

# Fisheries and Marine Resources of Hawaii and the U.S.-associated Pacific Islands: An Introduction

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## Introduction

Fisheries of Hawaii and the U.S. insular Pacific are quite different from typical industrial and recreational fisheries of the mainland U.S. Fisheries productivity in coastal waters of these tropical and subtropical islands may be similar to that in temperate continental shelf-slope fish communities (Marten and Polovina, 1982), but the higher species diversity results in more diverse, lower volume fisheries. Larger, commercial fisheries are often dependent upon deep water, slope-dwelling species or the highly migratory pelagics such as tunas and billfishes. Although land masses in this region are small,

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*ABSTRACT — The fisheries of Hawaii and other U.S.-associated islands in the Pacific Ocean are characterized by high diversity, both in the species exploited and the human cultures that exploit them. The commercial sector has undergone rapid growth in recent years, but recreational and subsistence sectors remain important. Information on these fisheries is generally not available in published form. This paper presents an overview and introduction to a volume of papers describing fisheries in the region, with the goal of making the information available to scientists and the general public. A great deal remains to be learned about the dynamics of these fisheries as well as the associated issues in biological research, fisheries management, and environmental protection.*

the U.S. Exclusive Economic Zone (EEZ) surrounding the island areas is immense, covering over 2 million square miles. Over this broad geographic expanse, a variety of cultural differences affect fishing practices, and even those practices present today are significantly different from the native approaches to fishing methods in Hawaii (Smith, 1993) and Guam (Hensley and Sherwood, 1993). Finally, variations in the population size and in the fishing pressure on the nearshore ecosystem are marked among islands, from the highly populated island of Oahu in Hawaii to sparsely populated islands elsewhere to the mostly uninhabited islands of the Northwestern Hawaiian Islands (NWHI) and Commonwealth of the Northern Mariana Islands (CNMI).

The objective of this volume is to describe our current knowledge on the varied fisheries of Hawaii and the U.S.-associated islands of the Pacific. This introductory paper provides some general background on fisheries in the region.

## Diversity of Fisheries

In the U.S. insular Pacific, the combination of highly complex habitats, high species diversity, and both native and newly introduced cultural practices leads to a diversity of fisheries unparalleled in most other parts of the U.S. Many fisheries are unique to certain localities, such as that for palolo worm in American Samoa (Craig et al., 1993), seasonal juvenile fisheries for rabbitfish in Guam (Hensley and Sherwood, 1993), and limpet, or opihi fisheries in Hawaii (Smith, 1993). Others are common to all islands, such as the seasonal fisheries for juvenile big-

eye scad in all areas. The adults of these coastal pelagics, known as akule in Hawaii or atule in American Samoa, represent the largest volume fishery in nearshore waters but are poorly known in terms of their resource potential. Nearshore reef resources are often overexploited in populated areas, a problem perhaps characteristic of tropical reef fisheries in general (Ferry and Kohler, 1987).

## Evolution of Fisheries

With increasing population, changing cultural composition, and advancing technology, island fisheries have changed in many ways. Prior to western colonization, indigenous peoples of the islands depended on the marine environment and had developed a unique knowledge of marine resources and varied approaches to conservation and management. The cultural impacts of colonization of the islands by non-indigenous peoples had marked effects and typically led to the decline of traditional conservation measures (Johannes, 1978); a concise description of how this happened in Belau, in the Western Caroline Islands, is provided by Johannes (1981). In Guam, Spanish persecution of Chamorros led to the demise of the traditional fishing methods in the mid-1500's (Hensley and Sherwood, 1993). Similarly, in Hawaii, it led to the decline of the traditional management regime of the native Hawaiians that had long protected nearshore resources (Smith, 1993). Trends in the fisheries of Hawaii are perhaps the most pertinent to examine, for the greatest changes have occurred there and these may serve as a warning of what may come in the other island areas as populations increase there as well.

Temporal trends of fisheries differ markedly. Shomura<sup>1</sup> described the differences in fisheries of Hawaii between 1900 and 1986, the early period based upon a comprehensive data collection scheme and subsequent analysis by Cobb (1902) and the later period upon State of Hawaii commercial fishery data collection systems. While the two data sets are not identical in coverage, they provide useful comparisons. The total catch nearly doubled in the period considered. Shomura<sup>1</sup> noted several important trends related to the distance of the fishery from shore. Catch of coastal species declined by about 80%, while those of neritic-pelagics (akule, opelu) declined by 40%. Catch of slope and seamount species increased by 80%, whereas many-fold increases in offshore pelagics catch were evident.

It is likely that the decline of nearshore fisheries is based largely upon two factors. First, increasing population and improved fishing technology led to overfishing in the absence of effective management and regulations. Gillnet use, for example, is largely unrestricted, and this can have negative impacts on coral reef fish populations (Gobert, 1992). Similar concerns are expressed about this gear in Guam (Hensley and Sherwood, 1993). Second, habitat destruction from coastal development leads to a decline in availability and quality of critical habitat area needed to support the reef populations. This was most evident for species utilizing fishponds, a habitat which may be similar to estuaries for enhancing juvenile fish production. The decline of the numbers and function of fishponds in Hawaii has been dramatic. Cobb (1902) documented the use of fishponds in his survey of fisheries of Hawaii and even then noted a marked decline in the numbers of functioning fishponds. While the reasons may differ, declining nearshore catches in American Samoa over the last two

<sup>1</sup>R. S. Shomura. 1987. Hawaii's marine fishery resources: Yesterday (1900) and today (1986). Honolulu Lab., Southwest Fish. Cent., Natl. Mar. Fish. Serv., NOAA, Honolulu, HI 96822-2396. Southwest Fish. Cent. Admin. Rep. H-87-21, 25 p.

decades (Craig et al., 1993) are also a concern.

Significant growth in several fishery sectors of Hawaii has been based upon improved technology and an expanded potential geographic range of fishing. The combination of increased catch and targeted high-value markets led to a doubling of the ex-vessel value of Hawaii fisheries from 1970 to 1990 (Pooley, 1993a). Insular fisheries moved to increasingly deeper water, and technology allowed the expansion of the slope fishery in the main Hawaiian islands during the middle of this century. As these fisheries approached full exploitation, the resource potential of the NWHI was examined by the National Marine Fisheries Service, the State of Hawaii, and the U.S. Fish and Wildlife Service in the tripartite Northwestern Hawaiian Islands Investigation in the mid 1970's to early 1980's. This program increased knowledge of resource potential (Uchida and Uchiyama, 1986) and ultimately led to a geographic expansion of the lobster and bottomfish fisheries to the NWHI (Polovina, 1993; Haight et al., 1993), providing a marked expansion of exploitable biomass. Within the NWHI lobster fishery, changing gear from wire to plastic traps led to significant catch of slipper lobster, which had been essentially unexploited with wire traps. As these resources become fully exploited, however, the available habitat for further expansion of insular fisheries in Hawaii declined markedly.

The pelagic fisheries sector has seen the most dramatic fluctuation in Hawaii. Improvement of vessel technology increased the range of the local trolling and handline fleet while other factors led to the near-demise of the skipjack pole-and-line ("aku") fleet; with the closure of the only cannery on Oahu, recent aku catches are nearly an order of magnitude below the historical peak (Boggs and Kikkawa, 1993). A general trend away from "bulk fisheries" for pelagics (e.g. fishcake, canned tuna) and development of "quality," high price products (e.g. sashimi tuna, transshipped products) has enhanced the market value of Hawaii's pelagic fisheries (Pooley,

1993b). Even so, continuing improvements in technology have led to substantial expansion of the longline fishery and more directed targeting for bigeye tuna and broadbill swordfish fishery during the late 1980's (Boggs and Ito, 1993).

### Management Issues

With the decline of traditional management approaches, increasing population, and development of new fisheries, declines in nearshore stocks were inevitable (Shomura<sup>1</sup>; Hensley and Sherwood, 1993). As offshore fisheries grew, allocation conflicts have developed (Boggs and Ito, 1993). With the passage of the Magnuson Fishery Conservation and Management Act of 1976 (MFCMA) and establishment of the regional fishery management councils, federal jurisdiction was established and in some cases established regulations that superseded state or territory regulations. As the Western Pacific Regional Fishery Management Council (WPRFMC) began to develop fishery management plans (FMP's), the lack of adequate fisheries data became evident. Although time series of fisheries catch information were available in the state of Hawaii, questions existed about the quality and consistency of these data for rigorous analysis (Smith, 1993). Data for Hawaii's recreational fisheries, which may represent a large portion of harvest in the nearshore areas, are virtually unrecorded. In Guam, American Samoa, and CNMI, however, de novo development of the WPACFIN system began consistent time series of fisheries data (Hamm, 1993).

Management mechanisms have evolved in Hawaii to reduce fishing effort in the commercial fisheries, including limited entry (bottomfish, lobster), moratoria on new entrants to the fishery (longlining), closed seasons and quota (lobster), and area closures (longlining). Nearshore areas in Hawaii have received limited protection through Marine Life Conservation Districts (MLCD's), a progressive approach taken by the Division of Aquatic Resources (Smith, 1993). Such closed

areas for fishery management purposes represent an alternative that is consistent with interest in marine refuges and sanctuaries, and a theoretical basis for such management is developing (DeMartini, 1993). Closed areas have also been used for special purposes, such as creating areas for nonconsumptive use of marine resources (a function served by many Hawaii MLCDD's) or for protection of sensitive areas. An example of the latter is protection of the Hawaiian monk seal in the NWHI (Nitta and Henderson, 1993). Lobster fishing is prohibited inside 10 fm in the NWHI owing to designation of critical habitat for the monk seal, and longlining is prohibited within 50 n.mi. of the NWHI owing to fishery interactions.

Interactions among different scales of fisheries and the differing agencies responsible for their management present a challenge in many areas. In the nearshore, non-selective gears like gillnets and lack of data on their catch make specific management measures difficult and contribute to stock declines. Moving offshore, many stocks, such as bottomfish, fall within the jurisdiction of both state (or territory) and federal management prerogatives; this problem is presently being faced with bottomfish management in the main Hawaiian Islands. For pelagics, even though all species are now under the MFCMA, fluctuations in catch rates of many species mimic many of the changes in Pacific-wide stocks, suggesting that local fluctuations are in concert with the wider Pacific stocks, and that local effects often change with environmental variation. Unfortunately, the wider ranging stocks lack the scientific basis and institutional structures needed for management (see Douman, 1987).

### Environmental Issues

Improved awareness of environmental issues in the marine environment is evident in the general public, and Hawaii and the Pacific islands are no exception. Land-based development associated with increasing population in island ecosystems is a serious concern owing to degradation of nearshore

habitats (Boehlert et al.<sup>2</sup>; Baines and Morrison, 1990). Examples of problems include point and nonpoint source pollution, coastal landfills, diversion of freshwater from former estuarine areas or fishponds, dredging and siltation impacts on corals, and algal blooms. While such problems may not be evident in all these island areas, their relationship to human population pressure is well documented.

Fishing can itself impact the environment; destructive fishing practices (bleach, dynamite, or nonselective gears) have a long history in island areas, but public awareness has led to regulations banning or controlling them. Set gillnet fishing is increasingly viewed as a nonselective method with relatively high bycatch of unintended species, similar to driftnet fisheries. In Hawaii, however, bills to regulate set gillnets have routinely been killed politically, although a recent (1992) resolution calling for studies to improve regulations was passed.

Impacts of fishing on protected species is also a point of environmental concern. Examples in local fisheries include gillnet impacts on turtle, and longline takes of turtles, monk seal, and seabirds (Nitta and Henderson, 1993).

Fishing may also have impacts on biological diversity. Fishing only selected species in the high diversity ecosystems characterizing these areas may lead to species replacement, and the new dominant species may be smaller and less useful for human consumption (Jones, 1982). While concrete documentation of such species replacement is not evident in Hawaii and the U.S. insular Pacific fisheries, experimental fishing on patch reefs at Midway did change community structure and the abundance of certain prey species (Schroeder, 1989). A more dramatic example is provided by the trawl fishery in the Gulf of Thailand, where

<sup>2</sup>G. W. Boehlert, P. L. Jokiel, and D. J. Mackett. 1985. Issues in fisheries habitat conservation and research for the Hawaiian archipelago and Central Pacific. Honolulu Lab., Southwest Fish. Cent., Natl. Mar. Fish. Serv., NOAA, Honolulu, HI 96822-2396. Southwest Fish. Cent. Admin. Rep. H-85-10, 39 p.

the dominant fish and large invertebrate species decreased to less than one-fifth of their original abundance (as reflected in catch rate), and the squid *Loligo* spp. became the clear dominant, with perhaps a ten-fold increase in abundance (Longhurst and Pauly, 1987). Multispecies management models for tropical fisheries are not sufficiently well developed to predict these kind of changes (Sainsbury, 1982).

### Concluding Remarks

The papers in this volume document the development of this region's fisheries and indicate the scope of research that has been conducted by many agencies; still, it is clear that much remains to be learned. This is also true for the fisheries management and environmental protection issues as for the basic biological and environmental research required to understand the physical processes at work in these diverse island habitats. For successful fisheries management, however, it is critical to appreciate the human diversity of these island areas; this requires a deeper understanding of the social processes which affect the ability of government to work with the community on common solutions to fishery management problems. I hope that this volume contributes the basic background information which can place the search for such solutions on a firmer scientific footing.

### Literature Cited

- Baines, G. B. K., and R. J. Morrison. 1990. Marine pollution from landuse in the Pacific islands region. *Mar. Pollut. Bull.* 21:506-515.
- Boggs, C. H., and R. Y. Ito. 1993. Hawaii's pelagic fisheries. *Mar. Fish. Rev.* 55(2):69-82.
- \_\_\_\_\_ and B. S. Kikkawa. 1993. The development and decline of Hawaii's skipjack tuna fishery. *Mar. Fish. Rev.* 55(2):61-68.
- Cobb, J. N. 1902. Commercial fisheries of the Hawaii Islands. U.S. Comm. Fish. Fish., Rep. Comm. 1901, Pt. 27, p. 381-499.
- Craig, P., B. Ponwith, F. Aitaoto, and D. Hamm. 1993. The commercial, subsistence, and recreational fisheries of American Samoa. *Mar. Fish. Rev.* 55(2):109-116.
- DeMartini, E. E. 1993. Modeling the potential of fishery reserves for managing Pacific coral reef fishes. *Fish. Bull.* 91(3):414-427.
- Douman, D. J. (Editor). 1987. Tuna issues and perspectives in the Pacific Islands region. East-West Cent. Press, Honolulu, 314 p.

- Ferry, R. E., and C. C. Kohler. 1987. Effects of trap fishing on fish populations inhabiting a fringing coral reef. *N. Am. J. Fish. Manage.* 8:580-588.
- Gobert, B. 1992. Impact of the use of trammel nets on a tropical reef resource. *Fish. Res.* 13:353-367.
- Haight, W. R., D. R. Kobayashi, and K. E. Kawamoto. 1993. Biology and management of deepwater snappers of the Hawaiian archipelago. *Mar. Fish. Rev.* 55(2):20-27.
- Hamm, D. C. 1993. The western Pacific fishery information network: A fisheries information system. *Mar. Fish. Rev.* 55(2):102-108.
- Hensley, R. A., and T. S. Sherwood. 1993. An overview of Guam's inshore fisheries. *Mar. Fish. Rev.* 55(2):129-138.
- Johannes, R. E. 1978. Traditional marine conservation methods in Oceania and their demise. *Ann. Rev. Ecol. System.* 9:349-364.
- \_\_\_\_\_. 1981. Words of the lagoon: Fishing and marine lore in the Palau District of Micronesia. Univ. Calif. Press, Berkeley, 245 p.
- Jones, R. 1982. Ecosystems, food chains and fish yields. *In* D. Pauly and G. I. Murphy (Editors), Theory and management of tropical fisheries, p. 195-240. ICLARM Conf. Proc. 9.
- Longhurst, A. R., and D. Pauly. 1987. Ecology of tropical oceans. Academic Press, New York., 407 p.
- Marten, G. G., and J. J. Polovina. 1982. A comparative study of fish yields from various tropical ecosystems. *In* D. Pauly and G. I. Murphy (Editors), Theory and management of tropical fisheries, p. 255-286. ICLARM Conf. Proc. 9.
- Nitta, E. T., and J. R. Henderson. 1993. A review of interactions between Hawaii's fisheries and protected species. *Mar. Fish. Rev.* 55(2):83-92.
- Pooley, S. G. 1993a. Economics and Hawaii's marine fisheries. *Mar. Fish. Rev.* 55(2):93-101.
- \_\_\_\_\_. 1993b. Hawaii's marine fisheries: Some history, long-term trends, and recent developments. *Mar. Fish. Rev.* 55(2):7-19.
- Sainsbury, K. J. 1982. The ecological basis of tropical fisheries management. *In* D. Pauly and G. I. Murphy (Editors), Theory and management of tropical fisheries, p. 167-194. ICLARM Conf. Proc. 9.
- Schroeder, R. E. 1989. The ecology of patch reef fishes in a subtropical Pacific atoll: recruitment variability, community structure and effects of fishing predators. Ph.D. Diss., Univ. Hawaii, Honolulu, 321 p.
- Smith, M. K. 1993. An ecological perspective on inshore fisheries in the main Hawaiian Islands. *Mar. Fish. Rev.* 55(2):34-49.
- Uchida, R. N. and J. H. Uchiyama (Editors). 1986. Fishery atlas of the Northwestern Hawaiian Islands. U.S. Dep. Commer., NOAA Tech. Rep. NMFS-SWFC-38, 142 p.