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Review Article

Marine Resource Management in the Hawaiian Archipelago: The Traditional Hawaiian System in Relation to the Western Approach

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Over a period of many centuries the Polynesians who inhabited Hawai'i developed a carefully regulated and sustainable "*ahupua'a*" management system that integrated watershed, freshwater and nearshore marine resources based on the fundamental linkages between all ecosystems from the mountain tops to the sea. This traditional scheme employed adaptive management practices keyed to subtle changes in natural resources. Sophisticated social controls on resource utilization were an important component of the system. Over the past two centuries a "Western system" gradually replaced much of the traditional Hawaiian system. There are major differences between the two systems in the areas of management practices, management focus, knowledge base, dissemination of information, resource monitoring, legal authority, access rights, stewardship and enforcement. However, there is a recent shift toward incorporating elements of the traditional scheme using methods and terminology acceptable and appropriate to present day realities. This trend is exemplified by the management plan for the newly formed Papahānaumokuākea Marine National Monument in the Northwestern Hawaiian Islands. This is one of the largest protected areas in the world and is being managed with a focus on Native Hawaiian cultural values in relation to conservation, ecological, historical, scientific, and educational resource protection.

1. Introduction

For the past century Hawai'i has been dominated by a "Western" model of marine environmental management. Recently, however, there has been a renewed interest in the traditional management practices of ancient Hawaiians. Throughout Hawai'i, a growing cultural, sociological, and scientific movement is working to investigate and revive some of these traditional management tools and to integrate them with modern scientific methodology. The native islanders had devised and implemented every basic form of what are now considered modern marine fisheries conservation measures centuries ago, long before the need for marine conservation was even recognized in Western nations [1]. Traditional restrictions on fishing in Hawai'i were achieved by the use of closed seasons, closed areas, size restrictions, gear restrictions, and restricted entry. Additional social, cultural, and spiritual controls strengthened the conservation ethic under the old system. Ancient Hawaiians used a holistic approach that we might now recognize and strive for as integrated coastal management. Bridging the gap between traditional management and Western science represents a challenge to researchers, government agencies, resource managers, cultural practitioners and organizations, and to the people of Hawai'i. This paper was undertaken in order to define, describe, and clarify primary differences and similarities

between the traditional and Western systems in various areas such as management practices, management focus, knowledge base, dissemination of information, resource monitoring, legal authority, access rights, stewardship, and enforcement methods. Finally, we summarize evidence that a synthesis of the two management systems is slowly occurring throughout the Hawaiian Archipelago.

2. Description of the Traditional System

Elements of the traditional Hawaiian management system for managing nearshore resources are known from several sources. The primary historical literature translated to date contains written descriptions of various practices and customs used in ancient times. The most important accounts were written between 1830 and 1870 as reported by Kamakau [2–4], I'i [5], and Malo [6]. Additional information on marine resource usage is contained in works by Beckely [7], Kahā'ulelio [8], Cobb [9], Handy [10], Titcomb [11], Kawaharada [12] and E. S. C. Handy & E. G. Handy [13]. Recent ethnographic studies include K. Maly and O. Maly [14, 15], Peterson and Orr [16] and Glazier [17]. Thousands of additional primary source documents and newspaper articles written in the 100 year old Hawaiian language remain to be translated and studied and will one day reveal more than is known today. An oral tradition also persists, especially in the more isolated areas of the Hawaiian Islands.

Certain traditional Hawaiian words are used in this discussion because of nuances in meaning that do not translate into the English language. These Hawaiian terms are increasingly used within the State of Hawai'i and within the U. S. Government in reference to various management practices. For example, the Hawaiian word *pono* does not have a suitable direct English language meaning and refers to actions that are "appropriate, correct, and deemed necessary by traditional standards in the Hawaiian culture". Therefore this word was included in the regulations that established the Northwestern Hawaiian Islands Marine National Monument as published in the Federal Register [18]. Likewise the native Hawaiian name *Papahānaumokuākea* was subsequently chosen for the monument in keeping with the intent to manage the area using traditional values. This name has deep spiritual and cultural meaning (http://papahanaumokuakea.gov/about/name.html/) that is relevant to past and present management practices in that region of the archipelago.

2.1. Tenure and Management Concepts. The predominant traditional system in the eight high islands of the Main Hawaiian Islands (MHIs) was based on the *ahupua'a*, which is a unit of land that extends from the mountains to the sea and generally includes one or more complete watershed(s) and all nearshore marine resources [19, 20]. Each *ahupua'a* contained a broad cross section of island resources and was managed within a complex social system associated with each area. The general belief is that each *ahupua'a* met the needs of the local population with an excess for tribute and trade. At present the traditional cultural, economic, and social structure of the *ahupua'a* are no longer in general use although the land boundaries continue to be informally recognized in the State of Hawai'i. However, a resurgence of interest in traditional Hawaiian resource management during the last decade has led to wide use of the term *ahupua'a* in reference to integrated coastal management based on individual watersheds and their offshore waters.

The modern concept of the *ahupua'a* may not be totally accurate compared to what it meant to the ancient Hawaiians. The *ahupua'a* can be viewed as a unit for production of goods. Maintaining ecological integrity led to sustainable production of foods and other material which could be offered in *ho'okupu.* Pukui and Elbert [21] define *ho'okupu* as tribute, tax, or ceremonial gift given as a sign of honor and respect. An alter (*aha*) was located at the edge of each *ahupua'a* with a likeness of a pig's head (*pua'a*), and it was here that tribute to the ruling chief was deposited each year during the *makahiki* as the long god circled the island [13, 22]. However, the smaller strips within the *ahupua'a*, the *'ili*, represented the true basic unit of land division to which the local people retained fidelity over long periods of time. The various *ahupua'a* were redistributed to secondary chiefs after every major power shuffle on an island, so that frequently the *ali'i* (chiefly caste) that ruled an *ahupua'a* did not actually come from that *ahupua'a*, or even from the island on which it was located [2]. There were times when *ali'i* from Maui controlled many of the *ahupua'a* on O'ahu [13]. By contrast, the *'ili* were inhabited by the same extended families, or *'ohana*, for many generations. Just as with our modern concept of the *ahupua'a*, the *'ili* required a cross-section of available resources—they generally incorporated a piece of the mountain, a piece of the valley, and a piece of the shoreline. If this condition could not be accommodated in a single narrow mountain-to-shore strip (*'ili pa'a*), then an *'ili* could be set up as a series of two or three disconnected units (*'ili lele*) that provided the necessary components; in some cases these separate pieces comprising a single *'ili* could be in separate *ahupua'a*. Thus a family's traditional near shore gathering grounds might be some distance from their upland fields (or even at the mouth of another valley).

Prior to Western contact all land and ocean resources were held in trust by the *ali'i* (chiefs) with harvest rights overseen by a *konohiki* (an expert resource manager for each area) who was responsible for the coordinated stewardship of all extractive natural resources. Although the *konohiki* was originally considered to be merely a manager of the *ahupua'a*, the term eventually came to mean landlord/chief of the *ahupua'a* [23]. The *hoa'āina* (native inhabitants) had rights to the resources for subsistence and tribute. The *konohiki* was advised by *kūpuna*, who were elders acknowledged for their knowledge and wisdom. The *po'o lawai'a* (master fishermen who held and transmitted knowledge) also consulted with the *konohiki* on matters concerning management of marine resources.

Knowledge was developed over centuries and handed down from generation to generation. Decisions were based on detailed information on the local area and a keen understanding of natural cycles. Transmission of knowledge occurred through an oral tradition and by direct teaching and experience. One of the primary management tools was

the *kapu* which was a decree that imposed restrictions on extraction of resources at certain times and places. The term *hoʻomalu* is found in announcements by *konohiki* when reserving fish for themselves as was articulated in the laws of 1839-40. Certain marine resources (e.g., turtles, octopus, dolphins, and jacks), were also *kapu* for women and those not of the *aliʻi* caste. Violation of *kapu* was often punishable by death [24]. Enforcement often was immediate and severe.

2.2. Spiritual and Cultural Values. Deeply ingrained traditional sociospiritual aspects of the culture provided a further safeguard against overexploitation. The *kānaka maoli* (native Hawaiians) demonstrated a deep spiritual connection with nature that was expressed through offerings and prayers that were an integral part of the fishing effort. *Koʻa* (fishing shrines) were built along the coast. Help from ocean creatures was sought for success in the fishing effort. Sharks, turtles, and various fishes served as *ʻaumākua* (family guardians). *ʻOli* (chants) and the *hula* (dance) were important parts of the Hawaiian oral transmission of information concerning the importance of the sea. For example, the predominant Hawaiian creation chant, the *Kumulipo* [25], describes the first creation of life following the male and female as the coral polyp, which in turn gave rise to subsequent organisms.

> *Hānau ka ʻuku koʻakoʻa, hānau kāna, he ʻakoʻakoʻa, puka.* (Born was the coral polyp, born was the coral, came forth.)

Cultural values and concepts were also shared and practiced through *ʻōlelo noʻeau* (proverbs). Many of these traditional sayings [26] refer to the lifeline of the native people:

> *Mālama i ke kai, a mālama ke kai iā ʻoe!* (Take care of the ocean and the ocean will care for you.) [15].

The term *kuleana* refers to specific responsibilities that accompanied the privilege of sharing in the resource. *Kuleana* also means "interest" as in having a shared interest in some entity. The Hawaiian concept of *kōkua* requires sharing of resources with those in need, and the responsibility of all resource users to maintain the systems that produced those resources [27]. *Mālama* is the practice of caring for the land.

2.3. Management Practices. In ancient Hawaiʻi, the art of fishing was passed along family lines. Fishermen were of a special lineage and trained for years as an apprentice. During this time they were taught to observe subtle and major changes in the condition of the marine resources. They were educated in the life cycle, diet, daily, and seasonal feeding habits, preferred habitat, and growth conditions. They obtained knowledge of the appropriate season, time of month, time of day, and method for harvesting of the many species of fishes, invertebrates, and seaweeds. Harvest management was not based on quota, but on identifying the specific times and places that fishing could occur so that it would not disrupt the basic habits of important food resources nor deplete fish stocks. Until training was complete, young fishermen were only allowed to observe the process and hold the catch. Fishing activities were often regulated by the moon calendar [28] which emphasized repetitive biological and ecological processes (e.g., fish spawning, aggregation, and feeding habits). Social and cultural controls assured compliance of a strictly imposed code of conduct. Behavior of the fishermen before, during and after fishing was controlled. The belief was held that resources were limited and there was a social obligation to exercise self-restraint in resource exploitation. The ancient Hawaiians viewed themselves as an integral part of nature [12, 14, 15, 19, 22].

2.4. Transmission of Knowledge. Based on centuries of trial and error and astute observation, Hawaiians incorporated their understanding of the oceans into self-sustaining management practices. Hawaiians possessed a complex understanding of the life histories of fishes. Perceptive observations led to a keen familiarity of physical (e.g., weather patterns, currents, tides, wind, waves), biological (e.g., spawning seasons, recruitment, and growth), and ecological (e.g., foraging patterns, behavior, and habitat) factors that influence fisheries. In these areas the traditional knowledge of Hawaiian fishermen may have surpassed what is known by modern marine biologists [29, 30]. Knowledgeable *kūpuna* also consulted with *poʻo lawaiʻa* (master fisherman) who had intimate awareness of the status of various populations of reef organisms. When populations declined to low levels, a *kapu* (forbidden practice) was placed on extraction to allow the resource to recover [14, 15]. Knowledge and management practices were place specific, and kept secret. Kamakau reported that Hawaiian fishermen would paddle out of sight before pulling up their catches so that no one would know exactly where the fish were taken: "In this way those who had secret fishing grounds kept their locations from becoming common knowledge" [3]. Families and communities found especially fertile areas above seamounts, information of which they passed on orally to their offspring but tried to keep secret from others [31].

2.5. Effectiveness of Traditional Management System. Historical accounts from the nineteenth century attest to the abundance of the marine resources of precontact Hawaiʻi and the sustainability of the fisheries [15]. This would also be true for the coastal pelagic and open ocean species given their widespread distribution and abundance and the limitations in the harvesting technologies of the day. For nearly a millennium, Hawaiʻi's fishers and gatherers helped to sustain a native population, which according to some accounts reached between 500,000 and 1 million [19], but more likely was in the range of 150,000 to 250,000 [32–35]. The current population of the State of Hawaiʻi is 1.3 million, but it is estimated that over 90% of the food and seafood consumed by the population come from outside of Hawaiʻi. It is difficult to know with certainty the status of inshore and coral reef associated resources during the precontact period and whether the supply decreased as the Hawaiian

population grew. Evidence from archaeological excavation suggests that nearshore marine resources in Hawai'i and the Pacific were susceptible to human overuse [36–38]. Early overexploitation of marine food sources in Oceania might have led to increased dependency on more reliable and predictable terrestrial food resources [39]. The widespread construction and operation of fishponds [40–44] supplied the *ali'i* and others with fresh fish during times when the reef resources were under *kapu* and during times when severe weather prevented fishing. Also, such ponds augmented or replaced wild caught stocks, as is the case for modern analog aquaculture and stock enhancement programs. The placing of permanent or temporary *kapu* on various species and life stages of marine life [6] was motivated by various economic, cultural, and spiritual factors, but certainly the maintenance of fishery stocks was an important motivation. During post-contact times there are accounts of periodic famine [13] and reports of a "deficiency of fish" [36] suggesting that resources were sensitive to overexploitation at that time if not managed properly.

2.6. Breakdown of the Traditional System. The breakdown of the traditional marine management system was precipitated by major cultural changes following Western contact. The abolishment of the traditional kapu system in 1819 by Kamehameha II (Liholiho) and Ka'ahamanu was one of the most significant and transformative events in Hawaiian history [45, 46] that set the stage for further changes. The Hawaiian Kingdom attempted to resist colonialism and adapt to the changing global political environment through modification of traditional structure using Hawaiianized Euro-American practices to suit their own needs [47]. For example, the mapping of the lands was largely conducted by the *ali'i* and other Hawaiian nationals as a means for the Hawaiian State to secure national lands in the face of colonial pressures [48]. A key element in the breakdown was the redirection of the activities and energies of the *hoa'āina* (native tenants) to produce products for trade in order to acquire foreign goods for the *ali'i* and their *konohiki* [10]. Contemporary writers and the historian Kuykendall [49] considered this redirection as one of the prime causes of famine, sickness, and depopulation of the Hawaiian Kingdom prior to 1829 [10].

Subsequent changes in land tenure led to a further erosion of the *ahupua'a* as a social unit. The *Māhele 'Āina,* (division of the land) in 1848 was followed by the *Kuleana Act* in 1850, which established fee simple ownership in which land could now be sold to parties with no historical interest in sustaining the *ahupua'a* as a whole. This transfer of land created large plantations. Importation of workers resulted in a rapid ethnicity shift. Hawaiian communities were diluted, eroding traditional management. Foreigners brought new technology and unfamiliar concepts of resource exploitation, replacing centuries old sustainable management practices.

Although the *ahupua'a* concept of management began to break down on land, elements of the system still persisted in the marine environment. In laws published between 1839 and 1859, King Kamehameha III codified fishing rights and divided the fishing grounds amongst the people of Hawai'i. The King granted fishing rights within the reef (or to one mile offshore in those areas without a reef) to the *konohiki* and the tenants of the *ahupua'a* (known as the *hoa'āina*). The *konohiki* could *kapu* a single species of fish for his exclusive use or after consultation with the tenants prohibit fishing during certain months of the year [23]. During the 1848 land division, the Land Commission received over 1,000 claims for ocean resources. These fisheries records also document the testimonies of the *ali'i* and *konohiki* that were awarded *ahupua'a*. Public notice was issued concerning the *i'a ho'omalu* (*kapu* or protected fishes). A plethora of information about Hawaiian fisheries and traditional practices were recorded in 1874 when the Commission of Boundaries was established to ascertain the location of each of the *ahupua'a* that had been awarded in the *Māhele 'Āina.*

Following the overthrow of the Hawaiian kingdom and annexation to the United States in 1898, fisheries management was delegated to various government agencies. As was the case with colonial powers throughout much of Oceania traditional fishing rights were systematically extinguished in the name of the discredited "freedom of the seas" concept and because such customs prevented newcomers from expropriating the islanders' resources [1]. Ocean tenure practices based on regulation of fisheries through control of fishing rights were replaced by unlimited entry, often referred to as the "tragedy of the commons," leading to eventual resource depletion through overharvesting. The traditional system based on cooperation for the good of the community was slowly replaced by commercial forces and competition to benefit the individual. The subsistence-based, locally governed economy was converted to a cash-based economy controlled by remote global market demand. As time progressed, technology provided refrigeration and more efficient fishing gear, further accelerating the shift from subsistence to profit-based economies. A dramatic decline in Hawaiian fisheries stocks and fishery production occurred during the period of commercialization of fisheries [15]. The spiritual connection to the ocean slowly deteriorated, along with the concepts of *kuleana*, *kōkua*, and *mālama* (responsibility, sharing, and caring) with the increasing disconnect between neighbors. The social pressure to support the traditional system was reduced as fisheries management switched from within the local community to a more remote and poorly enforced organizational scheme. The Hawaiian Organic Act of 1900, passed a year after Hawai'i's annexation as a United States Territory, further limited most *konohiki* fishing rights through condemnation of *ahupua'a* fisheries. [50]. The 1900 law repealed earlier laws conferring these exclusive rights and opened the fisheries of the Territorial waters to all citizens of the United States. Specifically excluded were fisheries which were already vested and filed with the circuit court within two years, but even these fisheries could be condemned for public use upon payment of just compensation. As recently as the 1940's several of these *konohiki* fisheries were still extant [15]. The Organic Act and subsequent state court decisions effectively eliminated *konohiki* and *hoa'āina* fishing rights, but more recent federal courts have taken a broader view and continue to recognize them as a legal form of property ownership [23]. The breakdown of *mālama* coupled with

the loss of traditional guidance from *kūpuna* (knowledgeable elders in the community) further removed social controls on fishing and hastened the decline of traditional near-shore fisheries resources. The dismantling of this system undermined native Hawaiian lifestyles, values, and culture.

Between 1898 and 1905 detailed reports on the condition of the fisheries and management recommendations based on commercial values of catch were prepared by the U. S. Fish Commission. These data [51] provide an important baseline that has been used to document an 80% reduction in coastal fish catch (Figure 1) between 1900 (1,655,000 kg) and 1986 (285,000 kg).

2.7. Management of Offshore Waters. A different management scheme existed in offshore waters beyond the boundaries of the traditional *ahupua'a* of the MHI. Native Hawaiians located and utilized offshore fishing grounds above banks and seamounts that were located far from the coastline of the MHI [2–4, 52–56] extending into the NWHI. At that time all inhabitants were free to fish on the high seas so long as they respected specific restrictions set by the ruling class and observed cultural and religious taboos. Locations of deep sea fisheries were the proprietary knowledge of individual fishermen [3, 31], not the communal property of the *ahupua'a*. These management policies were eventually codified into written law by King Kamehameha III.

Deep water snappers in Hawai'i are only found in localized areas (known as a *ko'a*) that are characterized by proper depth range, presence of rock outcrops and other conditions that are favorable to the fish. These locations were the guarded knowledge of single families [4], and as such were probably more closely associated with the *'ili* to which the families were bound. Bottom fishing was not linked to the spawning cycle as was the case for inshore species due to unpredictability of offshore weather conditions which could limit access [8]. Bottom fishing continued through the summer, a season of fine weather, but also the season in which most of the deep water species were spawning. Given the simple technology in use at that time (e.g., *olonā* hand lines that were woven from native plant fibers, hooks made of bone or shell, and dugout canoes), this arrangement appears to have had no major impact on fish stocks.

3. Description of the Contemporary System

The existing Western-based management system must deal with social and economic conditions that did not exist in ancient times. Major changes in land use and alterations of stream and near-shore environments have occurred almost everywhere. Waste disposal, invasive species, major shoreline construction, and other major environmental changes are presently occuring at a rapid rate. Hawai'i has experienced massive immigration of various cultural groups, fundamental changes in government, and advances in technology that have changed fishing practices and essentially eliminated past harvesting limitations of depth, distance, weather conditions, and darkness. Multiple interest groups vie for recognition and major shifts have occurred in societal perceptions. Conflicts arise with mandated protection for endangered species, difficulties with enforcement transpire, and national and global influences combine to create an environment that can be counterproductive to sustainability.

3.1. Structure and Functioning of Contemporary Management System. Under the present Western scheme, management responsibility of the marine environment is split between numerous agencies. The Hawai'i State Department of Land and Natural Resources (DLNR) administers all marine resources within 3 miles of land through the activities of various divisions. The DLNR Division of Aquatic Resources (DAR) is the primary agency responsible for management of living marine resources throughout the archipelago within 3 miles of land, with the exception of waters around the island of Kaho'olawe which are administered by the Kahoolawe Island Reserve Commission (KIRC). The DLNR Office of Conservation and Coastal Lands (OCCL) is responsible for overseeing approximately 2 million acres of private and public submerged lands that lie within the State Land Use Conservation District and for beach and marine lands out to the seaward extent of the State's jurisdiction. The DLNR has overlapping responsibility with other state and federal agencies. The U. S. Federal Government manages waters from 3 to 200 miles offshore (the U. S. Exclusive Economic Zone). The recently created Papahānaumokuākea Marine National Monument encompasses 137,792 square miles of U. S. waters, including over 4,500 square miles of relatively undisturbed coral reef habitat and is administered jointly by the U. S. National Oceanic and Atmospheric Administration (NOAA), the State of Hawai'i and the U. S. Fish and Wildlife Service. The U. S. Environmental Protection Agency (EPA) and Hawai'i State Department of Health are responsible for enforcing laws on water quality. Additional management responsibility in certain areas falls to the U. S. Army Corps, National Park Service, and the U. S. Coast Guard. Certain marine areas are under partial military jurisdiction. In addition there are numerous agencies involved in the regulation of activities affecting watersheds and streams that have an impact on marine resources.

In the MHI the DAR utilizes several management tools including full or partial closure of a reef area as a marine protected area (MPA), rotational and seasonal closures, restrictions on fishing gear or methods, size and bag limits, and rules preventing the take of certain species. Identifying and addressing a resource problem is a protracted process that requires surveys and scientific studies to establish the cause of decline, as well as the "buy in" of various user groups and interested parties through public meetings. Fishermen blame pollution and introduction of alien species for reductions in fish stocks and demand unequivocal evidence that overfishing is the cause of decline. Often the proper course of corrective action is unclear or controversial, and the problem is studied or debated for years. The "trigger" for management action is ill-defined and, based on available data, must often involve a devastating decline in the resource before action can be initiated.

Once there is sufficient scientific data to identify a problem and the appropriate course of corrective action, the DAR has two alternative procedures for establishing new

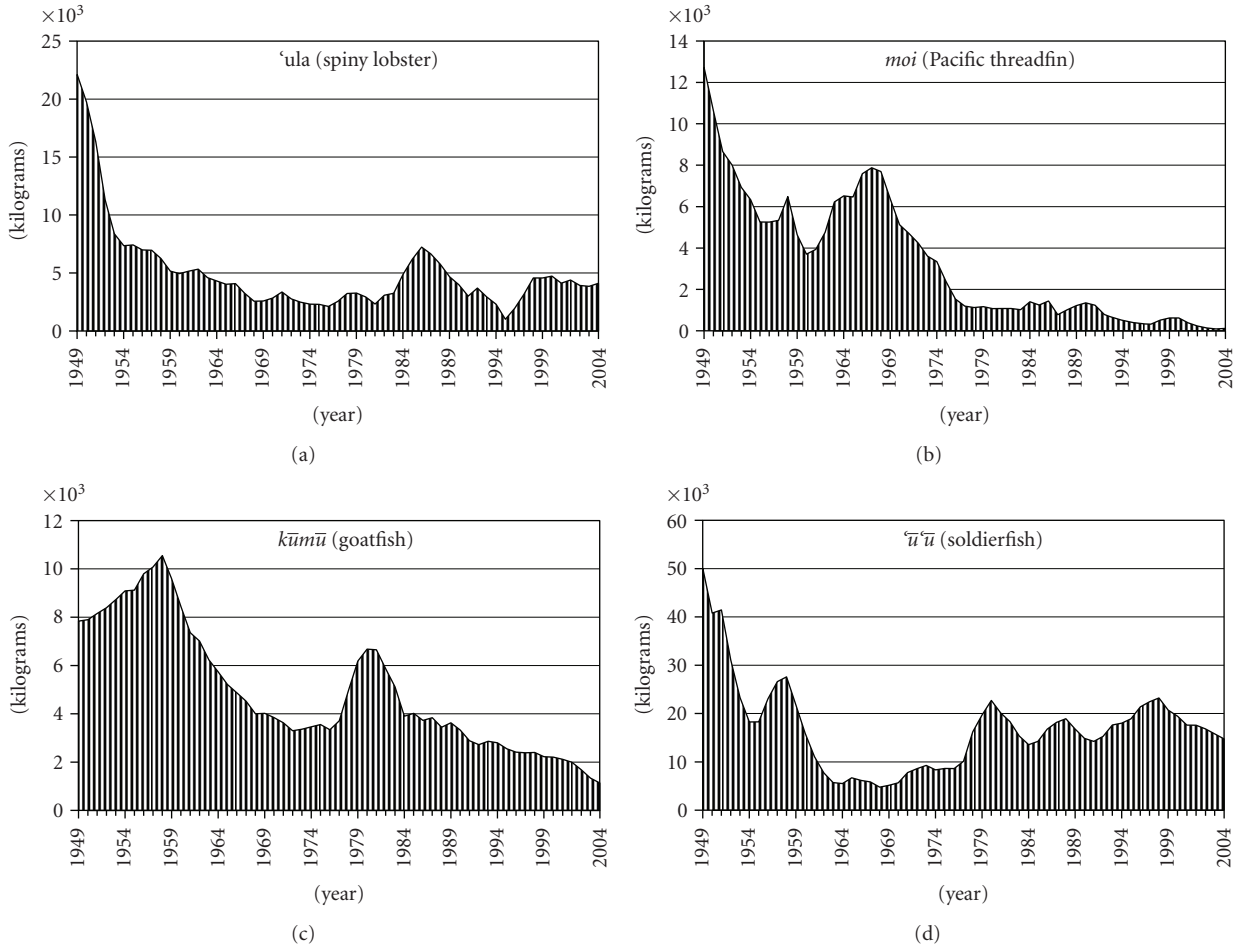

Figure 1: Main Hawaiian Islands commercial marine landings 1949–2005 for the *ʻula* or spiny lobster (*Panulirus* spp.), *moi* or Pacific threadfin (*Polydactylus sexfilis*), *kūmū* or goatfish (*Parupeneus porphyreus*) and *ʻūʻū* or soldierfish (*Myripristis* spp.). Data presented as 3 yr. moving average. Source: Division of Aquatic Resources unpublished data.

rules and regulations. The first method is to propose and draft a bill as an element in the Governor's legislative package that is developed internally each year from September to December. The bill is introduced when the legislature convenes in January. No public hearing is required for this process, but the legislature typically holds several public committee meetings. A legislative bill must be passed by both houses and be signed by the Governor to become law. The process takes approximately six months following the time that the bill is introduced and is effective immediately after being signed into law. It is up to the individual fisherman to know which bill passed and which laws are in effect. New laws may be published in the newspapers but this is not mandatory. The Hawaiʻi Revised Statutes which contains such laws can be accessed by the public and is updated annually, as is the rulebook published by the DAR. Those with a personal agenda often prefer the legislative process because bills can be introduced by any legislator on their behalf. Furthermore, all activity and discussion on a bill occurs in Honolulu, the seat of the Legislature. Time and travel constraints effectively reduce the opportunity for input from people living on the neighboring islands, particularly in remote areas. If a bill is not passed during a legislative session it can be introduced again in a later session, so a persistent minority of the population can potentially change regulations, given enough time.

The second means of establishing new regulations is the Administrative Rules Process which involves a series of public meetings and public testimonies. This process generally takes from one to five years to implement a new rule. DAR prefers this approach because it addresses concerns of all stakeholders and incorporates the public's point of view. Simple matters such as modification of zones within an MPA can take a year while more complex and controversial issues that have a great impact (such as gill net ban or establishment of fishery management areas) can take over five years. The process generally leads to compromise on all sides. Once the laws or administrative rules are enacted they can subsequently be repealed, amended or new rules can be initiated.

3.2. Effectiveness of the Contemporary Management System. Even though a much smaller proportion of the population presently fishes or consumes local fish products relative to

ancient times, marine resources have steadily declined over time coincident with the shift away from the traditional Hawaiian management system [14, 15, 51]. Early in the 20th century Jordan and Everman [57] noted that the fisheries of Honolulu were falling rapidly due to localized overfishing. Titcomb [11] relates that in 1923 one Hawaiian wrote to the Hawaiian newspaper *Ka Nūpepa Kuokoa* inquiring "why there was so much fish in the days of our ancestors and so little in our time…?" Responding to concerns over the high cost of fish in the markets in the 1920's, Hercules Kelly, Territorial Fish and Game Commissioner noted that wasteful methods, destructive fishing techniques, pollution, and overfishing had reduced the abundance of fish in Hawai'i's waters [27]. In 1927 it was reported that the fish fauna of Hawaiian reefs was much less abundant than several decades earlier and many common species were now rare [58]. Declining marine resources were acknowledged again by resource managers in the 1950's when they reported that desirable food and game fishes were "on a declining trend and have deteriorated to such an extent that the need for sound conservation measures is urgent" [59].

In Hawai'i only commercial fishers are required to file catch reports. Catch reports for several key species over the past 60 years are shown in Figure 1. Since the termination of ocean tenure practices and the associated controls on fisheries, the harvest of many species has decreased [51]. The largest declines in reported catch occurred in the first two decades after World War II. Commercial catch in more recent decades has remained relatively stable [60] albeit at a much lower level than in the preceding decades. Comparison of fish abundances in the MHI to those of the relatively unexploited Northwestern Hawaiian Islands (NWHI) also points to abnormally low levels of fish stocks near the populated islands [61].

Catch data are not available for recreational and subsistence fisheries. However, reconstruction of the noncommercial catch for both inshore and bottom fishes indicates that total landings in this sector are approximately three times that of the commercial sector. The commercial catch underwent a 70% decline from 5,641,000 kg 1950 to 1,868,200 kg in 2002 [62]. Fishermen and other ocean users are well aware of declining reef resources. Surveys of both commercial and noncommercial fishers [63, 64] have clearly documented this perception. In the 1998 survey 57% of respondents felt inshore fishing was now poor to terrible. Overfishing is most often cited as the prime cause of resource depletion [64, 65].

In contrast to the technological limitations in ancient times, modern fishing technology has depleted bottom fish stocks throughout the MHI and even in remote areas of the NWHI [65]. The National Marine Fisheries Service (NMFS) determined that overfishing was occurring on the bottom fish multispecies complex around the Hawaii Archipelago, with the primary problem being excess fishing effort. NMFS requested the Western Pacific Regional Fishery Management Council to take appropriate action to end the overfishing. An interim seasonal closure was placed in effect from May 15, 2007 to October 1, 2007, and the fishery has been managed by an annual total allowable catch since 2007.

4. Comparisons between the "Traditional" and "Western" Systems

Available information from various sources consistently identifies the same dominant features of the traditional management method versus the current Western management scheme. Both systems were developed in an attempt to ensure protection and sustainability of marine resources. However, tabulation of the dominant characteristics graphically shows fundamental differences in nearly every important respect (Table 1). There are positive and negative aspects of each system, so the comparison is intended as an objective means of sorting out the differences without a bias towards either the traditional system or the Western system. Each major aspect of the management comparison of Table 1 is discussed in more detail as follows.

The Western system of management is based on federal, state, and local laws and regulations implemented by various agencies or departments, which is a reality that hampers effective management. In contrast, the traditional system was based on the authority of the ruling *ali'i*. The central feature of the traditional system was that reef tenure as well as land tenure was in the hands of the residents of the watershed (*hoa'aina*) and under the rule of a single authority (*ali'i)* and his manager the *konohiki*. When fishing regulations were formalized in law, the *ali'i* were required to consult with the *hoa'aina* before closing the fishery which suggests that the local community traditionally had input into the process. Nevertheless sources generally acknowledge that the traditional system was highly autocratic and has features that would not be acceptable in a democracy.

Under the traditional system local inshore marine resources were held in common with equal access to all people living within the boundaries of the *ahupua'a*, but with certain management restrictions. Inhabitants of the *ahupua'a* in consultation with *ali'i* limited access to others, but outsiders could gain access by permission from chiefs and local villagers. This aspect of the traditional system provided another means of limiting the impact of humans on the resource. In the Western system, access is unrestricted, so any person from any district can fish in other districts, so a given area can be heavily exploited by the entire population with no control of outsiders.

Under the Western system, trained professionals in multiple government agencies are the managers with responsibilities defined by law. They generally have responsibility for very large areas and cannot possibly be knowledgeable about local conditions and local resources. In contrast, under the traditional system a very knowledgeable *konohiki* (district manager) was appointed by *ali'i* to manage a very specific geographic area for a specific community of people. Stewardship was supported by an individual sense of *kuleana* or responsibility for the local resource.

Under the Western system enforcement of any rules that are in place is generally weak and inconsistent due to concern for "due process" and rules of evidence. The positive social outcome is that rights of individuals are respected, but there is a negative impact on natural resources. In contrast the traditional system was based on the absolute authority in

Table 1: Comparisons between major aspects of "Traditional Hawaiian" and "Western" management systems in Hawai'i for inshore reef fisheries.

Management component	Western management system	Traditional Hawaiian management system
(1) Authority	Federal, state, and local laws and regulations implemented by various agencies or departments.	*Ali'i* (chiefs)
(2) Access rights	Reef held in common, equal access to all.	Inhabitants of the ahupua'a (district) in consultation with *Ali'i*. Limited access by permission from chiefs and local villagers.
(3) Managers-stewardship	Trained professionals in multiple government agencies with responsibilities defined by law.	*Konohiki* (district manager) appointed by *Ali'i*.
(4) Enforcement	Generally weak and inconsistent due to concern for "due process" and rules of evidence.	Authority in the hands of *Ali'i*. Punishment is immediate and can be severe. Conservation ethic reinforced by ingrained cultural rules of social behavior and spiritual principles.
(5) Management focus	Commercial as well as recreational fishery, economic development, conservation, endangered species, environmental protection, sustainability, and maintain biodiversity.	Limit take to only what is needed by inhabitants to insure sustainable yield. Focus entirely on plants and animals used for food, medicine, selling and trade.
(6) Management theory	Established western science of management (e.g., Catch Per Unit Effort)—Accepted theory and practice subject to revision with new information.	Traditional management practices that were developed and applied locally over many generations of trial, experimentation, study, application and observation.
(7) Knowledge base	Published reports, records, data bases, documents, objective measurements and observations, and quantitative analyses of data.	Oral transmission with restricted access to information—knowledge generally kept within family lineage.
(8) Primary fishery management tools	"Regulated inefficiency" to reduce harvest. Restrictions on gear type, number of fishing days, and marine protected areas.	Intermittent complete reef closures of reefs as indicated with *Kapu* (forbidden take) of certain species at certain times.
(9) Fishery management target	Generally single species. Increasing focus on ecosystems.	Generally entire reef ecosystem with species specific *kapu* at certain times.
(10) Resource monitoring	Infrequent quantitative surveys of environmental parameters and stocks, direct underwater observations. Perception of "insufficient data" required for decisive management actions.	Continuous daily interaction with reef resources, perception that accurate knowledge of resource is held by the local master fishermen (*po'o lawai'a)*, elders (*kūpuna*), and *hoa'āina* of that place.

the hands of *ali'i*. Punishment was immediate and could be severe [24]. This conservation ethic was reinforced by ingrained cultural rules of social behavior and spiritual principles.

Western management focus has been heavily driven by perceived gain from economic development, although tempered by concern for conservation, endangered species, environmental protection, and sustainability. In the traditional system commercial exploitation was unknown. Only what was needed was taken from the reef, which was considered to be a storehouse for food. These actions protected the resources from over-exploitation. The management focus was entirely on plants and animals used for food, medicine, selling, and trade, with the view that all elements of the *ahupua'a* were interrelated.

An established, science-based Western management scheme (e.g., Catch Per Unit Effort) drives the Western system of management. Decisions and regulations are based on accepted theory and practice subject to revision with new information, which is a positive feature of the system. Traditional management embraced practices that were developed and applied locally over many generations. These regulations were seen to be practical as evidenced by centuries of trial, experimentation, study, application, and observation. This system functioned well so long as there were no major social changes.

The knowledge base of the Western system consists of published reports, records, data bases, documents, objective measurements and observations, and quantitative analyses of data. Information is exchanged freely and major effort is expended at making all information available. Shared databases, frequent meetings, networking, and outreach are key aspects of the Western system. In stark contrast, oral transmission with restricted access to information was the norm in the traditional system. In general, marine resource knowledge was kept within a family lineage [3, 31].

In the past the primary fishery management tool in the Western system has been called "regulated inefficiency" to reduce harvest. Restrictions were placed on gear type and closed seasons for certain species. The Western model previously was focused on single species fisheries. In recent years there has been an enormous effort underway to use MPAs, including no-take reserves for all species, to augment regulations. This recent effort is reminiscent of the traditional system which maintained fishery stocks through closures of reefs that allowed the ecosystem to recover as a whole.

The traditional system also placed a *kapu* (forbidden take) on certain species, generally based on spawning cycles.

There is a strong contrast between the two systems in the area of resource monitoring. The Western system must depend on infrequent quantitative surveys of environmental parameters and assessment of stocks. There is always a perception of "insufficient data" required for decisive management actions. The traditional system operated at the other end of the spectrum with continuous daily interaction between the managers, fishermen, and the reef resources. Practitioners of the traditional system had the perception that accurate knowledge of resource is held by the local master fishermen (*poʻo lawaiʻa*), elders (*kūpuna*), and commoners (*hoaʻāina* of that place), and had confidence in difficult management decisions such as reef closures.

5. Evidence of Increasing Synthesis

Over two centuries that have passed since first penetration of westerners into Hawai'i, traditional ways of managing fisheries have been replaced with Western and scientific methods at the formal level. However, traditionally informed ways still exist and continue to be exercised in the everyday practices of individual fishermen and their families. A great deal of information still exists in the oral tradition and written documentation. The past thirty-five years have witnessed a renewed interest in traditional ancient Hawaiian culture and practices. Voyages by the *Hōkūleʻa*, which was the first replica of a traditional double-hulled canoe, have been instrumental in this renaissance. Throughout Hawaiʻi there has been a resurgence in the study and practice of the Hawaiian language, ancient chants, hula, and other aspects of the Hawaiian culture. With this shift has come a reevaluation of traditional marine resource management [28, 66] and the previously unquestioned superiority of contemporary management regimes.

There is a growing awareness that traditional management of marine resources contained features that even today may be more effective than the Western management schemes that replaced them. Initial descriptions of the traditional versus Western systems suggest that the two systems are diametric opposites in almost every category (Table 1), yet we are beginning to observe the beginnings of a synthesis of the two systems that incorporates their best features. During the past decade the Western system of management in Hawaiʻi has adopted many aspects of the traditional system that it replaced, albeit using modern terminology and following practices acceptable in our contemporary democratic society. Perhaps the rapidly increasing human population and resulting resource depletion in Hawaiʻi is creating an environmental crisis similar to that which led to development of management in ancient times. The major features of this renaissance are as follows.

5.1. Ecosystem-Based Management (EBM). The emerging Western practice of EBM integrates ecological, social, and economic aspects in reference to humans as a major component of the ecosystem. This approach is philosophically the same as that of the traditional management scheme. EBM is concerned with the sustainability of human as well as ecological systems, which is a key feature of the traditional system. The EBM approach incorporates adaptive management in order to deal with uncertainties due to changes in the natural environment and changes caused by humans. This aspect is analogous to what is known of the traditional method. Tissot et al. [67] note that there has been progress toward key elements of ecosystem-based management (EBM) in Hawaiʻi, including a network of MPAs and community-based co-management. Progress has been slow and driven mainly by increased awareness of the risks facing coral reef ecosystems, which has led to new legislation as well as emergence of increasing local engagement in fishery issues. Key elements of EBM in Hawaiʻi include enhanced coordination among multiple agencies, establishment of place-based and community-based, co-management, and acquisition of data on both the ecology of the nearshore system and the role of human impacts for use in management decisions.

5.2. Integrated Coastal Management. The integrated coastal management concept is in many ways a modern variation of the ancient *ahupuaʻa* system, but lacking some of the cultural and spiritual dimensions of the traditional approach. Nevertheless, there is a growing appreciation among managers and within local communities of the whole-system approach to resource management. This approach includes an integration of the watershed, streams, and coastal regions. Recognition of the impact of land-derived materials on nearshore areas is a central theme in today's ecological science that is analogous to the traditional understanding of the native Hawaiian people. A statewide plan has been formulated by a consortium of the Federal and State management agencies, the Hawaiʻi Local Action Strategy [68]. Other contemporary examples include the Hanalei Watershed Hui (http://www.hanaleiwatershedhui.org/), East Maui Watershed Partnership (http://eastmauiwatershed.org/), and the Waiʻānae Sustainable Communities Plan (http://www.honoluludpp.org/Planning/Waianae/Waianae5yr/Waianae.pdf).

5.3. Education and Outreach. Contemporary managers recognize that the social and spiritual values of the individual are vital in the promotion of a sustainable environment. This was a key feature of the traditional system of management. Today there is increasing emphasis on the importance of public outreach and education. Standards-based curriculum development by the State of Hawaiʻi's Department of Education currently includes the teaching of traditional Hawaiian values and cultural practices. Integrated, interdisciplinary studies based on ancient Hawaiian concepts include "Project *Ahupuaʻa*" which stresses sustainability. The project's motto "*Mālama I Ka ʻAina*" refers to taking individual responsibility for stewardship of our natural resources (Hawaiʻi Department of Education http://www.k12.hi.us/~ahupuaa). Traditional values such as love of nature, preservation of the environment, recycling, proper disposal of waste, exercising voluntary restraint on catch, and so forth, are widely promoted by all natural resource management agencies. Most granting agencies require an education and outreach

component for every project that receives funding. Thus, the key traditional social concepts of *mālama, kōkua,* and *kuleana* are being instilled in the younger generation as part of contemporary Western management practice as a means of achieving sustainability.

A program called "Navigating Change," is an education and outreach partnership created in 2001 among NOAA, FWS, the State of Hawai'i, the Polynesian Voyaging Society, Bishop Museum, and many other groups [69]. The program includes classroom curricula and multimedia materials and utilizes native Hawaiian voyaging traditions and cultural values to engage students and the public in learning about and caring for the NWHI as well as the MHI. As part of the project, voyages have been undertaken by the traditional Hawaiian double-hulled voyaging canoe *Hōkūle'a*, to and through the NWHI as well as the associated educational outreach efforts for the voyages.

5.4. Community-Based Management. Community-based fisheries management schemes that involve fishermen and other ocean users in decisions and give them responsibility for care of resources have been most effective in fairly remote communities with a high level of subsistence activity and limited outside intrusion. The community-based management of the *Hui Mālama o Mo'omomi* on Moloka'i incorporated knowledge from expert fishermen and marine scientists to implement conservation measures that would provide sustainable yields [28, 66]. The concept of *mālama* was employed to restore community stewardship, coupled with a science-based resource monitoring program. In addition, it applied the seasonal changes from the Hawaiian moon calendar to plan fishing activity. This holistic approach to the natural rhythms of the ocean, based on centuries of experience, revolve around the shifting tidal patterns and other environmental cues. Its success however has been challenged by both internal and external difficulties.

A more common model is that of local community organizations which voluntarily take on responsibilities for many aspects of resource management and community planning. For example, the Hanalei Watershed Hui (http://www.hanaleiwatershedhui.org/) on Kaua'i is directly involved in identifying environmental problems in the marine, freshwater, and terrestrial environments and has undertaken corrective action. The West Hawai'i Fisheries Council (WHFC) on the Island of Hawai'i is an example of a volunteer community advisory group encompassing a large geographic area (147 miles of coastline) with a diverse population. Formed in 1998, the stated mission of the WHFC includes goals such as "to effectively manage fishery activities to ensure sustainability, enhance nearshore resources, and minimize conflicts of use in the area". The Council has successfully addressed several contentious issues such as aquarium fish collecting and gill netting and has been instrumental in developing and recommending management actions [70, 71]. Government agencies are also promoting the "grass roots" approach through other volunteer programs such as "adopt a stream" beach cleanups and "*makai* watch", an ocean awareness program similar to urban neighborhood watch programs.

The development of community-based co-management and an MPA network along the western Kohala-Kona coast of the island of Hawai'i provides an excellent model for development of EBM through an incremental approach [67]. There are major challenges to scaling up the West Hawai'i model to other islands within the state due to the limited extent of community involvement as well as legislative and administrative support of community-based co-management and MPAs. Furthermore the complexity of conflicts is much greater on more populated islands with diverse stakeholders.

The Executive Order that designated the NWHI Coral Reef Ecosystem Reserve in 2000 required that native Hawaiians, among others, provide advice regarding management and ensuring the continuance of native Hawaiian practices [69]. This mandate is being carried out through partnerships with native Hawaiian organizations and institutions aimed at identifying and integrating native Hawaiian traditional knowledge and management concepts into management actions.

5.5. Enforcement. Enforcement of management regulations under the traditional system was immediate and severe. Violation of certain *kapu* could mean instant death [24], although less severe penalties could be invoked. Under the traditional system, the importance of obeying environmental management restrictions was clearly understood. The present social system in Hawai'i is based on individual legal rights and due process. No one is advocating a return to some of the more extreme traditional practices, but there is growing support for more consistent enforcement of existing rules. An essential and fundamental premise of all fisheries management whether contemporary or traditional is that pertinent rules and regulations must be enforceable and effectively enforced. In Hawai'i, public concern over the lack of effective enforcement of fishing and marine resource laws is widespread and frequently voiced and reflected in surveys of both recreational [64, 72] and commercial fishers [63]. The Division of Conservation and Resources Enforcement (DOCARE) is the state's primary agency for enforcement of natural resource regulations. Organized initially in 1925 within the Division of Fish and Game, it was established as a separate division within the Department of Land and Natural Resources (DLNR) in 1978. In 1981 Act 226 of the Hawai'i State Legislature expanded DOCARE's traditional duty of enforcing only laws, rules, and regulations relating to the preservation and conservation of natural resources to enforcing all state laws and county ordinances on all state lands, beaches, shore waters, and county parks. As a result, the proportion of citations (including arrests) issued for natural resource violations decreased markedly and is presently among the lowest of all U. S. coastal states. To further hinder enforcement, Hawai'i DOCARE officers are prohibited from inspecting the bags, containers, or vehicles of noncommercial fishermen unless there is "probable cause" that a violation has in fact taken place. Preemptory inspections to determine compliance with regulations governing seasonal closures, bag and size limits, and so forth are thus prohibited. Ongoing enforcement trends and inspection

limitations undermine the effectiveness of existing and future marine resource regulations. Major structural impediments remain to be resolved for enforcement to be truly effective.

There is a growing movement on the part of government to enhance enforcement by taking such steps as increasing the number of officers, entering into a joint enforcement agreement with NOAA/NMFS, placing interns with a legal background into the management agency and implementing rules permitting administrative handling of resource violations rather than through criminal procedures. An example of the positive shift toward stricter enforcement of environmental regulation in Hawai'i is provided by the unprecedented action taken by the government and the community in response to illegal grading that caused a 2001 mudslide which damaged Pila'a reef on the island of Kaua'i. The cost to the landowner for not complying with environmental laws exceeds $12 million, which includes state fines of $4 million, county fines of $3,075, state criminal penalties of $0.5 million, and $8 million in remediation costs as a result of settlement of a federal Clean Water Act lawsuit brought by Kaua'i community groups [73]. The settlement is believed to be the largest storm-water settlement in the country for violations at a single site by a single landowner and a major precedent for future enforcement action. As evidenced by these actions, the Western management system in Hawai'i has the same ability as the traditional system to bring about severe penalties for the breaking of a modern *kapu* if there is a will to enforce regulations.

5.6. Adaptive Management. Adaptive management is an iterative process of decision-making with the aim to reducing uncertainty over time through monitoring the response of the system to management actions. Using this approach, decision-making simultaneously maximizes one or more resource objectives and, either passively or actively, accrues information needed to improve future management. The ancient Hawaiians intuitively devised and operated such a system. The ponderous legal process currently used in Hawai'i for adopting and changing natural resource laws and regulations needs to be modified into a more responsive adaptive system. Some initial steps have been taken in this direction. One such example is the 2005 rule for harvesting sea urchins in a formerly closed Marine Life Conservation District (MLCD) in West Hawai'i. Based on input from urchin harvesters and the community, the West Hawai'i Fisheries Council developed a proposal which permits noncommercial harvesting from June 1 to October 1. Significantly, a moratorium on harvesting can be quickly implemented by the Board of Land and Natural Resources (BLNR) if conditions warrant it (e.g., overharvesting). In many respects this adaptive management parallels the traditional system.

Another example is an effort on the island of Kaho'olawe, which is one of the main eight Hawaiian Islands but is unpopulated due to its former use as a military target range. In 1993 the Hawai'i State Legislature created the Kaho'olawe Island Reserve consisting of the island itself and the submerged lands and waters extending two miles from its shore. A Kaho'olawe Island Reserve Commission (KIRC) was also created to manage the reserve while it is held in trust pending establishment and recognition of a native Hawaiian sovereign entity. Recently the island was returned to the Hawaiian people. The KIRC is in the process of instituting traditional Hawaiian management practices based on effective adaptive management. With the input of *kūpuna* (elders, keepers of wisdom), the Commission initiated the first state regulations that allow for the use of the traditional Hawaiian system of closing access to a resource by *kapu*. *Kapu* provides for flexible and responsive management of natural and cultural resources within the Kaho'olawe Island Reserve. The ability to provide for *kapu* closures protects any resources under pressure from overextraction. In addition, different practices of resource use, for instance traditional extraction methods versus modern methods will be allowed in designated areas, providing an opportunity to evaluate the impact of different resource extraction practices and methods on resource stocks. Thus far the *kapu* system has not met with a high degree of compliance. Fortunately, the remoteness and difficult accessibility limit the number of poachers in the Kaho'olawe reserve. Management has joined with researchers that work together with *kūpuna* to assess the status of resources, supplementing traditional techniques and values with quantitative scientific methods. Further, measures are being taken to increase enforcement and instill a greater conservation ethic on the part of the public using Hawaiian ethical principles described previously.

There is a long-standing awareness on the part of the DAR that effective management requires intimate contact with the resource. Although final authority is still centralized in the DAR, a process of involving local communities in decisions is in effect involving public meetings and participation of stakeholders in the decision process. There is an overall trend of decentralization of management with local authority on each island. Biologists assigned to the various islands and districts are intimately involved in field work and with those people using the resource. Often this includes working closely with local organizations who are taking increasing responsibility for stewardship of natural resources. There is a general awareness that managers are more effective when they get away from the desk and meetings and spend more time in the field.

Unfortunately in some areas of the state, adaptive management is hampered by various legal and bureaucratic restrictions as previously described. Nevertheless there is continuing interest in the possibility of constructing laws and regulations that describe trigger mechanisms that will immediately lead to a management action such as closure to fishing in areas that are depleted to a dangerous level.

5.7. Limited Entry, Granted Authority to Fish, and Fishing Licenses. A number of mechanisms existed under the traditional system that restricted fishing access. A family lineage existed among the *po'o lawai'a* (master fishermen who held and transmitted knowledge), which limited entry into fishing activity. Permission to extract resources was generally limited to those people living within the district, and under certain circumstances they were expected to share their catch with the management authority. Some analogies can be drawn with the Western system which has similar

tools available for use. Freshwater fishers in Hawai'i are required to purchase a fishing license, but noncommercial salt water fishers are not. Commercial fishers are required to purchase a commercial marine license for a nominal fee ($50) and are required to file monthly catch reports. Movement to a paid marine noncommercial fishing license with funds going to management of the resource would be a step closer to the traditional system which was based on the concept of *kuleana* which emphasized the responsibilities that accompanied the privilege of sharing in the resource. A recent survey of *kūpuna* and *kama'āina* with extensive experience in fishing and marine resources recommended the establishment of just such a license to support fishery management [15].

5.8. Fishing Closures. The Western system of management continues to utilize regulations governing closures during spawning of certain species as well as size limits and gear restrictions. These regulations are occasionally updated and posted on the DAR website (http://hawaii.gov/dlnr/dar/regulations.html). In ancient times the bottom fishery was not closed during the spawning season because the primitive technology of the time did not deplete the resource. A paradox is that current management practice has placed a "*kapu*" or total closure on bottom fish during the spawning season because modern fishing technology has depleted stocks throughout Hawai'i. In this case the Western management approach mirrors the ancient traditional practice in dealing with a depleted resource.

In addition to the *kapu* placed on the catching and consumption of specific resource species, traditional Hawaiian practices also involved the closing of entire reef areas for varying lengths of time. Although there are relatively few details known of the workings of these closures, they appear to be directly related to allowing resources time to recover from heavy harvesting or fishing pressures. The traditional system of closing (*kapu*) and reopening reef areas either as short-term or seasonal closures seemingly holds more appeal to fishers than long-term or permanent closures. Closure during the spawning season of a particular species is generally accepted. Seasonal closures by themselves are unlikely to be effective in protecting fish stocks [74]. A rotational closure system of alternate periods of open and closed fishing has been in place at the Waikīkī-Diamond Head Shoreline Fishery Management Area (FMA) on O'ahu for 28 years. The results of this rotational closure have not been favorable. While fish biomass increased during the closure periods, these increases were insufficient to compensate for declines during open periods. The net effect was that between 1978 and 2002, total fish biomass in the FMA declined by about two-thirds and large food fishes (>40 cm) virtually disappeared from the area [75].

In the practice of Hawaiian resource management, permanent closures did exist for certain species as restrictions and prohibitions related to gender or social status. In addition, technological limitations of those times created numerous natural "permanently closed refuges" in the form of areas where harvesting was difficult or impossible. The modern development of boat engines, depth finders, GPS units, diving gear, underwater lights, and other modern fishing gear in conjunction with the emergence of a market economy have greatly changed the nature of fishing and the ability of fishers to impact the resource. Such natural marine refuges no longer exist due to modern technological ability to extract fish and other resources.

The Western management system in Hawai'i has attempted to achieve the same result as the traditional *kapu* method through a variety of management strategies (e.g., size and bag limits, seasonal closures, gear restrictions, etc.) and a system of MPAs. The underlying concept of MPAs is that closed areas provide a refuge where fish can multiply in number, live long and reach optimal reproductive size. The protected areas serve as a source of renewal for fished areas through spillover and larval dispersal. In the MHI a total of only 0.4% of all coral reefs have complete no-take MPA status [76, 77]. The closed areas include a few small MPAs, military security restricted areas and the Kaho'olawe Island Reserve which constitutes the bulk of such closures. An additional 5.7% of the reefs have restrictions on one or more types of gear or fishing activity (e.g., no gill netting, no aquarium collecting, etc.). Recent evaluations of some of Hawai'i's MPAs have shown that they can be very effective in terms of increasing fish biomass within MPAs [76] and abundance and fishery yield outside [78].

5.9. Creation of the Papahānaumokuākea Marine National Monument. On June 15, 2006 President George W. Bush signed a proclamation that created the Papahānaumokuākea Marine National Monument. This area encompasses 137,792 square miles of USA waters, including over 4,500 square miles of relatively undisturbed coral reef habitat. This is the largest protected area under the U. S. jurisdiction and one of the largest no-take MPAs in the world (http://www.hawaiireef.noaa.gov/). It also represents an immense step forward in bringing traditional practices into contemporary marine environmental management. Preservation along with education and outreach centered on the traditional Hawaiian spiritual and cultural values are major themes in the management of this Marine National Monument [69]. The Monument's management plan is focused on engaging the Native Hawaiian community in active and meaningful involvement in the management process. There is an emphasis on increasing the understanding and appreciation of Native Hawaiian histories and cultural practices related to Papahānaumokuākea Marine National Monument. There is a major effort to cultivate an informed, involved constituency that supports and enhances conservation of the natural, cultural, and historic resources [69]. This program is engaging the Native Hawaiian community in active and meaningful involvement in management through its cultural working group comprised of Native Hawaiian practitioners, scholars, teachers, *kupuna*, fishermen, and community members. The Monument also sponsors multi- and interdisciplinary research projects that bring scientists and cultural practitioners and fishermen together to conduct research that is relevant to both groups, synthesizing approaches to knowledge acquisition, data, and ultimately developing an understanding of the natural environment.

In partnership with the University of Hawai'i at Hilo, the Monument is training students to develop research projects that require the study of both marine science and primary traditional Hawaiian source material. A central management goal is to cultivate an ocean ecosystem stewardship ethic founded on traditional Hawaiian principles, contribute to the nation's science and cultural literacy, and create a new generation of conservation leaders through formal environmental education.

6. Discussion

This paper presents a paradox in that two systems that are seemingly incompatible are presently showing the beginnings of integration that potentially involves the best features of each system. The emerging concepts that are readily recognized as features of the traditional system include adaptive management, integrated coastal management, community-based management, strong enforcement of regulations, ecosystem-based approach, fishing closures, and limited entry. Strong and shared cultural, social and spiritual values and a conservation ethic are the goals of the growing education/outreach program that will foster sustainability of resources in a manner found in the traditional method. Concepts of *pono* and *kuleana* are valuable tools for sustaining the environment. The strong and direct linkage between management, monitoring, enforcement and those utilizing the resource characterizes the traditional Hawaiian system and is a goal of the Western system.

The Western system that has gradually replaced the traditional system is centralized, often cumbersome, overly complicated and has many elements that could shut out community and "neighbor island" participation. In this area we can learn much from the ways of ancient Hawai'i. It is now clear that some of the limitations and inefficiencies of the Western management system stem from the absence of the linkages found in the traditional system. Western managers are responsible for large areas and frequently have little direct contact with the resource except through data supplied by occasional surveys, catch statistics, environmental impact statements, and so forth. Management authority often is fragmented between many agencies and enforcement is widely regarded as weak and ineffective. Those using the resource in common are not given any responsibility for stewardship and are often only concerned with exploiting the resource to their private advantage at the expense of the resource. Decision-making is largely "top-down" in the Western management system. However, these decisions are increasingly influenced by the public through active participation in the political process, and by a growing environmental awareness that is manifesting itself by increasing community action in local areas. Thus, the Western management system has the ability to receive input from the community and can be responsive to social and environmental change. The major strength of the traditional system was the ability to be place-specific and sensitive to local issues as well as its ability to deal with any transgression with immediate action by local experts (*kupuna*). A major strength of the contemporary Western system is its ability to adapt to changing social, political, and economic conditions, and to threats presented by pollutants, shoreline construction, invasive species, human pathogens, and so forth that were not components of the original ecosystem. Further, the Western system has the potential to adapt regulations to deal with the major advances in fishing technology (high power boats, GPS, sonar fish finders, power winches, inexpensive monofilament gill nets, self-contained breathing apparatus, etc.) that have eliminated many of the controls that prevented overexploitation in ancient times. Anthropogenic impacts have steadily increased with the increase in human population and technological development to the point where global climate change is now a serious concern. Western management practices must be open to incorporate approaches that have been proved successful in the past.

Perhaps the best evidence of the growing synthesis of Western and traditional management is being provided by the Papahānaumokuākea Marine National Monument mission statement:

"Carry out seamless integrated management to ensure ecological integrity and achieve strong, long-term protection and perpetuation of NWHI ecosystems, Native Hawaiian culture, and heritage resources for current and future generations." [69].

Delegates to the United Nations Educational, Scientific and Cultural Organization's (UNESCO) 34th World Heritage Convention in July 2010, inscribed Papahānaumokuākea Marine National Monument as one of only 26 mixed (natural and cultural) World Heritage Sites in the World and the first mixed World Heritage Site in the nation. This action recognizes Papahānaumokuākea's globally significant natural attributes that incorporate its living, indigenous, cultural connections to the sea and underscores the fact that for many indigenous peoples, nature and culture are one.

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