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THE MAIN HAWAIIAN ISLANDS MARINE RESOURCES INVESTIGATION (MHI-MRI) INTEGRATED WATERSHED AND INSHORE FISHERIES MANAGEMENT TO CONSERVE HAWAIIAN COASTAL FISHERIES ECOSYSTEMS

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The Main Hawaiian Islands Marine Resources Investigation (MHI-MRI) Integrated Watershed and Inshore Fisheries Management to Conserve Hawaiian Coastal Fisheries Ecosystems

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INTRODUCTION AND BACKGROUND: ANCIENT VERSUS MODERN FISHERIES MANAGEMENT IN HAWAII

Ancient Hawaiians managed fisheries resources in a manner that was sustainable, benefiting from the wisdom of a culture that had endured for centuries. Like most indigenous people in what is now the United States, the Hawaiian culture was based on a respect for the land and sea, a gift for sharing, an abhorrence of greed, and a deep-seated belief that human beings are a part of nature which is no greater than any of the Gods' other creations (Kelly 1984; Titcomb 1952). Their cultural lore bound them to a strict set of *kapus*, sacred and immutable "management measures" in modern terms (Malo 1835-38; Karnakau 1839).

Traditionally, ancient Hawaiians managed fisheries ecosystems as a unit, including protection of the entire watershed against pollution, erosion and deforestation. In their choice of a basic geographic management unit called the *ahupua'a*, a pie-shaped wedge of land extending from the top of the mountains to the edge of the reef, ancient Hawaiians recognized the relationship between the land and sea, rainfall, vegetation, nutrients and runoff, and preserved the integrity of the delicately balanced ecosystem of which they were a part and upon which they relied for their every need (Costa Pierce 1987; Smith and Pai 1992). The concept of *ahupua'a* based fisheries management is equivalent to what has been referred to throughout this conference as marine tenure.

A marine tenure system, limited entry, minimum size restrictions, and seasonal closures are among measures recognized today which were also part of fisheries management in ancient Hawaii (Jordan and Evermann 1905; Titcomb 1952; Johannes 1978). Management was based on a set of laws which protected certain locations, times of year, species and size-classes, or limited their harvest to a small group of *ali'i* (royalty) This system was run by the chiefs and their agents living on the land directly inshore of the fishery. Enforcement is not the word for it; the Hawaiian system integrated through cultural tradition, and a very high level of compliance. Skill and knowledge of traditional fisheries management were handed down through chants, songs and dance. The people respected and believed in these laws, as well they might. Although there was a chance for clemency, the penalty for breaking the rules was often death.

Under these conditions, fisheries resources sustained a population estimated to number upwards of a million people (Standard 1989) for centuries. Of course, there were occasional periods of hunger, when seasonal changes made fishing harvests scarce. Wise chiefs and extended families learned to plan for these eventualities and were able to live comfortably most of the time. The

upper limits of ancient population estimates were comparable to the number of residents in Hawai'i today (DEBDT 1993); yet fisheries resources were abundant when colonists arrived on Hawai'i's shores (Malo 1835-38; Jordan and Evermann 1905; Titcomb 1952).

The situation has changed dramatically since that time. The Hawaiian culture and its traditional coastal management system were gradually undermined, eroded and lost. At first there was a rapid decline In the native population, but immigrants soon built the resident population back to its original size. However, in addition to residents, more than six million tourists now visit Hawai'i each year (DBEDT 1993). With the decline in predominance of the Hawaiian culture, population growth has caused massive urbanization and alteration of the coastline. As part of this process, habitat degradation and overfishing have placed a tremendous strain on declining coastal fisheries (Jordan and Evermann 1905; Shomura 1987, Pooley 1993; Boggs and Ito 1993; Smith 1993).

Although population growth and technological advances have placed increasing demands on fish stocks; urbanization, industrialization and tourism have decreased the protection and food source provided by coastal habitats. Furthermore, a society has emerged which no longer agrees on the status of fisheries and coastal resources; thus, concepts such as optimal yield and "sustainable fisheries" have become topics for philosophical discussion and management represents a search for an acceptable norm which is often defined through political debate. The conflicts which arise are of a social and economic nature often beyond the experience and resources of fisheries managers. Thus, the need developed in Hawai'i for an interdisciplinary management effort, which could unite fisheries, ecological, social and political science with conflict resolution and communication. This is the climate in which a project called the Main Hawaiian Islands Marine Resources Investigation (MHI-MRI) was spawned.

MHI-MHI: AN EFFORT TO REINTEGRATE THE MANAGEMENT OF FISHERIES WITH COASTAL ECOSYSTEM MANAGEMENT

The Main Hawaiian Islands Marine Resources Investigation (MHI-MRI) is an inshore fisheries project, which integrates ecosystems and socio-political concerns with traditional fisheries research and management. The project was implemented in response to public concern regarding the depletion of inshore fisheries in the MHI (Pooley 1987; DAR 1988, 1991). This contribution will first describe the structure of the project, then illustrate its value with a number of practical examples taken primarily from MHI-MRI work which is planned or in progress.

ENHANCED INTER-AGENCY COMMUNICATION AND COOPERATION

MHI-MRI is a cooperative project, funded by the Hawai'i Department of Land and Natural Resources (DLNR), Division of Aquatic Resources (DAR). The first requirement of the project was to develop a forum which would encourage a more open exchange of ideas between research, monitoring and management agencies and organizations responsible for living marine resources and their habitat in Hawai'i. This was done by establishing a MHI-MRI Council, which would serve as advisors to the project, comprised of the University of Hawai'i (UH) Sea Grant College Program, UH Institute of Marine Biology, National Marine Fisheries Service's Southwest Fisheries Sciences Center Honolulu Laboratory (SWFC), US Fish and Wildlife

Service (USFWS) and Western Pacific Regional Fisheries Management Council. Because of their stock enhancement expertise, a private non-profit corporation known as The Oceanic Institute was also included in the MHI-MRI Council. Other entities, which were soon added to the Council, include: the Hawai'i Cooperative Fishery Research Unit (funded by DAR, UH and USFWS), UH Sea Grant Extension Program, UH Marine Option Program and Department of Health.

The project has a growing list of collaborators, in an effort to utilize available resources and expertise in the most efficient way possible (Smith 1992). The approach taken has been to avoid "reinventing the wheel", and instead to seek out alliances with contributing expertise. Collaborating agencies not on the MHI-MRI Council now include other departments of the UH (Ecology, Geology and Geophysics, Oceanography); federal organizations, such as the Soil Conservation Service and Environmental Protection Agency; state agencies, such as the Office of State Planning, Department Of Business and Economic Development and Tourism, and Information and Communication Services Division of the State Office of Budget and Finance (the latter for geographic data management. Numerous private organizations and individuals, fishers, legislators and the general public have also become involved as they recognize that communication is one of the keys to improved management.

GEOGRAPHIC BASIS

One of the concepts developed early in the project was the need for geographically based assessment, monitoring and management. In an effort to limit the scope and budget of the project within reason, five sites were selected for pilot studies. The experience gained in these five regions should serve as a model for integrating ecosystems concerns and fisheries management strategies throughout the MHI to restore abundance and ensure sustainable fisheries. The sites (Figure 1) selected on a basis of public input (DAR 1988) include: Kaneohe Bay, Oahu), Hilo and Kailua-Kona, (Hawai'i) and Hanalei Bay (Kauai) and the Kihei Coast, Maui).

MHI-MRI is a demonstration project, which is limited in geographic scope. But the need exists throughout Hawai'i for this type of work; therefore, these concepts are also illustrated With a few examples from areas In Hawai'i where the need for this type of work is clearly indicated. Human impacts are accentuated on Oahu, which houses 80% of the states population (DBEDT 1993). For this reason, this discussion also provides examples from areas on Oahu, such as: Waikiki, the Alawai Canal, Kewalo Basin (boat harbor), and Honolulu and Pearl Harbors. These are potential areas for future MHI-MRI efforts.

It is hoped MHI-MRI will serve as a model, upon which all work undertaken by the DAR will be improved and better integrated with findings and management responsibilities of the DLNR and other state, federal and municipal agencies, private individuals and organizations. This new management direction seems fairly obvious. What is not clear is why it has taken us so long to recognize the need for such a project.

THE SCOPE OF MHI-MRI RECOMMENDATIONS WITH RESPECT TO DLNR'S MANAGEMENT AUTHORITY

MHI-MRI research efforts are diverse, leading to an increasingly more complete understanding of the complex interactions between human activity, habitat loss and fisheries depletion. This is a monumental undertaking for a government agency, thus an effort has always been made to keep the project's work within the scope of the funding agency's reasonable limits of influence. Otherwise, recommendations can be made without a likelihood of their ever being implemented. Although there is fundamental research to be done, where the mechanisms of human impact are not known, "research for research's sake" is frowned upon by the general public; therefore, an effort is constantly being made to maintain a commitment to the implementation of management recommendations.

Since the DLNR seeks a better understanding of those human impacts under immediate control through improved management, MHI-MRI does not deal with some environmental issues. Global warming is an example of a critical issue for the world community, over which the State of Hawai'i (DLNR Specifically) has only limited influence. Since we are unlikely to resolve the problem in MHI-MRI's brief 5-10 year lifetime, research on topics like this would not be undertaken. There are many more proximate factors, within the state purview, for which DLNR is directly responsible. These are the issues of focus for MHI-MRI.

DLNR has nine divisions, including (living) Aquatic Resources, Land Management, Water and Land Development, Conservation and Resources Enforcement, Forestry and Wildlife, Water Resource Management, Boating and Ocean Recreation, State Parks, and Historic Preservation. It also manages a Bureau of Conveyances, an Aquaculture Development Program, and a Commission on Water Resource Management. In addition, DLNR has permitting control over development affecting natural resources through its Office of Environmental Quality Control and Board of Land and Natural Resources. These functions provide general guidelines for areas of research and management where DLNR is likely to improve their support for fisheries through changes in policies and regulations.

MONITORING AND DATA MANAGEMENT

A search of the literature for available information, including published and unpublished studies formed an important part of the projects development (Maybaum et al. in press). This work produced: **1.** a text database programmed in dBASE IV+) of available life history information of a list of over 40 target species (identified through historical landings records), and **2.** a geographic database containing information on the distribution of substrate, habitats, resources and human impacts for each of the target sites.

Both these products have multiple uses for management. The text database is being used to review existing fisheries regulations for necessary revisions, as well as to identify species for which further research is needed. The geographic database has been used to place historical fisheries landings, resource distribution and abundance, human impacts, etc. into geographic perspective, since Hawai'i has many geographical distinct fisheries tied to unique island habitats. It has also helped identify what is known for each of the target areas and where more information

is needed, and has provided a time series regarding fisheries distribution and abundance for some species and locations.

Tho geographic database has two sections, each with its own user-friendly, menu-driven query system. One, a statewide commercial landings database provides a geographic view of trends in Hawai'i's reported landings, by species and gear type. This is helpful for database managers checking the data for accuracy; managers working out area-specific regulations; and scientists making region-specific assessments, forecasting the impacts of coastal developments on fisheries, tracing migratory stocks, or whatever. The other is a geographic database, begun as a demonstration for the target sites only, which may later be expanded to include other locations. It contains historical marine survey data (biological and oceanographic), environmental impact studies, information on coastal developments, substrates, bathymetry and other geographic data. The purpose of both these databases is to bring this information readily to the eyes and minds of resource managers, who are not always computer literate, where it can be put to effective use.

Because of the inconsistencies and gaps found in available data, MHI-MRI began assisting in the development of more comprehensive, standardized monitoring protocols for living aquatic resources. For more than thirty years, the DAR has relied on dive surveys with SCUBA to quantify the biomass and diversity of inshore fisheries. Through MHI-MRI, an emphasis has been placed on the development of repeatable methodology, which attaches a margin of error to biomass estimates, for use where dive surveys are appropriate. Sampling is stratified by substrate type and biomass estimated for a given area based on the relative abundance and distribution of each substrate within the area. The use of tag and release methodology, sonic tracking, remotely operated vehicles, video equipment, sonar and echo-sound equipment have complemented existing methods to provide broader coverage, which is more suited to monitoring schooling and migratory species such as ulua and papio (various carangids), akule (*Selar crumenophthalmus*) and opelu (*Decapterus macarellus*) which are among Hawai'i's primary inshore fisheries resources.

MHI-MRI has also sought to train fisheries biologists to better meet the challenges of modern fisheries management. Training and guidance is provided in statistics, computer data management, experimental design, dockside and field interview techniques, and a variety of other skills fisheries managers did not previously realize they needed. When possible, a trained local expert is developed in an existing position, since their availability will surpass the life of MHI MRI.

Since only commercial fishers are required to report their catch in the state of Hawai'i, one important task is to obtain estimates of total catch and fishing effort. Under reporting by commercial fishers and the existence of a large number of recreational fishers, without licensing or reporting requirements, mean the implementation of management measures is often thwarted by the inability to document the problem, because of a lack of complete data. Much of this information can be obtained directly, through creel surveys. Creel surveyors walk or drive the shoreline, or wait at boat ramps, and talk story with fishermen, *keki* (children), *kupuna* (elders) and families, regardless of whether they fish for food, recreation or income. Information is obtained in this way and a good relationship is formed with fishers, who also share their experiences and ideas. Recommendations to improve fisheries management throughout the state

have come to light through the hands-on contact with fishers which takes place during creel surveys.

MHI-MRI has implemented creel surveys at Kaneohe, Hanalei and Hilo Bays. The data show there are significant differences between total and reported landings (Everson 1994 and in press; Kailapo and Smith 1994; Parrish et al. in press; Young et al. in press. Differences in fishing gears and methods, and differential targeting make recreational and subsistence catch composition different than that of commercial fishers. Spearfishing, crab netting, gill and surround netting, trolling and pole-and-line fishing are among methods which contribute significantly more to the total catch than is represented by reported commercial landings. For these reasons, MHI-MRI is developing and testing methods that can be utilized statewide to estimate total landings and fishing effort. The project is also assessing the financial and human resources needed to obtain this information on a comprehensive, long term basis.

HUMAN IMPACTS

Contrary to opinions expressed by many people at the beginning of the project that Hawai'i had a pristine environment, untroubled by pollution and human intervention, MHI-MRI research has shown clearly that in addition to overfishing, a variety of human impacts have affected the quality of inshore marine, freshwater and estuarine environments in Hawai'i for harvestable fishes, edible *limu* (algae) and invertebrates. Fishers have attempted to explain this in various forums over the years. Unfortunately, their arguments have been most poignant when linked to an attempt to avoid management measures necessary to protect Hawai'i's fisheries. Given the limited time available, it should suffice to point out some of the manageable human activities which have been seen to affect the quality of the coastal environment in Hawai'i for fisheries flora and fauna. Many references are contained in the proceedings of a MHI-MRI Symposium (Lowe et al. in press). Contributions referenced will be available by the end of the year for more in-depth information.

Various land management practices may drastically affect inshore fisheries, including deforestation, steep hillside grading during development, urban runoff, and the lack of adequate management and education regarding the use of storm drains (Ogden, 1993; Hunter in press). Reefs in Kaneohe and Hilo Bays are seen to be covered with sediments, smothering and killing live corals MHI-MRI researchers have documented reef destruction and decline in Kaneohe Bay, Oahu, caused by dredging, siltation and pollution (Hunter in press). Overgrowth of reefs by algae is thought to be due in part to long-term shifts in nutrient content of coastal waters, resulting from urbanization, agriculture and sewage (Laws and Allen in press; Atkinson in press). The use of absorption/septic systems (rather than a sewer system with treated discharge) in urbanized areas such as Hilo, Hawai'i, constitutes both a public health hazard and a detriment to coastal water quality Dudley and Hallacher 1991). Underlying causes of decreased recruitment and increased mortality of freshwater, estuarine, and reef-dependent species, include the loss of inshore reefs due to sedimentation, dredging, and pollution.

Reduced stream flow, due to diversion for agriculture, is well-documented in Kanehoe Bay (Devaney et al. 1982), affecting areas used for spawning and juvenile growth by coastal species. In streams adjacent to Kaneohe and Hilo, herbicides are used to clear channels, destroying refuge

and food for juvenile fishes. Pesticides and debris were only some of the insults to juvenile nursery habitats of Hilo Harbor, during this period of massive sugarcane agriculture (Welsh, 1949).

Tourism and shipping are two of Hawai'i's primary industries. Boat traffic and associated pollution are among the hazards met by diadromous and catadromous species, as streams and wetlands in Pearl Harbor, Hilo and Kanehoe have become shipping lanes, housing projects, highways, industrial and sewage treatment plants, Honolulu and Hilo are both major international harbors with containerized ports. As fishing activity and fleet sizes have increased rapidly in the last decade, these areas have been unable to meet the demand for dock space, or to adequately manage the impacts of shipping, tourism and fishing vessels on water quality.

Tourism adds another facet to human impacts on fisheries, affecting both access to the coastline, reefs and sandbars for local fishers and the quality of reef habitat. The effects of crowding and trampling of beaches and reefs are not well documented. Researchers are presently examining the causes of what appear to be coral tumors on heavily used reefs of Hanauma Bay, on Oahu. It is not clear whether trampling, declining water quality or some combination of these and other factors are the causes of the sick and dying coral. Tumors on fishes and turtles, occur as well, as yet also of unknown cause.

USER-GROUP CONFLICTS

As lucrative as the tourist industry is, it has also produced a new type of conflict between the tourist industry and fishing as a pastime and a way of life for Hawai'i's residents. Recently a Governors Task force actively mitigated conflicts between the commercial tour industry developing in Kaneohe Bay and local fishers and water sport enthusiasts (OSP 1992). The use of jetskis, recreational boating and reef/sandbar tour group activities produce congestion on the Bay's waterways, which were mitigated through area assignments, limits on the number of tour boats and their passengers, and a ban on weekend commercial tour activity. In other areas, such as Kailua-Kona (Hawai'i) and Waikiki (Oahu), there are consistent clashes between commercial dive tour operations (which often conduct some fishing feeding activities) and traditional fisheries.

Adding to the milieu are conflicts over the impacts of aquarium collecting by commercial fishers in areas preferred by commercial dive tour operations. This becomes a question of both managing a fishery for sustainable yield and satisfying conflicting views of an optimal use of the marine environment. Many of these conflicts can result in destructive activities by fishermen frustrated by the lack of understanding of what they do and why, as well as political decisions geared more toward keeping the peace than managing the resources. These are only some of the conflicts Mil-MRI seeks to help fisheries and resource managers better understand, so they may manage these disputes wisely and equitably.

OVERFISHING

To add insult to injury, overfishing is also a problem. Although there is almost universal agreement among experienced fishers that fish catches are declining, and there is considerable

evidence fishery resources are more abundant in areas where fishing activity is limited. Some of the information needed to assess the relative importance of fishing versus other causes of mortality and determine what levels of fishing are sustainable is still lacking. Historical databases were not designed for assessment. The state (DAR) is still in a transition phase to a system that may meet this challenge more fully. Until this challenge is met on a statewide level, sporadic surveys in critical areas will have to suffice.

Most net fisheries, except those using ancient methods, are among the primary candidates or management improvements. Unchecked fishing with small mesh nets is allowed for bait species in nursery areas that harbor many prized food fishes caught accidentally by bait fishers. Surround netting of akule and opelu by a few large purse seiners, and of papio and mullet by smaller operations, often leaves people sitting with pole and line onshore astonished at the disappearance of some many fish in a matter of hours or days. These fisheries will require some regulation as well, to prevent over-harvesting.

Coastal gillnetting has been regulated increasingly in recent years, through measures restricting the length of time gillnets may be left unattended to two hours, and requiring they fish no more than four hours in any 24-hour period. However, a net labeling and permitting system which will improve enforceability of these regulations and measures limiting the total length and number of nets allowed to fish, as recommended for this fishery (DLNR 1992), remain to be implemented.

Despite all the detrimental impacts mentioned above, overfishing still constitutes the driving force in the depletion of inshore fisheries. Due to the late hour, proposed measures currently being discussed to remedy problems of overfishing will be simply listed below:

1. Changes in bag limits and minimum size restrictions in accordance with new information about reproduction, growth and the impacts on fish stocks of current levels fishing

2. Assessment and regulation of the impacts of inshore baitfishing and collecting for fishponds using small mesh nets

3. Assessment and improved management of aquarium fish collecting

4. Permitting or registration of recreational fishers and funding to enable the DAR to estimate their landings and effort

5. Increased economic and logistic support to DLNR'S Division of Conservation and Resources Enforcement (DOCARE)

6. Increase premium on resources (petty misdemeanors raised to high level offense, civil in addition to criminal penalties to take SS remedies out of unsympathetic courts, educate judiciary)

7. Development of a more solid relationship with fishers and development of management measures with their assistance and that of DOCARE

8. An education effort to help the public understand the concept of overfishing and the reasoning behind existing regulations

9. Implementation of remaining measures to regulate overfishing with gill and surround nets

    a. Net permitting and labeling system
    b. Database of users (for ticketing, warn, response)
    c. Limitations on total net length
    d. Establishment of reporting requirements for all net fishers (commercial and otherwise).

EDUCATION AND ENHANCED COMMUNICATION

MHI research and management efforts have highlighted the need for integrated management of Hawai'i's coastal ecosystems as part of the management of the state's inshore fisheries. Part of improved management is developing better communication between agencies, researchers, managers and the general public. In addition to obtaining better information, management measures must be passed into law with popular understanding of the need for these controls and of the reasoning behind them. In this way, enforcement is not conducted down the barrel of a gun or by heavy policing, but through voluntary compliance for the majority of the fishing population, as was done in ancient times. For this reason, MHI-MRI conducts community outreach and makes findings and recommendations available to the public through regular workshops, meetings, classroom visits, informal discussion, phone calls, recently a video production.

CONCLUSIONS

The experience gained through applied studies in five regions of the Hawaiian Islands should serve as a model for integrating ecosystems concerns and fisheries management strategies throughout the main Hawaiian Islands to restore abundance and ensure sustainable fisheries. In addition to overfishing, other human impacts on coastal ecosystems may be increasingly important when the causes of inshore fisheries depletion are questioned and mitigative measures sought. Research is needed to document and understand factors such as:

1. The extent of sediment and pollutant runoff due to urbanization and deforestation

2. The long and short term effects of these sediments and pollutants on coastal organisms and communities

3. The impacts on coastal fisheries of diverting streams, dredging, filling in and otherwise altering wetlands, watersheds, estuaries and reefs

4. The effects of crowding trampling and overuse of coastal areas and many other impacts which may be controlled through improved management.

In addition to answering these types of questions, MHI-MRI has provided an opportunity to develop and standardize monitoring protocols for inshore fisheries resources and incorporate measures of variance into density and diversity estimates, so significant changes can be detected.

The ability to evaluate, detect and regulate detrimental impacts on coastal marine resources must be within the grasp of the Department of Land and Natural Resources and other agencies responsible for maintaining the health and viability of Hawai'i's coastal ecosystems. Although modern day informational needs are increasingly complex, with the assistance of collaborating researchers, MHI-MRI is developing the regional technical expertise which would make possible accurate and timely assessment of detrimental impacts, and design of appropriate management measures to protect coastal fisheries and insure their sustainable use for future generations. To that end, it is hoped MHI-MRI will help identify important milestones in the learning process and provide a meaningful direction for future management efforts.

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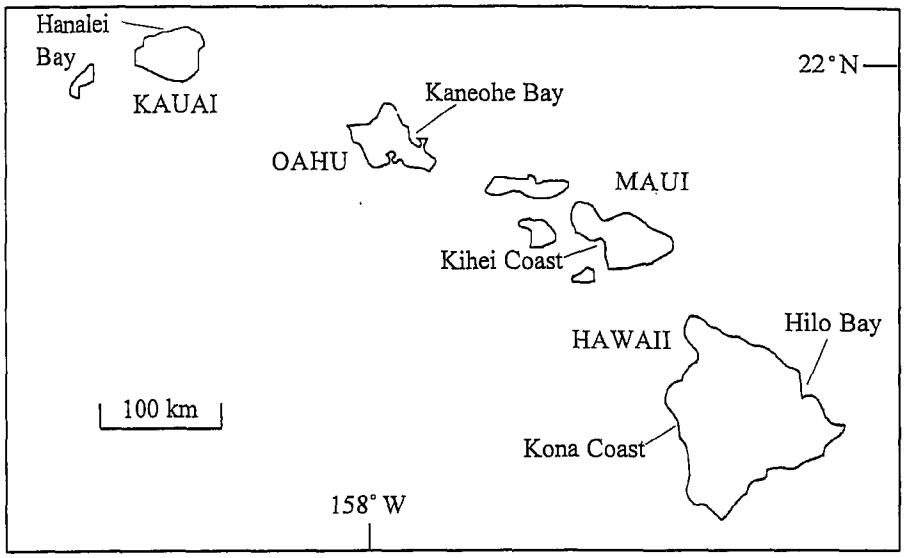

Figure 1: Main Hawaiian Islands, showing MHI-MRI target sites (adapted from Ogdeon 1993)

JOINT SPC/FFA WORKSHOP ON THE MANAGEMENT OF SOUTH PACIFIC INSHORE FISHERIES
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