THE ECOLOGICAL AND POLITICAL DIMENSIONS OF LOCAL KNOWLEDGE AMONG SMALL-SCALE FISHERS IN MOOREA, FRENCH POLYNESIA

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Mark Andrew Strother

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The Ecological and Political Dimensions of Local Knowledge Among Small-Scale Fishers in Moorea, French Polynesia

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DEDICATION

For my brother, who instilled in me a love for fishing and outdoor adventures.
For my mom, who inspired me to travel the world and to learn from other cultures.
And for my dad, who impressed upon me the value of human connection, and helped shape my ability to write about it.

I don’t really like fishing. I LOVE IT.

– Tahirivairau Teore, upon the outset of my first experience spearfishing with him.

There’s something about politics that bothers me: the partisanship. No one wants to listen, to lend an ear, to stretch out a hand, to speak to anyone who is in the other party. I will never accept being put in a position that prevents me from talking to whomever I choose.

– Henri Hiro, in an interview with Michou Chaze for *Nouvelles de Tahiti*, published on March 12, 1990.

ABSTRACT OF THE THESIS

The Ecological and Political Dimensions of Local Knowledge
Among Small-Scale Fishers in Moorea, French Polynesia
by
Mark Andrew Strother
Master of Arts in Anthropology
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Understanding how and why local knowledge undergoes change is vital for communities that hope to foster effective marine resource management initiatives. However, most studies tend to concentrate exclusively on the ecological dimensions of local knowledge at the expense of other domains such as those associated with political or cultural identity. This thesis quantitatively evaluates the local knowledge of small-scale fishers in Moorea, French Polynesia, using distinct metrics in order to assess two of its domains, local ecological knowledge and local political knowledge. To gauge ecological knowledge, the results of a lagoon fish habitat ranking exercise completed by fishers (n=56) are compared with data from commonly cited marine science literature. Individual variation in political knowledge is measured by assessing fishers' (n=94) familiarity with a Moorean lunar calendar, known as a *tarena*, which is an important symbol of Polynesian identity and resistance to French colonialism. Results indicate that ecological knowledge is negatively associated with level of income. Familiarity with the tarena is negatively associated with increased exposure to formal education and positively associated with selective spearfishing. Women also tend to have more familiarity with the calendar than men. These findings contribute to our understanding of the socio-cultural, economic, political, and environmental influences on local knowledge, while also underscoring the importance of employing varied metrics and conceptualizing knowledge as a dynamic social process rather than just a compendium of information. More broadly, this study can orient local community groups towards potential pathways to nurture the continuation of sustainable fishing practices and coral reef fishery management strategies.

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CHAPTER 1

INTRODUCTION

After several trips with some of Moorea's most well respected fishers, one aspect stands out. Beyond its physical and mental demands, fishing is a labor of love on Moorea. Certainly, some fishers are motivated by the need to make money or the need to feed their family, but the majority of people who fish the lagoon that surround the island are not obligated one way or another. Rather, they choose to fish because it is fundamental to their identity – a sense of self and culture tied to catching, eating, and sharing certain kinds of lagoon fish. The emphasis that Moorea's culture places on taste became evident to my advisor almost immediately. At the outset of his first experience spearfishing in Moorea, he was told, quite matter-of-factly, "here, we fish with our stomachs". This same ethos was expressed to me at the beginning of my first visit, when I was practicing my pronunciation of vernacular fish names with a local woman. When we got to *Iihi* (soldierfish, *Myripristis* spp.), she cooed in approval, saying, "c'est le meilleur, le plus délicieux" (that is the best, the most delicious). This same excitement is often apparent from the reactions of friends and family waiting on shore when fishers return with their catch. Success is not necessarily perceived by the size of the haul, but by the kinds of fish caught. In addition to *Iihi*, people tend to focus their attention on *Ume* (unicornfish, *Naso* spp.) and *Paati* (multiple species of parrotfish, predominantly *Scarus* spp. and *Chlororus* spp.). At several of these occasions, I recall being struck by the visceral pride and pleasure collectively expressed by the group, complete with discussions of how they could not wait to eat this or that particular fish, and descriptions of how to best prepare the catch.

It was not until long after my fieldwork in Moorea was complete that I began to fully grasp the implications of the above anecdotes. Initially, my research objective was to understand the underlying reasons why knowledge about the marine environment varies within the fishing community. In other words, I wanted to know if certain socio-economic

factors drive ecological knowledge heterogeneity among fishers in Moorea, and if so – what are they? To this end, I designed a survey to investigate the drivers of ecological knowledge variation, and eventually interviewed 94 small-scale fishers during fieldwork in 2015. Over the course of that process, however, it became increasingly clear that my conceptualization of knowledge was overly simplistic and narrow, especially in the socio-cultural and political context of Moorea. By solely focusing on the ecological dimensions of local knowledge, I had failed to consider the full extent of its value and use among fishers, ignoring how such knowledge relates to identity and the politics of cultural preservation in a community still grappling with the reverberations of colonialism. What follows, at its crux, is an argument in support of expanding the parameters that shape how we define, discuss, and understand local knowledge.

This thesis is the culmination of nearly six months of research in Moorea. I lived in Afareaitu, a district in the southeastern corner of the island, for 11 weeks from June to August 2014, and for another 12 weeks from June to August 2015. Over the course of these two seasons, myself and two other graduate students worked with local counterparts in order to gather baseline data related to Moorea's fishery. We administered a total of 350 household surveys and 16 key informant interviews, collecting demographic data and learning about local fishing practices, marine resource perceptions, marine policy concerns, and consumer preferences. This experience, and the information gleaned from it, helped frame the research I carried out in 2015 – during which primary data for this research were collected.

OVERVIEW OF THE THESIS

Utilizing mixed quantitative and qualitative methods; my thesis addresses three key research questions:

1. What is local knowledge and how can we better understand such knowledge as a dynamic social process?
2. What are the ecological and political dimensions of local knowledge?
3. What drives local knowledge variation among small-scale fishers in Moorea?

In Chapter 2 (Background), I provide historical and contemporary context to the social, political, and ecological dynamics in Moorea, paying particular attention to how they relate to its fishery. Through an exploration of the evolution of these histories, I provide a

contextual framework for the above research questions – prefacing why they are relevant and significant questions in the process. In Chapter 3 (Theoretical Orientation), I review the development of theory related to local knowledge scholarship. This section allows me to explore how previous literature has addressed my first two research questions, and how this information can be used to assess my remaining question specific to Moorea.

In Chapter 4, I use quantitative statistical analyses in order to show trends related to the relationship between local knowledge (LK) and various socio-economic factors, and employ qualitative methods in order to help explain some of the underlying causes of these trends. I also argue for the importance of evaluating multiple domains of LK, in this case doing so by assessing its political and ecological dimensions. More specifically, I evaluate the political knowledge of 94 fishers by assessing their familiarity with the tarena – a lunar calendar for fishing and farming that I argue primarily functions as a means to reinforce an indigenous ethos on Moorea. Findings suggest that familiarity with the tarena is negatively associated with formal education, but positively associated with spearfishing specificity. Moreover, women tend to be more familiar with the tarena than men. Using a subsample of 56 fishers from the overall group, I also measure local ecological knowledge (LEK) by comparing results of a lagoon fish habitat ranking exercise with data from widely cited marine science literature. Results indicate that LEK is negatively associated with income. The findings related to LEK reinforce what other studies have suggested – income is a relatively strong predictor of ecological knowledge displacement. That is, increased exposure to a market economy can sometimes displace LEK with other kinds of knowledge more relevant to occupational or lifestyle changes brought about by a capitalistic system. Analysis of the results concerning familiarity with the tarena, however, offer insight into some of ways in which certain segments of the fishing community in Moorea are responding to shifting socio-political dynamics in terms of education policy, contemporary fishery management, and cultural identity. This study (confined to Chapter 4) has been prepared as a manuscript in order to be submitted to a peer-reviewed journal. Because of this, some redundancy in other chapters is wholly unavoidable, although kept to a minimum.

CHAPTER 2

BACKGROUND: AN ISLAND IN FLUX

Moorea is a high-volcanic island in the south Pacific. Bordered by shallow lagoons and a barrier reef with 11 natural passes, its land area is approximately 135 square kilometers. Much of the island's interior has dense vegetation, with sharp volcanic peaks that reach over 1,200 meters. 17 kilometers northwest of Tahiti, Moorea is part of the Windward Group of Society Islands within French Polynesia. The climate is tropical, with a hot and humid season from November to April and a cooler and drier period from May to October. The trade winds trend east to west for most of the year and cyclones occasionally roll westward through the region during the rainy season (Bellwood 1987). The 29-kilometer barrier reef surrounding Moorea not only buffers the island from inclement weather and destructive waves, it also helps to protect a 49 square kilometer coral reef-lagoon ecosystem composed of a fringing reef, sandy channels, two bays on the northern side of the island, and a reef crest that borders the open ocean (Bell and Galzin 1984; Salvat and Pailhe 2002). The ecosystem supports rich marine biodiversity that is economically and intrinsically valuable to the local population. Interestingly, some of Moorea's reef habitats have exhibited unique resilience despite being heavily fished by locals. In recent years, outer reefs have faced several major environmental disturbances in the form cyclones, bleaching events, and Crown-of-Thorn Starfish (*Acanthastar planci*) outbreaks, but they have consistently returned to coral dominance within decadal increments (Done et al. 1991; Adjeroud et al. 2009). Such ecosystem resilience contrasts with many coral reefs around the world that are collapsing in the face of similar threats (Mumby and Steneck 2008). The reef's ability to absorb environmental and anthropogenic shocks is particularly notable considering intense population growth and economic development in Moorea over the last few decades.

Moorea's population of over 17,000 people is spread across five districts – Paopao, Teavaro, Afareaitu, Haapiti, and Papetoai – made up of 22 villages. Approximately 88% of

Mooreans were born in French Polynesia, with the majority of other residents coming from France. There are four main ethnic groups on the island: 65% of the population is of Maohi (indigenous Polynesian) descent, 16% mixed Euro-Polynesian, 12% French, and 5% Chinese (Institut de la statistique de la Polynésie française 2012). French is the official language, although most people also speak Tahitian and it is the primary language spoken by some families. Once driven by small-scale fishing and farming, the economy is now largely tourism based. Moorea's 52 square miles of land support 11 major hotels and 50 smaller "pensions de famille"[1] (SDT 2013). A tourism-led economy has provided French Polynesia some measure of economic prosperity, with a $US 15,272 per capita GDP – making it one of the wealthiest Pacific Island nations (Baudchon, De Clercq, and Supera 2008; Leenhardt et al. 2016).

[1] Pensions range from two person bungalows to larger lodges and campgrounds that can accommodate approximately 20 guests (SDT 2013).

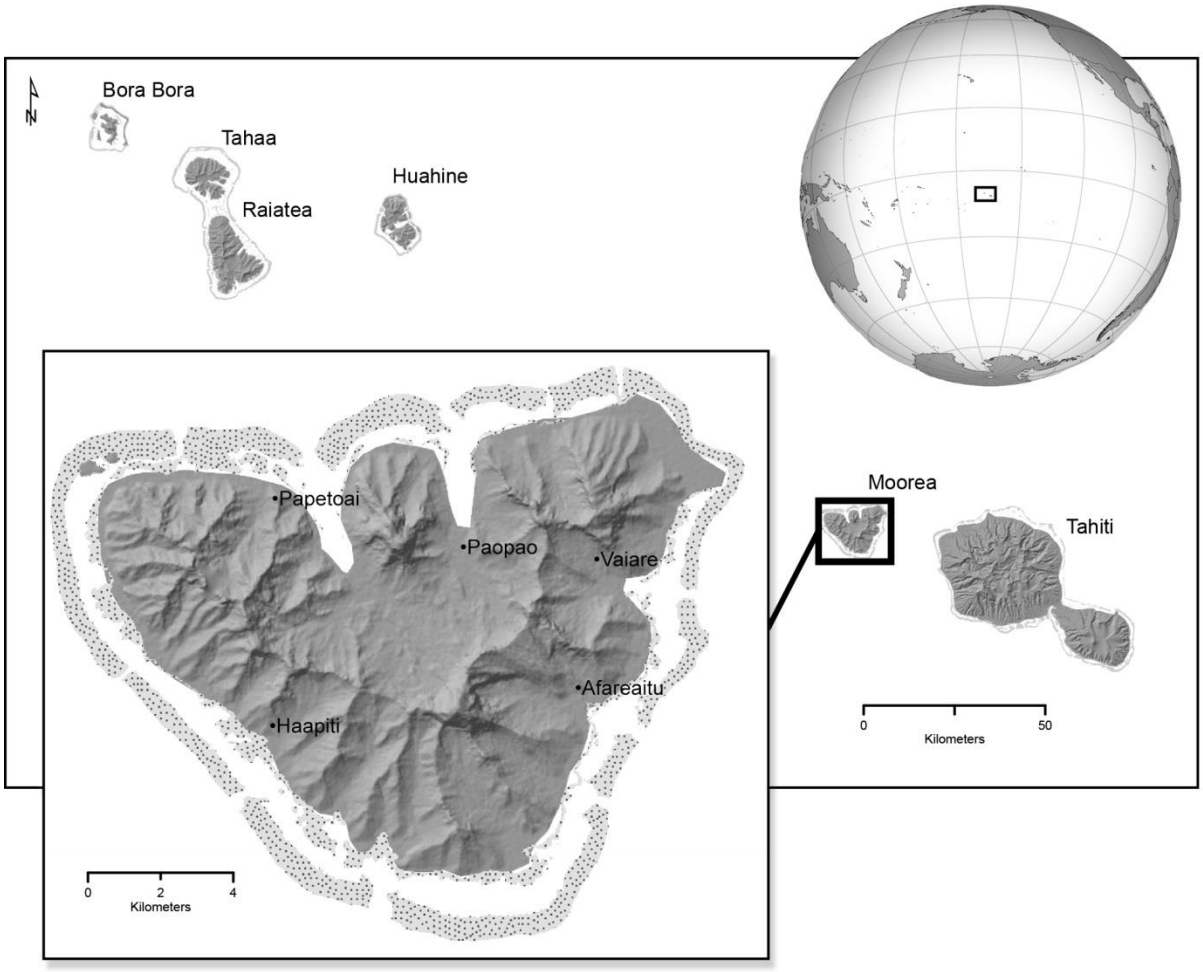

Figure 1. Map of Moorea and its location in relation to the other Society Islands and the rest of the world. Moorea includes the names and locations of district seats

PREHISTORY OF MOOREA: A BRIEF OVERVIEW

A culture of maritime sophistication that included the development of long distance sailing canoes enabled ancient Polynesians to begin migrating east across the Pacific from Samoa over 2,000 years ago (Bellwood 1987; Finney 1996). Eventually, this diaspora colonized a collection of islands dispersed across some 8,000 square kilometers of ocean – a fifth of the world's surface. Archaeological evidence suggests that Moorea's earliest inhabitants arrived between 1,300 and 1,400 years ago, and that residential structures indicating status differentiation were established by 800 B.P (Green 1996; J. G. Kahn 2003). Prior to the arrival of Europeans, Moorea was divided into eight socio-political districts consisting of three main descent groups (Panoff 1971). A chief and his immediate family

made up the *arii* (ruling class), which governed the *raatira* (middle class) and *manahune* (lowest class). Although fishers and boat builders were part of the manahune, there is some evidence that they were granted a level of respect typically reserved for those in the higher classes (Oliver 1974, 760-71).

This respect, in part, was driven by Maohi dependence on seafood in the face of relatively scarce terrestrial protein options. Fishers relied on an arsenal of techniques and ecological knowledge to capture and collect fish and other marine life throughout Moorea's prehistory. Numerous kinds of nets, spears, and weirs were devised and commonly used near shore and in deeper waters. Hook and line specialists were able to exploit lagoon and open ocean areas. Fishing practices were regulated by environmental processes including weather, seasonality, moon periodicity, and through the socio-political and religious institution of *rahui* (Oliver 1974).

A tenure regime similar to other customary resource access arrangements across the Pacific, rahui management units stretched from inland mountain ridges and agricultural fields to coastal fishing areas up to the reef crest (Hviding 2003). Under this system, district chiefs had the political power to enforce *tapu* – a temporary closure of resource use areas. Tapu was enacted during certain seasons and periods of mourning, but was most often enforced in order to preserve resources for upcoming feasts or religious ceremonies (Oliver 1974; Kirch 1984). Although the driving force behind rahui was to maintain hierarchical social relationships (Foale et al. 2011), its spatial and temporal flexibility is similar to the iterative style of governance that many contemporary resource management scholars promote. The cultural infrastructure that supported this system, however, began to transform following European contact. Colonizers not only thinned out Pacific island populations through violent conflict and the spread of disease, they also heavily altered the social landscape with the introduction of new laws, assimilation policies, and a cash-based economy.

FRENCH COLONIZATION IN THE PACIFIC

The era of France's involvement in the central Pacific began in 1768, when a Louis Bougainville led circumnavigation made landfall at numerous islands across Polynesia (Henningham 1992). On his return, Bougainville penned *Voyage autour du monde* – an account that romanticized Tahiti as a hospitable and sexually liberal paradise enveloped by

stunning natural beauty (Henningham 1992; M. Kahn 2011). Although the voyage preceded Cook's initial trip through the region, France was consistently a step behind England in the race to establish a colonial foothold in the Pacific. France had several pressing land based concerns at the time, most notably the French Revolution and subsequent Napoleonic Wars. French nautical capabilities were also inferior to those of Britain, and the British were able to stake their claim to places such as Australia and New Zealand just prior to French arrival (Henningham 1992, 2-4). In any case, by 1800, French explorers – in part allured by the romantic descriptions of Bougainville and other authors – had visited all of the Pacific islands that would eventually become property of France. Colonizing such places, however, would be no easy task.

In Tahiti and Moorea, for example, violent resistance lasted nearly three years from 1844 to 1847, with indigenous rebels based in various mountain strongholds (Henningham 1992, 9). Moreover, in their attempts to repel the spread of Catholicism, British Protestant missionaries actively encouraged Polynesian rebellion. Prolonged conflict between French colonizers and indigenous communities also emerged in most of the other islands that would eventually become part of French Polynesia. However, Maohi elites themselves were sometimes partly culpable for indigenous defeat as the French military was regularly able to exploit traditional rivalries in order to gain an advantage in battle.

Towards the end of the 19th century, following significant and protracted difficulties, France had come to establish what largely remains the modern shape of its colonial hold in the Pacific. After the region officially became a French colony in 1880, the colonial administration began to reorganize the spatial layout of population centers. This was especially the case in Papeete, the capital of Tahiti. "As part of its strategy of expansion and production of capital (the state) linked transportation networks, established sites of capital accumulation, invested in urbanization projects, and orchestrated everyday life" (M. Kahn 2011, 45). Urban design, in particular, served as an effective means to further establish military control, regulate activities, and instill political order. In other words, indigenous people were relegated to the margins, physically separated from the influx of French immigrants who occupied a burgeoning colonial center. Steady pressure from missionaries also sought to "civilize" natives through the spread of Christianity, French language, and Francophone culture (Oliver 1974; Dodd 1983). This forced enculturation strategically

served to incorporate Maohi into a new colonial economy, making them subjects to – but also contributing members of – the state (M. Kahn 2011, 46). Instead of using physical aggression to accomplish these goals, the administration established hegemony[2] through the symbolic violence of nation building.

In turn, a more thorough assimilation of French language and culture began to take root. Such integration was greatly aided at the outset of the 20th century when the London Missionary Society relinquished control over the spread of Christianity to the French Protestant church (Henningham 1992, 21). Furthermore, state run schools became mandatory at the beginning of the 20th century, and both the state and the church threatened to fine Maohi families if their children did not attend (Nicole 2001, 144). As religious and education initiatives were starting to reshape the linguistic landscape on Moorea and the surrounding islands, another aspect of traditional culture also began to transform. Although small-scale subsistence farming and fishing remained crucial to some indigenous communities in the region, the rise of a cash economy drove many islanders to shift towards commercial agriculture, enabling them to make money from crops such as copra and vanilla (Henningham 1992, 22). By the mid 20th century, the economy in Moorea and Tahiti had become dominated by commercial agriculture. Before long, however, another major economic shift would engender even more widespread socio-economic and environmental change throughout French Polynesia.

NUCLEAR TESTING IN FRENCH POLYNESIA

In the early 1960s, the French government began the process of moving its nuclear testing campaign out of the Sahara Desert in Algeria, eventually establishing new testing facilities on Moruroa and Fangataufa, two atolls in the Tuamotu Archipelago – approximately 1,200 kilometers to the southeast of Moorea. Over the course of 30 years,

[2] Here, I am referencing Antonio Gramsci, an Italian Marxist who came up with the concept of hegemony – a concept relating to the process by which dominant social classes maintain political control by instilling their own world view upon subordinate classes, effectively making that reality the one, true way of viewing and experiencing the world (see Gramsci 1971).

from 1966 to 1996, the French government proceeded to test 192 nuclear bombs (46 atmospheric and 146 subterranean), consistently maintaining that such actions posed essentially no threat to the health of the region's environment and the safety of its citizens (Danielsson 1988; M. Kahn 2011). Initially, fears of nuclear fallout were somewhat allayed as French Polynesia's economy grew exponentially. Military spending in the territory rose from 4% of the GDP in 1960, to 76% in 1966 (B. L. E. Walker et al. 2014, 707). Infrastructural improvements stimulated by this spending opened up new avenues of employment and brought about major regional migration to Tahiti (Henningham 1992). But such growth also created new dependencies. As more people sought wage labor on Tahiti, there was a substantial drop in small-scale food production throughout the territory. Before long, the majority of the region's food was imported. In a matter of years, many families in Moorea and elsewhere within the region had become almost entirely dependent on the money that France was bringing in to support its nuclear program (M. Kahn 2011, 74). This economic boom, including the construction of an international airport and shipping ports, also provided the state with the means to further invest in tourism – a supremely ironic byproduct of the nuclear era, considering that France was literally poisoning the very same environment it continued to promote as an idyllic paradise.

All the while, residents throughout the region – indeed, throughout the Pacific – routinely felt misled if not outright lied to by the French government. Radiation related studies were exclusively administered by French military doctors who either refused or were forbidden to disclose the scientific findings on which they based public assurances that the tests had no adverse health risks (Danielsson 1988, 265–66). Moreover, the French National Radiation Laboratory was prohibited from sending in experts to assess health effects and ensure adequate safeguards. At the same time, several studies from New Zealand and Australia in the early 1970s made clear the ecological and public health related risks. These studies emphasized the extent of the nuclear fallout that occurred following each atmospheric

test[3] – with nuclear debris found on numerous inhabited islands across the South Pacific and as far away as some stretches of Australia's coastline (Aldrich 1993, 310). Another series of studies in the late 1970s by Japanese scientists linked a precipitous rise in ciguatera fish poisoning within French Polynesia to the improper disposal of toxic waste (Danielsson 1988, 266).

An incident in 1985 exposed just how far the French government was willing to go in order to suppress the growing notoriety of its nuclear program. Following several months of intense international speculation, it was eventually revealed that French secret service agents were responsible for the bombing of the *Rainbow Warrior* – a Greenpeace vessel anchored in New Zealand with intentions of sailing to French Polynesia to protest against the nuclear sites on Moruroa and Fangataufa (Henningham 1992, 192). In addition to murdering a volunteer crewmember and incensing the governments of the South Pacific region, the act further galvanized Pacific islanders who already felt that French testing not only jeopardized both their health and the environment's, but also epitomized the continuation of colonial policies that deliberately subjugated indigenous communities.

As a result, much of France's policy in the Pacific during the 1980s was geared towards appeasing varied regional frustrations. Somewhat ironically, popular opinion in French Polynesia expressed a clear desire to retain at least some level of connection with France. The French government continued to pump money into the region, and made substantial financial contributions to the South Pacific Commission,[4] which created a network in which Western countries provided a measure of economic stability to Pacific islands that were struggling to find some level of comfortable internal autonomy following

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[3] In 2013 the French government declassified several nuclear era documents, finally admitting that plutonium fallout from testing was much more extensive than they had previously professed. Tahiti, for example, was exposed to 500 times the accepted maximum levels of radiation following some of the tests. Independent investigators have pointed to abnormally high levels of leukemia and thyroid cancer throughout French Polynesia, especially in the Tuamotus. So far only 11 people who worked at or near the testing site have received compensation from the French government (Le Parisien 2013).

[4] Formed in 1947, the South Pacific Commission is the region's main scientific and technical organization and is designed to support development projects in participating countries and territories (Henningham 1992).

the time of more integrated colonial rule (Henningham 1992, 209-19). Towards the end of 1980s, France did well to nurture the perception that its presence had a stabilizing influence on the region. After the bombing of the *Rainbow Warrior*, France was particularly focused on repairing its public image in Polynesia. In 1988, France established the French University of the Pacific and opened a campus in Papeete. The government also constructed an environmental monitoring station in response to increasing concerns related to the greenhouse effect, and substantially upped the disaster relief funds it allocated to the area. As a result, the useful potential of France became reaffirmed in the eyes of many politicians and officials in Polynesia as well as in other South Pacific countries (Henningham 1992, 214-15).

MAOHI RESISTANCE DURING THE NUCLEAR ERA

> Colonialism's inability to reproduce and inculcate itself totally and harmoniously over colonized peoples and spaces mean that, apart from its own inherent contradictions and weaknesses, colonial discourse came face to face with an extremely complex and vibrant entity: an indigenous ethos.
>
> –Robert Nicole, *The Word, The Pen, and The Pistol*, 2001

Despite, and in some cases because of France's diplomatic maneuvers, the era of nuclear testing brought about a resurgence of violent resistance to French neo-colonial policy in French Polynesia. Some of the more notable examples include a 1977 bombing of the central post office in Papeete, several prison riots on Tahiti in the 1970s and 1980s, a 1983 hotel and tourism industry strike on Tahiti that cost the economy an estimated $764,000, and a 1987 dock-workers strike in Papeete that resulted in large scale urban fires and violent clashes between protestors and police (Nicole 2001, 173). The growing unrest reached a boiling point in September 1995, when France's newly elected president, Jacques Chirac, decided to continue testing nuclear bombs in Polynesia[5] – breaking an international moratorium on nuclear testing that had been honored by both the USA and Russia since

[5] The last nuclear test in French Polynesia was on January 27, 1996. On the same day, President Chirac announced an immediate end to its testing program amid increasing pressure from within Polynesia and abroad (M. Kahn 2011, 98).

1992. As a result of Chirac's decision, public protests turned into riots and looting on Tahiti, a sit-in was organized on airport runways in Papeete, and construction equipment was commandeered in order to destroy state property. The damage in and around Papeete was significant, with an estimated cost upwards of US $40 million (M. Kahn 2011, 87). The events were fundamentally tied to a contestation over place; with indigenous resistance targeting continued hegemonic control as well as the abuse of stolen land that embodies ancestral roots and cultural identity (M. Kahn 2011, 86-88).

But the nuclear era also brought about more subtle, although no less substantial, forms of resistance to French policy:

> If anything, the history of Polynesians is all about the refusal of cultural assimilation – the refusal to forsake their language (in 1983, 21 percent of them were not fluent in French), to take part in school competition (in 1983, 20.5 percent of Polynesians had not attended school), to accept the moral, puritan-like constraints of the foreign religion (in 1988 there were 3,279 illegitimate births versus 2,326 legitimate births), to abandon joint ownership, to acknowledge the burden of wage labor, to sacrifice their way of life to tourism, and generally to give up some measure of the freedom to live as they will (Poirine 1994, 76-77).

The late 1960s and the 1970s also fueled indigenous revival movements that saw a rebirth of traditional tattooing, song, dance, and art throughout Polynesia. In short, "this resurgence prompted a return to indigenousness through the arts" (Mateata-Allain 2003). This politically charged era also ushered in the first significant wave of indigenous authors in French Polynesia.

One such writer was Henri Hiro, an indigenous poet and intellectual born in Moorea in 1944. Hiro's poetry speaks to reaffirming a lost connection between Maohi and the land and sea – acknowledging the need to care for the places that have a long history of providing the material and spiritual means to sustain Maohi culture (M. Kahn 2011, 68). His writing also delves into themes related to the continuation of traditional fishing and farming practices, meal preparation, and communal sharing networks. Above all, Hiro was a major proponent of reviving the Tahitian language (*Reo Maohi*, colloquially), encouraging his readers to reject or relegate French whenever possible (Nicole 2001; Mateata-Allain 2003; Stewart, Mateata-Allain, and Mawyer 2006; M. Kahn 2011). Some of his views were also more radical: he supported independence and a complete severing of ties with France, promoting a minimalist lifestyle relatively free of the constraints of materialism and

capitalism. He explains in an interview towards the end of his life, "The basics are here. It's not a dream...Coconut trees produce for seventy years. We still eat *uru* (breadfruit) from trees planted by our ancestors. The fish are here. We can have a self-sufficient economy" (Stewart, Mateata-Allain, and Mawyer 2006, 78). By reigniting and affirming a collective indigenous experience and consciousness through the written word, Hiro's work provides a lens through which to view the counterhegemonic discourse of the time. An excerpt from his poem *Aitau* (Devour Ravaged Time) underscores Hiro's hope for future Maohi generations:

> Coiled in upon myself
> I'm seated at an opening in Time.
> And I murmur to myself:
> For too long
> I've distanced myself from my homeland
> And the need for deeply rooted identity
> Has disappeared from among the recent generations
> It's been far too long since I sat
> At my homeland's side.
> The previous generation carelessly tossed
> Their ways of thinking into deserts of elsewhere.
> For far too long
> I've forsaken my country.
> The conviction of the new generation
> Feeds itself on vanity.
> It's been far too long since
> I reached down into myself
> To find the roots of my people,
> Just as the new generation
> Wanders about, lost in its own homeland.
> Devour the time, devour the lost time.
> Consume the ravaged waste
> So that the deep past can unite with the future.
> (Stewart, Mateata-Allain, and Mawyer 2006, 85–86)

In Moorea, Hiro was involved in creating the *tarena*, a lunar calendar that documents the knowledge of an elder fisher and farmer. Having been used as a guide to inform small-scale lagoon fishing and farming for generations before it was ever written down, its codification in the early 1970s was at once a political statement and an endorsement of

environmental awareness during the nuclear era. At the time, French policy still outlawed Tahitian in schools throughout French Polynesia[6]. The tarena, written entirely in Tahitian, was a means through which Hiro encouraged resistance to French colonialism by fostering an indigenous ethos that purposefully undermines feelings of inferiority and powerlessness perpetuated by the colonial experience (Mateata-Allain 2003).

The tarena remains popular in Moorea today. According to Etienne Houout, the sales and marketing manager at the Manutea juice factory – where the calendar is currently produced and distributed – 5,000 calendars are made each year and the supply is typically exhausted within the first three months (personal interview). Its popularity as a means to spread the Tahitian language is also growing. A few years ago, the Protestant church in Afaraeiatu, a village on the south east coast of Moorea, began requesting the content from Manutea so that they could put together their own brochure based on the calendar. In this way, the Tahitian language and culture reach a wider audience through an outlet that was once intent on cultural subjugation. The calendar's daily advice for fishing and farming is also read each morning on Polynésie Premiere – a Tahiti based radio station that primarily broadcasts in Tahitian. Although the majority of fishers do not actively consult it for fishing advice, I argue that engagement with the tarena is one way in which Mooreans are redefining their world view on their own terms, reestablishing power, and reaffirming Maohi identity.

THE SOCIO-POLITICAL DYNAMICS IN MOOREA

Recently, however, the personal and cultural identities of small-scale fishers have become increasingly threatened. In 2004, the state implemented PGEM (Plan de Gestion de l'Espace Maritime), a spatial marine management arrangement that restricts access to fishing grounds via eight no-take zones as well as various size restrictions and seasonal bans on catching certain fish and invertebrate species. In sum, the zoning covers roughly 20% of the

[6] Tahitian officially became recognized as an official language in the territory (alongside French) in 1980. Subsequently, Tahitian was allowed in schools although there were no concrete policies to encourage its development. Prior to this time, students and teachers were punished for speaking Tahitian at school – even during recess (Mugler and Lynch 1996).

lagoon surrounding Moorea (B. L. E. Walker 2001). Despite 10 years of planning before its implementation, PGEM has largely been met with hostility from the fishing community – some of whom feel like it is an extension of colonialism because it has changed the way they interact with the lagoon.

The roots of PGEM can be traced back to the economic transition that occurred in Moorea during the nuclear testing program. The drastic population rise and economic development on Tahiti between the 1960s and 1990s had a spillover effect in Moorea. The establishment of a daily ferry service between the two islands in 1991 essentially turned Moorea into a suburb of Papeete, allowing day laborers to easily commute back and forth. The population has risen from approximately 5,000 in 1971 to over 17,000 today (Institut de la statistique de la Polynésie française 2012). These occurrences, in addition to the growth of the tourism industry, have prompted extensive expansion of coastal development in Moorea over the last 30 years. Since 2001, the total number of hotels and pensions has increased from 31 to 61 (SDT 2013).

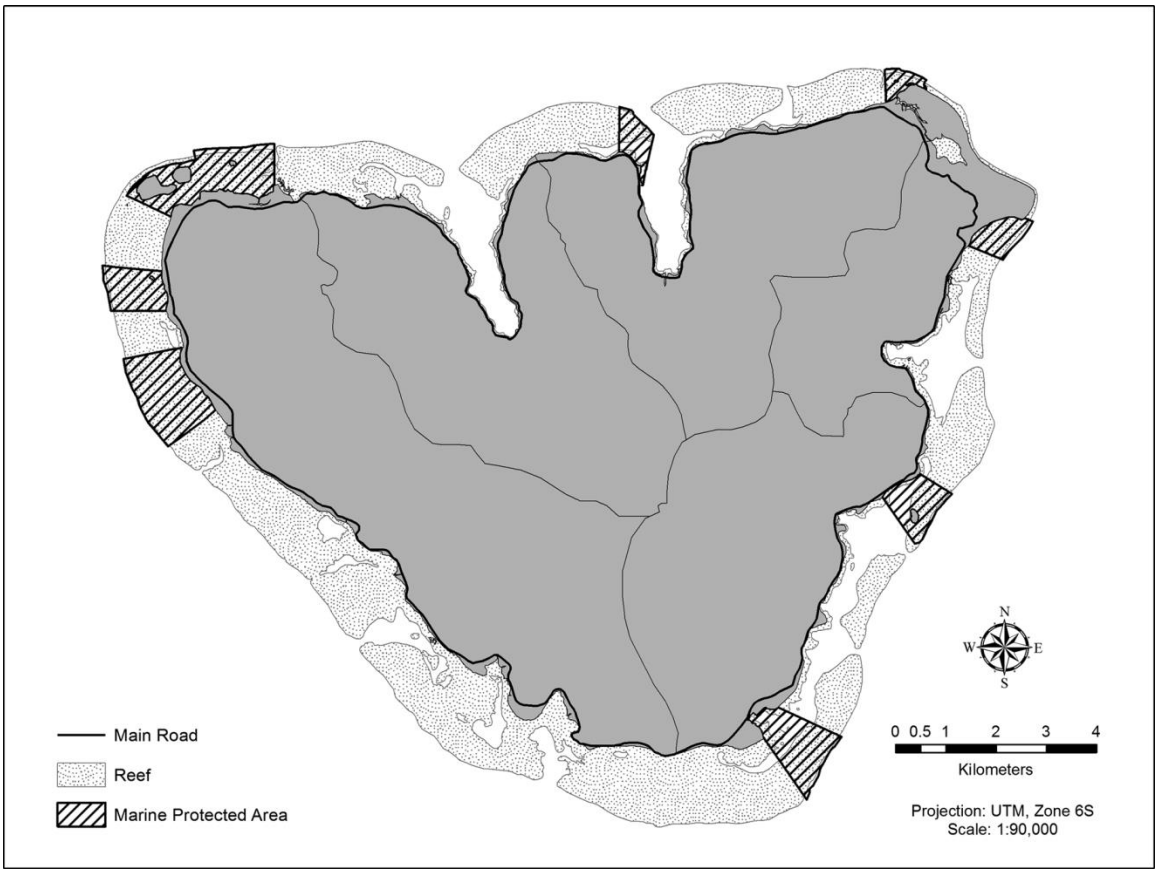

Figure 2. Map of Moorea including PGEM marine protected areas. Source: (B. L. E. Walker et al. 2014, 709.)

In 1992, realizing the importance that the health of the lagoon plays in bringing tourists to the island, Moorea's municipal council set in motion the process of developing and planning PGEM – the marine management arrangement that would eventually be implemented in 2004 (B. L. E. Walker and Robinson 2009). The following year, in 1993, with the end of the nuclear program drawing near, the government of French Polynesia began an economic development initiative called *Le Pacte de Progres* (The Pact of Progress). Designed to decrease French Polynesia's long-term economic and financial dependence on France, the plan included over $US 2.1 billion in development contracts from France (Osman 2000; B. L. E. Walker et al. 2014). Although the stimulus also sought to buoy the economic self-sufficiency of commercial agriculture, pearl farming, and fishing – its main aim was to bolster the tourism industry in the wake of decreased military spending. In Moorea, *Le Pacte* resulted in the construction of new resort hotels, renovations at many existing hotels, financial assistance to various tourism operators, the development of a golf course, and

infrastructural improvements to the port in order to accommodate cruise ships (B. L. E. Walker and Robinson 2009; B. L. E. Walker et al. 2014).

Le Pacte de Progres also incentivized the development of PGEM. Although most Mooreans tend to agree that marine conservation is necessary, PGEM has been a source of controversy even prior to its inception. Many residents felt left out of the planning process and continue to feel marginalized by the government's dismissiveness of their input regarding its weaknesses (B. L. E. Walker and Robinson 2009; B. L. E. Walker et al. 2014). Its critics emphasize its temporal and spatial inflexibility, a major strength of rahui in the past. Since it commenced 13 years ago, PGEM has remained unaltered without any rotation of the restricted areas. As such, the plan fails to utilize the local knowledge of fishers – a group whose regular interaction with the fishery could provide valuable feedback in terms of adjusting policies to reflect shifting resource dynamics. However, PGEM policies are currently under review – a process that is three years overdue according to the original plan – and the future of the plan remains politically volatile.

CHAPTER 3

THEORETICAL ORIENTATION: AN INTERPRETIVE FRAMEWORK FOR UNDERSTANDING LOCAL KNOWLEDGE

Anthropologists have long studied issues related to local knowledge through a variety of theoretical frameworks (Barth 2002; Zent 2009; Briggs 2013). What follows is a six-part overview of the development of theory related to this body of literature. First, I begin with a summary of early ethnoscientific work, a research approach primarily focused on developing a universal framework for the environmental classification systems of indigenous people. Second, I discuss the broad methodological and theoretical reorientation of indigenous/local knowledge research that began in the 1980s. Propelled by various environmental movements that took shape in the preceding decades, this period of literature emphasizes the value of ecological knowledge in terms of its utility for international development programs and natural resource management initiatives. Third, I explore the political dimensions of local knowledge by considering some of the critiques leveled against the project of incorporating indigenous/local knowledge into management and development plans. Fourth, I analyze some key debates that surround the politics of representation in the Pacific region, a discussion that highlights the link between knowledge, power, identity, and tradition. Fifth, I discuss recent trends in indigenous/local knowledge research, focusing on approaches that explore the dynamic processes of knowledge variation and change. Sixth, I summarize the development of fishers' knowledge research, tracing its progression from ethnographic documentation towards a more applied approach that seeks to integrate local knowledge into fisheries science and management. Additionally, I have included a final section that frames how I will weave some of these diverse strands of theory into my case study of Moorean fishers.

Throughout this chapter I regularly alternate between the terms "local ecological knowledge" (LEK) and "indigenous ecological knowledge" (IEK), as is the typical fashion in the literature I am reviewing. I refrain from using "traditional ecological knowledge" (TEK) because it implies static modes of interacting with and understanding the world, ignoring the dynamic characteristics of knowledge in the process. However, the terms "local" and "indigenous" are also problematic because they can reinforce notions of isolation and otherness, respectively (Agrawal 1995; Lauer and Aswani 2009). Despite these inherent problems, I use the term local knowledge (LK) in Chapter 4 in order to accomplish three things. It effectively dissolves the indigenous/modern divide suggested by the use of IEK. It also allows me to assess a broader range of knowledge rooted in local practices and values, including ecological and political domains of knowledge. Finally, "indigenous" is not a word typically used by people from Moorea, and would therefore be out place in the context of this study.

ETHNOSCIENCE: THE EARLY YEARS OF INDIGENOUS KNOWLEDGE RESEARCH

Social scientific research related to the ecological knowledge of indigenous people began to proliferate in the 1950s and 60s. Known as environmental ethnoscience, this discourse primarily seeks to document non-Western human-environmental interaction through linguistically driven ethnographic studies. Importantly, the work of Harold Conklin (1955, 1969) helped to disrupt notions that frame such ways of thinking about the world as primitive by documenting the complex indices of environmental knowledge drawn upon by the Hanunoo, an indigenous group of horticulturalists in the Philippines. This body of literature led to an explosion of research that focused on investigating the ways in which different cultures perceive and categorize plants and animals. Championed by Brent Berlin, Dennis Breedlove, and Peter Raven (1973), this brand of ethnoscience has been driven by ethnographic research intent on developing a universally applicable theoretical framework of the biological and psychological foundations of non-scientific (often referred to as folk biological) classification of the natural world. Much of this scholarship has been interdisciplinary, pairing anthropologists with both natural scientists (e.g. botanists and zoologists) and other social scientists (e.g. psychologists). In addition to cementing the

collaborative reach of anthropology, such boundary-crossing research has done much to broaden the credibility of non-Western environmental knowledge across the scientific community (Zent 2009, 24).

Despite the fact that these studies showcase the organization, detail, and accuracy of "folk" knowledge, they simultaneously undermine its legitimacy by imposing Western scientific ideals on indigenous culture. They have also been critiqued for espousing a fundamental mind-body divide that prioritizes cognition over embodied skill, effectively locating knowledge exclusively in people's minds (Lauer and Aswani 2009) – indeed, this is a debate that persists today. Equally problematic, early ethnoscience has been criticized for its reductionist tendencies, not only characterizing indigenous knowledge as normative and homogenous within communities, but also across cultures. In other words, theorizing knowledge in this way can strip it from the social and material contexts that provide its meaning and value to particular groups of people (Zent 2009).

In reaction to this, Eugene Hunn (1982) argues that early ethnoscientists failed to pay enough attention to the practical significance of knowledge. He suggests that researchers must move beyond taxonomic documentation and instead investigate the purposes of these systems, and the culturally dependent activities and outcomes that stem from them. Similarly, Roy Ellen (1986) contends that a taxonomic approach is inadequate because it presents knowledge as mere abstraction, removed from the behavior that produced it and the cultural constraints it is bound by. He urges scholars to focus on the varied social, cultural, and environmental contexts – both past and present – that give rise to the way humans understand and categorize the world around them. Only then, he posits, will ethnoscience accomplish one of its intended goals: representing knowledge in a way that provides enough information to enable culturally appropriate ways of behaving (Ellen 1986, 86).

The work of Hunn and Ellen – among others – was instrumental in reorienting the discipline towards the dynamic and context-dependent constructions and uses of knowledge. Indeed, their efforts helped to pave the way for the contemporary "processual" trend in human-environmental research (Zent 2013). Importantly, this period of scholarship also began to transition environmental anthropology towards more engaged, applied research. During the 1980s, indigenous knowledge became increasingly talked about in terms of its potential value for conservation, resource management, and sustainable development.

THE IMPLICATIONS OF LOCAL KNOWLEDGE FOR ENVIRONMENTAL MANAGEMENT AND INTERNATIONAL DEVELOPMENT

By the 1980s, scientists, environmental management practitioners, and development professionals began to acknowledge the utility of incorporating local perspectives, knowledge, and practices into project planning and implementation. This paradigm shift coincided with a widespread realization within the scientific community that top-down, non-participatory initiatives were largely ineffective in unraveling many of the international issues – typically related to poverty, hunger, and institutional capacity building – that they were designed to resolve (McCorkle 1989). An outcropping of research related to the adaptive strategies of indigenous agriculturalists (Barlett 1980), the vast majority of this scholarship focused on documenting approaches to improving the livelihoods of rural farmers in non-Western settings (Brokensha, Warren, and Werner 1980; Warren, Slikkerveer, and Brokensha 1995). As these edited volumes emphasize, researchers increasingly recognized that local people have their own forms of "science", incrementally learned through lengthy intervals of time spent using and managing the resources integral to their communities. Attempting to understand the social, cultural, and political contexts in which local ecological knowledge has adapted became equally imperative (McCorkle 1989). For many scientists, assisting these communities no longer meant providing technical oversight exclusive of communal involvement. Indeed, Sillitoe (1998) argues that this broad reorientation in theory also ushered in revolutionary methodological change for anthropology – repositioning research subjects as collaborators in applied projects as opposed to mere informants of ethnographic insight.

More recently, scholars have focused on documenting the ways in which local ecological knowledge is fundamental to adaptive natural resource governance and biodiversity conservation (Gadgil, Berkes, and Folke 1993; Johannes 1998; Berkes, Colding, and Folke 2000; Moller et al. 2004; Cinner and Aswani 2007). It has been argued that LEK informed management facilitates a flexible system of governance, customized to specific contexts and capable of adapting to complex socio-ecological dynamics. Often, these arrangements are discussed in terms of co-management projects, endeavors that pair community members with various institutions (Olsson, Folke, and Berkes 2004; Gutiérrez,

Hilborn, and Defeo 2011; Cinner et al. 2012). Increasingly, adaptive co-management is viewed through a resilience framework – a theoretical perspective that conceives of successful management as fluid in structure, capable of dealing with, learning from, and in some cases improving in the face of uncertainty and change (Folke et al. 2005; Folke 2006). More specifically, authors herald adaptive co-management as enabling and nurturing: the use of accumulated knowledge to constantly reshape management tactics; regular contextually appropriate and constructive assessment of policies and practices; and collaboration between various stakeholders including scientists, managers, and locals (Armitage et al. 2009).

Some case studies emphasize the efficacy of co-management in pairing different systems of knowledge. The work of Olsson, Folke, and Berkes (2004), details an example in Canada where indigenous and scientific knowledge were combined to exact change on policy decisions related to a river dam project affecting ecosystem dynamics. This scenario illustrates how local knowledge can sometimes fill in gaps that remain after initial scientific assessments. For instance, the Cree of James Bay were able to visually recognize the tenuous health of local white fish stocks after scientific length-weight analysis incorrectly determined the fish population to be healthy. Subsequent changes were made to dam policies during winter months, increasing river flow and revitalizing a crucial seasonal habitat. The Cree's perspective was informed by a long history of fishing practices that made them adept at recognizing subtle changes to fish populations over time. In another case, the Cree's traditional method of assessing river-ice thickness (i.e. gauging thickness by color and by the sound emitted from tapping) proved untrustworthy because the newly installed dam resulted in atypical flows of warm water, affecting the ice in novel ways. However, collaboration with scientists enabled them to use scientific monitoring techniques (i.e. ice coring) to more accurately judge ice thickness and enable safe crossing for hunting and trapping (Olsson, Folke, and Berkes 2004, 82). Numerous other studies have highlighted complementary arrangements between indigenous/local knowledge and formal western science in a variety of management contexts around the world, including: agricultural development (DeWalt 1994; Lado 2004); soil management (Barrera-Bassols, Zinck, and Van Ranst 2006) rangeland management (D. H. Walker et al. 1999; Homann, Rischkowsky, and Steinbach 2008); rainforest preservation (Becker and Ghimire 2003); wildlife monitoring (Moller et al. 2004;

Gilchrist, Mallory, and Merkel 2005); water scarcity (Liwenga 2008; Marin 2010); and marine resource governance (Drew 2005; Foale 2006; Thornton and Scheer 2012).

But as one case study in Hawaii illustrates, the possibility of co-management sometimes only presents itself after local people organize enough political capital to incite policy reform through collective action (Ayers and Kittinger 2014). In Hawaii, community based arrangements only materialized after top-down, centralized governance of coral reef fisheries had proved largely unsuccessful. Recognizing this failure, the members of some communities began to advocate for policy overhaul that enabled the revitalization of some elements of customary marine governance that were perceived to have been more effective in the past than existing policy (Ayers and Kittinger 2014, 258). Local level leadership, in fact, also appears to be fundamental to project effectiveness following initial establishment, at least in the context of fisheries. A recent meta-analysis of 130 co-managed fisheries from 44 different countries, for example, identified the presence of prominent community leaders as the single most important factor promoting project success (Gutiérrez, Hilborn, and Defeo 2011). This finding makes sense when bearing in mind one of the foundational concepts of co-management: the people most affected by environmental policy should be involved in its formation and upkeep (Berkes 2009).

Of course not all places – and the cultures, politics, and environments that comprise them, are well suited for this style of management. Its advocates admit this, acknowledging that adaptive co-management is by no means universally appropriate and is still very much in the exploratory phases of development, implementation, and assessment in various contexts around the world (Armitage et al. 2009). Problematically, contemporary legal frameworks can sometimes handcuff designs to incorporate traditional forms of governance and knowledge into adaptive systems of co-management. This is exactly the case in Hawaii, where the majority of community based fisheries co-management initiatives have encountered bureaucratic roadblocks because state law conflicts with one of the cruxes of traditional resource control – preferential access for communities or subgroups within communities (Levine and Richmond 2014). Ironically, if the socio-political landscape were to change so as to accommodate traditional notions of tenure in modern laws, many native Hawaiians would find themselves even further marginalized in terms of coastal access – likely lacking the funds to purchase ocean side real estate (Levine and Richmond 2014).

Other authors have pointed out the problems that can arise when large non-governmental organizations become involved with local communities in management and development contexts. Mac Chapin (2004), notes the disturbing irony embedded in the funding streams of NGOs like The Nature Conservancy, Conservation International, and the World Wildlife Foundation – a significant portion of which comes from large-scale industrial companies. How are these NGOs to disentangle themselves from the corporate web in which they are ensnared? They need large sums of money to make conservation a viable option, but funding from big corporations can make conservationists beholden to industrial aims. This sometimes pits NGOs against the very people that conservation projects most directly affect – indigenous people whose culture and livelihoods are intertwined with the ecosystems that such projects are purported to protect and sustain. As I will discuss in more detail below, the task of integrating local knowledge into management, development, or conservation projects is often a highly politicized endeavor in which multiple stakeholders with differential access to power attempt to negotiate success – often with "success" meaning entirely different things to the various people and organizations involved.

THE POLITICAL DIMENSIONS OF LOCAL KNOWLEDGE

Another branch of local knowledge literature focuses on exploring its political dimensions, often discussed in the context of environmental policy. Although there has been a significant amount of research as well as a growing number of applied projects devoted to the linkage of local knowledge and management, recent history has illustrated that this assimilation can be fraught with difficulties. These problems are typically explained in the literature in terms of the technical incongruities that can arise between the disparate epistemologies of Western science and indigenous understandings of the natural world. Branching away from this analytical path, Nadasdy (1999) instead concentrates on another underlying problem of co-management arrangements – differential power relations between local people and the institutions involved in development and management projects.

In some cases, Nadasdy argues, scientists and management practitioners are at odds with the validity and relevance of LK, claiming that cultural erosion combined with environmental change has made the efficacy of local knowledge dubious. Often, scientists feel obligated to collaborate with local people because it is the politically correct thing to do

in contemporary management contexts. In this light, transitioning away from centralized governance towards co-management arrangements sometimes has more to do with legitimizing the institutional powers already in place than inciting actual reform (Kothari 2001; Nadasdy 2005). Moreover, project funding can be easier to secure if plans accommodate alternative viewpoints such as those from local stakeholders and resource users (Nadasdy 1999). In addition to these trends, the very process of incorporating LK into management schemes is problematic because it distills knowledge by removing it from the social context in which it is created (Agrawal 1995). In other words, knowledge becomes an "artifact" that conservation practitioners attempt to plug into project plans (Nadasdy 1999, 10). Successful integration, Nadasdy argues, "will require that local beliefs, values, and practices themselves –not merely the abstract forms affixed to them – be accepted as a valid basis for action" (Nadasdy 1999, 14). Furthermore, the marriage of LK and management will never be fully realized until local leaders are given "full decision making authority" (Nadasdy 1999, 14). Rather than concentrating power in administrative centers, agency needs to be created for locals – the people who interpret and adjust management schemes, and are most affected by their outcomes.

However, true integration can also be hard to achieve because the ideas of locals intended to drive participatory projects are typically molded by pre-existing conditions that reflect patronage-type relationships between these people and the institutions involved (Kothari 2001; Mosse 2001). Thus, increased access to local perspectives does not necessarily mean that such views are representational of community values and goals. In a development context, participatory projects tend to generate plans more reflective of donor agendas than anything else (Mosse 2001; Chapin 2004; Nadasdy 2005). As a result, local forms of knowledge rarely have a role in shaping development or management initiatives unless some community members "acquire and learn to manipulate new forms of 'planning knowledge'. In this way local knowledge becomes compatible with bureaucratic planning" (Mosse 2001, 32). The crux of Mosse's argument is relatively straightforward – local people must empower themselves by becoming familiar with embedded power dynamics and bureaucratic processes in order to make their voices heard in participatory projects. In a marine resource context, Jentoft also discusses co-management in terms of empowerment, a concept he relates to the enhancement of people's ability to control their own lives (Jentoft

2005, 2). The notion of empowerment is particularly relevant to devolution scenarios in which top-down arrangements transition towards community based schemes. Without some measure of "planning knowledge", however, co-management arrangements can become an act of subjugation masked as empowerment – merely "empowering" local communities to reinforce the very same power relations they were designed to dissolve (Henkel and Stirrat 2001).

This reasoning aligns with the argument of Peter Brosius (2006), who advocates for a broader definition of local knowledge – something that is often referred to as merely environmental in terms of its value and scope. As Serena Heckler (2007) points out, defining knowledge depends on what is considered to be valuable. But in terms of policy formation involving local stakeholders, an understanding of ecological dynamics can have little import if local opinions are stifled under the weight of bureaucratic processes that prioritize governmental or scientific authority. In the words of Brosius:

> In a policy environment characterized by dispossession, where the threats to local communities result from the actions of 'decision makers', of what relevance is indigenous knowledge of nature by itself, divorced from its significance with respect to the making of claims? What matters is not how much (indigenous people) know about the landscape they inhabit, but how they position that knowledge, and themselves, within the broader contours of power (2006, 136).

Brosius' thoughts regarding political positioning, Nadasdy's advocacy for decision making authority, and Mosse's concept of planning knowledge collectively emphasize the importance of a local leader (or leaders) emerging to enact change on behalf of their community.

As discussed in the previous section, the establishment and eventual effectiveness of community based environmental management has been empirically linked to local level leadership stepping to the forefront of policy decision-making efforts (Gutiérrez, Hilborn, and Defeo 2011). This leadership – or perhaps more aptly, political capital (Birner and Wittmer 2003) – has also been described as an important aspect of local knowledge (Mosse 2001). However, as the discussion below reveals, there are debates about how to most accurately conceptualize the interrelations of knowledge, power, identity, and political resistance. The following section explores a sample of the literature related to discursive practices in the context of identity politics in the Pacific region.

THE POLITICS OF REPRESENTATION IN THE PACIFIC

Relatively recent scholarship concerning history, knowledge, and identity in the Pacific underscore the complex, and often divisive nature of the politics of representation within the region. In reference to the many indigenous revival movements that took shape across the Pacific in the 1970s and 1980s, the anthropologist Roger Keesing (1989) argues that these campaigns draw on elements of cultural heritage and pre-colonial history that are essentially derived from Western ideologies. Moreover, he posits that certain aspects of indigenous culture have been selected and valorized in order to purposively stand in contrast to dominant colonial culture, effectively deeming indigenous forms of knowledge and expressions of culture largely inauthentic (Keesing 1989, 23). This argument echoes Hanson's (1989) assertion that the Maori of New Zealand endorse dubious, yet not unflattering cultural histories propagated by anthropologists in order to "bolster a sense of their own ethnic distinctiveness and value" that stands in contrast to the country's Pakeha (white) population (Hanson 1989, 893).

Although Hanson stops short of saying as much, Keesing laments that indigenous Pacific Islanders are doomed to reinforce the very system they are actively trying to protest against – the project of colonialism and its continued subjugation of indigenous people. In other words, "counterhegemonic discourse pervasively incorporates the structures, categories, and premises of hegemonic discourse" (Keesing 1989, 23). To this end, Keesing contends that leaders of indigenous countercolonial movements are so inundated with Western thought through the education system in which they are ingrained, that they promote an idealized vision of indigenous culture that is at once primitive and staunchly environmentalist. Building on Linnekin's (1983) concept of "the invention of tradition", Keesing argues that these constructions of culture are used by Westernized Pacific elites as a tool to make political demands via connections to ancestral cultural traditions – simultaneously endorsing a skewed narrative of history while perpetuating the hegemonic order forged by colonialism (Keesing 1989; Antón 2008). His remedy? Keesing encourages a more engaged self-reflexivity on the part of Pacific Islanders and scholars alike, one that closes the gap between a "mythic" and "real" past in a way that more openly acknowledges the dialectic between colonial subjugation and indigenous identity (Keesing 1989, 37).

A response article published in the spring of 1991 made clear the divisiveness of Keesing and Linnekin's stance on the invention of culture, especially among indigenous scholars in Oceania. The reply came from Haunani-Kay Trask, a native Hawaiian and professor in the Hawaiian Studies Department at the University of Hawaii at Manoa.

To put it mildly, Trask was displeased with several elements of Keesing's piece, calling it a "gem of academic colonialism" (Trask 1991, 159). This comment underscores Trask's primary complaint about Keesing's article – a failure to balance out his own assertions with the viewpoints expressed by native scholars and Hawaiian nationalists (Trask 1991, 160). This exclusion, in effect, both suppresses and delegitimizes the scholarship amassed by indigenous academics and politically engaged nationalists. Trask also rebukes Keesing's claim that Natives do not have a firm grasp on an authentic history of their people. She is critical of both Linnekin and Keesing for their "willful ignorance of solid evidence from Native forms of history", mainly genealogical research that reveals, among other things, a familial relationship between land and the Hawaiian people. Furthermore, Keesing's lack of knowledge about this historical documentation indicates that he is also unfamiliar with modern Hawaiian resistance efforts to decry the tourism industry's repackaging of "traditional" Hawaiian culture as a sexual fantasy held aloft by hula dancers and ukulele players – a myth that Keesing suggests Hawaiians willfully promote as a means of economic gain. Trask provides evidence to counter his point, detailing a conference in which "Hawaiians from each of (the) major islands spoke eloquently of tourism's damage to Hawaiian sites, dance, language, economics, land, and way of life" (Trask 1991, 161). She also addresses the issue of hegemony raised by Keesing, arguing that Native cultural resistance challenges hegemony as opposed to reinforcing it.

The controversy surrounding these articles was fueled, in part, by the mediums through which they were spread. Subsequent to its original publication in the *American Anthropologist*, Hanson's article reached a wider audience among the general public because parts of it were reprinted in the *New York Times* as well as in various local newspapers in New Zealand. Although neither was summarized in any major newspapers, Keesing's article and Trask's response were published in *The Contemporary Pacific* – an interdisciplinary journal that diversified the professional readership that encountered the literature (Hanlon and White 2000, 12).

Despite the austere "insider versus outsider" dichotomy developed by Trask, she raises crucial points regarding Keesing's failure to include indigenous knowledge and viewpoints in his critique of their own cultural traditions and systems of knowledge. She simultaneously uses her Hawaiian identity to contest the validity of his argument while also discursively engaging with him as an academic colleague. In doing so, it becomes apparent that a person's ability to make claims concerning the history of other people is directly related to their inclusion within the culture being discussed (Antón 2008). In a post-colonial context, the democratization of literature expands the field of indigenous voices (Nicole 2001) – reaffirming long marginalized cultural identities while creating new knowledge in the form of political resistance to the hegemonic order of power. Indeed, I contend that identity reaffirmation, and the political positioning embedded in this process, is fundamental to local knowledge itself. The following section explores some of the ways in which knowledge is increasingly being understood and evaluated as a dynamic process, although as discussed in more detail below, this body of literature overwhelmingly concentrates on the ecological dimensions of knowledge – largely overlooking the political realms described in the previous two sections.

THE PROCESSUAL TREND IN LOCAL KNOWLEDGE SCHOLARSHIP

Over the past three decades, as local knowledge has become valorized for its perceived utility in environmental management contexts, anthropologists have become increasingly focused on exploring the dynamic aspects of indigenous knowledge. Citing the growing impetus to investigate knowledge change and variability, Stanford Zent terms this a "processual" trend in research (Zent 2013). Building from the tenets of early ethnoscience, this discourse has moved beyond conceptions that essentialize indigenous or local knowledge as traditional or ancient, terms that connote static modes of understanding and interacting with the environment. Processual scholars often frame environmental knowledge as historicized, transformative, and variable within a population (Barth 2002; Berkes 2008). In other words, knowledge is informed by and built on past information and practical skills, but also incorporates contemporary input. Knowledge is thus as a corpus of information, values, and skills that are continually reproduced and shaped by engagement with various

environmental, social, economic, or political influences (Berkes 2008; Zarger 2011; Vermonden 2012).

One characteristic of knowledge that processual approaches emphasize is its dynamism within and across cultures, with authors often portraying it as heterogeneous and emergent. How and why there are vast differences in the ways in which knowledge undergoes change, however, remains poorly understood. This has led researchers to emphasize quantitative methodologies – empirically measuring how various demographic and cultural factors correlate to knowledge variability, and then contextualizing findings with qualitative data gleaned from ethnographic insight. Recent ethnobiological studies have identified several common indicators of knowledge variation, including: gender, age, education level, livelihood, income, religion, fluency of the local language, exposure to tourism, and integration into a market economy (Zarger 2011; Lauer and Matera 2016). Although this kind of work continues to amass, scholars have decried a lack of replicability between studies, calling for standardized methods that more easily enable case-to-case comparisons (Reyes-García et al. 2007). Despite these concerns, it is clear that studies related to knowledge variation began to increase markedly by the mid 1980s. Some authors have noted that the push towards a better understanding of the drivers of knowledge variation coincides with a deeper awareness of both the value and the vulnerability of indigenous/local knowledge (Zent 2013). As the previous chapter illustrates, ecological knowledge is increasingly perceived as a valuable asset for conservation and resource management initiatives. Owing to this, the exploration of individual discrepancies in knowledge is especially prominent in recent scholarship.

Particular attention has been paid to the displacement of ecological knowledge – something that is commonly perceived as an ongoing, and potentially accelerating occurrence because of widespread economic development, modernization, and environmental deterioration throughout the world (Schultes 1994; Cox 2000; Zent 2009). It is often argued that these changes, and associated lifestyle shifts that stem from them, have the potential to supplant ecological knowledge with other kinds of knowledge more relevant to the expansion of the global market economy (Nolan and Robbins 1999; Benz et al. 2000). For example, a study led by Reyes-García focusing on Tsimane' forager-horticulturalists in the Bolivian Amazon quantitatively links market integration to ecological knowledge displacement. More

specifically, village distance to market was correlated with higher levels of plant use knowledge among individuals. At the same time, further analysis revealed no significant association between specific market-related activities and knowledge levels. This is likely the case, the authors contend, because different lifestyle changes affect knowledge in various ways. For instance, Tsimane' involvement in wage labor occupations may decrease forest dependency and displace plant-use knowledge. Conversely, activities such as selling timber enhance forest dependency and tend to facilitate knowledge maintenance (Reyes-García et al. 2005, 656).

In fact, this kind of scenario mirrors the findings from Godoy's et al. (1998) study of the Tawahka Indians of the Honduran rain forest. Godoy's results suggest that Tawahka individuals involved in the economy through agricultural crop sales or wage labor occupations exhibit significantly less knowledge of local rain forest plants and animals than do those involved in the sale of timber and non-timber forest goods (e.g. plants used for the construction of homes and canoes). The latter group of individuals retained higher levels of plant and animal knowledge because their occupational specialization places an emphasis on the commercial value of some of these species (Godoy et al. 1998, 228). This finding underscores the notion that markets exert multifaceted and uneven effects on the knowledge of people who come in contact with them. This idea is substantiated by the work of Spoon (2011), who focuses his study on Khumbu Sherpas in the Everest region of Nepal. Spoon's results indicate that, overall, a rise in tourism has had a detrimental effect on Sherpa knowledge of various plants and animals, information once vital to an agro-pastoralist lifestyle. As the region's dominant economic sector has transitioned towards tourism, Sherpas have adjusted their values and understanding of the natural world accordingly, sometimes boosting economic success at the expense of environmentally sustainable practices (Spoon 2011, 671). These shifts, however, varied widely throughout the Sherpa population – further illustrating the complex and irregular way in which the global economy can shape ecological knowledge heterogeneity.

Other studies show how today's youth typically demonstrate less ecological knowledge and understanding than elders, often brought about by a break down in knowledge transmission due to transitions away from subsistence based lifestyles (Begossi, Hanazaki, and Tamashiro 2002; Pearce et al. 2011). As a case in point, in his study of a

Lacandon Maya milpa farming community in southern Mexico, Ross (2002) reports stark inter-generational differences in familiarity with local plant-animal relationships. He explains how regional development has dissolved much of the Lacandon's isolation from external economic influence. Increased access to the market economy has led younger community members to abandon farming for craft making – catering to an influx in tourism brought about by the development and expansion of roads. The presence of missionaries has also disrupted younger generations from learning about traditional Lacandon religion – a set of beliefs that emphasize the interconnectedness of plants and animals. Shifts in social relations are also changing the physical layout of the village, with younger Lacandons opting to build their homes closer together. This emphasis on social cohesion takes families farther away from their milpas, resulting in less interaction with the environment and fewer crops being planted (Ross 2002, 136). In this case, it is clear that cultural, social, and material changes have precipitated ethnoecological knowledge displacement with other kinds of market-influenced knowledge among younger Lacandon adults.

At the same time, there are also numerous studies that demonstrate how social and economic shifts do not always correlate to ecological knowledge transformations. One of the most frequently cited examples of this comes from Zarger and Stepp (2004), who focus on the diachronic botanical knowledge of Tzeltal Maya children in the Chiapas region of southern Mexico – an area that has dealt with pronounced economic development, population growth, political turmoil, and environmental change over the last 50 years. Utilizing a data set collected by J.R. Stross in 1968, Zarger and Stepp compare these results to their own findings from a parallel survey they conducted within the same Maya community in 1999. Surprisingly, the case-to-case comparison revealed that there has been little or no change in children's plant naming aptitude over the 31-year period (Zarger and Stepp 2004, 416). These results suggest that ecological knowledge can endure among some portions of the population despite widespread acculturation.

Findings from Quinlan and Quinlan's (2007) study of medicinal plant knowledge among horticulturalists in Dominica also disrupt the common perception that modernization equates to knowledge displacement. Their results reveal that both commercial occupation and more modernized households are associated with higher individual levels of ethnobotanical understanding and ability. This is the case, the authors posit, because local pharmacies are

both inadequately stocked and hard to reach. Knowledge of "bush medicine" thus remains a priority for people, regardless of occupation or economic status (Quinlan and Quinlan 2007, 185). Similarly, Lauer and Matera (2016) show how market involvement is positively associated with the marine ecological knowledge of small-scale fishers within three villages on the island of Vonavona in the Solomon Islands. Out of six reported occupations, in fact, salaried workers were by far the most adept at detecting post-tsunami ecological changes to the local lagoon, outperforming villagers involved in more traditional lines of work such as fishing and farming. Importantly, these workers still fish regularly, and thus remain engaged with the marine environment on a regular basis. More to the point, the authors argue that this finding can potentially be explained by salaried workers' contact with other kinds of "global knowledge", gained by off-island experiences that exposed them to news reports highlighting tsunami-induced ecological change (Lauer and Matera 2016, 43). This finding, like those of Zarger and Stepp (2004) and Quinlan and Quinlan (2007), emphasizes the difficulty of generalizing about a worldwide displacement of ecological knowledge, especially as it relates to the expansion of the global economy.

Overall, the processual trend in research has done much to advance our understanding of the various ways in which ecological knowledge undergoes change. It seems clear that knowledge displacement and maintenance occur at individual levels across different bio-cultural contexts. However, there is a complete absence of quantitatively driven studies that bridge the gap between ecological knowledge and the political aspects of integrating such knowledge into management (i.e. Mosse 2001; Brosius 2006). As such, local knowledge is discussed solely in terms of its value for environmental insight, exclusive of its political dimensions related to enacting policy change on behalf of local communities. This is likely the case, in part, because of the methodological difficulty of gauging political knowledge. It is also clear that the vast majority of these studies are limited to terrestrial ecology – often with the evolution of ethnobotanical knowledge as the primary focus. With the exception of some notable outliers (Guest 2002; Garcia-Quijano 2006; Robinson, Cinner, and Graham 2014; Lauer and Matera 2016), relatively few studies have documented knowledge variation in marine contexts. It perhaps comes as no surprise, then, that the marginality of marine ecology in the processual literature is echoed by that of fishers' knowledge research in the context of fisheries science. The progression of this body of literature is detailed below.

FISHERS' KNOWLEDGE RESEARCH

Throughout its relatively long history, fishers' knowledge research has been relegated to the margins of mainstream fisheries research, an approach fundamentally based on the knowledge of professional scientists (Hind 2015). Despite this marginalization, its researchers have long advocated for its legitimacy next to formal Western science. More recently, researchers have begun to call for the integration of fishers' knowledge into fisheries management. Although this same ethos was not fully espoused by the first pioneers of fishers' knowledge research, it is clear that these authors recognized the profound level of detailed environmental knowledge exhibited by fishers plying their trade. Interestingly, the first and shortest wave of literature was initiated not by social scientists set on broadening the scope of fisheries science, but by an amateur historian (Munn 1922) and a keen fisherman and writer familiar with the Society Islands in the Pacific (Nordhoff 1930).

Although he did not characterize it as scientific research, Munn's work was based on interviews he conducted with Newfoundland fishers familiar with the habits of local cod stocks. Based on these conversations, and the qualitative information he had amassed, he was able to piece together some overall trends related to cod migration patterns (Munn 1922; Hind 2015). Nordhoff (1930) took things a step further, advocating that the scientific community heed the knowledge of fishers – explaining that the "time was ripe" for an anthropologist to dedicate several years of scholarship to the task of recording what he deemed an impressive index of ecological knowledge amongst the fishing community. His remarkably meticulous writing on Tahitian offshore fishing documents Society Islanders' extensive experience targeting certain pelagic species, as well as the detailed knowledge involved in this undertaking. For example, the bonito fishermen with whom Nordhoff regularly fished were able to locate a school by studying the swooping behavior of terns. They also had to quickly and efficiently select the appropriate style, size, and color of pearl hook to be used by assessing how weather, time of day, and moon phase might influence the fish (Nordhoff 1930).

Within the same region, the writing of Handy (Handy 1932) complements Nordhoff's account by offering cursory descriptions of fishing in Tahiti and its surrounding islands. Although less nuanced, and without the benefit of several years worth of experience living and fishing with locals throughout the region, the intellectual merit of Handy's work is found

in his diversity of coverage across varied kinds of fishing, detailing some of the methods and gear types employed by fishers who operate nearby or in coral reef lagoons. His description of the lunar calendar used by islanders, for example, showcases how fishing practices are governed in large part by moon periodicity. For Tahitian fishers, each month – indeed every night within each month – holds some significance in terms of the scarcity or prevalence, and the spawning behaviors, of a variety of both pelagic and near-shore fish species. Similar to Nordhoff, Handy articulates the potential value of long-term research documenting the location specific knowledge of fishers from a variety of sites, explaining that, "should such a study ever be made, the information collected will constitute an exceedingly useful record for natural science" (Handy 1932, 76).

Although Nordhoff and Handy made clear the fruitfulness of this kind of scientific study, especially in the Pacific, over a half-century would elapse before Robert Johannes would answer their call. A tropical marine ecologist, Johannes' research experience in the field ignited his interest in the specialized ecological knowledge of Pacific Island fishing communities and traditional forms of coral reef management. His seminal 1978 article draws attention to the importance of emic oriented research, contending that a conservation system can only be understood if an effort is made to understand the perspectives of local resource users and conservers (Johannes 1978). Johannes frames his argument in the context of small-scale Pacific Island fisheries, where marine stewardship has been evolving for hundreds and in some cases thousands of years. Indeed, an understanding of the finite nature of the marine food supply represents a crucial element of how these cultures were able to thrive in the face of scarce terrestrial protein options. As documented by Johannes, the quintessential form of marine conservation enacted by Pacific island cultures was sea tenure: a system of governance in which clans, chiefs, or families dictated who could fish where. Limited or preferential access to coastal waters and in some cases areas farther off shore kept overfishing in check most of the time. It is also evident that some cultures restricted the consumption of certain marine resources to particular individuals according to age, sex, and social status. Other regulatory measures such as the seasonal closure or rotation of fishing grounds, size limits, the protection of spawning aggregations, and periodic species-specific harvesting bans were customary throughout much of the region. In sum, nearly every marine resource management strategy more recently "devised" in the West was used to sustain

fisheries in historical and ancient Oceania (Johannes 1978, 352). Moreover, the temporal flexibility of such practices, despite its social motivation, is similar to the style of adaptive management increasingly embraced by management scholars today (see Berkes, Colding, and Folke 2000, for example).

This is not to say that Pacific island cultures were never harmful towards the marine environment or imprudent with its resources. There is historical documentation of egregiously excessive royal feasts in the Society Islands that decimated lagoon ecosystems on a periodic basis (Oliver 1974). Seasonal overfishing of tuna in Hawaii sometimes resulted in massive amounts of waste. Some Pacific islanders used fishing methods that involved smashing coral or employing poisons that killed superfluous amounts of marine life (Johannes 1978). As Johannes succinctly explains, "environmentally destructive practices coexisted, as in most societies, with efforts to conserve natural resources.[7] But the existence of the former does not diminish the significance of the latter" (Johannes 1978, 355).

Drawing on several years of experience living and fishing alongside Palauan fishers, Johannes (1980, 1981, 1989) also highlights the practical knowledge of fishers in contemporary contexts – focusing on their awareness of the timing, locations, and routines of spawning aggregations of various fish species, as yet scarcely documented within the scientific literature. During his research in the 1970s, he learned details about the lunar activity and spawning behaviors of 55 species of lagoon fish from Palauan fishers, over double the amount that had been recorded in the scientific record throughout the entire world at that point in time (Johannes 1981). However, he was also frustrated by his biologist colleagues' relative lack of interest in fishers' knowledge, lamenting that many of them continued to privilege formal Western science over indigenous knowledge. After all, Johannes points out, fishers not only vastly outnumber marine scientists, they also spend

[7] This portion of his statement is controversial. Johannes argued it, to be sure, but almost all of the examples in the Pacific suggest that environmental conservation was a byproduct rather than a specific goal (Foale et al. 2011).

considerably more time in the field than visiting scientific professionals who are burdened with publishing demands and the rigors of academia (Johannes 1989).

Johannes' ethnographically driven work ushered in a new wave of fishers' knowledge research by the 1980s and 1990s, largely devoted to the qualitative documentation of local fishing knowledge and its relevancy to contemporary fisheries management. For example, Ruddle (1988, 1991) focuses on indigenous systems of management across the Pacific Basin, adding to the comparative framework of customary fisheries governance within the region begun by Johannes two decades prior. In another study, Bavinck (1996) discusses gear banning in the context of social justice and ecological understanding of small-scale fishers in several communities along the Coromandel coast in India. Despite its economic incentives and practical efficiency, villagers chose to ban a new kind of fishing technology that adversely affected near-shore fishery dynamics. The case demonstrates how the collective decision-making processes of common pool resource users can adjust to benefit what is perceived to be the common good, effectively undermining Hardin's (1968) influential tragedy of the commons argument. Likewise, the work of Stoffle and colleagues (1994) highlights the efficacy of traditional coral reef management practices in Buen Hombre, a small fishing village on the north coast of the Dominican Republic. In addition to documenting how resource users adapt to near-shore ecosystem dynamics (e.g. species specific temporal catch restrictions based on population changes over time), the researchers were also able to facilitate government assistance for the village, providing villagers with legal recourse from encroachment by non-local commercial fishers. Not only do authors from these studies warn resource managers of the dangers of ignoring fishers' knowledge (i.e. (Johannes, Freeman, and Hamilton 2000), they tend to argue that the localized knowledge of fishers should, in many cases, become the sole source of information on which fisheries management is based (Hind 2015). Other notable publications from this era of research include examples from: Canada (Berkes 1987); Indonesia and the Solomon Islands (Berkes, Folke, and Gadgil 1995); Venezuela (Ruddle 1994); and Russia (Klubnikin et al. 2000).

More recently, fishers' knowledge researchers have sought to advocate for less radical fisheries policy reform, pushing for the integration of local knowledge and scientific data as opposed to wholly replacing the latter with the former (Hind 2015). Although this body of literature is relatively scarce compared to terrestrial based research, there are several

examples in which authors have shown the utility of using fishers' knowledge to bolster marine management strategies (Drew 2005; Cinner and Aswani 2007; Zukowski, Curtis, and Watts 2011; Cinner et al. 2012). For example, in the Solomon Island's Aswani and Hamilton (2004) integrated marine and social science approaches while documenting environmental issues identified by local resource users. More specifically, the knowledge of fishers was able to: confirm scientific assessments regarding the vulnerability of the bumphead parrotfish – a species vital to coral reef ecological processes and an important source of food and income for local communities; verify crucial habitat distributions of bumphead parrotfish; identify certain habitats where conservation efforts are most needed; and detail how lunar phase affects the behavior of bumphead parrotfish and the catch patterns of fishers targeting them (Aswani and Hamilton 2004, 79). Furthermore, by studying local systems of resource tenure, the researchers were able to position future marine protected areas in appropriate places – both in terms of addressing ecological vulnerability and enhancing local participation (Aswani and Hamilton 2004, 79–80).

Problematically, in some parts of the world there is scant marine science information on which to base management decisions. The work of Silvano and Begossi (2012), along the southeastern coast of Brazil, illustrates broad agreement between local knowledge and marine science literature regarding the habitats and seasonal mobility of various reef and pelagic fish species. However, the scientific literature regarding some of these species is relatively limited. In this case, *Hemiramphus balao* (a commonly used baitfish) and *Seriola* spp. (commercially valuable amberjacks) are virtually absent from biological studies in Brazil, but are well known to local fishers. Better incorporating such knowledge into management, the authors argue, would more accurately reflect the real needs of fisheries regulations that are often designed at broad scales and inflexibly implemented in varied contexts without the advantage that local-level monitoring and feedback would afford. In some countries, the authors contend, the knowledge of fishers may be the only available source of information relevant to fisheries policy (Silvano and Begossi 2012, 143).

At the same time, fisher knowledge is also embedded in larger social, cultural, and political processes (Maurstad 2002). Some authors have pointed out the concerns of social and political influences on local knowledge. They argue that such knowledge is susceptible to skewed narratives more intent on achieving political aims than accurately representing

reality (Maurstad, Dale, and Bjørn 2007). Drew (2005) draws attention to another potential problem related to fishers' knowledge – its heterogeneity. This fact, he argues, raises methodological concerns for fishers' knowledge research. Given that knowledge is variable within communities, it is important to understand who actually holds such knowledge. Identifying community experts is therefore a priority. If policies hope to reflect local realities and needs, assessing what drives knowledge variation at individual levels is equally important. However, as explained in the previous section, there are relatively few examples of fishers' knowledge research that explore the socio-economic factors shaping inter-cultural knowledge variation and change. Future studies addressing this gap in the literature will produce more nuanced, and locally appropriate fisheries policy.

FROM THEORY TO PRACTICE

Following this broad review of literature covering a wide range of disciplines, themes, and time periods, it is necessary to preface how these theories will be used to help frame the argument that follows. My research takes a step towards expanding the scope of processual literature away from terrestrial ethnoecology – focusing, in part, on the marine ecological knowledge of fishers. Following Brosius (2006), this study also emphasizes the value of more expansive epistemologies of local knowledge. Conceptualizing local knowledge as multidimensional (as opposed to solely ecologically oriented) enables an assessment of two of its domains – in this case, the ecological and political knowledge of local fishers. By quantifying both ecological and political knowledge through varied metrics, I am able to empirically measure the socio-economic drivers of knowledge variation within the fishing community in Moorea. Although there are numerous recent studies that evaluate the drivers of *ecological* knowledge change, assessing the factors that contribute to *political* knowledge variability is relatively novel. Doing so in the context of fishers' knowledge is especially rare. Moreover, this study represents the first of its kind in French Polynesia, a part of the world that has undergone immense environmental, cultural, and political transformation in recent years.

CHAPTER 4

LOCAL KNOWLEDGE AND IDENTITY REAFFIRMATION AMONG SMALL-SCALE FISHERS IN MOOREA, FRENCH POLYNESIA

INTRODUCTION

Local knowledge (LK) is heterogeneous, and understanding what shapes that heterogeneity is a crucial step for communities which hope to galvanize marine conservation efforts. Much recent research focuses on the ecological dimensions of LK, suggesting that local ecological knowledge (LEK) is fundamental to adaptive natural resource governance (Berkes, Colding, and Folke 2000; Aswani and Hamilton 2004; Cinner and Aswani 2007). LEK-informed marine resource management initiatives enable site-specific conservation policies and practices that can adapt in response to social or ecological changes. Management scholars argue that this iterative style of governance can foster ecological and social resilience because it is designed to deal with and learn from uncertainty and change, rather than manage for specific end results (Folke et al. 2005; Cinner et al. 2012). In the context of small-scale fisheries, these arrangements are increasingly discussed in terms of co-management, devolution projects that typically pair community members with government organizations (Berkes 2010; Cinner et al. 2012). Fisheries co-management has been associated with several advantages over top-down centralized governance approaches, including improved collaboration between various stakeholders, community empowerment, and the integration of local knowledge into management decision-making processes (Jentoft, McCay, and Wilson 1998; Jentoft 2005). The literature that supports incorporating local forms of knowledge into marine conservation policy highlights its empirical accuracy and rich detail, qualities that are reinforced by sustained interaction with the environment on the part of resource users (Drew 2005; Thornton and Scheer 2012). This interaction is often

driven by subsistence patterns or livelihoods, which demand robust and location-specific knowledge about highly variable and shifting resource dynamics. The biomass of coral reef fishes, for example, has been known to shift by several orders of magnitude in short time periods of two or three years (Adam et al. 2011; Adam et al. 2014). It was not until relatively recently, however, that LK scholars began to explore the dynamic nature of knowledge.

Until the 1990s, researchers tended to conceptualize LK as homogenous within communities and across cultures (Zent 2009; Briggs 2013). Now, scholars increasingly frame such knowledge as historicized, transformative, and variable within a population (Barth 2002; Berkes 2008). In other words, knowledge is informed by and built on past information and practices, but also incorporates contemporary input. LK can thus be defined as a corpus of information, values, and skills that are continually reproduced and shaped by engagement with various environmental, social, economic, or political influences (Berkes 2008; Zarger 2011; Vermonden 2012). How and why there are differences in the ways in which such knowledge undergoes change, however, remains poorly understood, especially in fishing communities.

Due in part to its implications for future resource management strategies, the assessment of individual variation in knowledge is particularly salient in recent scholarship. These studies typically employ quantitative methodologies – empirically measuring how demographic and socio-economic factors are associated with knowledge variability, and then contextualizing findings with qualitative information obtained from ethnographic work. This body of literature has established several common indicators of knowledge variation, including: gender, age, education level, livelihood, income, religion, fluency of the local language, exposure to tourism, and integration into a market economy (Zarger 2011; Zent 2013; Lauer and Matera 2016). Numerous studies within the last two decades (Begossi, Hanazaki, and Tamashiro 2002; Pearce et al. 2011; Spoon 2011; Vandebroek and Balick 2012; Demps et al. 2015; McCarter and Gavin 2015) have empirically evaluated knowledge variation, although the vast majority have focused on ethnobotanical knowledge in terrestrial contexts. Only a handful have assessed the marine ecological knowledge of fishers (Guest 2002; Garcia-Quijano 2006; Robinson, Cinner, and Graham 2014; Lauer and Matera 2016). Attempting to pinpoint key drivers of knowledge displacement has been an especially prominent theme of late (Voeks and Leony 2004; Reyes-García et al. 2013; Zent 2013).

Several studies have demonstrated the transformative effects a cash economy can have on LEK (Ross 2002; Godoy et al. 2005; Reyes-García et al. 2005), although others have shown that in some circumstances the influence of market integration on LEK is negligible (Zarger and Stepp 2004; Quinlan and Quinlan 2007).

Much of this quantitatively driven scholarship, however, tends to maintain a relatively narrow conceptualization of "knowledge", focusing primarily on people's understandings, perceptions, and practices directly related to the biophysical world. As Heckler (2007) points out, defining knowledge hinges on what is deemed to be valuable. But in the context of resource management and policy formation, a sophisticated understanding of environmental processes may be of less importance if prevailing social dynamics have resulted in power imbalances that threaten resource users' autonomy and ability to manage their own affairs. Drawing on Brosius (2006), I contend that local knowledge research should address not only environmental knowledge but also how that knowledge is positioned within the socio-political context in which it is embedded.

Here, I argue for the importance of conceptualizing local knowledge as a dynamic social process that involves domains beyond environmental understanding, such as those related to cultural identity. The ways in which "LK" interrelates environmentally associated knowledge with personal and cultural identities has significant implications for co-management, especially as these arrangements relate to community empowerment. In other words, in a colonial context such as Moorea, the assertion of cultural identity can become entangled with political positioning and sovereign rights. Illuminating the entanglement between identity, politics, and environmental awareness is important for communities that hope to cultivate more autonomy for local resource users. A deeper understanding of Polynesian identity formation and reaffirmation can help to empower community members in preserving the kind of political capital that is necessary to achieve communal goals related to the environment and to cultural revitalization. An awareness of the factors that underlie LEK heterogeneity can help resource users in maintaining a rich body of knowledge related to coral reef ecological processes. Moorea makes for an especially interesting arena of study because of the continued socio-cultural importance of fishing – despite, and perhaps even in response to pronounced economic development in the last few decades, and a 200-year history of colonial subjugation.

STUDY SITE

Moorea is a triangularly shaped high island, centrally located in the south Pacific. Bordered by shallow lagoons and a barrier reef with 11 natural passes, its land area is approximately 135 square kilometers, with verdant volcanic peaks that reach over 1,200 meters. Situated 17 kilometers northwest of Tahiti, Moorea is part of the Windward Group of Society Islands within French Polynesia. A population of over 17,000 people is dispersed across five districts (Paopao, Teavaro, Afareaitu, Haapiti, and Papetoai) comprised of 22 villages (Institut de la statistique de la Polynésie française 2012).

Moorea has been under varied levels of French control since 1843.[8] The island's socio-economic landscape has undergone two major shifts over the last century. Its economy was dominated by small-scale fishing and farming up until the early 1900s, and then gradually shifted towards commercial agriculture, in the form of copra and vanilla cropping. (Henningham 1992). French military activity in the 1960s, though, brought abrupt and far-reaching economic, political, and environmental change to the region. In 1966, the French government initiated a nuclear testing campaign on Moruroa and Fangataufa, two atolls in the Tuamotu Archipelago. The program spurred major urban development in Papeete, Tahiti's capital. As more jobs were created to support a burgeoning infrastructure, including an international airport and shipping ports, Papeete's population grew exponentially with extensive immigration from throughout the region (Henningham 1992). Coupled with an influx of people moving to Tahiti, regular ferry service between Moorea and Papeete essentially established Moorea as a de facto suburb of the capital. In turn, population pressure from Tahiti precipitated a significant increase in coastal development on Moorea over the last 30 years, almost exclusively in the island's northern districts. Moreover, the infrastructural changes on Tahiti firmly established the region as major hub for tourism – what has since remained the dominant economic sector of Moorea. Even though Moorea's land area is only 135 square meters, there are 11 major hotels and 50 smaller "pensions de famille" on the

[8] In 2003 all of French Polynesia became an overseas collectivity of France, providing the region with more political autonomy.

island (SDT 2013). During the 1990s, in fact, over 80% of overseas tourists visiting the region spent time on Moorea (B. L. E. Walker et al. 2014). Despite all of this, France continued to test nuclear bombs until 1996, paradoxically poisoning the same environment it promoted as a tropical paradise (M. Kahn 2011).

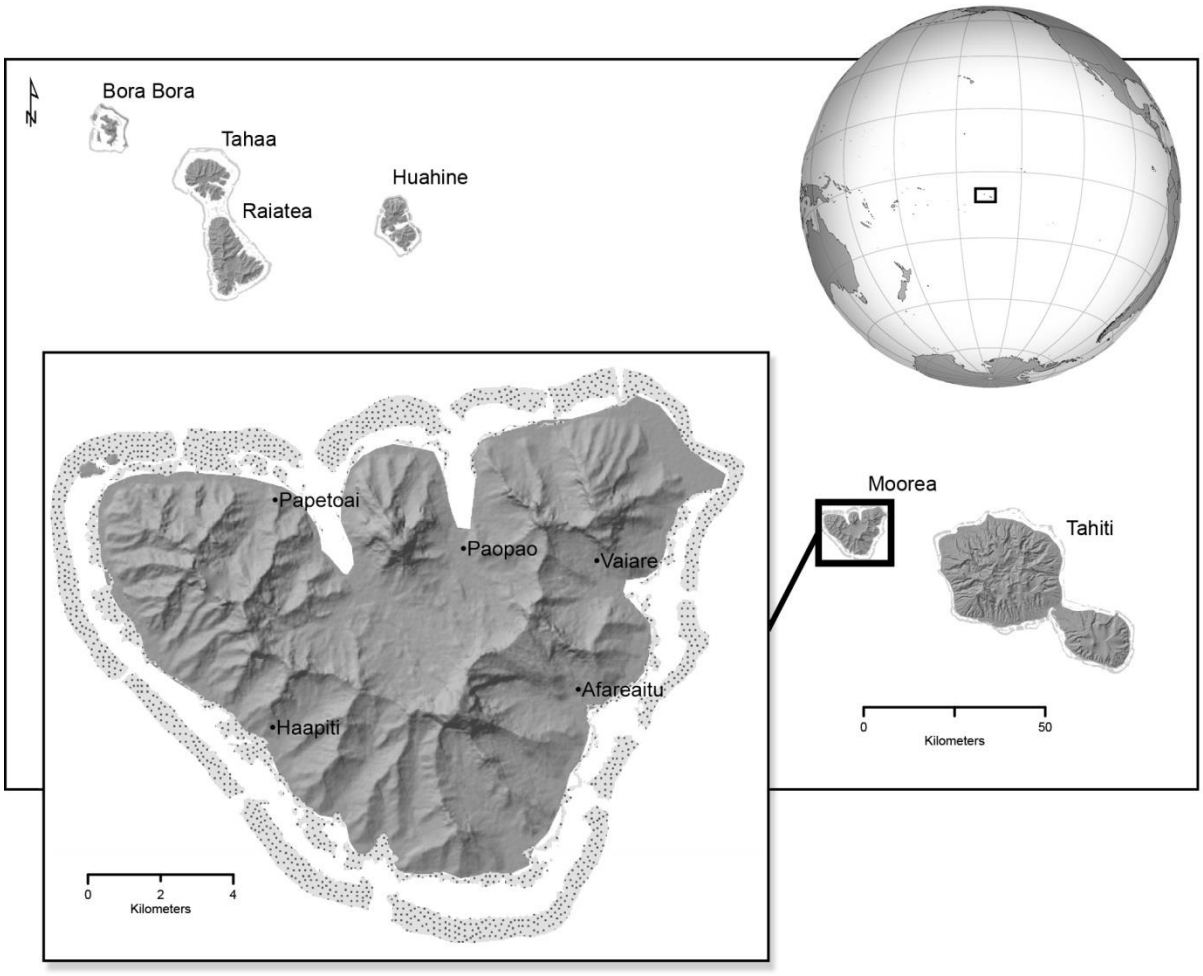

Figure 3. Map of Moorea and its position in relation to the other Society Islands and the rest of the world. Moorea includes the names and locations of district seats.

THE SOCIO-POLITICAL CONTEXT

In the preceding decades, the nuclear testing program consistently caused ripples of dissent towards French policy from both Pacific and international communities. The epitome of continued French colonialism, the program stoked the flames of indigenous cultural revival movements that began to take shape in the late 1960s (Nicole 2001). One way in

which the renaissance gained momentum was through the anti-colonial writings of Henri Hiro, an indigenous artist and intellectual born on Moorea in 1944. His poetry, in particular, voices the socio-political tension between the French government and the Maohi (i.e. indigenous Polynesian) population within the region. More specifically, his literature explores place-based themes related to local linguistic revival movements, ancestral and spiritual connections to the environment, and the maintenance of customary practices in terms of food procurement, meal preparation, and communal sharing networks (Nicole 2001; Stewart, Mateata-Allain, and Mawyer 2006; M. Kahn 2011). This work is thus a lens through which to view the continued assertion of indigenous identity in the face of structural oppression.

One project that Hiro was involved with on Moorea was the creation of the *tarena,* a lunar calendar that documents the knowledge of two elders, one a fisher and the other a farmer. As uncodified ecological knowledge that had been used to help guide fishing and farming practices for generations, the decision to produce a written calendar was both a political statement and a call for environmental stewardship. Compiled during the early 1970s when French policy still outlawed the teaching of the Tahitian language in schools, the tarena – written entirely in Tahitian, represents one way in which indigenous Mooreans are able to push back against the hegemonic power of France. Today, awareness of and engagement with the tarena is a means by which some fishers continue to connect with their Maohi heritage and reassert their identities.

Over the last decade, however, such identities have become potentially threatened by contemporary fishery policy. In 2004, the state established a new set of marine management rules (Plan de Gestion de l'Espace Maritime, PGEM) that included the implementation of eight no-take zones as well as species specific season and size restrictions. Although PGEM was cautiously designed over a 10-year period, a significant portion of the population – especially fishers – felt marginalized by and left out of the planning process. For the time being, it remains a politically volatile source of controversy on Moorea (B. L. E. Walker and Robinson 2009; B. L. E. Walker et al. 2014). To a lot of people – especially fishers, PGEM feels like an extension of colonialism because it is changing the way they interact with the lagoon.

Fishing, of course, has long been significant on the island. Prior to European contact, practices were controlled through traditional tenure regimes termed *rahui* that were bolstered by the accumulation of nuanced marine ecological knowledge (Handy 1932; Oliver 1974). Because traditional Tahitians conceptualized the land and sea as continuous and indistinct from each other, rahui stretched from inland agricultural zones to coastal fishing areas (Hviding 2003). Regulated by socio-political institutions and religious beliefs, this arrangement placed resource-use decisions in the hands of district chiefs and affiliated families who had the power to impose *tapu*, a periodic closure that hinged on environmental awareness informed by local resource knowledge and regular monitoring (Oliver 1974; Johannes 1978; Ruddle 1988). As elsewhere in the Pacific, this system of management was not focused on restricting harvest quantities (Ruddle and Akimichi 1984; Cinner and Aswani 2007). Rather, it established a flexible rhythm in which marine resources were extracted from particular places at specific times in order to sustain hierarchical social relationships (Johannes 1978; Foale et al. 2011). As colonization and economic development in Moorea have undermined rahui, the ecological knowledge and cultural identity of the island's fishers continues to adapt in relation to contemporary socio-ecological dynamics. Interestingly, some authors have pointed out that certain aspects of traditional rahui style management have recently been revived in other communities within French Polynesia (Bambridge 2016). These developments make an exploration of the ways in which local knowledge is evolving in Moorea particularly relevant in terms of illuminating how its community members can foster cultural revitalization efforts related to marine resource management.

METHODS

Data Collection

This work builds on five months of research carried out from 2014 to 2015 during which our team administered 350 household surveys and conducted 16 key informant interviews with community-identified expert fishers in three of Moorea's districts, Papetoai, Haapiti, and Afareaitu. These semi-structured and more open-ended means of data collection enabled us to gather baseline information related to the fishing practices, marine resource perceptions, consumer preferences, and the socioeconomics of the island's fishery.

Primary data for this study were collected between June and August of 2015. With the help of two local interpreters, we conducted semi-structured interviews with 94 informants in Tahitian, French, or English, depending on each informant's language of preference. The interviews addressed 17 socio-economic variables: gender, age, education level, religion, Tahitian fluency, district of residence, length of time living on Moorea, average number of days spent fishing per week, average hours spent fishing per trip, perceived economic necessity of fishing, weekly income from fishing, total weekly income, occupation, level of tourism interaction, boat access, main gear type used when fishing, and spearfishing specificity (i.e. commonly targeting a specific set of fish species). This list is based on factors commonly identified in previous literature (Zarger 2011; Zent 2013; Lauer and Matera 2016) as influencing LK variation, but also includes place-based adjustments in order to index conditions unique to Moorea's fishery. The variable related to spearfishing specificity, for example, was included because preliminary research suggested that "fishing for taste" (i.e. targeting the "best tasting" fish, as opposed to the largest or most economically valuable species) is a primary motivation for local fishers. More specifically, this variable was constructed by asking spearfishers whether or not they tend to exclusively target a limited range of fish species when they hunt, or if they spearfish in a more general or convenient fashion – going after whatever edible species they happen to encounter while fishing.

Fishers' (n=94) familiarity with the tarena was also assessed. In addition to open-ended questions in which respondents were asked to describe the main purpose of the lunar calendar and explain their current engagement with it, we posed five tarena content-based questions related to spawning cycles, seasonal abundance, and lunar phase activity of commonly fished lagoon species.

Table 1. Questions and Answers Used to Assess Fishers' Familiarity with the Tarena

According to the tarena, which night of the moon has the most iihi (soldierfish, *Myripristis* spp.)?	Five nights after the full moon
" what is the season of the marava (silvery rabbitfish, *Siganus argenteus*)?	November to February
" when do the ume (unicornfish, *Naso* spp.) lay their eggs?	June to August
" what fruit is ripe when the vana (sea urchin, *Echinothrix* spp.) are ready to be harvested?	Tahitian mango
" what months are best for catching lagoon fish?	September to October

Using knowledge of tarena content as a proxy for local knowledge was initially chosen because the calendar – and its use as a guide for fishing – was brought up several times in 2014 during household surveys and key informant interviews. Over the course of the primary research during 2015, however, it became increasingly apparent that although most people use some form of lunar calendar to inform their practices (i.e. written calendars based on personal experience, or, more commonly, mental notes acquired through personal experience) – the majority of fishers does not actively consult the formalized, written version of the tarena for fishing purposes. Instead, I contend that familiarity with the tarena's content, although certainly ecologically centered, appears to be more representative of engagement with and reaffirmation of cultural identity in Moorea. Moreover, in a colonial context like Moorea, identity reaffirmation is an important aspect of cultural revitalization that is inherently political. Importantly, this enables us to quantitatively assess a dimension of LK that is often overlooked in studies that explore knowledge variation.

For the second metric of local knowledge – LEK, a short ranking exercise was designed to illuminate some of the ways in which spear fishers are potentially adapting their practices to localized ecological disturbance (i.e. increasing levels of algae [*Turbinaria ornate*]). A subsample (n=56) of the overall informant group took part in this exercise because some fishers either do not spearfish, or personally felt that they spearfish so irregularly that they were not sufficiently capable of completing the task. The exercise required informants to rank six randomly selected 22 x 28 cm laminated pictures (from a set of 45) of local marine habitats (i.e. sand, reef, algal covered coral, coral rubble, lagoon descents, and deepwater) in terms of preferred fishing locations for five commonly targeted lagoon fish species. Informants elicited the first four species, and the fifth was then selected

from a list of five key herbivorous genera vital to local coral reef ecosystem processes (*Naso*, *Scarus*, *Chlorurus*, *Siganus*, and *Acanthurus*). Respondents were also asked to indicate whether trips are routinely planned in order to catch these specific species, or if they are fished in a more opportunistic fashion (i.e. spearing the first edible species encountered). As described above, this is how we constructed the variable related to spearfishing specificity.

Data Analysis

Bivariate statistical analyses were undertaken in order to evaluate to what degree certain socio-economic variables influence the political knowledge of individual fishers. As explained above, a proxy for political knowledge – tarena familiarity, was used as the dependent variable in the first set of analyses. In order to meet assumptions of normality, the dependent variable was transformed using a variation of a square root transformation ($y = \sqrt{x+1}$). Categorical responses were then converted to dummy variables. Gender, for example, was dichotomized as 0 for female and 1 for male. Tarena familiarity scores ranged from 0 to 4 (out of a possible 5), with a mean of .87.

A composite score of local ecological knowledge from the habitat ranking exercise was obtained by calculating the agreement between informant responses and marine science literature (MS, hereafter) in regards to species habitat (Allen et al. 2003; Bacchet, Zysman, and Lefèvre 2007). For each of the five rounds of rankings, perfect LEK-MS agreement was given a score of 1, whereas no agreement was scored 0. More specifically, perfect LEK-MS agreement was scored when informant responses matched the MS literature on coral reef fish habitats (see Table 2 below). In some cases, there were multiple correct answers because some species have more than one preferred habitat. Furthermore, if there was a habitat card later in the ranking that achieved closer agreement (i.e. a significantly higher percentage of correct habitat coverage), half credit (0.5) was taken away from that particular round's score. Lastly, there were some instances in which informants indicated that none of the six cards they were randomly presented sufficiently represented the habitat of the fish under consideration. In those cases, we asked informants to describe the habitat and scored their description against the MS literature. There are two habitat categories (rock ledges, reef passes) listed in the table below for which we had no habitat cards. Agreement scores for the

rankings of each of the five species were then summed for a composite. LEK scores ranged from 3 to 5 (perfect LEK-MS agreement) with a mean of 4.49.

Table 2. Fish Habitats Used to Create LEK-MS Agreement Scores. Some Species Include More Than One Preferred Habitat Identified in the MS Literature

Tahitian name	English name	Scientific name	Habitat
Paati / Pahoro	Parrotfish spp.	*Scarus* spp. and *Chlororus* spp.	Reef
Ume Paa	Unicornfish	*Naso unicornis*	Reef/Deepwater/Algae
Ume Tarei	Orangespine unicornfish	*Naso lituratus*	Reef
Iihi	Soldierfish spp.	*Myripristis* spp.	Rock Ledges/Lagoon Descents
Apai	Sabre squirrelfish	*Sargocentron spiniferum*	Rock Ledges/Lagoon Descents
Parai	Yellowfin surgeonfish	*Acanthurus xanthopterus*	Reef/Sand
Oturi	Blackstreak surgeonfish	*Acanthurus nigricauda*	Reef/Sand
Maito	Surgeonfish spp.	*Acanthurus* spp.	Reef
Marava	Silvery rabbitfish	*Siganus argenteus*	Reef/Coral Rubble
Paauara	Spiny rabbitfish	*Siganus spinus*	Reef
Vete	Goatfish spp.	*Mulloidichthys* spp.	Sand
Ahura	Goatfish spp.	*Parupeneus* spp.	Sand
Roi	Blue-spotted grouper	*Cephalopholis argus*	Reef
Tarao	Grouper spp.	*Epinephelus* spp.	Reef
Papae	Wrasse spp.	*Cheilinus* spp.	Reef
Nanue	Chub spp.	*Kyphosus* spp.	Deepwater
Oeo	Emperor	*Lethrinus* spp.	Reef
Moi	Sixfeeler threadfin	*Polydactylus sexfilis*	Reef
Paaihere / Omuri	Jack spp.	*Caranx* spp.	Lagoon Passes/Deepwater
Toau	Yellow-margined snapper	*Lutjanus fulvus*	Reef

RESULTS

To evaluate both metrics of LK, bivariate regression analyses were performed for the eight continuous independent variables. Welch's two-sample T-tests (for binary categories), and one-way ANOVA tests (for categories with more than two possibilities) were used to assess the influence of the nine categorical variables (see Table 3 below). For tarena familiarity, the analysis revealed that five of the 17 variables tested influence this domain of knowledge within the total sample (n=94) to a statistically significant degree: age ($p < .019$), length of time living in Moorea ($p < .037$), level of formal education ($p < .021$), gender ($p < .002$) and spearfishing specificity ($p < .011$). More specifically, age and length of time living in Moorea are positively associated with tarena familiarity while level of formal education, on the other hand, is a negative predictor. Further analysis of the two categorical variables that elicited significant results (gender and spearfishing specificity), indicate that women tend

to be more familiar with the tarena than men, and specific spearfishers tend to have more knowledge of the calendar than non-specific spearfishers. The sample size for spearfishing specificity, however, was necessarily smaller (n=67) because it required that informants spearfish at least once a month.

Table 3. Descriptive Statistics for Variables Included in Regressions, One-Way ANOVA's, and T-tests with Tarena Familiarity as the Dependent Variable

		N=94			
Variables	Description	Min	Max	Mean	Std. Dev.
Dependent (Continuous)					
Tarena Familiarity	A composite of five tarena-content based questions	0	4	.87	.9
Explanatory (Continuous)					
Age	Age of participant in years	17	75	41.6	13.5
Years in Moorea	Number of years participant has lived on Moorea	1	75	36.3	17
Years of Formal Education	Age when participant stopped attending formal school	8	21	15.6	3
Tahitian Fluency	A composite score of participant's oral, written, and reading fluency in Tahitian	0	6	4.8	2
Number of Fishing Trips per Week	Average number of trips participant goes fishing per week	.25	7	3	1.7
Number of Hours per Fishing Trip	Average number of hours participant spends fishing per trip	1	13	5.8	2.6
Individual Income from Fishing per Week	Average weekly income participant makes from fishing (XPF)	2,500	100,000	30,472	24,053
Total Individual Income per Week	Average weekly income participant makes in total (XPF)	9,000	195,000	45,766	38,369
(Categorical)		N		% of total	
Occupation	1=Fisher	42		45%	
	2=Farmer/Gardener	8		9%	
	3=Salaried worker	20		21%	
	4=Pension	14		15%	
	5=Other	2		2%	
	6=NA	8		8%	
Gender	1=Male	87		93%	
	2=Female	7		7%	
District of Residence	1=Afareaitu	67		71%	
	2=Haapiti	4		4%	
	3=Paopao	15		16%	
	4=Papetoai	7		8%	
	5=Teavaro	1		1%	
Religion	1=Protestant	65		69%	
	2=Catholic	12		13%	
	3=Mormon	6		6%	
	4=Jehovah's Witness	3		3%	
	5=Adventist	1		1%	
	6=No religion	7		7%	
Tourism	1=Involvement (past or present)	19		20%	
	2=No involvement	75		80%	
Necessity of Fishing	1=Economic necessity (a need)	25		27%	
	2=Chosen endeavor (a want)	69		73%	
Main fishing gear used	1=Spear	50		53%	
	2=Line	22		23%	
	3=Net	13		14%	
	4=Trawl/Buoy (non-lagoon)	9		10%	
Fishing Specificity	1=Specific	47		70%	
	2=Opportunistic	20		21%	
Boat Access	1=Primary access to a boat	70		74%	
	2=Secondary access	11		12%	
	3=No access	13		14%	

Results from the second metric, LEK-MS agreement, reveal a significant negative relationship with only one of the 17 predictor variables: total weekly income ($p < .013$). Higher income correlates with lower levels of marine ecological knowledge. Just as our overall sample was reduced for spearfishing specificity within our first analyses, the sample size for this entire set of tests was (n=56), due to it being limited to spearfishers who completed the lagoon habitat ranking exercise (see Table 4 below).

Table 4. Descriptive Statistics for Variables Included in Regressions, One-Way ANOVA's, and T-Tests with LEK-MS Agreement Scores as the Dependent Variable

		N=56			
Variables	Description	Min	Max	Mean	Std. Dev.
Dependent (Continuous)					
LEK Composite Score	LEK- MS Agreement	3	5	4.5	.6
Explanatory (Continuous)					
Age	Age of participant in years	17	62	37.5	10.6
Years in Moorea	Number of years participant has lived on Moorea	1	62	31.7	15.1
Years of Formal Education	Age when participant stopped attending formal school	8	21	15.7	2.6
Tahitian Fluency	A composite score of participant's oral, written, and reading fluency in Tahitian	0	6	4.9	2
Number of Fishing Trips per Week	Average number of trips participant goes fishing per week	1	7	3.1	1.6
Number of Hours per Fishing Trip	Average number of hours participant spends fishing per trip	2	13	5.8	2.7
Individual Income from Fishing per Week	Average weekly income participant makes from fishing (XPF)	2,500	78,000	32,157	20,217
Total Individual Income per Week	Average weekly income participant makes in total (XPF)	9,000	180,000	43,437	33,561
Explanatory (categorical)		N		% of total	
Occupation	1=Fisher	30		54%	
	2=Farmer/Gardener	5		9%	
	3=Salaried worker	13		23%	
	4=Pension	3		5%	
	5=Other	1		2%	
	6=NA	4		7%	
Gender	1=Male	55		98%	
	2=Female	1		2%	
District of Residence	1=Afareaitu	40		72%	
	2=Haapiti	4		7%	
	3=Paopao	8		14%	
	4=Papetoai	3		5%	
	5=Teavaro	1		2%	
Religion	1=Protestant	40		71%	
	2=Catholic	4		7%	
	3=Mormon	4		7%	
	4=Jehovah's Witness	2		4%	
	5=Adventist	1		2%	
	6=No religion	5		9%	
Tourism	1=Involvement (past or present)	10		18%	
	2=No involvement	46		82%	
Necessity of Fishing	1=Economic necessity (a need)	18		32%	
	2=Chosen endeavor (a want)	38		68%	
Main fishing gear used	1=Spear	29		52%	
	2=Line	14		25%	
	3=Net	8		14%	
	4=Trawl/Buoy (non-lagoon)	5		9%	
Fishing Specificity	1=Specific	40		71%	
	2=Opportunistic	16		29%	
Boat Access	1=Primary access to a boat	40		71%	
	2=Secondary access	10		18%	
	3=No access	6		11%	

DISCUSSION

Four major findings from this study merit further discussion. One result, related to income, echoes what some prior studies conducted in terrestrial contexts have suggested as a significant source of LEK displacement. Three others, pertaining to education, gender, and spearfishing specificity, offer insight into some of the socio-economic, cultural, and political influences on local knowledge variation among Moorean fishers. These findings underscore the significance of conceptualizing LK as a dynamic social process with ecological and political domains, enabling assessment of how each domain of knowledge is adapting to social and environmental dynamics in Moorea.

Ecological Knowledge

First, based on the LEK-MS agreement scores, results indicate that individual income is negatively associated with knowledge about the marine environment. The relationship between LEK and market integration has been an especially common theme in recent ethnobotany related literature (Reyes-García et al. 2007) although to date few studies have assessed marine ecological knowledge, and even fewer have measured ethnoichthyological knowledge variation (Guest 2002; Garcia-Quijano 2006, 2009). Some authors contend that greater involvement in a market-based economy leads to LEK displacement. This rationale is centered on the notion that ecological knowledge becomes increasingly obsolete as people become immersed in an array of socio-economic changes that no longer demand regular environmental interaction (e.g. transitions to wage labor occupations, and higher levels of income). For example, Ross' (2002) findings from a Maya farming community in southern Mexico reveal that some members of the younger generation have abandoned farming for craft making, catering to the arrival of tourism brought about by the development and expansion of modern road systems. In turn, the plant and animal knowledge once integral to traditional farming practices is beginning to transform into other kinds of knowledge more relevant to the shifting social dynamics among younger segments of the population. Although in some cases, it seems clear that different kinds of market related activities affect knowledge in diverse ways. Results from Godoy's (1998) study among the Tawahka in the rain forests of Honduras suggest that individuals involved in the market economy through agricultural crop sales or wage labor occupations demonstrate significantly less knowledge of

local rain forest plants and animals than do community members who sell timber and non-timber forest goods (e.g. plants used for building homes and canoes). The latter group of individuals maintains higher levels of LEK because their occupational specialization emphasizes the commercial value of some of these species. Some kinds of market involvement thus reinforce LEK rather than displacing it with other types of knowledge (Godoy et al. 1998, 228).

In fact, other studies have found that as long as regular engagement with the environment is sustained, market integration can be positively associated with LEK (Guest 2002, Quinlan and Quinlan 2007, Furusawa 2009, Ahmed et al. 2010). For instance, Lauer and Matera's (2016) work among small-scale fishers in Vonavona Lagoon in the Solomon Islands found that salaried laborers were by far the most adept occupational group at detecting post-tsunami ecological changes to the local lagoon, outperforming villagers involved in more traditional lines of work such as fishing and farming. This is perhaps the case, the authors contend, because salaried workers encounter other kinds of "global knowledge" acquired by off-island experiences that brought them in contact with news reports highlighting tsunami-induced ecological change (Lauer and Matera 2016, 43).

Further analysis of related variables in our study in Moorea, however, did not suggest a strong relationship between occupation and LEK variation. Out of the six categories (fisher, farmer/gardener, salaried worker, pensioned retiree, unemployed, and other) salaried workers have the second highest mean agreement score, behind only that of pensioned retirees. Mean differences are negligible, however, and scores are relatively homogenous across all of the occupations. Regardless, this information implies that people involved in occupations such as fishing in which they regularly interact with the local reef do not have a richer understanding of the marine environment than those with occupations unrelated to the environment like wage-laborers. In fact, out of the six occupations, salaried workers fish the least in terms of both average hours spent per trip, and average number of days fished per week.

When breaking down income into five tiers, informants in the upper most echelon of individual income fish an average of 3.4 days per week – just above the overall sample mean of 3.1. This group also fishes an average of 7.7 hours per trip, well above the overall sample mean of 5.8. Despite spending considerable time fishing, the highest earners had the lowest agreement scores, suggesting they are the least knowledgeable about fish habitats. What is

more, this cannot be further explained by boat access or main gear used when fishing, as there is no evident relationship between wealth and either of these two variables. Considering the lack of apparent connection between income and any other variables examined in this study, it stands to reason that some kind of lifestyle change or material influence brought on by increased wealth underlies this result. Clearly, more research is needed in order to better understand why income is detrimental to marine ecological knowledge in Moorea.

Familiarity with the Tarena

The three remaining results that prompt this discussion come from assessment of fishers' familiarity with the tarena. First, formal education is negatively associated with knowledge of the calendar. These results suggest that the school system in Moorea – the same system that is in place throughout French Polynesia – has undermined Moorean fishers' sense of Polynesian identity as well as their interest in symbols of identity that are embedded in the tarena. This finding is not entirely unexpected, given that up until the 1980s French policy banned the use of Tahitian in schools across the territory (Nicole 2001). French, in fact, is still the language of instruction across French Polynesia and the curriculum is largely the same as is taught in France. Despite French Polynesia's increased political autonomy, the education system continues to adhere to an assimilation policy that purposefully undermines Polynesian culture (Gonschor et al. 2012).

Another finding from this study establishes that women, at least within the sampled group, have more familiarity with the tarena than men (see Figure 2 below). An obvious starting point when exploring what might underlie this variation is to examine the extent of gender differences in fishing and marine resource harvesting in Moorea, and how such disparity is embedded in the local political context. B. L. E. Walker and Robinson (2009) observe that since the 1980s, Moorea's fishery has become increasingly homogenous in terms of what once was a more defined set of gendered practices. Now, there is much less of a distinction between the kinds of fishing done by women and men. One of the main reasons for this, according to B. L. E. Walker and Robinson, is that invertebrate gleaning (a major activity for women prior to the 1980s) has become severely limited due to overexploitation of *Pahua* (giant clam, *Tridacna maxima*). As a result, traditional gender roles within the fishery have become fluid as women have branched out into other modes of fishing.

Results from our 2014-2015 household surveys support this finding, revealing that both women and men are involved in the four main extractive lagoon activities: spear, line, net fishing, and invertebrate harvesting. Although women are much more involved in spearfishing than in the past, a much higher percentage of men spearfish (see Table 5 below). Importantly, spearfishers are able to circumvent some of the access issues imposed by PGEM by focusing their efforts just outside the reef crest – habitats that are not part of the protected areas. Since fewer women spearfish, not as many fisherwomen are able to take advantage of the relatively expansive fishing zones that spearfishing enables. What is more, hook and line fishing – by far the favored method of women, is often done from inshore areas that are now partially restricted or even completely off limits.

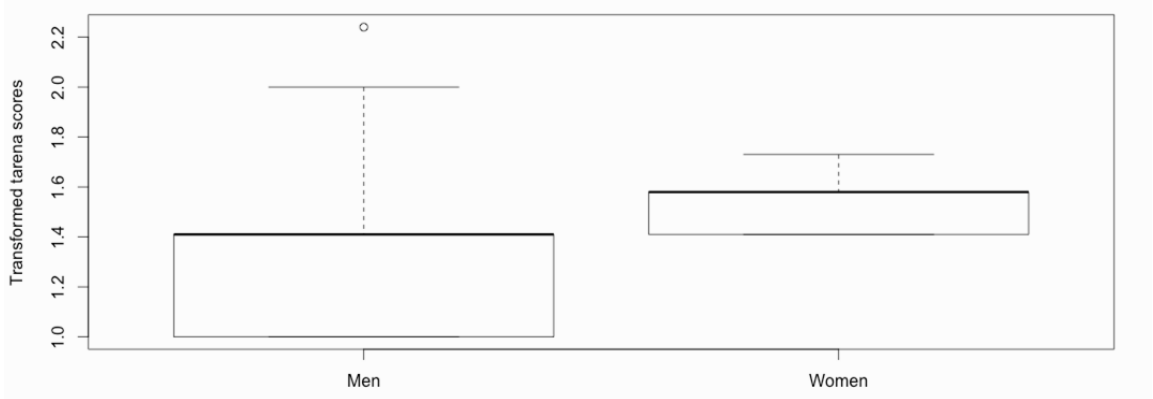

Figure 4. Boxplot showing observed differences in tarena familiarity based on gender (n=94) *note the outlier among the men

Table 5. Descriptive Statistics for Gender Breakdown of Fishing Practices by Gear. Data from Household Surveys (n=350) Administered in Moorea during 2014 and 2015. Total Women Surveyed (n=155) with (n=81, or 52%) Being Fishers. Total Men Surveyed (n=195) with (n=141, or 72%) Being Fishers. Categories are Not Mutually Exclusive (i.e. Many People Regularly do Several Kinds of Fishing)

Fishing Gear	Fisherwomen (n=81)	Fishermen (n=141)
Net	34 (42% of fisherwomen net fish)	70 (50 % of fishermen net fish)
Line	72 (89% of fisherwomen line fish)	88 (62% of fishermen line fish)
Spear	22 (27% of fisherwomen spearfish)	107 (76% of fishermen spearfish)
Invertebrate Harvesting	9 (11% of fisherwomen harvest invs.)	8 (6% of fishermen harvest invs.)

Moving to other, non-protected fishing areas via boat could alleviate some of these limitations. However, data from the household surveys also illustrate that women fishers have less access to boats than do men. Out of 141 fishermen surveyed, 101 (72%) own a boat that they use for fishing. Contrastingly, of the 81 fisherwomen interviewed, only 46 (57%) own a boat. Moreover, only 17 (37%) of these women have a motor for their boat, compared to 55 (54%) men. These data draw attention to the difficulty that women, in particular, have in regards to coping with PGEM regulations that often necessitate traveling farther in order to access legal fishing grounds – both laterally and in terms of distance from shore. This is one underlying reason, it seems, why women might be more politically engaged and vocal than men in terms of galvanizing efforts to reform marine conservation policies – a set of rules that disproportionally marginalizes women's fishing practices. Through this lens, the political utility of LK becomes clear. Assuming that familiarity with the tarena represents higher levels of engagement with a politicized cultural identity, it appears to be a political instrument that enables women to reassert their identities while firmly establishing their importance to Moorea's fishery.

Considering the relative depletion of *Pahua*, and the resulting PGEM regulations that restrict its harvest based on both size and season, it is apparent that these changes have demanded that women adapt by expanding their knowledge and skill sets over the last 30 plus years – remolding their identities as fishers in the process. This helps to explain why women are more knowledgeable about the tarena. As women have become more involved in the full array of fishing practices in Moorea, perhaps they have engaged more with the tarena in order to better familiarize themselves with the habits of fish species that they might not have been experienced with prior to expanding into other kinds of fishing practices. Moreover, the politicized nature of contemporary invertebrate harvesting might be urging women to become further involved in the political arena that currently surrounds marine resource governance on the island. Engagement with a calendar that has roots in identity politics is perhaps one way in which this involvement is occurring.

Admittedly, women only account for 7.45% of the overall sample from the 2015 fisher surveys – so it is entirely possible that the women we happened to survey are especially knowledgeable about fishing or more politically active than another, potentially more representative cohort of Moorean women. Regardless, this result underscores the

importance of involving women in discussions related to fishery policy on Moorea. After all, the 2014-2015 household data regarding gear use and boat access (with a much larger sample size of informants) makes clear that women's practices are especially vulnerable to the limitations imposed by contemporary management plans. Given the current push for the restructuring of PGEM, the need to incorporate women in this process seems especially urgent. Lastly, it must be mentioned that knowledge is often gendered to the extent that women and men typically maintain different, sometimes complementary domains of LK (Pfeiffer and Butz 2005; McCarter and Gavin 2014). This draws attention to the merits, both theoretically and methodologically, of expanding the way in which we conceive of and explore LK.

This study also finds spearfishing specificity to be positively associated with familiarity with the tarena. In other words, spearfishers who plan trips in order to catch specific species tend to more closely identify with a Hiro-inspired Polynesian indigenousness than spearfishers who opportunistically target whatever fish they happen to encounter.

According to results from the fisher survey, spearfishers focus their efforts on catching three main groups of reef fish: *Paati* (several species of parrotfish, predominantly *Scarus* spp. and *Chlororus* spp.), *Iihi* (soldierfish, *Myripristis* spp.), and *Ume* (unicornfish, *Naso* spp.). This echoes what Leenhardt et al. (2016) found to be the most common lagoon fish sold at roadside stands around the island over the last 25 years. Moreover, the 2014-2015 household surveys indicate that *Paati*, *Iihi*, and *Ume* are also the first, second, and fourth most frequently consumed groups of reef fish in Moorea. *Tarao* (grouper, *Epinephelus* spp.) is third, although it is most often caught via line fishing.

Some authors have noted how selective targeting offers fishers a way to distinguish their products from the glut of options available in a globalized economy. Griffith et al. (2013), for example, discuss how small-scale Puerto Rican fishers prioritize the freshness of the fish they sell in order to contend with the high levels of imported seafood that stream into the country. By emphasizing quality over quantity, fishers are able to defend their livelihoods by appealing to the cultural significance that local consumers place on incorporating certain species of fish into family and community meals. Indeed, promoting locally sourced and sustainable goods over products from large-scale manufacturers has become a global trend (Andreatta, Nash, and Martin 2011; Griffith, García-Quijano, and Pizzini 2013).

In Moorea, however, the main reason why many spearfishers selectively hunt is not in order to defend their livelihoods, but to defend their identities – a sense of self and culture that is intertwined with enjoying the taste of particular kinds of fresh lagoon fish. This is made clear by the fact that the majority of Moorean households do not rely on catching and selling fish as a main source of income. Due in large part to its tourism-based economy and a generous social safety net subsidized by France, Moorea is relatively affluent when compared to many other Pacific islands with small-scale coral reef fisheries (Osman 2000; Castri 2002; Salvat and Pailhe 2002; Gonschor et al. 2012; Bernard 2014). As a result, many residents find work in development or tourism sectors instead of fishing for a living. In fact, 69% of Moorea's fishery is recreational, with commercial and subsistence capacities only accounting for 11% and 20%, respectively (Leenhardt et al. 2016). These figures are substantiated by the way in which informants discussed their roles in the fishery. When asked to describe their involvement with fishing in terms of financial need, for example, 86% of the 94 informants characterized fishing as something they choose to pursue, rather than an activity they are compelled to do out of economic necessity. Furthermore, only 40% of respondents feel pressure to fish in order to adequately feed themselves and their family.

Given that most fishers are not financially tied to the practice, the relationship between a fisher's familiarity with the tarena and selective spearfishing underscores the cultural impetus inherent to Moorea's fishery. This finding resonates with Menendez-Baceta et al.'s (2015) recognition that cultural factors, such as engagement with Basque nationalism, can drive local knowledge maintenance through the fostering of identity reaffirmation.

In Moorea, the pride and pleasure people take in catching, preparing, sharing, and eating certain fish, is a major factor in reinforcing the knowledge that is required in order to connect with and learn from the island's coral reef ecosystem. Although financial gain is certainly a motivation for some fishers, factors related to personal and cultural identity are more essential to the underlying reasons why people fish – and why they fish for particular species. It stands to reason, then, that selective spearfishers are more familiar with the tarena and its cultural symbolism. In this way, defending one's cultural and personal identity can be viewed as a political act of cultural preservation.

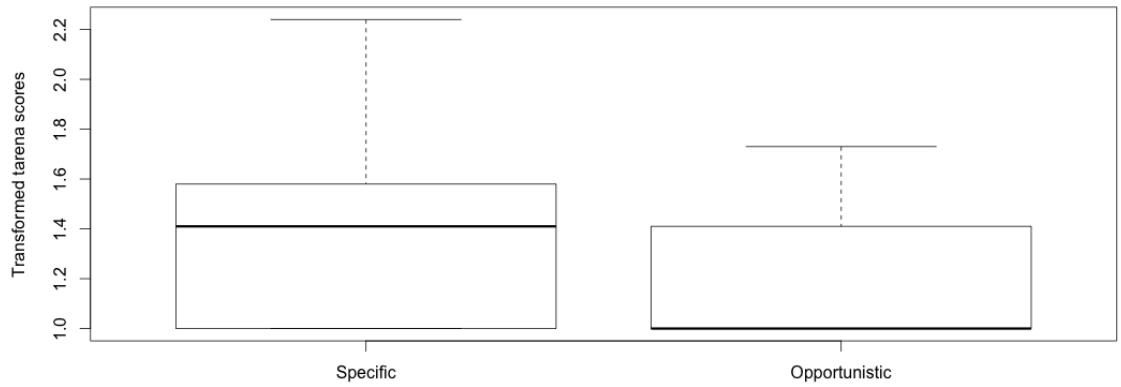

Figure 5. Boxplot showing observed differences in tarena familiarity based on spearfishing specificity (n=67)

CONCLUSIONS

When taken together, these results emphasize the intellectual merit of conceptualizing LK in a broad, and more inclusive framework. By exploring a more political dimension of local knowledge, fishers' familiarity with the tarena, this study provides additional insight into the factors currently influencing knowledge variation in Moorea. Tarena familiarity, for example, is negatively associated with increased exposure to formal education. Perhaps the island's education system needs broader reform in order to overcome France's long history of assimilation policy that purposefully undermined local knowledge and culture. At the same time, women's relatively high level of familiarity with the tarena compared to men, and the way in which their practices are being marginalized by PGEM, point to the necessity of including them in the political processes that underpin future marine policy reform efforts. Lastly, the positive association between familiarity with the tarena and selective spearfishing emphasizes the culturally driven nature of Moorea's fishery. The main impetus behind local fishing practices, it seems, is the socio-political identity and knowledge that Moorean fishers continually reinforce as they hunt for culturally important fish species that live among the coral reefs surrounding the island. The ways in which LK is used as a political tool and expressed through personal and cultural identities, has important implications for co-management, particularly in terms of enhancing community empowerment. More broadly, by framing local knowledge as a dynamic social process with ecological and political domains,

we are able to more fully explore how it is generated, contested, and adapts under changing social and environmental dynamics.

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