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Editor's note

The two articles in this issue make important contributions to subjects about which almost nothing has hitherto appeared in the literature. In their article, "Local knowledge on white-dotted grouper (*Epinephelus polystigma*) aggregations in Melanesia", Richard Hamilton and Tapas Potuku have essentially initiated the literature base for this rare and little known species, one among the 48 listed as "data deficient" in the recent IUCN Red List assessment of all groupers. Most of the information on *E. polystigma* presented here was assembled by the authors in 2003 and 2004, during their local knowledge surveys on reef fish aggregations in New Ireland and Manus provinces of Papua New Guinea.

The subject of taboos and fisheries management is of major interest in the Pacific Islands, and over the years has been the topic of several contributions to this Information Bulletin. So it provides an interesting comparison to examine their role in other parts of the tropical world. With this in mind we include here "The role of taboos in conserving coastal resources in Madagascar," by Joshua E. Cinner, based on his survey of 13 communities within and adjacent to all five of Madagascar's national marine parks. Unlike some Pacific Islands, where customary management is often implemented adaptively to manipulate resources, in Madagascar taboos are highly inflexible, and some communities have resisted inclusion of them in contemporary conservation. Until this contribution, little has been available on the subject of Malagasy marine resource taboos.

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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.

Local knowledge of white-dotted grouper (*Epinephelus polystigma*) aggregations in Melanesia

Richard Hamilton¹ and Tapas Potuku²

Introduction

In a recent assessment of all grouper species, a panel of experts concluded that 20 out of 160 grouper species are considered vulnerable or endangered under IUCN Red List criteria (Sadovy 2007). Aspects of grouper life history that appear to make this family particularly vulnerable to overfishing include slow population turnover (Coleman et al. 2000) and the spawning aggregation behaviour of many species (Johannes 1978). Indeed, 50% of the groupers listed as vulnerable or endangered on the IUCN Red List are known to form spawning aggregations. Spawning aggregations occur when mature fish travel to a specific location at a specific time for the purpose of reproduction (Domeier and Colin 1997). Some grouper species form spawning aggregations of hundreds or thousands of fish (Johannes et al. 1999; Rhodes and Sadovy 2002), and at these times the aggregating population is highly susceptible to overfishing (Sadovy and Domeier 2005a).

Many grouper species in the Pacific are important to subsistence, artisanal and commercial fisheries (Wright and Richards 1985; Dalzell et al. 1996; Rhodes and Tupper 2007). Although both aggregating and non-aggregating groupers are fished, species that form aggregations often bear the brunt of fishing pressure. Grouper spawning aggregations can be rapidly depleted or totally eliminated when subjected to moderate to high levels of subsistence or commercial fishing (Hamilton and Kama 2004; Johannes 1997; Sadovy et al. 2003; Hamilton and Matawai 2006). In the Indo-Pacific, the live reef food fish trade (LRFFT) and night spearfishing are some of the main threats to grouper spawning aggregations (Sadovy and Vincent 2002; Hamilton et al. 2005).

At the global level, approximately 13% of all groupers are considered to be vulnerable or endangered, and a further 30% cannot currently be assessed as there are insufficient data on them (Sadovy 2007). Two

recommendations made at the 2007 IUCN workshop on groupers were that 1) all larger data deficient species should be the immediate focus of more data gathering, especially in Southeast Asia and the Pacific Islands region, and 2) species that aggregate to spawn need more protection if aggregations are targeted (Sadovy 2007).

In this article we draw on local knowledge and field observations to provide a picture of the aggregating behaviour and status of the white-dotted grouper (*Epinephelus polystigma*) in Melanesia. *E. polystigma* was one of 48 species listed as data deficient in the recent IUCN Red List assessment of all groupers (Sadovy 2007)

E. polystigma is a medium-sized, rare grouper species that inhabits estuaries and mangrove habitats of Indonesia, the Philippines, Papua New Guinea and the Solomon Islands (Heemstra and Randall 1993). One of the only published accounts of this species is a short article that describes fishers' local knowledge of *E. polystigma* in Isabel Province, Solomon Islands (Johannes 2001). Isabel fishers state that *E. polystigma* is a lazy fish, that is exceptionally easy to approach and spear, and that it often aggregates in water "so shallow that the backs of fish protrude from the water as they rest on the bottom" (Johannes 2001). Isabel fishers also stated that the ease with which this species could be captured meant that it was now rare around areas inhabited by humans (Johannes 2001)

Most of the information on *E. polystigma* presented here was documented in 2003 and 2004 while we were conducting local knowledge surveys on reef fish aggregations in New Ireland and Manus provinces in Papua New Guinea³ (Hamilton 2003a; Hamilton et al. 2004). These surveys were intended to quickly amass information on reef fish spawning aggregations. It was envisaged that the local knowledge on aggregation parameters that was documented (such as specific locations, species

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3. Information on *E. polystigma* aggregations in Roviana Lagoon presented here was documented by one of the authors (RH) while he was residing in Roviana Lagoon in 2000 and 2001.

composition and aggregation status) could provide a template of information for tailoring future research and conservation efforts in these provinces of Papua New Guinea.

Using local ecological knowledge for research and conservation

Local knowledge is an important component of the intellectual and cultural property of many indigenous societies (Carrier 1987; Foale 1998). From a rationalist viewpoint, local knowledge bases also hold a great deal of information valuable to conservation and science. This potential is increasingly recognised, and there exists a large body of literature advocating its documentation and integration with more quantitative types of research (Christie and White 1997; Johannes and Neis 2007). Interest in local ecological knowledge stems from a mosaic of disciplines, including agriculture (Walker et al. 1999), environmental impact assessment (Usher 2000), conservation (Warren 1997), toxicology (Huia and Xu 2000), and fisheries research and management (Ruddle 1996; Bergmann et al. 2004). As many authors have pointed out, the lack of a university degree does not mean that a person is not knowledgeable or that his or her knowledge is unimportant (Nordhoff 1930; Johannes 1981; Foale 1998).

Local ecological knowledge contains baseline information on local ecologies, including information on the components of local ecosystems, and their temporal and spatial patterning. Fishers can provide critical information on inter-annual, seasonal, lunar, diel, tide- and habitat-related differences in behaviour and abundance of target species, and how these dictate fishing strategies (Johannes et al. 2000). These data are particularly relevant to marine biologists working in the Indo-Pacific region, where sources of more orthodox ecological information are normally unavailable. Fishers often know much more than biologists about the location of critical habitats such as spawning grounds (Johannes 1989), spawning behaviour (Hamilton 2005), nursery areas (Johannes and Ogburn 1999), and seabird aggregation sites (Nakashima 1993). Local fishers are also often the only people who know that during particular seasons certain otherwise unremarkable islets or coral sites become critical habitats, such as nesting beaches for sea turtles (e.g. Johannes 1981), rookeries for seabirds (e.g. Nakashima 1993) and egg-releasing beaches for land crabs (e.g. Foale 1999).

Fishers' local knowledge can also be critical in providing a perspective on the historical state of reef fish communities. In the Indo-Pacific area, coastal fisheries quantitative baseline studies are rarely available to marine biologists, but rich bodies of local ecological knowledge frequently exist, and if ac-

cessed correctly, can provide detailed insights into past abundances, size structure and spatial distribution of a particular fish stock. In situations where large-scale ecological changes have occurred within the lifespan of fishers, the knowledge of such changes can be extremely detailed (Johannes and Yeeting 2001; Hamilton 2003b; Dulvy and Polunin 2004). Finally, fishers' local knowledge is increasingly playing an important role in the demarcation of marine protected areas and ecoregional assessments, since both of these processes require a prior knowledge of the spatial and temporal distribution of marine species (Aswani and Hamilton 2004; Aswani and Lauer 2006; Smith and Hamilton 2006; Hinchley et al. 2007).

It is important to highlight that although local knowledge of marine environments can be of great practical value to scientists and conservationists, there are several cultural and methodological issues that need to be taken into account. In particular these include:

1. Local ecological knowledge needs to be documented and utilised in ways that are endorsed by the custodians of this information.
2. Anthropological methods such as interviewing and participant observation are required to accurately document this material.
3. Local knowledge is often stratified by gender, age and geographical location, and specific knowledge pertaining to specific families of fish is often restricted to expert fishers who specialise in targeting those species (Johannes et al. 2000).
4. Most local knowledge of marine ecologies is ultimately directed towards identifying patterns that maximise capture success. Thus, some details of fish biology that are important to a marine biologist studying reef fish ecology may well be irrelevant to a local knowledge base, since these biological parameters have no influence on subsistence practice (Hamilton and Walter 1999).
5. While local knowledge of recent changes in the abundance or size structure of local fish stocks will often be very accurate, local explanations for the mechanisms underlying these changes may not be compatible with scientific paradigms: "In some places declining yields may be attributed to sorcery or a failure to propitiate the gods." (Ruddle et al. 1992:262).
6. Fishers' knowledge, like scientists', is fallible, and this cultural information needs to be gathered systematically and treated with the same critical scrutiny that is applied by scientists to any other data set (Johannes et al. 2000).

Methods

Study sites

The local knowledge of *E. polystigma* reported on here was documented from New Ireland and Manus provinces in Papua New Guinea and Roviana Lagoon in the Western Province of the Solomon Islands (Fig. 1).

Community liaison and interviewing procedure

In each region where local knowledge surveys were conducted, we attempted to cover as wide a geographical area as possible, focusing on communities known to be heavily dependent on marine resources. The authors' knowledge of a region, word of mouth, and any available unpublished or published literature were used to determine where we placed our main efforts. In each region, the surveys lasted for approximately two weeks. Upon arrival we asked to speak to community leaders, and would introduce ourselves and explain our agenda. Typically, they would then call a group of available expert fishers together, under a tree or by the beach. We then introduced ourselves and gave an introductory talk on the life cycle of aggregating fishes, over viewing among other things, aggregating behaviour, spawning, pelagic larval stages of fish, and sex reversal. We then pointed out that al-

though biologists knew a lot about fish biology, we knew nothing about where or when spawning aggregations occurred on reefs in the region we were now in, which is why we wanted to ask local fishers for their help. We ended by clearly stating that the information we were collecting was part of a preliminary assessment of spawning aggregations that we were making in their region, and specific details on locations of sites and other sensitive local knowledge would remain confidential.

These introductory talks frequently generated a great deal of interest, and served as a very effective way of initiating conversations on reef fish aggregation sites. Fishers often enthusiastically shared their own observations and asked numerous questions on spawning aggregations. Reef fish guide books and posters showing the main target species of the LRFFT were used as visual aids, so that fishers could show us what species aggregated on their reefs. Importantly, these introductory talks also served as a quick way of assessing the level of local knowledge of spawning aggregations in the area visited. If we drew completely blank stares from all fishers at the completion of a talk and further inquiries confirmed that no such aggregations were known to occur on surrounding reefs, then we moved onto the next location fairly quickly. On the other hand, when we discovered an area that had a wealth of knowledge about reef fish aggregations, we often asked to

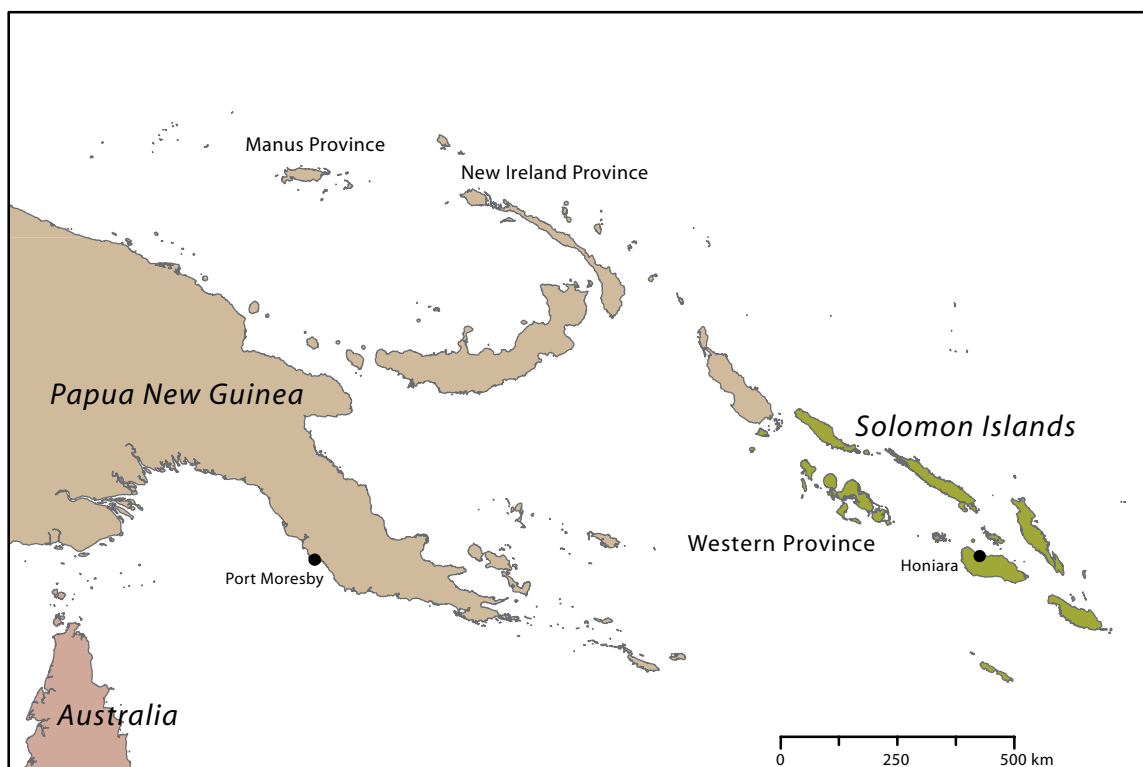


Figure 1. Manus and New Ireland provinces in Papua New Guinea, and Western Province in the Solomon Islands.

stay for a few nights so that we could get to know the fishers and learn as much as possible. In these instances we also asked local experts to take us to known aggregation sites, so that we could observe aggregation habitats and collect GPS coordinates on aggregation boundaries.

Individuals or groups of knowledgeable fishers who were willing to be interviewed in detail were asked a wide range of questions on reef fish aggregations that occurred within their fishing grounds.⁴ The questions laid out in the Society for the Conservation of Reef Fish Aggregations (SCRFA) questionnaire (<http://www.scrfa.org/scrfa/studying/introduction.htm>) formed the template of the questions covered. Interviews were conducted in Tok Pisin and Solomon Islands Pijin.

Results

Local knowledge of *E. polystigma* aggregations in New Ireland Province, Papua New Guinea

Aggregation 1

When conducting interviews with fishers in New Ireland province we were provided information on the location and timing of a large and recently discovered nocturnal grouper aggregation (Hamilton et al. 2004). This species, known locally as *avou*



Figure 2.

A sleeping *E. polystigma* lying on its side in very shallow water.

Figure 3.

A sleeping *E. polystigma* in slightly deeper water resting on its belly.



(later identified as *E. polystigma*) is reported to be common in river mouths and brackish mangrove regions around the island. Fishers report that the species is solitary and wary by day, and they regard the fish as “sneaky” due to its habit of “stealing” crabs knocked from mangrove roots by banded archerfish (*Toxotes jaculatrix*).

The aggregation site was first discovered in early 2003 by local fishers hunting for mud crabs. The finding was made at night during low tide, with fishers reporting large numbers of loosely dispersed *E. polystigma* sleeping in very shallow water among mangrove roots and on shallow sandy and rocky substrate at the mouth of a large remote estuarine bay. Fishers reported that the fish were in ankle-deep water and that catch rates were about 50 fish hr⁻¹ from a small area (>5000 m²). Fish were captured by simply using a bush knife to cut the sleeping fish in half.

The fishers who discovered this aggregation noted that the night on which they discovered it coincided with peak aggregations of squaretail coral grouper (*Plectropomus areolatus*) that are known to form in this region. Fishers presumed that *E. polystigma* aggregations might also display a predictable lunar aggregation pattern. Fishers reported that over the previous year they had returned to this site on a near monthly basis at various lunar stages, and they were in agreement that *E. polystigma* aggregations occur each month approximately a week prior to the new moon. Fishers were unable to state whether captured fish from these aggregations were running ripe.

Exploitation of this recently discovered nocturnal aggregation appears to be growing as

4. These local knowledge surveys produced a wealth of information on a great number of species that are not dealt with in this paper. For detailed findings of these surveys refer to Hamilton 2003; Hamilton et al. 2004 and Hamilton et al. 2005.

fishers from nearby villages learn of its location and timing, although fishing has been limited to subsistence use. It is noteworthy that the aggregation is not targeted every month as fishing is limited to aggregation periods that coincide with low nocturnal tides. Fishers have not yet investigated the aggregation boundaries, since all the fish required for subsistence can easily be collected within the limited aggregation area initially discovered.

Field observations

At 10 p.m. on 19 January 2004, three days prior to new moon, we accompanied a local fishing party to the recently discovered *E. polystigma* aggregation site during low tide. We immediately located several *E. polystigma* sleeping on the sand and mud against stones or mangrove roots in 10–20 cm of water. Larger fish that were in very shallow water were lying on their sides, presumably to keep their gills irrigated, while fish in slightly deeper water often had their bellies resting on the bottom (Figs 2 and 3).

An identification of the species was made from the first fish speared (Fig. 4).

Over the next 50 minutes we sighted approximately 30 individuals and captured 18 in an area of approximately 4000 m² (Fig. 5). Fish were located by flashlight and speared with a handheld spear.

Fish were patchily distributed in small clumps over a fairly large area. At times we walked for several minutes without seeing a single fish; other times we observed 5–6 individuals in an area of ± 100 m². We never observed two individuals in close proximity to one another. Larger *E. polystigma* remained motionless regardless of the amount of disturbance we made and even the repeated flash of a camera did not disturb them. In contrast, smaller individuals had pronounced swollen bellies, were much more skittish and more numerous than big fish, and would often dart away before they could be speared. No *E. polystigma* were seen in water deeper than 20 cm, and no other fish species were observed.



Figure 4.

A very recently captured male *E. polystigma*. Small yellow (sometimes white) dots covering most of the body can be seen on the caudal and dorsal soft fin rays in this specimen, hence the name white-spotted grouper.



Figure 5.

Two local fishermen holding up their catch. The fisherman on the left is holding the handheld spear used to capture the fish.

Sex specific size structure and sex ratio

The 18 *E. polystigma* sampled were measured (nearest mm, total length) and sexed macroscopically. Fish were not weighed at capture. All individuals were ripe and were easily sexed in the field. Ripe ovaries were dark orange with a mass of oocytes clearly visible when cut transversely. Males were running ripe with a white compact testes and extractable milt. All male gonads were substantially smaller than those of females (Fig. 6).

Male and female *E. polystigma* had a pronounced bimodal size distribution, with no overlap in the size range of the sexes (Fig. 7). Females outnumbered males 2:1 in this sample. Given that all small (presumably female) individuals were more skittish and harder to capture than large (presumably male) fish, females were probably under represented in this sample.

Aggregation 2

Information on another *E. polystigma* aggregation in New Ireland was documented by one of the authors (TP) in 2006 and 2007. This *E. polystigma* aggregation occurs along the mangrove-lined edges of a

seaward facing channel in the Tigak Islands. Aggregations are known to occur prior to the new moon in most months of the year. Aggregated *E. polystigma* are captured with gill nets, handheld spears and spearguns.

Highest catches are made by fishers using spearguns and underwater flashlights at night. Fishers report that this species is rarely caught on a fishing line. Interviewees state that the location and periodicity of this aggregation has been known to a limited number of fishers for decades, but historically, fishing this aggregation was only for subsistence purposes. Support for this claim comes from extensive surveys of artisanal fisheries in the Tigak Islands in the early 1980s. No *E. polystigma* was recorded in the artisanal catches from the Tigak Islands in the early 1980s (Wright et al. 1983). In the late 1980s, underwater spearfishing (day and night) became common throughout the Tigak Islands (Hamilton et al. 2005), and it may be that this practice led to many more fishers discovering and subsequently exploiting this aggregation site.

Currently, fishers from six nearby communities exploit this aggregation site for the specific purpose of selling *E. polystigma* in Kavieng. On several oc-

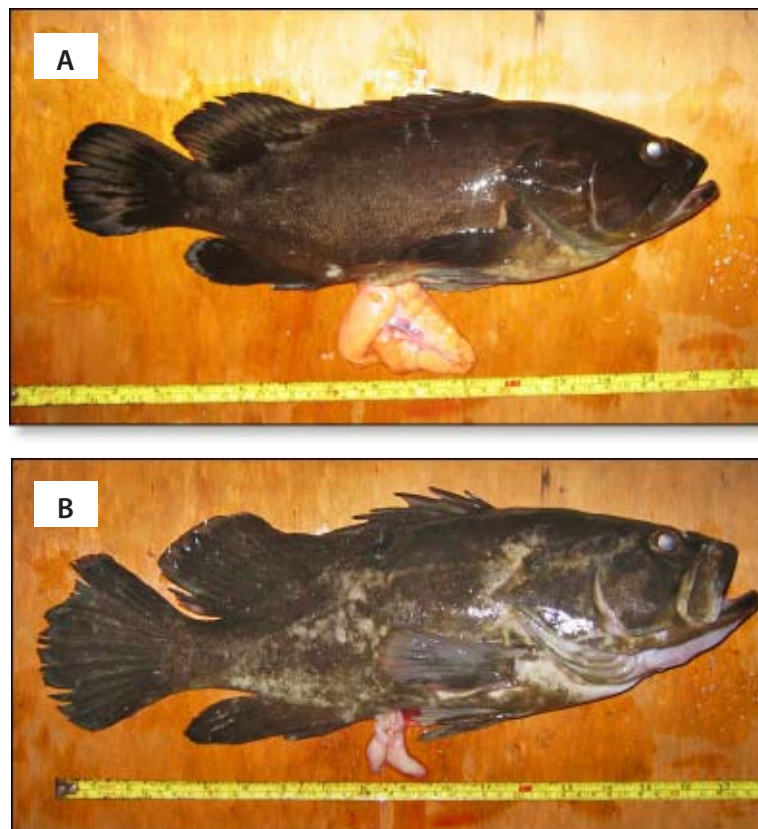


Figure 6. Top: Gonads of a ripe 305-mm female;
Bottom: Gonads of a ripe 475-mm male.

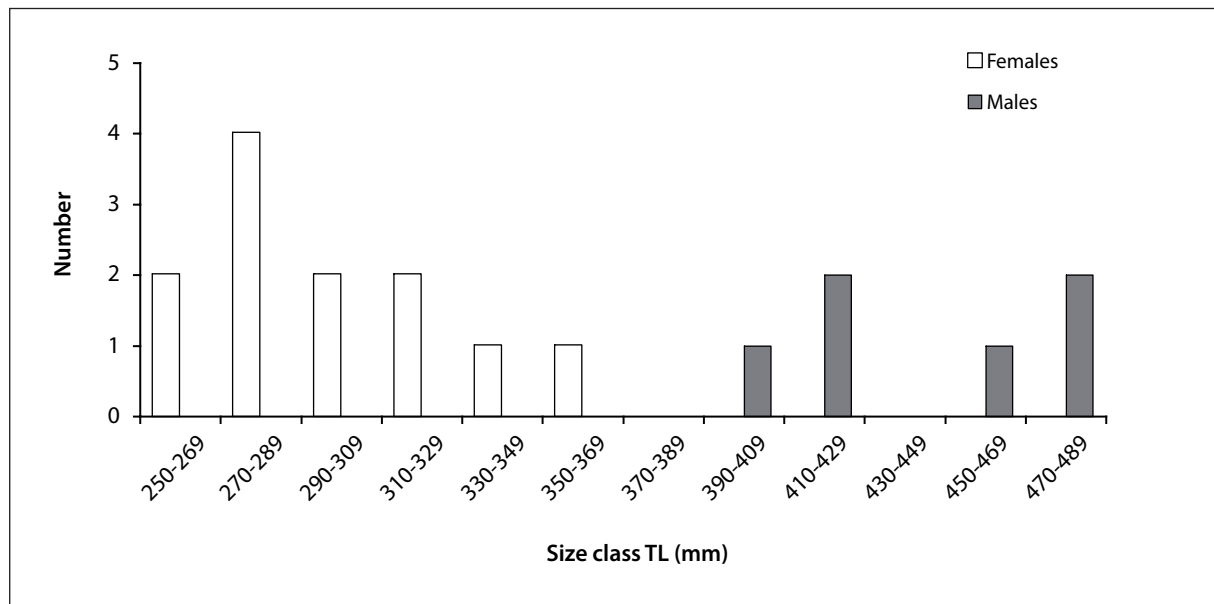


Figure 7. Size frequency distribution of *E. polystigma* in 20 mm size classes (n=18).

casions in 2006 and 2007, one of the authors (TP) observed catches of *E. polystigma* in excess of 50 individuals (that were captured from this aggregation site) being sold to local fish buyers in Kavieng. Interviews with local fishers in 2007 revealed that catch rates at this *E. polystigma* aggregation site were in decline. The attractive prices currently being offered for all grouper species in Kavieng appears to be driving heavy exploitation of this and other grouper spawning aggregation sites in the Tigak Islands.

Local knowledge of *E. polystigma* aggregations in Manus Province, Papua New Guinea

In Manus we documented local knowledge of two *E. polystigma* aggregations: one that appears to already have been seriously overfished, and the other, which appears stable. Information on the first of these aggregations was documented in 2003 when Pomat Powayai, a Manus fisheries officer, told one of the authors (RH) about large aggregations of two estuarine cod species that formed monthly in a shallow estuarine bay near his village over a five-day period prior to a new moon. Females of both aggregating species are known to be gravid at this time (Hamilton 2003a). In 2003, Powayai identified one of these aggregating estuary cod as *Epinephelus coioides*. The other fish was said to be absent from available coral reef fish identification books and, thus, not identified. In January 2004, we again interviewed Powayai about these aggregations and showed him digital photos of *E. polystigma* captured

in Kavieng. He confirmed that *E. polystigma* was the other cod that aggregates in the estuarine bay near his village. This Manus aggregation of *E. coioides* and *E. polystigma* was discovered in the 1970s, and initial catch rates of these two species were said to exceed 200 fish per night. Fishing pressure has had a marked impact on these aggregations, with current catch rates being several magnitudes lower than original catch rates (Hamilton 2003a), and continuing to decline (Pomat Powayai pers. comm. January 2004).

In 2004 we documented local knowledge of another *E. polystigma* aggregation, located on the south coast of Manus (Hamilton et al. 2004). In this region of Manus *E. polystigma* is known as *kali moniol*. This *E. polystigma* aggregation site occurs on very shallow, muddy inner reef areas that are in close proximity to mangroves. *E. polystigma* is said to only ever be present at this site on the first and second day of the new moon in every month of the year. Fishers believe that *E. polystigma* aggregate for the purpose of spawning, based on the fact that all captured females are gravid and captured males are always running ripe. Fishers we interviewed were unable to give us an estimate of aggregation numbers, stating that the extremely poor visibility of this site limited their ability to estimate the size of aggregations. However the aggregation area appears to be small, with fishers estimating that the total aggregation area was less than 10,000 m². Daytime spear-gun fishing appears to be the main method used to exploit this aggregation, although fishers who

were interviewed stated that this fish will also take a baited hook.

Our main informant on this aggregation was an expert spear fisherman who is renowned in his village for his local knowledge. He has consistently targeted this aggregation site for over a decade, and had an interesting method to enhance his chances of capturing this species from the aggregation site. He reported that the very dark colour of this species combined with the muddy substrate and very poor visibility at the aggregation site made it difficult to spot *E. polystigma*, which are typically lying motionless on the mud. He stated that when he first started spearfishing at this site he would often only see *E. polystigma* when he had disturbed them and they were darting away. To enhance capture rates, he sinks coconut fronds within the aggregation area several days prior to the known aggregation period. When he returns during an aggregation period, *E. polystigma* are often sheltering under the coconut leaves, with their eyes clearly visible. They are much easier to spear as they are reluctant to flee from the shelter provided by the coconut frond.

This particular aggregation site appears to be stable, with the spear fisherman who regularly exploits this site stating that the maximum number of *E. polystigma* he caught in a single trip was approximately 15, and that his maximum catch had not declined in the 10 years he has been fishing this site. It appears however that fishing on this aggregation site is limited, as only a few individuals knew of the location and timing of this aggregation, and even those spear fishers that were aware of it often did not target this area due to the very poor visibility.

Local knowledge of *E. polystigma* aggregations in Roviana Lagoon, Solomon Islands

In mid-2000, the late Robert Johannes asked one of the authors (RH) to interview fishers in Roviana Lagoon about their knowledge of the behaviour and status of *E. polystigma* populations in this region. At the time, RH was residing in Nusabanga village, Roviana Lagoon and was completely unaware of this species, having never seen it in local catches. However interviews with several older fishers revealed detailed information on past *E. polystigma* fisheries in this region. Known as *kobili* in the Roviana language, *E. polystigma* is reported to have once been very abundant in the shallow inner lagoon areas directly surrounding Nusabanga village, and easily captured at night. In the 1950s when the island of Nusabanga was settled, fishers reportedly caught

over 50 *E. polystigma* in a night. *E. polystigma* were speared in very shallow water, using burning coconut fronds and later flashlights as a source of light. Interviews did not reveal any information on the reproductive state of captured *E. polystigma* or the best lunar times to capture this fish.

The very close proximity of Nusabanga village to *E. polystigma* fishing grounds had rapid negative effects on this population, with older fishers reporting that *E. polystigma* catch rates quickly declined and had completely disappeared from inner lagoon areas around Nusabanga by the early 1970s. Indeed, an experienced Nusabanga fisher in his early thirties who came across and speared two *E. polystigma* in 1998 had to ask his father to identify these fish, having never seen this species before. Over the uninterrupted 12-month period that RH resided in Nusabanga village (August 2000–July 2001), only once did he examine two *E. polystigma*. A Nusabanga fisher speared both specimens at night on 28 November 2000 (two days after the new moon) in shallow water in the inner lagoon adjacent to Nusabanga village. These two *E. polystigma* were 510 mm and 470 mm long (1.6 kg and 1.35 kg total weight), and could not be sexed macroscopically because they had no obvious gonad development.

Discussion

Information documented in the New Ireland and Manus local knowledge surveys and that obtained by interviewing elderly Roviana fishermen has enabled us to fill in some of the data gaps pertaining to the ecology of *E. polystigma* and its susceptibility to fishing. Local knowledge indicates that this species is normally solitary, with aggregations only occurring at specific sites in the days leading up to and including the new moon. Aggregations are reported to occur in every month of the year, and form in very shallow water in close proximity to mangroves. Manus local knowledge of this species indicates that aggregating *E. polystigma* have ripe gonads, an assertion that is supported from our field observations in New Ireland.

The lunar periodicity with which aggregations form, and the fact that aggregated females are gravid, provides indirect evidence for reproductive activity at or near the known aggregation sites. Although we have not been able to prove that these aggregations definitely represent spawning aggregations (Colin et al. 2003)⁵, all available evidences indicates these periodic *E. polystigma* aggregations are occurring for the purpose of spawning, a behaviour trait that is characteristic of this family. Interestingly, local

5. Unequivocal evidence of spawning requires observing actual spawning or demonstrating the presence of hydrated eggs or post-ovulatory follicles in the ovaries of aggregating females (Colin et al. 2003).

knowledge relating to the lunar periodicity and annual seasonality with which *E. polystigma* aggregations form is identical to local knowledge of square-tail coral trout (*Plectropomus areolatus*) aggregations. Many local fishers throughout Melanesia know that spawning aggregation of *P. areolatus* occur prior to the new moon in every month of the year, assertions that have been validated through underwater monitoring programmes at multiple spawning aggregation sites in Melanesia (Smith and Hamilton 2006).

The pronounced bimodality and female bias sex ratio observed in the New Ireland sample of *E. polystigma* suggests the possibility of monandric protogynous hermaphroditism (adult female to male sex change), a sexual mode of development that typifies the serranids (Sadovy 1996). However, the sample size presented here is very small, and bimodal size-frequency distributions and female-biased sex ratios are non-specific features that may have many causes, only one of which is protogyny (Sadovy and Shapiro 1987). In some cases presumed protogynous species have been shown to be gonochoristic (sexes separate throughout life) upon histological examination (Sadovy and Domeier 2005b; Hamilton et al. 2007). A conclusive diagnosis of the sexual pattern of *E. polystigma* will require histological examination of gonads from representatives of all size classes of this species (Sadovy and Shapiro 1987).

Despite the uncertainty concerning aggregation function and the sexual ontogeny of this species, one thing is absolutely clear: the remarkable ease with which these aggregations can be exploited makes the species highly susceptible to overfishing. Moreover, the larger size and placid nature of males creates a scenario for selective fishing that could easily skew the sex ratio for the aggregation, resulting in reductions in reproductive output (Koenig et al. 1996).

For example, subsistence fishing alone appears to have essentially wiped out an *E. polystigma* aggregation in Roviana Lagoon as early as the 1970s, and in Manus a historically large aggregation site for *E. polystigma* and *E. coincides* has been significantly overfished by subsistence fishers in several decades. These findings concur with Johannes (2001), who reports that in Isabel Province in the Solomon Islands, this species is rare in those mangrove and estuarine areas in close proximity to human settlements. Finally, it seems highly unlikely that the recent artisanal exploitation of one of the two known *E. polystigma* aggregations in New Ireland is sustainable.

Our synthesis of Melanesians' local ecological knowledge of *E. polystigma* permits some preliminary conclusions about this fish. It appears that *E. polystigma* meets many of the IUCN Red List crite-

ria that make this fish family, as a whole, particularly vulnerable to fishing. It forms aggregations at predictable times and locations that are extremely easy to overfish, it is exploited throughout much of its range, its populations are in decline, and it has a limited geographical range. Clearly, further studies of this species are needed, including a detailed analysis of its reproductive biology, spatial distribution, spawning season and sexual pattern. Until that time, special management is warranted that should include restricting known aggregations from fishing. Perhaps, more importantly, local village leaders and fishers should be made aware of the species' vulnerability through aggregation fishing through a sharing of information on declines of aggregations and populations elsewhere.

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The role of taboos in conserving coastal resources in Madagascar

Joshua E. Cinner

Abstract

This paper examines the role of taboos in limiting the exploitation of marine and coastal resources in Madagascar. I surveyed 13 communities within and adjacent to all five of Madagascar's national marine parks. The presence of food and/or species taboos and gear restrictions is widespread, with sacred areas in three national marine parks. However, only one sacred area restricted fishing. Although customary management in the Pacific is often implemented adaptively to manipulate resources, in Madagascar, taboos are highly inflexible and some communities have resisted attempts to amalgamate them with contemporary conservation methods.

Introduction

Taboos are widespread throughout Madagascar and Malagasy speaking areas in the Western Indian Ocean (Lambek 1992; Ruud 1960). Taboos form a significant part of Malagasy life; they are central to reckoning status and position in society and are frequently used to define social groups (Lambek 1992; Walsh 2002). For example, the name of many social groups begins with the negative participle *tsy* based on taboos specific to that group (Lambek 1992). For example, the Tsimihety people are "those that do not cut their hair" (Lambek 1992).

A number of studies have described Malagasy taboos (e.g. Ruud 1960) and their social role in society (Lambek 1992, 1998; Walsh 2002). However, few have examined taboos that restrict resource use and their potential roles in conservation (Bodin et al. 2006; Lingard et al. 2003; Jones et al. 2006; Loudon et al. 2006; Schachenmann 2006), particularly in the marine environment (Langley 2006). Studies in Papua New Guinea, Indonesia, and Kenya have shown that traditional conservation practices can conserve marine resources (Cinner et al. 2005, 2006; McClanahan et al. 1997). However, little is known about Malagasy marine resource taboos and the degree to which they differ from the widely studied customary management practices in the Pacific.

The objective of this paper is to examine taboos regulating resource use within and adjacent to all of Madagascar's national marine parks by documenting and, where possible, providing some history and context relevant to Malagasy customs and taboos about marine and coastal resources. This research was conducted as part of a project to catalyse

a socioeconomic monitoring programme for Madagascar's marine protected areas (MPAs). Collecting information about customary management at these sites was only a minor objective in the monitoring programme, and so had to be balanced with other data needs. Thus, the information I present is not necessarily as detailed as studies primarily focusing on customary management (e.g. Hviding 1996, 1998; Hickey 2006). Nonetheless, given the importance of Madagascar as a conservation hotspot (Myers et al. 2000) and the dearth of information about the role of taboos in conservation there, I attempt in this paper to provide a useful account of coastal resource taboos in a timely fashion.

Methods

I conducted socioeconomic studies in 13 communities within or adjacent to all five of Madagascar's MPAs. These were: 1) Sahasoa (Nosy Atafana MPA), 2) Nosy Barifia, 3) Nosy Valiha, 4) Antranokira (Sahamalaza MPA), 5) Marofototra, 6) Ambodiforaha (Tampolo MPA), 7) Ambodilaitry, 8) Ambinaibe and Ankitsoke (Cap Masoala MPA), 9) Antsobobe, 10) Ankarandava, 11) Andomboko, 12) Tanjona, and 13) Ifaho in Tanjona MPA (Fig. 1). Technically and administratively, Tampolo, Tanjona, and Cap Masoala MPAs are all part of the Masoala National Park. I selected villages that encompassed a range of geographical, social and economic conditions, which included population size, development, history/length of settlement, and dependence on marine resources.

I spent between one and two weeks collecting data in each park between September and November 2005, and used a range of quantitative and qualitative techniques to gather information, including

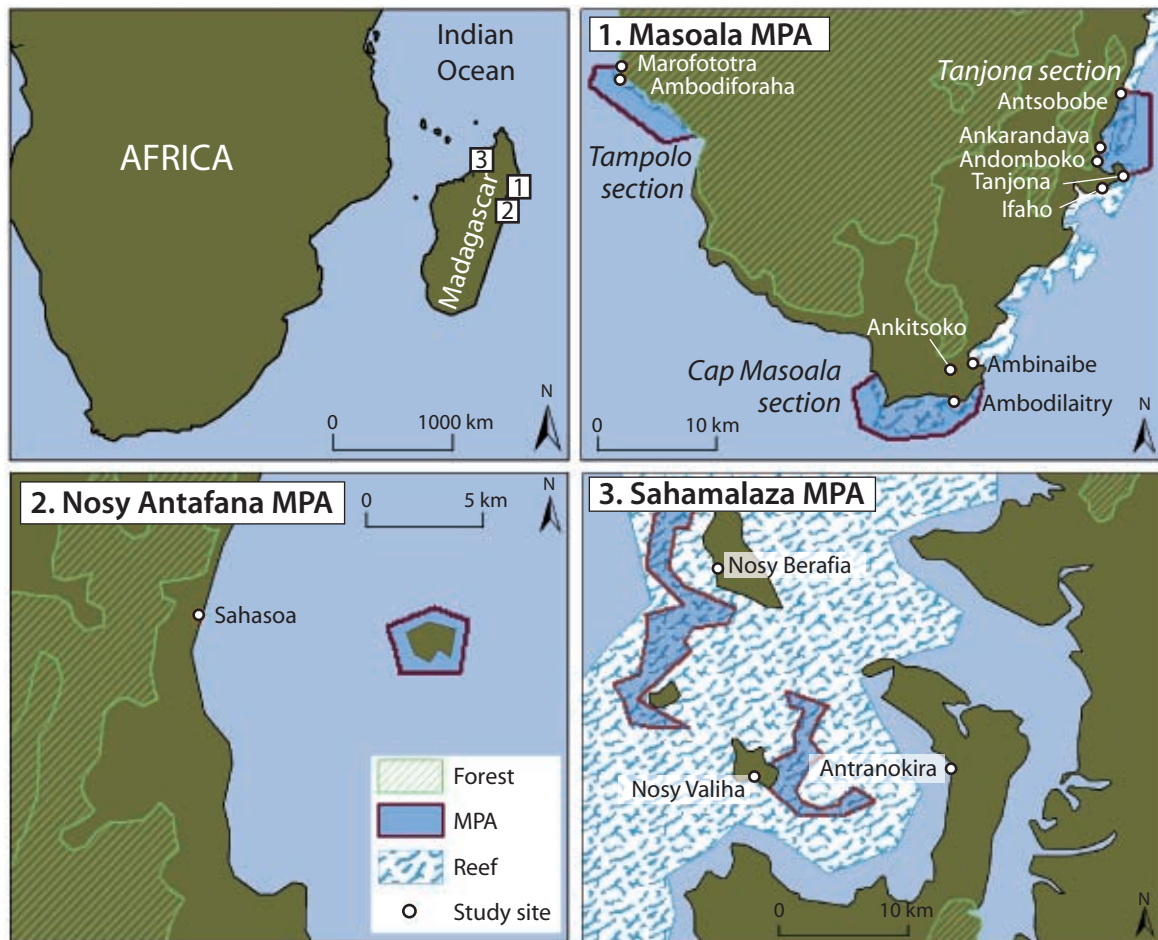


Figure 1. Study sites

systematic household surveys (Cinner 2005), key informant interviews, participant observation, and oral histories. I conducted between two and five key informant interviews per park. Key informants included village leaders, elders, a local queen in the Sahamalaza region, and other community members that were knowledgeable about resource use and taboos. I used between two and three Malagasy assistants at each site to administer surveys and translate. I also employed a local guide at each village to help with introductions and avoid local taboos.

Sampling of households within villages was based on a systematic sample design, where we sampled a fraction of the community (e.g. every 2nd, 3rd, or 4th household) (Henry 1990; de Vaus 1991). The specific sampling fraction for each community was determined by dividing the total village population by the sample size we aimed to collect.

In very small communities (<30 households), I attempted to survey every household (but never achieved this because of longer-term absences of specific residents). For the purposes of this study I

have defined a household as people living together and sharing meals. The number of surveys per park ranged from 43–70. The number of surveys per community (within each park) ranged from 7–44, depending largely on the population of the village, and the available time per site (this was influenced by factors such as weather, the availability and frequency of transportation to certain sites, and budget requirements). In total, 264 household surveys were conducted, of which 55% were fishers.

To determine awareness and compliance with fisheries management regulations, fishers encountered during the household surveys were asked whether there were any taboos or restrictions on fishing areas, time, species, size or gear. Fishers were then asked if people still engaged in the restricted practice. If they mentioned that people did not comply with the regulations, they were then asked if most people broke the regulations or just a few. I attempted to separate the traditional restrictions (i.e. taboos) from the contemporary restrictions resulting from MPAs or fisheries management, although sometimes this distinction was unclear.

I organised results from the survey information into the following thematic categories: 1) local institutions governing marine resources, 2) connections to ancestors, 3) sacred places, 4) food and/or species taboos, 5) temporal restrictions, 6) gear restrictions, 7) sea spirits, 8) marine tenure, and 9) compliance. In these sections, I also included examples from other relevant studies.

Local institutions governing marine resources

There are two types of informal institutions governing coastal resources in Madagascar: *fady* and *dina*. A *fady* is a taboo that constrains a particular activity in a specific location (Langley 2006). A *fady* may be limited to a particular family or lineage and so does not necessarily have an impact on the entire community. A *dina* is a local law based on Malagasy social code (Rakotoson and Tanner 2006). In general *dina* is codified, signed by the village president and relevant stakeholders, and recognised by the national government (Langley 2006; Rakotoson and Tanner 2006). Although *dina* can be used to regulate coastal resources code (Rakotoson and Tanner 2006), this was not the case in any of the sites studied. As a result, this paper focuses on the role of *fady* in regulating coastal resources.

Connections to ancestors

Ancestor worship is widely practiced throughout Madagascar. In a related study, Cinner et al. (2006) reported that 60% of the 264 the households surveyed throughout Madagascar's MPAs followed traditional beliefs of ancestor worship. Walsh (2002) notes how many ceremonies and rituals are used by Malagasy social groups as exchanges of service for blessings between descendents and ancestors. Re-

specting certain codes of conduct, such as taboos, may also be seen as an offering or service in exchange for the blessings of ancestors (Walsh 2002).

Generally, spiritual leaders liaise between the living and their ancestors. Responsibilities of these leaders include overseeing ceremonies, making sacrifices, and, when needed, consulting ancestors for advice. Spiritual leaders can include elders, royalty (kings and queens) and mediums (those considered to have supernatural connections) (Walsh 2002). For example, in the Sahamalaza region, spiritual connections are mediated largely by a queen, whom I interviewed. Her responsibilities include presiding over day-to-day spiritual matters, leading an annual ceremony, and communicating with ancestors. She communicates with ancestral spirits through dreams and direct communication to learn about the future and which medicinal plants can cure specific illnesses. The origin of her royalty status is that she is descended from an African king (Ndraman-disoaravo is the reported name on the tomb), who brought rice and other plants to Madagascar from Africa. Because he brought what is considered a superior food to the sorghum that people were growing before, the king and his descendents remained royalty.

Sacred places

There are sacred places within the Sahamalaza, Cap Masoala, and Nosy Antafana MPAs (Table 1). In the Nosy Antafana MPA, there is a small (20 m x 10 m) spring on one of the park's islands (Fig. 2). There are several taboos associated with the spring: 1) no fishing, 2) no swimming, and 3) no defecating or urinating anywhere on the island. There is no taboo prohibiting people from fishing in the ocean adja-

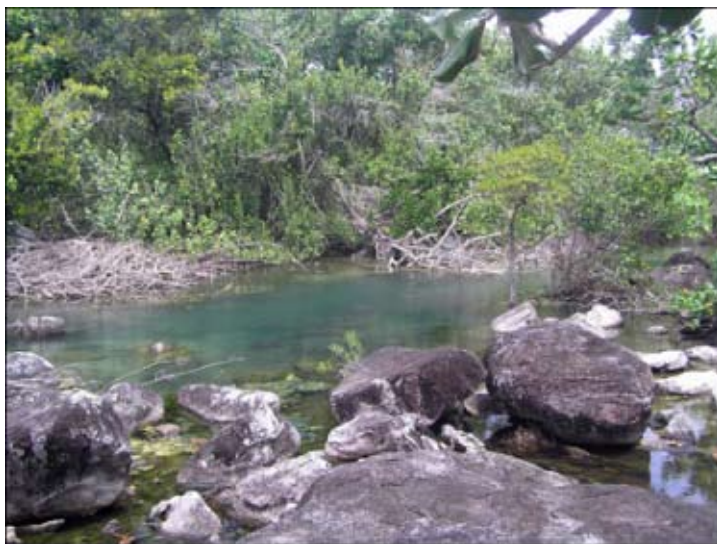


Figure 2. Sacred lagoon in Nosy Antafana.

Table 1. Presence of specific taboos mentioned by fishermen and key informants at each park. Taboos are grouped into four broad categories: Sacred areas, food, time and gear. Taboos under these headings are organised in descending order based on the frequency of responses. Thus, more people mentioned taboos on consuming guitarfish than on pufferfish.

Description	Tanjona	Cap Masoala	Tampolo	Sahamalaza	Nosy Antafana
Sacred areas					
Sacred area		X		X	X
Food (marine species)					
Guitarfish	X	X	X	X	
Turtle	X	X	X	X	
Pufferfish (and their eggs)	X		X	X	
Dugong	X	X	X		
Dolphin	X	X	X	X	
Red parrotfish	X	X			
Whale	X	X		X	
Sea cucumber	X				
Sardine (October– January)	X				
Other*	X		X	X	
Time					
Work in fields on Thursday	X	X	X	X	X
Work in fields on Tuesday	X	X	X		X
Work in fields on Monday			X		
Work on Sunday	X		X		
Work in fields on Wednesday		X			
Fishing on Saturday				X	
Gear					
Traps	X	X		X	
Speargun			X		X
Wier				X	
Use black line/rope				X	
Total	14	11	11	12	4

* Including electric and poisonous fish, cardinalfish, juvenile fish, stingray, octopus, algae and big fish that drive smaller fish to shore.

cent to the spring. This island forms the core of the MPAs no-take reserve, so fishing around the island is prohibited by law but not by the taboo.

There is no monetary fine or penalty for breaking the taboo of fishing in the lagoon, but rather supernatural sanctions. Two examples of these supernat-

ural sanctions were provided by respondents. First, the last person to fish in the sacred lagoon slipped and hit his head on a rock, knocking himself unconscious. Second, there were reports of an Italian tourist who broke the taboo by going to the toilet on the island. Reportedly, two of his sons fell sick on the island and died shortly thereafter. Their local

guide was also killed in a boat accident as they left the island. Informants did not know when the taboo started or what its origin was, but according to local legend, the spring is said to be part of a river from the village of Sahasoa that comes up on the island and continues underwater till it reaches the Masoala peninsula. Respondents suggested that there used to be more fresh water in the spring and our guide's grandfather remembered when freshwater fish were abundant there. In those days, the villagers captured fish by making a sacrifice that would serve to "call" the fish from the lagoon. The fish would leave the pond and swim to the sea, where they would be caught.

There are several sacred areas in the Sahamalaza MPA. On Nosy Berafia Island, there are five sacred areas (four in the south of the island and one in the north), although only the northern one is aquatic. A large rock on the northern tip of island and an adjacent shallow reef that is sometimes exposed during low tides, are both considered sacred because the area is used as a ritual sacrifice. The purpose of the sacrifice is to ask for rain, to prevent disease (e.g. cholera), and to ask for protection. Usually a *zebu* (cow) is sacrificed and the belly is placed on the exposed reef. The sacrifice takes place usually in October or November, but the exact date depends on the local intermediary's communication with spirits. People can fish there, but are not allowed to go to the toilet there.

In the southern end of Nosy Berafia is a house near the former king's place that is used for traditional purification. Three trees on the island are considered sacred. The history of one of these trees dates back to when the ancestors brought a local king's body for burial on the island. They constructed a raised platform to place his body on so it would not touch the ground. One of the posts from this platform sprouted and grew into a tree, which is now considered sacred. The tree is fenced off approximately 10 m around, creating a small grove (e.g. Bodin et al. 2006). No one is allowed inside the fence, except to pray. There is no collecting firewood or cutting trees inside the fence and nobody is allowed to go to the toilet anywhere near it.

On neighbouring Nosy Valia, there is one sacred area where ancestors prayed so that they could stay on the island (the circumstances surrounding this were not clear). That place has remained sacred and people now pray there for productive crops and/or fishing. The only prohibition associated with the taboo is that people don't take firewood around 50 m from that area.

The only sacred area encountered in this research that restricts fishing is between Ambodilaitry and Ambinambe villages at the Cap Masoala MPA. Be-

tween the villages is a headland that is considered particularly sacred, and is the location of an ancestral tomb and important spiritual ceremonies. Several taboos are associated the area: 1) there is no fishing anywhere around the headland (although descendants of the first settlers are said to have a spiritual connection to the place and can fish closer than others); 2) people are not supposed to wear a uniform or even pants when approaching the headland (one has to wear a sarong); 3) nobody is allowed to have their head covered when approaching the headland (for example, one must take their hat off as they pass the area by boat); 4) menstruating women may not pass by boat (they must walk around on a trail that is well out of view of the headland); 5) certain types of food may not pass the point; and 6) no hunting is allowed near the headland. Only the elder (*Tangalamena*) from Ankitsoko can take people to the headland. The communities believe that supernatural retributions for transgressing these taboos are severe. While surveying the neighbouring village of Ambinambe, one child was severely ill and had large (10–15 cm) growths emanating from his eye socket and cheek. People explained that the boy's father had been hunting near the sacred area and captured a lemur. He killed the lemur by hitting it over the head, which dislocated its eye. The community viewed the son's illness as the consequences of the father hunting near the headland. Consequently, the family was unwilling to take the child for medical attention because of a fatalistic view of the son's outcome.

Langley (2006) also documents several sacred areas that prohibit fishing around Andavadoaka, in southwest Madagascar. Fishing is strictly forbidden around Andavadoaka rock (Ambatoloaka) and nobody is allowed to touch the rock or swim through a natural arch created by the rock. Similar to the sacred lagoon at Nosy Antafana MPA, the supernatural sanctions for violating the taboo are not believed to be restricted to Malagasy. Langley (2006) notes:

There are several local stories emphasizing the serious consequences attached with breaking this local taboo, or *fady*. It is widely reported in the village that a few years ago a French visitor, or *vazaha* (foreigner), was snorkelling around Andavadoaka rock. A local fisherman saw him and warned him not to touch the rock or to swim through the arch. He didn't listen, and shortly afterwards the fisherman saw him passing through the forbidden archway. By the time he had arrived back on shore the effects of breaking the *fady* were beginning to show, and he was unable to speak. Breaking the *fady* had somehow caused him to lose the power of speech. Unfortunately, there were more effects — a

serious fever set in and he became seriously ill. Many people in the village were very concerned and arranged for a car to take him to Toliara. According to the story, the visitor died in Toliara five days later.

It is also taboo to fish, swim or snorkel around a tabular shaped rock to the north of Andavadoaka, known as tern rock (Langley 2006). Langley (2006) notes that, "Many fishers believe that a giant octopus lives under this rock. The octopus is very powerful and controls many things at sea. There is an elder in the village who has the ability to communicate with the octopus, often in need of appeasement, through dreams." Taboos in the Andavadoaka area also extend to mangrove resources. Langley (2006) notes "it is forbidden to exploit any natural resources within the mangrove forest, dominated by the species *Avicenia marina*, south of the island of Nosy Mitata. Fishing, cutting mangrove trees and relieving oneself are strictly forbidden."

Food and/or species taboos

There were food or species taboos recorded everywhere except the Nosy Antafana park (Table 1). At Antranokira (the mainland village studied in the Sahamalaza MPA) it is taboo for certain families to eat pork or lemur, *zebu* without horns, white and red *zebu*, and octopus. It is taboo to take ginger root anywhere near the region (there is a landmark tens of kilometres to the south of the village beyond which ginger is not allowed). It is prohibited to even touch lemurs or octopus. The story of the octopus prohibition is as follows: The ancestral grandfather of the queen of the region was walking by a lagoon while fishing for octopus. He saw an octopus opening its tentacles in the sun and tried to touch the octopus but was grabbed and held by it until the tide came up. Now, people believe that bad things will happen if they eat octopus. Bad things include getting rashes and sores. To cure these rashes and sores, people have to go to an ancestral temple tens of kilometres south of the village and drink water from a special bowl. Then an ancestral spirit advises what to do next. The story of the lemur taboo is as follows: There were once lemurs staying in a sacred place (although this exact location is unclear now). The people wanted to eat lemur meat, so they threw rocks at the lemur. The lemur put his hands up in a gesture indicative of "don't throw rocks at me". The people continued to throw rocks and eventually hit the lemur with a rock. When the lemur fell to the ground dead, the person who threw the rock fell dead at the same time. People now believe that bad things will happen to them if they kill lemurs.

On nearby Nosy Valia Island, it is taboo to throw stones at crows. Informants did not know why but

suggested it is somehow related to the king that owned neighbouring Berafia Island. Informants recalled that a man became dizzy after throwing rocks at a crow, so now people don't throw rocks at them. On both Nosy Berafia and Nosy Valia Islands, it is taboo to eat guitarfish. Informants at Nosy Berafia suggested that this is because one of their ancestors had a problem at sea (e.g. his boat capsized) and the guitarfish chased the sharks away and lifted people on its back and swam them to shore. It was previously strictly forbidden to kill guitarfish, but now some people kill and sell the fins, although nobody consumes this fish. It is also taboo for many people on Nosy Berafia to eat turtles or turtle products. Some informants suggested that nobody buys or sells turtle or turtle products, but other informants noted that about half of the population can eat turtle and everyone can eat turtle eggs. Metcalf (2007) also notes, "For the local Sakalava ethnic group eating turtle is *fady*, or taboo, confirmed by numerous interviewees and the unwillingness of children to handle turtle remains...However adherence to *fady* has declined and lucrative fisheries have attracted large migrant populations, many from ethnic groups not bound by such taboos." Likewise, in Sahasoa, near the Nosy Antafana MPA, it is taboo for many people to eat sea turtle.

Temporal restrictions

There were taboos governing the days of the week that people could engage in certain activities at all study sites (Table 1). Many of the restricted activities were terrestrial-based. For example, at all sites it is taboo to work in the rice paddies on Thursdays (Table 1). Walsh (2002) also notes how it is taboo to dig or break ground on Tuesdays in the Ankarana region of northwest Madagascar. The Ankarana people believe that any crops planted on this day will die and buildings constructed on this day will quickly rot. Walsh (2002) suggests that Ankarana residents believe transgressing taboos, such as breaking ground on a Tuesday, may result in drought and consequently affect those that follow the taboo, as well as the transgressor. These taboos on terrestrial activities have direct relevance to marine resource use. For families that fish, these days become the *de facto* fishing days. In the Nosy Antafana MPA, rules have been adjusted to allow fishing in the park's buffer zone on these days.

Gear prohibitions

All sites had customary restrictions on gear, including traps, spearguns, and weirs (Table 1). The most widespread is the taboo for Nosy Berafia (Sahamalaza MPA) residents to use fishing traps. Malagasy fish traps are generally made from locally available material (Fig. 3).



Figure 3. Trap construction in Tanjona MPA.

Sea spirits

Only people from Nosy Berafia (Sahamalaza) noted the presence of sea spirits (*lulurano*). A key informant said that sea spirits kill people when they are drunk or when they break taboos. For this reason, it is thought unwise to get in a boat while drunk.

Marine tenure

None of the communities studied had a history of marine tenure or excluding outsiders from fishing. However, in the Masoala marine parks (Cap Masoala, Tampolo, and Tanjona), recent developments in management have resulted in the exclusion of non-residents from fishing within the marine parks. Several respondents and key informants in Sahasoa expressed an interest in a similar arrangement.

Compliance

Compliance with taboos was reportedly very high. Approximately 75% of the fishers that mentioned the presence of taboos commented on the level of compliance. Of these, almost 90% suggested that everyone complied with the taboos. Approximately 11% of the fishers noted that “a few” people broke the taboos, but none of the respondents mentioned that breaking the taboos was widespread. The taboos that were broken by “a few” people, included 1) working in the field on certain days of the week (Sahamalaza, Cap Masoala, and Tampolo), 2) the use of traps in Cap Masoala and Sahasoa, 3) the sacred area in Nosy Antafana, and 4) a prohibition of fishing for sardine-type fish in Tanjona.

Discussion

In the coastal areas of Madagascar, a range of local resource use restrictions exist in the forms of taboos. These local taboos restrict the consumption of certain marine species (for example guitarfish, red parrotfish and turtle), regulate the days that people can work in the rice fields (which can serve to limit the number of fishing days for those that consider fishing secondary to agriculture), restrict the use of certain gear, and prohibit fishing in certain areas. As with reports in the Pacific, the size at which species are harvested is not regulated by taboos (Cinner and Aswani 2007). These taboos form an important part of Malagasy society by defining individual and social group identity (Walsh 2002).

The level of compliance with taboos in these study sites was reportedly high. However, studies in southwestern Madagascar have indicated that few fishers are respecting local taboos and traditional fishing practices, particularly those associated with marine turtles (Walker and Roberts 2005). Walsh (2002) details the complex relationship that occurs between the transgressors of taboos and the living and spiritual authorities imposing them. Transgressing taboos is one of the only ways in which people can respond to or “answer” an otherwise unquestionable authority (Walsh 2002). By transgressing taboos, the imposing authority itself is threatened. Walsh (2002) notes, “When such transgressions occur... it is the places themselves, and not the taboos, that are said to be ‘broken’ (*robaka*), and it is the authorities that govern these places, as well as the valued continuities

they guarantee that are endangered.” Consequently, considerable social strife in Malagasy society is created by individuals who transgress taboos.

To date, the ecological impacts of Malagasy marine taboos have not been studied (but see Bodin et al. 2006 for a study of the ecological effects of Malagasy terrestrial taboos). Rigorous ecological monitoring will be necessary to determine whether these practices are having any impacts on the marine ecosystem. However, this may be difficult because the taboos that restrict fishing also frequently restrict swimming (and hence, underwater visual census ecological monitoring). In these areas, other types of monitoring that are sensitive to local taboos may need to be employed (e.g., baited remote underwater video, see Cappelletti et al. 2004).

There is increasing interest in incorporating local taboos and customs into contemporary conservation in Madagascar (Lingard et al. 2003; Bodin et al. 2006; Langley 2006; Loudon et al. 2006). However, information about the roles of taboos in the local culture and the socioeconomic conditions that enable these taboos (e.g. Cinner et al. 2005, 2007) are widely lacking. Several of Madagascar’s MPAs are attempting to develop regulations that reflect and complement local taboos. For example, in the Nosy Antafana MPA, park officials altered the rules to allow people to fish in the buffer zone during days it is taboo to work in the rice paddies. Likewise, in the Cap Masoala MPA, the core no-take area was zoned next to the sacred headland to maximise the area protected from fishing. However, one respondent noted that the park boundary markers are in violation of the taboos associated with maintaining the purity of the area. Consequently, some community residents believed that the Cap Masoala Park was providing negative spiritual forces, which accounted for bad weather, poor crop yields and low fish catches (Cinner and Aswani 2007). Considerable care must be taken to understand taboos before they can be effectively incorporated into conservation initiatives (Cinner and Aswani 2007). Consequently, spiritual leaders should be considered key stakeholders in conservation initiatives.

In the Pacific, customary management is often considered very adaptive and flexible (Hviding 1998; Cinner et al. 2006). Indeed, parallels are sometimes drawn between customary practices and adaptive management (Berkes et al. 2000; Cinner et al. 2006). However, in Madagascar, taboos on resource use frequently appear to be focused on spiritual connections to ancestors and are not practiced to consciously manipulate resources (Bodin et al. 2006; Elmqvist 2004). The same also appears to be the case in Kenya (see McClanahan et al. 1997). Consequently, Malagasy taboos are highly inflexible and in this regard differ considerably from much of the

customary management described in the Pacific (Cinner and Aswani 2007).

Conclusion

This paper highlights how a wide range of taboos regulate the ways that people exploit both terrestrial and marine resources in coastal Madagascar. These taboos regulate aspects of space, species, gear, and time. In contrast to the dynamic and flexible customary management often documented in the Pacific, Malagasy taboos appear relatively inflexible. Although attempts have been made to integrate these taboos into contemporary marine conservation, these have met with limited success, particularly when the spiritual role of the taboo was not well understood by conservation agencies. Effectively integrating Malagasy taboos into the modern conservation context will require a thorough understanding of the history, spiritual role, spiritual leaders and rules associated with each location.

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The collected works of R.E. Johannes available

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Robert Johannes was a tropical marine ecologist who, beginning in the mid-1970s, pioneered the idea of integrating the specialized ecological knowledge and traditional marine resource management systems of Pacific Island communities with Western concepts of scientific management for the purposes of resource conservation. In so doing, he highlighted the importance of indigenous knowledge and community-based systems as key factors in marine conservation.

Aware that the rapid disappearance of traditional knowledge and the lack of interest of younger people in acquiring this knowledge was a serious constraint to implementing his approach, Johannes sought to create a widespread awareness of this often encyclopedic knowledge base. He advocated a reawakening of traditional environmental ethics among youth and hereditary chiefs related to their exclusive reef and lagoon tenure, an ancient form of marine protection which, he contended, provides a practical and time-tested model of "limited entry" that Western fisheries biologists and economists were only then hitting on as an innovative way to manage their own fisheries.

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