perceived changes in these during their lives,

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presumed causes, and possible remedies in cases where the changes were seen as deleterious. We also asked about past and present village-based controls on fishing activities.

Interviews were deliberately unstructured. When unanticipated but promising subjects came up we pursued them with further questions, thus following any potentially instructive pathways along which the interviewees' knowledge seemed to be leading us. To minimize the constraints put on informants by the limitations of our own knowledge and preconceptions, we did not use questionnaires or a survey-style format. The latter are useful when pursuing well-defined and circumscribed questions; they are inappropriate, however, in exploratory interviews concerning specialists' knowledge where the interviewer is uncertain concerning what types of useful information may be forthcoming (Johannes, 1993).

Yeeting, an I-Kiribati fisheries researcher, acted as interpreter between Johannes and most informants. A few informants were at ease communicating in English. Interviews most often occurred at informants' homes. Occasionally groups of fishermen were interviewed in their maneaba (village meeting house). Interviews lasted from 20 minutes to about 2 hours, with several informants being interviewed twice. Each night the results of the day's interviews were transcribed using a laptop computer.

A number of students of Gilbertese culture have claimed that intense secrecy surrounds special knowledge, including important fishing knowledge (e.g. Sabatier, 1977). Our experience, however, suggests that such secrecy is either much reduced from what it once was, or never was as pronounced as is sometimes claimed. Our experience is more like Koch's. Koch (1986, p. xvii) stated, "the techniques of even simple processes related to the daily provision of food are regarded as "secret", although, on account of the limitations of the environment, the resources and the methods of using them have long since become widely known." Secrecy today seems to be associated mainly with ritual aspects of preparations for fishing, such as what to chant as one prepares the bait, and the locations of certain fishing spots. It did not appear to interfere seriously with the provision by informants of the kinds of information most relevant to our study.

Before describing the results of our interviews, we summarize here the scattered literature on traditional knowledge and management of reef and lagoon resources on Tarawa.

VILLAGE-BASED FISHING REGULATIONS

Historically marine resources were the only significant source of animal protein for the I-Kiribati. Consequently the islanders developed a host of fishing methods (e.g. Banner and Randall, 1953; Catala, 1957; Lawrence, 1977; Luomala, 1980; and Koch, 1986) and possessed detailed knowledge of their marine environments.

They also may have possessed a traditional marine conservation ethic (eg. Sabatier, 1977; Teiwaki, 1988; and Zann, 1990) - that is, an awareness of their ability to overharvest these resources plus a commitment to minimize the problem[3]. Lawrence (1977) noted "continued and largely successful efforts to regulate fisheries on the island (Tamana). These are not new or recent efforts but stem, according to our informants, from pre-missionary times." Teiwaki (1988, p. 41) states, "each island had its own rules about fishing; when to fish, how to fish and where to fish, and what should be done before, during and after each fishing expedition."

Sabatier (1977) notes that I-Kiribati had a large number of sea-food taboos relating to age, sex, totem or for the whole community (see also Grimble1933, 1989; Teiwaki, 1988; and Zann, 1990). Various other fishing regulations, also often in the form of taboos, were promulgated and strictly enforced. Punishment for not observing them included threatened supernatural sanctions, fines, removal of fishing rights and even death (e.g. Bobai, 1987). Public censure was also an effective deterrent. Such controls were already in decline in Grimble's time, however, and have since declined further (e.g. Turbott, 1949). Observance of a few totem-related seafood taboos were still professed, however, by certain individuals we interviewed on Tarawa in 1991-93.

It seems very likely that not all traditional controls were devised with conservation in mind. Regardless of their original purpose[4], however, a traditional control would have functioned as conservation measure where the tabooed species was, or was in danger of becoming, overexploited and if the taboo did not result in additional harvesting pressure being directed toward other more heavily exploited species.

Sea turtles, for example, were taboo to pregnant women and never eaten during times of war or crisis because of their "cowardly ways" and the possible assumption of such traits by those who ate them, or by their unborn children in the case of pregnant women (Grimble, 1933). This regulation apparently was not based on conservation needs but nevertheless exercised a sparing effect on species that are well-known for their susceptibility to depletion. However, we cannot be certain that such regulations did not arise because of an awareness among leaders of the need for conservation. In many, if not most cultures and religions, the probable reasons behind various prohibitions are often unstated, while spurious but more persuasive reasons are articulated. The threat of supernatural retribution, for example, has proven a more effective deterrent in many

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[3]Koch (1986, p. 9) states, however, "there appears to be hardly any attempt at a controlled regeneration of resources. In places the sipunculoidea are being wiped out without a second thought, young clams and other animals are gathered before they have reached the correct stage of growth, and hiding places are destroyed without regard for subsequent catches." There is nothing inconsistent with the two contrasting assertions. Examples of disregard for environmental limits coexisting with environmental wisdom can probably be found in many cultures. Indeed, many Western cultures today provide striking examples of both extremes simultaneously. The point we wish to make here is that a local conservation ethic can provide a valuable reference point when promoting conservation. If it is not present, as is the case in some fishing cultures (e.g. Johannes and MacFarlane, 1991) a major education campaign is necessary to provide it.

[4]Older men we interviewed said they suspected that resource allocation was a more important factor than conservation in the evolution of these controls.

cultures than the real consequences of undesirable activities.

As conditions changed after Western contact, I-Kiribati responded with new management regulations. For example, nylon gillnets, which were introduced to Kiribati in the late 1950s, were subsequently banned on a number of islands because they were considered to be "too efficient" (Tikai, 1980). Similarly, imported lures or local lures fitted with steel hooks were banned on several islands because they were also considered too efficient as well as damaging to the mouths of fish that escaped (Lawrence, 1977; and Tikai, 1980).

Other institutions also reduced pressure on some marine resources. For example, a variety of shallow-water invertebrates and algae were not eaten by choice, but reserved for consumption during times of hardship when fish were unavailable in sufficient quantities and as a form of "social security" for old people and other disadvantaged who could not fish (Zann, 1990).

For centuries, I-Kiribati have raised milkfish in specially constructed ponds (Catala, 1957). Green turtles were also raised with hand feeding in an enclosure on North Tarawa in the early 1980s according to Zann (1990). Zann (1990) points out that the designation of tunas as high-prestige fish has also helped redirect fishing pressure from limited shallow-water resources to functionally unlimited migratory pelagic stocks.

Some of the islands' customary fishing rules were embodied in the *Tuan Aonteaba* (Island Regulations) 1950, passed by the British colonial administration. These regulations were repealed in 1967, however, following the introduction of local government to the islands. Island councils were given the responsibility to control all kinds of fishing activities on their islands, but any council fishing bylaw had to be approved by the central government. Getting this approval proved to be an insurmountable obstacle until after independence in 1979.

Even then, according to Teiwaki (1988, p. 41), the central government was not "very receptive to the Island Councils' requests to pass certain fishing byelaws to protect the inshore fisheries and traditional fishing rights." The central government has become more receptive in the past few years, although the difficulty of reconciling the legal system and government policies adopted from colonial times with local regulations has slowed progress, just as it has in many other Pacific Islands (e.g. Zorn, 1991).

CUSTOMARY MARINE TENURE

Customary marine tenure (CMT) was the most important marine conservation mechanism in Kiribati and the foundation for most other fishing regulations. It gave tenure holders the right to exclude others from their fishing grounds. It underpinned villagers' marine resource management, providing them with the incentive to look after their marine resources by ensuring that they could retain for themselves the future benefits of doing so.

We focus here on the conservation value of CMT, but it should be stressed that, to islanders, CMT is much more than just a means of facilitating marine resource conservation. As Teiwaki (1992) pointed out, CMT "is the embodiment of the political, social, economic and psychological needs and responses of (Tarawa people) in relation to their marine environment." As elsewhere in the Pacific islands, it is not unlikely that CMT arose initially in Kiribati as a way of allocating marine territory rather than as a conscious marine conservation measure. Regardless of its origins, however, ownership of fishing grounds provides the essential foundation for conservation of marine resources.

On south Tarawa in precontact times, the island of Betio, now part of the Gilbert Islands' only urban center, was divided, according to Teiwaki (1988, p. 37) "into eight different *Kaingas*. A *Kainga* is a cluster of households with families living together for their own common interests. Each *Kainga* had its own plots of land and designated marine areas. A member of a *Kainga* might have fishing and other similar privileges in other *Kaingas* because of intermarriage, as a gift, or as a result of a *tinaba* . . . a special gift given to a woman who had provided sexual hospitality to a close male relative of her husband."

Teiwaki continues (p. 38), "...the size of a *Kainga* in precontact Betio was very small, consisting of not more than a dozen households with an average number of six people in a family. The population of the village was relatively small and there was no need to compete for the use of the sea amongst the village people, except in the case of aliens. *Nei Teba*, a rock formation about a mile eastward of Betio, was the designated maritime boundary between Betio and the next village, Bairiki. People from these villages could not extend their fishing or other sea-related activities beyond *Nei Teba.* It is understood that there was a passage named after a Bairiki person (Ten Taraia) who was killed by the Betio people because he was usually seen fishing beyond the boundary towards the Betio side."

Starting in colonial times, government action (and inaction) has contributed significantly to the decline of CMT and a consequent decline in the ability of villagers on Tarawa and elsewhere in Kiribati to manage their marine resources. In 1892 the Gilbert Islands became a British protectorate. At first the British colonial government, "allowed the customary sea tenure to prevail and ensured that the long-term fishing interests of the Kiribati people were protected from outside interests" (Teiwaki, 1988, p. 38). In 1946, Teiwaki relates, the first Fisheries Ordinance was initiated recognizing traditional fishing rights and making specific provision for the registration of these customary rights. The Native Lands Commission, which was responsible for registering land rights, also was empowered to deal with similar issues with respect to traditional marine tenure.

However, after the departure of a colonial official who spearheaded this initiative (the anthropologist, Harry Maude), little was done to follow through; no formal registration of marine tenure rights was ever undertaken. This was apparently because,

Teiwaki (1988, p. 38) states, the colonial administration favored the "principle of open access to fish anywhere and at any time irrespective of traditional norms. The local concept of marine rights was contrary to the British notion of public rights in the sea and its resources, the ownership of which were vested in the Crown or state." (It should be noted here that not only modern fisheries theory, but also the United Nations Convention on the Law of the Sea, constitute a sound global repudiation of this notion of the inherent "rightness" of open access, a principal that once held almost sacred status, not only in Britain but throughout the Western world).

Zann (1990) suggests another likely contributing factor to the decline of customary marine tenure. The British amalgamated small hamlets into larger villages on land chosen by the administration. The *utu* (extended families) who owned the fishing grounds adjacent to each hamlet were often relocated to areas distant from those fishing grounds. Goodenough (1963) attributed the decline to the increased use of canoes when imported timber became available and, therefore, greater emphasis on offshore fishing. This suggestion is unconvincing; many other Pacific Islanders, who were well-endowed with canoe trees and were expert in the art of offshore fishing (e.g. Hawaiians, Samoans), nevertheless maintained strict marine-tenure laws.

Traditional fishing rights were also seen to be obstacles to the implementation of government projects such as baitfishing by commercial tuna-fishing interests in once-tenured waters. According to Zann (1990, p. 89), on Tarawa, "former sea owners have prevented *Te Mautari* from collecting milkfish (*Chanos chanos*) fry for their baitfish aquaculture, but a confrontation between traditional interests and the national government was averted by the decision to pay villagers $5 per bucket of fry (Teiwaki, pers. comm.). Traditional owners of the lagoon floor at Ambo, on Tarawa, are complaining about an *Eucheuma* algae farm in their area, while those at nearby Bonriki are protesting the establishment of government milkfish ponds in their traditional waters."

Teiwaki (1988, p. 41) states, "the Island Councils were sensitive about the depletion of fishery resources in their vicinity because of the needs of their own people. There was no subscription to the government's argument that the fisheries resource was for the benefit of the public and not for the exclusive use of the people who were indigenous to a particular Council area." Teiwaki (1988, p. 25) also states that "certain Island Councils had managed to recommend to central government the institution of specific bylaws concerning the management of fishing activities within their own traditional fishing grounds. The ownership of fish traps had been previously registered in 1952 as part of the codification of land rights and ownership. Some islands, like Tabiteuea North and North Tarawa, have bylaws prohibiting fishing or sailing within a prescribed limit at a time of the fishing season (*te ikabuti*)[5]."

Other limited marine rights recorded by the government included ownership of fish traps, sea walls, accretions, reclaimed lands and fishponds. Unfortunately, as

[5]*te ikabuti,* described in detail later in this report, refers to the phenomenon of the lunar periodic migrations of bonefish (*Albula* sp.) to spawn, a time when they are especially vulnerable to exploitation.

Teiwaki relates, "the registration of these rights . . . was made in the name of an individual, usually the male head of the *Kainga* or *te utu.* Although the registered 'owner' had customary obligations toward other members of the *Kainga* or *te utu,* the law did not specify this social requirement, causing considerable ill-feeling amongst the relatives. The effect of this was that the registered owners could be oblivious of social obligations towards their own kin. . . . . The Lands Commission should have arranged the registration of the recognizable marine rights under the joint ownership or trusteeship of the leading members in the *Kainga* or *te utu* to ensure the continuous access of those members to those rights." (Teiwaki, 1988, p 40).

Until the construction of causeways destroyed bonefish spawning runs, and goatfish spawning runs dwindled (see below), private ownership of traps constructed to catch these species was reported to be generally respected on South Tarawa. We could find no one who could remember a time when more general marine-tenure rights were practiced here.

Today the thousands of outer islanders who now live in South Tarawa place heavy pressure on nearby lagoon seafood stocks, especially shellfish. According to Teiwaki (1988, p.12), "the Tarawa landowners (*Kain Tarawa*) moan and complain about these (marine) foraging activities of the non-*Kain Tarawa* people (nonindigenous to Tarawa), but the government advised that the lagoon and its resources belong to the state and every I-Kiribati is entitled to harvest its resources. The Tarawa people argued that the shellfish grounds had always been a traditional source of food before the arrival of the British and other people from their outer islands. The village leaders had to be consulted before people from other places could collect the shellfish from their village. Failure to conform would result in a feud between the opposing parties. It would seem impossible for the Kiribati government to accept the complaints of the Tarawa people as it would mean that the individual islands could follow suit and claim rights over such shellfish. However, it is without doubt that the Tarawa landowners have become relatively disadvantaged as a result of their home island becoming the national capital."

Seaweed farming in shallow nearshore waters has waxed and waned in recent years in Tarawa Lagoon. Because the government does not recognize customary marine tenure, there are no restrictions on where farmers can raise their seaweed. This often has resulted in conflicts among seaweed farmers competing for the best places, and between seaweed farmers and fishermen. Vandalism has caused disruption of several farms. Teiwaki (1988, p. 28) states, "unless some amicable arrangements are made by the government and the lagoon users, the utilisation of the lagoon may be severely hampered."

A *de facto* form of marine tenure has replaced the old system in some areas. Teiwaki (1992) states, "In spite of their non-codification, traditional marine tenure is very much alive and respected in the rural villages." Local councils have thus limited access to certain fishing grounds to a particular village or island (e.g. Zann, 1990) despite the central government's unwillingness to formally sanction such actions.

In North Tarawa, where people remain somewhat closer to their original patterns of resource use than South Tarawa residents, some forms of customary marine tenure are still exercised today and others are remembered. The following presents a summary of our necessarily superficial investigation of the status of CMT today on North Tarawa. A more thorough study would require longer periods of more narrowly focussed interviews.

Traditional ownership by certain families was exercised over certain specific locations on the reef and in the lagoon in North Tarawa (see below). Seventy-seven-year-old, life-long Buariki resident and former North Tarawa senior magistrate, Ruka Kaburoro, told us that prior to British times, Buariki claimed ownership of adjacent waters. Because of the rich resources contained there in the form of bonefish and goatfish spawning runs, there was much fighting over locations for siting rock-fish traps. People were killed in arguments over these sites and certain rock traps are still identified today by the names of some of those individuals who died fighting over them.

The famed Arthur Grimble (later Sir Arthur), who was at one time British High Commissioner of the Gilbert and Ellice Islands, decided, according to Kaburoro, to try to end this disharmony. He proposed that the fishing grounds be divided between different Buariki families. Although this was done amidst much bickering, and allocations were decided as much on the basis of political clout as on equitability, Grimble's strategy worked and harmony (relatively speaking at least) prevailed on the fishing grounds.

When the British government first declared public ownership of most marine resources other than registered fish traps, some fishermen took advantage of this, according to Kaburoro, by refusing to observe the Grimble-inititiated allocations any longer, as well as the traditional exclusive right of Buariki people collectively over their fishing grounds. This attitude persists today, supported by various court decisions over the years discouraging villagers' efforts to control the activities of outside fishermen. Buariki villagers, however, have chased off outsiders gathering shellfish for commercial purposes on the lagoon reef flat in recent years.

Other north-Tarawa villagers told us that, traditionally, certain families or villages claimed exclusive fishing rights over particular sand banks or "rocky" (meaning coralline) outcrops in the lagoon where the fishing was good. The people of Nabeina, for example, had the exclusive rights to fish over certain banks and coral outcrops stretching as far as Bikeman Island, according to one informant. Here they used special sennet nets, hung with *te bun* shells as weights, to fish for jacks (carangids) and gerreids (silverbiddies). As at Buariki, observance of these fishing rights at Nabeina faded when the government declared its ownership of Tarawa waters.

LOCAL MARINE ECOLOGICAL KNOWLEDGE

The Literature

Pacific Island fishermen often possess knowledge concerning their marine resources unknown to fisheries biologists. Some of it can be invaluable in developing contemporary marine resource management programs. Unfortunately, the ethnographic literature dealing with indigenous marine environmental knowledge of I-Kiribati is unreliable. Grimble's descriptions of fishing and fishing lore cannot be trusted. Interspersed among descriptions that may or may not be accurate are absurd fantasies masquerading as true accounts, such as a description of how Gilbertese fishermen (and latterly Grimble himself) used themselves, tied to a rope, as bait to catch giant octopus (Grimble, 1952). Luomala, the only other ethnographer to devote significant space to Gilbertese fishing lore, was under the impression that sharks and rays have lungs, porpoises attack canoes (Luomala, 1984, pp. 1212, 1219, 1234), crabs have tails and groupers are toothless (Luomala, 1980, pp. 544, 549).

Local Knowledge: Results of the Interviews

Spawning Migrations and other Movements

Among the most useful local knowledge for purposes of marine-resource management in many Pacific Islands is that concerning the spawning migrations and aggregations of reef and lagoon fishes. A large variety of such species migrate along a highly regular route during a predictable season, moon phase and tidal stage. They aggregate at the terminus of this migration in order to spawn, then return to their prespawning areas (e.g. Johannes, 1981; and Thresher, 1984).

The spawning migrations of certain reef and lagoon fishes have been the focus of much fishing activity in Tarawa because they presented regular opportunities for making very large catches. Accordingly, fishermen were able to provide us with considerable information concerning some of these migrations. Fish engaging in such behavior are not only more accessible to fishermen, but they also offer biologists exceptional opportunities for monitoring stocks. Just as populations of salmon returning to their rivers to spawn are far easier to monitor than at other times, so many reef fish are easier to census when they are concentrated in their spawning runs. In addition, these runs provide a useful focus for the regulation of fishing pressure (Johannes, 1980; Sadovy, 1997; and Johannes et al., 1999). In Tarawa, fishermen have taken advantage of such spawning runs for centuries. So far, fisheries managers there have not.

Bonefish

Bonefish, or *te ikari,* is not only the most popular food fish in Tarawa but catch statistics show that it has also been the single most important species[6] in shallow-water catch and in commercial sales[7]. Sabatier (1977, p.121) observed in the 1930s that on some islands in the Gilberts, bonefish accounted "for perhaps half the fish consumed." Research elsewhere has shown that, after an oceanic larval stage, bonefish move into shallow water. Here they feed on invertebrates on sand or mud bottoms. They are found in Tarawa Lagoon over such bottoms. Although bonefish are found throughout the nearshore tropics and are a highly valued game fish in some regions, very little has been published concerning their reproduction. The descriptions of bonefish reproductive behavior given to us by Tarawa fishermen were highly consistent with one another and contained considerable information not to be found in the scientific literature.

Every lunar month, according to Tarawa fishermen, bonefish formed large schools one to three days before the full moon[8]. These aggregations (which we will refer to here as prespawning aggregations) formed in the lagoon near the spot where the fish would subsequently leave the lagoon on their spawning migrations. All but one of their reported migration routes involved passes between islands. The most important passes for bonefish migrations were Buota, Abatoa, Taborio, Tabonibara, the passes now blocked by Steward and Anderson causeways, and the Betio-Bairiki pass. The latter has been almost completely blocked by a causeway since 1987.

At low tide, bonefish entered the inner mouth of the interisland channels waiting to migrate to the ocean. When the tide rose and the water currents became strong in the channel, the fish moved laterally up into shallow, slower-flowing water at the edges of the passes and moved seaward. An important bonefish run, which did not use an interisland pass, was located near Buariki where the fish migrated across the reef southeast of the village.

The location for which we were able to obtain the most information on prespawning aggregations, and how I-Kiribati responded to them, was a spot in the lagoon near Buariki, called *Te Tao*. Traditionally an elder from Buariki was responsible for directing where and when people could place their nets during the bonefish spawning period. Great care was taken not to disturb prespawning aggregations and no one was allowed to fish, to sail on the lagoon in their vicinity, or even to make loud noises in the village. The reason given for this was that disturbing

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[6]There may be two species of bonefish, genus *Albula*, present in the Gilbert Islands (Shacklee et al., 1982). Lacking adequate information on this question, however, we will refer to Tarawa bonefish as a single species in keeping with Tarawa fishing statistics and reports. Often referred to in the literature as *Albula vulpes,* Tarawa's main bonefish species has been identified as *Albula glossodonta.*

[7]Bonefish appear to be more important as food in those islands in Kiribati with appropriate lagoon habitats than anywhere else we know of in its circumtropical range. This is due in part to its very high production rate in these lagoons, an apparent consequence of very high lagoon productivity associated with equatorial upwelling (see Kimmerer and Paulay, this volume). In addition, the infamous bones for which the species gets its English name are less prominent in *Albula glossodonta* than they are in the better known *Albula vulpes.*

[8]One fisherman said that occasionally the migration would start as late as one day after the full moon.

the fish at this time tended to break up and scatter them, making fishing for them subsequently much less successful.

Similar village rules prohibiting any activities that might disturb the fish during their prespawning aggregations were said to have been in force in other Tarawa villages. As discussed below, bonefish are exceptionally wary and easily put to flight by nearby disturbances. Fishing was allowed to start only after the aggregation began its spawning migration across the sand flat and outer-reef flat toward the outer-reef slope.

However, when the government declared lagoon resource public property (see above), the people of Buariki lost the ability to control these activities. Eventually, as a result, people started fishing over these prespawning aggregations before they began to move out.

On or about the day of the full moon, and starting around 4 p.m. and ending around 10 p.m. (i.e. in the period bracketing the high spring tide at Tarawa during this lunar period), the schools at *Te Tao*, as well as at least seven other locations around Tarawa, migrated seaward. At this time their gonads filled their body cavities.

Fishermen report that, in response to harassment by sharks, schools of bonefish reaching the ocean would hug the outer-reef edge and move up into shallow water on the outer-reef flat when the tide permitted. When the fish returned to the lagoon at the place they had left it, they were invariably spent, according to fishermen. In the lagoon their schools were said to be unusually easy to find for the next few days because they stirred up clouds of mud to a degree not seen at other times[9].

No one we interviewed, including divers who frequent the outer-reef slope, had ever seen bonefish spawn[10]. Fishermen surmise, however, that bonefish from throughout Tarawa converged seaward of the reef dropoff off the southeastern tip of Tarawa Atoll near Temaiku to spawn. Consistent with this is the fact that bonefish leaving the lagoon to spawn at Abatao, which is near Temaiku, typically returned after only one day, whereas, fish migrating from the lagoon at more distant locations, such as Betio and Buariki, typically returned after three days, according to fishermen.

There is additional evidence that the massing of bonefish takes place in this area during their spawning migration. The pass at Temaiku, which used to open to the ocean until about 30 years ago when it was closed by local landowners, never had bonefish runs according to fishermen. Nevertheless, the remains of the highest concentration of bonefish traps (see below) on Tarawa are located on the ocean-reef flat here. Since there was no bonefish run through the adjacent channel, the bonefish these traps were built to catch therefore must have migrated to this location from elsewhere. There is only one

[9]Bonefish feed by grubbing in the sediment; perhaps they feed particularly heavily after spawning because their energy reserves have been depleted.

[10]Many reef and lagoon fish spawn during a short period around dawn or dusk, making observation difficult (Johannes, 1981; Thresher, 1984). Also, some Pacific Island fishermen do not recognize the spawning act for what it is when they see it (Johannes, 1989).

reason bonefish are known to migrate outside the lagoon, that is, to spawn.

Adding further plausibility to fishermen's hypotheses concerning where Tarawa bonefish spawn is the fact that spawning aggregations of a wide variety of tropical nearshore fishes are known to occur at outer-reef promontories such as the one near Temaiku (e.g. Randall and Randall, 1963; Johannes, 1978).

For centuries on Tarawa, bonefish returning to the lagoon after spawning were captured in rockfish traps built specifically for that purpose[11] at strategic spots on the outer-reef flats. Not uncommon were catches so large, we were told, that people could not harvest them all, with as many as 2,000 fish being gathered from a trap in one morning and the trap being full again by evening. A thousand fish in a trap was said to be a typical catch with as few as 400 being caught in "poor months". Some of the excess were salted. During their return from spawning, the fish would sometimes be so abundant and crowded on the reef that many would simply strand at low tide.

We are quoting from local fishermen here, and fishermen throughout the world have a reputation for exaggeration. However, fishermen from all over Tarawa volunteered the same quantitative information. A passage from a report by the famed Pacific Island ecologist, Dr. René Catala (1957, p. 132) lends further credibility to their statements. Here he describes bonefish fishing on Tarawa in 1951:

> "It is indeed exactly at the moment of the full moon that they approach the shore and that a great number of them get caught inside the traps without being incited to escape by the ebbing tide. Unlike mullet caught in this way, they do not jump over the walls; or when they try to do so it is too late. The fishermen are around the trap spearing them. The women carry them to the shore where the sharing is done in the shade of the coconut trees between the owner (of the trap) and the close relations and friends, a portion being left for the people who helped catch or carry the fish. . . . .The haul will vary in importance each month. We were fortunate enough to attend one of these distributions at the full moon of August. While not a record, the catch was nevertheless one of the best for the year, totaling over two thousand fish for one trap only. Only four hundred had been caught the preceding month, which was considered a very low figure. The weights we recorded gave a total of 45 pounds for twenty fish, taken at random. The largest weighed 4.5 lbs."

Catala (1957 pp. 122, 129) also refers to "massive concentrations of *teikari* (*Albula vulpes*) along the shores outside Tarawa Atoll" and "huge concentrations of *Albula* " at Tarawa. Sabatier (1977, p. 121) states that from rock fish traps "you can on occasion pick up as many as two thousand of them (bonefish)."

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[11]Catala (1957, p. 131) supports fishermen's descriptions of the specificity of these traps: "These property rights (over rock fish traps) are a real benefit only at the times when the ikari are caught. The rest of the time the catch is small and made up of the same very small species that anybody can gather on the reef flat daily."

Since Catala was a trained biologist, we assume that his sample was indeed random and that his estimated mean weight of a fish (2.25 lb) was thus reasonably accurate. We, therefore, can make a rough estimate of the harvest from these runs. Catala's and fishermens' statements both suggest that an average monthly catch per trap was about 1,000 fish weighing 2.25 lb each, or a total of about one ton. This amounts to 12 tons of fish per year, per trap (there are, in fact, 12.3 lunar months in a solar year).

This calculation does not include the bonefish that were caught by net fishermen during the spawning migration. Although the rock traps were privately owned, as were their catches, bonefish on spawning runs also were easily caught with nets by nontrap-owners, according to fishermen.

The remains of well over 150 bonefish traps are clearly visible today from the air on Tarawa's outer-reef flat. In the 1850s, Tarawa's population was estimated to be about 3,500 (Maude and Doran, 1966). If the 150+ bonefish traps were all in existence and operating simultaneously at that time, their catches alone would have provided about 1.5 kg of whole fish per capita, per day— a catch considerably in excess of their needs. It seems likely, therefore, that many of these traps were built in more recent times as Tarawa's population boomed.

Conditions have changed greatly in recent decades, however. Detailed interviews with expert fishermen throughout Tarawa revealed that by 1990 only one spawning run of bonefish remained — the one near the village of Buariki — and that it was declining fast. In addition, only five bonefish rock traps were still maintained on Tarawa, all of them at Buariki, and even these have now ceased to catch bonefish.

Some bonefish spawning runs began to dwindle in the late 1960s. Some were blocked by causeways (e.g. Tabonibara, Anderson, Stewart, and Taborio)[12]. More recently the Betio-Bairiki causeway, completed in 1987, destroyed what is said to have been the largest bonefish spawning run in Tarawa, apparently because the fish refused to go through the tiny pass (10 m wide) built into the 3 km-long causeway.

Fishermen say that the runs at Abatao and Buota passes dwindled and disappeared as an apparent result of localized overfishing. In the old days, bonefish would arrive at these passes in a few very large schools and were "as thick as baitfish." Imported gillnets began to be used intensively in and near these passes in the late 1950s to exploit the spawning runs. By the late 1960s, the fishermen noticed that the numbers of *te ikari* moving through these two passes were decreasing. In addition, instead of coming in a few large schools, the fish began to come in numbers of smaller schools. Then the runs began to miss a month, then two months. Then several months would go by without a run coming. Finally, about 12 years ago, the runs stopped entirely.
A decline in the numbers of migrating bonefish, presumed by fishermen to be due to overfishing, was also observed at the Betio-Bairiki pass prior to the elimination of this

[12]There were no suggestions from informants that blocked spawning aggregations sought egress elsewhere.

run by the causeway in 1987.

Buariki is the furthest village from the district center of south Tarawa. It is in one of the least heavily populated portions of the atoll and is one of villages least involved in commercial fishing. Perhaps for these reasons its bonefish run was the last on Tarawa to dwindle. Changes in the bonefish runs were not noted by Buariki fishermen until the early 1980s when the fish began to migrate in the form of many small schools rather than in a few very large ones as they did formerly. This is the same change in behavior as described independently by other fishermen for the other Tarawa spawning runs beginning in the 1960s before they ceased altogether. In addition, Buariki bonefish began to take a migration pathway further offshore in deeper water, out of reach of Buariki's five rock traps. Since about 1990 none of these traps—the last intact bonefish traps remaining on Tarawa — had caught any bonefish.

Since April 1992[13] the Buariki spawning run, the last known bonefish run on Tarawa, has failed to appear, according to fishermen. Occasionally since then small prespawning schools of bonefish formed at *Te tao* (see above). But these aggregations had become so small, and the fishing pressure on them so great, that no fish were seen to escape to complete the spawning run. These developments are of great concern to Buariki villagers who say that bonefish, along with *te maebo* (see below), have always overwhelmingly dominated their catch. They blame the decline mainly on "splash" gillnetting, which is described below.

Throughout the lunar month, large bonefish used to be caught on the lagoon side of Tarawa close to shore. By the early 1990s even small ones were not generally found there. Bonefish could still be caught in significant numbers in deeper lagoon waters, however, and in late 1993 were still frequently available from roadside fish sellers on South Tarawa.

Goatfish, Upeneus sp. (*te maebo*)

This goatfish is described by fishermen as making spawning migrations from the lagoon onto the reef flat on rising tides, and into the ocean as the tide drops, for three days around the new moon throughout the year. *Te maebo* do not migrate through interisland passes, but rather around the tips of the southernmost and westernmost islands on the atoll, Betio and Buariki. No one was able to tell us exactly where these fish spawn.

Low rock traps were used on the reef flat near the southern end of Betio specifically to trap this species during its spawning migrations. The traps are little used now because the migrations have dwindled to insignificance in recent years, according to fishermen. Overfishing, including the use of the splash gillnetting method (see below) is presumed by them to be the cause. For a few years before the catches diminished noticeably, many net fishermen moved into the area during the spawning

[13]Our interviews were carried out in 1992 and 1993.

run, placing their nets between the traps so that the fish had little chance of running the gauntlet.

Rockfish traps built specifically for *te maebo* are still used by the Buariki people on the reef flat to the west of the area where their bonefish traps are located. There are about 30 such traps and all of them remain in use. They are repaired periodically just before the new-moon spawning runs. The Buariki runs have also declined significantly in recent years, according to fishermen. In contrast to the bonefish near Buariki, *te maebo* now tend to run closer to shore during their migrations than they did in the past. Ten years ago a good catch would be up to 1,000 fish per night, per trap. By 1993, trap owners would be fortunate, we were told, to get 100 in a night. The mean size of the *te maebo* caught in the traps at Buariki, however, has not changed noticeably over the years, according to fishermen.

Goatfish, Mulloidichthys sp. *(te tewe)*

According to fishermen the goatfish, *te tewe*, made seaward spawning migrations through several channels in the early morning on a rising tide, often returning at the beginning of the same evening on the following rising tide. On their return they were described as travelling in small compact schools consisting of around 100 individuals. The biggest runs were said to be at Buota and Abatao passes. Both these runs are said to occur rarely now and consist of very small schools. Depletion is believed by informants to be the result of overfishing with gillnets. Runs were also destroyed by causeways at Tabonibara and Nuatabu, and, according to fishermen interviewed by Johannes (unpublished) in 1979, also by Anderson and Stewart causeways. A minor run reportedly still occurs at Kainaba. Information concerning the moon phases associated with these runs was inconsistent, although "around the full moon" was the most frequent description of their lunar timing.

Te tewe used to return from spawning in significant numbers via at least two channels (Tabituea and Nuatabu) not used by the species for outward migrations. Until the 1960s, *te tewe* could be caught in traps and with nets on the ocean reef at Nuatabu (a village near the pass of the same name, now blocked by a causeway, at the western end of Buariki Island), during which time they were full of eggs. A few days later small schools of *te tewe* would move from the ocean side through the channel in the evening as the tide rose. These movements continued until high tide each evening for three to five days.

We were unable to get an idea of how important these runs may have been as a source of food on Tarawa. Certainly they do not appear to have been as significant as bonefish or *te maebo* spawning runs, but important enough, nevertheless, to have prompted the building of specially designed rock traps along their migration routes at Nuatabu and Tabonipara and possibly elsewhere on the atoll.

Silver Biddy or Moharra, Gerres spp. (*teninimai*)

The silver biddy, *Gerres* spp., is said to come into shallower water to form large

schools in the lagoon over or around the edges of certain sand banks and islands around the period of the full moon.

The island of Bikenamori (literally "Island of the large silver biddies"), in the lagoon south of Tabonibara in south Tarawa, was often mentioned as the most important of such sites. A fish trap designed specifically to catch this species was said to have been once located there. There is a legend that Bikenamori belongs to a ghost called Bukamarawa who materializes as a light. *Teninimai* are "pets" of this ghost and are attracted by this light. The full-moon aggregation at Bikenamori was said to have become irregular in recent years. At this time the gonads fill the body cavity and the fish are easy to catch (with gillnets). Fishermen we talked with were unanimous throughout Tarawa in their assertions that, whereas numbers of these fish are still comparatively high, their average size has decreased dramatically and spawning aggregations have all but disappeared. These fish do not show up significantly in government catch statistics, but appear to form an important element of Tarawa villagers' subsistence catch.

Lethrinids and Lutjanids

Despite the fact that the spangled emperor, *Lethrinus nebulosus* (*te morikoi*), is the second most important species in shallow-water catches in Tarawa according to Fisheries Division data, we were unable to find out much about it from fishermen. The same is true of other popular, drop-line-caught lutjanids and lethrinids, including *te ikanibong*, *Lutjanus gibbus,* and *te rou*, *Lethrinus elongatus* All three species are said to have well-developed roe around full moon but are not believed even to school up to spawn, let alone leave the lagoon.

Many lethrinids and lutjanids are reported to migrate to outer passes or reef edges to spawn on lunar cycles in other tropical areas. Fishermen do not think they do this in Tarawa. In fact, fishermen we interviewed did not seem to know of any specific movements of these species, finding them mainly around rocky or coral outcrops in the lagoon. They said that it is becoming increasingly difficult to get good catches, although they are still to be had occasionally. The mean sizes of *te morikoi* and *teikanibong* are declining very noticeably, fishermen said, and some of their favorite fishing spots do not produce at all any more.

Mullets

Several species of mullet seem to be fairly important in catches in some parts of Tarawa today, according to fishermen. They were said to constitute the main replacement for depleted bonefish and *te tewe* runs in areas of North Tarawa (e.g. Abatao) where they are caught in deeper lagoon waters using a recently developed gillnetting technique.

Some informants told us that they had seen mullet in spawning aggregations around full moon off the point near Temaiku where bonefish are also believed to spawn (see above). Tarawa fishermen interviewed by Johannes (unpublished) in 1979 stated that the mullets *Liza macrolepis (te bauamaran*) and *Valamugil seheli (tebauataba)*

migrated from the lagoon to the ocean to spawn around full moon. According to these fishermen, such runs were restricted largely to channels along the eastern reef of Tarawa. Today all such channels are blocked, or nearly blocked, by causeways.

One informant said that mullet used to spawn in the lagoon near Temaiku before extensive dredging and filling disturbed the area. Another said that he had sometimes seen very large, compact schools of mullet six to seven miles at sea off Tarawa at the surface. Mullet were once seen in abundance during high tides on both the ocean reef near shore and in the lagoon near shore, but are no longer found in either location in significant numbers, according to fishermen.

Leatherskin

In 1979, fishermen told Johannes that the leatherskin, (*te nari*) *Scomberoides lysan*, migrated through the Betio-Bairiki channels to spawn five to seven days after the full moon. Similar migrations reportedly occurred near Buariki.

Sharks

Although I-Kiribati like to eat shark meat, fishermen did not provide much information on shark movements or aggregations, and sharks are not a common constituent of fishermen's catches today. Grimble (1952, p. 134) claimed that, "there is a four-fathom bank of Tarawa Lagoon where the tiger-shark muster in hundreds for a day or two every month," Their numbers were clearly visible from canoes, he said, and a few of them attained lengths of 18 feet. None of the fishermen we interviewed had heard of such a phenomenon. This could be because this shark aggregation was fished out as Tarawa's population grew. (Because of their low fecundity, shark populations are especially vulnerable to overfishing.) Another possible explanation is that this story is a product of Grimble's creative imagination (see below).

Whales and Porpoises

Whales and schools of porpoises once commonly entered Tarawa lagoon through Boat Passage according to fishermen. They often swam right into the Temaiku Bight area to a spot called *Uningan te kua*, meaning "Whale's Pillow" in Gilbertese. They were presumed by fishermen to do so because they could sense the fresh seawater coming into the lagoon in this area and therefore thought that they could get to the sea by swimming in this direction. This may account for the confused belief of some younger I-Kiribati that whales actually entered the lagoon through the pass connecting Temaiku Bight and the ocean. The pass was filled by adjacent landowners several decades ago. Prior to that time, however, it was never big enough to allow the entry of whales, according to an older informant. Inspection of the area supports this recollection.

Damaging Fishing Methods

Tarawa seems free of the twin scourges of many tropical-reef fisheries, dynamite and chlorine. A technique introduced in the early 1980s for driving fish into gillnets by splashing heavy six-foot crowbars into the water is a matter of considerable concern to many fishermen. The sound of these heavy bars penetrating a few inches into the water

when they hit it, scares bonefish more effectively than wooden rods which just smack the surface, according to fishermen.

The technique enables fishermen to scare fish from water deeper than that in which they can easily be gillnetted into shallower water where the nets are waiting. As mentioned above, fishermen believe that this method is responsible for important changes in the behavior of bonefish and *te maebo.* Feeling against the method ran very high among fishermen we interviewed in some parts of north Tarawa. In south Tarawa, even some fishermen who used the method told us they thought it should be banned.

DISCUSSION

Customary Marine Tenure

The above account of CMT in Tarawa is fragmentary and unsatisfactory, but it is the best that could be accomplished in the time available. When asked if it was reasonable to conclude that the current government's position on customary marine tenure was confused, one government official replied "chaotic would be a better word."

Teiwaki (1992) has expressed the need for a "remodelled" CMT system which, he says, "depends on an overall review of some government policies, particularly those related to the disruption of the marine environment or those policies that help to facilitate or accelerate the extinction of the traditional marine tenure system." (see also Teiwaki, 1988). We agree, and suggest that any such effort would require a more detailed study of the local traditional systems of fishing rights, and how they operated throughout Tarawa, than was possible in the time available during the present study. It would also require a detailed examination of the legal dimensions of the subject.

Kiribati government explicitly endorses a policy of decentralization yet does not support the keystone to decentralization of reef and lagoon resource management (CMT). I-Kiribati villagers have long demonstrated a desire to manage their fisheries. But today, although pressure on these resources by outsiders is significant, villagers have no authority to exclude them or control their activities and thus little incentive to regulate their own activities on the fishing grounds.

The resurrection, even in remodelled form, of CMT is bound to generate or reactivate boundary disputes and disputes concerning who has what traditional rights within bounded areas. We believe it is a price worth paying; it seems to be the only feasible way to implement sound management of reef and lagoon resources beyond South Tarawa. The expense and logistics of government management increase greatly with distance from administrative centers. Extensive consultation with a wide range of interested parties would be essential in order to minimize disputes and arrive at a satisfactory system.

Reestablishment of CMT in south Tarawa may be not be feasible because so

many of the residents are not traditional fishing rights owners. CMT- based management is often impractical near district centers (e.g. Johannes, 1998). In this case the responsibility must fall to the government. Government management is somewhat less difficult in areas in the immediate region of the enforcement agency because of simpler logistics.

Local Knowledge

As with many Pacific Islanders, the I-Kiribati of Tarawa possess valuable information about spawning migrations of important food fishes, including changes in their behavior and abundance as apparent consequences of human actions. Important information obtained during the interviews proved to be unknown to fisheries scientists and managers. Our study clearly demonstrates the value of appropriate interviews with selected fishermen as a means of obtaining practical information on the prior history of local fisheries where scientifically derived information is sparse. The most valuable information for management purposes was that concerning changes in bonefish behavior and distribution, the cessation of all but one known bonefish spawning run, and the severe depletion of the remaining run.

Clearly causeways have been responsible for the destruction of some of the spawning runs, and overfishing seems to have played an important role in eliminating others. It is worth stressing that, if village authorities had not lost their traditional right to exclude outsiders from their fishing grounds, some almost certainly would have prohibited practices such as splash fishing and blocking passes with nets during spawning runs.

As mentioned earlier, fishermen say that while splash fishing catches more bonefish in the short run, in the long run, it "spooked" the fish causing migrating schools to break up and, in the case of Buariki, causing the fish to shift their migration path to deeper water. How plausible are these assertions?

Tests carried out by Tavolga (1974) on a single specimen of *Albula vulpes* indicated unusually acute hearing at low frequencies (between 100 and 300 Hz). He also pointed out that bonefish are notorious among sport-fishing guides for taking flight in response to very small noises. In the field Tavolga determined that, by hitting an oar lightly against the gunwale of a boat or by dropping a lead sinker into the water, the resulting noise had most energy around or below 300 Hz, i.e., where the bonefish has its greatest sensitivity. The resulting noise level was above the animal's hearing threshold at 10 m from the source. He also noted that bonefish are often more "spooky" at depths of over 3 m than at 1 m or less. In this connection it is worth reiterating that Tarawa fishermen say they are targeting bonefish in deeper lagoon waters when using the splash-fishing method. Bonefish also produce a "startle-type" sound when disturbed (Myrberg, 1981) which may function to spread alarm, caused by splash fishing, to fish beyond the direct reach of the sound of the splashing.

Observations and measurements made elsewhere therefore support Tarawa fishermen's contention that splash fishing "spooks" bonefish. But what of their contention that the Buariki fish have altered their spawning migration pathway, now using deeper water in an apparent response to heavy splash-fishing pressure? Such behavior would entail learning, both to avoid the "noxious stimuli" (as behaviorists might describe splash fishing) along the old pathway, and to adopt, as a group, an alternate migration pathway. That bonefish, like many other fish, learn to respond negatively to sounds is demonstrated by Tavolga's experiments; his hearing tests on bonefish were based on a type of learning known as conditioned response.

How would new recruits learn the new migration path? The same way they probably learned the old migration pathway from experienced adults. No relevant research has been done on bonefish, but such learning of migration routes by novice fish from experienced fish has been confirmed for another tropical nearshore species,[14] the Caribbean grunt *Haemulon flavolineatus* (Helfman and Schultz, 1984). In short, what we know about the behavior of fish, including bonefish, provides no information inconsistent with fishermen's assertion that splash fishing has altered bonefish spawning migration pathway and behavior.

As mentioned earlier, Buariki fishermen say that bonefish in their area now no longer make spawning migrations, even in deeper waters, because their small and increasingly rare prespawning aggregations are eliminated by fishing before they can migrate. If bonefish learn to alter their migration pathways, however, the possibility remains that some have developed one or more alternative migration routes in Tarawa that are unknown to fishermen. It seems unlikely that this could occur in such a heavily fished lagoon, but the possibility cannot be dismissed. It is obviously prudent to assume that this has not occurred, however, and that if the Buariki spawning run cannot be reestablished, Tarawa may lose its *te ikari* entirely within a few years.

Large bonefish used to be readily caught in shallow lagoon waters close to shore according to fishermen, but even small bonefish are uncommon there now. Large bonefish are still caught in sizeable numbers in deeper waters in the lagoon (Beets, this volume). This tends to reduce the concern of some I-Kiribati over the fate of their bonefish stocks. But the observation is not as reassuring as it might appear. For one thing, the sex ratio of these fish is now heavily biased towards males (Beets, this volume). In addition, if Tarawa bonefish live for up to 12 years like their Caribbean counterparts (Bruger, 1974), there will be some bonefish in the lagoon, even in the absence of spawning (barring their complete removal by fishermen) for at least 12 years after the last known spawning, that is, until about 2004. We would, however, expect them to become increasingly uncommon before then due to natural and fishing mortality.

Some recruitment of bonefish larvae to Tarawa Lagoon from spawnings at nearby atolls may occur, but it cannot be taken for granted. If it does occur, it would

[14]It has been repeatedly demonstrated in migrating birds.

suffice to maintain adequate stocks. In addition, bonefish spawning runs are said to be seriously threatened on at least some of these other atolls, for example at Abemama (Tebano, 1991; and Siwau Awira, Kiribati Minister of Education, pers. comm.).

We thus conclude that Tarawa's single most important species of lagoon food fish could suffer local extinction unless concerted action is taken quickly to protect and rebuild the Buariki spawning run. Scientific proof of the seriousness of the situation is lacking, but would be expensive and very time consuming to obtain. In our opinion, waiting for such proof is a risk that the I-Kiribati can ill afford.

The total protection of any prespawning aggregations of bonefish that may form near Buariki seems critical. The banning of splash fishing seems desirable despite the absence of proof that it is as harmful as Tarawa fishermen believe it to be. In addition to the possible benefits of such an action discussed above, the banning of this method would appear to result in the *de facto* creation of a reserve in the deeper waters of the lagoon where bonefish would be out of reach of net fishermen altogether. Such a ban, as suggested by fishermen, also could help rebuild spawning runs of the goatfish, *te maebo* and perhaps other species.

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Note: Since this report was presented in Tarawa in 1994, steps were taken to protect the bonefish spawning run near Buariki. In 1995, the people of north Tarawa established and enforced an informal ban on fishing for bonefish in north Tarawa waters during the three days either side of the full moon. They also banned the use of long gillnets and the splash method to catch bonefish. This latter ban was officially recognized by the central government in 1999. In 1999, fishermen reported that the catch-per-unit effort and the average size of bonefish were both increasing. There were also unconfirmed reports of a bonefish spawning run being seen outside the reef of south Tarawa.

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