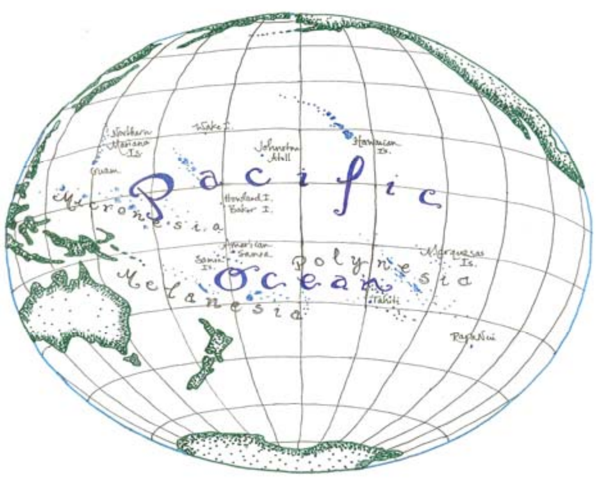
WESTERN PACIFIC REGIONAL FISHERY MANAGEMENT COUNCIL

ECOSYSTEM SOCIAL SCIENCE WORKSHOP

\- FINAL REPORT -



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July 17, 2006

Mr. Paul Dalzell, Senior Scientist
Western Pacific Regional Fishery Management Council
1164 Bishop Street, Suite 1400
Honolulu, Hawai'i 96813

Dear Mr. Dalzell:

In accordance with the terms of our contract with the Western Pacific Fishery Management Council, we are pleased to submit the enclosed final report on the Ecosystem Social Science Workshop held in Honolulu during late January of 2006. The report has been developed in compliance with the terms of Contract Number 05-WPC-00.

The objective of the report is to summarize the proceedings, contributions, findings, and recommendations of the experts assembled to provide guidance to the Council as it develops its fishery ecosystem plans. Additional context is provided to enhance the value of the report for the Council and interested readers.

An introductory section summarizes the mission and purview of the WPRFMC, the rationale for pursuit of an archipelagic system of ecosystem-based management in the region, and the underlying pragmatic rationale for implementing the ecosystem management workshops

A background section reviewing pertinent ecological principles and the historical and methodological evolution of ecosystem approaches to fisheries management in this region and elsewhere is provided to communicate underlying tenets of historic and contemporary ecosystem paradigms.

As per the principal objective of the report, the majority of its content is devoted to summary of speaker presentations and group discussion, as observed and recorded during the course of the workshop. We summarize and synthesize these materials in the concluding sections of the report in the spirit of developing informed approaches to future ecosystem-related social science research in the region.

We wish to express both our sincere thanks for the opportunity to be involved in this important project and our deep appreciation of the efforts of Michael Orbach, Kitty Simonds, and you and your staff in the preparation and conduct of the workshop described herein.

Mahalo nui loa,

Edward W. Glazier, Ph.D.
Project Manager

John S. Petterson, Ph.D.
President

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WESTERN PACIFIC REGIONAL FISHERY MANAGEMENT COUNCIL
Ecosystem Social Science Workshop

1.0 Introduction

In 1998, the United States Congress authorized NOAA Fisheries to establish an Ecosystem Principles Advisory Panel (EPAP) to examine ways in which ecosystem principles might be applied to the management of our domestic marine fisheries. The Panel subsequently determined that such principles would best be applied by gradually replacing existing Fishery Management Plans (FMPs) used by the nation's regional fishery management councils with plans that incorporate useful information about the ecosystems within which domestic fisheries occur. These would be called Fishery Ecosystem Plans (FEPs), and would involve a management approach that is "adaptive, specified geographically, takes into account ecosystem knowledge and uncertainties, considers multiple external influences, and strives to balance diverse social objectives" (NOAA 2004).

The Western Pacific Regional Fishery Management Council (WPRFMC; the Council) subsequently incorporated ecosystem principles in the nation's first ever ecosystem-based fishery management plan— a plan for managing coral reef ecosystems, first implemented in 2001. The Council has since drafted place-based FEPs to further the ecosystem-based approach across the region. A Draft Programmatic Environmental Impact Statement has also been completed (National Marine Fisheries Service 2005a).

In keeping with EPAP recommendations, the Council has undertaken an incremental and collaborative approach to implementing FEPs across the region. One element of this approach is the series of three workshops being conducted by the Council to aid in the transition from FMPs to FEPs and to enhance application of ecosystem-based management principles over the long-term. The workshops are facilitating informed discussion and expertise regarding the ecosystem approach and its effective application in the Western Pacific.

The following pages report on the Ecosystem Social Science Workshop held by the Council in January of 2006. The first workshop, held in April 2005, addressed biophysical dimensions of ecosystem-based management. The social science workshop described herein addressed human dimensions of ecosystem-based approaches to resource management. A final workshop will be designed to synthesize the full range of biophysical and human considerations in an examination of regional ecosystem policy and governance. This will be held sometime late in 2006 or early 2007.

The social science workshop was organized and conducted through the collaborative efforts of Dr. Michael Orbach of the Duke Marine Lab, Nicholas School of the Environment and Earth Sciences; and Impact Assessment, Inc. (IAI). This report has been prepared by the Pacific Islands Office of IAI under WPRFMC Contract Number 05-WPC-00.

1.1 Rationale and Questions for an Ecosystem-based Approach in the Western Pacific

Evidence of decline in production associated with open access fisheries in the Northern Hemisphere during the late 19th century eventually led to development of international conventions for limiting fishing pressure in the Atlantic and North Sea. These were the first of a long series of strategies designed to improve the status of marine fisheries amidst growing pressures on natural resources in heavily populated areas of Europe and the United States. Management strategies and underlying theory have since varied in nature and extent by region and over the course of time. Propagation theory, growth theory, biological productivity, equilibrium, logistic models, maximum sustainable yield, maximum economic yield, and a range of other conceptual approaches and applications have been tried. Modifications and paradigm shifts have emerged in response to ongoing challenges.

Most recently, fishery scientists, managers, and policy analysts in the U.S. and abroad have shifted attention to the principles and strategies of an *ecosystem* approach to fisheries management. The definitions and parameters vary and continue to evolve, and there are similarities to previous approaches (Garcia 2003), but there is general consensus that the ecosystem approach to fisheries management is novel in its attention to *whole marine systems and physical and biological relationships among the components that comprise those systems.* The WPRFMC defines ecosystems as "geographically specified systems of organisms, the environment, and the processes that control its dynamics." Significantly, it also considers humans and their societies to be an integral part of ecosystems (WPRFMC 2005:4) as per the EPAP (1998), which states that:

> Managers must also understand the complex linkages between natural ecosystems and the economic, social and political dynamics of human systems. Humans are integral components of ecosystems and their interests, values and motivations must be understood and factored into resource management decisions. Information on human systems is as important as that from natural systems and must be included in any ecosystem research and management efforts. (EPAP 1998:47)

The impetus for planning and implementing an ecosystem approach to fisheries management in the Western Pacific relates not only to this nascent paradigm shift, but also to the readiness of the Council to engage a strategy that is attentive to vital relationships within and between biophysical and human systems in the unique island settings of the region. The ecosystem approach is seen as particularly amenable to the Pacific island context in that: (a) historic management strategies undertaken here effectively recognized human and biophysical relationships and interactions and therefore provide conceptual models for planning a new approach, (b) island settings foster common recognition of such relationships and interactions, and (c) an ecosystem strategy organized by archipelago may well serve to improve focus on such relationships and interactions at local and archipelagic levels of analysis while reducing administrative burdens associated with management of single species pursued by multiple fleets across distant archipelagos.

The approach clearly holds promise for enhancing existing fishery management efforts in the region. But its prospective development and application also leads to various questions and uncertainties for students and practitioners of contemporary fishery management. These include questions about human dimensions of ecosystems. One might justifiably ask, for example, whether establishment of the ecosystem approach will: (a) necessitate collection and analysis of new forms of information about relationships within and between groups of fishery participants, governance entities, and the marine environment, (b) require development of behavioral modeling efforts to help predict its human or environmental outcomes, and/or (c) call for identification and development of indicators useful for assessing its economic or social impacts and/or ultimate effectiveness in maintaining the sustainability of marine resources.

1.2 Purpose of the Workshop and Report

Given the importance of such questions, the need to complement the initial biophysical workshop with analogous examination of social, economic, cultural, political, and demographic aspects of fishing, fisheries, and fisheries management was clearly recognized by the Council. Humans and human needs have always been considered pivotal aspects of fisheries management in the region, and thus immediate recognition followed that social science had much to offer in terms of furthering understanding of marine ecosystems, associated resources, and their effective management under the "new" ecosystem paradigm.

The principal intent of this report is to document the outcome of the WPRFMC social science workshop. This is, in itself, a relatively straightforward descriptive task. But because we wish to maximize its utility for persons involved in fisheries management and ecosystem-related social science in this region and others, we provide additional context and draw on the workshop to move toward a general approach for incorporating the human dimension into ecosystem-based resource management in the region. Indeed, in reporting on the many human dimensions of ecosystem-based fisheries management and by describing aspects of the regional context, we unavoidably and naturally arrive at basic conclusions and recommendations of potential value to resource managers and observers of ecosystem-based management in this region and elsewhere.

1.3 Organization of the Report

This introductory section and following sections build preliminary context. We begin with discussion of the WPRFMC mission and purview and its rationale for moving toward an ecosystem-based management regime. This leads to discussion of unique aspects of Pacific islands and islanders and conditions that render the ecosystem approach particularly amenable in this setting. Some pertinent ecosystem models and lessons from the past are also reviewed. Section Two builds additional context with discussion of formalized ecosystem principles, review of council actions on ecosystem issues to date, and brief discussion of the evolving role of social science in ecosystem-based fisheries management. Section Three summarizes the conduct and outcome of the workshop with especial focus on speaker presentations. Section Four synthesizes previous sections of the report and concludes with discussion of prospective social science approaches to ecosystem-based management in the Western Pacific. References and appendices follow.

1.4 WPRFMC Mission and Purview

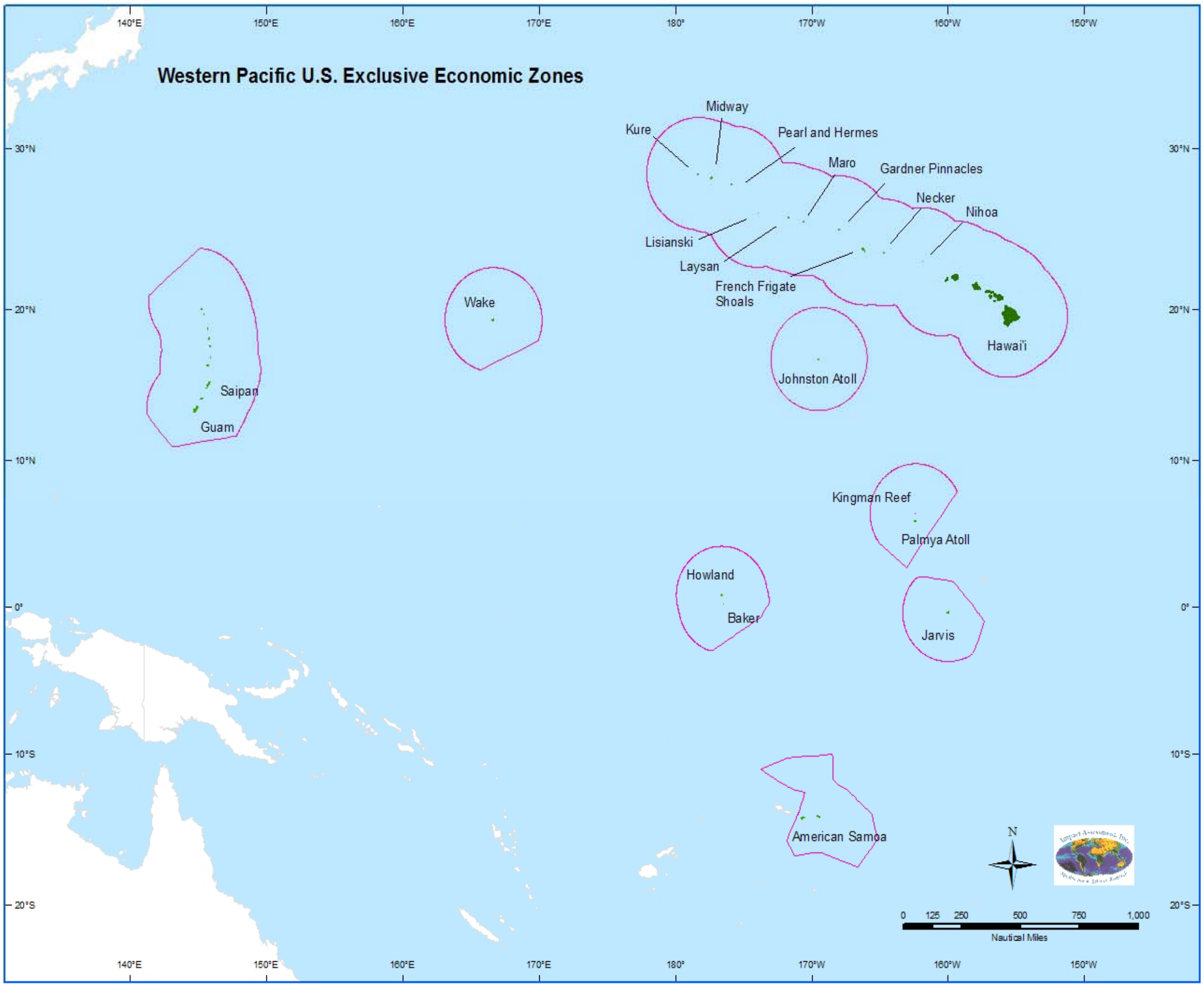
As stipulated in the Magnuson Fishery Conservation and Management Act (MSFMCA), the WPRFMC was established as one of the nation's eight fishery management councils in 1976. It has thus been involved in the management of fisheries in the region for 30 years.
The Council is the policy-making body for the management of fisheries in the U.S. Exclusive Economic Zone (EEZ) of the Western Pacific. This includes fisheries conducted around the Hawaiian Islands, American Samoa, Guam, the Commonwealth of the Northern Marianas, various Pacific remote island areas, and in the vast open ocean areas of the region. The Council monitors fisheries and marine resources throughout the region with the cooperative interaction of NOAA Fisheries, and develops and adjusts policies to ensure their sustainability over time.

That region is truly vast (see map, following page). It includes the entirety of the exclusive economic zones (EEZ; three to 200 miles offshore) surrounding the various archipelagos and remote islands possessions of the U.S. in the Central and Western Pacific. The nearly 1.5 million square nautical mile area is by far the largest area of purview of any fishery council in the United States and, in fact, comprises 48 percent of the nation's EEZ.

The region is also complex in terms of national and international political-jurisdictional boundaries. It should be kept in mind that the region extends across the EEZ of one state (Hawai‘i), two territories (American Samoa and Guam), a commonwealth (the Commonwealth of the Northern Marianas - CNMI), and seven atolls or islands (Johnston Atoll, Palmyra Atoll, Baker Island, Howland Island, Jarvis Island, and Midway Island).

Moreover, some of these areas share offshore jurisdictional boundaries with other nations. These include: (1) Palmyra Atoll and Jarvis Island, adjacent to the Republic of Kiribati-governed Northern and Southern Line Islands; (2) Howland and Baker Islands, adjacent to the Kiribati-governed Phoenix Islands, (3) American Samoa, adjacent to independent Western Samoa and Tonga, and to the Cook Islands, Niue, and Tokelau; (4) Wake Island, adjacent to possessions of the Republic of the Marshall Islands, (5) Guam, adjacent to possessions of the Federated State of Micronesia, and (6) the Northern Marianas, adjacent to various islands of Japan.

The Council is also responsible for managing migratory and highly migratory pelagic fishery resources across the region. This is increasingly complicated in that numerous groups and conventions now address management of those resources across international jurisdictional bounds, including those of the U.S. EEZ. These include the Inter-American Tropical Tuna Commission, the Interim Scientific Committee for Tunas and Tuna-like Species in the North Pacific, the Western and Central Pacific Fisheries Commission, the Secretariat of the Pacific Community, the Multilateral Treaty on Fisheries between the Government of Certain Pacific Island States and the Government of the United States, and others.



1.5 Brief Overview of the Fisheries

Contemporary management of marine resources in the Western Pacific region necessarily relates to the history and modern experience of indigenous peoples of the various island groups. The history of fishing and use of marine resources are truly ancient in this region. For instance, early voyagers settled in the Marianas by at least 3,500 years before present, in Samoa by at least 3,000 years before present, and in Hawai‘i by at least 1,700 years before present (Kirch 2000). Seafood was basic to the diets of the early voyagers and island residents; fish bones, hooks, and other accoutrements are typically found in the earliest sites and throughout the archaeological record.

Pacific island societies and cultures have continually evolved over the millennia, of course, but modern indigenous groups retain knowledge, interest, and a political stake in traditional aspects of harvest and management of marine resources. Indeed, fish and fishing retain great social, cultural, and economic significance for Native Hawaiians, Samoans, Chamorros, Carolinians, and other indigenous persons residing in the region. Consideration of the historic and modern experience and perspectives of these groups remains an important dimension of contemporary marine resource management in the region.

Fishing and fisheries obviously are important to broader populations of island residents as well. Persons with fishing knowledge and skills have arrived from outside the region over the past century or more, gradually increasing the level of effort via new vessel and gear technology and subsequent the availability of seafood. Ongoing demand for seafood products in local and distant markets has led to extensive processing and distribution sectors in the larger island areas and the development of various commercial fleets (e.g., Pan and Pooley 2005).

Given that deep water occurs in close proximity to these mid-ocean islands, commercial pursuit of pelagic fish is most common. Participants in the Hawaiʻi-based longline fleet pursue tunas and swordfish around the island groups and in more distant locations throughout the region and beyond. Most participants in the Samoa-based longline fleet tend to pursue tunas close to the Samoa archipelago, but some fish distant waters as well, with permit arrangements to enter neighboring EEZs. Small-boat commercial trolling and handlining for tuna species occur in both Samoa and Hawaiʻi, and commercial pole and line fishing for aku (skipjack tuna) occurs in Hawaiʻi. Of note regarding the remote island areas, some Hawaii-based longline operators regularly fish around Palmyra Atoll, and operators of the U.S. purse seine fleet periodically fish for tuna species around Palmyra Atoll, Jarvis Island, Howland Island, and Baker Island. The purse seine fleet is not regulated through Council decisions, but rather through a separate treaty process. Commercial trolling for pelagic species is common offshore Guam and CNMI.

Commercial pursuit of bottomfish is also important throughout the region, and deep, mid-slope, and shallow handline fisheries have been developed around all of the main islands. A commercial lobster fishery occurs in the Hawaiian Islands. There is extensive shoreline fishing and gathering throughout all of the populated island areas.

Recreational and mixed-commercial/recreational vessels pursue pelagic species throughout the region. Charter fishing is a particularly important form of tourism in Hawaiʻi, and increasingly so in the other island groups, especially CNMI and Guam.

The act and practice of small-scale commercial and non-commercial fishing are similarly important. Many small local societies are, in many ways, organized around the pursuit, harvest, distribution, and consumption of seafood. Seafood is commonly shared and consumed in extended family settings and is an object of generalized reciprocity, sharing, celebration, and associated practices and customs for persons of various ethnicities. Opportunities for small-scale operators to sell fish actually enable a modern form of subsistence and associated ways of life. The full range of inshore and offshore species is important in this context, and thus the Council is attentive to this kind of fishing and the social and cultural status and needs of its practitioners.

Ecological knowledge is as significant in the context of inshore and offshore small-boat operations as it is for operators of larger vessels in the far offshore waters. As has long been the case for voyagers in Oceania (Gladwin 1970; Lewis 1972), accomplished fishery participants today often reveal extensive and intricate knowledge of the ocean environment, the weather, swell and sea states, sea signs, bird activity, the habits of pelagic and other species, and the various bathymetric features, habitats, and ecosystems that surround the islands (Glazier 2006; Maly and Maly 2003).

Seafood is itself critically important in economic terms throughout the entire region. Quality seafood products are purveyed in mainland and overseas markets, and consumed by tourists visiting the islands. Indicative of the economic importance of the industry in the region, in 2004, Honolulu was ranked 42nd among U.S. ports reporting commercial seafood landings at 18.2 million pounds, and 9th in terms of the value of those landings at $44.6 million (National Marine Fisheries Service 2005b:7). The commercial fishing industry is also linked in various ways to the larger economy of the region, and regulatory or other changes that affect commercial production are likely to affect the larger economy as well (Cai et al. 2001).

Although catch-and-release style of fishing is relatively rare, recreation-oriented fishing is also quite important in the region. This is especially so in the MHI where the rate of participation far exceeds that of other regions in the U.S. where the Marine Recreational Fisheries Statistics Survey (MRFSS) is conducted (National Marine Fisheries Service 2005b:21-22).[1]

Research and management of marine resources involves numerous agencies, institutions, and groups across the vast area and complex sociopolitical configuration of the Western Pacific. The principal marine fishery management entities at the level of the state, commonwealth, and territory include: the State of Hawaiʻi Division of Aquatic Resources (HDAR), the American Samoa Department of Marine and Wildlife Resources (DMWR); the Division of Fish and Wildlife (DFW) in the Commonwealth of the Northern Mariana Islands; and the Guam Division of Wildlife and Aquatic Resources (DWAR). At the federal level, the WPRFMC and the National Marine Fisheries Service (NMFS) are the principal entities involved in management of fishery resources in the EEZ. The U.S. Department of the Interior Fish and Wildlife Service and U.S. Coast Guard are also involved in fishery issues in the region. Numerous non-government organizations and groups assert interests in the management of resources in the region.

1.6 A History of Ecosystem-based Management in the Pacific Islands

It is within this vast region and complex social and economic context that the Council has sought to achieve balance between the use and conservation of marine resources under its kuleana (purview). As for the other fishery councils around the nation, management efforts have, to date, assumed the structural form of fishery management planning and plans, wherein species, fisheries, and participants active in specific fisheries are considered in relatively distinct terms.

[1] Per the National Marine Fisheries Service (2005b:21-22), an estimated 407,000 Hawaii residents engaged in some form of marine recreational fishing in 2004. This was nearly 32 percent of the total population of 1,275,194 residents estimated for 2005 (U.S. Census Bureau).

The now operational exception is the WPRFMC Coral Reef Ecosystems Management Plan, the first ever ecosystem-based fishery management plan developed in the U.S. As noted in WPRFMC (2003:8), the plan incorporates contemporary ecosystem principles in its establishment of a management regime for an extensive region and set of resources:

> The goal of the FMP is to establish a management regime for the entire Western Pacific Region that will maintain sustainable coral reef fisheries while preventing adverse impacts to stocks, habitat, protected species or the ecosystems. To achieve this goal, the FMP implements several management measures, including (1) the designation of zoned Marine Protected Areas (MPAs) for coral; (2) permit and reporting requirements to fish in designated low-use MPAs . . ., and if needed, a general permit program for all EEZ reef fisheries and; (3) a prohibition of non-selective/destructive fishing gears and conditions on the types and uses of allowable gears.

Council analysts note that the central feature of the Coral Reef Ecosystems FMP is adaptive management, "which recognizes the uncertainty, changing conditions and resilience associated with coral reef ecosystems" (ibid., p. 8). Significantly, the plan also recognizes the extensive and lengthy precedent of indigenous management of reefs and associated resources around the Pacific islands:

> Management systems for coral reef ecosystems have allowed Pacific islanders to survive for millennia . . . and are best viewed as adaptive responses over time. (WPRFMC 2003:8).

Clearly, both of these ecosystem-relevant concepts - adaptive management and indigenous management as adaptive process - can be applied to other marine resources and habitats in the region. Indeed, both may be particularly amenable in the context of the Pacific Islands.

1.7 Pacific Islands and Ecosystems

Several attributes render islands, and especially small Pacific islands, most suitable for examining the roles of humans in ecological processes (Kirch 1997:31) and, by extension, suitable environs for applying ecosystem-based approaches to management of natural resources. They are small relative to continents and oceans, and in the central and western Pacific, they tend to be isolated. "Boundaries" between land and sea and their respective biophysical sub-systems are readily envisioned (Berkes 1999:69). The sea itself is highly visible and its resources are important in the lives of many residents. Further, marine life congregates at islands (Sibert and Hampton 2003). At the same time, however, marine resources are perceived by islanders as finite and sometimes challenging to acquire (as they are everywhere), and increasingly, many goods and services are not available unless they are imported. Viewed in historical perspective, such limitations have clearly required islanders to develop extensive knowledge of marine resources and the factors that constrain or enable their availability, abundance, and acquisition (see Poepoe et al. 2003).

Of direct relevance on the biophysical front, as cited in Kirch (1997:21), Vitousek (1995:11) asserts that islands afford the "opportunity [for scientists] to understand controls on ecosystem structure and function in a relatively simple, well-defined set of ecosystems" and to develop models which "can then be applied as the basis for understanding more complex continental systems." Similarly, Kirch (1997) makes clear that understanding the long-term feedback effects of ecological change on Pacific islands may yield much insight into similar processes enacted in larger island and continental ecosystems around the world.

The latter discussion is significant in this context. Kirch (1997:30-42) uses archaeological findings to compare the long-term responses of two divergent societies of islanders to ecological problems wrought by their ancestors. Early colonists of Tikopia in the Solomon Islands initially generated ecological challenges through deforestation and extirpation of various species. But subsequent generations overcame those challenges by developing cultural mechanisms to balance population size with highly effective means of resource production and conservation. The long-term response of colonists of Mangaia (Cook Islands) to similar problems caused by *their* ancestors was not so effective and ultimately led to further ecological damage, including damage to the marine ecosystems surrounding the island (p. 34). This, in turn, resulted in severe social problems and rapid decline of the human population. Of Mangaians, the author writes:

> . . the social terror that pervaded late precontact Mangaia was inextricably linked to (I do not say "determined by") the sequence of ecosystem perturbations that had been precipitated [earlier] . . .The Mangaians were in a very real sense the authors of their history, for in destabilizing and thus biotically impoverishing their island environment, they set up severe constraints that entailed severe cultural responses. (Kirch 1997:37)

More highly adaptive responses prevailed on Tikopia. These involved certain socio-cultural mechanisms for regulating population that may be considered draconian when viewed through our own ethnocentric filters. But when such controls were used in conjunction with effective strategies for managing resources, equilibrium was achieved between population density and food production:

> Protein is obtained almost exclusively from the reef and open sea through a sophisticated range of fishing and collecting strategies, the dangers of overexploitation held in check through the exercise of conservation strategies invoked by chiefly sanction (*tapu*) . . . Let it suffice to say that Tikopia is a model of the sustainable microcosm . . . (Kirch 1997:35)

Interestingly, Kirch reports that hegemonic disruption of population control mechanisms by Christian missionaries during the period 1920-1950 preceded rapid population growth on the island. This peaked in 1952 and, in fact, exceeded the capacity of residents to produce sufficient food to respond to the effects of cyclones occurring that year and in 1953. Relief supplies arrived through the intercession of economic anthropologist Raymond Firth, who was still active in the area after his landmark work with the Tikopia in the 1930s (see Firth1936, 1939, 1967). Kirch writes that the Tikopian council now closely monitors its population density and in fact, some Tikopians have been forced to reside elsewhere in the Solomons. The chiefs reportedly are "acutely aware that their sustainable ecosystem depends upon a delicate balance between human numbers and productive resources" (Kirch 1997:36).

1.8 The Antiquity of Ecosystem Concepts in the Region

History bears many lessons in the Pacific islands. It must be kept in mind that Polynesians, Micronesians, and Melanesians were developing detailed knowledge of and traditions regarding use of island ecosystems and resources long before the Viking expansion into continental Europe and longer still before arrival in the New World. Indigenous peoples in the Western Pacific gradually developed and modified settlement patterns and sociopolitical systems to utilize and/or produce marine and terrestrial resources in their respective island groups.

The early Chamorro peoples who first inhabited the Mariana Archipelago developed a "semi-mobile archipelago-wide settlement system adapted to irregular rainfall and frequent typhoons" (Amesbury and Rosalind-Hunter 2003). The society gradually evolved in terms of cultural and political complexity, and the population expanded through subsequent millennia. Problematic contact with the Spanish preceded rapidly diminishing populations and changes in life ways during the late 17th century. While the Chamorros continued to inhabit the region, members of societies from around the Pacific islands and Pacific Rim gradually accompanied them. Carolinians practiced low impact subsistence fishing around Guam beginning in the early 19th century. Filipino immigrants followed, and subsequently Japanese, Americans, and others arrived - each with unique approaches and intensity of use of marine resources and ecosystems.

Indigenous residents of Samoa continue to dominate the political and cultural dimensions of life in that island group to the present day. A mixed horticultural-maritime economy characterized the region throughout much of its development, with fish and shellfish providing most dietary protein (Kirch 2000:216). Missionaries influenced changes in the Samoan cosmology, and foreign governments occupied and eventually divided the islands into politically distinct America Samoa and Western Samoa (now independent Samoa). But the local political system of hereditary rank has remained intact. Indeed, local social institutions requiring allegiance to the matai or family chief are at the heart of *Fa'a Samoa*, or the Samoan way of life as enacted in both American and Western Samoa. Local village-level control over *fa'nua* (land) and nearshore marine resources is retained through the matai system, and fishing, seafood, regulation of fishing practices, and communal use and distribution of seafood remain critically important aspects of island life and organization of local society (Tuilosega 2005; O'Meara 1990; Severance and Franco 1989).

Marine resources have long sustained Native Hawaiians. Seafood was originally consumed directly by nucleated groups residing on the lush windward sides of the islands (Kirch 1985:287-288). As new areas were explored and inhabited, society increased in complexity and seafood became a commodity for trade (see Sahlins 1992). Hawaiian society was increasingly disrupted through contact and interaction with Europeans, and so also were the social processes that sustained fishing, such as the expert crafting of hooks, line, and other gear. By the mid and late 19th century, Hawaiians were fishing primarily for purposes of consumption by the extended family ('ohana), or as a means for earning money in the context of an increasingly dominant cash economy. Methods developed during ancient times persisted in certain places through the Plantation era (see Maly and Maly 2003) and continue to be used around the Hawaiian Islands today.

1.9 The Ahupuaʻa and other Forms of Ecosystem-based Management in the Pacific Islands

A particularly relevant lesson on ecosystems and ecosystem management derives from ancient Hawaiʻi and the ahupuaʻa - the formalized system through which Hawaiians managed resources of land and sea. Ahupuaʻa were geographically-influenced political land divisions within which available resources from mountain to sea were produced, managed, and utilized, including pelagic resources from the deep sea (Kirch 1985:208; Goto 1986:448).

The approach was particularly amenable to the geologic configuration of the Hawaiian Islands: characteristically steep mountains at center, uplands sloping downward to the coastline along ridgelines of sharp relief, resource-rich shoreline and nearshore areas, and deep water and pelagic resources occurring in close proximity to land. Ahupuaʻa bounds followed the topography, typically assuming a wedge shape, with the narrow point in the mountains broadening along the coast. People living or working in the forested upland areas would provide services and goods to people in the coastal portions, and vice-versa. A hierarchy of persons and leaders held and transmitted knowledge and made decisions about the proper manner of pursuing, using, and managing resources in the respective zones. There was extensive interaction between commoners and leaders (aliʻi) within and across each ahupuaʻa and island district (Sahlins 1992). The great Native Hawaiian historian Samuel Kamakau (1815-1876) provides a first-hand account of how this hierarchical political economy, still functioning during the early 19th century, had enabled management of natural resources and their efficient use across the Hawaiian Islands for hundreds of years (Kamakau 1992).

Marine resources associated with koʻa (areas of mounded reef) and other nearshore bathymetric features were pursued and used as food for residents of the proximate ahupuaʻa. Kuleana also extended to fishing locations and resources in the offshore waters (Kamakau 1992:177-178). Even very specific grounds and resources in distant waters of the deep sea could be located by triangulating between landmarks (Kahaʻulelio 2006:42-61).

Variations on the Hawaiian system include the tabinau in Yap, the vanua in Fiji, the puava in the Solomon Islands (Ruddle et al. 1992), and others. Berkes (1999:70) emphasizes the close connection between society and land and sea under each of these systems:

> In each, the term refers to an intimate association of a group of people with land, reef, and lagoon, and all that grows in or on them. This "integrated corporate estate" concept is effectively the "personal ecosystem" of the group in question: "puava is a defined, named area of land and, in most cases, sea. A puava in the widest sense includes all areas and resources associated with a butubutu (descent group) through ancestral rights, from the top of the mountains to the open sea outside the barrier reef (Hviding 1990:23)." The Fijian vanua is conceptualized in similar terms (Ravuvu 1987; Ruddle 1994). Vanua describes the totality of a Fijian community. Depending on the context, it may be used to refer either to a social group . . or the territory it occupies, thereby expressing the inseparability of land and people in the Fijian ethos . . .

Such models are particularly useful in conceptualizing use and management of marine and terrestrial resources and their biophysical and human dimensions in the Pacific islands. It is essential to note that Native Hawaiians and other indigenous peoples in the Western Pacific region have long recognized and understood elements and dynamics of marine ecosystems, and there are numerous examples of customary marine tenure and various forms of marine resource management across the region (Johannes 1978). In the case of Hawaiʻi, for instance, an extensive post-missionary literature regarding use of the marine environment by Native Hawaiians indicates long-standing understanding of: (a) complex biophysical relationships between land, reef, nearshore sea, deep sea, climate, and lunar phenomena, (b) effects of human activities on marine biophysical systems (no doubt including historically detrimental effects), (c) the benefits of specialization in knowledge and pursuit of marine and terrestrial resources, (d) the utility of or necessity for politically-delineated bounds that related to geophysical, biological, and human considerations and needs, and (e) social organizational and customary means of managing marine and terrestrial resources in the island setting (Kahaulelio 2006; Maly and Maly 2003; Summers 1990; Abbott 1992; Costa-Pierce 1987; Kirch 1985; Goto 1986; Handy et al. 1972; Titcomb 1972; Kamakau 1976; Newman 1970; Scobie 1949, Lind 1938; Beckley 1883; Fornander 1878; Malo 1847).

In Hawaiʻi, the historic ahupuaʻa system is considered by some to be a useful model for envisioning connections between components of the physical environment, and for effectively managing natural resources and their use by humans (e.g., Matsuoka et al. 1998). The system is reflective of the Hawaiian concepts of holoʻokoʻa (wholism) and piliʻana (connections therein). But clearly, given the complex social, economic, and political context of contemporary life in the Main Hawaiian Islands, such a system would be challenging to emplace in the manner it was used historically. The historic systems were developed in the context of well-established (though ever-evolving) forms of social and political organization, related customs and traditions, and modes of governance and enforcement, now significantly altered. This is not to say that some traditional form of ecosystem-oriented resource management could not be modified to fit modern conditions or vice-versa. In fact, the old systems or related concepts may be particularly well-suited for application in certain areas, and there is the possibility that aspects of traditional Hawaiian society may eventually be reestablished in certain areas. In any case, there is need for assessment of the pragmatic potential of traditional systems to succeed given variable sociopolitical conditions and constraints across the region today.

Indeed, social, cultural, economic, and political aspects of life have changed radically since the ahupuaʻa system was used in Hawaiʻi, and these factors continue to evolve in each of the island groups in the Western Pacific. Establishment of any new form or mode of management of marine resources in the Pacific islands clearly calls for assessment of those conditions that would influence its establishment in often rapidly changing modern settings. This begs questions about the historic challenges and successes of ever-evolving traditional forms of resource management; the nature of contemporary human pursuit, use, and management of marine resources in the archipelagos; and the capacity for success under the existing concepts and parameters of the ecosystem model now at the forefront of fisheries management across the U.S.

Contemporary challenges notwithstanding, we reiterate that ecosystem concepts are in no way new to the Pacific islands. Johannes (1978:352) concurs, noting that "almost every basic fisheries conservation measure designed in the West was in use in the tropical Pacific centuries ago" (see Table 1). This is not to suggest that conservative use of marine resources was universal over time and space in the Pacific. Indeed, there were instances of problematic use and management of marine resources here (Johannes 1978:355) as elsewhere (McGoodwin 1990:57-59). In fact, radical modification of terrestrial ecosystems by early Polynesians had profound implications for the subsequent ordering of island societies (Kirch 1997; Kirch and Hunt 1997). As such, care is warranted in contemporary use of concepts regarding "traditional" forms of resource management in this region and others (see Pollnac and Johnson 2005).

Indeed, there were eons of trials and adaptation in the Pacific islands, as has been characteristic of societal interaction with the physical environment in all regions of the world. The assertion here is that, in the Western Pacific, small human societies gradually progressed through trial, error, and various social processes to enable broad expansion and growth of indigenous populations in each archipelago. Accumulation of ecological knowledge and mechanisms of social control were basic to this eventuality, as is made so clear, for instance, in the literature regarding life in proto-historic and early contact-era Hawai‘i. It should be noted that it was exogenous concepts, disease, and socioeconomic pressures that led to subsequent demographic decline of indigenous peoples in the larger archipelagos, such as Hawai‘i.

The story of indigenous people in the archipelagos has been one of change and adaptation, first to the unique environmental conditions of isolated islands and island groups, subsequently to environmental changes wrought by early settlers, and eventually to social and environmental pressures associated with the arrival and tenure of bearers of very different cultures and economies. Localized knowledge of connections within and between biophysical and human elements of marine and terrestrial ecosystems and their use and management in the Western Pacific has been hard-won, characteristically dynamic, and perennially associated with mechanisms of social control. Clearly, that knowledge and aspects of those mechanisms may be of great importance as contemporary resource managers seek to adopt a "new" approach that in reality has a long history of application in this region.

Table 1-1 Forms of Marine Resource Management Used Historically in the Pacific Islands *

Select Management Measure	Select Places of Usage
Closed fishing areas	Pukapuka, Marquesas, Truk, Tahiti, Satawai
Closed seasons	Hawai‘i, Tahiti, Palau, Tonga, Tokelaus
Allowing portion of catch to escape	Tonga, Micronesia, Hawai‘i, Enewetak
Holding excess catch in enclosures	Pukapuka, Tuamotus, Marshall Islands, Palau
Ban on taking small individuals	Pukapuka, Palau
Restricting some individuals for emergencies	Nauru, Palau, Gilbert Islands, Pukapuka
Restricting harvest of seabirds and/or eggs	Tobi, Pukapuka, Enewetak
Restricting number of fish traps	Woleai
Limited entry (by social structural arrangements)	e.g., Hawai‘i, Samoa
Aquaculture (fish ponds)	e.g., Hawai‘i

* after Berkes (1999:70)

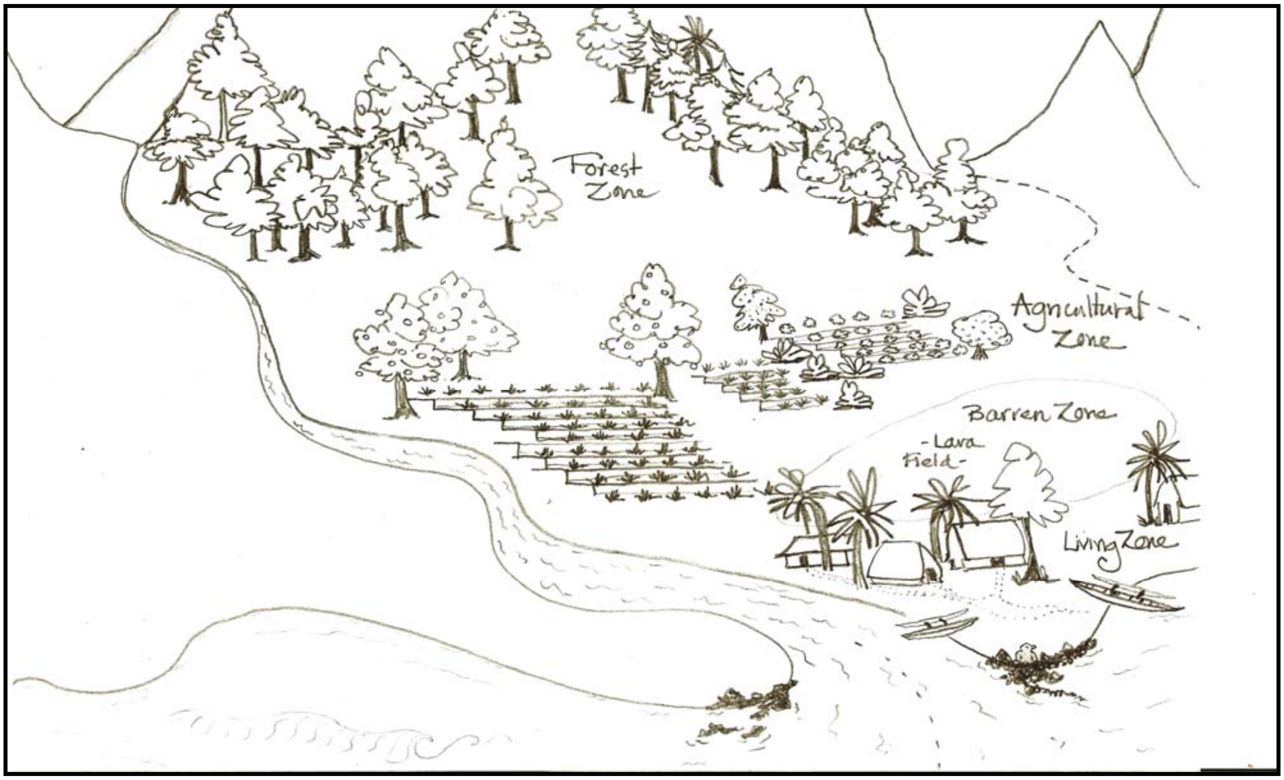


Illustration of a Functional Ahupua‘a
(Rendering courtesy of Libby Stevens)

View of Distant Kaena Point and the Various Ahupua'a of Waialua District; Photo Taken from Ancient Pu'u o Mahuka Heaiau above Waimea Bay on O'ahu's North Shore, Winter 2005

2.0 Formal Conceptual and Policy Background

Concepts about dynamic relationships between components of ecosystems have long been used around the world (Berkes 1999). In fact, knowledge of such relationships and effective means of pursuing and using natural resources enabled the proliferation and broad geographic distribution of human societies over the course of time (Bentley and Ziegler 1999:16).

In Europe, concepts about relationships between components of the natural world were gradually developed and modified through formalized scientific methods. These were communicated in literature through use of a distinct terminology. Given the strong influence of "western" science on contemporary institutionalized management of natural resources, formalized concepts and principles regarding ecology and ecosystems have subsequently come to be widely recognized and used in the arena of fisheries management.

2.1 Ecological Principles Originating in Europe

Students of natural history in 18th century Europe commonly used theory and data regarding interconnections within and between components of the physical environment. These became popular and widely influential. Alexander von Humboldt used such principles in groundbreaking bio-geographical observations described in *Kosmos* (1845), and Charles Darwin drew upon ecological principles and observation of exotic species to formulate *The Origin of Species by Means of Natural Selection* (1859). The word *oekologie* (ecology) was originated by German biologist and philosopher Ernst Haeckel in 1866. The term derives from the Greek words *oikos* (house) and *logie* (study). Baltic biologist and ecological pioneer, Jakob von Uexküll, reportedly used the word *umwelt* (environment) for the first time in 1909 (Capra 1996:33).

The formal discipline of ecology, nascent in the 1930s, furthered the study of natural systems and relationships between components thereof. Significantly and ironically, botanist Sir Arthur Tansley first used the term “ecosystem” during a personal philosophical conversion to reductionism. Tansley (1935:289) defined ecosystems as "wholes [that] are in analysis nothing but the synthesized actions of the components in associations."

Ecology nevertheless stimulated interest in the study of whole systems, and it became more analytical, quantitative, and experimental with the passage of time. The discipline has become widely accepted and ecosystems-related concepts are now used in many environmental sciences. Definitions of ecosystems vary, but basic attention to linkages between components is typical, as in the definition provided by Mayhew (2004:168):

> [Ecosystems are] communit[ies] of plants and animals within a particular physical environment which is linked by a flow of materials through the non-living (abiotic) as well as the living (biotic) sections of the system. Thus, ecosystems can range in size from the whole earth to a drop of water, although in current practice, the term ecosystem is generally used for units below the size of biomes . . .

2.2 Human Ecological Principles

Systems concepts were being applied in the social sciences as early as the 1920s. For instance, thinkers in the Chicago School used ecological principles to describe and explain social phenomena in urban settings where component parts of social systems such as individuals, families, modes of production and transportation, and government institutions were readily visible and tended to induce questions about how these functioned in totality. There was emphasis on the spatial distribution and explanation of social problems as these related to systemic processes of migration, economic problems, and coping mechanisms.
Other thinkers, such as Hawley (1950), used biological concepts such as natural selection, adaptation, and succession to characterize and explain the development of human communities in a range of settings. Yet others have used economic, socio-cultural, geographic, and other human factors to explain social behavior in relation to various environmental contexts (e.g., Palinkas et al. 1985). As conceived in the contemporary context, the discipline provides a well-established conceptual framework for understanding human interactions with their physical environmental, social, and institutional surroundings.

2.3 Formal Development of Ecosystem Approaches to Fisheries Management

Application of ecosystem principles to fisheries management was initiated in the mid-1990s subsequent to increasingly common perceptions that management of single species through the principles of maximum sustainable yield and maximum economic yield were not producing optimal results. For example, the National Research Council (NRC) asserted perspectives on the old and new paradigms in 1995 in *Understanding Marine Biodiversity*, and again in 1999 in *Sustaining Marine Fisheries*. The NRC perspective is clearly stated in the latter report:

> It is the perception of many observers that single-species fishery management has failed, and that a new approach, which recognizes ecosystem values, is required to achieve sustainable fisheries. A move toward fishing and management that recognizes the importance of species interactions, conserves biodiversity, and permits utilization only when the ecosystem and its productive potential is not damaged, is a worthy objective.

A precautionary approach to the new ecosystem paradigm was included in revisions to the Sustainable Fisheries Act (SFA 1996) and, as noted at the outset of this report, the Secretary of Commerce was authorized to form an Ecosystems Principles Advisory Panel to develop recommendations regarding application of ecosystem principles in the arena of fisheries management. These principles are as follow: (a) the ability to predict ecosystem behavior is limited; (b) ecosystems have real thresholds and limits that when exceeded can affect major system restructuring, (c) once thresholds and limits have been exceeded, changes can be irreversible, (d) diversity is important to ecosystem functioning, (e) multiple scales interact with and among ecosystems, (f) components of ecosystems are linked, (g) ecosystem boundaries are open; (h) ecosystems change with time. The EPAP (1999) also identified basic elements of ecosystem-based management and developed concepts about ecosystem health and the need for indicators thereof:

> Ecosystem health refers to a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization that has evolved naturally. Provided that a healthy state can be determined or inferred, management should strive to generate and maintain such a state in a given ecosystem. Inherent in this management strategy would be specific goals for the ecosystem, including a description of "unhealthy" states to be avoided (EPAP 1999).

The EPAP recognized that several legislative changes would be required to implement FEPs. It subsequently recommended interim measures to develop demonstration FEPs and, as noted above, called for voluntary adoption of ecosystem principles, goals, and policies by the nation's fishery management councils and NOAA Fisheries.

NOAA Fisheries' Marine Fisheries Advisory Committee established an Ecosystem Approach Task Force in 2001. Members identified five issues considered essential for implementing ecosystem-based fisheries management in the United States: (1) enhancement of intra- and inter-agency cooperation and communication; (2) delineation of geographic parameters of marine ecosystems; (3) preparation of quantified natural resource goals and objectives; (4) identification and application of specific indicators of ecosystem health; and (5) examination of socio-economic data for the purpose of evaluating management tradeoffs. The Task Force recommended implementation of several pilot projects to illustrate the benefits and challenges to Ecosystem-based Fishery Management (Busch et al. 2003). These are currently being undertaken in New England, the Mid-Atlantic region, the South Atlantic region, and the Gulf of Mexico region.

In this report, we move beyond typical conceptualizations of the term "ecosystem," which are still primarily biophysically-based. Here we emphasize the critical importance of recognizing human beings as pivotal elements of marine and terrestrial ecosystems. As such, we specifically define the term "ecosystem" to encompass three basic elements: (1) a distinct biophysical realm; (2) people who are interested in or whose behavior affects or is affected by that realm; and (3) people who have authority or responsibility for developing and enforcing formal legal rules of human behavior with respect to that realm. The human and institutional ecology of constituent user and interest groups and governance entities must be considered an indispensable aspect of ecosystem research and ecosystem-based management.

2.4 Fishery Council Actions

Two influential reports indicating national dependence on marine resources and ecosystems also made clear the vulnerability of those systems to human activities. These are *America's Living Oceans* (Pew Ocean Commission 2003), and *An Ocean Blueprint for the 21st Century: Final Report of the U.S. Commission on Ocean Policy to the President and Congress* (U.S. Commission on Ocean Policy 2004). Both reports call for ecosystem-based approaches to fisheries management. A consensus statement signed by ocean science and policy experts followed release of the reports, and also called for conservation and management of marine systems through an integrated ecosystem approach. The Bush Administration's *Ocean Action Plan* was released late in 2004 in response to the U.S. Commission on Ocean Policy report, and further advocates an ecosystem approach to marine resource management.

NOAA Fisheries has subsequently initiated exploration of regional governance structures to evaluate overall capacity for engaging in ecosystem-based management and to identify relevant management objectives, threats, options, and alternatives. The agency is developing quantitative decision support tools for evaluating management options, and it has conducted workshops to identify information and technical needs for scientists and managers seeking to examine and apply ecosystem principles in real time settings.

Certain historic and current management strategies utilized by the nation's fishery management councils already incorporate ecosystem principles and considerations. But many of the councils are now initiating comprehensive ecosystem planning processes. The Northeast Fishery Management Council conducted ten stakeholder meetings in 2005 to elicit public commentary on the nascent ecosystem approach. Preliminary workshop summaries are available at www.nefmc.org/ecosystems/index.html. The Mid-Atlantic Fishery Management Council has conducted stakeholder workshops for the same purpose. Results are pending. The South Atlantic Council developed an action plan outlining its ecosystem-relevant goals and objectives and is developing a Comprehensive Ecosystem Amendment (CEA) to convert its FMPs to FEPs. Information is available at www.safmc.net/ecosystem/Home/EcosystemHome. The South Atlantic Council has also initiated public scoping meetings on its action plan and CEA. The Gulf of Mexico Fishery Management Council has formed an Ecosystems Science and Statistical Committee to assist with development and implementation of FEPs in that region. It held stakeholder workshops in 2005; a report is available at www.gulfcouncil.org/. The North Pacific Council has recently reconstituted its Ecosystem Committee and is moving forward with development of an Alaska FEP. Its Science and Statistical Committee held a multi-species ecosystem modeling workshop in 2005. Relevant information is available at www.fakr.noaa.gov/npfmc.

2.5 WPRFMC Actions to Date

As noted above, the Western Pacific Regional Fishery Management Council has adopted a plan for management of coral reef ecosystems. Further, it has drafted FEPs for the region, and NOAA Fisheries has completed a Draft Environmental Impact Statement to assess the potential effects of the new approach. The place-based FEPs will replace the extant species-based FMPs and will correspond with each geographic area under Council jurisdiction (see map below): (1) the Mariana Archipelago (Guam and the Northern Mariana Islands); (2) the Hawaiian Islands Archipelago (including Midway and Johnston Atolls); (3) the Samoa Islands (American Samoa and possibly Western Samoa); and (4) the Pacific Remote Island Areas (Howland, Baker, Jarvis, Kingman Reef, Palmyra Atoll and Wake Island). The new FEPs would subsume FMPs for bottomfish, seamount groundfish, coral reef ecosystems, crustaceans, and precious corals under a single plan for each archipelago. A separate FEP is being developed to address management of pelagic species and related ecosystem issues across the region.

The Archipelagos and Remote Islands under Council Purview

2.6 Challenges

While the goal of improving management of marine resources through ecosystem-based approaches is laudable, requisite objectives and strategies are, as yet, largely uncertain. The process is continuing to unfold. Uncertainties notwithstanding, there is now much momentum, and actors in agencies and institutions in the U.S. are moving forward in response. Challenges associated with that response are reported further along in the report, as numerous workshop participants described them. Not the least of these is individual and collective adaptation to the new paradigm. Moreover, various management challenges persist while the new strategies are being formulated. Some amount of time and fiscal resources formerly applied to "traditional" management strategies are now being consumed by planning for and adopting and adapting to the ecosystem approach. One function of the workshops being held by the WPRFMC is to identify such challenges early on and move towards meeting them in this region in as efficient a manner as possible.

A perennial challenge is the desire, need, and mandate to balance the health or level of productivity of the physical environment with that of human user groups. Understanding relationships between biophysical components of marine and terrestrial ecosystems is a highly complex undertaking of vital importance to management needs and interests. But it must be kept in mind that the end goal of that understanding is to enhance the sustainability and utility of marine resources and environs *for the sake of human beings*. People both use and influence marine and terrestrial resources and environs in many ways, and understanding and appropriately managing those uses and influences are at the core of the management equation.

But ecosystem approaches in the present context will likely require amplification of attention to complex connections between humans and between humans and their environs. Complexity and challenges abound in that human behavior is multi-dimensional. It is cultural, social, economic, political, contemporary, historic, local, national, and global. Again, the intent of the ecosystem workshops being held by the WPRFMC is to move toward efficient identification and solution of the most critical of those complexities and challenges in the context of the Western Pacific.

2.7 Working Definition of Social Science, and U.S. Marine Resource Management Policy

Given that the ecosystem workshop described in this report is a *social science* workshop, it may be useful at the outset to provide a working definition of social science as relevant in this context. We offer the following: fisheries social science is the study and analysis of individual and/or collective human behavior associated with or affecting the pursuit, use, distribution, and management of marine resources and related environs. As noted above, when conceived in full, that behavior is complex and multi-dimensional. But research of human behavior in the context of marine ecosystems is not new. Complex dimensions of marine fisheries have been studied by social scientists for many decades. For instance, Bronislaw Malinowski published *Argonauts of the Western Pacific* in 1922, and Raymond Firth wrote his dissertation on Maori economics in 1927 and *We the Tikopia* in 1936. Policies requiring social research and analysis to meet the tailored information needs of resource management institutions and entities in the Pacific are relatively recent.

Passage of the National Environmental Policy Act (NEPA) in 1969 required that decision-makers working in federal agencies adequately address the human dimension - the effects people have on the environment, and the way in which people are affected when some aspect of the environment is thereby altered. This was precedent for subsequent federal and state policies that recognized the place of human beings in the marine and terrestrial environment. The environmental impact statement (EIS) was subsequently instituted as the standardized means for objective decision-making. NEPA required consideration of the human dimension in environmental analysis through use of a "systematic, interdisciplinary approach which will ensure the integrated use of the natural and social sciences . . in planning and decision-making" [Section 102(2)(a)]. The Council on Environmental Quality clarified these terms in *Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act*, expanding interpretation of the "human environment" to include the relationships of people with their natural and physical environment (40 CFR 1508.14).

NOAA Fisheries and the fishery management councils have addressed the human dimension in varying degrees since inception of the Magnuson Fishery Management and Conservation Act in 1976 (amended in 1996 as the Magnuson-Stevens Fishery Management and Conservation Act or MSFMCA). In 1991, NOAA Fisheries provided interim guidance to the councils and its own regional offices regarding the need for and use of social impact assessment (SIA) for purposes of management and planning. This guidance has been revised over time, and now SIAs ideally assess prospective or actual management actions in terms of their direct, indirect, and cumulative human effects, including aesthetic, historic, cultural, economic, social, and health effects (Inter-organizational Committee on Guidelines and Principles for Social Impact Assessment, 1994).

Under stipulations in the MSFCMA, social impact assessment is to be linked to actions associated with FMPs and in some cases to a particular benchmark. For instance, when considering "a system for limiting access to the fishery in order to achieve optimum yield," the Secretary of Commerce and fishery management councils are to consider the social and economic effects of that decision [MSFCMA section 303 (b) (6)]. Direct and indirect effects of management measures on fishery participants must also be included in fishery impact statements per amendments in the Sustainable Fisheries Act [MSFCMA section 303 (a) (9)], and a significant part of the core definition of the MSFCMA, Optimum Yield, requires consideration of social and economic factors. Most recently, with the addition of National Standard 8, FMPs must incorporate assessment of management effects on fishing communities so as to assure sustained participation and avoidance of adverse economic impacts [MSFCMA section 301 (a) (8)]. As the administrative and management parameters of FEPs are still under development in the Western Pacific region via planning and EIS processes, potential changes in the manner or extent of application of social science under the new paradigm remains uncertain. Again, the workshops are intended to assist in informing those processes.

The Ocean End of the Ahupua'a of Halawa on Moloka'i
Area First Inhabited about 650 A.D. (Kirch 1985:19)

3.0 The WPRFMC Ecosystem Social Science Workshop

The focus of this section of the report is summary presentation of the organized discussions held during the course of the workshop. We precede this with reiteration of the rationale for the workshop, and discussion of its purpose and manner of conduct.

3.1 Workshop Goal, Objectives, and List of Participants

The social science workshop was initiated based on recognition of the pivotal importance of humans in marine ecosystems in the Western Pacific and elsewhere. The Council recognizes the utility of an ecosystem approach in island settings with extensive historical precedent in what essentially were indigenous forms of ecosystem-based management. The approach is also considered highly practical in that it may reduce administrative burdens associated with management of single species by multiple fleets across highly divergent and distant archipelagos.

The overarching goal of the social science workshop was to facilitate informed discussion of social science requirements for effectively supporting ecosystem-based approaches to marine resource management in the Western Pacific region and its island sub-regions (archipelagos). A series of interrelated objectives was developed to meet this overarching goal, as follow:

1) Convene nationally-recognized social scientists and regional experts to review social science applications relevant to ecosystem-based marine resource management;

2) Review resource management requirements and pertinent issues in the Western Pacific and its sub-regions;

3) Identify the best suite of ecosystem indicators related to the human and institutional ecology of marine ecosystems in the Western Pacific and its sub-regions;

4) In the short term, and within the parameters of existing mandates, identify the most effective ecosystem-based approaches to marine resource management that incorporate the human dimension and that can be implemented based on current data;

5) Explore what new social and policy science data or models would be needed to advance ecosystem-based approaches to marine resource management in the Western Pacific region and its sub-regions;

6) Explore changes in policy or social and policy science administration that would be needed to more effectively implement ecosystem-based approaches to marine resource management in the Western Pacific region and its sub-regions.

Objectives (2) through (6) above involve complex issues and challenges that have been addressed to varying degrees by fisheries social science and marine policy experts in other regions of the country. As such, it was decided that much would be gained by inviting such experts to discuss their experiences and explore the issues at the WPRFMC offices in Honolulu.

Social, cultural, economic, demographic, and political conditions and factors vary widely in the Western Pacific region (see Appendix B). Moreover, they differ in many ways from those of the Continent. Therefore, it was decided that persons knowledgeable of both social science applications and social conditions in each island group should also be invited to participate in the workshop.

Continent-based participants were invited to inform generalized discussion about: (1) fisheries social science methods and models as applicable in the context of ecosystem-based management, (2) fisheries social science data challenges and solutions in that context, and (3) social and economic indicators of potential utility for managers engaging the ecosystem approach. The workshop was so organized in part to parallel the conduct of the previously conducted biophysical workshop and in part because these are indispensable elements of a comprehensive social science approach to implementing the new strategy. Island-based participants were also invited to the workshop to provide their perspectives on methods and models, data challenges and solutions, and prospective indicators, but with the additional dimension of local knowledge and experience.

Given time limitations, a subset of participants was asked to conduct presentations. Time was allotted for discussion of the presentations by the entire group and all participants were encouraged to provide input as desired. The workshop was led by Michael Orbach of the Duke University School of the Environment. Dr. Orbach is a widely-recognized authority on marine policy and application of social science to issues surrounding management of marine resources. Following is the list of workshop participants and their respective affiliations.

Participating Council Staff

Kitty Simonds, Executive Director
Paul Dalzell, Senior Scientist/Pelagics Coordinator
Marcia Hamilton, Economist
Jared Makaiau, Habitat Coordinator
Charles Kaaiai, Indigenous Coordinator
Irene Kinan, Sea Turtle Coordinator

Continent-based Participants

Susan Abbott-Jamieson, NOAA Fisheries/NMFS
Lee Anderson, University of Delaware
Shankar Aswani, University of California at Santa Barbara
Leah Bunce, Conservation International
Jim Burchfield, University of Montana
Patrick Christie, University of Washington
Tom Fish, NOAA/National Ocean Service
David Fluharty, University of Washington

Svein Fougner, Fisheries Consultant
Susan Hanna, Oregon State University
Tim Hennessey, University of Rhode Island
Jeff Johnson, East Carolina University
Marc Miller, University of Washington
Bryan Oles, Marine Protected Area Institute
Michael Orbach, Duke University (Moderator)
John Petterson, Impact Assessment, Inc.
Richard Pollnac, University of Rhode Island
Lia Protopapadakis, Duke University
Janna Shackeroff, Duke University
Peter Wiley, National Ocean Services, Special Projects Division

Pacific Island-based Participants

Stewart Allen, NMFS, Pacific Islands Fisheries Science Center
Judith Amesbury, Micronesian Archaeological Research Services
Fini Aitaoto, WPRFMC Island Coordinator, Am. Samoa DMWR
Paul Bartram, Akala Products, Inc.
Leimana Damate, Association of Hawaiian Civic Clubs
Gerry Davis, NOAA, Pacific Islands Regional Office
Leanne Fernandes, Great Barrier Reef Marine Park
John Gourley, Micronesian Environmental Services
Ed Glazier, Impact Assessment, Inc.
Karla Gore, NMFS, Sustainable Fisheries Division
David Hamm, NMFS, Pacific Islands Fisheries Science Center
David Itano, University of Hawaiʻi, JIMAR, PFRP
Kurt Kawamoto, NMFS, Pacific Islands Fisheries Science Center
Kem Lowry, University of Hawaiʻi, Dept. Urban & Regional Planning
Minling Pan, NMFS, Pacific Islands Fisheries Science Center
Samuel Pooley, NMFS, Pacific Islands Fisheries Science Center
Jesse Rosario, University of Guam
Craig Severance, University of Hawaiʻi at Hilo
Herman Tuiolosega, State of Hawaiʻi, DOH, Environmental Planning Office
Joeli Veitayaki, University of the South Pacific

3.2 Summaries of Speaker Discussions and Participant Input

Following are summaries of speaker discussions, provided in sequence as presented during the course of the workshop. While presentations were often followed by group discussion, this varied in nature and extent. Given limitations of space in this report, we do not summarize all such discussion but rather limit such to cases in which it afforded particularly useful insight into the primary points being made by the speakers. We do, however, synthesize additional group discussion in later analytical sections of this report. The summaries were developed through review of observer notes, transcripts, and written presentations (in most cases, Powerpoint presentations). The summaries are consistently presented in third-person narrative form so as to minimize use of quotations and redundant shifting between person and tense. Interpretive-artistic license was taken in certain cases with the intent of enhancing points being made by the presenters.

3.2.1 Overview of Ecosystem Approaches to Management in Region

Speaker: Kitty Simonds
Executive Director
Western Pacific Fishery Management Council

Background. Kitty Simonds is Executive Director of the Western Pacific Fishery Management Council, a position she has held since inception of the Council in 1977. Following pule (prayer) by the Council's Indigenous Coordinator, Charles Kaaiai, Executive Director Simonds welcomed the participants to Hawai‘i and to the Council offices and, as presented in summary form below, subsequently offered overview discussion of the Council and its mission, and the purpose, nature, and utility of the shift to ecosystem management planning in the region.

Summary of Opening Comments. Ecosystem-based planning efforts are now being undertaken by the nation's fisheries management councils. The Western Pacific Council has been moving toward adoption of ecosystem-based management for some time, and the conduct of the biophysical and social science workshops is intended to facilitate informed discussion of the approach and related issues of importance to resource management in the region.

Ecosystem-based management should be seen as highly appropriate and practical in the island settings that comprise the region. The ocean surrounds island residents, and has long been and continues to be a critically important aspect of social, cultural, and religious life. The ocean provides sustenance, and thus the well-being of islanders is directly related to the status of its resources.

The Council is developing fisheries ecosystem plans (FEPs) for each archipelago: (1) the Mariana Archipelago (Guam and the Northern Mariana Islands); (2) the Hawaiian Islands Archipelago (including Midway and Johnston Atolls); (3) the Samoa Islands (American Samoa and possibly Western Samoa); and (4) the Pacific Remote Islands (Howland, Baker, Jarvis, Kingman Reef, Palmyra Atoll and Wake Island). The new FEPs will combine the formerly distinct fisheries management plans (FMP) for coral reef ecosystems, precious corals, bottomfish, and crustaceans. Pelagic species will be managed under a separate FEP.

The archipelago-based strategy is intended to accommodate and address the unique biophysical, social, and cultural attributes characteristic of each island area. It will also enable more equitable attention to the needs and issues specific to each region.

The workshop series is a proactive effort to enable expert discussion of the ecosystem approach to fisheries management. The intent is to enhance planning efforts in advance of full adoption of the FEPs. The Council views federal mandates to adopt ecosystem-based management as following rather than driving its own ecosystem planning efforts. Indeed, the Council interacted with NMFS to hold an ecosystems workshop in 1986, and planning for a coral reef ecosystem approach to management was first undertaken by the Council in the 1990s.

The social science workshop was convened to identify and review models and concepts of how the social sciences may contribute to understanding of the role of human beings in fisheries ecosystems, and in ecosystem-based fishery management. It was also intended to generate discussion about the manner and sources of information needed to facilitate that understanding, and research methods needed to acquire it. Finally, it was intended to facilitate discussion of indicators of social conditions and human behavior as these are relevant to understanding the dynamics of marine ecosystems and their effective management.

The social science workshop has involved the convening of both national and regional experts from academia, government agencies, and non-government organizations to discuss these concepts in the context of the Western Pacific Region. Again, this is the second of a three-part series. A third workshop will incorporate results of this and the biophysical workshop to address marine policy issues under the new ecosystem-based approach. The final meeting will bring together biophysical scientists, social scientists, resource managers, and stakeholders.

In her conclusions, Executive Director Simonds related two Hawaiian proverbs to provide guidance for the social science workshop and for ecosystem planning in general. The first translates as “no breadfruit can be reached when the picking stick is too short.” That is, success requires preparation and the acquisition and use of the appropriate tools. The second translates as “gird the loincloth and sharpen the spear.” Historically, this was a call to prepare for war. In this case, it was a call to prepare for the project at hand.

3.2.2 NOAA Fisheries, WPRFMC, and Managing Fisheries in the Region

Speaker: Paul Dalzell
Senior Scientist, Western Pacific Fishery Management Council

Background. Paul Dalzell is Senior Scientist and Pelagic Fisheries Coordinator for the Western Pacific Regional Fishery Management Council. He has worked in the Pacific Islands for the past 30 years and has published a range of papers and reports on the biology, stock assessment, and management of coastal and pelagic fisheries across the region. While at the Secretariat of the Pacific Community in New Caledonia, he co-authored a comprehensive review of Pacific Island coastal fisheries. Mr. Dalzell oversees a variety of Council programs and projects across the region, including those related to recreational fisheries, commercial by-catch, and protected species interactions. Given his experience and knowledge of the subject, Mr. Dalzell was asked to provide an overview of fisheries in the Western Pacific region. Key elements of his presentation, titled “The Western Pacific Region and its Fishery Management Plans” are provided in the following paragraphs.

Presentation Summary. Prior to 1976, representatives of coastal states were responsible for managing marine fisheries in their respective nearshore and offshore areas. Federal representatives resolved disputes among the states and addressed matters associated with international fleets then pursuing fishery resources in territorial waters. Subsequent to the MSFMCA and delineation of state and federal jurisdictional boundaries, the eight fishery councils were established to assist in governing fisheries in the EEZ. The principal goals were to conserve and manage domestic marine fishery resources, phase out the activities of foreign fleets in territorial waters, and enable development of domestic fisheries in the EEZ. Those original goals have been met to greater and lesser degrees, though the sustainable use of marine resources obviously continues to challenge managers throughout the nation. Landings by foreign fleets in U.S. territorial waters declined from 71 percent of overall offshore landings in 1977 to near zero percent in 1992.

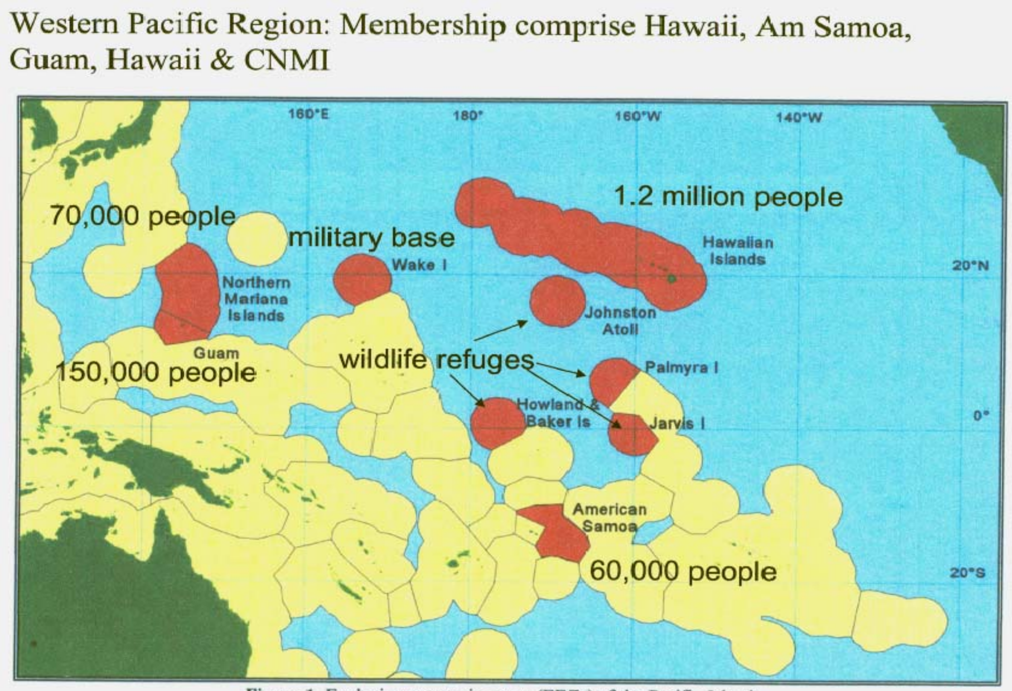


Figure 1. Exclusive economic zones (EEZs) of the Pacific Islands.
Western Pacific Regional Fishery Management Council EEZ area shown in red.

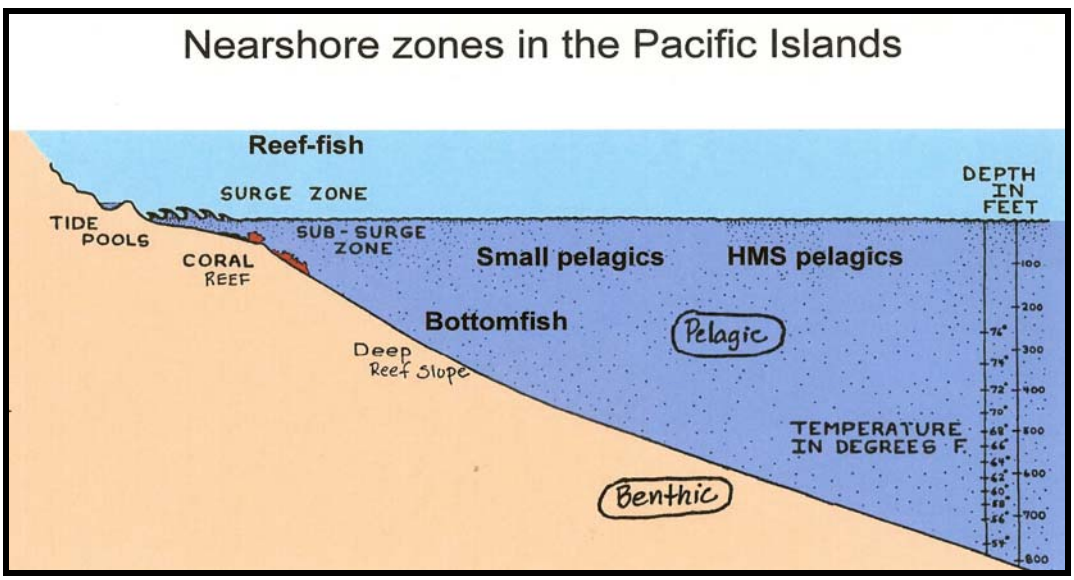
But the subsequent expansion of domestic fishing activities may have been too successful in some ways, as it tended to leave certain stocks in peril. Thus, when reauthorized in 1996, the Magnuson Act focused primarily on conservation-related issues. The amendments focus on overfishing, rebuilding stocks, minimizing by-catch, protecting habitat and, in the social realm, establishing means for assessing and protecting fishing communities. The amendments also set the stage for ecosystem-based resource management.

The "National Standards" (Section 301) are the principles by which management efforts are assessed under the MSFMCA. The latter three were added as part of the 1996 amendments. These involve the following: (1) prevent overfishing while achieving optimum yield; (2) use the best scientific information available in decision-making processes; (3) manage stocks as units; (4) do not discriminate between residents of different states; (5) consider efficiency issues; (6) take into account variations and contingencies; (7) minimize costs and avoid duplication; (8) consider the effects of decisions on fishing communities; (9) minimize by-catch and mortality; and (10) promote safety of human life at sea.

The MSFMCA called for the establishment of eight regional fishery management councils to be funded through Congressional appropriations. Today, the council system provides stakeholders with a substantial opportunity for involvement in managing fisheries and resources in their respective areas. Council members are appointed by the Secretary of Commerce for three-year terms. The WPRFMC has 16 members, three of whom are non-voting federal agency representatives from the State Department, U.S. Fish and Wildlife Service, and U.S. Coast Guard. Current voting membership on the Council includes three commercial fishery representatives, four recreational fishery representatives, and one cultural representative. Since 1976, the composition of voting council members has remained relatively constant, with government representing 35 to 55 percent of votes, recreational industry comprising 25 to 35 percent, and the commercial industry representing 20 to 35 percent of votes over time. Local and federal fishery agency representatives hold the remaining five voting seats.

The EEZ in this region extends far beyond what is popularly conceived to be the western limit of federal jurisdiction in Hawai‘i. The MHI actually comprise merely the eastern edge of the WPRFMC area of jurisdiction. That area actually continues westward for many thousands of miles.

The equatorial and sub-tropical islands in this region are characterized by narrow fringing reefs, precipitous bathymetric slopes, a deep nearshore zone, and vast open ocean areas. Many of the fisheries in the region tend to occur in the reef zone and along the steep slopes of the islands, with pelagic fisheries occurring farther offshore.



As regards contemporary socio-demographic conditions in the region, the MHI are relatively highly populated, with the year 2000 Census figure surpassing one million persons. Guam has the second largest population with some 155,000 persons enumerated in 2000, followed by CNMI with some 69,000 persons, and finally American Samoa with some 57,000 persons in 2000. Various military bases contribute to the population.

In **American Samoa**, fishing is dominated by pelagic longlining (with volume of landings currently approaching that of the Hawai'i-based longliine fleet), pelagic trolling, bottom fishing, and reef fishing. In socio-cultural terms, this is a relatively homogenous island area, with nearly 90 percent of residents reporting Samoan ancestry in 2000. Independent Western Samoa is immediately adjacent.

Note that **Guam** is much closer to Asia than North America. As such, a burgeoning Japanese-based tourism industry has developed here. Moreover, most seafood landed in Guam is marketed in Asia. Guam fisheries include troll fishing, bottomfish fishing, a short-line fishery for sharks, and an emergent pelagic longline fishery. There is considerable ethnic and cultural diversity on Guam. Persons of Chamorro ancestry comprise 37 percent of the population, Filipinos 26 percent, Palauans 14 percent, Caucasians seven percent, and persons of Chuuk ancestry four percent.

The **Northern Marianas Islands** form a half-moon shaped island-arc chain to the north and west of Guam, also in close proximity to Asia. Fisheries here include pelagic trolling, bottom fishing, and various forms of fishing along the reef ecosystems. The CNMI population growth rate is quite high, due in part to an influx of workers in the growing garment and tourism industries. The indigenous population includes Chamorro and Carolinian peoples and comprises approximately 24 percent of the total population of 70,000. The Filipino ethnic group is the largest single ethnic group in the CNMI, comprising approximately 26 percent of the total population. Persons of Chinese ancestry comprise 21 percent. Other resident groups include various Pacific Islanders, Japanese, Caucasians, Koreans, and individuals of multiple ancestries.

The most diverse and productive fisheries in the region occur in the **Main Hawaiian Islands**. Pelagic longline, hand-line, troll, and pole-and-line fisheries have been historically important, as have the bottomfish fisheries. There are also lobster trap and mixed crustacean trap fisheries. Fishing along the reef ecosystems continues to be important for recreational and subsistence purposes. Precious corals harvesting and aquarium fish collecting also occur in the MHI. With the exception of O‘ahu, the population density in the MHI is relatively low. Per the 2000 census, some nine percent of persons reporting one race reported being Native Hawaiians or other Pacific Islanders, some 42 percent reported a single Asian background, 24 percent reported being Caucasian, and two percent reported being African-American. Significantly, over 21 percent of Hawai‘i residents reported having two or more ancestral backgrounds (the national average is about 2.4 percent), and nearly seven percent reported three or more backgrounds. Alu Like, Inc., a non-profit organization for Native Hawaiians, reports that as much as 20 percent of the population in Hawaii may be Native Hawaiian or part-Native Hawaiian (Severance 2006). The per capita gross domestic product in Hawai‘i is much higher than in American Samoa, Guam, and CNMI.

Reported domestic landings of pelagic species in the Western Pacific region increased from about 7,000,000 pounds in 1982 to about 32,500,000 pounds in 2004. Landings of other species remained static or declined over the same time period. Hawai‘i-based fleets contribute the vast majority of landings volume and value. In 2004, Hawai‘i-based fleets landed 35.7 million pounds for an ex-vessel value of $67.9 million. This was 73 percent of total landings and 85 percent of total value in the region. American Samoa-based fleets landed about 25 percent of total landings during 2004. American Samoan tuna canneries process between 150,999 to 200,000 tons of skipjack, yellowfin, and albacore tuna each year, generating some $250-300 million annually. Guam is a major point of air-transshipment for Japanese, Chinese, and Taiwanese-based longline operators. Between 5-12,000 tons of sashimi grade yellowfin and bigeye are shipped from Guam to Tokyo yearly. Exports were worth about $43 million in 2004.

As regards management of these fisheries and resources, the Council devotes much energy to informed decision-making processes in association with its Fishery Management Plans (FMPs). NOAA Fisheries staff provides the Council with extensive scientific information and consultation, and is continually advised by various standing committees, a Scientific and Statistical Committee, five Plan Teams, four Advisory Panels, and various ad hoc committees and review boards.

Nationwide, 40 Fisheries Management Plans (FMP) have been instituted by the Councils to manage a total of 535 species. The WPRFMC has established five FMPs, all of which are multi-species plans, described below. One such plan, the **Bottomfish Fishery FMP** was established for the purpose of managing snappers, groupers, emperors, jacks, and seamount ground fish, such as armorheads, alfonsins, and ratfish. The principal management measures involve a ban on bottom-trawls and longlines used to pursue bottomfish species. The FMP also includes a permanent moratorium on fishing for groundfish at Hancock seamount; and a limited entry program, vessel size cap, and observer program for the NWHI bottomfish fishery. The Council is currently implementing area closures to large (>50ft) vessels pursuing bottomfish in certain areas in the region.

Spiny lobsters, slipper lobsters, and Kona crab are covered by the **Crustacean Fishery FMP.** Its principal management measures involve a harvest guideline model based on a ten percent risk of overfishing the stocks; this was exceeded and the entire fishery has been closed since the late 1990s. A major closure was previously instituted for Laysan Island in the NWHI in order to provide a spawning refuge and protect monk seals. Prior to closure, the plan included trap specifications to permit maximum escapement of juvenile lobsters and incidental species.

The **Precious Corals Fisheries FMP** established management measures for pink, gold, black, and bamboo corals. It involves establishment of quotas, and establishment of a NWHI mega-refugium to protect monk seals. There is no active black coral fishery at the present time.

As noted in Section One of this report, the **Coral Reef Ecosystem Fishery FMP** was the first ecosystem-based fishery management plan established in the U.S. The plan addresses over 250 species of coral reef fish, invertebrates, and a diverse range of potentially harvestable species. Principal management measures involve permitting and reporting requirements for coral reef fisheries occurring in the EEZ, a ban on the use of destructive gear types (including SCUBA assisted spearfishing), and a ban on the collection of certain corals and live rock. The FMP also includes a network of no-use and low-use Marine Protected Areas (MPAs).

The **Pelagic Fishery FMP** involves the regulation of fisheries involving tunas, mackerels, billfish, pelagic sharks, wahoo, mahimahi, gempylids, and pomfrets. It will also include squid fisheries. Principal management measures include limited entry programs for longline fisheries in Hawai‘i and American Samoa; closed areas for longline fisheries in the NWHI to protect turtles, seabirds, and monk seals; and areas closed to longline fishing around the MHI and American Samoa to enhance small vessel pelagic fisheries and obviate potential gear conflicts. A protected species program supports several turtle conservation programs at nesting beaches and foraging grounds along the Pacific Rim. [In reiteration], management of pelagic species in the Pacific relates to decisions made by the Inter-American Tropical Tuna Commission (IATTC), the Western and Central Pacific Fisheries Commission (WTFCC), and other entities and conventions. A longline quota for bigeye tuna is now being addressed by the Council.

The shift to from FMPs to FEPS will augment the efforts of the Council to effectively manage fisheries in the region. The Council has been working toward this end since 2003. Revising the Pelagics plan may be the simplest process, as the current Pelagics FMP is a *de facto* ecosystem plan. Transforming the other current FMPs into a series of FEPs is more challenging. [As discussed previously], plans will be written for each archipelago: (1) the Mariana Archipelago (Guam and the Northern Mariana Islands); (2) the Hawaiian Islands Archipelago (including Midway and Johnston Atolls); (3) the Samoa Islands (American Samoa and possibly Western Samoa); and (4) the Pacific Remote Islands (Howland, Baker, Jarvis, Kingman Reef, Palmyra Atoll and Wake Island).

The Council is working with NOAA Fisheries to implement a two-step approach to establishing the FEPs. Boundaries and institutional structures are being determined initially through draft plans, and a programmatic DEIS has been prepared. Information needs and indicators will be determined, and fishery regulations will ultimately be finalized.

Presentation: Steven Murawski
NOAA Fisheries

Background. Steve Murawski is Chief Scientist of NOAA Fisheries. Dr. Murawski was unable to participate in the workshop due to concurrent commitments, and asked Dr. Sam Pooley to speak in his stead. The presentation was titled “Some perspectives on marine ecosystems, governance, and science.”

Presentation Summary. Although marine ecosystem science is still relatively young, significant progress has been made in theory, observation, and experimentation. The application of ecosystem science to marine resource management in the EEZ and adjacent marine and coastal areas has been the focus of the NOAA Ecosystem Goal Team since its inception. The task is a particularly challenging one given the complexities of temporal scope and spatial scale associated with the physical processes of marine ecosystems and the larger climatic and oceanographic systems that influence those processes. But given the goods and services marine ecosystems can provide to human beings, and the importance of understanding the interconnections of physical and social systems, application of ecosystem science is critically important. But significantly, a clear path of reference for building and implementing such an approach is not yet available.

An ecosystem involves a geographically specified system of organisms (including humans) that interact in dynamic fashion in the physical environment. An ecosystem approach to management (EAM) must also be geographically specified and dynamic. It must be adaptive both to knowledge and uncertainty, and it must be capable of accommodating multiple external influences and diverse social objectives. Clearly, such an approach must address the human dimension - the influence of culture, economics, and other factors specific to the relationship between humans and the marine environment. It must consider the adequacy and competence of existing institutions to effectively manage and the prospect that existing institutions may need to be reformulated or reconstructed in their entirety to enable the new approach. The need for effective governance is a critical consideration in establishing an ecosystem approach to management- considered at all levels of analysis, from local to regional to international.

The **Large Marine Ecosystem** approach adopted by NOAA Fisheries involves efforts to manage coastal systems that exhibit a wide range of physical characteristics and challenges to effective governance. This is a perennially complex process, especially given the need to assess and understand changes occurring across space and over the course of time.

The **Integrated Ocean Observing System** (IOOS) has been employed as a scalable system for observing marine ecosystems. The system involves coordinated sampling of relevant data at fixed locations, and the management and communication of data products and analysis for use in the context of management. The PICES Reports prepared by the Alaska Science Center for use by the North Pacific Council are IOOS products.

An effective ecosystem approach to fisheries management involves three principal objectives: (1) development of a broad stakeholder-based governance system; (2) conservation of essential parts of the ecosystem in question; and (3) conservation of essential ecosystem processes. Effective ecosystem approaches to management should be seen as accommodating the input of multiple stakeholders in developing options that accomplish specific management goals. These should be linked with decision support systems, and assisted by an observing system (such as IOOS) that provides feedback on the effectiveness of those decisions and the nature of effects resulting from other sources of change.

The development of an ecosystem approach to management will require tradeoffs between conflicting interests. The approach should be transparent, equitable, and highly adaptable. Moreover, it may be necessary to broaden the scope of attention beyond fisheries so as to address coastal or terrestrial processes that affect or are related to marine ecosystems. Development of standard definitions, objectives, and requirements may enhance the EAM framework. Investment in good science (e.g., the IOOS), and outreach efforts that increase the coordination, efficiency, and outcome of ecosystem goods and services should be aggressively pursued.

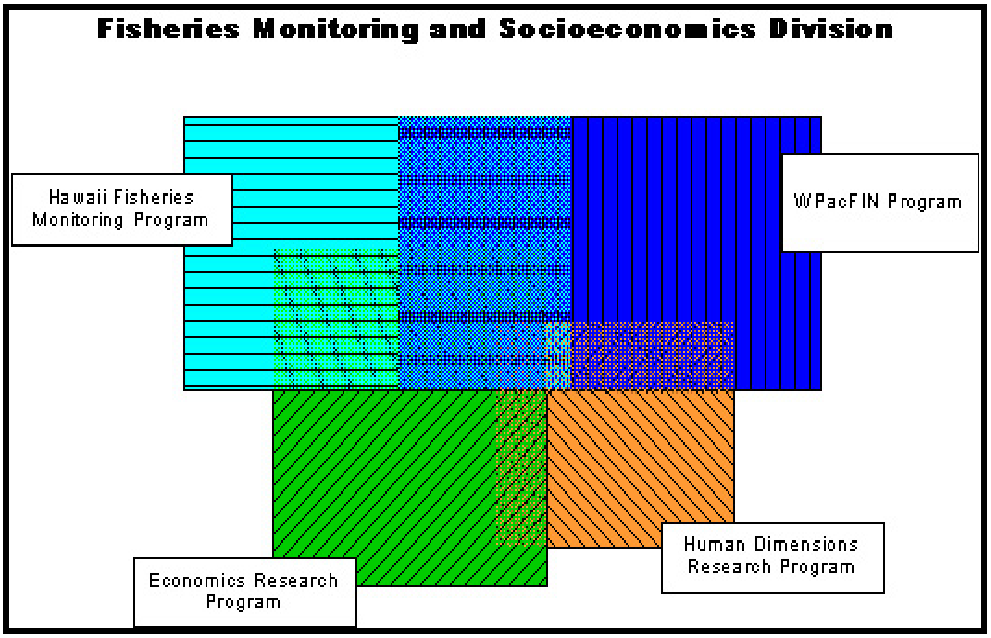
Speaker: Samuel Pooley
Director - NOAA Pacific Island Fisheries Science Center

Background. Dr. Samuel Pooley is Director of NOAA's Pacific Island Fisheries Science Center (PIFSC) in Honolulu, and U.S. representative to the Governing Council of the North Pacific Marine Science Organization (PICES). Dr. Pooley served for twenty years as the lead economist for NMFS Honolulu Laboratory, with responsibilities ranging from economic analysis of commercial fisheries to evaluation of the benefits of recreational fisheries and conservation of endangered species. He has published papers on bio-economic analysis, alternative fishery management and property rights regimes. He is also affiliate graduate faculty with several departments and programs at the University of Hawai'i, as well as a member of the steering committee for the Joint Institute for Marine and Atmospheric Research (JIMAR). Dr. Pooley received his doctorate in Political Science with a dissertation on economic decision-making from the University of Hawai'i, and the masters in Economics from the University of Birmingham (U.K.). Dr. Pooley discussed the PIFSC social science research program with a presentation titled "Pacific islands Ecosystem and Social Science Research."

Presentation Summary. Islands in the Western Pacific are in many ways unique. They are mostly remote islands, the Hawaiian Archipelago being an extreme case. Some are pristine and others are relatively degraded, with such variability sometimes occurring in close proximity. They are situated on narrow topographical bands of volcanic origin amidst the vast Pacific Ocean. They are profoundly impacted by cyclical oceanographic and atmospheric influences such as the ENSO cycle. Relative to other marine regions in the Pacific, marine resources are not superabundant. Yet there is extensive cultural diversity in the region, and while local social and economic processes obviously are important, in reality many of the most profound economic decisions affecting people here are made elsewhere in the United States and in Asia.

One way in which the ancient Hawaiians adapted to environmental conditions in this region was through the ahupua'a system. Responsibility for managing resources of land and sea was based in part on the geography of the islands, wherein a given ahupua'a typically encompassed land between mountain peaks, down through the upland area, into the broadening lower valley, across the inshore reef system and into the offshore zone. The approach tended to integrate human and biophysical systems, and marine and terrestrial systems. This ancient form of environmental interaction and economic production is not explicitly used by NOAA Fisheries in Hawai'i, but it does serve as a valid means for conceptualizing island ecosystems and related management issues.

Contemporary management and conservation issues and challenges abound and intersect with an array of institutions and regulatory efforts in the Western Pacific region. The WPFMC must address a range of issues while maintaining a focus on sustainable fisheries across a broad region: sea turtles and marine mammal interactions, community development, international management conventions, and regulations such as the Endangered Species Act, the Marine Mammal Protection Act, the Coral Reef Protection Act, and the National Marine Sanctuary Act. Analysis of the distribution of costs and benefits resulting from management strategies is also a subject of concern per the Regulatory Flexibility Act and Executive Order 12866.



Social science research activities at the Pacific Islands Fisheries Science Center (PIFSC) are diverse, and include extensive application of social science in support of effective resource management throughout the region. **Fisheries Monitoring and Socioeconomics Division** staff undertakes socio-economic research with an implicit ecosystem approach. Led by David Hamm, this includes an Economics Program, a Human Dimensions Program, and two Fishery Monitoring Programs. The **Economics Program** supports NOAA Fisheries' conservation and management goals, and based on historical development of the program remains largely utilitarian in nature. The program, led by Minling Pan, involves collection and compilation of economic data, assessment of changes in economic indicators, and conduct of applied research and analysis of the economic impacts of alternative management measures for the range of fleets active in the Western Pacific. Stewart Allen leads the **Human Dimensions Program**, which addresses social and cultural aspects of fisheries, fishing communities, and ecosystems. A **Fishery Monitoring Program** undertakes various ecosystem-relevant missions and is associated with the observer program.

It is anticipated that future social science research undertaken by the PIFSC will address the needs of NOAA's Fisheries Economics and Social Science Coordinating Committees, the Council's Social Science Research Committee, and priorities set by the University of Hawai'i Pelagic Fisheries Research Program. Addressing linkages between the terrestrial, near-shore, and open ocean marine environments is a priority. Plans also include heightened social and economic research in other parts of the region, such as American Samoa, Guam, and the Northern Marianas. Relevant topical areas for which increasing attention will be applied include governance processes, non-commercial fisheries, marine aquaculture, and invasive species issues.

As an inter-agency initiative, the Hawai'i Archipelagic Living Marine Ecosystem Research Initiative is being established to involve a broad range of partner agencies and participants in ecosystem research, monitoring, and management efforts in the region. This multi-year, multidisciplinary research program is designed to enhance understanding of the range of factors affecting marine ecosystems in the Hawaiian Islands, including those associated with terrestrial and nearshore zones. Major partners include the PIFSC, the University of Hawai‘i, the University of Guam, the National Ocean Service, and the Fish and Wildlife Service.

An important question raised by this process, and still an open one, is whether the social and economic sciences would need to be applied differently within the nascent ecosystem-based management context. In moving toward an answer to this question, it should be noted that: human beings may be seen as a pivotal aspect of marine ecosystems; ecosystem approaches to resource management may require consideration of broader range of participants, stakeholders and jurisdictions; and, thus, striving to attain balance between the needs and interests of an larger field of constituents may be concomitantly challenging. It can also be suggested that efforts to apply social science in this context may benefit by examination of historic social scientific approaches to management of terrestrial ecosystems.

New issues are inevitably raised in this context. These include a range of important topics that may need to be addressed as the Council moves toward the new approach: prospective regulatory change; the potential need for and utility of ecosystem-related education and outreach; needs for management-derived community development and optimization of benefits; and potentially competing social science paradigms.

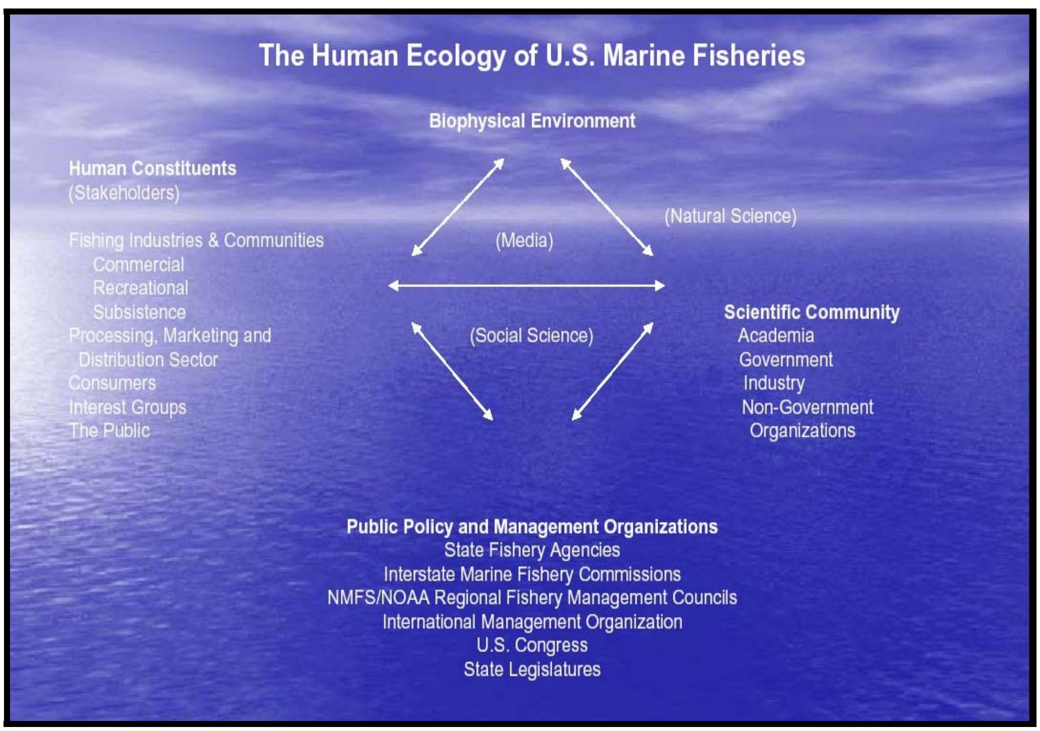
3.2.3 Non-Economic Social Science and Ecosystem-Based Management

Speaker: Michael Orbach
Director - Duke University Marine Laboratory
Coastal Environmental Management Program, School of the Environment at Duke University

Background. Michael K. Orbach is Professor of Marine Affairs and Policy and Director of the Duke University Marine Laboratory and the Coastal Environmental Management Program in the School of the Environment at Duke University. His B.A. is in Economics from the University of California at Irvine, and his M.A. and Ph.D. are in Cultural Anthropology from the University of California at San Diego. From 1976-79 he was Social Anthropologist and Social Science Advisor with the National Oceanic and Atmospheric Administration in Washington, D.C. From 1979-82 he was Associate Director of the Center for Coastal Marine Studies at the University of California at Santa Cruz. From 1983-93 he was Professor of Anthropology in the Department of Sociology and Anthropology and Senior Scientist with the Institute for Coastal and Marine Resources at East Carolina University. He joined Duke, with offices at the Duke Marine Laboratory in Beaufort, North Carolina, in 1993, and became Director in 1998. Mike has performed research on, and has been involved in development and implementation of coastal and marine policy on all coasts of the U.S. and in Mexico, Central America, the Caribbean, Alaska and the Pacific. He has published widely on social science and policy in coastal and marine environments.

Presentation Summary. People have long migrated to the Pacific islands from around the Pacific basin and beyond. This has resulted in a highly diverse and complex mosaic of human societies and cultures. Such diversity forces social scientists to adopt an array of methods and models appropriate for understanding that context. Such researchers also have an opportunity to apprehend the perspectives of those who are part of that context. In acquiring this **emic perspective** in the specific context of human-environmental interaction in the marine realm, a better understanding of marine ecosystems may be achieved and communicated to managers, scientists, and others.

It is important to recognize the diversity of perspectives, needs, and expectations of the many individuals and groups involved in the use and management of marine resources in this region and elsewhere. More often than not, the nominal or behavioral "bounds" between categories of user groups are permeable. They are, in reality, fluid and mixed. For instance, persons fitting in a commercial category may best be described in a recreational or subsistence category, or in both. It is important to consider such individuals and groups, because they are part of marine ecological systems. Ecological systems involve interrelated biophysical and human dimensions. The human dimension is critically important – human beings and social groups, relationships between individuals and groups, and relationships between those persons and groups and the biophysical environment. The study of these relationships is known as **human ecology**. As a subset of human ecology, **institutional ecology** involves the study of relationships between institutions involved in governing marine resources and resource users.



Thus, when looking at the ecology of a fisheries system, one must consider not only its biophysical aspects - typically the primary interest of the scientific community, academia, government, industry, and NGO's. One clearly must also consider and address the human component as part of the ecology of fishing systems. This is identifiable as a **system of**

stakeholders or constituents: the fishing industries and communities, those who process and distribute seafood, the consumers and interest groups, the recreational user groups, the general public. From the institutional subset, public policy and management organizations should also be considered. Natural scientists tend to focus on the nonhuman components of the ecosystem, whereas social scientists focus on the interplay between human user groups and governance entities, and between these components and the biophysical environment.

When considering these components and relationships in the context of resource management, inevitably, there is need for a certain detachment from objective science. Science is about objectivity, reliability, and validity. It can serve to describe and explain what was, what is, and the range of possibilities and probabilities for what might be. But it cannot determine what management *choices* should be made. That is a subjective process involving human judgment, guided by human values, assisted by science and scientific findings. Governance is ultimately a human value-based decision-making process. This fact is critically important in that human values and choices are malleable, with important implications for the management of ecosystems, including marine ecosystems.

It follows that ecosystem management may be defined as the management of human behavior against specific objectives, defined and executed through systems of governance - behaviors which influence and are influenced by the physical world. Contrary to managing biophysical factors to achieve certain social changes, the process ideally involves managing human-social behavior to achieve certain biophysical effects. **Governance systems** by definition involve a variety of acceptable options and approaches, formal and informal, from modern institutions such as the NMFS and Council, to the ancient *ahupua'a* or *matai* systems in the Pacific islands. One important role of social science in this context involves the production of better understanding of systems of governance, how they have historically functioned to work in any given place, and how they might be applied in the future.

Important issues emerge from a perspective that prioritizes management of human behavior above management of the resources they pursue and the environment in which they interact. First, if ecosystem management has not prioritized human behavior, how would such change if human beings and their behaviors were prioritized? Might it be simply a matter of exchanging existing concepts, labels, and perceptions, or are truly significant differences in approach called for? Clearly, better integration of human behavioral considerations is sorely needed to improve the current system(s) of management, especially under an approach that emphasizes the importance of relationships between aspects or components of environmental systems. Can social science contribute to this task and what changes are called for to better accommodate human-social considerations in marine ecosystems?

Again, given the broad range of relationships people have with the marine environment, it is clear that social science does have the capacity to contribute to more effective understanding and management of marine ecosystems. In fact, given that human beings have the capacity to modify and regulate their own behavior, and positively affect and influence the biophysical environment, the social sciences may be applied not only to study of ecosystems, but also more proactively to the ***design* of healthy marine ecosystems**. There is much promise in the application of social science in this arena, and many challenges ahead.

Roundtable Discussion during the First Day of the Workshop

3.2.4 Economic Social Science and Ecosystem-Based Management

Speaker: Susan Hanna
Professor of Marine Economics
Oregon State University

Background. Susan Hanna is professor of marine economics at Oregon State University. Her research and publications are in marine economics and policy, with a focus on economic performance of fishery management, ecosystem-based fishery management, and application of incentive-based tools and institutional design. Dr. Hanna serves on the Science Advisory Board of the National Oceanic and Atmospheric Administration and the Independent Science Advisory Board for Columbia River Basin Salmon Recovery. She is a former member of the Science Advisory Panel, U.S. Commission on Ocean Policy; Ocean Studies Board, National Research Council; Scientific and Statistical Committee, Pacific Fishery Management Council; Marine Fisheries Advisory Committee, National Oceanic and Atmospheric Administration; National Research Council Committee to Review Individual Quotas in Fisheries, and NRC Committee on Protection and Management of Pacific Northwest Anadromous Salmonids. Dr. Hanna's presentation was titled "Economics of Organization and Ecosystem Management."

Presentation Summary. The **U.S. Commission on Ocean Policy** explicitly stated that institutional challenges underlay many of the problems associated with fisheries management and efforts to maintain the sustainability of ocean resources. Commission members believe that humans are an integral and influential part of ecosystems and that problems stem from failures to build robust institutions to solve those problems. Better integration of agencies and institutions is central to the challenge. The Commission recommends enacting regional ocean governance strategies for which it gives primarily structural recommendations. Should management efforts extend beyond marine fisheries to address marine-terrestrial relationships, this approach may prove particularly beneficial.

The **FAO Code of Conduct** provides guidance on issues of direct relevance to ecosystem management. It calls for attention to issues of biodiversity, endangered species, species interdependence, fishery impacts, non-fishery impacts, waste, uncertainty, and risk. It also mandates integration with coastal zone management objectives. Accommodating each of these factors has clear institutional implications.

Ecosystem management entails an expanded perspective of biophysical and human interactions within and between marine ecosystems. The approach involves a **change in degree** over the way fisheries have been managed thus far. It will require a more extensive examination of a range of interactions: climate-oceans, oceans-ecosystems, within-ecosystems, people-ecosystems, people-communities, and user group-user group. All of this also relates, in varying degrees, to broader social and economic spheres of consideration.

As we expand the degree to which management addresses more and more complex interactions, the **institutional decision environment** becomes similarly complicated. More and more complex interactions between scarcity, tradeoffs, impacts, reversibility, integration, compatibility, decentralization, devolution, and equity will need to be considered.

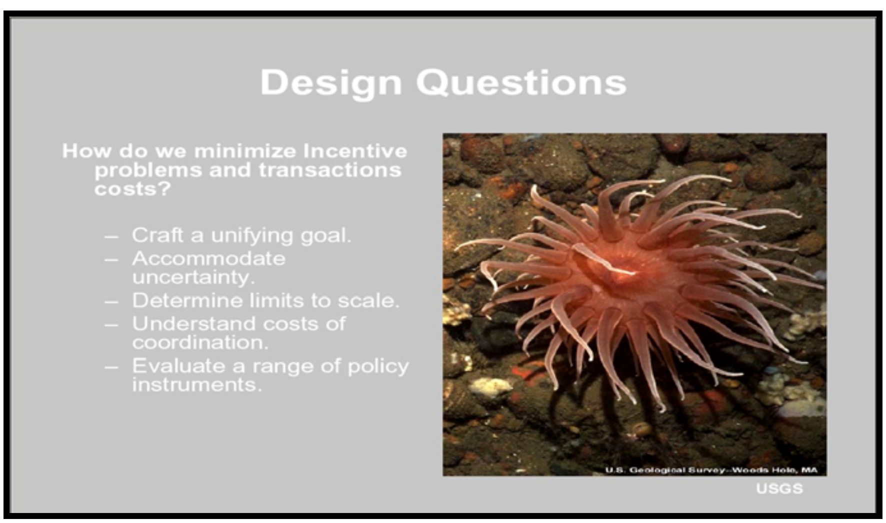
The issue of **tradeoffs** becomes increasingly complicated under conditions of numerous interests, goals, and objectives. Maintaining **flexibility and the ability to reverse decisions** enables learning and subsequently reduces uncertainty. Issues of compatibility among components of the institutional environment are critical, as is the option to decentralize decisions or devolve them down to their most effective level. Questions of **equity**, which are always difficult to address, become even more so when expanding the scope of interests and actors under the parameters of ecosystem management.

Greater institutional complexity may be inevitable. But assuming institutions will simply expand naturally to address the wider scope of considerations is spurious. Institutional expansion raises design issues relevant to important economic principles. A number of incentive problems can limit the effectiveness of complex organizations and increase transactions costs. One problem involves a failure to understand fully the implications of expanding parameters as these relate to incentives and behaviors, and as the decision environment is made more complicated and complex. Incentive problems have very direct implications for transaction costs, in this case the costs of implementing the new system of management.

The Williamson Puzzle accurately frames the incentive problem. It asks, 'why can't a large firm do all that a collection of small firms can do, and more?' In truth, we cannot realize gains from integration without experiencing losses. In institutional environments, such losses result from impaired incentives. As transactions are transferred from smaller organizational entities and melded together into a more complex institutional environment, all of the ways the smaller entities developed to deal with transactions are misfit - problems inevitably result. These are all fairly typical institutional problems. As fisheries management expands to broaden its institutional scope, it needs to pay attention to typical kinds of incentive problems, anticipate and design around them, and thus prevent costlier outcomes.

A typical problem is **power ambiguity**, or uncertainty about the distribution of power. A second is the failure to make credible commitments, a situation that can occur in the absence of clear delineations of responsibility. Manifesting in uncertainty, instability, or the absence of property rights, this problem can make it hard to deliver on promises. Similarly, low-intensity incentives can reduce accountability in the system. **Opportunism** is another typical institutional expansion problem. Increased opportunity for unobservable actions arises, because transparency decreases as complexity increases. The issue of **bounded rationality** should also be considered. Under expanding parameters, full scientific information or constant information feedback is increasingly less likely, and uncertainty and inconsistency can lead to unintended consequences. Truncated learning relates to bounded rationality. It suggests that opportunities for learning-by-doing and adaptation can be limited by heavily regulated decision environments.

All of these issues lead to design questions. How can incentive problems and transactions costs be minimized? Unifying goals and objectives across widely disparate interests will clarify direction. Uncertainties need to be recognized, with management occurring in a manner sufficiently conservative to accommodate that recognition. Limits to scale will also need to be determined - in terms of institutional structure, decision environments, and the unique contexts that are characteristic of marine fisheries.



Given what is known about incentive problems, it is rational to be **proactive in crafting solutions** as the institutional environment is expanded. We must pay careful attention to the design of institutional structures, with explicit consideration of incentive problems and transaction costs. As these design requirements are known, measurable indicators may be identified through which the performance of institutional environments can be monitored and evaluated. Studies of governance and institutions may contribute to understanding of institutional or organizational issues likely to surface under conditions of increasing complexity, and hence to design of programs that minimize social problems.

[Dr. Hanna's presentation led to discussion about whether studies of institutions are relevant to FEPs. Dr. Hanna and others emphasized that studies of institutions and governance are critical to effectively implementing ecosystem management, but not necessarily material for a FEP. Dr. Fernandes concurred, describing how her agency experienced institutional disincentives in rezoning the Great Barrier Reef Marine Park, both in working across institutions and with communities. The agency had institutional limits regarding the degree to which it could involve other agencies and stakeholders in decision-making. But arriving at a common goal, clearly articulating authority, and not making promises which could not be delivered were important for success. While this information did not appear in the plan, it was critical in the decision-making process.

Workshop participants struggled to understand what product the Council needs or wants with regard to social science aspects of ecosystem planning. Dr. Hanna's presentation highlighted important institutional process considerations that should accompany implementation of complex regulatory structures, such as ecosystem management. Some participants considered it important to provide the Council with social science principles and instructions about how these would best contribute to implementation of FEPs. Executive Director Simonds asserted that information about institutional processes and appropriate application of social science would both be appreciated by the Council.]

3.2.5 Fisheries Social Science Research Methods and Modeling

Speaker: Jeffrey Johnson
Senior Scientist, Institute for Coastal and Marine Resources
Professor, East Carolina University

Background. Dr. Jeffrey Johnson is Senior Scientist at the Institute for Coastal and Marine Resources, and serves as Professor in the Departments of Sociology, Anthropology, and Biology and Biostatistics at East Carolina University. He conducted a long-term research project supported by the National Science Foundation comparing group dynamics of the over-wintering crews at the American South Pole Station with those at the Polish, Russian, Chinese, and Indian Antarctic Stations. He is interested in network models of complex biological systems and is currently working with several ecologists to examine problems associated with trophic dynamics in food webs. His most recent work funded by NSF involves the development and testing of cognitive models of Inupiaq understandings of the Kotzebue Sound ecosystem in the Arctic. Dr. Johnson discussed a presentation titled "Incorporating Humans in Ecosystem-based Models of Fishery Management."

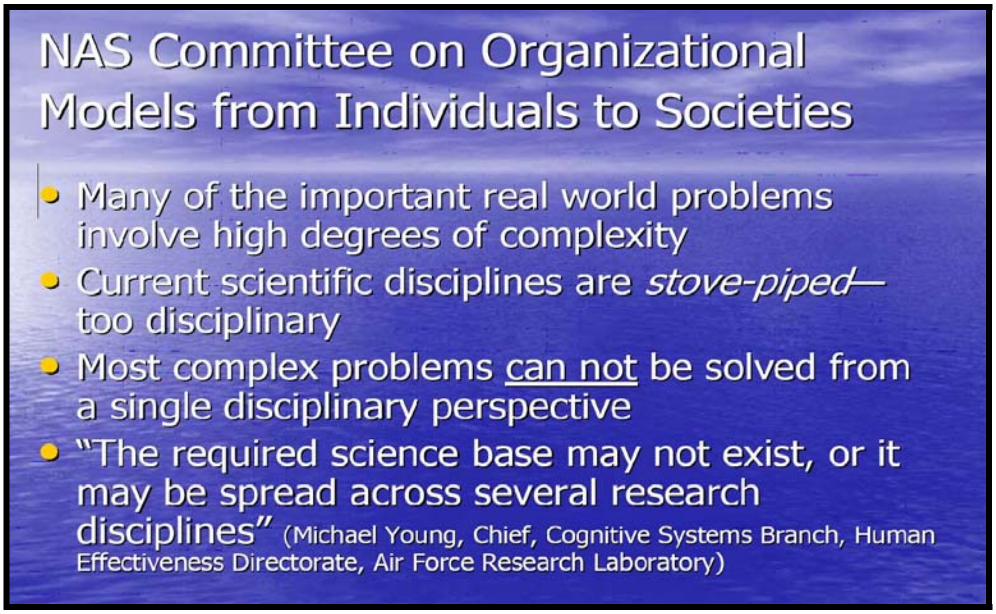
Summary of Presentation. Scientists are often too narrowly specialized to address the complexities of modern environmental problems. Solutions thus often require the contribution and interaction of persons with different perspectives and expertise. The National Academy of Sciences has recognized the importance of the multidisciplinary approach. For instance, the National Science Foundation Advisory Committee for Environmental Research and Education recognized the need "to meet these complex challenges as well as urgent human needs, [by moving toward] environmental synthesis to frame integrated **interdisciplinary research** questions and activities to merge data, approaches and ideas across spatial, temporal and societal scales." Coastal problems are particularly amenable to such an approach; several large-scale research programs in the U.S. currently address these, with particular attention to the interface between human and natural systems.

Despite the fact that humans are components of natural systems, they often see themselves as external to nature. This is evident in management designs and approaches that have no or little embedded human component. As defined by USCOP, effective approaches to ecosystem-based management are to be understood the following way:

> ". . . ocean and coastal resources should be managed to reflect the relationship among all ecosystem components, including human and non-human species, and the environments in which they live."
>
> Applying this principle will require definition of relevant geographic management areas based on ecosystem, rather than political, boundaries."

A review of the current literature would indicate, however, that humans are to be accounted for primarily in terms of the extractive actions and disturbances they exert on natural systems. Research tends to focus on biological communities, trophic structures, habitat issues, and so forth. A preferable approach is one that accepts humans as critically important components of natural systems, and examines interactions within and between social groups and the environment - a total ecosystem. Consequently, it becomes important to examine the relationships of human systems. The complexity and richness inherent in the human component needs to be recognized. This includes behavioral networks, the trophic effects of human activities, the structure of communities of user groups and institutions, incentives and well-being, nutrient output behaviors, and others.

Human behavior can be seen from multiple perspectives: **behavioral structures or networks**; behavioral incentives or dependencies occurring in systems with diverse degrees of robustness and adaptability; terrestrial-based activities that impact marine ecosystems, such as nutrient loading. There are clear and measurable relationships between human and ecological networks. Regarding these, the conventional view is focused on how humans impact the ecosystem, either directly or indirectly, through cascading effects on **trophic systems**. Less attention has been given to the way human systems are affected by ecosystems; how these fare in terms of robustness, flexibility, and adaptability; and the nature of feedback between humans and surrounding natural systems.



This difference in treatment is further evinced by the number of indicators that have been developed for the natural system, befitting conservation objectives such as ecosystem diversity, species diversity, genetic variability within species, directly impacted species, ecologically-dependent species, and trophic balance. But **analog indicators** can also be developed for the human counterpart, as for example: fishery diversity, fishing constituency diversity, ecologically-dependent communities, social and economic balance, directly-impacted groups, indirectly-impacted groups, human system diversity, and so forth. It stands to reason that it would be useful to acquire knowledge of these, and then proceed to link indicators from both sides in order to obtain a more comprehensive understanding of the overall ecosystem. Doing so will eventually require the establishment of causation between indicators. One of the ways of doing so is through experimental research.

In the context of marine fisheries milieu, human behavioral networks can be depicted in terms of the structural relationships between different types of species and gear combinations in relation to those persons who use them. These can be expressed as either two-node or one-node networks (or relations), depending on the number of variables that are being used (2 or 1, respectively). Such networks may exhibit certain structural characteristics that can be linked to elements of the natural system in which the behavior in question occurs.

Characteristics of **social networks** include: density (connectance); graph centralization (the extent to which a given node of a certain behavior dominates and influences the entire system); and fragmentation (the number of network components that are produced when removing a key player from the system). The latter proves useful in revealing key behaviors in fishing behavioral networks, as a change of behavior among those persons who play a central role in structuring the system will incur a significant change in the structure of that system. Identified mathematically are these keystone behaviors; related to the robustness of the network are changes in its preponderance (by reduction or elimination). Depending on the density and centralization around a node or group of nodes, the removal of one or more behaviors from the network will have different effect(s), revealing varying degrees of resilience, adaptability, and so forth.

This approach is exemplified in the project titled "**Incorporating Humans in Ecosystem-Based Models of Fishery Management**," to start in spring 2006 with funding from UNC Sea Grant. A multi-disciplinary team of scientists will work to develop a framework that includes humans as important components of coastal food webs and that enables modeling of the behavior of fishermen in that system. In terms that are more detailed, the objectives are as follow:

(1) Controlling for ecological and environmental factors through standard sampling techniques and analyses of gut contents and stable isotopes, characterize trophic networks (food webs) in Core Sound with: (a) little human input (Primary Nursing Areas), (2) moderate human input (Secondary Special Nursing Areas), and (3) high human input (Core Sound);

(2) Characterize behavioral networks of fishery participants (harvester) in the study area;

(3) Characterize the interactions between human behavioral networks (fishing networks) and corresponding trophic networks (food webs);

(4) Work to understand and measure the direct and indirect effects of fishing effort on benthic, plankton, and fish components of the food web, and vice-versa.

Six unique food webs are to be modeled for the Core Sound area, each including the fishery pressure component. By testing various hypotheses, comparing and contrasting the effects of fishing behavior, it will be possible to evaluate whether and how fishing pressure and types of fishing pressure ultimately impact the food webs.

This is a unique project in that it involves simultaneous collection of social and natural science data that is directly relevant to understanding of complete ecosystems. It applies network methods to model both food webs and the shifting behaviors of the harvesters. Finally, it is capable of assessing species richness and predator/prey linkages resulting from changing fishing pressure.

The study of **Traditional Ecological Knowledge** (TEK) may be particularly useful for ecosystem-based management of marine fisheries. Much of the work on TEK has been of an anecdotal or qualitative nature, though TEK approaches have been increasingly systematic and quantitative. When approached systematically, this form in inquiry can enable understanding and comparison across different knowledge systems or time gradients, between types of knowledge such as TEK and **Scientific Ecological Knowledge** (SEK), and within particular groups. Regarding the latter, it is possible to model variations of knowledge and how these relate to factors such as social roles, experience, social status, and gender.

Recent work with Iñupiaq people in Kotzebue Sound has been effective for enhancing understanding of human connections with the physical environment. Kotzebue Sound is home to about 3500 persons, 80 percent of whom are Iñupiaq. Traditional ecological knowledge is critically important in this setting where hunting, fishing, and gathering are common means of survival. Two hypotheses were tested in this case, one relating to the existence of a shared cultural ecological model of the Ugruk (bearded seal) amongst Iñupiaq hunters, and the second relating to the level of agreement between TEK and SEK regarding the structure of the trophic web. It was found that agreement among hunters increased when the topic of interest involved higher levels of the food such as the Ugruk, and that TEK and SEK were most closely correlated when the topic involved higher trophic levels.

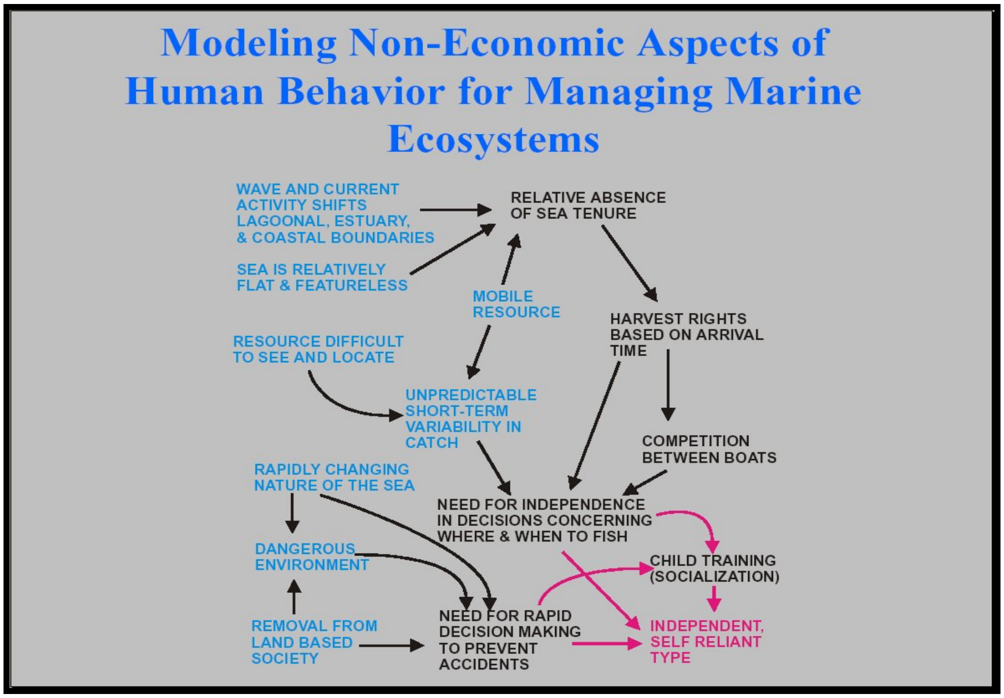
This approach allows for direct comparisons of different systems of knowledge, detecting where similarities and differences lie. This may assist scientists and resource managers in assessing TEK for potential use in frameworks of ecosystem-based management. Also examined by this study were problems associated with communication of TEK to scientists; the methodology may assist in structuring that information for use in management, as in the formulation of ecological boundaries, seasons, and gear use. Furthermore, TEK may be useful in formulating valid research topics. Future use of more advanced techniques, such as Markov chain models of trophic network dynamics would open the way for more powerful analytical approaches. The application of true statistical models would allow the measurement of changes in some network parameters while controlling others, and in conducting test of significance on structurally based food web statistics. Changes in food web structure could be taken to more detailed levels of analysis, and modeling could be extended to include true changes in ecosystem structure and no longer be limited to macro-level summary statistics, such as species diversity.

In sum, there is a need to conceptualize ecosystems in terms of interactions both within and between human and natural subsystems. A promising avenue of understanding is through analysis of human and ecological networks. Recognition that impacts occur not only from the human to the biophysical but also the other way around is important, as is the need to incorporate and relate indicators from both components. Finally, modeling TEK may help in developing a comparative interface between various forms of human knowledge, so as to assist in ecosystem-based management processes.

Speaker: Richard Pollnac
Professor of Anthropology and Marine Affairs, University of Rhode Island

Background. Richard Pollnac became interested in modeling human adaptation to large bodies of water while conducting research concerning intra-cultural variability in cognition on the shores of Lake Victoria, East Africa. He has since conducted research among coastal peoples in Africa, Southeast Asia, the Middle East, Europe, the Pacific Islands, the Caribbean, and North, Central, and South America. Recent research has been conducted in Southeast Asia and in Alaska, with involvement in projects investigating the success of MPAs and sustainability of integrated coastal management projects in the Philippines and Indonesia (2000-2003), conflicts between fisheries in Vietnam (2004), tsunami recovery in Thailand (2005), and responses of Native American communities in Norton Sound to the Community Development Quota (Fisheries) program (2005). Dr. Pollnac's presentation was titled "Modeling Non-Economic Aspects of Human Behavior for Managing Marine Ecosystems."

Presentation Summary. Taking human behavior into full consideration in the management of marine ecosystems is of paramount importance. But it is hampered by the complex and delicate task of identifying and analyzing the many variables that influence and structure behavioral interaction between humans and marine ecosystems. In addressing non-economic aspects of human interaction with the marine environment, a very broad set of variables could potentially be addressed. Of particular relevance in any such analysis of relationships between participants in the harvest sector of marine fisheries is the dependent variable "happiness" or "**well-being**," envisioned as an expression of occupational satisfaction. By extension, one could examine management options in terms of their capacity to enable continued **job satisfaction** or well-being.



The complexity of relationships between factors associated with the well-being of human beings calls for analytical tools that enable conceptualization and analysis of those relationships. Several types of models are relevant and useful: (a) the heuristic model, (b) the causal model, and (c) the pattern-oriented model. **Heuristic models** are useful during early stages of research. They assist in developing theory and structuring decision–making processes associated with data collection. They can be constructed in various ways and involve an iterative approach. **Causal models** are useful for testing hypotheses, for building theory, and for making decisions. A typical sequence involves use of a heuristic model to collect quantitative data about pre-defined variables, and use of that data to test hypotheses about causal relationships. **Pattern-oriented models** are helpful for development of theory about complex agent-based human systems.

Building such models requires initial review of previous relevant research and associated data, as available. Fieldwork and collection of new data ensues. Models are built and tested and their elements and configuration confirmed or dismissed. If findings lead to reformulation or abduction of a model, a new structure emerges. This cycle of compilation of existing information, field observation, induction, deduction, abduction, and trial and error tends to generate myriad variables purportedly connected to the dependent variable under consideration.

Study of a given dependent variable involves examination of a range of known and unknown factors. A good sampling strategy is fundamental to proper evaluation of the contribution of known factors and the validity of the research hypothesis. Case studies may also yield important information and suggest unseen relationships. Attention to feedback between quantitative and qualitative research is often helpful. It is important to remember that if these considerations are to be applied in an ecosystem-based management context, the known and unknown factors potentially relating to the dependent variable will derive from both the human and natural environment.

An example of the complexities inherent in modeling the interface between human groups and the marine environment is noted of a coral reef project conducted in the Philippines. It was thought that high human population density would correlate with coral reef mortality. But a model constructed with both coral reef mortality data and several socioeconomic variables indicated that increasing population density was actually positively correlated with high quality reefs, while decreasing density was inversely correlated. A hypothesis that sound reef areas were attracting migrants was confirmed by fieldwork; new communities were being settled where the reefs were still in good shape. The findings clearly suggest a need for nuanced interpretation of the situation and perhaps **longitudinal assessment of population-related fishing pressures** in the area. This has obvious implications for managers seeking to predict changes in coral ecosystems in the region.

Human factors such as fishing pressure, environmental activism, and demographic change will tend to affect management strategies, as will biophysical factors such as oceanographic or climatic regime shifts. Changes in management strategies may- in turn- shape the attributes of fishing occupations by, for instance, shifting the allowable intensity of activity. This may affect job satisfaction and, subsequently, job performance, mental and physical health, family and social relations, and so on. However, job satisfaction appears to involve more than gainful employment. Several variables appear to contribute to satisfaction, but the experience of hunting and catching fish in a challenging environment appears central, and a corresponding personality type is implicated. An independent, self-reliant, risk-taking personality is common, and issues of identity come into play. In sum, job satisfaction relates in part to identity and affinity with a way of life.

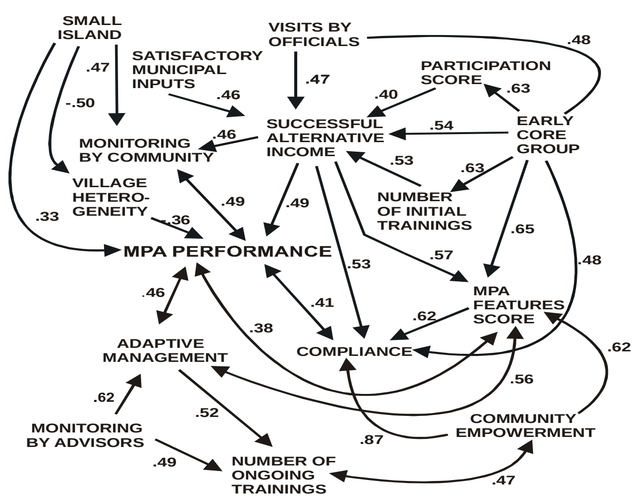
External forces will influence and be influenced by management strategies. Management will influence occupation attributes which, in turn, will be interrelated to job satisfaction. Job satisfaction will influence individual attributes and the occurrence of social problems. Social problems are not only interlinked to individual attributes, but also to the contextual social structure. These cascading factors affect the **well-being of the fishers**.

An example is the Individual Fishery Quota (IFQ) system in Alaska. External forces led managers to implement IFQs; this influenced crew size and structure: having no need to maximize effort during a limited season, the owner could rely on a few family members. On the other hand, the high costs of the IFQ led to the relatively few, relatively wealthy in the fishery.

Job satisfaction increased for those able to stay in the fishery, but diminished for those unable to participate. **Social stratification** in certain communities was amplified, with unemployed crewmembers on the one side and IFQ holders on the other. Participants simultaneously **improved access to and influence in the management arena**. As such, there was unequal distribution of effects, with implications for the well-being of the participants.

Another approach to modeling involves inductive use of statistics and working backwards from the dataset to develop **heuristic models** that can the tested with causal analysis of another dataset. A correlation matrix with predictor variables and a measure of performance is developed, and the analyst, using a predetermined criterion of strength of relationship, works backward from the dependent variable through the predictor variables to determine patterns of interrelationships between strongly related variables.

An example of this procedure was applied to evaluation of 45 no-take MPAs in the Philippines. A measure of MPA success was created by incorporating three biological parameters, assessed by direct observation with snorkel surveys. A coral mortality index was created, and number of fish families and top predators were assessed to generate an aggregate indicator of MPA success (the dependent variable). A previous survey of literature was used to identify independent variables suggested to be related to MPA success. The dependent variable was examined in terms of its relationships with 83 independent variables: 12 environmental and demographic variables, 29 socioeconomic and cultural variables, and 42 project activity and project output variables. The resulting matrix had 3,486 entries. It was found that independent variables such as adaptive management, monitoring by community, and successful alternative form of income were linked to the dependent variable. By replicating and extending this process in several steps, it was possible to construct a model, including a total of 15 independent variables and infer causal relations that could later be tested (see figure below).



In conclusion, different types of models can be of great assistance at different stages of the research process. These can serve to highlight relationships that might go unnoticed and further understanding about relations between multiple human and biophysical factors, thereby enabling a better grasp of systems and related management decisions of great complexity.

3.2.6 Challenges to Effective Policy Development and Implementation

Speaker: Lee Anderson
University of Delaware

Background. Lee G. Anderson earned a Ph.D. in Economics from the University of Washington in 1970. He is Professor of Economics and Marine Studies at the University of Delaware. He has written or edited six books and over sixty scientific papers on fisheries economics and the economics of fisheries management. He is a past member and chairperson of the Mid-Atlantic Fishery Management Council, and past President of the International Institute of Fisheries Economics and Trade. He is currently President-Elect of the North American Association of Fisheries Economists, and a member of the Ocean Studies Board. His current work deals with simulation models, design and implementation of ITQ programs, the economics of fishing in time and space, and marine reserves. His presentation was titled "“Bio-Economics and Ecosystem Approaches to Fisheries Management.”

Presentation Summary. Dr. Anderson advanced a **cautionary** perspective on adopting ecosystem-based management without due consideration of inherent challenges. An initial challenge involves the clarification of definitions of terms related to ecosystems and ecosystem-based management. The goals and objectives of ecosystem-based management must also be made clear at the outset. A valid approach would involve managers and stakeholders generating a list of objectives, goods and services desired for whom, and what types of trade-offs would be allowed. Management plans or planning exercises could then be designed according to this prioritized list, and implemented carefully to ensure that scientists, managers, and the public understand and have reached some level of consensus on objectives and intentions.

Ecosystem approaches to fisheries management may be seen as differing from single species management primarily in **terms of degree** rather than radically different approach. The ecosystem approach signifies a paradigm shift. But by considering it as primarily a change in degree, we can eliminate some uncertainty about its true nature. Certain commonly held beliefs about ecosystems-based approaches may at this time be inappropriate or not fully developed, and should be subject to assessment and potential revision. These include the following: (1) we need to conserve the form and structure of the ecosystem; (2) we need to develop a series of ecosystem indicators; (3) we need to develop a series of MPAs (no take areas) over wide sections of the ocean; (4) we need to maximize species diversity. Clearly, these are important concepts of pertinence to management. Rather than instigating argument between biologists, social scientists, and economists, it may be possible to engage in free and open discussion about these concepts.

Ecosystem approaches are geographically-specified and adaptive approaches that take into account levels of **current knowledge, uncertainty, and multiple external influences**. Ideally, they balance diverse social objectives and are implemented incrementally and collaboratively. The process of developing and implementing such approaches would start with a clear statement of the objectives of management while specifying acceptable trade-off rates between conflicting objectives; that is, what types of goods and services do we want to flow in and out of the system over time?   Persons developing such approaches would then select a range of potential management options and seek to determine the likely effects of those options. Finally, those options that most nearly achieve the objectives of management would be selected and implemented.

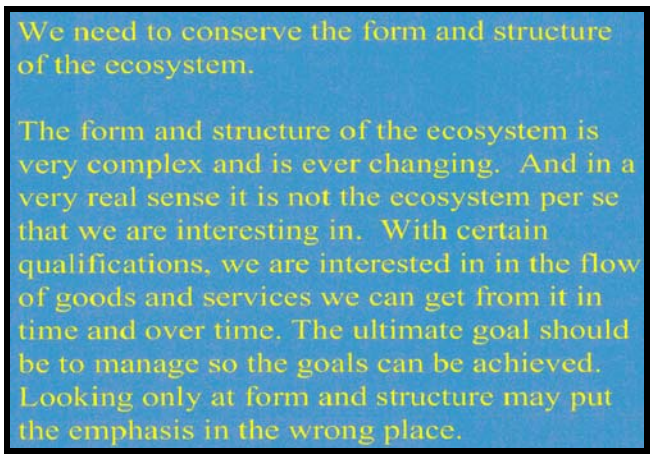
In **prioritizing formulation of management objectives**, it is necessary to know what types of goods and services are desired from the ecosystem. This should include the widest conceivable range of goods and services, not simply those that are market-related. For example, we might be interested in fish for sustenance, to catch, to observe, and other related ecosystem services, such as the ability of estuaries to protect against storm surges. In the end, this would be a long list.

Determination of **trade-offs** will necessitate stakeholder involvement. It may be a messy process, and likely will generate conflict. At this stage, diverse social objectives may be balanced through a collaborative process. There will be degrees of winning and losing. Some may be unwilling to make trade-offs, perhaps because they view the problem as more of a moral imperative than a basket of goods and services, no matter how broadly the basket is defined. But while stakeholders may have strong feelings about what they want, clear leadership and thinking are needed because not all stakeholders possess complete understanding of all ecological interactions. For instance, some will have desires for directed catch, but may not have by-catch on their radar. In sum, we must determine what we know, do not know, cannot know, and what risks society is willing to take with what we do not or cannot know.

Compared to the conventional approach ecosystem approaches will involve a broader range of potential outputs, interested stakeholders, and a greater likelihood that moral imperatives will be brought to the table. Bio-economic Management Strategy Evaluations (MSEs) may be useful in that they can enable determination of which management strategies will most closely achieve stated objectives. These tools can simultaneously reveal the effect of a management strategy on: (a) likely future changes in important elements of the ecosystem over time, (b) likely future pattern of ecosystem-related flow of goods and services over time, and (c) distribution of gains and losses over time [examples are available at the following link: http://www.st.nmfs.noaa.gov/st7/ecosystem/workshop/2005/index.html].

A **bio-economic MSE model** for the Western Pacific would incorporate standard stock assessments and relationships between patterns of fishing effort, fishing mortality, effects outputs, and welfare of participants. It could help provide answers to questions about the effect of various patterns of fishing mortality on stock size, age class, distribution, and spawning biomass. It could also address issues about how or what regulations could affect patterns and distribution of profits, exit and entry, and gear changes among various participants. In order to create an effective model we must understand the incentive structure of participants and be ready to accommodate new factors, such as cultural assessment components. The Fulton model contains many ecological and human dimensions. But models will only be useful if they take into account the objectives of management.

While we may seek to conserve the very complex and ever-changing form and structure of the ecosystem, in a very real sense it is not the ecosystem we are interested in *per se*, but rather the associated flow of goods and services over time. Emphasis on form and structure may be misplaced. As such, biological indicators should also be able to tell us about the ability of the system to provide the desired goods and services over time (e.g., status of structural habitat biota, environmental fluxes, and seabird population trends). Design of MPAs and no-take areas over wide sections of the ocean should account for patchy distribution of goods and services and relate clearly to management objectives. In seeking to maximize species diversity, once again, the real goal is maximizing the ability of the ecosystem to provide goods and services associated with those species.



In sum, movement toward the ecosystem approach needs to proceed incrementally, patiently, and carefully. Clarification of definitions and management objectives is critical, as is recognition that ecosystems may be conceived and managed in terms of their long-term capacity for bearing goods and services for society.

[Commenting on the presentation in heuristic spirit, Dr. Jim Burchfield[2] reversed the logic, pointing out that goods and services may also be seen as following from **ecosystem *functionality*** as an objective. Thus, by prioritizing functional marine ecosystems as a management objective, assurance of extractive marketable products and non-market goods and services may follow].

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[2] Jim Burchfield is Associate Dean at the College of Forestry and Conservation at the University of Montana (UM). He is trained as a rural sociologist and forester, and his major interest centers on how people may reside in and interact with forest and grassland settings in a productive, harmonious manner. His recent work examines the principles of social acceptability in forest management, the effects of wildfires on rural communities, and the implications of stewardship contracting on public lands. Prior to becoming the Associate Dean, Jim was the Director of the Bolle Center for People and Forests at UM. He has also worked for the USDA Forest Service, and has conducted social assessment research in the Columbia River basin, worked in the international division of the Forest Service in Washington, D. C., and helped implement forest management operations on National Forests in Michigan, Ohio, Oregon, and Washington.

Speaker: Tim Hennessey
Professor of Economics
University of Rhode Island

Background. Timothy Hennessey is professor of Marine Affairs and professor of Political Science at the University of Rhode Island. He holds an undergraduate degree from Brown University and a Ph.D. from The University of North Carolina at Chapel Hill. He has done postgraduate work at The Workshop on Political Theory and Policy Analysis at Indiana University. He has also held senior research appointments at the Woods Hole Oceanographic Institution, Dalhousie University, and the University of British Columbia. He is interested in the design and analysis of governance institutions as these relate to the management of natural resources.

Dr. Hennessey is author of numerous peer-reviewed articles and four edited works. He recently completed a National Sea Grant funded study on the governance dimensions of large marine ecosystems with a number of colleagues from URI and The Northeast Science Center in Woods Hole. He completed a large-scale comparative analysis of governance systems in six estuarine watersheds, funded by the National Academy of Public Administration. His most recent publication is "Large Marine Ecosystems: The Human Dimension." Dr. Hennessey presented a talk titled “The Ecology of Governance: Policy Perspectives on Ecosystem-Based Fishery Management.”

Presentation Summary. From a **broad policy perspective**, the ecosystem model can be considered a paradigm shift driven by mounting problems and perceptions that the existing management structure has been largely ineffective. The shift was instigated, in part, by depleted fish resources in national and international waters, lawsuits brought against NOAA Fisheries, and an institutionalized process of developing solutions without truly linking them to problems.

Yet, is it not entirely clear what ecosystem-based management truly entails. As a solution generated long ago in the absence of a specific problem, ecosystem-based management has recently been called upon to deal with the problems at hand. But its ambiguity has already surfaced in the current setting. Even in the current context, while many workshop participants have expressed ideas about ecosystem-based fisheries management, no clear definition or objectives have been clearly formulated.

Throughout the policy process, ecosystem managers must cope with the uncertainty and changing nature of the organizational and institutional environment. These structures and processes may be referred to as “**the ecology of governance**.” Players in such a system are connected in some way from a **central node** of governance structure and process. In our example, one can envision NMFS headquarters as the central point of structures and processes. Within the system, some connections work well, others do not, and yet others do not exist. Moreover, the system changes as personnel move to other positions, as policy shifts, as new administrations enter and exit. Uncertainty characterizes the setting. While adaptive management may be useful, it is difficult to achieve in the policy arena.

Adaptive management is 'learning by doing.' Implementing programs involves an opportunity to test and improve the scientific basis for action. Adaptive implementation means there is active participation by relevant actors. Those involved in the delivery of policy learn by doing rather than mechanically following standard operating procedures. This requires adjustment of policy based on the situation at hand. Generally speaking, the implementation phase enables clarification of policy. Only at this time can the words comprising the policy in question be understood in pragmatic terms. But significant challenges may remain even after a modified policy is indoctrinated. For instance, when the Clean Water Act was enacted several decades ago, those delivering the policy dealt with point source pollution first. After some initial adjustments and successes, the full implications of a comprehensive policy began to be recognized and numerous agencies are now addressing the massive challenge of implementing non-point, source pollution programs around the nation.

The **Organizational Conservatism Hypothesis** describes additional constraints to a new ecosystem management paradigm. For example, imagine a bureaucrat at Headquarters. A brand new management system is indoctrinated. You say to yourself, "wait a minute, we devoted 20 years to this other system, there are massive sunk costs, I don't think I'm going to like this, I think I'll just drag my feet." This may be termed organizational conservatism.

In the context of the nascent ecosystem approach, a significant challenge involves institutional integration among as many as16 agencies. Yet, historically, NOAA and the EPA could not effectively integrate when explicitly required by the Coastal Zone Management Act Amendments of 1990. This is problematic in that ecosystems must be subdivided for management purposes into goals, subdivided into programs, and again into projects. Assuming five goals are established, for each of these there will be 20 programs and 100 projects. The challenge is to relate the measures for these goals into an assessment of the overall progress towards achieving the **broad goal of ecosystem health**.

For example, according to an expert review panel on the Chesapeake Bay Program, the overall progress towards ecosystem health in the Chesapeake Bay should have been assessed using an integrated approach with broad scale measures. Because ecosystem elements are no longer to be viewed separately, integration and unifying concepts become critically important issues. This has relevance for the establishment of boundaries, selection of policies and issues, designation of the lead agency, and the establishment of partnerships between levels of government.

[Drs. Hennessey and Anderson were asked to clarify whether the extent of challenges associated with ecosystem-based management could be terminal to the effort. Neither believed implementation of the approach to be impossible. Dr. Anderson reiterated that defining and developing goals for ecosystem-based management requires ongoing clarification and careful deliberation. Dr. Hennessey asserted that when the short list of goals is developed for the WPRFC FEPs, these need to be integrated into to one final, overarching measure, such as productivity, sustainability, resilience, or ecosystem health since funding and accountability agencies tend to respond best to a **single overarching measure**.]

3.2.7 The National MPA Program and Approach

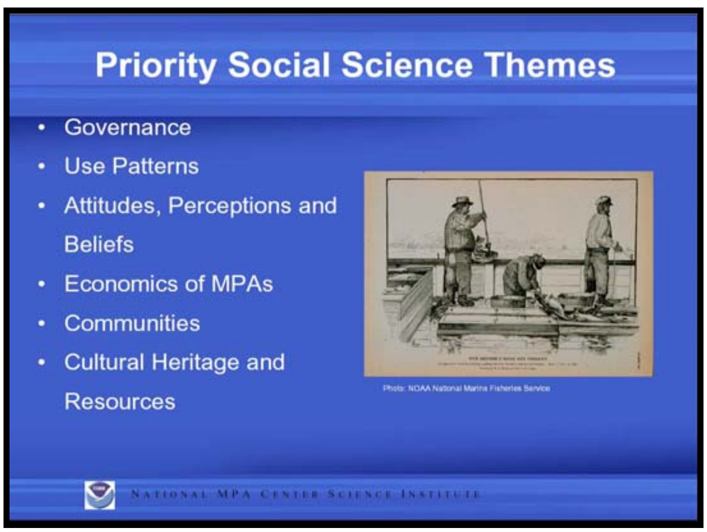
Speaker: Bryan P. Oles
Social Scientist
National MPA Center - Science Institute

Background. Bryan P. Oles, Ph.D., is Senior Social Scientist at the MPA Science Institute, which is part of the NOAA National Marine Protected Areas Center. Dr. Oles has extensive experience managing and conducting social science research projects in coastal communities in the United States and abroad. He has lived and worked with subsistence and small-scale commercial fishermen in the Federated States of Micronesia, investigating traditional marine tenure systems, human dimensions of local marine resource use, and socioeconomic impacts of global political and economic processes of change. More recently, he has been involved in research on the human dimensions of marine protected area management and coastal communities in the United States. Much of his work is concerned with clarifying theoretical and methodological issues related to the use of social science in support of marine resource management, such as modeling and implementing social impact assessments, incorporating local knowledge in management processes, and developing tools for effective participatory research and cooperative management. He received his doctorate in Cultural Anthropology from the University of Pittsburgh. Dr. Oles' presentation was titled "People and Marine Protected Areas: Research Priorities."

Presentation Summary. Persons and groups potentially affected by marine resource management decisions are often highly diversified. People have a wide range of experience with and perspectives on the marine environment and what it may afford them. The capacity to assess what is valuable and important and to whom is an important aspect of the management process. The role of the social scientist in the formulation, monitoring, and evaluation of MPAs and other forms of resource management is crucial to success.

The policy basis for the establishment of MPAs in the United States is **Executive Order 13158**, signed by President Clinton in 2000. The three principal goals of the Order are as follow: (1) strengthen the management, protection, and conservation regime of existing MPAs, (2) develop a comprehensive system of MPAs based on scientific advice that represents the diversity of ecosystems, and natural and cultural resources; and (3) develop federally-funded activities to protect existing MPAs from any harm. The link between Executive Order 13158 and social science derives from some of the conditions stated therein: the need for science-based criteria and protocols for monitoring and evaluating the effectiveness of MPAs; the identification of potential threats and user conflicts that pertain to MPAs; the identification of appropriate management solutions, including enforcement strategies that could mitigate, reduce or eliminate those threats; and the assessment of economic effects of management solutions.

The National MPA Center - Science Institute has developed a social science research strategy for strengthening the application of social science in MPA planning, management, and evaluation, while catalyzing the interest in human dimensions as they apply to MPAs. The strategy addresses: (1) governance, referring to the structure and function of relevant institutions and processes; (2) patterns of resource use, relating to the intensity, significance, and spatial and temporal patterns of relevant activities; (3) attitudes, perceptions, beliefs, cultural models, and systems of meaning associated with human-environmental relationships; (4) market and non-market values and economic trends; (5) socioeconomic and cultural characteristics of both place-based and identity-based communities; and (6) cultural heritage and resources as socioeconomic dimensions of maritime heritage.



Several regional social science workshops have been held to address these themes and issues, and to discern regional variation. The resulting reports include recommendations and guidelines for enhancing regional capacity for social science research and documenting existing research, regulations, institutions, and information sources pertaining to MPAs.

This effort relates to the outreach and coordination role assumed by the Center. Similarly, public dialog sessions have been held with stakeholders, and online regional information centers have been established. The Center also supported and engaged several research projects to develop baseline data needed for MPA planning, management, and evaluation. This includes development of the **Marine Managed Area (MMA) descriptive inventory** of MPAs around the U.S. and its territories.

Other programs involve an MPA decision support tool being developed in cooperation with the Monterey Bay National Marine Sanctuary and the California Marine Life Protection Act Team. ***OceanMap*** was designed to collect and depict, in spatial terms, ecological knowledge of fishery participants for use in MPA planning processes. Reports such as *Enforcing MPAs* and *Lessons Learned from MPA Designations* have focused on stakeholder processes and the success and failures of models for stakeholder participation. As regards the future of the Institute, the West Coast Pilot Project will coordinate identification of priority conservation areas at a regional level.

Identification, implementation, and assessment of MPAs bear lessons for the establishment of ecosystem-based management strategies around the nation. The issues and data needs that apply to the MPA context may be scaled to inform the nascent ecosystem management process. The challenge lies in defining which data needs are truly essential.

3.2.8 NOAA Fisheries National Social Science Research Programs

Speaker: Susan Abbott-Jamieson
Senior Social Scientist
NOAA Fisheries Headquarters

Background. Susan Abbott-Jamieson is anthropologist and Senior Social Scientist at NOAA Fisheries Headquarters, Office of Science and Technology, Silver Spring, Maryland. She joined NOAA Fisheries following a twenty-five year career as a faculty member in the Department of Anthropology at the University of Kentucky. She is currently guiding the development of the NOAA Fisheries social sciences portion of the Economics and Social Sciences Program. This is part of the agency's effort to improve its ability to meet its mission-related social science research requirements. Dr. Abbott-Jamieson discussed social science data sources in the context of NOAA Fisheries social science research programs.

Presentation Summary. The recent history of social sciences such as geography, anthropology, political science, social psychology, and sociology emerged with the MSFMCA in 1996. Implementation of National Standard 8 (NS8) and appropriation of research funds in FY 1999 allowed NMFS to begin developing its **Social Science Research Program**. Its Sociocultural Analysis Component now employs ten full-time staff nationwide and operates on a budget of approximately $300,000 across six regions. Staff members are developing the **Sociocultural Practitioners Handbook**, community profiles and databases, a national community port database, and a Social Impact Assessment Conceptual Model. Various social science research is ongoing in a variety of topical areas, including: the dynamics of fishing crews, women in fisheries, and local and traditional ecological knowledge, among others.

Perhaps most relevant to ecosystem management considerations are the research program's **Community Profiles Databases and Indicators.** The Community Profiles Databases identify and profile communities and ports where fishing-related activities occur. Given the specific requirements of NS-8, fishing community analysis is place-based. NOAA Fisheries evaluates extent of community involvement in fishing-related activities, including those associated with commercial, subsistence, and recreational fishing.

The research program is creating and maintaining regional and national databases to support research and monitoring at the community level of analysis. These data may ultimately be of use in the development of fishery ecosystem plans. The databases incorporate a wide range of information relevant to fishing activities and local socioeconomic and demographic conditions. Key indicators that will help determine extent of involvement and engagement in fishing include pounds and value of landings attributable to the community, base economic activity generated by fishing or related services, and history of involvement in marine fisheries.

Once completed, the federal database will allow for comparative socio-cultural analyses of fishing communities and activities. Since ecosystem-based management approaches are likely to require the spanning of local and regional boundaries, the data will support analyses that extend beyond the community.

Participants in the ESSW should pay attention to a parallel effort being developed by agency and academic social scientists. The **Social Impact Assessment (SIA) Conceptual Model** project aims to make social impact assessments more compatible with those of biologists and economists. The effort corresponds with visions of integrating social science into fisheries ecosystem plans. The model incorporates data on community demographics; community jobs related to fishing and associated industries; crew, owner-operator, processor worker information; characteristics of fishing-related businesses; subsistence participation, landings, and consumption; species; governance and institutions; cultural heritage and resources; community resilience; public health and social problems; perceptions of the future; and perceived community identity.

3.2.9 National Ocean Service Social Science Program

Speaker: Peter Wiley
Economist - NOAA
National Ocean Service

Background. Peter C. Wiley is an Economist with NOAA National Ocean Service. In his sixteen years in this position he has concentrated on developing a better understanding of the dynamic relationship between human society and coastal and ocean ecosystem resources. Mr. Wiley received his bachelor's degree in economics from St. Mary's College of Maryland and his master's degree in economics from the George Washington University. His work has concentrated on the economic impact of management actions in National Marine Sanctuaries, strategic socioeconomic characterization and economic valuation of coastal and ocean resources, and estimation of the socioeconomic elements of marine-related outdoor recreation participation. Mr. Wiley's recent work has included characterizing and valuing ecosystem services for NOAA's Ecosystem Goal Team. Mr. Wiley's discussion focused on NOS social science integration and coordination.

Presentation Summary. The National Ocean Service (NOS) is one of the several NOAA line offices, as are the National Marine Fisheries Service (NMFS), the National Weather Service (NWS), the National Environmental Satellite, Data, and Information Services (NESDIS), the Office of Oceanic and Atmospheric Research (OAR), and the Office of Program Planning and Integration (PPI). NOS personnel are responsible for handling matters related to coastal zone resources and ecosystems, through the Office of Coastal Resource Management. Other NOS offices include the Office of Coast Survey, the Center for Oceanographic Products and Services, the Coastal Services Center, and the Sanctuaries Program, among others.

The development of an **NOS Social Sciences Plan** (SSP) dates back to work by Leah Bunce and a Social Science Review Panel. Several recommendations were issued by the Panel to the NOAA Science Advisory Board as a way to build social science capacity inside the institution. One of the proposed measures was that each line office should develop a social science plan. A **Social Science Team** was thus set up within NOS to determine the status and direction of social science in the agency. NOS social science needs are diverse and encompass distinct areas of inquiry: characterization of sanctuary resource use, evaluation of MPA use and impacts, socioeconomic monitoring, and providing assistance in management planning and technical support.

Several goals were defined to aid in initiating a coordinated effort to build social science capacity in NOS that would explicitly support both NOAA and NOS missions. The underlying vision aimed at strengthening program planning, management decision-making and performance measures to better integrate the biophysical and social sciences in NOAA, NOS, and outside organizations. The guiding goals were to: (1) enhance NOAA's ability to monitor, understand, evaluate, and communicate socioeconomic benefits; (2) acquire more accurate decision-support tools by integrating social science, biophysical science, and monitoring results; (3) increase models and methods for assessing the impact of human and natural disturbances; (4) improve the understanding of the needs, knowledge, perceptions, and values of NOAA's partners and their constituents.

Due to the complexity of this process and a need to harmonize the interests of social scientists and program directors, the SSP was constructed in several steps. Issues and needs for social science that would meet and support **NOS and NOAA social science-related missions were identified**. NOAA directors and key personnel then prioritized these. From this point forward, the social science team identified areas with better integration potential. Since an increase in efficiency, communication, and coordination between social scientists and users of social science within NOS was one of the major objectives, a database was assembled to better manage existing information. Due to specific demands, a dual-system database format was compiled, separately describing the personnel and projects components. This allowed for deeper and more flexible analysis of information at several levels (geographic, functional, chronological, etc.).

Members of the social scientist team were linked to a NOS Office and a NOAA program, working with them to develop social sciences-relevant missions within an integrated vision. The degree of effort required varied in part based on the existence of previous social science programs. One challenge related to the current structure of NOAA. NOAA programs define strategic planning and budgeting, while the line offices provide the operational and functional framework. Development of a social sciences plan for NOS had to take both perspectives into account. Later, NOAA Office of Program Planning and Integration would assume the task of integrating the NOS Social Science Program with those from other NOAA agency social science plans.

Important questions arose early in the process regarding the definition of social science. The following definition was used as a reference point for the SSP: “the process of describing, explaining, and predicting human behavior and institutional structure and change in interaction with their environments, to include the fields of economics, anthropology, sociology, geography, political science, social psychology, and history.”

Connection of social science with NOS Ecosystem Approach to Management (EAM) was the next step. In accordance with an NOS EAM Action Plan, this connection was established at the Ecosystems Goal Team (EGT) level. This would correspond to the lowest level of decentralization possible in NOAA, following the “bottom-up” approach defended by the Action Plan for the programs of interest: the Coastal and Marine Resources Program, the Corals Program, and Ecosystem Research and Habitat Restoration.

The **Coastal and Marine Resources Program** focuses on promoting healthy and productive ecosystems and incorporates socioeconomic and demographic factors in its management processes. There are 11 full-time social scientists in this program, distributed across the MPA Science Center, National Marine Sanctuaries Program, the Coastal Services Center, the Office of Coastal Resource Management, and the International Programs Office.

The **Corals Program** aims to preserve, sustain and restore coral reef ecosystems. These bring numerous benefits to society through the tourism and fishing industry, bio-prospecting for pharmaceutical research, protection of the shoreline, and so forth. With only one fully funded social scientist, this program relies extensively on NOS staff. Total NOS investment in social science amounts to $594,000 ($614,000 with partnerships), distributed by the Offices of Response and Restoration, International Programs Office, the National Marine Sanctuaries Program, and the Coastal Services Center.

Ecosystem Research focuses on providing scientific information and decision-support tools by integrating research from the biophysical and social science perspectives to advance understanding of ecosystems. The integration process is performed through assessment of information needs of coastal managers, coordination of biophysical and social science research, facilitating use of said research by coastal managers, and building local capacity and environmental literacy.

Finally, the **Habitat Restoration Program** is designed to improve the quality and quantity of coastal habitat restoration. The main role of social science in this program is in the area of damage assessment. This is accomplished via National Research Damage Assessment (NRDA).

Two specific examples of projects being developed by these programs include the **Regional Priorities for Research on MPA’s** project and the **Northwestern Hawai‘i Islands Reserve Commercial Bottomfish study**. The priorities project established to detect needs for social science research were at a regional level. Methodologies have included the development of several workshops, with focus groups, targeted discussions, and identification of regional priority projects. The bottomfish fishing study originated as a means for enhancing the Environmental Impact Statement and management plan for the Sanctuary Designation Process of the Northwestern Hawai'i Islands Reserve. The methodology was based on the assessment of existing information, an iterative survey of the fishers, and spatial analysis of logbook data.

3.2.10 Fisheries Management in the Western Pacific EEZ

Speaker: Paul Dalzell Western Pacific Fishery Management Council

Summary of Presentation. Senior Scientist Dalzell reviewed the unique and important features of the Western Pacific Region. The presentation expanded on regional issues outlined in his presentation on the first day of the workshop ("The Western Pacific Region and its Fishery Management Plans").

The **U.S. purse seine fleet** is an important aspect of the economy and fisheries in the Western Pacific region. A treaty between the U.S. and 16 Pacific island nations provides regulatory structure and authority over the fleet and other purse seine operations in the region. The seine fleet contributes substantially to the fisheries-related economy in the region, in large part because it supplies tuna to canneries in American Samoa.

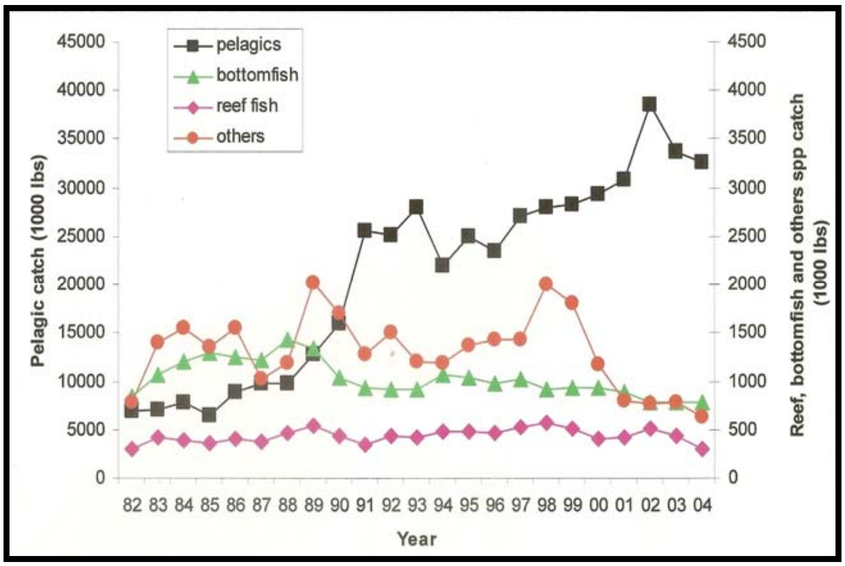
Troll fishing is the most widely practiced form of fishing in American Samoa. Bottomfishing and diverse reef fishing practices also occur here. Longline operations in American Samoa are subject to area closures. Large pelagic fishing fleets are subject to 50-mile closures around the islands, while the nearshore waters are open to small-scale longline vessels. The latter employ outboard motors and gear is deployed and retrieved without the use of hydraulics. American Samoa tuna canneries process more fish than any other in the world. Between 150 and 200,000 metric tons of skipjack, yellowfin, and albacore valued at between $250 and $300 million are processed on an annual basis.

Trolling is the most important fishery for Guam. Bottomfishing occurs predominantly on the southern banks. A small fleet specializes in deployment of short lines (less than one mile in length). Guam is a major point of air transshipment of seafood destined for markets in Japan, China, and Taiwan. Guam-based distributors typically send between 5,000 and 12,000 metric tons of large sashimi grade tuna to Tokyo. Exports were valued at $43 million in 2004. Various regulations such as the Shark Finning Act have impacted the transshipment industry, as have shifts in home-port preferences by longline operators.

The principal fishing methods in the CNMI are troll fishing and bottomfish fishing. A long distance bottomfish fishery operates to the north. Small-scale coral reef fisheries are prolific. There is an extensive skipjack fishery in Saipan.

The longline fishery has a long and productive history in Hawai‘i. An extensive small boat pelagic troll fishery operates within about 20 miles of the Main Hawaiian Islands. Participants in a smaller handline fishery target offshore banks, nearshore koas, seamounts, and weather buoys. Once popular as a source of fresh skipjack, the pole-and-line fishery is now almost defunct. The lobster trap fishery in the Northwestern Hawaiian Islands is under a moratorium. Trap fishing for crustaceans also occurs in the region, as does black coral harvesting. Trap, hook and lines, and spearfishing are some of the gear used to target reef fishes in the islands. Tropical aquarium fish collection has been increasing in intensity.

Area closures have been established to separate longliners from protected species in the Northwestern Hawaiian Islands, and in the Main Hawaiian Islands to separate them from small boats. Most fishing that occurs near Hawai‘i occurs around the main islands (~10,000 metric tons per year), while relatively little occurs around the Northwestern Hawaiian Islands (~100 metric tons annually; primarily bottomfish species).



Annual Domestic fishery Production in the Western Pacific Region

Recreation-oriented fishing is also important in Hawai‘i, in per capita terms perhaps more than anywhere in the country. Most people in the islands have a strong relationship to the sea and love to fish for a variety of reasons. But differentiating commercial, recreational, and consumptive-oriented fishers can be rather difficult in Hawai‘i, and nearly impossible in places like Samoa. Another factor that makes the region unique is the strong affinity for marlin. Marlin fishing is important for the charter vessel fisheries and it is also commonly consumed, sold, and otherwise distributed. There are close to **200 active charter vessels based in Hawai‘i**. Smaller charter fleets are based in Guam and CNMI.

The vast majority of landings in the region derive from pelagic stocks. While coral reef fishes (small pelagic species such as ‘*ōpelu* and *akule*) and various bottomfish have been subject to static or somewhat declining harvest, the harvest of pelagic species has increased by one percent or more each year. The Samoa longline fleet is increasingly productive. It should be noted that fisheries in the region are characterized by relatively low volume of landings and relatively high ex-vessel value. Virtually all seafood landed in the region is sold fresh.

3.2.11 Overview of Social Science Data Issues in the Western Pacific Region

Speaker: Craig Severance
University of Hawai‘i at Hilo
Member of WPFC-SSC

Background. Craig Severance is a cultural anthropologist at the University of Hawai‘i at Hilo, and a member of the Western Pacific Fishery Council Scientific and Statistical Committee. He also sits on the Council's Recreational Fisheries Data Task Force and Social Science Research and Planning Committee. He was a member of the National Research Council's Committee to Evaluate the Community Development Quota Program in Alaska and its relevance to the Western Pacific. Dr. Severance has done field research with fishermen and fishing communities in American Samoa, Commonwealth of the Northern Marianas Islands, Hawai‘i, Chuuk and Pohnpei. He has an interest in TEK, CMT, MMA, and SIA. He is a board member of Hilo Trollers and a part-time commercial, recreational and subsistence troller-handliner.

Presentation Summary. Despite political bifurcation, American Samoa and Western Samoa are bound by a single culture. As regards marine fisheries, although only American Samoa has a seat at the Council, there are significant interactions between both Samoas. There is much interaction and exchange. For instance, a shared albacore stock may present an opportunity for international co-management.

Understanding ***Fa‘a Samoa*** - the Samoan way – is critical to understanding society, culture, and human interaction with the physical environment in Samoa. The chiefs or *matai* hold great authority, and cultural identity and resilience among Samoans relate to respect for the matai system, and adherence to customs and traditions. Oversight of fisheries occurs at the village level and permission to fish in a given reef area is granted by local chiefs. Fishing and fish are central to local society and culture, and fishing-related matters are taken seriously.

Commercial fishing is particularly important in economic terms, facilitated in part by the presence of the canneries. In American Samoa, commercial permits and licenses are granted by the Department of Marine and Wildlife Resources.

The pursuit, capture, distribution, and consumption of seafood in this context are critically important. **Seafood circulates or flows across the community from point of extraction to point of sharing or consumption**, and important social processes and cultural meanings are associated with each exchange. Fish and fishing are pivotal in the cultural identity and vitality of the Fa‘a Samoa and its resilience, integrity, and continuity. Analysis of the flow of seafood is useful in this setting not only for enhancing understanding of its role in Samoan society, but also as a means for guiding management in a manner that is culturally appropriate and that ensures the well-being of local societies.

Chamorros are deeply involved in the pursuit of seafood in the Marianas Archipelago, which includes Guam and the CNMI. Although Chamorros are a minority population in the CNMI, the group tends to dominate the political landscape. Other ethnic groups are involved in fishing as well, including **Filipinos**, **Micronesians**, and **Carolinians**.

The social and cultural importance of seafood in the Marianas is exemplified in ***fiestas*** - festivities held in honor of the patron saints of the villages. Fresh fish is of paramount significance at these events. Captains and crew in the local fleets are seasonally focused on fishing for such events, raising questions about whether management scenarios can accommodate such cultural considerations.

Multiple cultures and social groups are characteristic of life in the Hawaiian Archipelago, and seafood is significant throughout. There is extensive demand for seafood products with distinct characteristics at different times of the year and for diverse ends - from the ‘*ohana* setting to Japanese and Chinese New Year celebrations to the mixed commercial-recreational fishery sectors. Again, analysis of the **flow of seafood** is an appropriate way of conceptualizing these culturally significant patterns of distribution and use.

Description and analysis of social and cultural systems associated with the pursuit, distribution, and use of seafood requires the capacity to conduct a specific brand of social science. There is limited potential in this regard in Samoa and CNMI. Generally speaking, there are **relatively few social scientists trained in research and analysis of fishing cultures and ecosystems**. Limitations to such investigation are further constrained by logistical factors, including long travel distances and costs, and language and cultural challenges.

Given that Pacific island societies have endured massive changes following the arrival of Europeans, resistance to research undertaken by outsiders is common. Incorporating local **community members as full and paid participants and as interviewers on the research team** has been effective in mitigating such resistance and in enhancing meaningful input in social science research conducted in American Samoa and CNMI. For example, a Samoan research team member recently developed a particularly useful social network approach for tracing the culturally important flow of fish backwards from the event of presentation and consumption to the source of the fish. This method is now being applied elsewhere in the region. Adequate representation of the perspectives of Pacific Islanders in the arena of marine resource management should be seen as more than just a diplomatic gesture. Rather, the necessary steps should be taken to enhance fisheries social science capacity throughout the region. One such step toward capacity building efforts in the region should involve implementation of properly focused graduate and undergraduate programs and internship programs.

3.2.12 Importance of Traditional and Local Ecological Knowledge in the Hawai‘i Context

Speaker: Paul Bartram
Cultural Practitioner and Scientist
from Moloka‘i, Hawai‘i

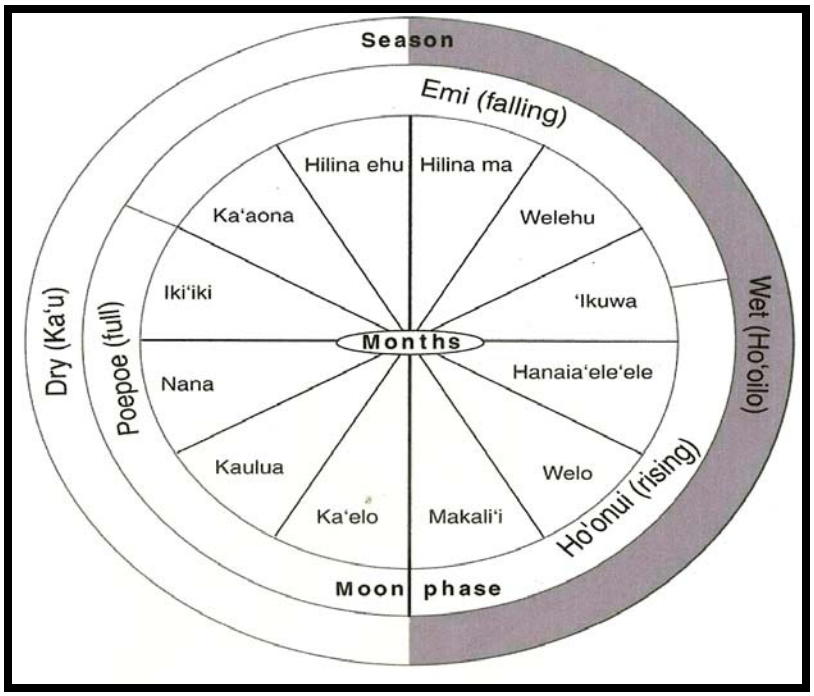
Background. Paul K. Bartram has over 20 years of experience in marine and coastal resources use, assessment, and management throughout the Pacific basin. Mr. Bartram is a member of Hui Malama o Mo‘omomi, a community organization that is revitalizing and applying traditional Hawaiian knowledge to coastal fisheries conservation on the island of Moloka’i, Hawai’i. He managed *‘Imi ‘Ike* (“search for knowledge”), a Native Hawaiian Education project that incorporated traditional Hawaiian learning approaches into public school curricula on Moloka‘i. Bartram also serves as an adviser to community-based fishermen’s organizations in Guam and American Samoa and he regularly consults for the Western Pacific Regional Fishery Management Council and other fishery organizations in the region.

Presentation Summary. While it is less than 50 miles from the island of O‘ahu, Moloka‘i is a very different island. It is rural and undeveloped. It is an ideal location through which to practice and illustrate traditional principles of Native Hawaiian interaction with the marine environment. Gauging and living in rhythm with local environmental cycles was and is critically important to the **Kanaka Maoli** (indigenous Hawaiians).

Hawaiians conducted and conduct research in the daily practices of fishing and through other extractive and observation-based forms of interaction with the physical environment. They also used and use models about that environment. **Cognitive models of environmental cycles** have been developed through observation of very long-term patterns over the course of many generations. Hawaiians traditionally monitored the moon, seasonal changes in resource behavior and abundance, and the nature of habitats. Such **observation-based models** formed the basis for regulating fishing pressure in certain times and places. Such models and related regulatory rationale were communicated between generations, and modified based on intimate and ongoing contact with the ecosystems and resources.

To the Hawaiians, the primary objective of fisheries management is to enable the sustainability of marine resources so that they may be used for purposes of consumption, sharing, celebration, and so forth. Consumptive or subsistence-oriented fishing is critically important in the Hawai‘i context. In some rural locations, **fishing may provide as much as 30 percent of the local diet.**

Ancient Hawaiians developed a code of conduct to regulate fishing. As nearshore fish aggregate in favorable locations called ***ko‘a***, the Hawaiians monitored these areas and decisions were made to open or close fishing based on environmental cues. A management action might have taken, for example, if one *ko‘a* seemed to be bearing an excessive burden such as carrying an unusually large proportion of spawning fish as compared to other nearby *ko‘a*.



Hawaiians also regulated fisheries by seasons and by the phase of the moon. There are two general seasons. The wet season, ***Ho‘oilo,*** typically occurs between November and April. The dry season, ***Ka‘u***, generally sets in between May and October. Nighttime fishing activities tended to be undertaken in the wet season and daytime fishing activities in the dry season. The lowest of the low tides in the winter months occur in the dark, and during the day in the summer.

Seasonality in tidal flux has profound effects on tropical shallow water reefs. Accordingly, under the Hawaiian system, certain fish could be taken at certain phases of the moon and left alone during others. The effects of lunar phase on fishing were and are believed to be profound and complex. In general terms, nights prior to the emergence of the moon are the best nights for nearshore fishing, while the Whole Day Nights or full moons are thought to present poor conditions for nearshore fishing. Moons like egg drops, or those before the full moon, are considered good for pursuit of offshore pelagic species. .

[Mr. Bartram was asked to respond to the suggestion that Western science is not needed in this context, but rather a good understanding of local culture and a way to facilitate it in the resource management context. He responded that this may hold true in some places, but less so in those areas where indigenous residents have been displaced. The Hawaiian system requires that participants have been continually associated with ecosystems and that a social and cultural system is extant to enable its conduct and enforcement. In historic times, the timing and nature of marine resource management varied across the Hawaiian Islands depending on local conditions, knowledge, resource migration patterns, and so on. The key was and is localized knowledge and an established system of social interaction with and informed awareness of ecosystems and associated resources.]

3.2.13 Fishing, Culture, and Data Collection in American Samoa

Speaker: Fini Aitaoto
WPRFMC On-Site Coordinator for
American Samoa

Background. Fini Aitaoto is a licensed grant writer and federal grants instructor. He was the former Acting Director and MIS Manager for the Department of Marine and Wildlife Resources for more than 20 years. He has served on all of the WPRFMC Plan Teams and is the Council's American Samoa On-Site Coordinator. He is former Executive Director for two NGOs and is a Samoan High Chief. Fini graciously provided a hard copy report titled "Notes on Certain Social Science Issues Relating to Fishing in American Samoa."

Presentation Summary. American Samoa tuna canneries employ about one-third of the roughly 15,000 documented employees in the country. Another several hundred persons supply the fish. Subsistence-oriented fishing is also important for American Samoans in various ways- dietary, cultural, social. The 660,300 pounds landed in 1994 by the inshore subsistence-oriented fleets constituted almost 30 percent of total landings that year. Shoreline fisheries involve the harvest of over four times the amount of commercial landings of pelagic and bottomfish. While the shoreline fishery is thought to be stable in terms of catch and effort, the accuracy of landings data is uncertain.

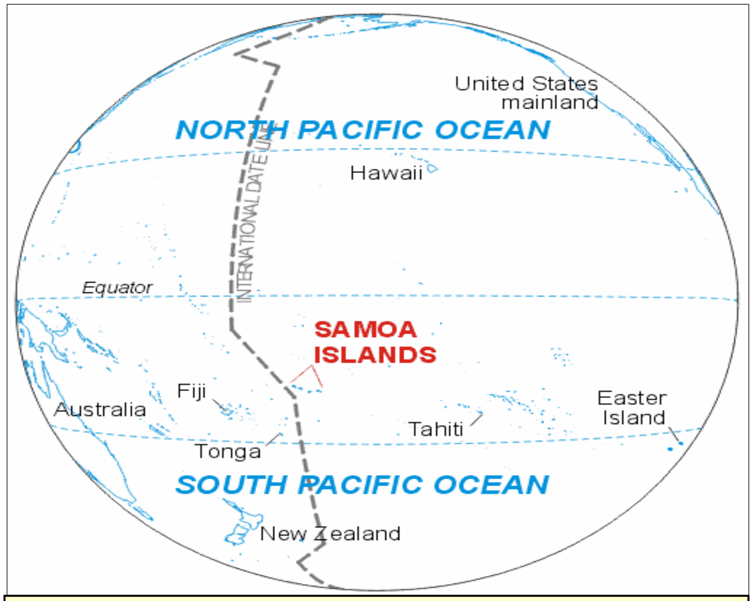
Commercial fishing in Samoa is discussed elsewhere, and is not the subject of focus here. Last year there were only six ***alia*** longline operations active in American Samoa, down from 38 or so in 1996. A recent study of the fleet indicated that albacore catch rates are low, consistent with overall decline in albacore fisheries throughout the larger region. Declining market prices, occasional shortage of bait, and increasing fuel prices are contributing factors.

Imported foods account for some 83 percent of the American Samoan diet as measured by value. In 1990, 23 percent of reef fish sold in the local markets was imported, but two years later the figure had increased to 78 percent. Because the domestic small-boat fleet has been unable to provide a consistent supply of fresh fish for the local community over the last decade, seafood increasingly has been imported from Western Samoa.

American Samoans tend to have higher standards of living than their cousins to the west, and generally utilize reef marine resources to a lesser degree. However, in the last few years, local reef resources such as *limu* (seaweed), sea urchins, and *alili* (*Turbo spp*.) have appeared in American Samoan markets for the first time.

Fa'a Samoa is the term for the Samoan way of life or how Samoans live, do, and perceive their world. Since the 1840s, the power and influence of churches and clergy has grown and exerted significant influence of foreign religion on Samoan society and culture. The gradual acceptance of Christianity stems partly from the fact that Samoans have long had a creator concept, and partly from an open spirit of hospitality and willingness to adapt.

Fishing-related stories and customs are an important part of Samoan culture. Many proverbial expressions originate from fishing experiences, and the Samoan language is rich with names of marine creatures and fishing gears and methods. While missionaries and other sources have led to change among Samoans, it is important to realize that outside influences have not always been degrading and threatening. Western education has had a positive effect in that it lead to the convening of the International Samoan Language Commission, the establishment of a local university, the publication of over 30 books on Samoan language and culture, teaching of Samoan culture in high schools and community colleges, and the perpetuation of the Samoan language through federally funded programs. The churches were the primary vessels for preserving and teaching Samoan language and culture prior to public schools. The **Samoan bible** remains the leading authority of the formal Samoan language.



American Samoa
The Territory is located just east of the International Dateline; the Capital (Pago Pago) is located at 14.23° South and 170.56°West

Samoans continue to follow some **traditional fishing practices**, and while commercial fishermen are not required to provide portions of their catch to the chiefs and the community they will occasionally donate catch to festivals of family or community events. Providing fish to relatives and friends waiting at landing sites (*tapuaiga*) is a traditional fishing practice that is still widely observed. Similarly the practice of providing and consuming fish for Sunday brunch is common to this day. The communal seining of the polychaete worm *palolo* (*Eunice viridis*) in October and November each year continues to involve whole villages. Another fishing method that involves the whole village and is still practiced in certain areas is the *lau.* Villagers gather on the inner reefs and use strings of coconut leaves to surround and trap *atule.* As for *palolo*, it was traditionally taboo to sell the *atule* catch, but it is now commonplace to see the fish sold at roadside.

Some fishermen have been using illegal fishing methods around Tutuila for some years despite the fact that disruption of nearshore marine ecosystems for commercial gain is culturally unacceptable. *Ava niukini*, a traditional fish poison extracted from the local plant *futu* has been used. One group used dynamite in 2005, and a group of Tongan fishermen reportedly used bleach to land reef fish around Tutuila.

A number of problems currently challenge fishermen in American Samoa. These include the following: (1) airline service necessary for the export of fresh fish is often unreliable; (2) no market for incidental catch landed by operators of the larger vessel fleet; and (3) the Fish Aggregating Device program is sporadic. Also problematic, compared to neighboring independent Samoa, is a lack of fisheries-related development programs. Moreover, professional grant writers are needed to assist the government in applying for various federal grant monies. Finally, the importance of fishery-related industries in American Samoa cannot be overstated and the potential departure of the tuna canneries is an immediate and serious issue. Tightening of immigration laws has rendered many Western Samoan cannery workers ineligible to work in American Samoa and thus there is an ongoing cannery worker shortage.

There are some positive signs and potentialities for fisheries development in American Samoa. An increase in the number of American Samoan charter boats may help the struggling tourism industry. Although the giant clam aquaculture project is no longer operational, the facilities exist and could be used once funding is available. A variety of NGO and family fish farms are currently operating in American Samoa.

As regards fisheries data and data collection, DMWF conducts an **Offshore Creel Survey,** sampling participants in the region's commercial, recreational, and subsistence fisheries on two weekdays and one weekend each week. There is a commercial invoice system as well. This requires that outlets buying or selling fish complete an accounting invoice each month. Inshore surveys are conducted irregularly, but seven different studies may provide valuable information about recent and historic activity. Data sources also include: (1) community-based MPA programs in four local villages, (2) records of various fishing tournaments held since 1974, (3) the federal longline logbook system, (4) monthly reports of fish processed and landed at the canneries, (5) intermittent market surveys and special projects, and (6) the giant clam project.

Efforts to effectively manage fisheries resources in American Samoa are challenged by issues related to adequate enforcement, representation, and jurisdictional authority. Local enforcement of the community-based MPAs may suffer from ambiguous authority, as well as poaching and variable levels of support beyond community boundaries. Several local residents have voiced the need to elect state legislators rather than nomination through a local council. Fishermen and fisheries managers prefer a fisheries-proactive representative to assist in DMWR mandated duties. The lack of a unified voice of local fishermen is partially due to the absence of a fishing association. Of several formed over the years, all but one has been disbanded. Jurisdictional issues have arisen between DMWR and the USFWS relating to the administration of Rose Atoll.

Maritime boundaries between American Samoa and Western Samoa are not formal and have led to jurisdictional issues regarding regulatory enforcement.

Moreover, there are staffing problems at DWMR. A lack of local biologists is likely due to small numbers of American Samoan students studying marine biology, and the need to improve the marine science program at the local community college. While DWMR biologists report conflicting views on the status of some reef fish stocks and the general health of reef ecosystems, all agree that a local stock assessment is sorely needed. Mr. Aiaoto offered a word of caution regarding collection of valid information while working in villages in American Samoa, noting that it is essential to take a **culturally suitable approach** and to ask appropriate questions.

3.2.14 Monitoring and Forecasting Ecological Change in the Mariana Archipelago

Speaker: Judith R. Amesbury
Micronesian Archaeological Research Services

Background. Judith R. Amesbury is an archaeologist with Micronesian Archaeological Research Services, Guam. She received her education at the University of Arizona. Before moving to the Pacific, she worked on Native American and Spanish sites in Arizona, as well as the Neanderthal cave site of Tabun in Israel. In Hawai‘i, Amesbury worked for the Bishop Museum and the State Historic Preservation Division. She has now been conducting archaeological research in Guam and the CNMI for more than 20 years. Her area of expertise is analysis of archaeological faunal remains, which has led to an interest in long-term fishery data, indigenous fishing, and fishing communities. Ms. Amesbury's presentation was titled "Monitoring and Forecasting Ecological Changes in the Mariana Archipelago."

Presentation Summary. The Marianas Archipelago is subject to a **wide range of biophysical sources of change**, including typhoons, super-typhoons, drought, fires, El Nino Southern Oscillation (ENSO) events, volcanic eruptions, and earthquakes. Humans also exert impacts. In Saipan, for instance, bombs and vessel gouging pockmark some reef systems. Military structures have been built to the very edge of the shoreline, and lands farther inland show evidence of large-scale development and agricultural activities. Given the long history of biophysical and human effects in the region, longitudinal data and analysis are required to fully understand and effectively monitor terrestrial and marine ecosystems here.

Assessment and monitoring human and physical environmental sources of change would serve to inform and enhance the development of effective fishery ecosystem plans. Research should focus on factors that shape ecological rhythms and sequences. Understanding of the timing of seasonal fish runs would reciprocally contribute to understanding of subsistence activities. Assessing and monitoring extreme events such as typhoons, super-typhoons, and **ENSO events** for several years would aid in understanding biophysical limits on long-lived species and other dynamic processes in the physical systems. ENSO events have been shown to lead to a wide range of effects, including lower than average sea levels, higher water temperatures, and droughts. Typhoons can lead to extensive terrestrial runoff. While such events can significantly affect coral reef ecosystems, the associated biophysical processes and dynamics are not well understood in the CNMI.

Habitat structures, key determinants of fish assemblages, are highly variable across Guam and the CNMI. When considering protected areas, habitat structure would ideally be evaluated and planning would seek to ensure protection of a range of habitats. Structural factors might include: number and size of holes; rugosity; extent and nature of live coral (especially finger coral); extent of coral cover; water quality; presence of fleshy seaweed and sea grass; presence and extent of mangroves; the presence of barriers that fragment habitat; and the measured or potential influence of typhoons.

Nationally-prescribed sampling and testing efforts to assess local habitat quality will soon be implemented in Guam. Surface and nearshore coastal water quality testing will be conducted by the Guam EPA according to nationally-standardized protocols. Water, sediment, habitat, and plant and animal life will be sampled from the shoreline to the 60-foot contour. Such efforts in the CNMI are ongoing and include EPA-required water quality testing at 46 sites. The **CNMI Marine Monitoring** team is assessing and monitoring coral communities, benthic communities, and the abundance of invertebrates and fish in different habitats and watersheds throughout the southern islands.

One effective indicator of potential utility for the development of fishery ecosystem plans in the region is seafood consumption. A range of variables could contribute to such an indicator: consumption of seafood versus other food products, rate of seafood consumption, species consumed, and the percent of locally-landed food fish. Consumption in the CNMI has declined dramatically since the 1940s when life in the region was relatively insular and islanders depended so heavily on seafood. Some 365 pounds of seafood were consumed per person per year in 1940. This rate of consumption diminished significantly over the following decades. The situation was similar in Guam where, as of 2002, only 57 pounds of seafood were consumed per person annually. Consumption patterns may reflect growth in the cash economy, and a concomitant decrease in reliance on subsistence fisheries and home cooking.

Given the extent of **cultural variability** in the CNMI, use and consumption patterns vary extensively. A wide variety of nearshore species are pursued and consumed, including sea cucumbers, small crabs, varieties of mollusks, and a wide variety of reef fish. The importance of seafood in the CNMI is suggestive of a need to assess and monitor security and resiliency of foodstuffs, rates of local seafood production versus imports, and general seafood consumption patterns. This relates in part to the potential for planning a **suite of fish refuges** in the region to provide protection against all types of disturbances, such as wave exposure, natural predators, and people.

One means through which pertinent environmental and ecosystem conditions might be effectively monitored and communicated for the Mariana Archipelago is through an annual report that would relate to the FEP for the region. A model for the structure and content of such a report would need to be developed through the collaborative input of the Council and other fishery management entities in the area.

3.2.15 Fisheries Management Challenges and Related Issues on Guam

Speaker: Jesse Rosario
University of Guam
Indigenous Fisheries Expert

Background. Jesse Rosario is with the Office of the Dean of the College of Natural and Applied Sciences and the Office of the Director of the Agricultural Experiment Stations at the University of Guam. He is an indigenous fisherman from a long line of Guam fishermen, and has a long-term understanding of marine ecosystems in the region. He has been involved in community-based fishery management on Guam for many years. Mr. Rosario's presentation was titled "Managing Guam's nearshore Fishery and Fishery Impacts."

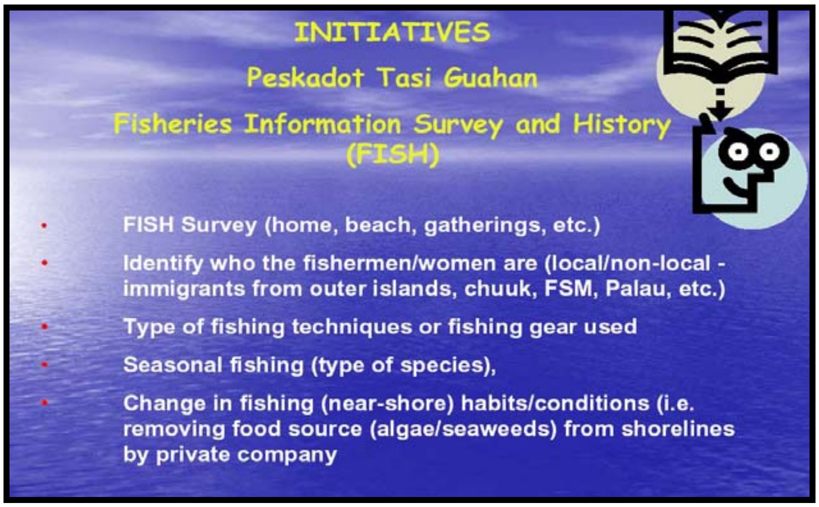
Presentation Summary. Guam is a relatively small island, 35 miles long and no more than about nine miles wide. Yet its nearshore ecosystems have historically supported both local villagers and people from neighboring islands. But changing social conditions, pressures, and resource management strategies have preceded several marine ecosystem-related problems.

The **tourism industry** has been growing. Hotel owners have developed strategies to attract more visitors. Many have begun advertising and implementing various leisure activity programs that are tending to conflict with the resource use patterns of local fishermen. The use of jet skis in and around fishing areas has led to some such problems. Moreover, hotel operators are allowed to manage activities and resources 33 feet seaward of the high water mark. As such, many have undertaken various actions with the intent of improving the experience of their patrons. For instance, some have removed algae from certain areas to improve the bathing experience, with implications for the status of the nearshore ecosystems.

Regulatory actions have had a significant effect on fishing and fishery participants around the island. Guam has **five MPAs:** one is located north of the island, three along the west-central region and one is south of the island. Establishment of the protected zones has led to heightened tension between harvesters who have had to concentrate fishing effort in ever-smaller areas. Political effects include assertions about inequitable treatment of persons violating protected area boundaries. Some fishermen report that establishment of the MPAs and subsequent spatial changes in fishing effort have led to more rapid depletion of certain fish populations than would have occurred otherwise.

It is thought that local fisheries may also change as a result of policies regarding the definition and regulation of subsistence-oriented fishing. Under **Public Law 228**, the definition of such fishing effort would be limited to household consumption only and would prohibit customary trade of the catch.

Imperiled by the actions of hotel owner-operators is the *manahak*, a traditionally pursued nearshore species. Typically, pursuit of the fish occurs in spring and summer, with distribution of the catch among relatives and neighbors within and between villages. Disruption of algae beds and Jet Ski use significantly disrupts this fishery.



The **Fishery Information Survey and History (FISH) project** has been undertaken to characterize Guam fisheries. Data is being collected regarding the characteristics of the fishers, including local residents and fishers from other islands; fishing gear and techniques; targeted species and seasons; and perceived changes in fishing habits and conditions. The survey is expected to contribute to an historical and cultural assessment of fishing and associated challenges on Guam.

Other local fisheries projects include a public awareness campaign to inform residents and visitors about traditionally important marine resources, biological cycles, and existing regulations. A **watershed research project** is being developed by the University of Guam.

A future goal is to establish a common platform to facilitate interaction and cooperation between Guam and federal agencies, fishery participants, relevant businesses, and other partners. The intent is to enable initiatives to improve the status of marine resources and ecosystems, increase capacity for regulatory enforcement, and encourage responsible fishing and shoreline management practices.

3.2.16 Fisheries and Social Science Data in the Commonwealth of the Northern Marianas

Speaker: John Gourley
Micronesian Environmental Services
CNMI

Background. John Gourley is owner and principal of Micronesian Environmental Services, a firm specializing in environmental regulatory permitting issues associated with terrestrial and marine environments. Previous training grounds include the Virginia Institute of Marine Science, UT Port Aransas Marine Lab, and the U.S. Fish and Wildlife Service. John arrived in Saipan in 1989, working as a fishery biologist for the Division of Fish and Wildlife. He has been active in the CNMI consulting arena for the past 11 years. A former WPRFMC Advisory Panel and Plan Team member, John is associated with the Industry Advisory Council of the Center for Tropical and Subtropical Aquaculture, and the environmental and government affairs committees of the Saipan Chamber of Commerce. He discussed the contemporary fisheries context in CNMI.

Presentation Summary. The CNMI is comprised of 14 islands, five of which are inhabited. The smallest, Farallon de Medinilla, is used as a bombing target by the Department of Defense. The five southernmost islands are fairly well developed limestone platforms with outlying barrier reef and/or fringe reef systems. The nine northernmost islands are more volcanic in nature and there are active vents on a few of the islands. Saipan is the largest island of the group. Most (90 percent) of the approximate 70,000 or so residents of CNMI live on Saipan, and most of the economic activity also occurs here. The populations of Tinian and Rota comprise approximately five percent of the total population. A few families live on a couple of the northernmost islands.

The population of CNMI is **ethnically diverse**. Indigenous Chamorro and Carolinian ethnic groups comprise about 24 percent of the population and have traditionally maintained positions of political power. The sitting governor is the first Carolinian to reach this position.

With regard to **ethic dimensions of participation in the labor force**, Filipinos tend to work primarily in the service industry. Many are employed in hotels and restaurants around the islands, and in the construction industry. Persons of Chinese ancestry tend to be employed in the garment factories, an industry limited to Saipan. Persons of Korean and Japanese ancestry tend to work in various retail and wholesale business firms.

Persons of other ethnic backgrounds have also made CNMI their home. For instance, persons from Chuuk, Yap, and the Marshall Islands may immigrate under the Compact of Free Association and many such persons now reside in the CNMI.

COMMONWEALTH OF THE NORTHERN MARIANA ISLANDS

ETHNIC COMPOSITION

Filipino	18,141	26.12%
Chinese	15,311	22.12%
Chamorro	14,749	21.31%
Other races/mixed race	7879	11.38%
Carolinian	2,652	3.38%
Korean	2,021	2.92%
Palauan	1,685	2.43%
Chuukese	1,394	2.01%
African American	1,240	1.79%
White	1,012	1.46%
Japanese	952	1.38%
Bagladeshi	873	1.26%
Pohnpeian	640	0.92%
Nepalese	300	0.43%
Yapese	204	0.29%
Marshallese	112	0.16%
Kosraean	56	0.08%

Economic conditions in the region are challenging for many. Minimum wage is $3.05 per hour, and low wages are common, except in the public sector. Median income is $25,853, roughly half of the reported median income for families in the United States in 2000. This has implications for pressure on the region's marine resources in that consumptive-oriented fishing and shoreline gathering are common across many of the aforementioned groups, and each group tends to take a different approach to the harvest.

There is extensive diversity in marine species across the region. For instance, there are approximately **256 species of corals and over 1,100 species of nearshore fishes** here. Species diversity diminishes somewhat in the more northerly volcanic islands, where the development of coral reef has been less extensive than elsewhere.

A **controversial history of marine management** is associated with the northern islands in the chain. Some sanctuaries were designated by public law in the absence of public hearings or opportunities for public comment. Bird Island and Forbidden Island are managed to protect single species. There are currently eight MPAs around CNMI; some protect single species (e.g., sea cucumbers or trochus), while others protect important habitat. These vary widely in terms of primary form of protective measure.

3.2.17 Systematic Research of Marine Protected Areas in the Pacific

Speaker: Patrick Christie
University of Washington
School of Marine Affairs

Background. Patrick Christie received his B.S. in Zoology in 1987 from the University of Wisconsin-Madison, his M.S. in Conservation Biology in 1993 from the University of Michigan, his Ph.D. in Natural Resources and Environment in 1999 from the University of Michigan. He has been Assistant Professor, School of Marine Affairs at the Jackson School of International Studies, University of Washington since 2001.

Patrick recently concluded a three-year research project in the Philippines and Indonesia investigating challenges associated with coastal environmental management over time. His current work includes feasibility studies of expanding World Heritage sites to include marine systems globally and implementing ecosystem-based fisheries management models in the Philippines. Patrick conducted graduate research on the Caribbean Coast of Nicaragua, where he studied the potential of participatory research for improving environmental management. Patrick was previously involved in the implementation of a community-based marine protected area in the Philippines as a Peace Corps Volunteer. He is Associate Editor for the journal *Coastal Management*. Dr. Christie's presentation was titled "Socio-ecological Indicators for MPA Evaluation."

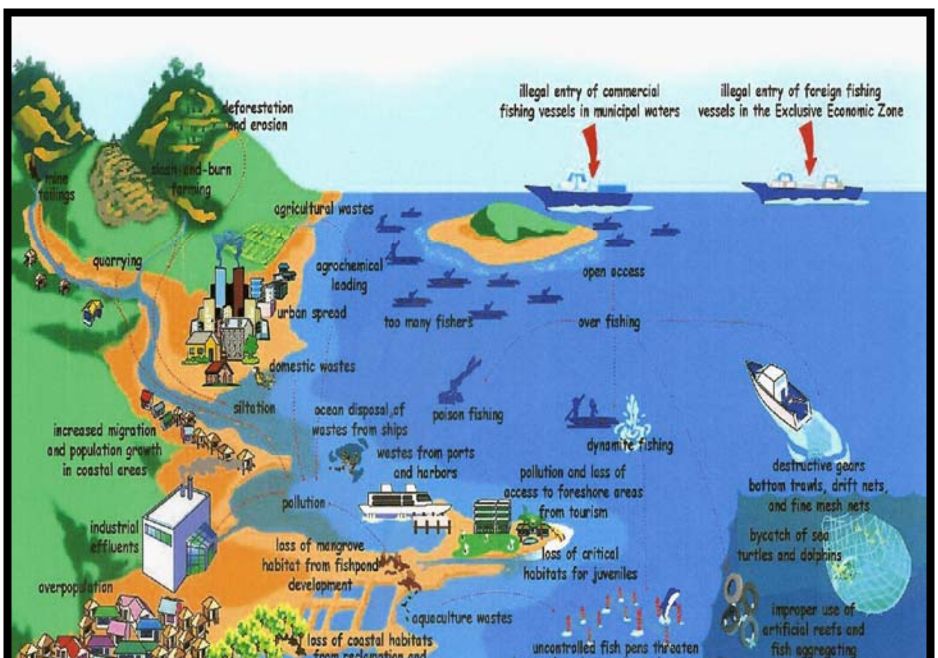
Presentation Summary. **Marine Protected Areas** are popular mechanisms for protecting marine ecosystems and resources. They have been championed by marine biologists in a variety of contexts. But comparatively little is known about human dimensions of MPAs despite that humans desire to establish MPAs, do establish MPAs, and are affected by the establishment of MPAs. As such, MPAs should not be evaluated solely in terms of biological success. Rather, both biological and social factors and outcomes should be examined and assessed.

Contestation about the placement, nature, or perceived or actual effects of a protected area can quickly cause problems in a given community. Some such problems can be avoided through effective planning and public input. For example, in cases where user groups are known to rely on resources associated with a proposed MPA for their living or for recreational purposes, carefully negotiated interaction with those groups prior to the setting of rules and boundaries may help mitigate potential conflict. Further research on the effectiveness of such efforts and development of new strategies for minimizing community problems is called for.

MPA-related research and monitoring efforts around the world would benefit by following principles for incorporating social needs and objectives. These include: (1) consistently **monitoring MPA programs** using scientific and participatory methods and indicators such as food security, government support and accountability, improved or restored fisheries, sense of pride in local management, etc. (2) using comparative in-depth qualitative and quantitative research to develop theory and new models regarding human dimensions of MPAs, (3) integrating research across the natural and social sciences, and (4) linking information generated through research and monitoring to real-time management.

Government agencies typically operate with specific information needs and management goals and objectives. But MPA programs are highly complex and often contention-laden, with issues and questions that extend beyond the informational parameters of such agencies. Thus, MPA-related research should be both **mandate-responsive** and **mandate-independent**. For example, mandate-responsive research might involve the conduct an economic valuation for the purpose of determining appropriate visitor fees to an MPA area that could have an underwater dive viewing option. In the same setting, mandate-independent research might investigate the capacity of that agency for monitoring or enforcing such an option.

MPAs can be biological successes and social failures. There are, therefore, long-term implications to focusing solely on biological considerations. Evaluative work in the Philippines is relevant. The Tree Hill MPA was established through a community-based participation process. Community participation was initially extensive. While establishment of the MPA was shown to precede improved coral cover, fish abundance, and species diversity, social science-oriented indicators of sustainability were not so positive. Evaluation work indicated that some persons were marginalized during the public participation process. It appears that this preceded disengagement from the group, and subsequently non-compliance and poaching. While biological assessment of the Tree Hill site indicated success in the short term, that assessment is conditioned by problems of "buy-in" by the full range of resource users. The long-term success of the program is therefore in jeopardy.



Effective **indicators** in this context tend to be composite variables best determined and measured through interviews and survey work. One particularly important indicator relates to the size of the affected communities and alternative means of income for those who use or used the resources in the prospective or established MPA. The Fish Project at www.oneocean.org provides some social variables for consideration in evaluating and monitoring the success of

MPAs. Potential indicators include: (1) use of ecological knowledge in the planning process, (2) establishment of a program to inform user groups and the public about the nature and intent of the MPA, (3) steps taken to minimize conflicts related to the cultural backgrounds of the involved parties, (4) means for enhancing acceptable relocation of fishing effort or other use of resources, (5) established mechanisms for enforcement, (6) improvements in fish biomass, (7) improved management of threatened species. Both process-oriented and outcome oriented indicators are necessary components of assessment and evaluation.

[Drs. Pollnac and Hennessey discussed the potential for identifying and **standardizing social variables and indicators** for evaluating and monitoring the success and sustainability of MPAs. Dr. Pollnac discussed the importance of specific composite variables for evaluative purposes: (a) satisfactory input of municipalities, (b) preliminary visits by officials, (c) participation of an early core group of stakeholders, (d) alternatives for earning income, (e) monitoring by the community, (f) numbers of initial training meetings or programs, (g) development of an MPA "features" score, and (h) assessment of regulatory compliance. All of these factors were highly correlated with the "performance" of MPAs.

Dr. Hennessey suggested that it may be useful to conceive relevant social variables in terms of the way they are interrelated. He also noted the potential utility of incorporating lessons from **global MPA networks** and experiences when developing indicators and models of MPA performance in the Western Pacific.

Dr. Aswani[3] discussed the importance of assessing **spatial** and **nutritive dimensions of MPAs**. For instance, displaced fishing effort can lead to human health consequences in populations dependent on marine resources for purposes of subsistence. This can be indicated in disproportionate effects on the health of women. Moreover, limiting or precluding effort in one area can lead to increased pressure on adjacent biological resources in adjacent areas, with implications for human groups dependent on resources in the latter. Effective assessment of MPAs therefore requires sufficient incorporation of spatial

[3] Dr. Shankar Aswani is Associate Professor of Anthropology and the Interdepartmental Graduate Program in Marine Sciences at the University of California at Santa Barbara. He is also a Senior Research Fellow at the University of Auckland and has conducted more than a decade of research in the Solomon Islands. In 2005, Shankar became the first anthropologist ever to be awarded the prestigious Pew Fellowship in Marine Conservation. He is currently involved in a range of projects in the Pacific and has developed a field school for ecological anthropology in the Solomon Islands. For more details, see www.anth.ucsb.edu/faculty/aswani

and socio-cultural considerations. Given implications for the physical well-being of humans, these may in fact be the most important considerations in the design of MPAs in the Pacific and elsewhere.

Dr. Severance indicated the importance of the fact that Dr. Christie recognized the **colonial history** of the Philippines in his interactions with indigenous research participants. The colonial context across the Pacific region is highly relevant to effective research and establishment of management frameworks such as MPAs. Historical processes influence the status and perspectives of prospective research participants across the region. These include the illegal overthrow of the Hawaiian monarchy, treaties in the Samoa Archipelago that were not agreed to by all parties, and transfer of colonial power in the Mariana Archipelago. These condition the manner in which local persons may react to new researchers, regulations, and evaluative programs now and in the future.]

3.2.18 Social Science Approaches to Ecosystem-based Management and Conservation

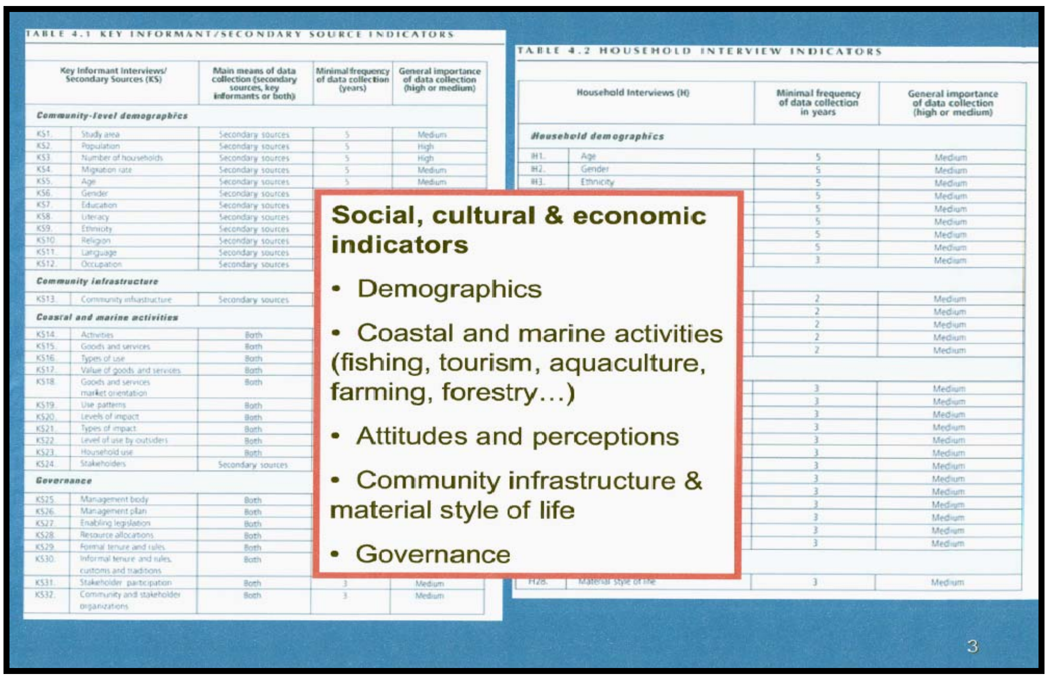
Speaker: Leah Bunce
Conservation International

Background. Leah Bunce is Senior Director for the Marine Management Area Science Program, a program based within Center for Applied Biodiversity Science of Conservation International. Dr. Bunce is a marine social scientist with roots in the natural sciences. She has focused on applying science to conservation throughout her career. She has a BA in Biology from the University of Pennsylvania and a Ph.D. in Environmental Studies from Duke University, where she focused on the socio-cultural aspects of marine conservation in developing nations.

Dr. Bunce joined the National Oceanic and Atmospheric Administration's (NOAA) International Program Office in 1998 after consulting for the World Bank, Organization of American States, and the Island Resources Foundation. At NOAA, she developed a global program for socioeconomic monitoring for coastal managers, coordinated various international coral reef and marine protected area activities, and served as one of the social science advisors to the agency. Dr. Bunce gave a presentation titled "Social Science and the WPRFMC: Know Thy Client and the Devil is in the Details."

Presentation Summary. Social scientists working in the context of marine resource management face challenges beyond those of social scientists working in other realms of inquiry. These include the tendency of resource managers and other scientists to prioritize biophysical research and research findings above social science and social science research findings. Managers also tend to fail to recognize that social research typically involves highly complex issues and subject matter, and that while biophysical researchers may be involved in single projects for months and years, it is often expected that social science projects should be completed much more quickly. Some scientists and managers tend to use terminology which positions social science as 'the other' or lesser science, or they simply refer to it in contrast to science. Yet others assume social science simply means outreach and communication. In reality, social science methods are as sophisticated and capable as any other, and are employed to examine phenomena that are in reality as or more complex than those addressed by the biophysical sciences. Equal investment of time and energy in the social and biological sciences is clearly called for.

Social science research and monitoring can generate information of profound importance to managers of marine resources around the globe. Particularly viable avenues of inquiry (and determination of indicators) include: (1) socio-demographics (gender, ethnicity, literacy, religion, occupation, etc.), (2), participation in activities like fishing or tourism (location, seasonality, type), (3) community infrastructure and ways of life, (4) perceptions and experiences regarding the condition of and threats to marine resources, and (5) mode and manner of governance. Social science can help analyze the effectiveness and effects of MPAs with regard to each of these dimensions, among others.



It is critical that the local social and physical environmental contexts within which these factors are framed are well-understood. It is critically important to understand the nature of the marine activities that are taking place, where the efforts of the user groups are focused, relevant dimensions of relationships between the participants, and relationships between the participants and the physical environment.

Spatial dimensions are pivotal. For example, prior to establishing the Dry Tortugas No Take Reserve, those responsible for establishing the Florida Keys National Marine Sanctuaries undertook spatial examination of the potential biophysical and socio-economic impacts that could result from the proposed management decisions. The resulting cartographic products illustrated how spatial use patterns in various fisheries could change under a no-take reserve. These were subsequently used in discussions with stakeholders to examine tradeoffs and to help determine the most practical and tractable management actions.

Ecological knowledge retained by persons in community settings can offer enormous assistance to scientists and managers involved in ecosystem planning and management. Such knowledge is accessible through social science research methods and can assist in tailoring management strategies to the peculiarities and nuances of the local context. Social science can further contribute to understanding of that context by description and analysis of local customs and traditions, use patterns, and dependence on and values regarding marine resources. Such analysis can demonstrate the value of marine resources in terms that policy-makers and the public appreciate.

Social science can also aid in identifying viable **economic and social incentives** through which communities may benefit by conserving adjacent natural resources. For instance, such research may identify **alternative sources of income**, including alternatives that may result from new forms of management. It may also serve to identify and describe key stakeholders and patterns of social relations and tendencies that suggest likely support or opposition to new forms of resource management. Finally, social science can help in identifying **human threats to marine ecosystems** and situations and sources of potential benefit to the health of those systems.

[The **Global Socioeconomic Monitoring Initiative**, conducted through the NOAA Global Coral Reef Monitoring Network, has involved development of: a series of guidebooks, conduct of socioeconomic training sessions, and funding for monitoring social factors at specific sites. Dr. Orbach noted that these programs are particularly useful because they are at once focused on coral reef issues and customized to the social and cultural conditions specific to different regions of the world. The guidebooks in particular may be useful in developing the FEPs in the Western Pacific region.

Dr. Christie cautioned that local people do not always respond well to managers arriving with a guidebook or model in-hand, even if they come with the most collaborative of intentions. He suggested that guides such as "How is Your MPA Doing?" are intended for use by community practitioners and managers rather than social scientists. Questions addressing issues such as where regulations coming from, how they may be made appropriate for each location, and whether and how they may be incrementally introduced are critically important in community settings, but additional mechanisms may be needed to provide sufficient answers.

Dr. Aswani asked how ecosystem social science research might address the issue of changing levels of support for conservation of marine resources generally and resource management programs specifically. Dr. Bunce suggested that finding areas of overlap may help assuage waxing and waning support. For instance, Dr. Veitayaki has developed programs that combine conservation efforts with programs that provide satisfactory trade-offs for any loss of availability of marine resources. These include programs that enhance potable water resources, enable treatment of sewage, and bring alternative sources of income and opportunity to the community. Dr. Bunce suggests that ongoing monitoring of conservation programs, sound partnerships with **pre-existing social networks of community actors**, and stable funding are central elements of successful locally-managed conservation programs.]

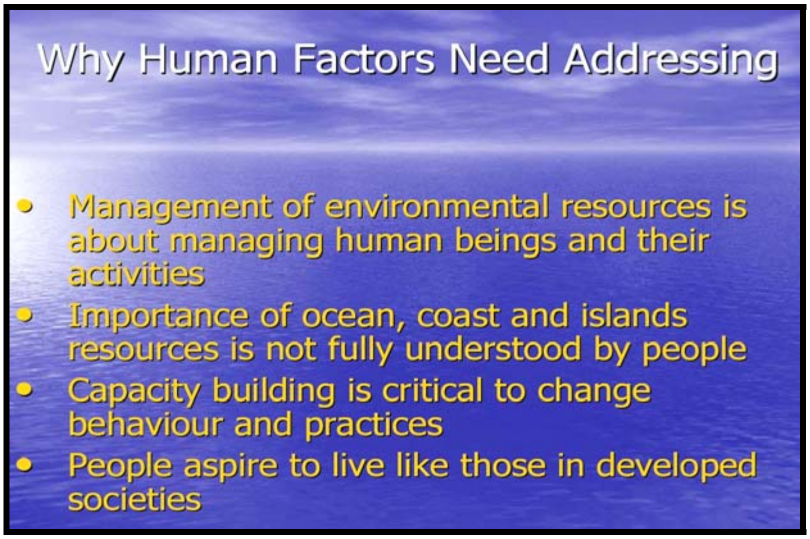
3.2.19 Lessons from Fisheries Development in Fiji

Speaker: Joeli Veitayaki
University of the South Pacific
Marine Studies Program

Background. Dr. Joeli Veitayaki is professor of marine studies at the University of the South Pacific in Suva, Fiji. He is project leader and Director of the Marine Affairs section of the Marine Studies Program (MSP) and remains actively involved with the Locally Managed Marine Areas Network. This network involves the conduct of hands-on projects in coastal communities in the region to facilitate development of effective management of marine resources. Joeli is also author of *Fisheries Development in Fiji: The Quest for Sustainability.* This is part of the larger project titled "Towards Sustainable Fisheries" led by MSP and funded by the Canada - South Pacific Ocean Development Program and with collaboration from the University of Prince Edward Island's Institute of Island Studies (IIS), Australia National University (ANU) and the Secretariat of the Pacific Community (SPC). Dr. Veitayaki's presentation was titled "Addressing Human Factors in Fisheries Development and Regulatory Processes in Fiji: the Mositi Vanuaso Experience."

Presentation Summary. The vision of an ideal world may serve as a model for understanding the complexities that actually confront those who manage marine resources. In that ideal world, residents of communities adjacent to marine ecosystems would be perennially happy and contented. Natural systems would be sufficiently productive, thereby meeting social and cultural needs. Production and use of natural resources would be facilitated by a variety of income alternatives. Rural development would be carried out smoothly and resource managers would face no obstacles as people transitioned to desired state and ways of living in ways that maintained the sustainability of the natural world and resources around them. Fish populations and fisheries would remain vibrant and readily meet and support commercial, consumptive, and recreational needs and interests without inconvenience to any given sector. The physical and human environments would always be healthy.

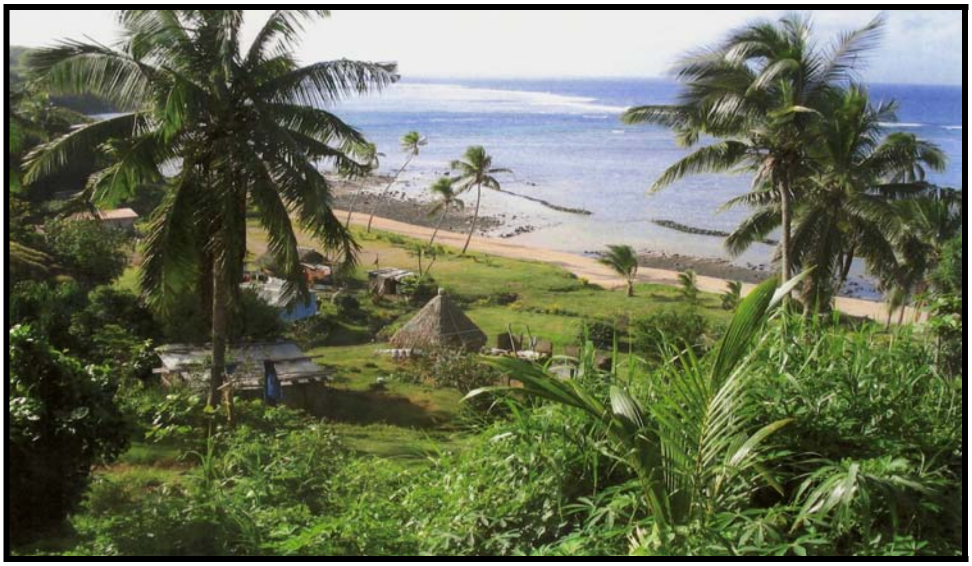
The model also makes clear that **human beings are pivotal in every meaningful aspect of marine ecosystems and their effective management**. Indeed, they define that meaning. Moreover, managing environmental resources is, first and foremost, about managing humans and their activities, and meeting their goals and objectives, including health and happiness.



Capacity building is critical in efforts to influence the behaviors and practices of marine resource user groups - in this case, residents of island villages. It is often the case that the full importance of the ocean and its resources is not grasped by the very people who depend on them. The arrival of new ideas, pressures, and people has in some cases preceded the erosion of traditional patterns of resource management. Assisting people to build understanding and maintain effective care of marine resources while improving local living conditions is best accomplished through community-based initiatives. Changes such as these can be implemented more quickly at the village level than in large-scale settings, and the results will also be visible more quickly. Because collective effort tends to outweigh the sum of individual efforts, partnerships in capacity building are most effective.

Work on Gau Island in Vanuaso District on Fiji exemplifies this approach. People in villages here typically are involved in subsistence practices, with supplementary resources purchased with money earned through occasional participation in wage jobs. These are indigenous Fijians who hold tenure rights to fishing grounds from the high water mark to the outer limits of the bay areas. They also often maintain jurisdiction from the village sites up to establishment of rapport - winning people's trust, confidence, and eventually their support.

Work was subsequently undertaken to improve care of local marine resources. First, an attempt was undertaken to collectively recall traditional resource management patterns and customs. The community was also brought together to discuss and evaluate the proposed objectives and means for enhancing treatment of the resources through traditional self-management. It was necessary to gauge the level of commitment of the local populace for undertaking and sustaining the initiative. Once underway, progress was checked on a regular basis, with new concepts and ideas introduced and negotiated along the way.



Focus was applied to the promotion of **long-term investment and change**. This required a willingness from the community to engage in management activities that might only yield benefits long after their time had passed; several projects started with this point in mind. Another important aspect was the setting up of institutions and champions to propel the work and involvement of all. Publication of the experience was undertaken for similar effect.

Challenges to this endeavor were numerous. On one hand, community development is called for by the people themselves, but consistent dedication and enforcement can be problematic over time. People tend to relax management of resources due to daily activities and constraints. Regular oversight can play an important role here, but with the intent of ensuring that motivation remains endogenous and not externally driven. Enforcement of regulatory measures is also a problem. Existing **social control mechanisms** may be sufficient, but these may not be able to cope with external elements, such as poaching of resources by outsiders.

It is important to promote **critical evaluation** of this form of development work. Connection with educational institutions is also important, as a means to transmit the new values and behaviors to younger generations. Connection with and support from the government should be sought as well, potentially opening a way for monitoring changes through an established institutional environment. It is necessary to secure and supervise funding to assist community-based initiatives. Further, given that effective management of resources is economically advantageous in the long term, effort should be made to disseminate experiences as broadly as possible.

The **Mositi Vanuaso Project**[4] commenced at Vanuaso Tikina, also on Gau, Fiji. Project managers expect to: (1) promote participatory decision-making in an area where a traditional system of resource management was still being used, and (2) examine the need for and undertake developmental measures that would at once enhance the well-being of villages, while ensuring conservation of the terrestrial and marine environments.

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[4] *Mositi* refers to something treasured or deeply valued.

The approach involved a series of workshops in which residents developed objectives and initiatives. Identified was a list of priority development options. This included specific measures, such as: (a) improvements in sanitary conditions, (b) use of water catchments and piping and distribution of water, (c) promotion of animal husbandry, (d) reduction in use of pesticides, (e) farming on hill slopes, (f) limiting unnecessary burning, and (g) combating deforestation and embarking on reforestation measures. Also identified were priorities and approaches that were more general, including: (a) definition of guidelines for environment-friendly land use, (b) a quest for alternative sources of livelihood or income, and (c) the undertaking of marine resource management and protection of locally valued valuable coastal habitats.

Several positive changes resulted from the enactment of these initiatives. Awareness of existing social and environmental problems increased, perception of responsibility towards the surrounding environment elevated, and basic infrastructure and services in the villages improved. In sum, the project empowered the community to develop basic infrastructure and services while simultaneously protecting the local environment and its long-term capacity to provide goods and services to those charged with its care. In this respect, the project served to enhance the long-term well-being of villagers in keeping with the ultimate goal of well-integrated and healthy human and biophysical systems.

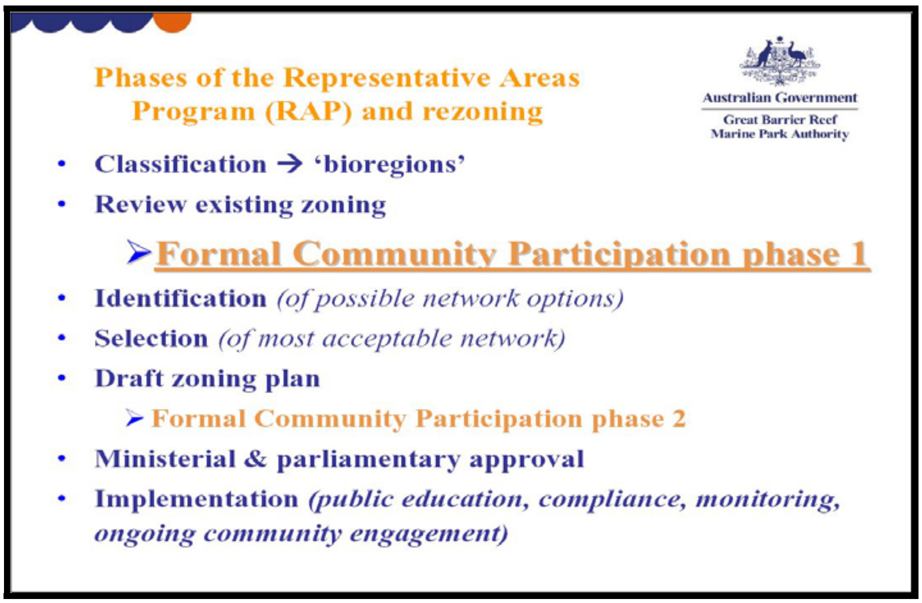
3.2.20 Developing and Operating a Large-Scale Marine Ecosystem Management Program

Speaker: Leanne Fernandes
Australian Government
Great Barrier Reef Marine Park Authority

Background. Leanne Fernandes has extensive academic and professional experience in sustainable use of natural resources and has conducted related research and applied work in various locations in the Caribbean, North Sea, the Maldives, and Australia. Her Ph.D. involved development of a multi-criteria decision support process for coral reef management, and she holds a masters degree in Resource Economics. Dr. Fernandes was Manager of the Great Barrier Reef Marine Park Authority (GBRMPA) Representative Areas Program from 1999 to 2005. This program involved the rezoning of the entire Great Barrier Reef Marine Park. Leanne is now Director of the GBRMPA Community Partnerships Group, formed to continue and build upon the Authority's community engagement work conducted through the rezoning process. Dr. Fernandes' presentation was titled "Socio-political Aspects of Developing and Operating a Large Scale Marine Ecosystems Management Program."

Presentation Summary. The rezoning efforts of the Great Barrier Reef Marine Park were intended to increase protection of **biodiversity** throughout the Great Barrier Reef system. The Great Barrier Reef spans thousands of miles along the northeast coast of Australia. Its supports numerous fisheries that generate hundreds of millions of dollars in revenue annually, and it is the focus of a several billion dollar tourism industry. Indigenous and colonial-immigrant populations inhabit the adjacent, largely rural land areas.

The GBRMPA process involved development of the **Representative Areas Program**. This was established to facilitate a network of no-take areas to protect representative examples of the range of habitats, communities, and species across the Great Barrier Reef. As an ecosystem-based planning measure, it differed from earlier management strategies in that it: (1) retained an analytical focus on whole ecosystems and the entire Great Barrier Reef as an ecosystem of itself; (2) addressed relationships between plants, animals, and habitats throughout the system, not just coral reefs; (3) reduced bias towards what is easy to assess and manage and addressed more difficult areas and issues; (4) was not ad hoc or limited to restricted sampling sites, but rather addressed specific data gaps so as to enhance comprehensive treatment; and (5) changed the extent and manner of the use of ecosystem relevant data.



Effective means for ensuring representation of the interests of stakeholders were absolutely critical to the success of the **Great Barrier Reef rezoning process**. A wide range of user groups were consulted. This included a wide variety of interest groups, aboriginal groups, fishery participants, and other ocean and reef users across a broad region of Australia. GBRMPA representatives held over 200 public meetings before the first formalized Community Participation Phase of the project. Some 800 meetings and other community informational meetings were held thereafter. Workshops with **key stakeholders** were held throughout. Of particular note in this process was the importance of **establishing rapport** with key persons in the communities and groups of interest. Such persons were highly influential of others in the community and could therefore spell the success or failure of a given objective.

GBRMPA staff began the process by conducting surveys to assist in developing a **communications strategy**. Focus groups were held to test the way in which messages about the beneficial effects of rezoning could most effectively be presented. For example, most persons in the region already realized the economic or recreational importance of the Great Barrier Reef.

However, many did not realize the complexity of the ecosystem, nor that the reef encompassed only six percent of the entire marine park area. Thus, communication strategies were formulated to inform the public about the extent of the park, the interconnectivity of reef-associated habitats, and the importance of effectively managing human activities that affected the marine and adjacent terrestrial environments.

Communications also described the Representative Areas Program and issues associated with species and habitat diversity, and reviewed existing zoning. Comments were solicited regarding prospective zoning approaches. Communication materials were tailored to meet the cultural attributes of the various groups, and these were updated throughout the process. Part of the communications strategy involved media campaigns and nationally known figures to promote meetings and solicit public input.

Attitudes and awareness about the park and rezoning program were monitored on a continual basis. Further, government and community representatives were updated throughout the process. This proved critical for meeting cross-jurisdictional challenges.

A **Natural Science Steering Committee** and a **Socioeconomic and Cultural Steering Committee** assembled to provide guidance over the course of the project. Members of these committees drew upon relevant research and scientific theory and findings to determine when data was sufficient for defining 70-plus bio-regions and to determine appropriate levels of protection for given areas. The Socioeconomic and Cultural Steering Committee also developed principles to confirm assessment of no-take areas and to guide decision-making in a manner appropriate to the needs and interest of adjacent human communities.

Scientific advisors determined early in the process that few new biophysical or socio-economic cultural data were needed to meet program objectives. Staff worked with Queensland fisheries managers to determine how to make best use of extant fisheries information to achieve the biological objectives and to **minimize deleterious effects on fishery participants**. Such collaborative efforts were fundamental to the rezoning process, particularly when logbook and other data were insufficient for understanding the social context of the fisheries, including the potential effects of displacing participants. Also useful in this regard were census data.

The formalized **Community Participation Phase** of the project involved solicitation of public comments on a draft rezoning plan. The plan derived from a combination of biophysical and socioeconomic data and analyses. A team of social scientists helped design comment forms and analyze elicited data so as to enable rezoning staff to fully understand the range of public perspectives on the plan. A GIS team extracted spatial data from the comments as well. Some 21,000 public comments were ultimately elicited and analyzed, and each rezoning effort reflected public input. Closing surveys indicated that between 80 and 90 percent of the stakeholders and the general public approved of the GBRMPA rezoning process.

3.2.21 The Ahupuaʻa Model and its Relationship to Contemporary Government

Speaker: Leimana Damate
Association of Hawaiian Civic Clubs
Ahupua'a Expert

Background. Leimana Damate has been working to integrate Native Hawaiian cultural values and practices into governmental and regulatory processes since the mid-1970s. She is currently Ocean Resources Program Director for the Association of Hawaiian Civic Clubs, a national confederacy of 51 Native Hawaiian organizations created in 1918 by Prince Jonah Kuhio. Leimana represents Native Hawaiian interests as a member of Governor Lingle's Ocean and Coastal Council, and consults with Native American and Alaska Native groups on various cultural and natural resource issues. Leimana has worked extensively with Hawaiian communities on every island, documenting and researching cultural values and practices as they pertain to conservation land, ocean, and associated ecosystems, and is involved in restoration of ahupuaʻa lands through various cultural resource management processes. Ms. Damate discussed challenges and potential solutions for reinstituting ahupuaʻa and related principles in 21st century Hawaiʻi.

Presentation Summary. Efforts to restore **ahupuaʻa** are seen by many as valid means for connecting past and future and for protecting and sustaining Hawaʻi's fragile and unique ecosystems through traditional use and conservation practices. Efforts to develop formal policy for reestablishing ahupuaʻa have been undertaken jointly by the Pacific Islands Resource Management Institute, the Association of Hawaiian Civic Clubs, and the Office of Hawaiian Affairs.

The remote location of Hawaiʻi has not hindered development of society in the region. Rich ocean ecosystems are enabled by climatic conditions that were and are both favorable and unique. For instance, recent discoveries indicate that the Hawaiian Islands interfere with the easterly trade winds, triggering an "**island effect**," wherein wind speeds increased between the islands but are significantly weaker on the lee sides. This generates a narrow eastward-flowing warm-water ocean current. Because the current is warmer than surrounding waters, it can generate convection cells in the atmosphere which, in turn, help to sustain the current. It is thought that current may have assisted Polynesians voyaging in the region.

Voyaging Polynesians are said to have arrived in this region between about 100 and 400 A.D. Ahupuaʻa were gradually developed as an adaptive social process of **hoʻolaulima** (cooperation), wherein early residents interacted closely to produce food and necessary items within three main land zones: ocean, agricultural areas, and upland forests. Spiritual beliefs about a holistic relationship between ʻāina (land), moana (ocean), and kanaka (people) helped sustain the system. In concrete terms, ahupuaʻa refers to a division of the land, usually extending from sea to mountain top. The name derives from the marking of the division boundaries with a heap of stones (ahu) surmounted by an image of a pig (puaʻa). Fishes such as the aholehole, ʻamaʻama, kumu, pualu or humuhumunukunukuapuaʻa could be also be used as offerings to mark the bounds.

Various terms were used to designate components of the division. The sea portion included the kahakai (beach shore), kulakai (sea plain region), moana (open ocean) or hohonukai (deep ocean) in the makai portion. The landward portion included the iʻlima (planting area), paheʻe (grass area), apaʻa (dry area), wao kanaka (living zone), the wao nahele (large forest line), wao akua (small trees). The mountain portions included kuamauna (rounded swell of the mountain) and the kuahiwi (uppermost zone), among others. The **social structure of a working system** was well defined, with distinct jobs, rights, obligations and responsibilities in each of the zones and sub-zones.

Many of the management principles underlying the historic ahupuaʻa system are now aspects of existing coastal zone and ocean management policies. But reincorporation of the concepts and structure of the system is challenging in that myriad federal, state, and county agencies now enact an intricate system of laws, policies, and programs that do not necessarily recognize the historic boundaries and social processes of the Native Hawaiians.[5] Nevertheless, effort is being applied to work within existing structures to on several fronts: through the Governor's Hawaiʻi Ocean and Coastal Council, through the Ocean Resource Management Plan, through community and local government planning processes, and through grassroots-level action.

Recommendations for reestablishing ahupuaʻa include: (1) incorporating traditional 'aha or decision-making councils into community-based planning and resource management programs and processes, (2) addressing ahupuaʻa objectives in existing administrative rule and policy-making; (3) identifying fiscal resources for moving forward with ahupuaʻa objectives, (4) creating watershed partnerships, (5) incorporating Native Hawaiian resource use and management practices into current marine education programs, and (6) incorporating traditional ecological knowledge and ahupuaʻa principles in prospective coastal development efforts, coastal recreation programs, and resource management programs. Principles relevant to resource management include: (a) traditional understanding of fish spawning cycles, (b) use of the Hawaiian Moon Calendar, (c) conserving wetland resources, and (d) consultation with **kupuna** (knowledgeable elders). Development of comprehensive ahupuaʻa maps would be most useful.

In sum, the ahupuaʻa and related principles were once central aspects of Native Hawaiian society. Their **reinstitution** in the contemporary context has the potential to enhance conservation and effective management of natural resources. This will require sustained effort to reintroduce important historic principles and social processes within a complex array of existing county, state, and federal laws and agencies. A joint effort toward that end has been undertaken by the Pacific Islands Resource Management Institute, the Association of Hawaiian Civic Clubs, and the Office of Hawaiian Affairs and is now in motion.

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[5] For example, the following is an example of federal laws governing use of the shoreline in Hawaiʻi: Rivers and Harbors Act (1899), National Historic Preservation Act (1966), National Flood Insurance Act (1968) and the Flood Disaster Protection Act (1973), National Environmental Policy Act (1969), Clean Air Act (1970), Coastal Zone Management Act (1972), Endangered Species Act (1973), Clean Water Act (1977), Magnuson-Stevens Fishery Management and Conservation Act (1996, amended). Relevant state laws are also numerous, and include: Chapter 46, HRS, which establishes the counties and their zoning powers; Chapter 205, HRS, which establishes State Land Use Districts; Chapter 205A, HRS, which implements the Federal CZM Act; Chapter 226, the Hawaiʻi State Planning Act; Chapter 343, HRS, which implements the Federal Environmental Policy Act; and a range of other administrative rules.

4.0 Synthesis: Toward Incorporating Social Science in Ecosystem-Based Fisheries Management in the Western Pacific

As was made clear during the course of the workshop, the social sciences may be applied in many and various ways to further understanding of human interaction with marine and terrestrial ecosystems, to improve governance aspects of resource management, and to assess the effects of management strategies on people and the marine environment and its resources. In the context of the Pacific islands, social science applications may allow expanded understanding of such interactions and effects in settings where marine resources have long been and remain particularly important for many social, cultural, and economic reasons.

As summarized in the previous pages, a wide range of topics pertinent to ecosystem-based management of marine resources was addressed during the course of the social science workshop. These topics included the following: (1) marine fisheries, fisheries management, and related human and biophysical factors in the Western Pacific, (2) the need for, and utility of social science in the context of ecosystem-based management in this region and elsewhere, (3) institutional constraints and opportunities for incorporating social science into ecosystem-based management, (4) relevant information needs, useful types of data, and data collection methods, (5) ecosystem-relevant human behavior and resource modeling, (6) indicators for assessing regulatory effects and the performance of management strategies, and (7) scope and scale of social science applications to ecosystem-based management. This section of the report synthesizes workshop discussion regarding these topics and draws on the background context developed earlier in the report to discuss elements of a general approach for applying social science to ecosystem-based management across the region.

4.1 Drawing on Ancient Concepts and Practices

The long history of human migration throughout Oceania is directly related to accumulation of detailed knowledge and successful pursuit of marine resources. Navigators led intrepid voyagers to distant horizons knowing they had the skills to sustain themselves while seeking land. Once islands were located, colonization and expansion of human populations were based in large part on knowledge of marine ecosystems and resources, and forms of social organization that enabled distribution and consumption of rich sources of dietary protein. In some places and cultures, social mechanisms were developed to formally manage marine ecosystems and resources.

Indigenous Pacific islanders now may draw on lengthy histories and ever-evolving knowledge and traditions of interaction with the ocean and with each other to successfully exploit the marine environment. Persons arriving here during more recent centuries also draw upon traditional and experiential knowledge of the ocean and its resources. This is not intended as token acknowledgement of history. Extensive oral tradition and literature may be drawn upon to conceptualize and plan effective ecosystem-based management in the Pacific islands.

The political and policy implications of indigenous knowledge and marine tenure are also highly significant in the context of contemporary ecosystem-based management. The ahupua‘a system once widely used by Native Hawaiians offers a model for a form of resource management that is attentive to ecological relationships between land and sea within geopolitically-specified boundaries. Those boundaries were significant in that they served to delimit attention and use of resources in an otherwise open system, thereby increasing the ability of the konohiki (leader) to monitor and regulate local resources and their use per the needs of the resident population. Ahupuaʻa were components of larger motus (districts), and thus monitoring and control of resources also occurred at a district, island, and island-wide basis.

Contemporary advocates of the ahupuaʻa system suggest that aspects of that arrangement can and should be considered for potential use under any new form of resource management in Hawaiʻi. For instance, some suggest that konohiki and ʻaha (councils) could once again be established to monitor and assist in decision-making processes regarding natural resources used by people in specific areas. While this would require adaptation to (or of) existing political and management entities and processes, it does follow logically that more and better localized monitoring of island ecosystems and the needs and use patterns of residents could enhance management of resources within and across those systems.

Similar forms of localized resource management processes are being tried in various parts of the coastal zone of the U.S., including various watershed models and programs. As Paul Bartram noted during the workshop, there is much potential in strategies that draw on traditional forms of resource use and management in the island context as is successfully occurring in a distinct spatial and cultural context on the island of Molokaʻi. We periodically revisit aspects of the ahupuaʻa model in the following pages to illustrate opportunities and challenges associated with establishment of the ecosystem approach in the contemporary Western Pacific.

4.2 Existing Institutions and Institutional Parameters

This leads to discussion of existing institutional opportunities and constraints for incremental introduction of the new form of marine resource management. The WPRFMC has drafted plans for establishing a system of FEPs based on the geography of this vast region. It is possible that at some point in the evolution of an ecosystem approach an ahupuaʻa or similar model would be formally reinstituted in Hawaiʻi. In fact, elements of the Council system have long incorporated concepts inherent in that approach. These include community-based management strategies and projects designed to increase the degree of participation of indigenous persons in management of marine resources.[6]

The Council is cognizant of the goodness of fit of ecosystem-based fisheries management in the island context and it has been proactive in establishing such approaches in the region. Yet, quite obviously, the WPRFMC is not alone in its management responsibilities here. This is clearly significant in the ecosystem context in that biophysical relationships occur regardless of sociopolitical bounds, while management interactions occur with direct regard to jurisdictional boundaries. The State of Hawaiʻi has also undertaken programs to enhance community

[6] For instance, the Council has developed and is implementing a Community Development Program (CDP) and a Community Demonstration Project Program (CDPP). The CDP calls for increased representation of indigenous islanders in regional fisheries management and the CDPP is a funding program that promotes traditional indigenous fishing practices.

participation in marine resource management efforts,[7] and while its jurisdiction extends to the landward limit of the EEZ, pelagic and other fish species haven't been told about the border and there is no border patrol! Meanwhile, members of the resource user groups also often aren't highly aware of geo-political boundaries and may pursue fish and other marine resources inside and outside of state and federal waters on any given fishing day. As such, management of marine ecosystems and user groups may be most effective where management measures address the realities of the system rather than its imposed political bounds.

Resource managers are well aware of this, and inter-jurisdictional efforts are not new in the region. But inasmuch as ecosystem approaches increase attention to biophysical systems that do not correspond with jurisdictional boundaries, further interaction and cooperation between agencies and entities may be required.

Lee Anderson and Tim Hennessey discussed problems potentially resulting from changes in the way resource management agencies will operate under the new system of management. They related that, in some cases, actors with skills and capacities that are tailored to existing management regimes will, or have been, forced to quickly adapt to new conditions. Resentment and resistance are not uncommon. Susan Hanna made a strong case for entering into the new management regime with awareness of the possibility for such outcomes, and with readiness to develop unifying goals and objectives across diverse interests and scales of power, control, context, and responsibility. Dr. Hanna also made clear the potential utility of indicators for assessing the performance and institutional challenges of new programs over the course of time.

The paradigm shift to ecosystem-based management may potentially lead to further institutional complexity and related challenges in all coastal regions of the U.S., but perhaps especially so in this unique region of multiple jurisdictions. Although archipelagic-based FEPs may serve to reduce administrative complexities over a vast area, Council and NOAA Fisheries representatives have recognized the potential for new challenges and are undertaking a measured approach to prospective policy changes. Given the immensity of this region, extensive diversity in socio-demographic and socio-political context, and the increasing influence of international decisions regarding the migratory species which are so important throughout the region, an incremental and adaptive approach may well be the best way to proceed.

4.3 Pursuing Ecosystem Goals and Objectives through Application of Social Science

As stated in the Council FEPs (e.g., WPRFMC 2005:5-6), pursuit of ecosystem-based management in the region relates in part to NOAA Fisheries' EPAP goal to maintain the overall health and sustainability of marine systems and resources, and to "establish a framework under which the Council will improve its abilities to realize the goals of the MSFMCA through the incorporation of ecosystem principles and science." As depicted in Table 4-1 below, the objectives for meeting that goal have been clearly stated (WPRFMC 2006:6). But as discussed by Dr. Anderson and others, there is good reason for Council representatives and representatives

[7] For instance, the West Hawai‘i Fishery Council was established to enable representation of aquarium fish collectors and persons pursuing reef and other fishes for consumptive purposes in the same areas (e.g., see Tissot 1999).

of other management agencies active in the region to review ways in those general objectives might best be achieved. That is, given the scope of the objectives and potential challenges associated with meeting them, setting of priorities and formulation of specific management measures may be most useful. As indicated in the table, those measures ideally will be formulated based in part on the potential contribution of the applied social sciences.

Table 4-1 Council FEP Objectives and Prospective Role of Social Science

Objective	Prospective Role of Social Science
(1) Maintain biologically diverse and productive marine ecosystems and foster the long-term sustainable use of marine resources in an ecologically and culturally sensitive manner through the use of a science based ecosystem approach to resource management	Determine culturally appropriate protocols for undertaking ecosystem-based management under variable social, cultural, and economic conditions and scenarios in each archipelago
(2) Provide flexible and adaptive management systems that can rapidly address new scientific information and changes in environmental conditions or human use patterns	Determine and document human use patterns and associated socioeconomic factors for each fishery in each archipelago; monitor changes in such patterns and conditions and assess associations with biophysical changes
(3) Improve public and government awareness and understanding of the marine environment in order to reduce unsustainable human impacts and foster support for responsible stewardship	Assess public and government awareness of environmental understanding within and across groups and institutions; identify means for improving venues for communication; identify, characterize, report, and monitor problematic forms of individual and collective interaction with or indirect influence on marine and associated terrestrial ecosystems
(4) Encourage and provide for the sustained and substantive participation of local communities in the exploration, development, conservation, and management of marine resources	Identify potential opportunities for and constraints on sustained community-level participation in these dimensions of marine fisheries; account for inter- and intra-cultural variability in receptivity to involvement
(5) Minimize fishery by-catch/waste to the extent practicable	Identify fisheries in which by-catch is significant; determine the nature of problematic fishing methods; determine whether individual or broad cultural processes or economic incentives are involved; identify alternative methods or fisheries suitable for offending user groups
(6) Manage and co-manage protected species, protected habitats, and protected areas	Identify practical and culturally appropriate means for co-management of such species, habitats, and areas; assess the potential for reintroduction of historic forms of resource management
(7) Promote safety of human life at sea	Identify and assess behavioral factors that contribute to at-sea hazards and identify affordable, amenable, and practical means for reducing these for the various fleets
(8) Encourage and support appropriate compliance and enforcement with all applicable local and federal fishery regulations	Assess economic and socio-cultural factors that may be associated with regulatory violations and identify ways in which regulations and/or user group behavior might be modified to improve compliance. Identify social and cultural settings in which extant customs/sanctions obviate regulations and enforcement and advance these or elements thereof as possible models
(9) Increase collaboration with domestic and foreign regional fishery management and other governmental and non-governmental organizations, communities, and the public at large to successfully manage marine ecosystems	Use economic, sociological, anthropological, and other social science theory and methods to assess the potential for effective collaboration; use such approaches to identify means for improving the effectiveness of such collaboration
(10) Improve the quantity and quality of available information to support marine ecosystem management	Identify information needs and perceived shortcomings of extant data from the perspective of managers and decision-makers working in the region; examine TEK and its potential for improving management of ecosystems

4.4 Research and Monitoring of Direct Ecosystem Relationships

Extensive attention was given during the course of the workshop to data collection methods and modeling techniques. Relatively less attention was focused on development and use of social or economic indicators. Irrespective of depth of coverage, each of these factors relates to measurement, assessment, or monitoring of direct connections between resource user groups and marine ecosystems. These might be termed first order relationships. Persons harvesting marine resources in the offshore and nearshore waters or shoreline components of marine ecosystems may be readily conceived as important biological components of those systems. Indeed, given that humans are so well equipped to target and capture top predators, we may appropriately seen as occupying a primary position in the trophic hierarchy of certain ecosystems. As such, the manner in which humans interact with marine ecosystems is an obviously critical consideration in the management of marine resources.

A number of speakers provided insight into methods for understanding those interactions in detail, and in fact an entire workshop might have been devoted to this and related issues. Both Leah Bunce and Byan Oles described the full range of methodological approaches used individually or in combination to understand, assess, and potentially improve human-marine environmental interactions. The recently published work of Shankar Aswani and Matthew Lauer (2006) is relevant in this regard, as is the ongoing social network modeling work reported by Jeffrey Johnson, and the MPA assessment work reported by Patrick Christie and Richard Pollnac. Dr. Aswani's attention to spatial aspects of sea tenure and the traditional knowledge, pursuit, use, and management of marine resources in the Pacific island context may provide a model for generating in-depth understanding of human-ecosystem interactions in and across specific island areas around the Western Pacific. Dr. Johnson's work also is valuable in this regard in that it bridges the interests of biophysical and social scientists by offering viable models for predicting the direct, indirect, and bi-directional effects of and on humans as components of ocean food webs. Johnson's systematic work with traditional ecological knowledge is also highly useful. Dr. Christie has presented a strong case for development of indicators capable of assessing success of management regimes (in this case, MPAs) in both biological and social terms. Similarly, Dr. Pollnac has developed modeling techniques to assess human-biophysical interactions in the context of ecosystem-based management, with emphasis on measurement of human happiness and well-being, and management measures that would enhance those often elusive states.

As discussed by Sam Pooley, Dave Hamm,[8] Stewart Allen,[9] Peter Wiley, and others, the ongoing programmatic research of NOAA Fisheries, NOS, HDAR, and other agencies active in

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[8] Mr. David Hamm is Chief of the Fisheries Monitoring and Socioeconomics Division at NOAA Fisheries' Pacific Fishery Science Center, long-time lead for the Western Pacific Fishery Information Network (WPacFIN), and member of the WPRFMC Pelagics Plan Team.

[9] Dr. Stewart Allen is social scientist with NOAA Fisheries' Pacific Fishery Science Center, and leads the Center's Human Dimensions Research Program. He is also a member of the WPRFMC Science and Statistical Committee. Stewart has worked as social scientist in a variety of natural resource settings since 1980 and has extensive research and analytical experience with human-ecosystem interactions.

the Western Pacific has yielded extensive information of potential use for assessing direct and indirect relationships between resource user groups and marine ecosystems. Council information needs regarding pressure on resources and related aspects of human-marine ecosystem interactions may be met in part through specific topical and spatial analyses of such extant data.

Such data may also be used, potentially in conjunction with data deriving from other research, to assist in developing valid indicators for understanding both the effects of human activities on biophysical systems and the effects of changing biophysical conditions on resource user groups. As indicated by Dr. Aswani during the workshop, the latter constitutes a highly significant form of understanding in that, in some island settings, changes in the availability of marine resources can be matters of life and death.

4.5 A Note on Social and Economic Indicators

One objective of the workshop was to identify the "best suite of ecosystem indicators related to the human and institutional ecology of marine ecosystems in the Western Pacific and its sub-regions." While there was background discussion of the potential value of social and economic indicators for assessing interactive relationships and effects between humans and biophysical systems, and their use in other settings, specific indicators of potential utility in the present context were not identified. Based on the rationale that certain "common denominator" indicators could be useful for a range of needs (as discussed by Marc Miller[10]), it may have been productive to facilitate elicitation of perspectives on such indicators during the course of the workshop. But in fact, the eventuality of background discussion may have been appropriate for several reasons.

First, useful social and economic indicators may rightfully be seen as following from specific ecosystem-specific management measures which, in the case of the nascent ecosystem approach, have not yet been fully determined for each archipelago across the region. As we recommend in subsequent sections of this report, a venue should be developed to aid in identifying measures that would be most effective for satisfying the Council's FEP objectives and overarching goals. Discussion/selection of specific appropriate indicators could follow in the same venue. Second, as noted above, selection of valid social indicators would ideally derive in part from understanding of extant data and focused consideration of the social and biophysical contexts in question. As such, the above-mentioned venue would ideally be attended by persons highly knowledgeable of that information and those contexts. Finally, an extensive literature on social indicators is available to inform such discussion (e.g., Minerals Management Service 1996; Boyd and Charles 2006). Ideally, analysis of lessons learned from social indicators research and applications in natural resource settings in other regions would be considered in advance of

[10] Marc L. Miller is Professor in the School of Marine Affairs and Adjunct Professor in the School of Aquatic and Fishery Sciences and the Department of Anthropology at the University of Washington. Professor Miller has served on the Scientific and Statistical Committees of the North Pacific and the Pacific Regional Fishery Management Councils. His work has concerned the social and cultural aspects of many kinds of fisheries (e.g., commercial, recreational, sport, tournament, subsistence). His research interests also include marine protected area and park management, and coastal recreation and tourism management.

selection and use of indicators by the Council or NOAA Fisheries in the Western Pacific. One perspective stated at the workshop was that, given developments in fisheries economics, it may be relatively less difficult to determine valid economic indicators of utility for ecosystem-based management and related analyses than it would be for non-economic social indicators.

An aspect of all social indicator research that bears mention at this juncture is that indicators are viable only insofar as the putative relationship with that which is being indicated is amenable to empirical testing. This is an obvious point at first glance, but in fact, in seeking to understand complex social processes there is always potential for drawing conclusions from spurious associations. At the same time, it should be kept in mind that indicators must be capable of gauging and monitoring the effects of a range of events or processes in addition to those potentially associated with the management measures or event or process in question, and analysts should be prepared to work through a variety of prospective causal and associative relationships.

We emphasize that none of these points is intended to diminish the potential utility of social and economic indicators in the region. Indeed, as numerous workshop participants made clear, valid indicators may be particularly useful as means for assessing and monitoring human-environmental interactions, and as a basis for adjusting resource use policy under the new mode of management.

4.6 Research and Monitoring of Indirect Ecosystem Relationships and Effects

Discussion of indicators is also relevant to assessment and longitudinal monitoring of human and physical environmental processes that are *indirectly* related to ecosystem management. We note at the outset that: (a) the term "indirect" is used here in the analytical sense and that indirect relationships may be as critical as direct relationships, and (b) direct and indirect relationships are often difficult to parse. For instance, given fluctuating market conditions, operational costs, and other factors affecting participants in the harvest sector, job opportunities outside of the fishing industry during off-seasons can in some cases be as critical for the ongoing functioning of a fishing fleet as can the availability of resources during the fishing season(s). Thus, while an indicator such as rate of employment outside the fishing sectors may appear extraneous to the interests of fishery managers, such information may in fact provide a valid if indirect indication of the functional capacity of a given fleet over time.

In fact, many variables and processes that may be seen as indirectly related to extraction of marine resources warrant ongoing assessment and monitoring. For example, during the course of her discussion about Guam, Judith Amesbury elucidated the importance of assessing and monitoring the effects of macro-scale climatic events such as ENSO events, related periods of drought, and volcanic disturbances since these can incur dramatic changes in marine ecosystems and hence indirect by equally dramatic effects on resource users. Similarly, as noted by Jesse Rosario in his discussion about contemporary conditions and challenges for fishers on Guam, the actions of persons with vested interests in coastal tourism can lead to a range of effects which indirectly affect the fleets and shoreline fishers, and by extension those who depend on the resources for consumptive and cultural purposes. Finally, as discussed by Fini Aitaoto, federal actions in domains other than fishing can also have a dramatic effect on the conduct of local fisheries, as in the case of immigration laws which have precluded Western Samoans from working in canneries in America Samoa. Given that the cannery managers reportedly are having trouble finding sufficient numbers of employees, this situation has indirect but clearly problematic implications for American Samoa fishers seeking to market their products to canneries in their home country.

Much workshop discussion also naturally focused on potential and actual historical indirect effects of biophysical management measures on fishers, fleets, and communities. This area of consideration is well-covered in the Social Impact Assessment literature and will not be belabored here. A couple of important issues bear reiteration by mention, however. These include displacement of fishing effort as a result of establishing MPAs (as discussed by Mr. Rosario and others) and associated implications - including loss of harvest, lost income, and lost cultural opportunities.

Factors associated with fishing communities also bear mentioning. Susan Abbott-Jamieson discussed a wide range of variables and factors that are being monitored by NOAA Fisheries staff around the country (further elaborated in the regional context by Stewart Allen). These have been chosen for monitoring by virtue of their potential for enabling valid assessment of collective engagement in or dependence on marine fisheries, and with the ultimate intent of reducing potentially deleterious indirect effects of regulations on "fishing communities" and the fishing-specific and secondary industries and activities associated with such communities. All such potential effects will need to be considered as aspects of an ecosystem approach that by definition is geared toward understanding and addressing a greater range of human and environmental relationships than has heretofore been considered. As noted by John Petterson,[11] this has implications for understanding and monitoring a range of other than regulatory factors impinging on fishing fleets and communities, from broad macro-social and economic processes to specific environmental events such as hurricanes (see Impact Assessment, Inc. 2006).

This incurs discussion of issues related to the preferred, mandated, and ideal scope and scale of research conducted for purposes of assessing or monitoring human dimensions of ecosystem-based management. Tom Fish[12] related concerns in this regard, noting that truly equitable treatment of all elements of marine ecosystems, inherent linkages with terrestrial ecosystems,

[11] Dr. John Petterson is President of Impact Assessment, Inc., a firm specializing in maritime social science around the U.S. and abroad. John has carried out a wide range of fisheries-specific social and economic studies for numerous federal and state agencies since 1979. He is presently working with NOAA Fisheries to assess the social and economic effects of Hurricane Katrina throughout Louisiana, Mississippi, and Alabama.

[12] Dr. Tom Fish is a human dimensions specialist with the NOAA Coastal Services Center in Charleston, South Carolina. Tom develops and leads training and technical assistance programs for coastal environmental professionals and protected area specialists. These are aimed at integrating social and biophysical information to enhance resource planning and management decision-making. He has worked in marine science education and natural resource management, planning, and research since 1986, including a four-year position conducting community-based research in support of national forest and ecosystem planning in the Upper Great Lakes region.

and inherent linkages with human societies would require immense outlay of time and energy and hence, some subjective decisions must be made to pragmatically limit or prioritize the foci of resource managers. Such priorities and foci may include macro-level social and economic processes indirectly but significantly affecting fishing fleets, marine ecosystems, and adjacent communities. Numerous presenters discussed or alluded to such processes. For instance, John Gourley elucidated the implications increasing cultural diversity for the status of marine resources in the Commonwealth of the Northern Marianas. Because many in-migrating groups have arrived here with well-developed methods and preferences for pursuing and using marine resources, macro-level demographic changes may be one of the most important considerations for managers attending to natural resource and ecosystem issues in this distant island region.

Fisheries social science may potentially be applied to further community development objectives of the WPRFMC and other entities. Although social and economic conditions in community settings throughout the region are influenced by a wide range of factors not directly related to fishing, engagement of residents in fishing-related industries and activities may benefit such communities in a variety of ways. These include fishing-related opportunities for employment, recreation, and avoidance of detrimental situations and activities. This eventuality was discussed by Council staff economist Marcia Hamilton, furthered by Dr. Miller, and exemplified in the Fiji-based community development work of Joeli Veitayaki, all of whom recognized the potential contribution of social science applications in identifying places, situations, conditions, and processes that could involve communities and individuals in the abundance of positive ocean opportunities available throughout the Western Pacific region. While social science cannot be equated with community development *per se*, its application may further understanding of the community context, local receptivity to or need for development programs, and the potential or actual social and economic costs and benefits of such programs.

4.7 Choices and Priorities

This chapter of the report has revisited some but not all of the important ecosystem-relevant human dimensions issues discussed during the workshop. Clearly, a wide range of questions and possibilities confront the Council and NOAA Fisheries and other institutions progressing toward adoption of ecosystem-based approaches to fishery management in the region. Moreover, while some measure of regional specificity was achieved during the workshop, much of the discussion was relatively general in nature and a greater range of specific factors and questions associated with the new paradigm will undoubtedly emerge over the course of time.

Given this ultimately vast array of considerations, setting of priorities may enhance the efforts of managers in the region to begin the incremental and adaptive undertaking of incorporating social science principles, methods, data, analysis, retrospective and predictive modeling, and related considerations in real-time ecosystem-based approaches to management. In the case of the WPRFMC and NOAA Fisheries, these priorities necessarily will relate to respective development of the FEPs and related EIS, and associated discussion and formulation of management measures in the upcoming final workshop and other prospective venues. We therefore articulate the following discussion of prospective approaches and means for setting priorities with those tools for planning and assessment.

4.8 Basic Elements of a Social Science Approach to Ecosystem-Based Management in the Western Pacific Region

We note once again that our intention is to move beyond ecosystem concepts that are primarily biophysically-based. The term “ecosystem” must be understood as encompassing both human and non-human elements. In all of the discussion and recommendations below, attention should be given to thorough social scientific description and explanation of the following principal components of marine ecosystems:

1) the biophysical ecology; and
2) the human ecology, which has two distinct components;
    a) the human ecology of the constituents, by which we mean the people whose behavior affects, or is affected by, a defined biophysical ecology, or who are otherwise concerned with the state of that biophysical ecology; and
    b) the ecology of the governance institutions which have authority or responsibility for formal rules of human behavior with respect to the defined biophysical ecology.

These ecological components – the biophysical, human constituent, and institutional –together comprise the “ecosystems” relevant to fisheries management considerations in the Western Pacific.

Perhaps the most outstanding feature for consideration in applying the social sciences to ecosystem-based management is the unparalleled extent of variation in social conditions across the archipelagos. In the case of the Hawai‘i Archipelago, social, economic, cultural, and demographic, conditions vary radically even across a given island, and certainly across the island chain. Factors relating to a shift in governance and management will necessarily vary accordingly.

For instance, population density is quite low on rural Moloka‘i and the majority of residents there are Native Hawaiian. Plans for formal re-establishment of an ahupua‘a system or ahupua‘a-like system of resource use and management on that island would involve different issues and strategies than on an island like O‘ahu, where population density is very high, where cultural conditions are relatively diverse, and where urban and rural areas are characteristically quite different in many ways. A shift toward a more traditional form of resource management and governance would likely be more widely received on Moloka‘i, while such a strategy would involve a more complex set of considerations on O‘ahu. This subsection of the report advances a generalized approach intended to assist the Council in addressing such variation while planning for specific applications of social science during the course of adoption and long-term administration of ecosystem-based management in the Western Pacific.

4.8.1 Addressing Variation with an Adaptive Approach

Each archipelago addressed in the Council's draft FEPs is distinct in terms of its socio-cultural, socioeconomic, and demographic conditions, in terms of its mode and culture of governance, in environmental terms, and in terms of the types and extent of fishing and other pursuits and uses of marine resources. As noted by Craig Severance during the workshop, local capacity to conduct social research and monitor social and environmental conditions also varies by region. It is essential that all such variation be addressed in planning processes related to the Council's FEP objectives in each archipelago.

For instance, it was made clear during the workshop that understanding of regionally-specific social and cultural factors can enhance effective resource management in cross-cultural settings. Thus, the Council's third FEP objective to "improve public and government awareness and understanding of the marine environment in order to reduce unsustainable human impacts and foster support for responsible stewardship" would best be pursued in American Samoa by developing adequate understanding of issues such as those discussed by Fini Aitaoto regarding illegal fishing activities in the offshore waters of Tutuila. Adequate understanding and documentation of variability in how such violators might traditionally be dealt with under *Fa'a Samoa* could assist the Council in planning management measures to address its sustainability and stewardship objectives in the region. In this case, depending on local political considerations (which may well vary by village), contingencies for intervention may or may not be necessary; an effective and adaptive management measure would reflect understanding of the cultural, social, and political context. Similarly, understanding of economic conditions and motivations associated with pursuit and use of pelagic resources among fishery participants on Guam could contribute to an empirical basis from which to collaboratively negotiate an adequate portion of prospective regional quotas on such species - in keeping with Council FEP Objective Nine.

These are two of many possible examples illustrating the potential value of social science research and monitoring vis-à-vis the Council's FEP objectives. Ideally, specific management measures developed to meet FEP objectives in each unique archipelago would involve use of such information. Although extensive fisheries, census, and other forms of archival information may be used in this regard, increased attention to direct and indirect human-environmental interactions under the ecosystem approach will ultimately require more and more detailed data and analyses. As such, we recommend that an approach be developed for identifying and compiling existing information relevant to human aspects of ecosystem-based management, and for gathering and making available new relevant data regarding core management issues and challenges, and pertinent economic, socio-cultural, political, and demographic factors and conditions from across the region. The approach and data framework will need to be flexible and adaptive in keeping with the changing dynamics of marine ecosystems and human interaction with those systems, and with the evolving nature of the ecosystem management approach itself.

4.8.2 Steps for Incorporating Social Science in Ecosystem-based Management in the Region

Based on review of workshop proceedings as described in this report, we recommend a series of steps for establishing priorities and incorporating social science methods, models, and principles in the development and long-term administration of management measures under the new management approach. In reiteration, this new approach must articulate with a definition of "ecosystem" that emphasizes the pivotal importance of human beings in marine biophysical systems. These recommended steps include the following.

Establish a Venue for Choosing Priorities and Specific Management Measures. The workshop described in this report generated an array of general and specific approaches that may be used to meet the Council's objectives for ecosystem-based management in the Western Pacific. Various challenges, lessons, and cautionary notes were also discussed. All of this material may be useful for the Council as it moves toward full adoption of the ecosystem approach, and this report may be consulted for general guidance during that process. More specifically, the social science workshop and these proceedings will contribute to the upcoming ecosystem policy workshop.

But a venue or venues for more specific guidance may also be warranted. Each of the Council's ten FEP objectives incorporates a complex set of issues and social science considerations, and that complexity is magnified by the fact that the Council's kuleana (responsibility) extends across a vast ocean area and multiple archipelagos with very different characteristics. Establishment of a venue for Council, NOAA Fisheries, and regional social scientists to work toward (a) prioritization of FEP objectives vis-à-vis social science applications, and (b) identification of specific management measures and related information needs to meet those objectives, may serve to resolve some of that complexity. This could potentially occur in or through an existing Council process, but insofar as the shift to the new approach is to be adaptive and incremental, such a venue would ideally be recurring.

Design Research to Meet Prioritized Objectives and Information Needs. Once prospective management measures are identified in association with the prioritized objectives, expertise would ideally be applied to formulate specific plans for conducting social research in the region - as needed to assess the possible effects of implementing those measures. Given that extant data may contribute both to the design of the research and to the necessary analyses, the first and indispensable step in the process would be compilation and organization of relevant data by archipelago. This also would require general expertise and ability to anticipate the kinds and extent of information that would be needed for purposes of modeling and analysis, including knowledge of local and regional data issues and sources. Some field reconnaissance may be useful in identifying salient issues and otherwise hard to identify data and data sources.

Implement a Research and Monitoring Strategy. In cases where existing data is insufficient for assessing the prospective management measures, a strategy for sponsoring and conducting the necessary research and analyses would need to be implemented. Given inevitable limitations on time and fiscal resources, such research would ideally be conducted in conjunction with or under the sponsorship of existing research programs. Alternatively, or additionally, other sources of funding would be identified. As was discussed by Dr. Severance and others during the course of the workshop, expertise in fisheries social science can be hard to come by in certain areas of the archipelagos, and thus building long-term local capacity for conducting social science may yield benefits in future years.

With regard to assessment and monitoring of the effects of new management measures, numerous workshop discussants championed the benefits of Geographic Information Systems (GIS). The broad utility of spatially-oriented social description and analysis is undeniable in the realm of marine fisheries management, and especially given the requisite geo-spatial parameters of ecosystem-based management. GIS can also assist in relating and monitoring aspects of residence, business, and recreation as these pertain to use of, and human influences on, marine ecosystems and associated resources.

Finally, monitoring of human-environmental interactions in this context would very likely benefit from identification and use of valid social and economic indicators. As noted above, generalized indicators (e.g., local rate of unemployment or availability of alternative forms of employment) may be developed for use in a wide range of settings. More specific indicators could be developed subsequent to identification of specific management measures (e.g. number of active commercial licenses associated with a specific fishery). Again, determination of both generalized and specific indicators would ideally be based on review of the natural resource-relevant social indicators literature and on focused, facilitated discussion between social scientists (and perhaps biophysical scientists) and marine resource managers working in the region, or possessing relevant experience garnered elsewhere.

Depending on the nature and scope of the prospective management measure or policy, it may be prudent to involve stakeholders in early and ongoing discussions about the potential costs and benefits of those measures or policies. The benefits of doing so were elucidated by Dr. Fernandes during her discussion of the public comment and participation process associated with establishment of the Great Barrier Reef Marine Park, and by others during the workshop. Identifying actual or potential constraints early in the process typically affords time and enhanced potential for meeting related challenges. A broad literature regarding public involvement in natural resource decision-making processes is widely available and may be consulted. In any event, the Council is well-versed in the process of engaging the commentary and participation of the general public and specific stakeholder groups in its decision-making processes. Community-based management and community participation are, in fact, stated elements of the FEP planning process (WPRFMC 2005:27-28).

Develop and Implement Liaison and Performance Evaluation Programs. Finally, we assert the potential utility of establishing means by which resource user groups may readily interact and communicate on a regular, non-contentious, and interactive basis with management entities in the region. One potential means would be through fisheries liaison personnel versed in cross-cultural communication. This may be particularly useful in this culturally diverse region. Such liaisons could also aid in developing and implementing evaluation programs designed to assess the performance of ecosystem-based management throughout the region(s), and the manner of its reception in host communities.

5.0 Summary Conclusions

This report has been compiled to describe the Ecosystem Social Science Workshop held by the Western Pacific Regional Fishery Management Council during January of 2006. This was the second of a three-part workshop program intended to aid the Council in adopting fishery ecosystem plans in the region. A biophysical ecosystem workshop was held in April 2005. A final workshop will synthesize the results of the previous workshops with the intent of developing a framework for regional ecosystem policy and governance.

The social science workshop described herein addressed human dimensions of ecosystem-based approaches to fishery resource management. The workshop emphasized the three major components of marine systems – the biophysical, the human constituent, and the institutional. A wide range of perspectives were presented on related topics and issues, including the following:

- Marine fisheries, fisheries management, and related human and biophysical factors in the Western Pacific,
- The need for and utility of social science in the context of ecosystem-based management in this region and elsewhere,
- Institutional constraints and opportunities for incorporating social science into ecosystem-based management,
- Relevant information needs, useful types of data, and data collection methods,
- Ecosystem-relevant human behavior and resource modeling,
- Indicators for assessing regulatory effects and the performance of management strategies, and
- Scope and scale of social science applications to ecosystem-based management.

Workshop presentations and discussions were both general and specific in scope, and regional experts were on hand to help ground the discussions with their own perspectives on the realities of island life in the Pacific, and on the various fishery management challenges and solutions that have been encountered and applied in the region.

5.1 Summary Points of Particular Relevance to Council FEP Objectives

An extensive assortment of valuable insights, lessons, and pertinent background information about ecosystems, ecosystem social science, and the context of fisheries in the Western Pacific may be derived from the workshop and from these proceedings. Interested persons may consult the body of this report for such information. But some areas of discussion are particularly relevant to the information needs and objectives of the Council as it moves toward full adoption of its Fishery Ecosystem Plans. These lend themselves to summarization and are provided here as a means for bringing the long prior discussion to a conclusion.

- Definitions and parameters vary and continue to evolve, but there is general consensus that the ecosystem approach to fisheries management is novel in its attention to **whole marine systems including relationships among the biophysical, human, and institutional components that comprise those systems**.

- Human beings, groups, and institutions are critically important elements of marine ecosystems, and given their place in the trophic hierarchy, **human behaviors, beliefs and values should be given primary consideration**.

- The Council's approach to ecosystem-based management to date involves **adaptive management and emphasis on indigenous forms of resource management**; both may be particularly amenable in the Pacific islands context.

- Indigenous Pacific islanders draw on lengthy histories and ever-evolving **knowledge and traditions of interaction with ocean ecosystems and with each other** to successfully use that environment. Persons arriving here during more recent centuries also draw upon traditional and experiential knowledge. Both groups may provide valid information and perspectives on viable models for planning and administration of ecosystem-based management in the region.

- The nascent paradigm shift to ecosystem-based management may potentially lead to further institutional complexity in this unique region of multiple jurisdictions. Given the size of the region, extensive diversity in socio-demographic and socio-political context, and the increasing influence of international decisions regarding migratory species, an **incremental and adaptive approach may be the best way to proceed**.

- The Council has developed ten objectives for its Fishery Ecosystem Plans. Given the scope of the objectives and potential challenges associated with meeting them, **setting priorities and formulating specific management measures** may prove most useful for effectively meeting Council goals. Those measures ideally will be formulated based on the many potential contributions of the applied social sciences.

- **Each archipelago in the region is distinct in terms of socio-cultural, socioeconomic, and demographic conditions; mode and culture of governance; environmental conditions; and types and extent of fishing and other pursuits and uses of marine resources.** This variation may be effectively addressed for purposes of meeting FEP objectives through appropriate application of social science methods and analysis, including those methods that facilitate public participation in resource management decision-making processes.

- An array of data collection methods and analytical techniques has been developed to aid in understanding and communicating both the effects of human activities on biophysical systems and the effects of changing biophysical conditions on resource user groups.

- **Selection of social science methods and analytical techniques should be closely tailored to the information needs and objectives at hand, and to particular environmental and societal aspects of each archipelago**.

- **Valid social and economic indicators are particularly useful for assessing and monitoring direct and indirect human-environmental interactions, and as a basis for adjusting resource use policy under the new mode of management**. Indicators should articulate with a wide range of climatic, macro-economic, socio-demographic, regulatory, and community-related factors. In this case, such indicators will need to be developed based on: (a) their potential utility for meeting Council objectives, (b) extant data and the social and biophysical contexts in question, and (c) relevant indicators literature.

- A **social science approach to ecosystem-based management in the region should be developed to enhance Council efforts to meet its FEP objectives** and to administer the new form of management over the long term. The approach would include a series of related elements, as follow:

    - A venue or venues for choosing high priority FEP objectives, specific management measures for meeting those objectives, and valid social and economic indicators;

    - Design of research to meet prioritized objectives and related information needs;

    - Implementation of a research strategy to gather and analyze requisite information, and an indicators-based archipelagic monitoring system through which to gauge and analytically parse social change potentially associated with Council actions; and

    - Implementation of a liaison and performance and evaluation program to ensure the validity and effectiveness of the social science approach to ecosystem-based management in the region.

- Social science cannot be equated with community development *per se*, but **application of social science may further understanding of community context, local receptivity to or need for development programs, and the potential or actual social and economic costs and benefits of such programs**. Social science may therefore be used to help identify ways in which communities and individuals may participate in the abundance of positive ocean opportunities available throughout the Western Pacific region.

- Given that **a number of fisheries or fisheries-relevant social science research and monitoring programs have been undertaken in the United States and abroad in recent years, the Council FEP social science approach would ideally articulate with these**, both drawing upon and contributing to the base of knowledge regarding human interaction with the marine environment and the many related aspects of human behavior discussed during the course of the workshop.

5.2 Concluding Discussion

Based on the input of national and regional experts convened for the WPRFMC Ecosystem Social Science Workshop, we have presented valid social science approaches to ecosystem-based management. These may be of potential utility to the Council as it moves toward full adoption of its FEPs across the region. The workshop and report have enabled development of background information necessary for initiating refinement of such approaches for real-time application in the Western Pacific. Further work with fisheries managers, compilation and review of archival data, and field reconnaissance will enable full inventory of relevant existing information, identification of salient and ongoing management issues and related information needs, and development of detailed research agendas and designs for specific island areas.

As for biophysical approaches to ecosystem-based management, viable social science approaches must enable understanding of whole systems and relationships between their respective components, including those of user and interest groups, seafood distributors and consumers, and even fisheries researchers and managers and the institutions within which they operate. In the spirit of holistic ecosystem principles and concepts, social science approaches must and can also bear ermpirically-grounded information of predictive utility for management of biophysical components of marine systems.

There is much human and environmental variability within and across the island groups that comprise the vast Western Pacific region. Social science approaches must address such variation and translate findings in a manner that is optimally useful for resource managers seeking to make fair and equitable decisions in an increasingly complex and contested socio-political environment. Regional variation notwithstanding, pursuit and consumption of seafood and related cultural processes are constant and critically important aspects of life throughout the archipelagos. As such, there is vital need for understanding and longitudinal monitoring of the full range of factors that may impinge on these activities and processes, including the potential effects of conservation interests and ecosystem-based management.

Ecosystem concepts and principles were developed and applied in adaptive fashion in this region long ago. Indeed, learned ways of efficient interaction with marine and terrestrial ecosystems led to the proliferation of island societies throughout Oceania. Initial periods of trial and error gradually led to the ordering of society in a manner that in certain places and times enabled equilibrium between available marine resources and the demands of human groups depending on them for purposes of survival. By virtue of attention to and accumulation of knowledge regarding the natural world that surrounded them, and through various mechanisms of social control, Pacific islanders were ultimately successful in overcoming various ecological challenges, including those initiated by their ancestors.

The context has changed dramatically over the millennia, and many of the challenges we now face are global in scale. Yet it may be that knowledge of connections within and across island societies and ecosystems, and proven means for managing the activities of those who use and depend on marine resources for so many reasons, remain the most viable points of departure for addressing marine resource challenges in the Pacific in the decades to come.

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Appendix A: Annotated Bibliography of Select Recent Literature

Aswani, Shankar. 2002. Assessing the effects of changing demographic and consumption patterns on sea tenure regimes in Roviana Lagoon, Solomon Islands. *Ambio Vol. 31 No. 4, June 2002: 272-284.*

Aswani compares two villages in the Roviana Lagoon region of the Solomon Islands to examine differential response to pressures associated with increasing population. The author attributes differences in response to the lasting effects of divergent settlement patterns and related patterns of sea tenure. Aswani demonstrates that different forms of sea-tenure governance contribute to or perhaps hinder marine environmental protection, and that understanding these patterns is essential to establishing any form of effective management in the Insular Pacific (p. 56). The author concludes by urging that closer attention be paid to behavioral aspects of the social, economic, and political context among the stakeholders whose institutions we seek to understand.

Aswani, Shankar and Richard J. Hamilton. 2004. Integrating indigenous ecological knowledge and customary sea tenure with marine and social science for conservation of bumphead parrotfish. *Environmental Conservation, 31 (1): 69– 83.*

Aswani and Hamilton demonstrate successful integration of indigenous ecological knowledge and customary sea tenure into co-management of bumphead parrotfish in Roviana Lagoon in the Solomon Islands. Participatory management in this case involves incorporation of local knowledge and delegation of management responsibilities to local communities. Indigenous fishers possess first-hand experience and knowledge of the marine environment and how this changes over time. The research indicates that it is imperative to examine the institutional reliability of local forms of sea tenure where still operational. Otherwise, it will be impossible to predict the capability of local people to institute, manage, and enforce regulatory mechanisms. Anthropological fieldwork helped to distinguish those institutional contexts and locations where there is greater likelihood of successful local participation and positive outcomes in precautionary marine resource management programs.

Aswani, Shankar and Richard J. Hamilton. 2004. "The Value of Many Small vs. Few Large Marine Protected Areas in the Western Solomon Islands." *SPC Traditional Marine Resource Management and Knowledge Information Bulletin #16 – March 2004: 3-14.*

Aswani and Hamilton demonstrate that MPAs are the most tenable and enforceable marine resource management in the Western Solomon Islands and that establishment of a network of small MPAs is a more biologically effective and socially attainable strategy here than is establishment of a few large reserves. The authors argue that it is a mistake to focus solely on the biological and ecological value of MPAs; economic and social sustainability issues are critically important. In this case, it is essential that persons and groups with marine tenure in the

MPA area are able to exclude interlopers and maintain and enforce rules regarding use of resources. Importantly, the authors note that conflict decreases when neighboring groups operate under similar regimes. In such cases boundaries tend to be respected and there is understanding that cooperation may enhance sustainable resource management practices over the long-term. In conclusion, Aswani and Hamilton contend that social parameters must be adequately addressed in the establishment of MPAs, and this involves selecting MPA sites in which: 1) there is minimal public contest over natural resources; 2) boundaries are well defined and recognized regionally; 3) there is little or no poaching by neighboring groups; 4) there is local capacity to monitor and enforce rules; and 5) the majority of inclusive stakeholders endorse the management initiative.

Aswani, **Shankar and Matthew Lauer**. 2006. Incorporating fishermen's local knowledge and behavior into geographical information systems (GIS) for designing marine protected areas in Oceania. *Human Organization*, *Vol. 65, No. 1.*

In this article, Aswani and Lauer describe development and use of a geographic information system (GIS) to establish MPAs in Roviana and Vonavona Lagoons in the Solomon Islands. The GIS in this case is developed through habitat mapping and anthropological fieldwork. The authors contend that spatial knowledge about social parameters that is based in part on the participation of user groups can aid in development of resource management strategies that are both highly effective and cost-efficient. Findings emphasize the utility of the methods for informing conservation biologists and fisheries managers who seek to understand ecological processes in areas where little data is available.

Boyd, Heather and Anthony Charles. 2006. Creating community-based indicators to monitor sustainability of local fisheries. *Ocean & Coastal Management, 49: 237–258.*

This paper describes creation of a framework for identifying indicators for monitoring social and ecological performance of marine fisheries at the community level of analysis. Actual indicators ultimately selected by the researchers are not provided in the article; the emphasis is on process. The process of selecting and monitoring those indicators involves the following steps: (a) identify participants, (b) develop a common (community) vision regarding the desired status of local fisheries, (c) develop a framework of indicators with which to gauge whether the vision is being met, (d) identify relevant characteristics of sustainability (through work with user groups and existing data), (e) classify and evaluate indicators, and (f) select indicators. The goal of the process is socioeconomic, community, and ecological sustainability.

Results suggest that indicators appropriate for measuring geographically extensive fisheries are often unsuitable for evaluating smaller fisheries, and that many currently ignored indicators appear suitable for evaluating small-scale fisheries. While the authors recognize limits in the extent to which their work in a case study community in Canada may be generalized, they also argue that certain findings may be of interest to persons engaged in indicator research in other settings. These findings include the following: (1) ecological indicators are the most commonly monitored, and thus the most likely to be available to inform management decisions; (2) most ecological indicators were neither appropriate nor practical for local level monitoring, and are typically not monitored at the scale of local communities due to the lack of fit between ecological boundaries (for the fish stocks) and political boundaries (of fishing communities); (3) a high proportion of the community, institutional, and socioeconomic indicators developed in this research are both appropriate and practical for local monitoring; and (4) only a small proportion of those community, institutional and socioeconomic indicators are currently monitored and available for the case-study community. The authors report that the following criteria were central to identifying indicators in this case: relevance, reference values, sensitivity, measurability, simplicity/understandability, sensibility and ease of expression, and timeliness.

Browman, Howard I. and Konstantinos I. Stergiou. 2004. Perspectives on ecosystem-based approaches to the management of marine resources. *Marine Ecology Progress Series, 274: 269–303.*

Browman and Stergiou argue that governance, and not science, is "the weakest link in the management chain." According to the authors, a truly functional approach to ecosystem-based fisheries management will require the meaningful participation of a many persons and constituencies. The authors assert that the status quo is one of dysfunction, and that a new structure will require the participation of "stakeholders, social and political scientists, economists, lawyers, political lobbyists, educators, journalists, civil engineers, ecologists, fishery scientists and oceanographers," and that all of these will need to operated in a conciliatory and integrative environment.

Brush, Grace S. 1997. History and Impact of Human Activities on Chesapeake Bay. In *Ecosystem Function & Human Activities: Reconciling Economics and Ecology*. R. David Simpson and Norman L. Christensen, Jr. (Eds.). London: Chapman and Hall. Pp. 125-145.

Brush investigates the role humans have played in altering the Chesapeake Bay estuary and watershed systems over the last several centuries. The author contends that effective management protocols must address the social dynamics of human groups who have used and continue to use and alter the resources and landscape of the region.

Brussard, Peter, F. Reed, J. Michael, and C. Richard Tracy. 1998. Ecosystem management: what is it really? *Landscape and Urban Planning, 40, 9–20.*

Brussard, Reed, and Tracy describe ecosystem management as a broad, holistic process rather than one involving narrow focus on discrete systems, and they argue the importance of including broad constituencies of stakeholders in the management process. The authors contend that ecosystem management requires the collection and linking of necessary ecosystem data at several spatial scales, and the collection and analysis of socioeconomic data "to determine the relationships among ecological conditions and human activities and the tradeoffs between ecological and socioeconomic values."

The authors further assert that, in most cases, such data is inadequate or lacking. As such, data collection and analysis should focus on "relationships between ecological conditions and human activities in the ecosystem, a realistic valuation of biodiversity and ecosystem services, and the potential trade-offs between ecological and socioeconomic values." The participation of social scientists in this process and in the ecosystem management process as a whole is said to be essential.

Christie, Patrick. 2005. Observed and perceived environmental impacts of marine protected areas in two Southeast Asia sites. *Ocean & Coastal Management 48: 252–270.*

Christie's study demonstrates that MPAs embedded in an integrated coastal management (ICM) framework have had positive impacts on coral reefs in Mabini in the Philippines, and within tourism-designated zones of the Bunaken National Park (BNP) in Indonesia. Using both qualitative and quantitative methodologies, Christie explores the perceived and actual environmental impacts of MPAs in these applications. He concludes that while perceptions of local residents can provide valuable information for management and education programs, it is also very important for purposes of effective management to ground those perceptions with direct observation and monitoring of the conditions of the reefs and associated fish populations.

Christie, Patrick. 2004. Marine protected areas as biological successes and social failures in Southeast Asia. *American Fisheries Society Symposium 42: 155–164.*

Christie reviews development and administration of four MPAs in the Philippines and Indonesia, and discusses how MPAs that are commonly regarded as biological "successes" may, in fact, be social "failures." Pointing to a lack of social research in the MPA literature, Christie illustrates some of the implications of ignoring the social complexities associated with MPAs. Because establishment and administration of MPAs can result in conflict and breaching of rules, standards for measuring both biological and social success should be applied equally. Christie asserts a need for more focus on comparative studies–especially those that explore inter- and intra-group differences that are likely to foment conflict and problematic management.

Christie, Patrick, **David Fluharty, Alan White, Rose-Liza Eisma-Osorio, Kem Lowry, Liana Talaue-McManus, Hilconida Calumpong, and Richard Pollnac**. 2005. Determining the Benefits and Feasibility of Ecosystem-Based Fisheries Management in the Central Philippines: Final Project Report.

Christie et al. report that there are very few existing published sources regarding socio-economic and governance dimensions of ecosystem approaches to fisheries management. Literature regarding the experiences and impacts of such approaches in developing countries is similarly lacking. The authors attempt to close this gap in understanding with a comprehensive report of ecosystem-based fisheries management in the Central Phllipines.

The authors contend that an interdisciplinary approach will yield the most useful results for ecosystem-based fisheries management. The following recommendations are advanced: (1) develop an appropriate working definition of the ecosystem approach that puts it in the context of other coastal resource management efforts ; (2) consider the institutional and organization structures that are required to support ecosystem-based approaches to fisheries management and facilitate interactions between key sectors in coastal marine systems; and (3) conduct feasibility analyses and design effective processes for implementing ecosystem approaches that put ecological function and social organization and effects on equal footing.

Christie, Patrick, Bonnie J. McCay, Marc L. Miller, Celia Lowe, Alan T. White, Richard Stoffle, David L. Fluharty, Liana Talaue-McManus, Ratana Chuenpagdee, Caroline Pomeroy, Daniel O. Suman, Ben Blount, Daniel Huppert, Rose-Liza Eisma-Oracion, Enrique Villahermosa, Kem Lowry, and Richard B. Pollnac. 2003. Toward developing a complete understanding: a social science research agenda for marine protected areas. *Fisheries, Vol. 28 (12): 22-26.*

Christie et al. assert that the conflict that often arises between stakeholders contributes to the high rate failure of MPAs, which approaches 90 percent in some countries. Further, the authors contend that any short-term biological gains, such as improved fish stock and habitat, will likely dissipate if attention is not also paid to the social dynamics associated with those improvements. Increased local participation in management, sharing of economic benefits, and conflict resolution mechanisms are highly desirable in this context.

Several factors tend to undermine the success of MPAs. For example, social science research, when it is included at all, is often not integrated early in the design process. The situation is said to "result in a poor understanding of frequently contentious social interactions operating on multiple levels (local, national, international, gender, class, ethnicity), unintended negative consequences, missed opportunities for positive change and reallocation of resources, and an incomplete scientific record." Willingness of local resource users to participate in MPA efforts also needs to be considered in depth, but all too often is not. This basic design principle can contribute markedly to the success or failure of MPAs.

The authors identify several contributions that social science research can make to improve MPA management success. These include: identification of potential conflicts between user groups; mitigation design; substantive constituent engagement; guidance of the cooperative planning process; and development of a more objective, mandate-independent research agenda.

Clay, P.M. and E.J. Dolin. 1997. Building better social impact assessments. *Fisheries, 22 (9): 12-13.*

Clay and Dolin argue that social impact analyses assist in formulating balanced, more effective fishery management plans, but often suffer from a lack of comprehensive, relevant, and useful social and economic data. The authors further assert that social impact analyses need to establish better-defined variables and data collection methodologies. They conclude that funding is critical to implement the kind of longitudinal research essential to measure systemic changes over time and to provide fisheries managers with the kind of science they need to make more informed and effective decisions.

Cooperrider, Allen Y. 1996. Science as a model for ecological management: panacea or problem? *Ecological Applications, 6 (3): 736-737.*

Cooperrider asserts that the "big science" approach to conservation ecology and resource management is problematic in that it only peripherally considers human actions as relevant. In reality, human behavior and processes such as those associated with rapid population growth and consumption are critically important to meaningful ecological research. The author asserts that , if we are to more effectively address the ecological problems "big science" must be more value-driven, holistic, inclusive, and address all relevant aspects of human behavior and society.

Cortner, Hanna J., Mary G. Wallace, Sabrina Burke, and Margaret A. Moote. 1998. Institutions Matter: the Need to Address the Institutional Challenges of Ecosystem Management. *Landscape and Urban Planning, 40; 1998: 159–166.*

Cortner et al. assert that ecosystem-based management is as much a social endeavor as a scientific endeavor. The authors underscore the political nature of the process. Present institutional practices are said to fail to recognize linkages between the way people relate to nature, each other, and our institutions. Drawing from review of relevant literature, the authors extract what they believe are the five main principles of ecosystem management. These include: (1) socially defined goals and management objectives; (2) integrated, holistic science; (3) broad spatial and temporal scales; (4) collaborative decision building; and (5) adaptable institutions. Asserting that an ecosystem approach will require a shift in institutional paradigms, the authors also examine how the social values embedded in the five principles of ecosystem management could refine existing practices. This leads to Identification of five problem areas or unknowns: (1) the extent to which existing laws, policies, and regulations may constrain or aid the development and implementation of ecosystem management policies, programs, and practices; (2) the institutional mechanisms for managing across jurisdictions under an ecosystem approach; (3) the level of public support for ecosystem management; (4) the examination of the theories which guide resource management; and (5) the current methods for researching institutional questions that can sufficiently address the goals of ecosystem management. The authors conclude by arguing against goal-centered, linear, manual-driven styles of management, and for a management style that "may be viewed as an 'improvisory art' where ''we combine familiar and unfamiliar components in response to new situations.''

Dwyer, John F. 1997. Integrating Social Sciences in Ecosystem Management: People-Forest Interactions in the Urban Forest. *In*: Integrating Social Science and Ecosystem Management: A National Challenge - Proceedings of the Conference on Integrating Social Sciences and Ecosystem Management Helen, GA. December 12-14, 1995. Electronic document, available online at: http://www.srs.fs.usda.gov/pubs/gtr/gtr_srs017.pdf, pp.39-43.

Dwyer argues that the social sciences are necessary to develop and implement effective ecosystem management strategies. He posits that such strategies must be able to identify, explain, and predict interactions between societies and natural systems. To accomplish these aims, Dwyer suggests that social science research focus on effective ways of communicating the physical and biological consequences of management options, as well as on finding the links between this "production" information and the needs, behaviors, and benefits received by the people who own, use, or manage the ecosystems in question. In particular, Dwyer recommends delving deeper into the following ecosystem management research issues: (a) the outcomes of alternative management strategies; (b) how the management of a resource area influences the management and use of other resource areas; (c) how to better coordinate resource user and management strategies for coordinated approaches to management by the numerous owners across the forest landscape; (d) identification of the improvements in ecosystem management brought about by partnerships among managers, users, and others; (e) promising approaches to initiating, developing, and sustaining partnerships and enhancing the resulting benefits; (f) identification of the benefits that individuals receive from forests and involvement in forestry programs; (g) information on how the benefits received by individuals are influenced by particular forest environments and management programs; (h) identification of the benefits that communities can receive from forests and forestry programs; and (i) how these benefits vary among community types, forests, and forestry programs.

Endter-Wada, Joanna, Dale Blahna, Richard Krannich, and Mark Brunson. 1998. A framework for understanding social science contributions to ecosystem management. *Ecological Applications, Vol. 8 (3): 891-904.*

Endter-Wada et al. contend that ecologists typically overlook the contributions social scientists can make to ecosystem management. Social scientists are seen as capable of providing much-needed empirically acquired insight into social beliefs and values that have direct bearing on the use, condition, and management of natural resources. The authors discuss two specific contributions that social science can make to ecosystem management: (1) increasing public involvement in the ecosystem management decision making process, and (2) providing social analysis of problems and salient issues associated with and resulting from such management.

Commonly employed public involvement processes include conflict management, collaborative learning, local decision-making partnerships, and co-management processes. Some commonly employed social analysis in this context includes process-oriented iterative social assessments, strategic perspectives analysis, and adaptive management.

Public participation processes are said to yield both positive and negative outcomes. By increasing public involvement in management processes, social scientists can better predict both the direction and magnitude of public response to alternative management strategies: such data can improve understanding of key social values, uses, and concerns about ecosystem management and will support more focused, rigorous, and scientifically defensible social analyses of social factors relevant to a particular ecosystem. On the down side, traditional public involvement processes can fail to elicit understanding of the way humans relate to the natural environment through cultural traditions, life ways, or social values.

FAO Fisheries Department. 2003. The Ecosystem Approach to Fisheries. FAO Technical Guidelines for Responsible Fisheries. No. 4, Suppl. 2. Rome, FAO. 2003. p. 112

The authors contend that socio-economic research is essential to developing and implementing effective ecosystem-based approaches to fishery management. They advocate research into the factors that influence the daily behavior of vessel operators—especially with regard to the choice of fishing gear, fishing ground, and manner and level of discard. FAO suggests applying an integrated environmental and economic accounting framework to assess and analyze the interaction between fisheries and other sectors of the economy. Participatory processes are said to be critical to effective implementation, and the authors strongly recommend more sociological research into improving the consultation process with stakeholders. Such research is said to e especially imperative where alternative livelihoods and employment are required for alleviating problems resulting from chronic over-fishing.

Fernandes, Leanne, **Jon Day, Adam, Lewis, Suzanne Slegers, Brigid Kerrigan, Dan Breen, Darren Cameron, Belinda Jago, James Hall, Dave Lowe, James Innes, John Tanzer, Virginia Chadwick, Leanne Thompson, Kerrie Gorman, Mark Simmons, Bryony Barnett, Kirsti Sampson, Glenn De'ath, Bruce Mapstone, Helene Marsh, Hugh Possingham, Ian Ball, Trevor Ward, Kirstin Dobbs, James Aumend, Deb Slater, and Kate Stapleton.** 2005. Establishing representative no-take areas in the Great Barrier Reef: large-scale implementation of theory on marine protected areas. *Conservation Biology, Vol. 19 (6): 1733–1744.*

Fernandes et al. discuss the principal steps involved in the successful establishment of a "large, comprehensive, adequate, and representative network" of no-take marine protected areas in the Great Barrier Reef Marine Park (GBRMP) along the coast of northeastern Australia. The case study is presented as an example of how this process may be replicated to implement MPAs in other industrialized nations around the world.

Factors contributing to the GBRMP zoning process included: "focusing initial communication on the problems to be addressed; applying the precautionary principle; using independent experts; facilitating input to decision making; conducting extensive and participatory consultation; having an existing marine park that encompassed much of the ecosystem; having legislative power under federal law; the linking of science, scientists, and community participation; developing high-level support; ensuring agency priority and ownership; and being able to address the issue of displaced fishers." The authors emphasize the critical significance of thorough consultation with key stakeholders and contend that this was what ultimately led to formal institution of the Park.

The authors conclude that the concepts and approaches applied in the process of reviewing Great Barrier Reef zoning have application elsewhere, regardless of the level of available data or technical support. The general steps of the process included the following: (1) defining and discussing the problem; (2) deciding on objectives; (3) engaging relevant and independent experts; (4) compiling existing biophysical, social, economic, and cultural data; (5) describing the biodiversity; (6) defining operational principles that will achieve the objectives; (7) inviting community input on all of the above; (8) gathering and layering data in round-table discussions; (9) reporting the degree of achievement of principles for each alternative map of no-take areas; and (10) developing and employing mechanisms by which to address any negative impacts.

Geoghegan, Jacqueline and Nancy Bockstael. 1997. Human Behavior and Ecosystem Valuation: an Application to the Patuxent Watershed of the Chesapeake Bay. In *Ecosystem Function & Human Activities: Reconciling Economics and Ecology.* R. David Simpson and Norman L. Christensen, Jr. (Eds.). London: Chapman and Hall. Pp. 147-173.

Geoghegan and Bockstael report on recent ecosystem valuation research, and assert that most studies have been too dichotomously focused on either ecology or economy. Economic models, for example, reportedly tend to measure commodities that are of immediate or obvious benefit to humans while ignoring those values that may contribute to social well being, while ecological models often fail to address human inputs altogether..

Thus, Geoghegan and Bockstael call for greater integration to better explore ecosystem form and direct and indirect relationships to human welfare. Toward this end, the authors support the research agenda advanced at a recent EPA conference, which brought ecologists and economists together to address shortcomings of previous research. The agenda defined two major future research areas: (1) increasing the understanding of ecosystem function and how human behavior impacts those functions; and (2) improving the identification and methods of determining which ecosystem services are of value to humans (p. 148).

Following the conference, the EPA sponsored several case studies in which ecological and economic modeling and analysis were to be better integrated. The stated goals of this collaborative effort involved improving understanding of the economic valuation of ecosystems, the impacts of human intervention in the ecosystem, and the manner in which different ecosystem configurations contribute to human well-being. More specifically, the "purpose of having an integrated model of the ecosystem and the economy is to reflect more accurately how the distribution of human activities such as farming, electric power generation, commercial and residential development, recreation, wastewater treatment, highway construction, and fishing affect the ecosystem" (p. 149), while measuring the effect of the ecosystem landscape on the quality of goods and services of value to humans.

Grumbine, **R. Edward**. 1997. Reflections on "What is Ecosystem Management?" *Conservation Biology, Vol. 11 (1): 41-47.*

Grumbine asserts that social science data is needed to adequately inform the processes and policies of effective ecosystem management, and that personnel in natural resource agencies often discount or simply do not collect the social data that could better help them do their job and achieve their management objectives. The author argues that this is imprudent in that numerous studies confirm that non-biological data are often more important than scientific information in solving management problems (p. 44).

Hennessey, Timothy M. 1997. Institutional Design for the Management of Estuarine Ecosystems: the Chesapeake Bay. In *Ecosystem Function & Human Activities: Reconciling Economics and Ecology.* R. David Simpson and Norman L. Christensen, Jr. (Eds.). London: Chapman and Hall. Pp. 199-223.

Hennessey describes three stages of development of the governance system for managing the Chesapeake Bay ecosystem. Stage I (1976-1983) brought scientists and key stakeholders together to discern key issues, Stage II (1983-1986) established the institutional structure and jurisdiction, and Stage III (1987-1992) focused on program implementation and evaluation. First defined in the Great Lakes Program, the management lessons learned from this analysis are now incorporated into the management system for the National Estuary Program (NEP).

The author argues that the dynamics of the ecosystem and its uses must inform the design of institutions and systems. He describes how the principles of adaptive management, which involves learning by experiment, effectively combine with the precepts of "bounded conflict." The bounded conflict model recognizes that opportunities for learning and institutional intervention result from the inevitable conflict that arises when multiple stakeholders interdependently demand and use the resources contained within a single ecosystem. Hennessey's evaluation of the management system developed for the Chesapeake Bay ecosystem is that it is an adaptive system able to address increasingly complex issues while integrating existing governance mechanisms. He recommends adding an experimental component to the program and emphasizes the importance of multi-jurisdictional, cooperative management programs in creating successful institutional designs for ecosystem management.

Hilborn, Ray. 2004. Ecosystem-based fisheries management: the carrot or the stick? *Marine Ecology Progress Series, 274: 275–278.*

Hilborn describes a form of ecosystem management that emphasizes interactivity between fish, fishermen, and government regulators, and advocates incentive-based participation of stakeholders. This brand of management is characterized as a more likely to sustain ecosystem-based management objectives than is a top-down, governmental regulatory approach.

The author underscores the importance of political power held by commercial and recreational fishermen in most of the industrial world and indicates that attempts to impose regulations that are contrary to their economic interests will most likely fail. He also points out that "ecosystem management that relies on top-down control for implementation and makes no allowances for the social/political dynamics of the regulatory structure is no more likely to succeed than conventional single species management." According to Hilborn, reducing or eliminating the current problems in fisheries thus necessitates considering humans as an integral element of ecosystem management.

Hilborn contends that ecosystem management include the following characteristics: (a) marine tenure incentives that would ensure long-term economic and social benefits and sustainable fishing practices; (b) attention to spatial scales appropriate to the biology of the fish and the structure of the fishing communities; (c) stakeholders intensively involved in all levels of science, management and enforcement and, under some circumstances, fishing groups with complete control over the resource; and (d) costs of research, management and enforcement paid by user groups. He also asserts that central governments need to audit the system to assure sustainability of the biology and economics of the fishery and to ensure respect and enforcement of national/international agreements and laws.

Jepson, **Michael.** 2005. Ecosystem Fisheries Management: a Summary of Workshops Conducted along the Gulf Coast. A report prepared for the Gulf of Mexico Fisheries Management Council. November 2005. Online at: http://www.gulfcouncil.org/downloads/GMFMC%20Ecosystem%20Fisheries%20Management%20Report.pdf#search='michael%20jepson%20gulf'.

This report illustrates one way in which the social sciences can contribute to ecosystem-based approaches to fishery management and associated research. Jepson conducted public workshops with 43 stakeholders in nine coastal communities from Key West, Florida to Corpus Christi, Texas in order to gather public opinion and facilitate discussion about the adequacy of current ecosystem approaches to management. Aggregated responses identified several important and overarching stakeholder perspectives: overall change in management is needed; jurisdictional authority changes are needed; and, single species management is not working. Jepson makes recommendations for improving and expanding stakeholder knowledge using the Delphi Technique or the Modified Focus Group/Game Theory approach for gathering public opinion and facilitating discussion. He concludes that developing an outreach program is essential to the process of informing the public and expanding the base of involved stakeholders.

Jorgensen, Joseph G., Richard McCleary, and Steven McNabb. 1985. Social indicators in native village Alaska. *Human Organization,* Vol. 44 (1): 2-17.

Jorgensen et al. conducted research in eight Alaskan villages: four in the Northwest Alaska Native Association (NANA) region and four in the Aleutian-Pribilof Islands Association (APIA) region. They investigate whether increases in village populations correlate with "increases in full-time employment, market economic activities, formalized institutions, nuclearization of families, mobility, understanding of economic processes, and the diminished time and investment in subsistence pursuits, and the sharing of the quarry and proceeds from it" (p. 4).

Two competing models of social change are analyzed —the liberal economic paradigm or "Western Industrial" model, and the model emerging from the dependency literature, the so-called "Underdevelopment" model. The goal is to use these communities as cases that test both the explanatory and predictive powers of both models. Jorgensen et al. conclude that the Western Industrial model, which predicts increasing market rationalization of previously non-market transactions, does not accurately describe the conditions of social change in the eight study communities. Most notably, the data fail to show a correlation between increasing market penetration into traditional society and economic growth in these regions. To the contrary, the authors interpret their data to show that the Underdevelopment model better characterizes contemporary regional socio-economic conditions in these eight villages. According to the latter model, "undeveloped" Native American societies become "underdeveloped" through "domination by developed nations, expropriation of their strategic resources areas, and dependency on public sector economies, including employment, but also dole in the form of transfer payments and services" (ibid). In short, underdevelopment often is the result of market integration of subsistence societies. Industrialization and a cash economy then do not necessarily improve quality of life for Alaska Natives.

Juda, **Lawrence**. 2003. Obstacles to Ecosystem-based Management. *In:* The Global Conference on Oceans, Coasts, and Islands Mobilizing for Implementation of the Commitments Made at the 2002 World Summit on Sustainable Development. Pre-Conference Proceedings Volume. Global Conference, UNESCO, Paris, November 12-14, 2003: 67-71.

Juda asserts that ecosystem-based management requires the collection and consideration of both natural and social science data. He points out that while the natural sciences may provide an understanding of natural system dynamics and the impacts of human use on those systems, social science can contribute to the understanding of human perception of nature, how people use the ocean/coastal environment and its resources, and why they use it as they do. The answers to the "why" questions are crucial to altering human behavior patterns that damage natural systems (p. 69).

Juda, **Lawrence and Timothy Hennessey**. 2001. Governance profiles and the management of the uses of large marine ecosystems. *Ocean Development & International Law, 32: 43–69.*

The authors discuss the contributions that social sciences can make to advancing ecosystem-based management. In particular, social science can contribute to enhanced understanding of linkages between behavior and outcome in the natural system, and how the environment is perceived by users and what motivates particular behavioral patterns. Such an understanding would enhance the potential for achieving needed behavioral change.

Kaplan, **Ilene M**. 2004. The Social Dimension of Ecosystem-Based Fisheries Management. Presentation at the Woods Hole Oceanographic Institution, Union College.

Kaplan asserts the importance of including dynamic human-environmental relationships in ecosystem models and related management strategies. The author argues that these should be implemented from the onset of the management process and inclusive of all stakeholder groups. She further asserts the importance of evaluating socio-cultural and economic interactions prior to implementation of a management plan, and calls for case studies of fishing communities to gain a better understanding of the depth, breadth, and diversity of fishing activities and associated forms of social and economic enterprise and involvement.

Kaplan, **Ilene M., Vishwanie Maharaj, David Fluharty, and Virdin Brown**. 2002. MAFAC Ecosystem-based Fisheries Management Task Force - Group 1: The Human Dimension of Ecosystem Based Fisheries Management. January 2002 MAFAC Workshop. Online at: www.vcu.edu/mafac/Group1.doc.

Kaplan et al. discuss the contribution of systems theory to ecosystem-based fishey management, and the role that social scientists can play in conducting social impact assessments that are in accord with the social goals of the ecosystem approach (i.e., optimization of social and economic benefits and the minimization of negative social and economic impacts to communities). Advocates of systems theory assert the importance of interconnections between actors and indstitutions in society and their interaction with the physical environmet. Thus, stress in the marine environment may affect marine resources and hence, inflict financial hardship on fishery participants. Subsequent regulatory change may also affect user groups, potentially resulting in increased benefits to some and economic loss to others. In keeping with these principles, Kaplan et al., recommend monitoring and evaluate socio-cultural and economic interactions that contribute to and occur as a result of ecosystem-based management, and adjusting regulatory and management policies to minimize deleterious human effects.

MPA Science Institute. 2003. Social Science Research Strategy for Marine Protected Areas. National Marine Protected Areas Center, Santa Cruz, CA.

This strategy statement advocates for inclusion of extensive social science applications in MPA-related research. Social sciences include the following disciplines: anthropology, sociology, economics, geography, psychology, political science, public policy, archaeology, humanities, and law and ethics. The authors point out that virtually all of the federal mandates relevant to MPAs refer to the integral role of social and economic factors in policy development and management decisions. These include the Sustainable Fisheries Act, National Marine Sanctuaries Act, Coastal Zone Management Act, and Presidential Proclamations and Executive Orders. The authors recommend the following specific efforts to further social science applications in the context of establishing and monitoring MPAs: (a) collection of both qualitative and quantitative baseline data regarding the existing conditions and past trends that are relevant to the human environment; (b) monitoring of both short- and long-term effects on human users; (c) evaluation of MPA processes, outcomes, and effectiveness in achieving goals and objectives; (d) identification of unintended consequences; and (e) recognition of the ethical issues that arise with collection of sensitive data.

Oracion, **Enrique G., Marc L. Miller, and Patrick Christie.** 2005. Marine protected areas for whom? Fisheries, tourism, and solidarity in a Philippine community. *Ocean & Coastal Management, 48: 393–410.*

The authors explore the conditions contributing to conflict between MPA managers and stakeholders in the interdependent tourism and fishery sectors in the Mabini MPA on the Luzon Peninsula. While both sectors helped establish this MPA, the authors suggest that the inherent economic advantages enjoyed by the tourism sector have marginalized access and control on the part of the fishery sector. With the stated goal of improving the Mabini MPA system, the authors propose several changes in institutional structure, policymaking process, research, and management-constituency relations. One recommendation is for a more multidisciplinary data collection effort. Another proposal stresses increasing access of indigenous user groups (in this case, the Barangay fishers) to the policy-making process. The authors also suggest providing education and user support for any new fishing technologies introduced; and, if necessary, assistance in occupational diversification.

Orbach, Michael K. 1997. Ecology and Public Policy. In *Ecosystem Function & Human Activities: Reconciling Economics and Ecology.* R. David Simpson and Norman L. Christensen, Jr. (Eds.). London: Chapman and Hall. Pp. 255-271.

Orbach explores the relationship between natural and social sciences and their practitioners. Focusing upon decision making in environmental and natural resource public policy, he argues that all policies that assign a categorical value to a particular component of the physical environment are based on cultural values. Hence, environmental policy is coterminous with *social* policy. The author also discusses the tacit naturalization of particular human beliefs and behaviors in any given ecosystem as a serious imbalance in the collection and analysis of data that informs environmental policy. Because humans and their beliefs are the major factors in the process of governance of the ecosystem, the author maintains that scientific input into policy making must be truly interdisciplinary, as mandated by the National Environmental Policy Act (NEPA). In particular, he argues that "the question of value, belief, perception and behavior – the human ecology– that is central to all governance and to our discussion of environmental policy and management here can *only* be answered with thorough, high-quality social science" (p. 265). However, he reminds us that *no* science–physical, natural, or social–will produce *the* answer to any governance question, including those involving environmental policy. Rather, the "answers," Orbach contends, will rise from the governance process that considers both natural and social science data as part of the puzzle. The author thus advocates increased emphasis upon the cultural as well as economic values that inform the decision-making processes. He concludes by stressing that the efficacy of any system of ecosystem governance depends upon the collaboration of and mutual respect for all key stakeholders, which includes scientists, policy makers, and private-sector constituents.

Perry, **R. Ian and Rosemary E. Ommer**. 2003. Scale Issues in Marine Ecosystems and Human Interactions. *Fisheries Oceanography, (12) 4/5: 513–522.*

Perry and Ommer assess both social and natural science scale analyses to understand the impact of natural systems upon people, and the impact of people upon natural systems. The authors contend that small-scale qualitative social science studies have been the most useful for understanding human motivation, without which, we have little chance of making reliable predictions about human response. However, they stress, "many methodological issues remain unresolved in integrating studies conducted at local scales to larger scales" (2003: 521).

In consideration of such methodological issues, Perry and Ommer conclude that there are probably good scale matches across large-scale social and natural science models and surveys. But while these studies reveal patterns and trends, they usually do not tell (or do not tell enough) about underlying human motivation, and thus do not tell us what is likely to happen if human conditions alter or become stressful. They also determined that the main difficulties for matching social with natural science models lie in (a) cross-scale social science studies, which tell about pathways; and (b) small-scale qualitative social science studies, which help us to understand e crucial human motivations. So far, these small-scale qualitative social science studies are proving the most successful ways of beginning to resolve this issue in particular, with problems that appear to originate with variability at intermediate temporal scales.

Perry and Ommer also assert that natural and social scientists need to work together to identify issues of ecosystem processes and human interactions, and their appropriate scales. The authors contend that by identifying these issues, social and natural scientists should be able to better develop policy guidelines for protecting ecosystems from excessive human depredations, and the human communities that depend on them from economic, social, and cultural collapse.

Poepoe, Kelson K., Paul K. Bartram, and Alan M. Friedlander. 2002. The Use of Traditional Knowledge in the Contemporary Management of a Hawaiian Community's Marine Resources.

This article is intended to educate persons in other coastal communities about traditional management systems used by Native Hawaiians. The authors assert that the system used for managing resources at Mo‘omomi is fundamentally different from that of industrial societies in that it was developed directly as means of adaptation to the availability and limitations of marine resources, and depends on community self-management for success. The authors suggest that without perpetuation of such systems, fisheries upon which people on Moloka'i depend would likely be in the same state of decline as elsewhere in the populated Hawaiian Islands.

Pollnac, Richard B. and Robert S. Pomeroy. 2005. Factors influencing the sustainability of integrated coastal management projects in the Philippines and Indonesia. *Ocean & Coastal Management 48 (2005) 233–251.*

This article examines factors influencing the sustainability of integrated coastal management projects (ICM) in the Philippines and Indonesia. The findings indicate that perceived and actual benefits influence early involvement and participation in the evaluated ICM projects. This early involvement, in turn, increases the chances that benefits will be those desired by the target population. Consequently, achieving these benefits sustains the ICM process by stimulating continuing involvement. Involvement and participation in the planning, conduct, and modification are the strongest predictors of ICM project sustainability. Such participation embeds in the community members a feeling of project ‘‘ownership’’ and involvement in all stages of the planning process increases the probability that the project goals fit the needs of the constituents.

Tissot, Brian. 2005. Integral marine ecology: Community-based fishery management in Hawai‘i. *World Futures, 61: 79–95.*

Tissot advocates community-based fisheries management as a way to resolve conflicts among multiple stakeholders over limited fishery resources. One of the stated benefits of community-based management is the development of strategies compatible with each unique environment, its resources, and the cultural and historical context of the local area, in this case along a rural stretch of coastline on Hawai'i Island.

The author asserts that Ken Wilber’s Integral Ecology theory is particularly well suited to examine complex interactions associated with the management of coastal fisheries. Most studies of fishery management are said to acknowledge the roles of biology, ecology, sociology, economics, and politics while paying little attention to important cultural or spiritual dimensions. According to Tissot, integrated ecology theory holistically describes an environment as co-occurring in four quadrants: the exterior-individual (behavioral) quadrant, the exterior-collective (systems) quadrant, the interior-collective (cultural) quadrant, and the interior-individual (experience) quadrant. The IE all-quadrants, all levels (AQAL) approach to ecological issues takes into account all perspectives and their respective knowledge claims, thus examining all interests, and providing recommendations for solutions that honor each perspective while maximizing the sustainability of the system as a whole. The principal strength of the AQAL approach is that it provides a means to understand the complexity of issues and beliefs in each quadrant and the interconnections among quadrants and between levels.

Tissot argues that a lack of understanding of the sociological, cultural, and spiritual dimensions of Native Hawaiian culture have historically resulted in conflicts between different marine-protected area user-groups. However, by incorporating both etic (modern ecological and social approaches) and emic (existing political and cultural Hawaiian beliefs) components into his analysis, he was able to make recommendations that resulted in the successful resolution of some multiple-use conflicts in a community managed ornamental reef fishery in Hawai‘i.

Appendix B: Demographic Tables

Table B-1 Select Demographics Conditions: Main Hawaiian Islands

Factor	1990		2000	
Total Population	1,108,229		1,211,537	
Ethnicity or Race*	**Number**	**Percent**	**Number**	**Percent**
White	369,616	33.4	294,102	24.3
Black or African American	27,195	2.45	22,003	1.8
American Indian and Alaskan Native	5,099	0.46	3,535	0.3
Eskimo	155	3.03	NA	NA
Aleut	206	4.04	NA	NA
Asian	685,236	61.83	503,868	41.6
Asian Indian	1,015	0.15	1,441	0.1
Cambodian	119	<0.01	NA	NA
Chinese	68,804	10.04	56,600	4.7
Filipino	168,682	24.62	170,635	14.1
Hmong	6	<0.01	NA	NA
Japanese	247,486	36.15	201,764	16.7
Korean	24,454	3.57	23,537	1.9
Laotian	1,677	0.24	NA	NA
Thai	1,220	0.18	NA	NA
Vietnamese	5,468	0.80	7,867	0.6
Other Asian	4,036	0.59	42,024	3.5
Native Hawaiian and other Pacific Islander	162,269	14.64	113,539	9.4
Guamanian or Chomorro	2,120	1.31	1,663	0.1
Micronesian	NA	NA	NA	NA
Melanesian	291	0.18	NA	NA
Native Hawaiian	138,742	85.50	80,137	6.6
Other Micronesian	1,848	1.14	NA	NA
Polynesian	NA	NA	NA	NA
Other Polynesian	885	0.54	NA	NA
Samoan	15,034	9.26	16,166	1.3
Tongan	3,088	1.90	NA	NA
Other Pacific Islander	261	0.16	15,573	1.3
Hispanic or Latino of any race	81,390	7.34	87,699	7.2
Cuban	NA	NA	711	0.1
Mexican	NA	NA	19,820	1.6
Puerto Rican	NA	NA	30,005	2.5
Other Hispanic or Latino	NA	NA	37,163	3.1
Some other race	21,083	1.90	47,603	3.9
Two or more races	NA	NA	259,343	21.4
Household Income (Median $)	38,829		49,820	
Poverty Status (Percent of Families below Poverty Level)	.06		7.6	

* The 2000 Census combines American Indian and Alaskan Native. Persons of Cambodian, Hmong, Laotian, Thai, and Vietnamese ancestry now must report as "Other Asian." Consolidation of Native Hawaiian with other Pacific Islander categories eliminated reporting options for persons previously reporting under Micronesian, Melanesian, Other Micronesian, Polynesian, Other Polynesian, and Tongan options.

Table B-2 Select Demographic Conditions: American Samoa

Factor	**1990**		**2000**	
Total Population	46,773		57,290	
Ethnicity or Race*	**Number**	**Percent**	**Number**	**Percent**
Single Ethnic Group	45,430	97.13	54,880	95.8
Pacific Islander**	NA	NA	52,450	91.6
Samoan	41,444	88.61	50,545	88.2
Niuean	51	.11	20	<.01
Tokelauan	68	.14	45	<.01
Tongan	1,726	3.69	1,600	2.8
Fijian	NA	NA	80	.01
Native Hawaiian	NA	NA	NA	NA
Other Pacific Islander	265	.57	165	.4
Asian	824	1.76	1,630	2.8
Chinese	85	10.31	330	.6
Filipino	415	50.36	790	1.4
Korean	224	27.18	200	.3
Japanese	28	3.40	15	<.01
Other Asian	72	8.74	285	.5
White	903	1.93	655	1.1
Black	10	<.01	20	<.01
Other Single Ethnic Group	139	.30	125	.2
Multiple Ethnic Groups	1,341	2.87	1,587	2.8
Samoan and other group(s)	1,196	89.19	NA	NA
Asian and other group(s)	373	27.81	NA	NA
White and other group(s)	391	29.15	NA	NA
Unspecified or unreported	2	<.01	NA	NA
Household Income (Median $)	16,114		18,219	
Poverty Status (Percent of Families below Poverty Level)	56.5		58.3	

* Changes in the 2000 Census preclude reporting of certain groups (N/A; Not Available). ** Data for Native Hawaiians reporting residence in American Samoa in 1990 and 2000 are not available.

Table B-3 Select Demographic Conditions: Guam

Factor	1990		2000	
Total Population	133,152		154,805	
Ethnicity or Race*	**Number**	**Percent**	**Number**	**Percent**
Single Ethnic Group	120,203	90.3	133,250	86.1
Pacific Islander	N/A	N/A	69,040	44.6
Chomorro	49,935	37.5	57,295	37.0
Carolinian	135	0.10	125	<0.01
Palauan	1,858	1.4	2,140	1.4
Chuukese	1,919	1.4	6,230	4.0
Kosraean	101	<0.01	290	0.2
Marshallese	71	<0.01	255	0.2
Pohnpeian	589	0.4	1,365	0.9
Yapese	199	0.1	685	0.4
Native Hawaiian	N/A	N/A	N/A	N/A
Other Pacific Islander	1,637	1.2	650	0.4
Asian	39,281	29.5	50,330	32.5
Chinese	1,959	5.0	2,705	0.17
Filipino	30,043	76.5	40,730	26.3
Japanese	2,244	5.7	2,085	1.3
Korean	3,931	10.0	3,815	2.4
Other Asian	1,104	2.8	990	0.6
White	19,160	14.4	10,510	6.8
Black	3,158	2.4	1,570	1.0
Other Single Ethnic Group	2,160	1.6	1,805	1.2
Multiple Ethnic Groups	12,877	9.7	13,687	8.8
Chomorro other group(s)	7,713	59.9	7,945	5.1
Asian and other group(s)	7,449	57.8	10,855	7.0
Unspecified or unreported	72	<0.01	N/A	N/A
Household Income (Median $)	30,755		39,317	
Poverty Status (Percent of Families below Poverty Level)	12.6		19.9	

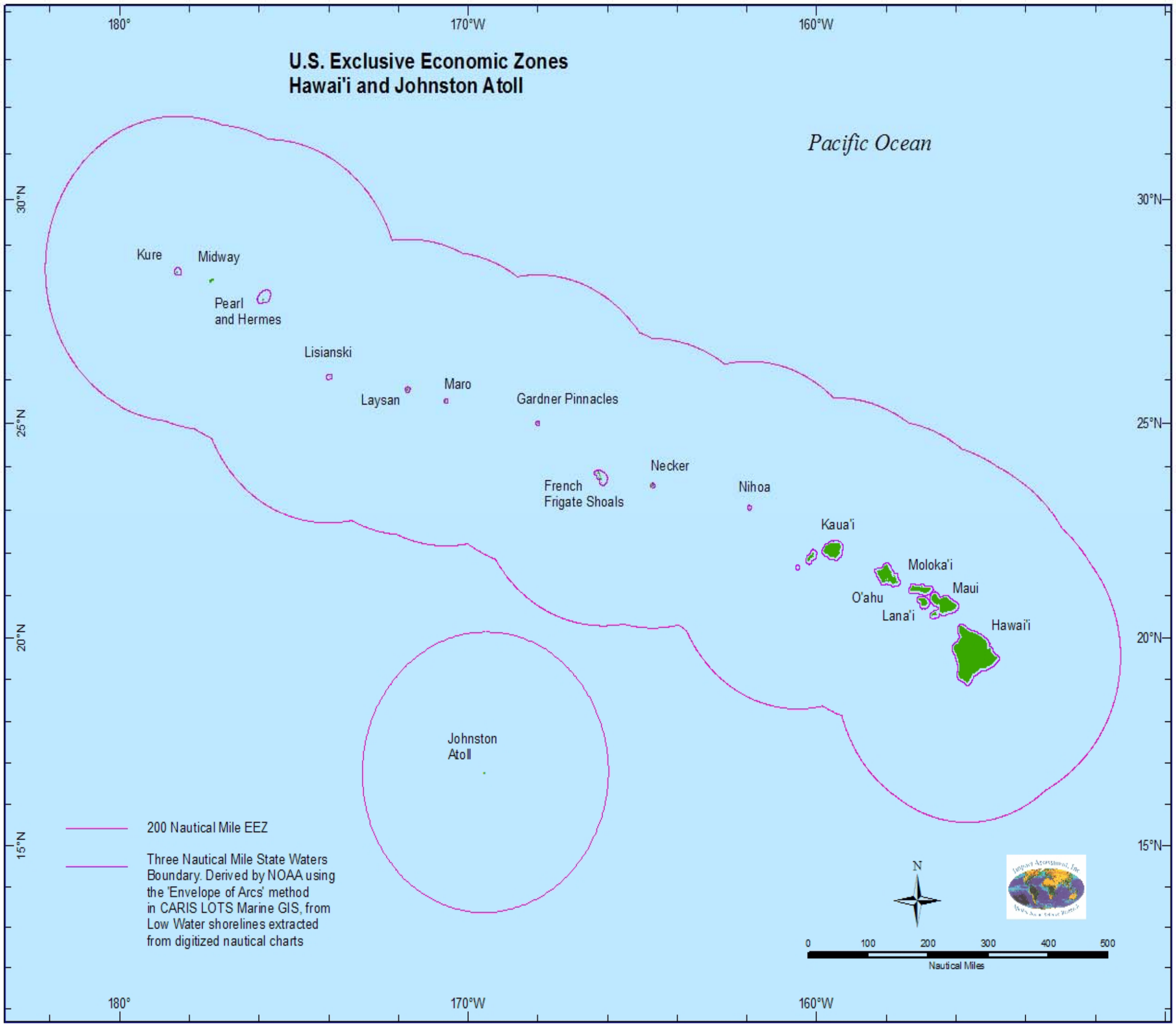
* Changes in the 2000 Census preclude reporting of certain groups (N/A). ** Data for Native Hawaiians reporting residence on Guam in 1990 and 2000 are not available.

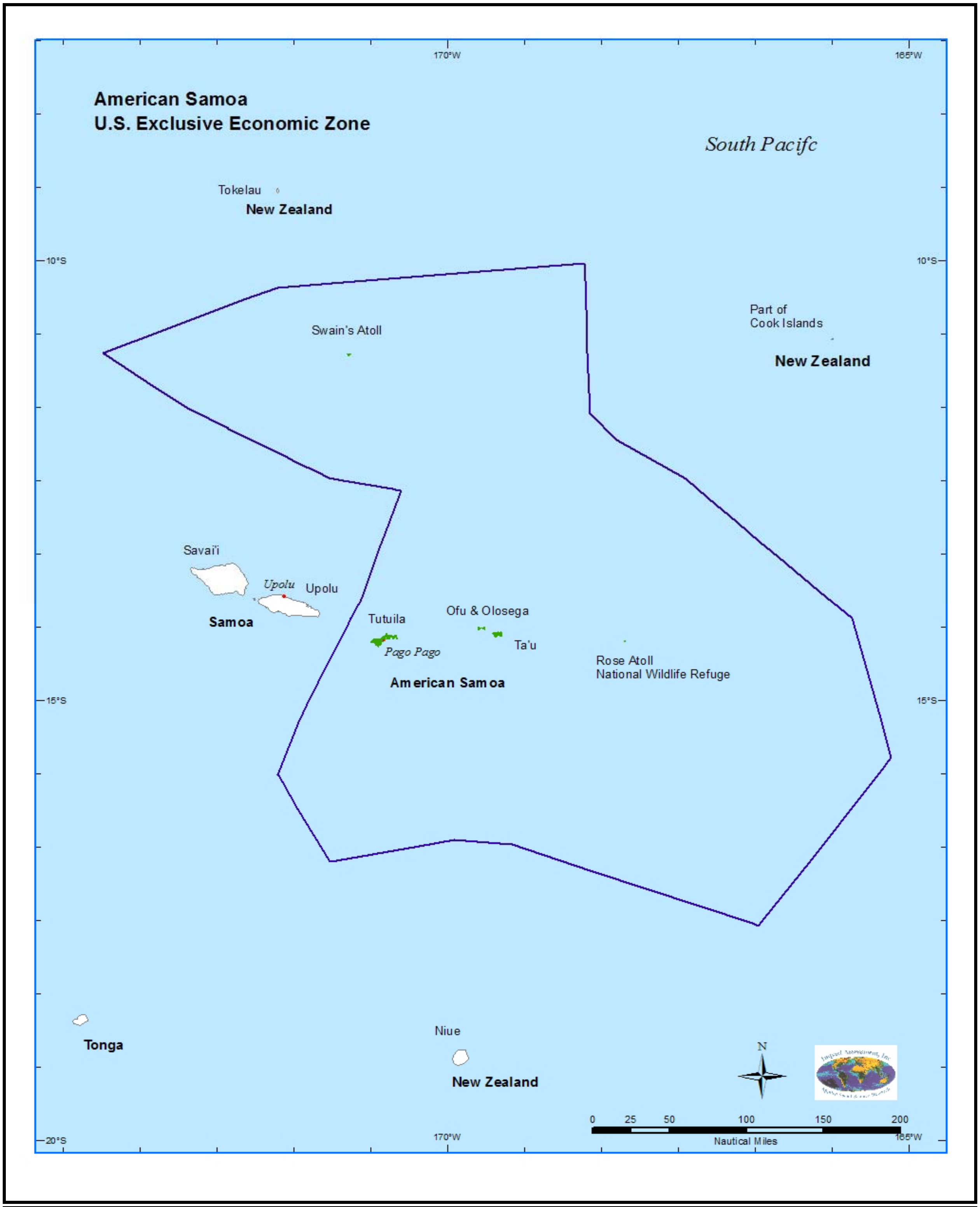
Table B-4 Select Demographic Conditions: Commonwealth of the Northern Marianas Islands

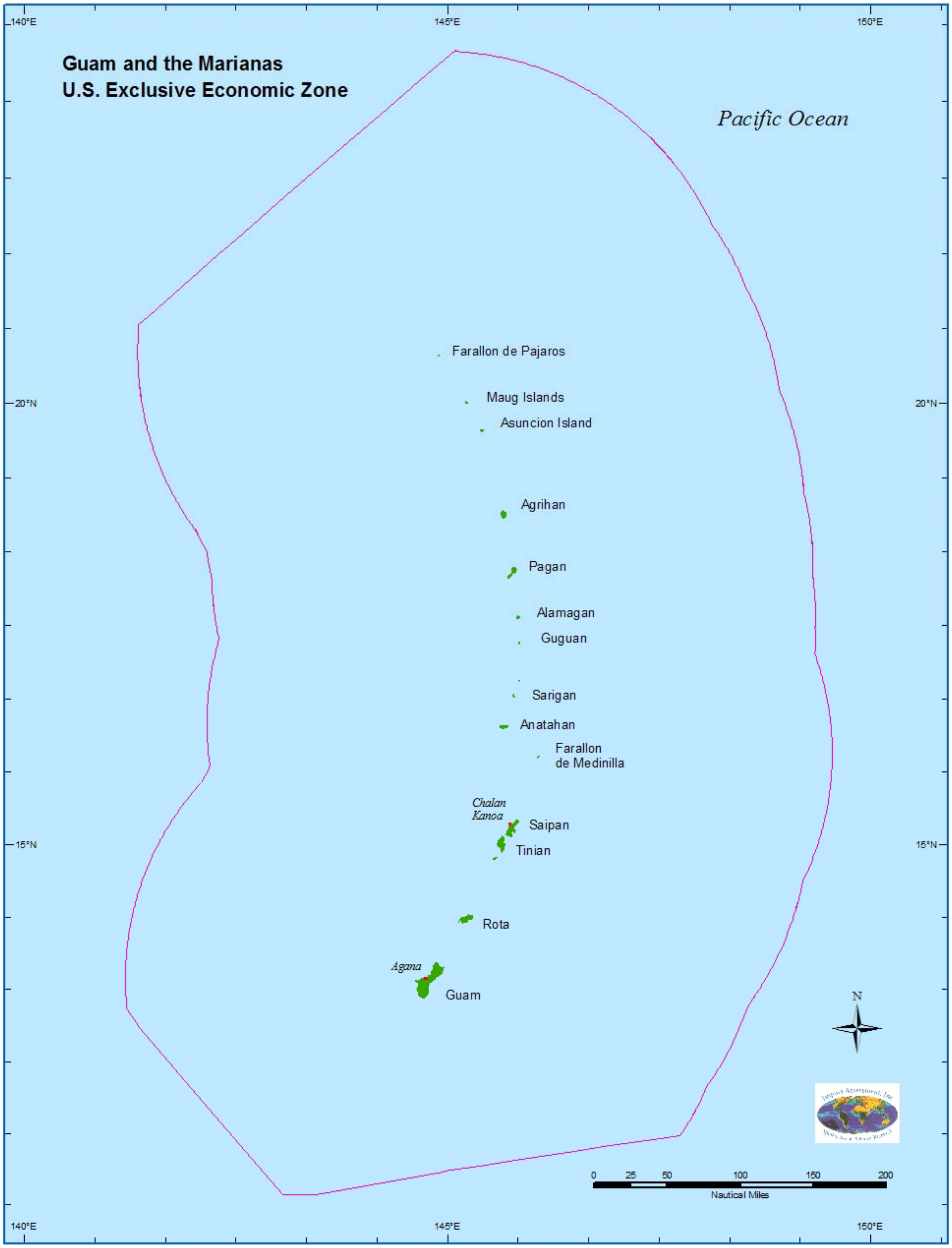
Factor	**1990**		**2000**	
Total Population	43,345		69,220	
Ethnicity or Race*	**Number**	**Percent**	**Number**	**Percent**
Single Ethnic Group	40,990	94.6	62,365	90.1
Pacific Islander	NA	NA	22,000	31.8
Chomorro	12,555	28.9	14,750	21.3
Carolinian	2,348	5.4	2,650	3.8
Palauan	1,620	3.7	1,685	2.4
Chuukese	1,063	2.5	1,395	2.0
Kosroean	17	<0.01	55	<.01
Marshallese	92	0.2	110	0.02
Pohnpeian	522	1.2	640	0.09
Yapese	152	0.4	205	0.03
Native Hawaiian**	N/A	N/A	N/A	N/A
Other Pacific Islander	197	0.4	510	0.07
Asian	21,332	49.2	38,610	55.8
Bangladeshi	NA	NA	875	1.3
Chinese	2,881	13.5	15,310	22.1
Filipino	14,160	66.4	18,140	26.2
Japanese	784	3.6	950	1.4
Korean	2,571	12.1	2,020	2.9
Nepalese	NA	NA	300	0.4
Other Asian	936	4.4	2,188	3.2
White	875	2.0	1,240	1.8
Black	24	<0.01	40	<0.01
Other Single Ethnic Group	193	0.4	475	0.7
Multiple Ethnic Groups	2,354	5.4	6,855	9.9
Carolinian and other group(s)	639	27.2	2,125	3.1
Chomorro and other group(s)	1,639	69.6	4,385	6.3
Unspecified or unreported	1	<.01	N/A	N/A
Household Income (Median $)	20,644		22,898	
Poverty Status (Percent of Families below Poverty Level)	32.1		30.6	

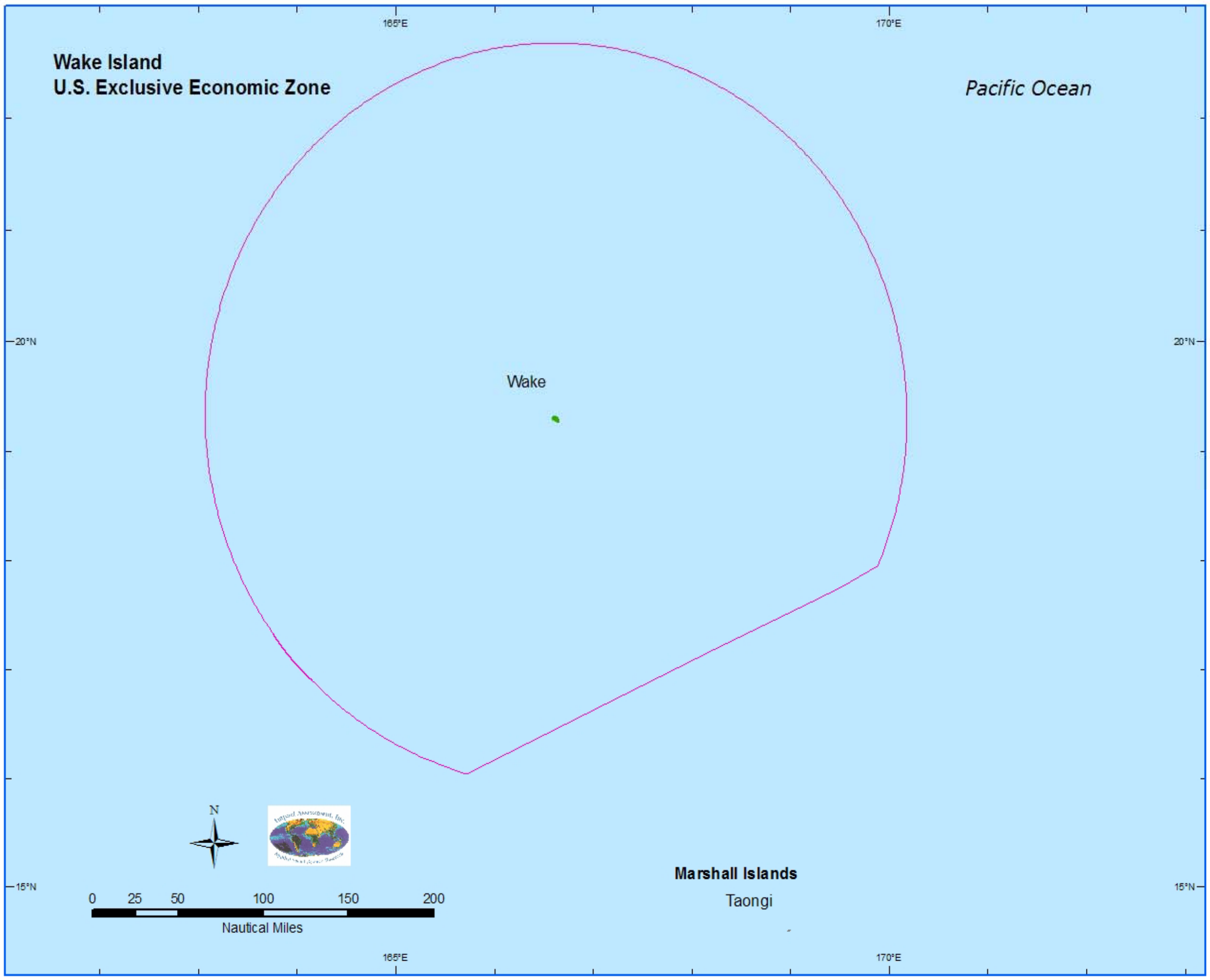
* Changes in the 2000 Census preclude reporting of certain groups (N/A). ** Changes in the 2000 Census preclude reporting of certain groups (N/A). ** Data for Native Hawaiians reporting residence in CNMI in 1990 and 2000 are not available.

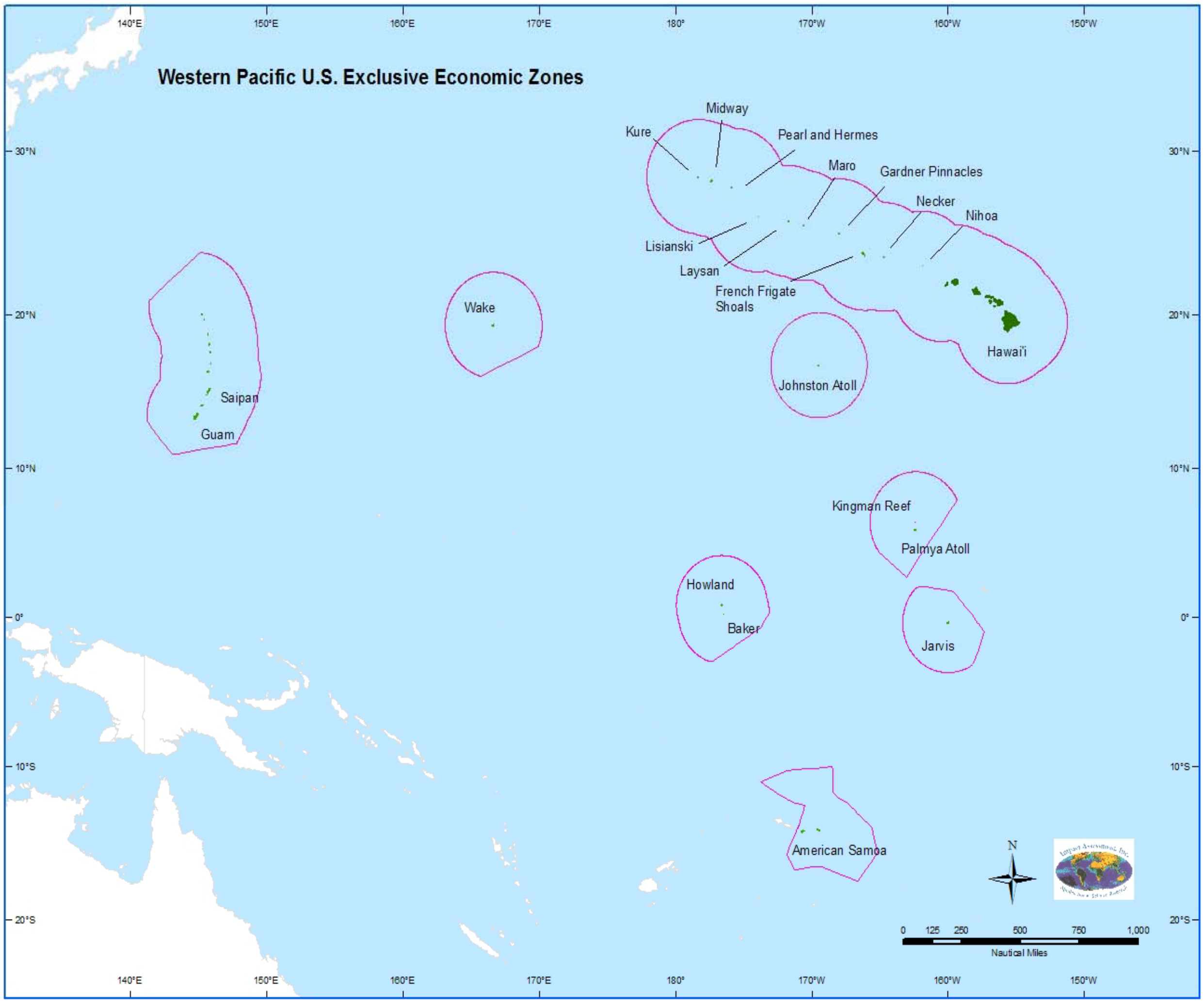
Appendix C: Maps of the Archipelagos/EEZ Areas




American Samoa
U.S. Exclusive Economic Zone
South Pacifc
170°W
165°W
10°S
15°S
20°S
Tokelau
New Zealand
Swain's Atoll
Part of
Cook Islands
New Zealand
Savai'i
Upolu
Upolu
Samoa
Tutuila
Ofu & Olosega
Ta'u
Pago Pago
American Samoa
Rose Atoll
National Wildlife Refuge
Tonga
Niue
New Zealand
N
0
25
50
100
150
200
Nautical Miles


Guam and the Marianas
U.S. Exclusive Economic Zone
Pacific Ocean
140°E
145°E
150°E
20°N
15°N
Farallon de Pajaros
Maug Islands
Asuncion Island
Agrihan
Pagan
Alamagan
Guguan
Sarigan
Anatahan
Farallon
de Medinilla
Chalan
Kanoa
Saipan
Tinian
Rota
Agana
Guam
N
0
25
50
100
150
200
Nautical Miles


Wake Island
U.S. Exclusive Economic Zone
Pacific Ocean
165°E
170°E
20°N
15°N
Wake
N
Marshall Islands
Taongi
0 25 50 100 150 200
Nautical Miles


Western Pacific U.S. Exclusive Economic Zones
Midway
Kure
Pearl and Hermes
Maro
Gardner Pinnacles
Necker
Nihoa
Lisianski
Laysan
French Frigate
Shoals
Hawai'i
Wake
Johnston Atoll
Saipan
Guam
Kingman Reef
Palmya Atoll
Howland
Baker
Jarvis
American Samoa
N
Nautical Miles

Appendix D: Participant Contact Information

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