THE USE OF TRADITIONAL HAWAIIAN KNOWLEDGE IN THE CONTEMPORARY MANAGEMENT OF MARINE RESOURCES

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ABSTRACT

It is traditional for Hawaiians to "consult nature" so that fishing is practiced at times and places, and with gear that causes minimum disruption of natural biological and ecological processes. The Hoʻolehua Hawaiian Homestead continues this tradition in and around Moʻomomi Bay on the northwest coast of the island of Molokaʻi. This community relies heavily on inshore marine resources for subsistence and consequently, has an intimate knowledge of these resources. The shared knowledge, beliefs, and values of the community are culturally channeled to promote proper fishing behavior. This informal system brings more knowledge, experience, and moral commitment to fishery conservation than more centralized government management.

Community-based management in the Moʻomomi area involves observational processes and problem-solving strategies for the purpose of conservation. The system is not articulated in the manner of Western science, but relies instead on mental models. These models foster a practical understanding of local inshore resource dynamics by the fishing community and, thus, lend credibility to unwritten standards for fishing conduct. The "code of conduct" is concerned with how people fish rather than how much they catch.

The Hawaiian moon calendar emphasizes natural processes that repeat at different time scales: seasonal, monthly, and daily. The calendar is crucial to community-based resource monitoring and management. By identifying peak spawning periods for important food fish in a Hawaiian calendar format, traditional closures (*kapu*) can be applied by the community so as not to disrupt spawning behavior and other natural processes.

Detailed mental models have been constructed for several important inshore food species: *aholehole* (*Kuhlia sandvicensis*, a Hawaiian endemic), *moi* (*Polydactylus sexfilis*) and *limu kohu* (the seaweed *Asparagopsis taxiformis*). Conservation principles derived from the models can be verified by the fishermen's own observations and knowledge.

Community self-management of inshore fisheries around Moʻomomi Bay incorporates elements of traditional Hawaiian caretaker (*konohiki*) practices. This approach has been successful in maintaining healthy local populations of most important food species. Other communities are interested in applying the Moʻomomi model to their own localities. Caution is advised because the practices that are successful at Moʻomomi will lose vitality if transferred outside of the specific cultural and ecological context in which they evolved and are effective. The framework from the Moʻomomi model may be derived by other communities but the specific practices need to adapted to each local situation.

INTRODUCTION

Fishery management based on Western scientific thought has displaced indigenous knowledge systems throughout the world and, for the most part, Hawaiʻi is no exception. The Western view asserts that management should be left to professionals, and that the users of resources should not also be the managers of these resources (Berkes 1999). This view is fundamentally different from traditional Hawaiian[1] marine resource use and conservation where the resource users were the managers.

Long before any association with westerners, Hawaiians depended on fishing for survival. The need to avoid food depletion motivated them to acquire a sophisticated understanding of the factors that cause limitations and fluctuations in marine resources. Based on their familiarity with specific places and through much trial and error, Hawaiian communities were able to develop ingenious social and cultural controls on fishing that fostered, in modern terminology, "sustainable use" of marine resources. It is important to recognize these practices not as merely traditional, but as adaptive responses to marine resource availability and limitations. Hawaiian traditions incorporate conscious conservation (Johannes 1997) and demand an

[1] The term "Hawaiian" is used throughout to mean the original Polynesian settlers of the Hawaiian Islands and their descendents.

awareness of nature and attention to detail not found in contemporary fishery management.

In ancient Hawai'i, fishing activities and catch distribution were strictly disciplined by rules (*kapu*). Overseers (*konohiki*) enforced the *kapu* on behalf of *ali'i* (chiefs). Community self-management of inshore fisheries in and around Mo'omomi Bay is a contemporary version of the traditional *konohiki* or caretaker system. Education, family, and social pressure have become the means to elicit proper behavior rather than the harsh punishments of ancient times.

The survival of Hawaiian civilization for close to 2,000 years prior to European contact validates the traditional system. This knowledge system is dynamic, not static, and modern influences do not make it less traditional. It is legitimate in its own right and does not have to be recast in Western idiom or verified through Western science. However, the Hawaiian system does need to be communicated more effectively in order to incorporate it into a contemporary management framework. That is the purpose of this.

TENETS OF TRADITIONAL HAWAIIAN MARINE RESOURCE USE

The most significant beliefs and values in Hawaiian culture revolve around three fundamental relationships: 1) the relationship between Hawaiian people and their local environment; 2) the relationship among humans; and 3) the relationship between people and their ancestry. The importance of the first two relationships stems from Hawaiians' dependence on one another and on the environment for survival. The third relationship demonstrates the belief that those who came before knew the correct and proper way.

The traditional practices of native Hawaiians are guided by cultural protocol. Protocol combines knowledge, practice, and belief, fundamental characteristics that evolve over time within a specific cultural and ecological context of most traditional systems (Berkes 1999). Protocol disciplines and brings responsibilities to fishing, as well as to other cultural activities. The most important of the responsibilities are:

Concern about the well being of future generations.

This is the ability to meet present food needs without compromising the ability of future generations to meet their needs. Irresponsible resource use is tantamount to denying future generations their means to survival.

Self-restraint.

Take only what one needs for immediate personal and family use, and use what one takes carefully and fully without wasting. A good Hawaiian fisherman is not the one with the largest catch but the one who can get what he or she needs without disrupting natural processes.

Reverence for ancestors and sacred places where ancestors rest.

Hawaiians inherited valuable knowledge from their ancestors. At one time, this knowledge was critical for physical survival. The "ancestry of experience" (Holmes 1996) stored in the memories of living Hawaiians is still transmitted largely through non-written processes. It is taught to succeeding generations by telling stories, creating relationships, and establishing personal meaning. Ancestors are worshipped because of the dependence on knowledge and skills passed from generation to generation.

Lokahi ("harmony").

Time spent in fishing cultivates intimacy and harmony with the ocean, reinforcing strong ties to specific places and close relationships with marine creatures that are a part of Hawaiian identity and spirituality. In ancient times, fishermen made offerings of fish and said prayer chants (*mele pule*) at a special class of temple known as *heiau ko'a*, dedicated to gods of fishing (Kamakau 1976).

Malama ("take care of living things).

The Hawaiian perspective is holistic, emphasizing relationships and affiliations with other living things. Nurturing and respect, important for good human relationships, are also beneficial in relationships with marine life.

Laulima ("many hands").

Sharing and cooperation maintains family unity and community interdependence. The intensity of subsistence fishing activities is determined by kinship obligations, generalized reciprocity, and communal exchange of productive labor and foods among family, friends and neighbors.

Ha'aha'a ("humility").

Hawaiians are a part of the living world, not superior to it. Excluding people from nature only serves to further alienate humans from other living resources and thus from their responsibilities.

'Imi 'Ike ("to seek knowledge").
The young fisherman was trained to watch for changes (major and subtle) in the condition of marine resources. Before becoming acknowledged as an expert, the apprentice had to understand the life cycle, diet, feeding habits, preferred habitat, and growing conditions of many marine food species.

Handy *et al.* (1972), Pukui *et al.* (1972) and Kanahele (1986) provide more detail about traditional values that guide Hawaiian behavior. The issue for Hawaiian civilization is no longer physical, but cultural survival. "The culture lives on through its practitioners" (Edith Kanaka'ole Foundation, 1995) and their activities have a strong sense of "place". The following case study reinforces the importance of having places where Hawaiian traditions can continue.

CASE STUDY

The northwest coast of the island of Moloka'i (Figure 1) is one of the few places remaining in the Hawaiian Islands where the traditional Hawaiian system still provides a framework for fishery resource use and conservation. Inshore fisheries around the main Hawaiian Islands have declined significantly during the past century (Shomura, 1987; Friedlander and DeMartini, in press). The relative isolation of the coastal area in and around Mo'omomi Bay and community consensus about appropriate behavior have protected local marine resources from overfishing.

Marine resources along a 12-mile length of wave-exposed coast on both sides of Mo'omomi Bay are mainly harvested by a community of native Hawaiians who reside in nearby Ho'olehua Hawaiian Homestead. Residents are far more dependent on subsistence farming and fishing (one-third of the food consumed by the 1,000 residents of this community) (Hui Malama o Mo'omomi, 1995; Pacific American Foundation and Hui Malama o Mo`omomi. 2001), than in most other communities in the state. Opened in 1924, Ho'olehua was the second homestead established after the US Congress passed the Hawaiian Homes Commission Act in 1921 with the intent of returning Hawaiians to the land. The first Ho'olehua homesteaders were selected for their self-sufficiency (Hui Malama o Mo'omomi, 1995) and succeeding generations have endured, despite the harsh land and ocean environment. The coastal area is rich in artifacts and human burial remains dating mostly from prehistoric Hawaiian communities and activities back to the 11th century (Summers, 1971).

The continuation of traditional Hawaiian practices in and around Mo'omomi Bay helps to maintain social and cultural identity and provides reinforcement of values shared by the Ho'olehua community. The repetition of subsistence fishing activities is one of the ways that knowledge, values, and identity are transferred to succeeding generations Cultural survival is thus entwined with resource conservation. The basic elements of fishery management are in place in the Mo'omomi area: a conservation ethic, community support, management knowledge, and a system of monitoring.

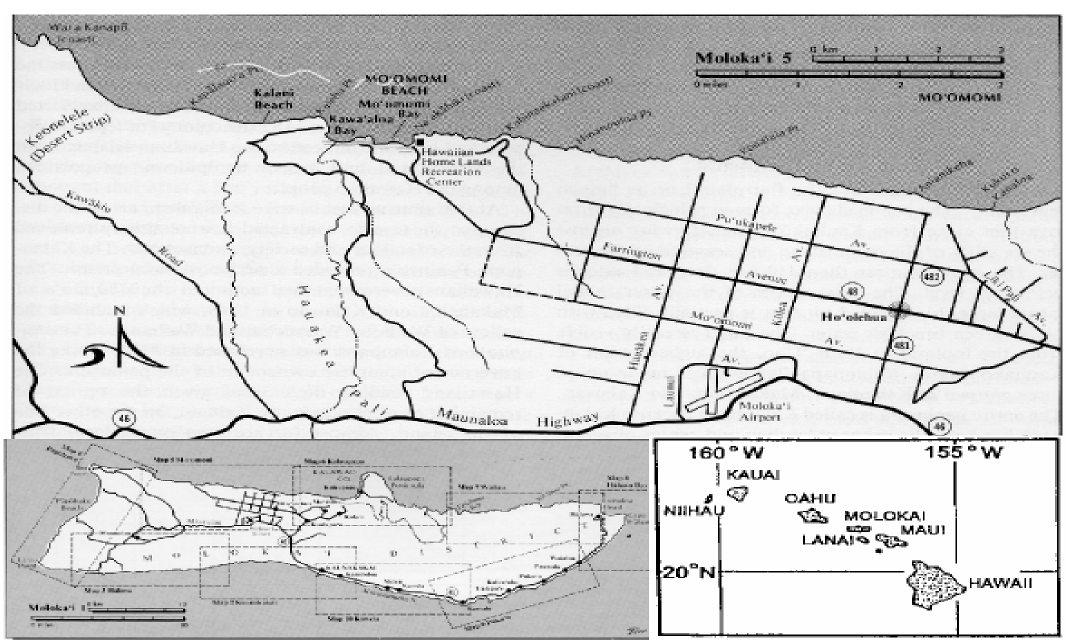

Figure 1. Mo'omomi and Kawa'aloa Bays located on the north shore of Moloka'i (adapted from Clark, 1989).

Conservation ethic

Fishing in and around Moʻomomi Bay continues to revolve around the subsistence use of local marine resources. Harvest practices are adapted to local environmental and ecological conditions. The community has no formal fishery management policies or institutions. Proper conduct of fishing is not controlled through formal rule making, as in Western regulations, but is inferred through internal cultural norms and values that guide and instruct the behavior of the community.

The wisdom and insights of leaders who hold and transmit traditional knowledge are crucial in lending credibility to the traditional system. The "code of conduct" focuses on how fishing should be practiced to maintain regular biological renewal processes, rather than on how much fish should be harvested.

Community support

The communal identity of Hoʻolehua Hawaiian Homestead is defined by a shared cultural heritage and is maintained by a system of interdependence and social reciprocity that is expressed in many ways, including the sharing of seafood gathered through subsistence. This system enables the homesteaders to live well and with confidence in a sometimes difficult environment.

Hui Malama o Moʻomomi was formed in 1993 to revitalize the traditional marine resource conservation system of the area by appealing to Hawaiian cultural beliefs, values, and conservation ethics. The Hui encourages responsible fishing based on individual conscience, social and family pressure, and the training of youths to become "good marine citizens." Networks of social ties and cooperation generated by subsistence activities create a collective interest in resource conservation and foster consensus about the proper conduct of fishing.

Management knowledge

Subsistence is the foundation of traditional Hawaiian knowledge. The homesteaders accumulate information that is essential for adaptation and survival in real life situations. This knowledge is not merely practical perception and "know how" but patterns of thought, understanding, and models of ecosystem workings.

The worldview and resource management perspective of Hawaiians is holistic. Humans are a part of the ecosystem. Land areas and adjacent marine waters are managed as interconnected and inseparable units known as *ahupuaʻa*. *Ahupuaʻa* were subdivisions of larger districts (*moku*). They typically extended from the mountain to the sea, providing the Hawaiian occupants with access to various natural resources for their subsistence (Costa-Pierce, 1987; Meller, 1985).

Despite substantial deterioration of Hawaiian ancestral marine resource knowledge in general, it remains dynamic, capable of being verified, regenerated, and even expanded for specific locations by new generations of Hawaiians. Hawaiian knowledge is a form of adaptive management. It takes a dynamic view of ecosystems, emphasizes processes that are part of resource renewal, acknowledges uncertainty and unpredictability, and stresses the importance of ecosystem resilience. The system continues to evolve through social learning; i.e., oral transmission, imitation, and demonstration.

Resource monitoring

The good Hawaiian fisherman is always watching the ocean, monitoring it for cues that signal what can be fished, where and when, in a manner compatible with local resource "rhythms" and to adapt fishing to changing environmental conditions. Key indicators include tidal cycles, waves and currents, day length, ocean temperature, habitat stability, sand movement, rainfall, wind velocity, and direction.

Many fish species aggregate to reefs for shelter, orientation of social behavior, and for food. Habitat complexity is one of the principal factors affecting spatial distribution of inshore fish abundance. Shallow-water habitats with low bottom relief and limited shelter are often associated with low standing stocks of fishes, whereas highly complex habitats harbor high fish biomass (Friedlander and Parrish, 1998). Native Hawaiians recognized the importance of *koa* (fish houses), special areas where fish were known to aggregate. *Koa* are focal points of fishing and resource conservation. The specific locations of *koa* are carefully guarded secrets of the Hawaiian families who held this knowledge. Western-trained scientists and resource managers acknowledge the existence of *koa* (Grigg, 1994; Friedlander and Parrish, 1998) but the concept remains poorly documented in fisheries science as well as contemporary management of Hawaiʻi's inshore fisheries.

Many natural processes that affect fish distribution are monitored by the community, the most important of which is moon phase. The moon was as essential in scheduling the activities of the ancient Hawaiians as clocks are to modern man. The moon calendar is a predictive tool based on awareness of natural cycles and their relationship to fishing and farming success. Its wisdom reflects lifetimes of observations and experiences by many generations of Hawaiians in their quest for survival (Edith Kanakaʻole Foundation, 1995). Present-day residents of Hawaii still refer to the moon calendar to plan fishing and planting activities and a popular form of the calendar is published annually by the Prince Kuhio Civic Club. Most contemporary users, however, extract only superficial information.

The moon calendar emphasizes natural processes that repeat at different time scales: seasonal, monthly, and daily. Distinctions are made between two general seasons (*kaʻu* or dry; *hoʻoilo* or wet) and three general phases of the moon: *hoʻonui* (nights of enlarging moon); *poepoe (*nights of full moon); and *emi* (nights of diminishing moon). In addition to illustrating seasons and moon phases, Figure 2 also gives the Hawaiian names for the 12 months of the year. Specific names were also given to each night of the Hawaiian lunar cycle (Figure 3)

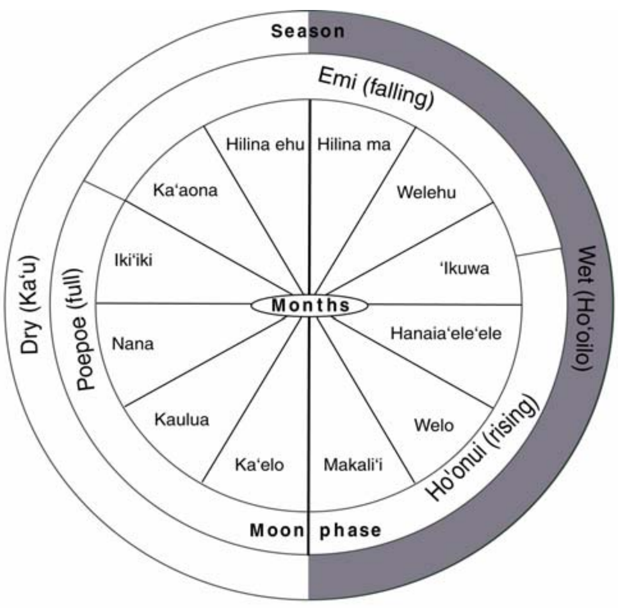

Figure 2. Hawaiian moon calendar showing months, seasons, and moon phases that are used to guide fishing activities. Names used for months in this calendar are specific to Molokaʻi.

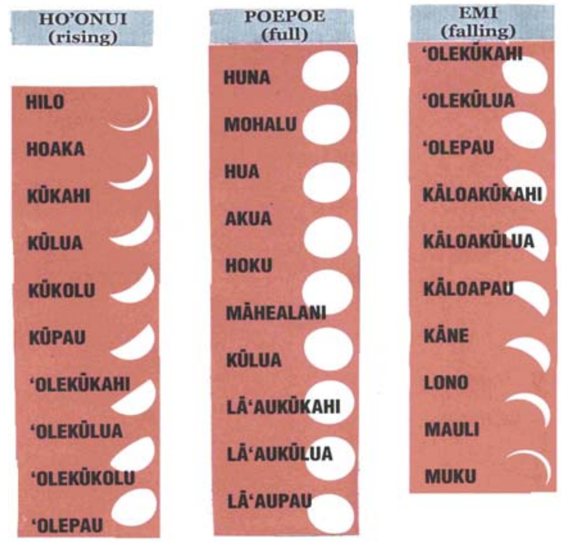

Figure 3. Hawaiian names for each night of the rising, full, and falling moon phases (adapted from Prince Kuhio Civic Club 2001).

Fish Spawning Calendar

By observing spawning behavior and sampling fish gonads, community monitors have constructed a calendar identifying the spawning periods of major food fish species. The Moʻomomi fish spawning calendar for the year 2000 is shown in Table 1. Peak spawning for *ulua*, *moi*, *uhu* and *aʻawa* occurred during the summer months. Late winter-early spring spawning was observed for *aholehole* and *kumu*. Surgeonfishes typically spawned in late winter, as well as in early spring. By identifying peak spawning periods for important resource species, traditional closures or *kapu* can be applied so as not to disturb the natural rhythms of these species.

Due to their local importance as food items, *aholehole* (Hawaiian flagtail, *Kuhlia sandvicensis*), *moi* (Pacific threadfin, *Polydactylus sexfilis*) and the red seaweed *limu kohu* (*Asparagopsis taxiformis*) were examined more closely and models of resource dynamics were constructed.

Applications of Hawaiian Mental Models

The traditional Hawaiian resource use system involved measuring and evaluating natural processes to produce representations of the workings of ecosystems, similar to Western science. Thus, theoretical constructs of Hawaiian scientific thought are <u>mental models</u> that recognize different states or "frames" capturing the essential aspects of dynamics that may apply to the same ecosystem at different times

(Starfield et al., 1993). However, Hawaiian knowledge relies on memory and does not incorporate the rigorous quantitative estimates or writings of Western science. There was no written Hawaiian language prior to the 19th century (Kuykendall, 1938), so traditional knowledge was orally transmitted from generation to generation through chants, stories, and demonstration.

Aholehole

The Hawaiian flagtail (*Kuhlia sandvicensis*) locally called *aholehole* is endemic to the Hawaiian Islands. Young occur in shallow water along the shoreline and may be found in tide pools, streams, and estuaries. They feed mainly on planktonic crustaceans but also on polychaete worms, insects, and algae. Length at maturity is about 18 cm, while spawning occurs year-round, though mainly during winter and spring months. The *aholehole* was used in sacrifices in ancient Hawaiʻi to keep away evil spirits when a white fish or pig was needed (Titcomb, 1972)

At Moʻomomi Bay, *aholehole* spawn during the wet season, typically in late winter-early spring. Much of the distribution of *aholehole* is based on the movement of sand in and out of nearshore habitats (Table 2). During the winter months, sand is transported offshore, providing ample space inside reef holes (*puka*) along the shore for *aholehole* to school. This change in habitat between seasons coincides with, and may be a cue to, the onset of spawning. During the summer months, sand is transported inshore resulting in reef *puka* being filled in and causing *aholehole* to move offshore. The conservation principles developed by Hawaiians to harvest *aholehole* included discouraging catch of sub-reproductive individuals and discouraging harvest during times of peak spawning.

Table 1. Moʻomomi Bay fish spawning calendar for the year 2000 for key resource species. Black boxes indicate months of peak spawning. Grey boxes indicate other months when spawning was observed (Friedlander et al. in press).

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
ulua (Caranx ignobilis)						■	■	■				
aholehole (Kuhlia sandvicensis)		■	■	■								
moi (Polydactylus sexfilis)					▒	■	■	■				
ʻuʻu(Myripristis species)							▒	▒	■	■		
kumu (Parupeneus porphyreus)	▒	■	■	▒								
aweoweo (Priacanthus species)								▒	■	■		
taʻape (Lutjanus kasmira)						■	■	■				
aʻawa (Bodianus bilunulatus)					■	■	■	■				
enenue (Kyphosus species)	■	■	▒	▒	▒							
uhu (Scarus species)					■	■	■					
uhu palukaluka (Scarus rubroviolaceus)					■	■	■					
ponuhunuhu (Calotomus carolinus)					■	■	■					
pualu (Acanthurus xanthopterus)		▒	■	■								
palani (Acanthurus dussumieri)		▒	■	■								
kala (Naso unicornis)		▒	■	■								
kole (Ctenochaetus strigosus)		▒	■	■								
manini (Acanthurus triostegus)		▒	■	■								

Table 2. Season movement patterns of *aholehole* (*Kuhlia sandvicensis*) in relation to changes in habitat.

Season	**Sand movement**	**Reef holes (*puka*)**	***Aholehole* distribution**
Winter	Offshore	Exposed	Inshore
Summer	Inshore	Filled	Offshore

Moi

The Pacific threadfin (*Polydactylus sexfilis*) or *moi* is a very popular and much sought-after sport and food fish in Hawaii that also supports a small subsistence fishery (Friedlander and Ziemann, in press). In ancient Hawaiian culture, *moi* were reserved for the ruling chiefs and prohibited for consumption by commoners (Titcomb, 1972). Hawaiians developed a number of traditional strategies to manage *moi* for sustainable use. *Kapu* or closures were placed on *moi* during the spawning season (typically from June through August) so as not to disrupt spawning behavior.

Moi are protandrous hermaphrodites, initially maturing as males after a year at about 20-25 cm. They then undergo a sex reversal, passing through a hermaphroditic stage, and finally becoming functional females measuring between 30 and 40 cm (fork length) at about three years of age (Santerre et al., 1979). Spawning occurs inshore and eggs are dispersed and hatch offshore (Lowell, 1971). Larvae and juveniles are pelagic until juveniles attain a fork length of about 6 cm, whereupon they enter inshore habitats including surf zones, reefs, and stream entrances (Santerre and May, 1977; Santerre et al. 1979). Newly settled young *moi*, locally called *moi-li'i*, appear in shallow waters in summer and fall where they are dominant in the nearshore surf zone fish assemblage.

Moi have a readily identifiable aspect of their life history (sex reversal) that has contributed to its decline in Hawai'i: continued overfishing results in relatively few females left in the population around heavily fished areas of the state. Hawaiians understood this, and prior to spawning season, females were normally released. Management was, and still should be, based on a detailed understanding of the life history of the species of interest (see also Barker and Ross, this vol).

At Mo'omomi, *moi* typically spawn near the northwestern end of Kawa'aloa Bay in the sand. *Moi* usually come inshore to spawn from June through August. Sand movement is very important in determining when and where *moi* spawn. In Kawa'aloa Bay, *moi* move inshore to spawn when sand has stopped moving, but before too much sand has moved in to fill in the *puka* in the reef. Shelter is an important controlling factor in reducing the risk of predation during the spawning period. Stable sand leads to higher infauna of *moi* prey (shrimp and crabs). Observation of sand movements and the height of sand waves can give a good indication of when *moi* will move inshore to spawn. As sand waves flatten out, the sand becomes more stable whereas steep sand waves indicate movement of sand.

Hawaiians developed a mental model of the life history of *moi* from which conservation principles and management practices were derived by integrating seasonal movement, spawning aggregation behavior, and the relationship of different life history phases to these behavior patterns. Table 3 is an attempt to construct a written representation of the knowledge concerning the behavior of *moi* and how it relates to Hawaiian conservation principles. Traditional Hawaiian conservation principles for *moi* included restrictions on harvest of *pala moi* (hermaphrodites) *or moi* (females), depending on population structure, and restrictions on harvest during the spawning season. Minimizing the disturbance to spawning and nursery habitats was another important conservation practice.

Awareness of the need to protect both immature moi and the female breeding stock from overharvest is an example of how Hawaiian resource knowledge can validate Western science, which has discovered and named this method of conservation as "slot limits." Not only was almost every basic fisheries conservation measure devised in the west in use in Oceania centuries ago (Johannes, 1978), including closed areas, closed seasons, size restrictions and restricted entry (Johannes, 1982), but some very sophisticated methods, including slot limits, were also practiced in Hawai'i.

Table 3. Seasonal movement of *moi* and related Hawaiian conservation principles

Fish size	Dispersed	Aggregated	Aggregated and spawning
Adults (*mana moi, pala moi, moi*)	Fall through winter	Spring -- in reef holes prior to spawning	June, July, and August -- one spawning per month cued by moon phase
Juveniles (*moi li'i*)	Leave for adult habitat after grown	In fall, as new recruits feeding in sand bottom areas with nearby rocky shelter	N/A

Limu Kohu

Seaweeds, collectively known as *limu* in Hawai'i, were the third component of a traditional, nutritionally balanced diet that also consisted of fish and *poi* (Abbott, 1984). Hawai'i is rich in *limu* species owing to the high volcanic islands and associated rainfall, which provides nutrients for the growth of *limu*. While the uses of seaweeds among other Polynesian peoples were either infrequent in the past or have been curtailed today (Abbott, 1984), Hawaiians continue to consume a wide variety of seaweeds. One of the most prized species is *limu kohu* (the supreme *limu*), or *Asparagopsis taxiformis*. There are several legends relating to how *limu kohu* got its dark red color, each referring to an event connected with legendary or real *ali'i* (royalty) (Abbott, 1984).

Fronting Mo'omomi and Kawa'aloa Bays, *limu kohu* grows in areas of intense surge from the splash zone on intertidal benches (*papa*) to boulder and flat limestone bottoms as deep as 40 feet. This seaweed is well suited to the shallow-water habitat off Mo'omomi, which is wave washed almost year round. There are, however, marked seasonal changes in the distribution of *limu kohu* (Table 4). During *ho'oilo* (wet season), the tides rotate in an opposite pattern from k*a'u* (dry season), when the highest tides occur during the day and the lowest tides occur at night. During the wet season, the coast is exposed to intense wave action generated by North Pacific swell and strong tradewinds. In these conditions, *limu kohu* is able to attach and flourish on long stretches of *papa* that experience less water movement during the dry season.

From January 2000-January 2001, seasonal changes in the distribution, abundance, and reproductive condition of *limu kohu* were studied at the major harvest site (*Kaiehu papa*). Information collected during 12 months of detailed observation is summarized in Table 4. The survey period began during the latter half of the 2000 wet season (January-April 2000), through the dry season (June-Oct. 2000) followed by the start of another wet season (Nov.-Jan. 2001). These data were collected by the authors and community resource monitors. Severe drought conditions later in 2001 severely retarded the growth of *limu kohu* on the *papa* over this time period.

Patterns observed in the relative abundance and height of plants (Table 4) indicate that the wet season provides the best growing conditions on shallow (0-1 m) benches, or *papa*. Marked changes in bench cover by this seaweed occurred during the wet season or after rainfall with young stands of *limu kohu* becoming one to two inches high during one cycle of the moon.

Limu kohu reproduces by spores. Observations during the wet season indicate that shallow-water plants bear spores after they have grown to a height of three inches, and sporing continues until full growth to 4.5 - 5 inches is completed (Table 4). As they grow taller, shallow stands of *limu kohu* are torn by high wave energy, starting with the fronds and eventually cutting off the main stems as they weaken.

Observations during *ka'u* (dry season) indicate that daylight exposure during minus tides, long days and reduced water movement make the shallow *papa* an inhospitable environment for *limu kohu* (Table 4). However, the longer days stimulate lush growths and sporing of this seaweed in subtidal areas of boulders and limestone flats to a depth of about 20 feet. At greater depths, growth is sparser because of limited sunlight.

There is a number of environmental factors that affect the growth of *limu kohu* on intertidal benches and subtidal areas (Table 5). The change of seasons from *ho'olio* (wet) to *ka'u* (dry) exposes growths of *limu kohu* on the intertidal benches to dehydration and sunburn and eventually causes die off. There is no conservation principle to be served by limiting the gathering of seaweed that is under such a "death sentence" and the largest harvest of *limu kohu* is made at this time of the year (May).

The continued availability of *limu kohu* at Mo'omomi Bay depends on the recruitment and growth of new plants. Success in reproducing (through sporing) and in attaching to local substrata are key processes that sustain the supply of this seaweed. Spores attach to suitable sizes of sediment and settle on the bottom wherever the preferred grain sizes are deposited. If particles are too small, they will be removed from the nearshore before settling.

The critical conservation principle derived from the mental model for *limu kohu* is to retain spores so they are more likely to settle out on local substrata (Table 5). That is why *limu kohu* gatherers are encouraged to rub off the root mass of plants against a rough surface (such as the collector's bag) as they are harvested. Many spores are trapped within the root mass and leaving this mass in the water increases the chance that spores will attach and grow near the original harvest location. Observations during the peak harvest period in May 2000 (see Table 4) suggest that *limu kohu* may replant in shallow inshore areas of the *papa* as a result of this practice.

Table 4. Observations of the seaweed *limu kohu* at the major shallow-water (0-1 m) harvest site (*Kaiehu papa*), January 2000 – January 2001.

Time of Observations	Condition of Shallow Plants	Height of Shallow Plants	Condition of Reproductive Spores	Other Information
Wet Season (Hoʻoilo)				
Jan. 2000	Abundant	3-4 inch	Attached	
Feb. 2000	Long plants breaking off, dying back, losing red color	3-4 inch	Large numbers attached, some being released	Wave action breaking off plants
March 2000	Shorter, sparse and pale in color	3 inch	Large number being released from shallow plants; evident on deep plants (20 ft)	
April 2000	Still abundant but long plants have broken off; pale color	2-3 inch on bench; 3-4 inch in pools	Same as March	
Dry Season (*Kaʻu*)				
May 2000	Pale color; what long plants remain are overgrown with epiphytes and dying back; some plants very close to shore	2 inch	Few spores attached to shallow plants; increasing number on deep plants (20 ft)	Time of peak harvest; collecting may spread spores for regrowth
June 2000	Sparse and short growths	2 inch	Not evident on shallow plants; abundant on deep plants	Lack of rainfall
July 2000	Plants getting longer	3 inch	Sparse on shallow plants; abundant on deep-water plants	Less than 0.1 inch rainfall in month
August 2000	Abundant	3-4 inch	Sparse on shallow plants; abundant on deep-water plants	0.25 inch rainfall on 8/25
Sept. 2000	Sparse	2.5 inch	Not evident	0.33 inch rainfall in month
Oct. 2000	Abundant	3 inch	Sparse	
Wet Season (*Hoʻoilo*)				
Nov. 2000	Abundant	3 inch	Increasing on longer plants	0.79 inch rainfall in month
Dec. 2000	Scattered, red color	3 inch on bench; 3-4 inch in pools	Increasing on longer plants	0.11 inch rainfall in month
Jan. 2001	Abundant, dark purple color	3-4 inch	Abundant on shallow plants	0.32 inch rainfall in month

Table 5. Seasonal distribution of *limu kohu* (an edible seaweed) and related Hawaiian conservation principles.

	Limu Kohu Habitat	
Season	Shallow (0-1 m depth)	Deep (1.1 – 10m)
Wet (*Hoʻoilo*)	Growth favored by winter rainfall (introducing nutrients), minus tides at night, short days, ocean turbulence dispersing reproductive spores	Growth favored by water motion dispersing reproductive spores but inhibited by short days
Dry (*Kaʻu*)	Growth inhibited by lack of rainfall, "sunburn" during minus tides, long days	Growth favored by long days

Discussion

How Unified and Transferable is Hawaiian Knowledge?

Traditional Hawaiian marine resource use poses a paradox. Communities in different island areas, on the one hand, are characterized by a unifying worldview and similarities of basic designs or principles that are the result of centuries of continuing experimentation and innovation. On the other hand, the details of practice vary from one area to the next because they are adapted -- fine-tuned -- to local situations. Detail is important because of the "patchy" character and variability of shoreline and nearshore environments in the Hawaiian Islands.

Transferring this knowledge to other places risks losing its vitality. Even writing it down, as in this paper, changes some of the fundamental properties of this knowledge, making it more portable and permanent, but with a loss of vitality. This increases the chances of dislocation and misapplication outside the restricted context in which the knowledge evolved and is effective.

How is Hawaiian Knowledge Different from Other Kinds of "Local Environmental Knowledge"?

Hawaiian indigenous knowledge differs from similar kinds of environmental knowledge held by non-indigenous people in two important ways. First, Hawaiian knowledge evolved in the cultural and environmental context of the first inhabitants of the Hawaiian Islands, where it was essential for survival. Second, Hawaiian knowledge has deeper roots and is the product of many more generations of intelligent reasoning about the marine resources of the Hawaiian Islands than practical knowledge held by non-Hawaiians.

Further Applications

The Hoʻolehua Hawaiian Homestead community is self-reliant in its fishery conservation efforts. Conservation is based on local resources (intellectual and social) as much as possible. Homesteaders work with what they have, with what they know, and what they can do.

Much more could be done to explore the ways to integrate the traditional knowledge of native Hawaiians with contemporary fishery management. But how desirable is this integration? Berkes (1999) cautions that the use of indigenous knowledge is political because it threatens to change power relations between indigenous groups and the dominant society. The example of Hoʻolehua Hawaiian Homestead may, nevertheless, inspire new approaches and suggest more participatory and locally-based alternatives to top-down centralized resource management. There are other rural communities in Hawaiʻi with values and features similar to those of the Homestead. These ideas challenge conventional fishery resource management, but forcing indigenous Hawaiian conservation into the mold of Western conservation is not likely to work:

> *"The resource management systems of indigenous people often have outcomes that are analogous to those desired by Western conservationist. They differ, however, in context, motive and conceptual underpinnings. To represent indigenous management systems as being well suited to the needs of modern conservation, or as founded on the same ethic, is both facile and wrong." Dwyer (1994, p. 91).*

Hawaiian fishermen understand and interpret natural phenomena differently than Western-trained scientists. The Hawaiian system is based on knowledge that is:

- Generated as a consequence of practical needs in everyday life;
- Based on intimate acquaintance with a local situation;
- Linked to specific places and sets of experiences;
- Preserved through the memories of particular individuals;
- Orally transmitted;
- Continually reinforced by experience, trial and error, and deliberate experiment;
- Dynamic and evolving, not static and rigid.
- Transferred through the practices and interactions of subsistence fishermen; and
- Shared in the community to a wider extent than conventional scientific knowledge about marine resources.

The residents of Hoʻolehua Hawaiian Homestead tend to care deeply about what becomes of their subsistence resources, not only as a source of food for themselves and future generations, but also as part of their way of life and identity. Without the unique and highly successful system for community self-management that has been perpetuated, the local fisheries might be in the same state of decline as elsewhere in the populated Hawaiian Islands.

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Questions

Melita Samoilys: How do we know the Moi were hermaphrodites?

Kelson "Mac" Poepoe: We cut them open and look inside to see the gonads.

Melita Samoilys: So they have both gonads, or are they sequential hermaphrodites?

Kelson "Mac" Poepoe: They can change from male to female. They change when they get to a certain size. If I look at a fish, I can say if it's a hermaphrodite, male, or female.

Michael Phelan: Does anyone stop fishing at the sites when they aggregate to spawn?

Alan Friedlander: There is an intricate social dynamic; you need to have the right proportion of males and females to spawn. If you break up the aggregation, there's no telling if it'll reform within a reasonable period of time to spawn. For the most part, it's understood that in the spawning season, fish are not to be bothered.

Ian Baird: In Laos, the way of passing on knowledge is to get kids to start fishing early. As soon as they can put a net or hook out, they do it. In Hawaiian tradition, it seems to be the opposite where they observe but not practice fishing until a certain age. I've never heard of this practice being done. Why do they do that?

Kelson "Mac" Poepoe: They do that to respect the social structure. If you are a master fisherman, no one interferes with you. If I'm out there fishing and there are fishermen below me, they have to respect me. But we do start fishing at an early age.

Alan Friedlander: On that same topic, there are only one or two places on the Mo`omomi area that are accessible to kids. What people did before and what they still do is leave those places for the kids to experiment and to get their feet wet both figuratively and literally.

Tony Pitcher
This is a fascinating study. I wonder how it's regarded by the official regulatory agency. Here in Canada, we look enviously at the system in Haida'gwaii and that is controversial. How do you make it workable?

Paul Bartram: It's very threatening to government agencies. We try to fly below their radar.

Alan Friedlander: The state came by in 1995 and established Mo`omomi as a place that's legislated. That was a very top-down approach and made rules that the community wasn't buying into. Guys were coming down from Oahu to hammer resources because they are in better shape in Mo`omomi. The state has washed their hands of it because the community washed their hands of the state.

Kerry Prosper: What is the ratio of fishermen and enforcement? Is there a low ratio of enforcement because of the structured value system in the community itself, or is it like here where the enforcement is overpowering the community?

Kelson "Mac" Poepoe: Enforcement comes from peer pressure. We don't approach fishermen with a top down approach. We watch out for each other. We set rules, everyone knows them, and they can tell if their neighbor is doing something wrong

Jeremy Prince: What is the population size?

Kelson "Mac" Poepoe: There are 6000 people on the island. The island is open to everyone. Anyone can fish there if they want.

Alan Friedlander: But there's only one access road that goes in. It is a dirt road. By going down that road, you implicitly accept the rules set by the community.