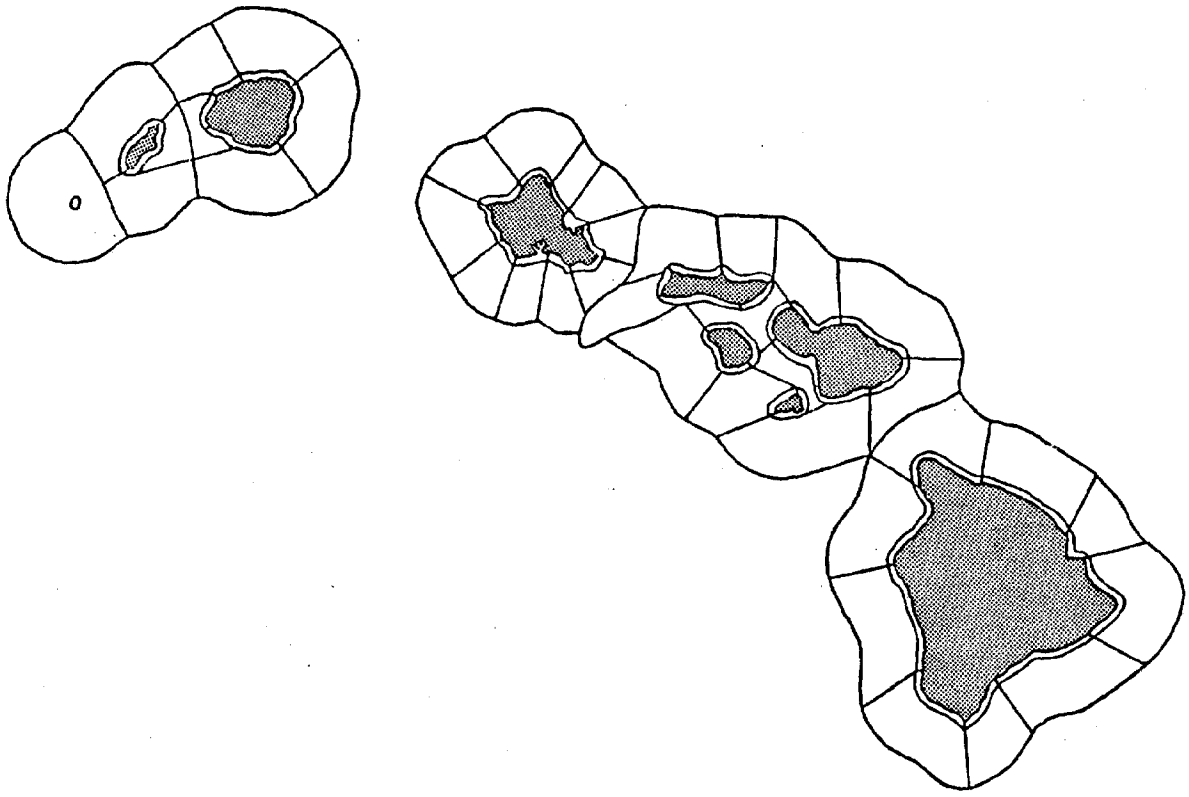
HAWAII COASTAL ZONE

FISHERIES MANAGEMENT STUDY



DEPARTMENT OF LAND AND NATURAL RESOURCES

HAWAII COASTAL ZONE

FISHERIES MANAGEMENT STUDY

DIVISION OF FISH AND GAME
DEPARTMENT OF LAND AND NATURAL RESOURCES
MARCH 1980

PREFACE

This report is a summary description of the fisheries component of the Hawaii Coastal Zone Management Program. It outlines the issues concerned with fishing in Hawaii including key fish species, biological distribution of fish, major areas of fishing pressure, individual island problems, coastal zone related issues, nearshore environmental destruction, competing user groups, and boating issues.

The primary goal of this report is to pull together the variety of circumstances that have led the fishing community of Hawaii to a point where good fishing is thought of nostalgically, conficts are frequent, and the people of Hawaii regret not having more and cheaper local seafood on their tables. This report sets the framework for the development of an advanced fisheries data collection and evaluation program under the auspices of the State's Division of Fish and Game in order to improve the technical basis for natural resource management.

The fisheries of Hawaii represent coastal-dependent development which contribute not only to the State's economy but to the health and well-being of a major sector of the population which engages in this activity. An over-view of the issues dealing with fishing in Hawaii is presented in hopes of achieving a balanced view of the situation and suggestions for improvement.

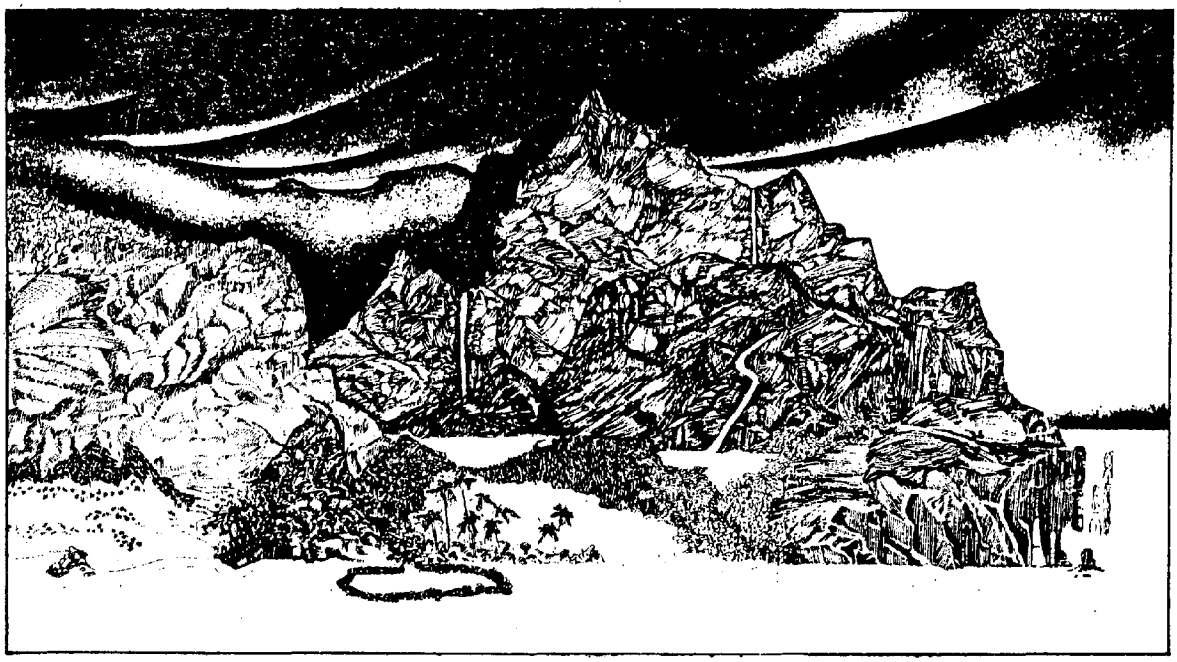
TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1

INTRODUCTION



FISHERIES MANAGEMENT: AN AGELESS ISSUE

CHAPTER I

INTRODUCTION

Fisheries Management: An Ageless Issue

The people of Hawaii have an historical identification with the sea and an affinity for its fish. They consume more than twice the national average of seafood on a per capita basis. Yet Hawaii has historically ranked near the bottom among coastal states in terms of commercial fish landings. Commercial fish landings here have ranged from 9 to 17 million pounds annually. Consequently, Hawaii imports most of its seafood products. Even *mahimahi* (dolphin fish), so famously associated with Hawaiian waters and recipes, is primarily imported from Taiwan and Ecuador. A number of elements have shaped the peculiarities of Hawaii's fisheries.

The ancient Hawaiians had a respect and admiration for the sea and its resources. Fish and shellfish were staples in the Hawaiian diet and of central interest to the community. Certain fish became objects of affection and respect, in some cases being afforded regal status, worthy of being eaten only by the aliis (chiefs). Great mythological legends evolved about the sea and the fish with management programs eventually developing in the form of kapus (bans). These kapus forbade or restricted fishing activities and were accompanied by heavy penalties for their disregard. Conserving resources was strictly adhered to both through kapus and through other religious

associations with the native gods protecting the sea and its inhabitants.

The kapus resulted in effective conservation programs which included seasonal fishing management by species and by area. Kamehameha III (1839) established the first set of written laws in which he divided the fishing grounds into three sections: one for commoners, one for the landholders, and one for the government. Fishes were associated with ownership rights. In the document creating the Territory of Hawaii, private ownership rights were abolished and areas opened to common use. "Fishery rights" were condemned and with them the greater part of the laws governing fisheries regulation and management. Although highly democratic, this common ownership of fishery resources has probably done more to jeopardize the status of Hawaiian fisheries by causing greater fishing pressure than any other single issue. From that moment on, the voices concerned with over-harvesting have never ceased.

The following are exerpts which describe the historical relevance of fishing pressure in Hawaiian waters.

Pre-Captain Cook

> A knowledge of the abundance of fish and the supply procured for consumption in pre-European days can only be partially arrived at, as well as whether the supply decreased after discovery of the islands and the great changes which occurred in ways of living for the Hawaiian. With at least 10,000 devoted to procuring enough food to eat, it is likely that the amounts of fish obtained and needed were very large indeed, especially as land animals were not counted on as a steady part of the diet.

To conserve the supply of all resources was constantly in the Hawaiian mind. Fishing grounds were never depleted, for the fishermen knew that should all the fish be taken from a special feeding spot other fish would not move in to replenish the area...Not only draining it completely was avoided, but also taking so many that the rest of the fish would be alarmed. At the base of this action to conserve was the belief that the gods would have been displeased by greediness or waste.[1]

1900-1901

The fisheries of Honolulu are rapidly falling off in amount, with corresponding rise in the price for fish, which are now perhaps higher than in any other seaport town in the world. One cause of the falling off is to be found in overfishing within a limited area.

At the present time very fine-meshed seines are used especially around Honolulu (Oahu) and Hilo (Hawaii), and immense numbers of very small young fish, such as the mullet, *ulua*, and *akule*, from 2 inches in length up, are caught and sold, although it is against the law to sell young mullet under 4 inches in length. Unless this great drain on the young is stopped the fisheries are bound to suffer severely.[2]

The most noticeable feature in this (Honolulu) market is the excessively high prices charged for fishery products. As compared with other retail markets of the United States, and possibly the world, Honolulu ranks first as regards high prices.... There are a number of reasons given to account for this condition of affairs (among which is)...the indiscriminate use of fine-meshed seines (which) has undoubtedly caused a falling off in the catch, although to what extent is a rather difficult problem to solve, owing to the lack of statistical data for previous years.[3]

1927

One feature of the local fauna may be especially noticed.... The chief fisheries are now carried out by the Japanese, who venture out to sea much farther than ever did the Hawaiians who seldom went beyond the coral reefs, where reefs

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[1]Titcomb, Margaret. Native Use of Fish in Hawaii. UH Press, 1972.

[2]Jordan, D.S. and B.W. Evermann. Preliminary Report on the Investigation of the Fishes and Fisheries of the Hawaiian Islands. US Fish Comm. Rep., 1900-01.

[3]Cobb, J.N. The Commercial Fisheries of the Hawaiian Islands. US Fish Comm. Rep., 1900-01.

exist. The fauna of the reefs is much less abundant than in the period of the first extensive explorations, those of Oliver P. Jenkins in 1899, and of Jordan and Evermann in 1901. Probably no species has been actually exterminated by over-fishing, but many once common have now become rare.[4]

1950

Although the game of the deep sea is as good as it ever was, the best reef fishes are declining.... The herbivorous fish are still plentiful. But these are not man's first choice for food.... In Hawaii there has been such selective fishing for the *oio* and the *ulua* that those predators have waned in number.

Another group of fishes which have declined from overfishing are those which feed on little crabs, shrimps and shellfish. They include the *moano*, *kumu*, *weke* (goatfishes), *aholehole* (silver perch) and *uku* (grey snapper), once abundant and the delight of spearmen and anglers. As they are easily accessible in the shallow shore waters, they are the game of almost anyone...and because Hawaii's population has increased, more people than ever before are going reef fishing, not only for the sport of it but to reduce their grocery bills.

Today the oldtimers are hurt to see the way everything possible is taken from the sea. The fishing continues, day and night without rest and fish have no chance to grow and reproduce.... Perhaps some of the sorties of the 'good old days' are a trifle enlarged by nostalgia, but many of the ideas of the old-timers have merit. One day an old fisherman...was complaining in general about the way times have changed: 'This young generation,' he grumbled, 'they don't care what they do when they fish. They go out with crowbars and break up the reef so the fish got no more homes to live in. That's not nice. When they go spearing, they shoot at anything that moves. They say if they don't get it, someone else will. But the old folks laugh at the tiny things they bring home. Next they'll be eating fleas.' "[5]

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[4]Jordan, D.S. and B.W. Evermann and S. Tanaka. Notes on New or Rare Fishes from Hawaii. Cal. Acad. Sci. Proc., Ser. 4, Vol. 16: 649-680. 1927.

[5]MacKellar, J.S. Paradise Lost: The Shore Fisherman's Plight. Hawaii Goes Fishing. 1968.

1972

> Especially among shoreline fishermen, the often expressed statement was to the effect that, on the one hand, there are too few fish in the areas where open and free access to the coastline existed and, on the other hand, in areas where fish were more plentiful, closed or limited accessibility prevented participation from reaching the otherwise desired levels. The historic roots of this problem stems, of course, from the basic land tenure changes under Hawaii's mid-19th century 'Mahele' (land reforms) and from the transition in Hawaii's form of government from early monarchy to present statehood status. The land-use patterns which developed around these changes over time have placed considerable stretches of coastline frontages under the control and restricted use of the military, large private estates, and agricultural plantations, and also contiguous series of small beach properties under several property owners. This problem has, in recent years, been compounded by the so-called further 'taking over' of coastline areas by resort developments, on the one hand, and squatter type settlements on the other. The problem here extends far beyond simple fishery resource management and involves more complex institutional issues of easements, regulations, compensation, etc., which is another and perhaps most important area of concern for the public control of recreational fishing.[6]

1977

TO: ALL SHORELINE FISHERMEN

We, members of Maui Pine Fishing Club, talk of the 'good old days' after several frustrating weekend shoreline fishing trips.

Twenty years ago it was not too uncommon to land a one pound papio with a small casting pole on the (close to home) beaches of Maalaea-Kihei or Kahului-Paia. *Oios* (bone fish) were plentiful and an occasional *moi* made fishing enjoyable. Few over-night *ulua* fishing trips would normally produce a strike (although we did not land all of them).

Our catches declined steadily in the ensuing years, we believe, because of increased shoreline net fishing. Recently, there

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[6] Hoffman, R.G. and H. Yamauchi. Recreational Fishing: Its Impact On State Local Economies. UH Ag. Exp. Station, Departmental Paper 3. 1972.

has been a sudden and sharp decline.

This can be attributed to the advent of fibre-glass boats and monofilament nets. We have watched two men carry a 12 foot boat, which can be towed to almost anywhere on our beaches. It carries about 300 yards of monofilament net and four men. They quietly set many of these 300 yard nets starting from shore out along a 5-10 foot depth path parallel to the shore. The fish are trapped. They race their outboard motor within the encirclement to flush the fish into the nets. (Modern Pai Pai)

Recently we saw in a fish market a tub full of *papio* weighing less than 3 oz. each. Seven or eight of these may make a pound. *Papio* being blunt headed, would get caught in our regulation 3/4" mesh or 1½" stretched-out netting. Sadly, this is the species, that grows to become an *ulua*, a primary shoreline game fish in Hawaii. The largest caught by one of our members in the 'good old days' weighing 86 pounds.

We hate to talk anymore of the 'good old days'. It is disheartening to watch many of our youngsters casting for hours, hoping, yet catching nothing. It is time to take action before near depletion. Even the netters are catching less fish each time. To compensate, their nets are getting longer.

Unlike our over-built Waikiki or the mushrooming hotels and condominiums choking our beaches we can, in a relatively short time, restore the fish population within our waters. This will require appropriate laws and enforcement.

We, the members of the Maui Pine Fishing Club, (would like to) join the other fishing clubs and all sport fishermen in our State in asking the next legislature to more effectively control fishing, not 200 miles off shore but within 200 yards of our beaches.

Respectfully submitted:
Members of Maui Pine Fishing Club[7]

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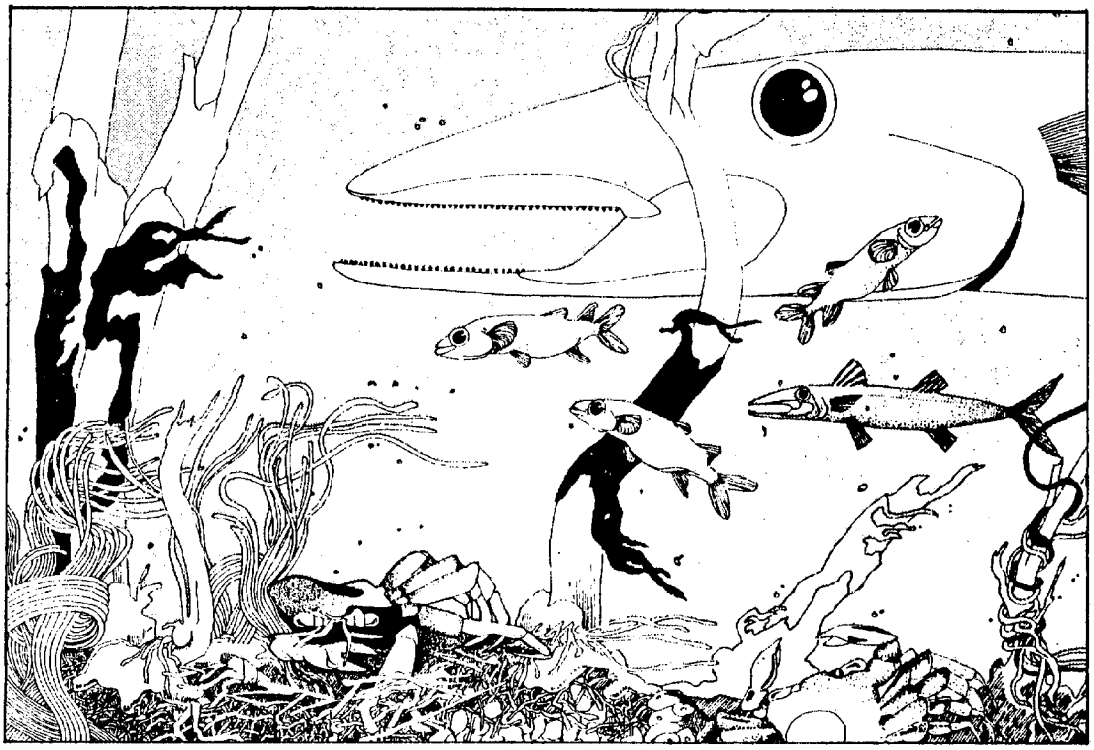
[7]Hawaii Fishing News. October 1977.

Most of the fishing grounds are within easy reach of population centers and have consequently been under heavy fishing pressure for a long time by all fishing groups. The fish in such areas are relatively scarce and wary as a result. As resources dwindle, fishermen become more competitive, gear becomes more efficient, and everyone becomes more and more disenchanted with the fishing situation. Conflicts are becoming more frequent with flagrant disregard for and ignorance of regulations. Recreational fishermen blame commercial fishermen, commercial fishermen blame recreational fishermen, and everyone blames pollution and habitat destruction for poorer fishing. The probable reasons, numerous and confusing, will be explored further.

II



ENVIRONMENT

CHAPTER II

ENVIRONMENT

The islands of Hawaii are situated in the North Central Pacific Ocean. The island chain runs approximately 1500 miles, starting at one end with the island of Hawaii, Maui, Kahoolawe, Lanai, Molokai, Oahu, Kauai, and Niihau, and ending in the Northwest Hawaiian Islands with Hancock Bank (Fig. 2.1). The linear arrangement of the islands reduces the amount of protected inter-island waters, most of these waters in the area bordered by Molokai, Maui, Lanai and Kahoolawe.

Most fishing effort appears strongly associated with operating conditions reflective of calm weather and protective inter-island waters. The northeast trade winds blowing across the island chain generally create preferable oceanic conditions on the leeward coasts.

A distinction is commonly drawn between the "main islands", that is, the high islands from Hawaii to Kauai and Niihau, and the leeward islands, or as they are now officially designated, the Northwestern Hawaiian Islands, from Nihoa to Kure Island. This distinction is based not so much on natural factors of significance to fisheries as on the remoteness of the leeward islands from main population centers, their lack of

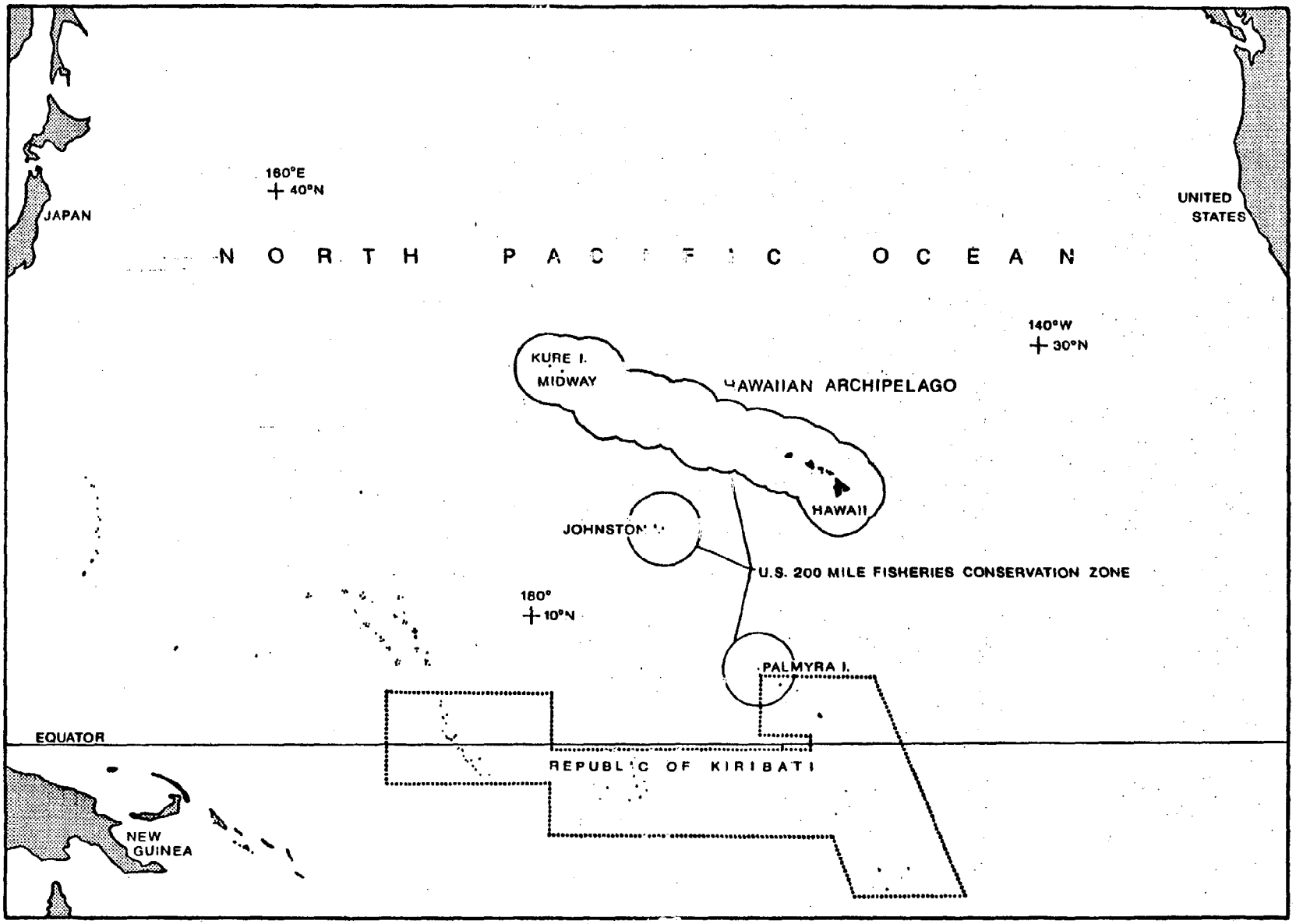

160°E
40°N
JAPAN
NORTH PACIFIC OCEAN
UNITED STATES
140°W
30°N
KURE I.
MIDWAY
HAWAIIAN ARCHIPELAGO
HAWAII
JOHNSTON I.
U.S. 200 MILE FISHERIES CONSERVATION ZONE
180°
10°N
PALMYRA I.
EQUATOR
REPUBLIC OF KIRIBATI
NEW GUINEA

Figure 2.

human inhabitants, except for a small Coast Guard contingent on Kure, the consequently under-exploited condition of their resources, and the fact that most of the islands are included in a Federal wildlife refuge. The Northwest Hawaiian Islands are the eroded remains of older high islands and at present are either flat coral and sand platforms only a few feet above sea level or small, isolated rock pinnacles and islets with, in some cases, fairly extensive associated banks and shoal areas.

Hawaii lacks extensive protective bays and estuaries. This provides us with very few natural harbors prevalent in continental regions. In addition, the island inshore waters are relatively free of fertile (nutrient rich) and protective nursery grounds also prevalent in continental waters. This lack of protected, nutrient rich areas is responsible for the scarcity of invertebrates of edible quality. California reports 36 varieties of crustaceans and mollusks of commercial significance. Hawaii lists only eight. Hawaii is looking to aquaculture to provide invertebrates for the marketplace such as oysters, clams and prawns (see Aquaculture Development for Hawaii, 1978). These invertebrates are not native to Hawaii and must be imported from other places in the world.

The introduction of exotic species (non-native) has arisen to deliberately enrich the relatively impoverished aquatic food web in Hawaiian waters. Inshore genera of groupers (*Serranidae*) and snappers (*Lutjanidae*) are missing or only poorly represented. These fishes are highly prized for both their fishing and eating qualities. In freshwater, we lack large lakes and perennial streams with the primary sport fishes so prevalent elsewhere. The native freshwater fishes of Hawaii are gobies which have edible qualities despite their small size.

At least 70 different species of aquatic animals have been released either accidentally or purposefully into Hawaiian waters. At least 38 have become established, approximately 20 have failed, and the success of the remainder is uncertain at this time. Many of the introductions are viewed both favorably and unfavorably. The *taape* (blue-lined snapper) has become a highly successful introduction. Many fishermen, however, claim its success has been at the expense of other, more favored species.

The islands of Hawaii offer a variety of year-round fishing. With such an abundance of oceanic water resulting from the uniqueness of being an island state, we have a great variety of conspicuously beautiful fish species. The coral reefs provide a substantial boost to the productivity of the waters and harbor a great diversity of fishes.

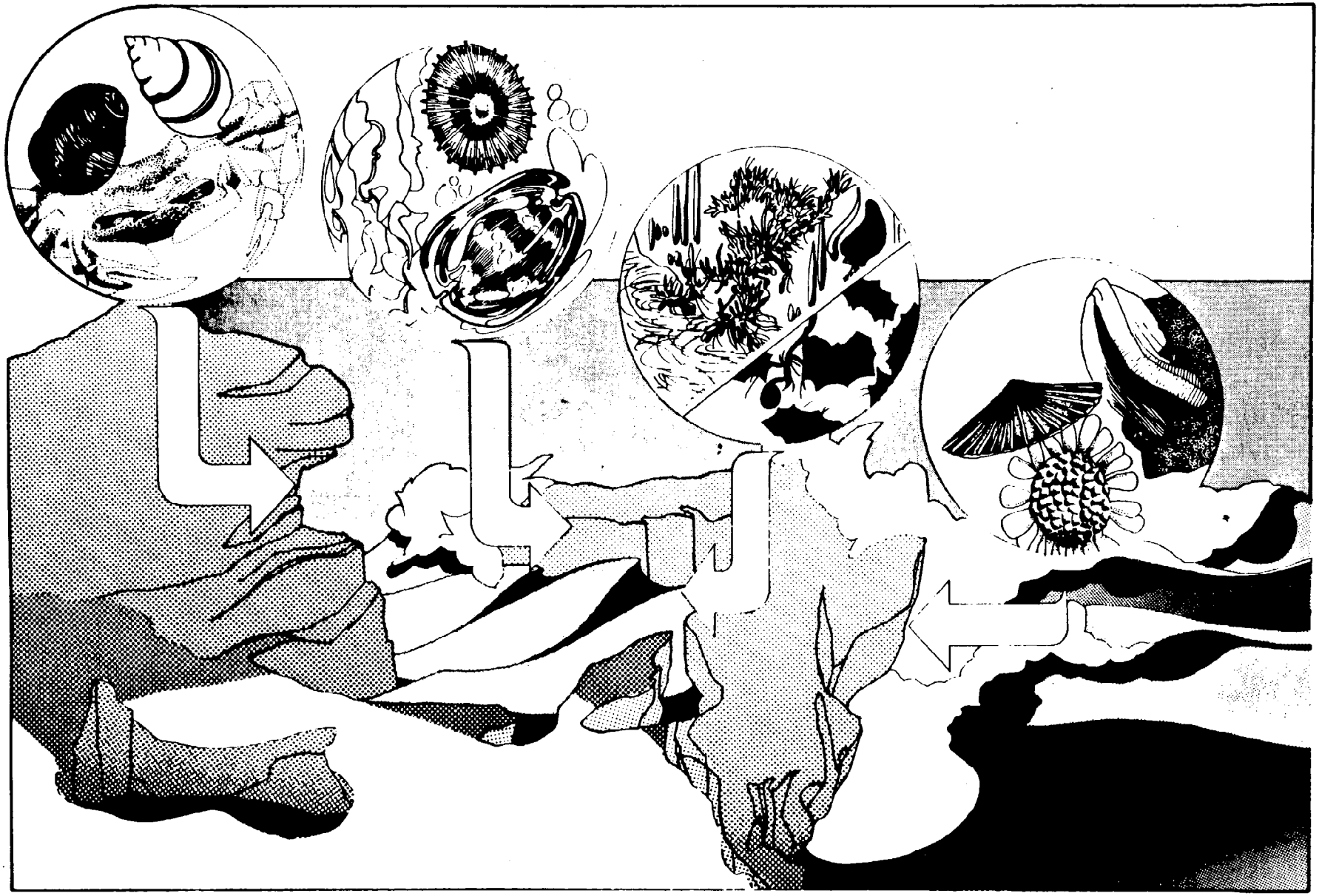
The primary characteristic of the Hawaiian aquatic environment is the narrowness of the major ecological zones. Tides have a negligible effect on the coasts of the Hawaiian islands — the impact of the one meter tidal range is minor compared to that of the surge and splash associated with wave activity.

There are a number of beaches and rocky points along the coasts of our islands which offer excellent surfcasting or sportfishing opportunities. Depending on the physical characteristics of the shoreline, one can fish for selected species associated with that shoreline habitat. Figures 2.2 through 2.10 depict the physical characteristics of our shoreline and nearshore environments.

The following pages detail these areas and identify the major species of plants and animals associated with the habitats. The illustrations were prepared by Mr. Robert Hill, under contract with the University of Hawaii Pacific Urban Studies and Planning Program, and have appeared in various issues of the Seagrant Hawaii Coastal Zone Newsletter. The text is from a report submitted to the State of Hawaii Department of Health's 208 Water Quality Program (Stahl et. al, 1977).

LAVA ROCK SHORELINES. The islands of Hawaii are of volcanic origin, built up from the sea floor by extrusions of basaltic lava. Where these lava flows meet the sea, like so many basalt coasts throughout the world, steep sea cliffs, horizontal benches or cobbles and boulder beaches may develop. Windward basalt shorelines are usually shaped and dominated by heavy surf and wave action. Striking differences are found in speciation associated with wave-exposed vs. wave sheltered, lava rock shorelines.

Vertical shores. Rocky vertical shorelines, sometimes projecting high above sea level and with portions reached only by spray, are inhabited by relatively few species, which are often dull gray or black in color and which can withstand long periods without water. These species include the littorines *(pupu kolea)*, among the mollusks and the black grapsid crab, *a'ama*. Seaward of the littorines and the crab but still above the reach of the tide are the black nerite *(pipipi)*, and the pulmonate limpet.



LAVA ROCK SHORELINE

Seaward of the spray zone, at mean tide level, much of the lava coast is colored pink by a coralline alga, and studded by a dome-like shingle urchin, and the *opihi*.

At zero tide level, surf-swept shorelines are inhabited by other rather dark colored and heavy shelled animals on the substrate and brown and white cowries in crevices. Fishes in these areas are strong swimmers and may be dark in color such as the Achilles tang. Other fishes associated with this area include: the damsel fish, the wrasse, and the blenny.

Basalt benches. Irregular continuous benches of basalt may form horizontal platforms along the shore. Waves play a dominant role in determining the pattern of biotic zonation on these benches with striking differences between windward and leeward coasts.

On windward shores, the highest level of wave action is marked by a red alga, below which there is a variety of frondose algae. Seaward of the algal mat, the substrate is principally the growth form of the encrusting calcareous algae.

Dominant mollusks are the black foot *opihi* and several smaller gastropods. Algae-encrusted areas are dominated by the yellow foot *opihi* and the shingle urchin. The frontal slope of basalt benches may be riddled by the borings of the sea urchin. Hobson (1974) reported 54 total species of fishes in this habitat off the Kona coast of Hawaii. Some of these include the surgeonfishes, the wrasses, and the damselfishes.

Examples of basalt benches occur from Napali to Kapaa and Poipu to Waimea on Kauai; Lanikai to Makapuu and Kaena Point on Oahu; the Hana coast and Cape Kinau on Maui; the north coast of Molokai and along most

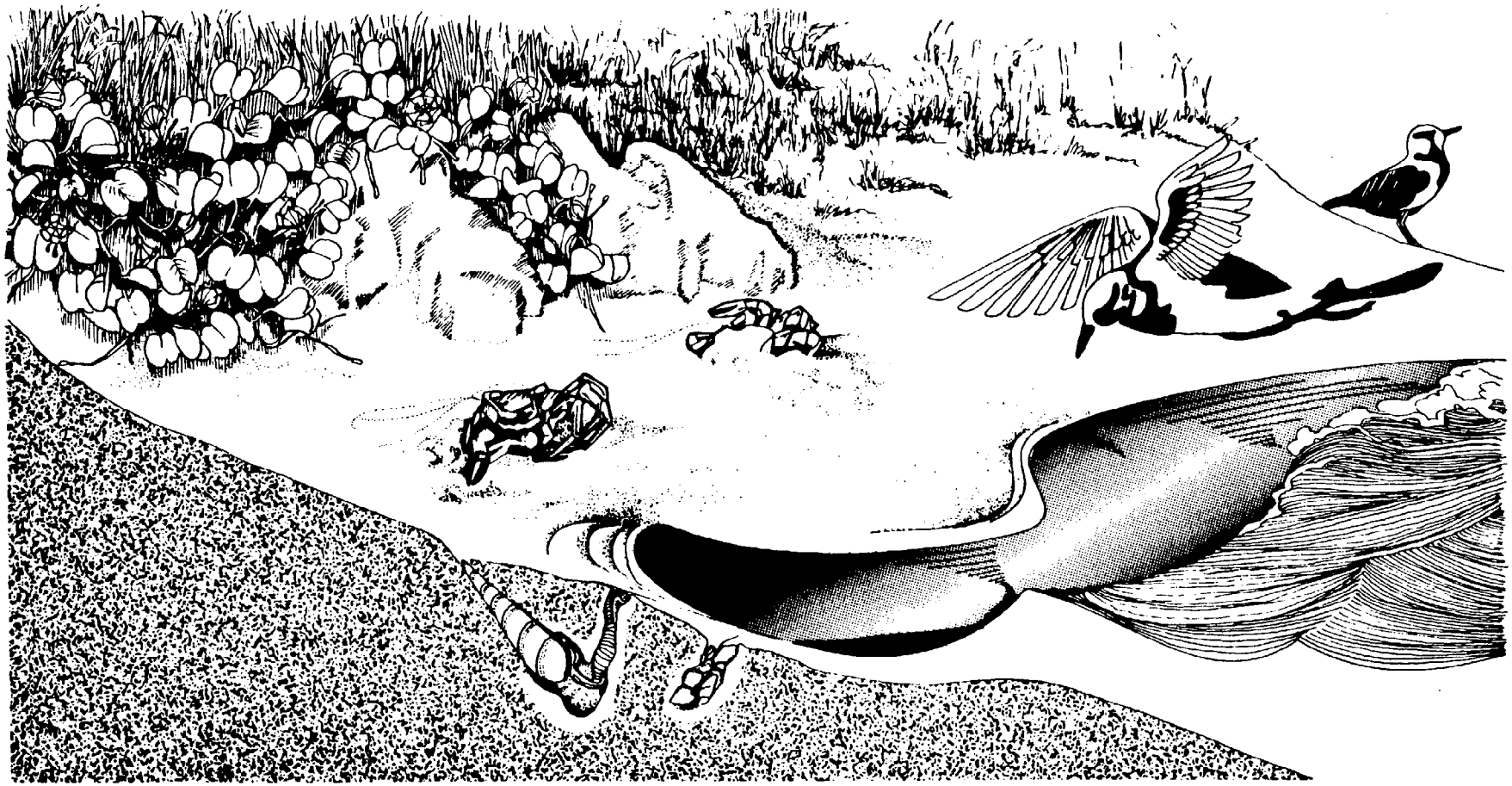
of the shoreline of the Big Island.

Boulder beaches. Boulder beaches are formed of large, worn boulders or cobbles of basalt composition. The cobbles and boulders are shaped by marine processes, such as wave scour, currents and other erosive factors, transported and then deposited on beaches by waves and during storms. Example coasts include Kona and Kealakekua on Hawaii, Hana on Maui and Napali on Kauai.

Because of the instability of the substrata and the continual scouring, few organisms inhabit these beaches with the exception of grapsid crabs and sparse interstitial and under-rock fauna. Hobson (1974) reported 77 species of fish off Kona boulder beaches. The majority of these are herbivorous fish which inhabit these areas grazing on benthic algal turf. They include the surgeonfishes, the yellow tang, and the achilles tang.

SAND BEACHES. Hawaiian beach sand is one of the most valuable mineral and recreational resources in the State covering 185 miles of Hawaii's 934 mile shoreline (see Figures 2.2 through 2.10 for maps of sandy beaches on each of the islands). Three types of sand comprise individual beaches in Hawaii: green (olivine), black basalt (lava) and white (calcium carbonate). Most of Hawaii's beaches are composed of calcareous beach sand which contains the remains of foraminiferans, mollusks, echinoderms, coralline algae and reef corals. Black sand beaches occur on the Big Island and on Maui. Olivine beaches are found on the Big Island and on Oahu.

The calcareous beach sand reservoir varies tremendously from island to island. Kauai, with 1.4×10^7 cubic yards, has the greatest



SANDY BEACHES

amount, while Hawaii, with 1.7×10^6 cubic yards, has the least. The largest individual beach sand reservoirs exist at Papahako on Molokai, Polihale on Kauai and Polihua on Lanai (Moberly and Chamberlain, 1964)

The beach community is divisible into three zones: 1) an upper zone with terrestrial vegetation and possible dune formation; 2) a mid-beach between the high tide line and the vegetation line; and, 3) the lower beach which is continually awash by waves.

The benthic animal life found on sand beaches is determined by particle grain size, slope of the beach and color of the sand. The upper beach is characterized by amphipods, isopods, and males of the ghost crab. Female ghost crabs and males of another ghost crab burrow in mid-beach areas. The mole crab, polychaetes and the mollusk *Terebra spp.* occur in low beach areas. The coloration of these animals usually blends cryptically into that of their environment.

Fishes which generally associate with sandy beach areas include the *moi*, the goatfishes, the bonefish, the trichonotid, and the burrowing eel.

Beaches continually change; at one time eroding, at other times accreting. Much of this variation is directly associated with the amount of wave energy that affects the beaches on a seasonal basis. Beaches with a western exposure, for example, begin to erode during winter months due to high Kona waves. During the summer, these western beaches accrete because of northeasterly winds and waves (Moberly and Chamberlain, 1964). Beaches on the windward sides of the Hawaiian Islands, however, accrete when the northeast trades diminish and erode during heavy northeast trade swells or North Pacific swells.

Non-climatic factors may also yield changes in beach size. For example, the construction of man-made breakwaters, jetties and groins results in modification of circulation and current patterns potentially causing the erosion and accretion of sand beaches, the deposition of silt in harbor basins and the resultant reduction and/or elimination of certain biota and their replacement by forms more tolerant of the changed environment.

SOLUTION BENCHES. The prime requisite for the appearance of a solution bench is a consolidated limestone coast. Fifty-two miles, or about 31 percent, of Oahu's coastline are comprised of this type (see Figures 2.2 through 2.10 for maps identifying solution benches). In Hawaii, the two main types include those from limestone composed chiefly of reef coral and calcareous algae and those formed from detrital limestone, composed of sand and gravel containing calcareous skeletons of various organisms. The solution bench is more typically and extensively developed on the reef limestone or carbonate. These solution benches, or sea level platforms, may extend from 1 to 30 meters seaward from the shoreline.

On Oahu, nearly continuous stretches of solution bench occur on the Waianae coast, east of Kaena Point on the north coast, near Waimea Bay, around Kahuku Point and on parts of the Mokapu Peninsula. Both windward and leeward coasts may contain solution benches which are developed from the exposure of limestone to both continual wash by sea water and periodic solution by rain water.

Two major characteristics of the solution bench are the bench and the nip. The bench commences at the seaward margin and rises fairly steeply from the ocean. Its inland margin is characterized

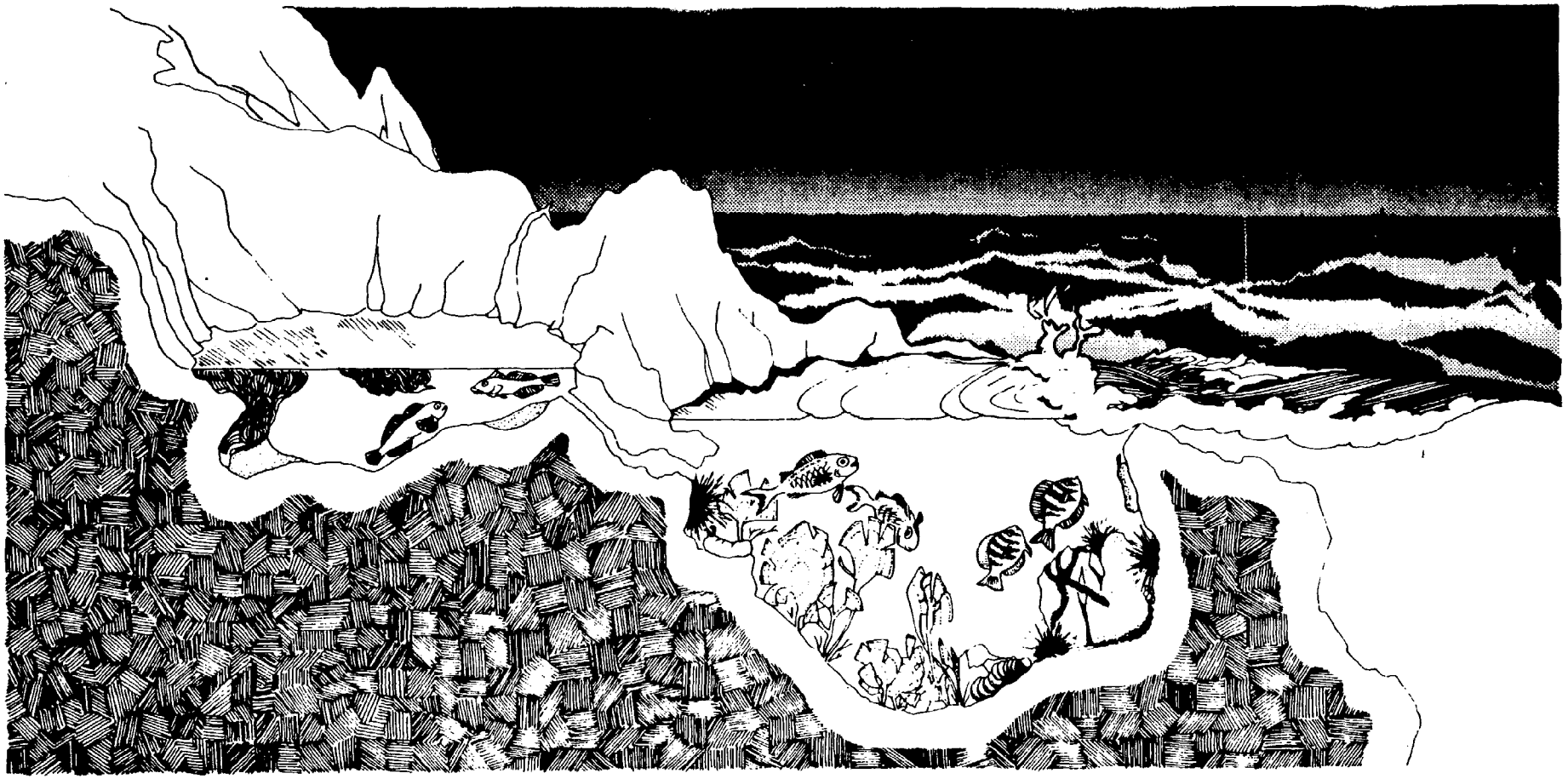
by a pitted zone. The nip is a marked notch which undercuts the limestone shore at one to three feet above sea level.

Solution benches are distinguished by a cover of thick algal turf and by conspicuous zonation of flora and fauna. Calcareous algae are concentrated at the sloping outer edge, where corals are sometimes present. Most information on biota is confined to the mollusks. Various assemblages of grazing herbivorous mollusks are found within the algal growth as well as mats of filter feeding mollusks and active carnivorous snails. The dominant micromollusks are the herbivores, which are associated with the algae on the beaches. The pools of the pitted zone contain a small littorine snail. On the bench appear the cone snails, with *Conus abbreviatus* nearest shore and *Conus chaldaeus* nearest the seaward edge.

Fishes occurring here are usually similar to those found in rocky tidepool areas and include young damselfish and blennies.

TIDE POOLS. Marine tidepools can be formed by depressions in sea level basalt outcrops or solution benches or by massive boulders fronting the sea (see Figures 2.2 through 2.10 for maps identifying marine pools throughout the islands). They can be extremely shallow or quite deep. Physical conditions of temperature, salinity and pH vary with exposure and with distance from the sea. Sub-surface connections to the sea are common, subjecting the pools to tidal fluctuations. The biota includes small mollusks, worms, occasional grapsid crabs, the blenniid fishes, and the gobiid fishes.

Some marine pools exposed to freshwater runoff or rain develop a type of thermocline below which the temperature may rise considerably.



TIDE POOLS

There may be great seasonal differences in biota, both above and below such thermoclines. On Rabbit Island and the south shore of Moku Manu, some pools are densely inhabited by algae at their bottoms only.

The larger the pools, the more uniform are the conditions, especially with a large volume in relation to the surface area. In some of these larger pools and in the smaller ones at high tide, they become hydrologically quite similar to the sea. These pools, particularly if they are large, provide suitable habitat for a variety of reef corals and tend to become havens for displaced deeper forms or for juvenile fish such as *manini* and *aholehole*. Some examples of these larger tidepool systems include Wailua Bay, Kiholo, Hilo, Honaunau, Kapoho and King's Landing on Hawaii, Hanamaulu on Kauai and the north coast of Molokai.

ARTIFICIAL BASINS. The influence of dredging, man-made structures and other human activities will have profound effects on the natural ecosystems of an area (see Figures 2.2 through 2.10 for maps depicting artificial basins for each of the islands). A common example of this is an altered community following the transformation of a natural embayment, coastline or estuary into a boat harbor. Honolulu Harbor is by far the largest commercial deepwater facility in Hawaii. Known originally as Kapalama estuary, it is fed by Nuuanu Stream, including its major tributary Pauoa Stream, as well as from Kapalama Canal. Originally, a natural channel in the reef, resulting from this freshwater input, restricted the growth of corals and allowed for the enlarging of the size of the harbor in the mid-1800's. Now, much reef has been destroyed and nearby lowland areas have been filled with dredged materials and sediment from natural runoff.

Other commercial deepwater harbors include Hilo and Kawaihae on the Big Island, Kahului on Maui and Nawiliwili and Port Allen on Kauai. Their shelter makes these waters desirable for a number of recreational as well as commercial uses. Consequently, conflict has arisen regarding optimum use of these waters.

Small boat harbors are found on all the islands and have only some characteristics in common with the larger harbors. Flushing action within the smaller harbors is generally better with resultant coarser bottom sediments. They are not as deep and light can generally penetrate to these bottom sediments. Small boat harbors have been built along and sometimes out beyond natural coastline features. Some representative small boat harbors include Maalaea and Lahaina on Maui, Honokohau on the Big Island, Nawiliwili on Kauai, Kaunakakai on Molokai, Manele on Lanai and Pokai Bay, Ala Wai, Kewalo and Haleiwa on Oahu.

Both the quantity and quality of the freshwater input to many artificial basins and harbors vary considerably. Perennial streams may drain through agricultural lands as well as through highly urbanized areas near the harbors. Groundwater seepage and artesian wells also contribute to this freshwater input. Although the "natural pollution" carried by this freshwater supply is long standing, it does not compare to pollution resulting from urban and industrial sewage disposal, accelerated sedimentation, sugar mill waste-water discharges, ship discharges, cesspool seepage and thermal effluent which cumulatively act in fouling the harbor waters and altering the original ecosystem.

Water depths vary among harbors and within the same harbor from 2 to 15 m. Those harbors projecting out from the natural shoreline are characterized by moles, revetments, breakwaters, rip rap and other

protective structures. Quarried harbors show a greater preponderance of vertical rocky walls. Most harbors contain wharves, docks, piles, piers, buoys, slips and other facilities and structures. The abundance and diversity of these structures can provide a variety of substrate habitats for algae, fouling organisms, rock crabs, the Hawaiian oyster, barnacles and several reef corals. In addition, several schooling fishes such as *iao, nehu, omaka, aholehole, hahalalu,* and mullet, migrate from surrounding environments.

NEARSHORE REEF FLATS. Hawaiian nearshore reef flats are shallow platforms which hug the shorelines of high islands at water depths of 0 to 3 m. (see Figures 2.2 through 2.10 for maps depicting nearshore reef flats for each of the islands). They are composed of reef rock derived from the skeletons of a variety of reef dwelling marine organisms. Crustose coralline algae and reef corals contribute the bulk of material to the reef framework but the skeletons or fragments of mollusks (primarily gastropods), foraminiferans, echinoderms (sea urchins, sea cucumbers, sea stars) and sand producing algae may also contribute mass to the reef, principally as sediment. Coralline algae are the principal agents cementing all of the components together forming consolidated reef rock. Prominent geological surface features on reef flats include reef blocks, coral rubble and sand patches.

Nearshore reef flats include both apron and fringing reef types. The former represents an earlier stage in reef growth leading to the latter. Apron reefs are smaller and project out from the shoreline as semi-circular aprons while fringing reefs are more extensive and form wide continuous flats parallel to the coastline for long distances.

NEARSHORE REEF FLATS

A great variety of marine life occurs on nearshore reef flats. Benthic algae usually dominate surface coverage on flats. Several forms of reef coral also are common components, particularly near the outer edges of flats.

The number of fish species is generally lower than in other reef areas and the following is a list of fishes which frequent nearshore reef flats.

Scientific Name	Common Name	Hawaiian Name	Feeding Habits
Acanthurus nigrofuscus	surgeonfish	maiko	herbivore
Thalassoma duperreyi	wrasse	hinalea	diurnal predator
Plectroglyphidodon imparipennis	damselfish		diurnal predator
Chromis vanderbilti	damselfish		diurnal planktivore
Thalassoma fuscus	wrasse	awela, hou	diurnal predator
Apogon menesemus	cardinal fish	upapalu	nocturnal predator

A variety of invertebrates also inhabit reef flats. Beneath the reef flat surface are found a myriad of mollusks, echinoderms, polychaetes, sipunculids, other worms, crustaceans and boring algae within the cavernous framework of solid reef, while infaunal mollusks and annelid worms live buried in sand deposits.

The growth and maintenance of reef flats is in uneasy balance between biologically constructive forces (carbonate secreting organisms) and physically destructive forces (scour, wave action and currents). Organisms occupying shallow reef flats normally cannot tolerate the extreme conditions associated with tidal, salinity, wave and temperature

fluctuations occur at the sea surface and, as a consequence, few reef flats grow to sea level and emerge at low tide. Thus growth of the reef and extension of the reef flat occurs primarily in a horizontal direction, away from the shore, once the upward limit of growth is attained. The water depth or level of a reef flat in any particular location depends partially upon the severity of growth-inhibiting factors. For example, flats on the windward sides of islands subjected to heavy wave action, freshwater runoff and natural sedimentation are unlikely to grow as vigorously because reef-building organisms may find these environments suboptimal. Conversely, reef flats may grow at very shallow water depths where conditions are more favorable. The activities of man onshore may upset the balance of the constructive and destructive forces changing the composition and structure of reef flat habitats; sedimentation from soil erosion, excessive flooding, sewage discharge and thermal pollution have been identified as adverse impacts.

Nearshore reef flats are common on Kauai's northeast coast and also present on the south and southeast coasts. Oahu's shorelines harbor extensive fringing reef flats along the windward (NE) and southern coasts with scattered apron reef flats along the north shore. Prehistoric uplifted reefs also form much of the existing land along the southern Honolulu plain and Kahuku. Virtually, the entire south coast of Molokai is fringed by a wide, deteriorating reef, perhaps the best developed among the high islands of the state and a small apron reef is located on the leeward (W) side of Kalaupapa peninsula. A wide and well developed fringing reef is found along the entire northeast coast of Lanai. In contrast, Maui has only a few apron reef flats which

are confined to Lahaina, Kahului, Kihei and Makena regions. Only a single small apron reef is reported from the island of Hawaii near Kawaihae-Puako. The lack of reefs and reef flats on Maui and Hawaii may be attributed to the geological instability and young age of the islands.

Nearshore reef flats serve many important functions and uses including: habitat for many subsistence and recreational fishery resources (including octopus, shellfish, lobster, crabs, limu and finfish); ideal conditions for surfing and boating; natural breakwaters protecting life and property from storm waves and tsunamis; sources of sand to replenish all white sand beaches; ideal swimming, diving and snorkeling conditions; aesthetics; and opportunities for scientific and medicinal research. Nearshore reef flats are also subjected to a number of consumptive uses including: mining for sand and aggregate materials for the construction industry; the sites for harbor basins and channels; the collection or harvesting of fishes, corals and shells for consumptive and commercial purposes and receiving waters for waste water discharge.

OFFSHORE REEF FLATS. Offshore reef flats are shallow submerged platforms, or shoals, of reef carbonate occurring at water depths of 0 to 3 m and separated from the shoreline of high islands by wide deep lagoons or ocean expanses (see Figures 2.2 through 2.10 for maps depicting offshore reef flat areas). Coralline algae, scoured reef rock, and live encrusting corals predominate on the outer or seaward facing sections of offshore reef flats; while sand and gravel deposits, scattered microatolls (pancake shaped corals), mollusk communities and

OFFSHORE REEF FLATS

extensive patches of benthic algae are conspicuous on the inner and usually shallower portions of these flats. Sand keys and low coral islands may be found on some offshore flats.

Normally, heavy wave action on the seaward side of the reef flat drives uni-directional water currents across the reef, contributing much to the biological and geological zonation characterizing offshore reef flats.

The presence of heavier wave action, water of more oceanic character and the absence of terrigenous influences (i.e., sediment, rainfall, runoff) from high islands distinguish the offshore reef flats from nearshore flats for water quality management purposes.

In Hawaii, there are three types of offshore reef flats -- patch, barrier and atoll reef flats. Although quite different from one another structurally, they all share the common significant factor of being separated from populous and stressed high island marine environments. As a consequence, the offshore reef flats are subjected to fewer perturbations by man.

Patch reefs are reported only from the lagoon of Kaneohe Bay, Oahu, among the high islands of the Hawaiian chain but are common within the lagoons of some of the atolls at the northwest end of the archipelago. The Kaneohe patch reefs structurally consist of the remains of reef corals, principally finger coral. They assume the shape of truncated cones with the shallow reef flats exhibiting a circular outline. The reefs are up to 20 m in height and 1000 m wide, although they are usually of smaller dimensions. The tops of the reef flats are covered with gravel and sand deposits, calcareous algae, and isolated scattered

coral heads. Live coral coverage becomes more predominant along outer edges of the reef flats; fingercoral, tree coral, plate coral and mushroom coral are most conspicuous.

A tremendous variety of reef fish inhabit patch reef flats, particularly near the outer edge. The work of Gerald Key (1973) identifies common fish species of Kaneohe Bay. The most common species observed in patch reef areas, in decreasing order of sighting were:

Scientific Name	Common Name	Hawaiian Name	Feeding Habits
Scarus spp.	parrotfish	uhu	diurnal herbivore
Pranesus insularum	silverside	iao	nocturnal planktivore
Thallasoma dupperreyi	saddleback wrasse	hinalea	diurnal predator
Dascyllus albisella	damselfish		diurnal planktivore
Zebrasoma flavescens	yellow tang	pala	herbivore
Gomphosus varius	bird wrasse		diurnal predator
Chaetodon miliaris	lemon butterfly fish		diurnal planktivore
Stegastes fasciolatus	damselfish		diurnal omnivore
Ctenochaetus strigosus	surgeonfish	kole	herbivore
Labroides phthirophagus	cleaner wrasse		cleans ecto-parasites
Stethojulis balteata	wrasse		diurnal predator
Abudefduf abdominalis	damselfish	maomao	diurnal planktivore

Larval fish species found in the lee of Kaneohe Bay reefs are those with demersal eggs, usually attached to hard substrate. Species whose larvae are taken from tidal channels between reefs typically have pelagic eggs - the adults also being found primarily in open ocean pelagic environments.

The second type of offshore reef flat is the barrier reef and the only example from the Hawaiian Islands occurs offshore from Kaneohe Bay. The reef is large, measuring 2 km by 5 km and is 2 km from the shoreline of Oahu. Large sand channels are found at each end of the reef. The reef is structurally complex and is composed of lithified dune rock, beach rock, reef rock and thick sand deposits. The ocean edge exhibits greater abundance of reef-building organisms and the zone of maximum wave exposure is heavily scoured. Unique sand mollusk communities and sea cucumber populations are found near the lagoon edge.

The most commonly observed fishes in the Kaneohe barrier reef area, in decreasing order of sighting were:

Scientific Name	Common Name	Hawaiian Name	Feeding Habits
Scarus spp.	parrotfish	uhu	diurnal herbivore
Acanthurus triostegus	convict tang	manini	diurnal herbivore
Stethojulis balteata	wrasse		diurnal predator
Mulloidichthys flavolineatus	goatfish	weke	predator on sand-dwelling inverts.
Thallosoma duperreyi	saddleback wrasse	hinalea	diurnal predator
Dascyllus albisella	damselfish		diurnal planktivore
Abudefduf abdominalis	damselfish	maomao	diurnal planktivore
Parupeneus porphyreus	goatfish	kumu	diurnal predator

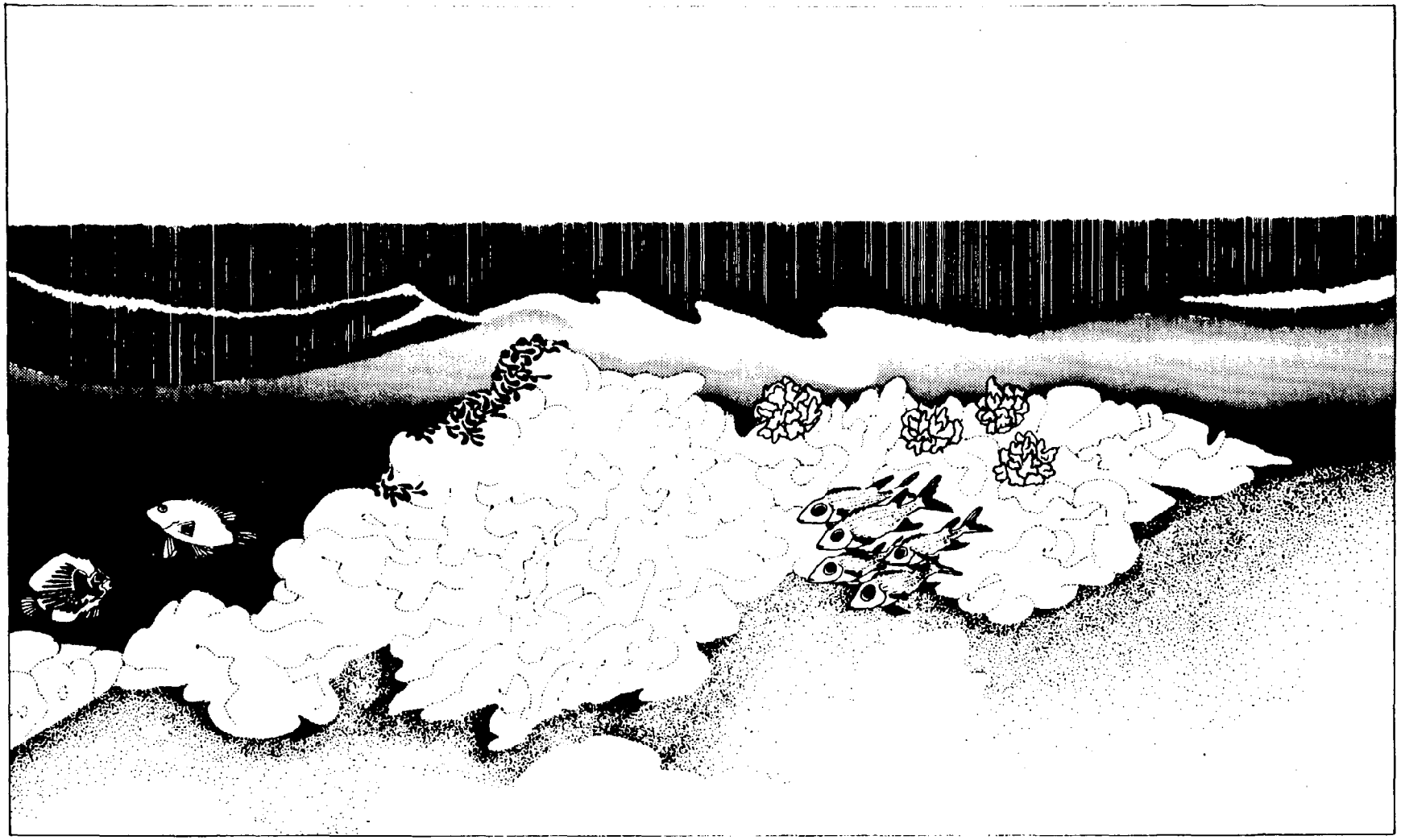
Atoll reefs represent the third type of offshore reef flats and are confined to the northwest end of the Hawaiian island chain, well removed from population centers. Only Midway, Kure and Pearl and Hermes Reef have been studied and information about Hawaiian atoll reefs in general is sketchy. Typically, atoll reefs are raised "rings" which partially or wholly enclose a lagoon of 3 m or more in depth. Shallow to deep sand channels and rocky passes bisect the reef rim and coral islands may be situated atop the reef flats, formed during tropical storms when large waves cast reef debris onto the flats. Little is known of the biological composition of Hawaiian atoll reef flats. Atoll reefs represent the most advanced stage of reef development and it is generally thought that most atoll reefs have evolved from earlier fringing and barrier reef stages.

Generally, offshore reef flats are important habitats for migratory birds and sea birds, some of which are rare and are feeding and nesting

grounds for sea turtles including some which are proposed threatened species. Offshore reefs are valuable to man in providing education, recreation and scientific research opportunities. Consumptive uses also include establishing island installations for navigation and weather facilities and commercial fishing operations.

WAVE EXPOSED REEF COMMUNITIES. Wave exposed reef communities are the most extensive shallow marine habitats in Hawaii and are subjected to heavy or continuous coastal wave action. These communities begin beyond the shoreline, if shallow reef flats are absent or beyond the outer edge of nearshore or offshore reef flats. The communities span depths of 0 to 40 m and overlie irregular solid substrata, the latter sometimes sloping gradually to deeper water often with several ledges and terraces. The hard substratum is composed of basalt or carbonate rock but sand channels and depressions are also conspicuous features.

Wave exposed reef communities can be separated into shallower (0 to 10m) and deeper zones (10 to 40 m) on the basis of biological differences and changes in the intensity of controlling forces such as wave action, surge, light penetration, sediment transport and other factors. The severity of the wave action usually dictates the degree of community development. Where wave action is low, coral and algal cover is higher and the communities flourish, sometimes approaching protected coral communities in ecological complexity. Where wave action is excessive, scour, mechanical stress and shifting sand inhibit biological development and the habitat appears generally barren but with extensive crustose coralline algal growth.



WAVE-EXPOSED REEF COMMUNITIES

The substratum of the shallow zone is dominated by coralline algae, turf algae and filamentous algae of many varieties. The coralline forms cement rock fragments together to maintain the rigid substratum, while the other algae serve as food for many invertebrates and fishes.

Reef corals are invariably present and are most important in maintaining relief and habitat for the community and contributing to the accretion of the substratum but corals are not the dominant bottom organisms in terms of surface coverage. The rose coral and encrustations or small heads of the coral *Porites lobata* collectively account for more live coral cover than all other coral species combined. Other conspicuous invertebrates include the sea urchins and the sea cucumbers. A variety of mollusks also occupy shallower areas in the habitat.

Fish species on the shallow reef include:

Scientific Name	Common Name	Hawaiian Name	Feeding Habits
Chromis vanderbilti	damselfish		diurnal planktivore
Ctenochaetus strigosus	surgeonfish	kole	herbivore
Zebrasoma flavescens	yellow tang	pala	herbivore
Acanthurus leucopareius	surgeonfish	maikoiko	herbivore
Acanthurus nigrofuscus	surgeonfish	maiko	herbivore

The deep zone is also dominated by benthic algae, but sand deposits and channels may be more conspicuous and coral coverage slightly higher. Common invertebrates include the green sea star, the crown-of-thorns starfish, the wana or black sea urchin, the heart urchin and the sea cucumber. Fish species include:

Scientific Name	Common Name	Hawaiian Name	Feeding Habits
Naso hexacanthus	surgeonfish	opelu kala	diurnal planktivore
Chromis leucurus	damselfish		diurnal planktivore
Xanthichthys auromarginatus	triggerfish		diurnal planktivore
Thalassoma duperreyi	wrasse	hinalea	diurnal predator
Zebrasoma flavescens	yellow tang	pala	herbivore

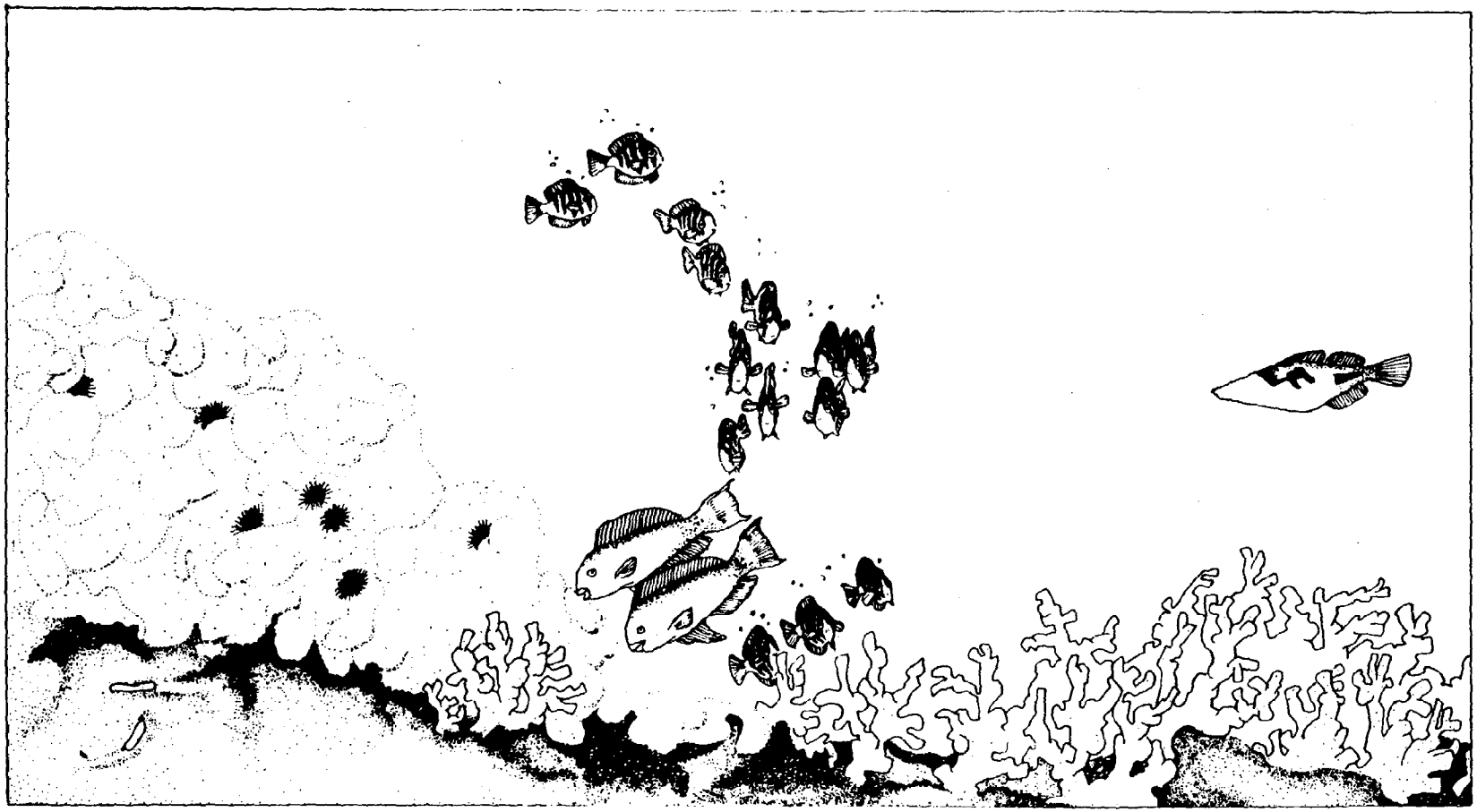
The wave exposed reef community habitat represents the zone where much of the active growth of shallow reefs is supposed to be taking place, counteracting the destructive forces of wave action and abrasion. However, some scientists do not believe that Hawaiian reefs in wave exposed environments are growing or even maintaining equilibrium. It is difficult to believe that many of the wide fringing reefs, particularly along windward coasts, could be growing under present conditions, as evidenced by the lack of development of the reef communities reported on many outer reef slopes. Present rigorous climatic conditions and perhaps water quality degradation may explain the apparent eroding or poor condition of some reef communities. There is, however, no question that the survival and growth of wave exposed reef communities is in uncertain balance with destructive natural forces. Additional disruptive environmental impacts, whether man induced or natural, can easily shift the dynamics of the systems to a more adverse posture.

Studies of the growth of reefs on submarine lava flows which have entered the ocean off the coast of the island of Hawaii during known historical times indicate the wave exposed communities may take 15 to 40 years to develop and reach maturity. Thus, it is assumed that damage or destroyed reef habitats would also take a protracted and comparable time to recover if adverse environmental factors are first eliminated. This is all the more reason to manage and protect these resources in a responsible manner.

Wave exposed coral communities are extremely important in offering food and shelter to a variety of recreational and commercial fishery resources. These systems also contribute significantly to replenishment of white sand beaches in the state. High underwater visibility renders these reef habitats excellent for diving, swimming and snorkeling. Many fishes for the aquarium trade are collected here.

The excellent water flushing and current characteristics in many locations where wave exposed reef communities exist provide some opportunities for disposal of moderate or small quantities of treated waste water and other pollutants without significant adverse environmental effects. This is not possible in shallow coastal environments where flushing and circulation conditions are not as favorable.

PROTECTED CORAL COMMUNITIES. Protected coral communities are found at water depths between 0 and 40 m but are best developed at depths of 10 to 30 m along favorable open coast environments or in shallower water in sheltered embayments (see Figures 2.2 through 2.10 for maps of these areas). Along open coasts, these communities are removed from heavy or continuous wave action by being confined to deeper water below



PROTECTED CORAL COMMUNITIES

the wave base (at approximately 10 m depth). They are found particularly along leeward coasts where tradewind wave energy is reduced. Elsewhere, protected coral communities are confined to lagoon environments behind atoll or barrier reefs or within the calm reaches of bays or coves.

The bottom surface is dominated by live coral which covers up to 50% or more of the bottom. Sand channels and patches are also occasionally scattered in depressions or valleys between coral thickets, mounds or platforms. Thick extensive sand deposits usually form the deep offshore boundaries of the habitat.

The sand within this habitat is produced from the breakdown of coral and skeletons of other carbonate secreting organisms. Protected coral communities can perpetuate themselves only where sand production and accumulation does not exceed the capacity of the corals to grow and avoid burial. Moderate to gentle slopes offer ideal conditions for these communities because sand, which is constantly produced, can be transported downslope away from the habitat.

The fingercoral, is usually among the most dominant of the corals in this habitat, particularly in its most protected portions. Fingercoral forms continuous platforms or thickets up to many meters across and provides a micro-habitat for a variety of invertebrates and small fishes. Almost pure stands of fingercoral grow in Kaneohe Bay and deeper ocean slopes off the Kona coast of Hawaii island.

Porites lobata is also a common coral in the community and forms large mounds or pinnacles scattered among the fingercoral. Larger fishes tend to associate with it because of the greater relief and larger shelters it can provide. Almost pure stands of *P. lobata* are found in shallower

waters off Lahaina, Makena (Maui) and the Kona coast of Hawaii, and the coral becomes more common where wave energy increases. Excellent examples of mixed *Porites* communities occur at intermediate depths off the Kona coast and Kahe, Oahu.

Occasionally, a third coral *Montipora verrucosa* becomes common (such as in Kaneohe Bay) or dominant (such as off south Molokai) in protected coral communities and appears to favor waters slightly diluted by freshwater intrusions or runoff from land.

Other common invertebrates include the slate pencil urchins, the heart urchin and mollusks of many varieties including the cowries. The soft coral occasionally is reported growing on dead coral, while filamentous algae, crustose coralline algae, bryozoans and sponges are seen on rocky surfaces.

Protected coral communities also harbor the greatest abundance and diversity of reef fishes including:

Scientific Name	Common Name	Hawaiian Name	Feeding Habits
Ctenochaetus strigosus	surgeonfish	kole	herbivore
Chromis leucurus	damselfish		diurnal planktivore
Zebrasoma flavescens	yellow tang	pala	herbivore
Stegastes fasciolatus	wrasse	hinalea	diurnal predator
Chaetodon multicinctus	pebbled butterfly	kikakapu	diurnal predator
Acanthurus nigroris	surgeonfish	maiko	herbivore
Myripristis argyromus	menpachi	u'u	nocturnal predator

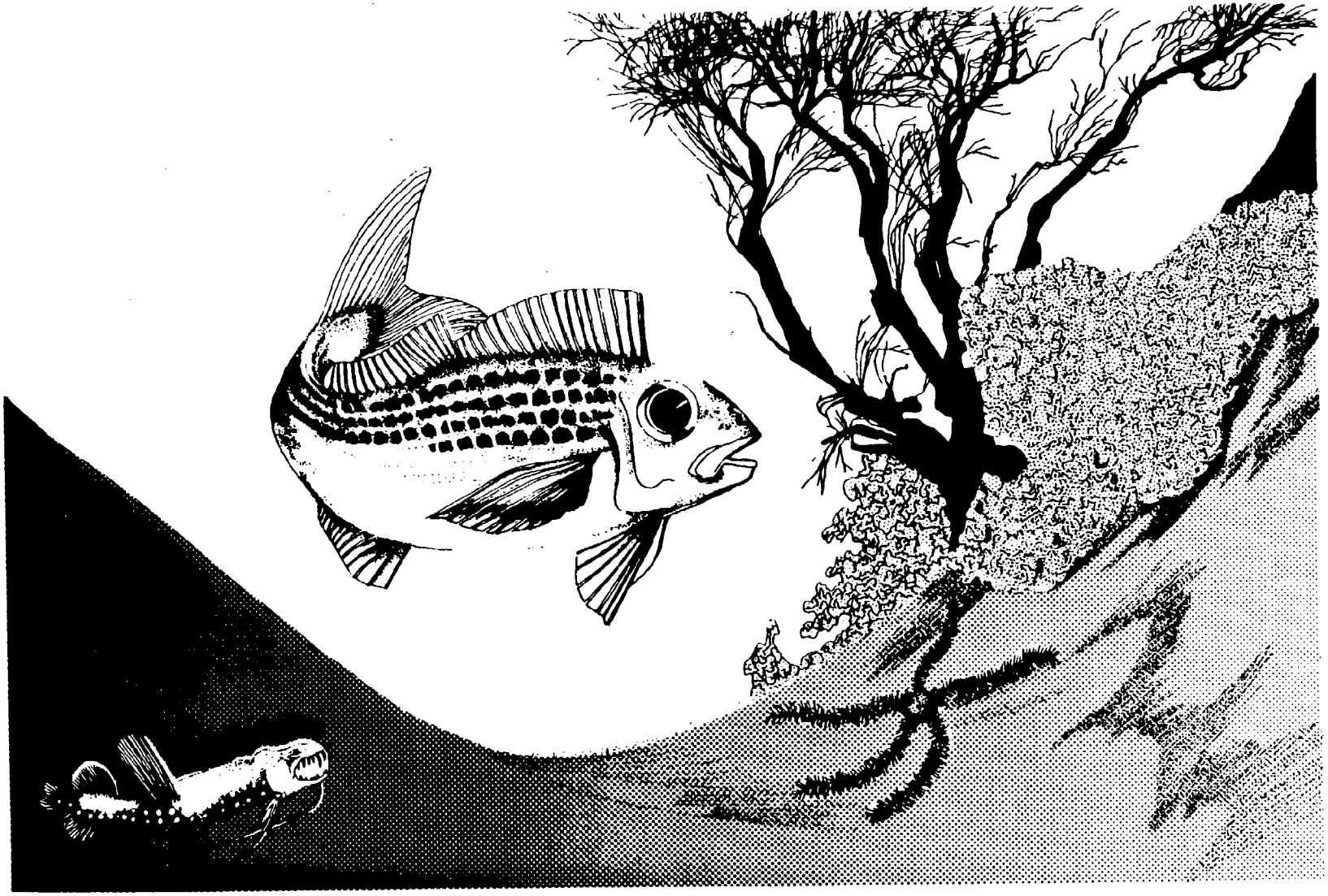
The best developed coral communities are normally associated with the clearest of ocean waters with underwater visibility approaching 50 m or more and are extremely sensitive to waste water discharges, sedimentation and severe freshwater flooding.

Where these communities occur in shallow water, they commonly form the actively growing faces of flourishing reefs, such as reported in northern Kaneohe Bay and off some of the southern coast of Molokai. The communities require 30 or more years to reach maturity based upon coral colonization studies on lava flows off Hawaii island.

Aside from areas already mentioned, protected coral communities are also found along the entire Kona coast of Hawaii; Honolua, Fleming, Ahihi, Puu Olae, Maalaea and La Perouse Bay on Maui; Molokini Island; Manele Bay on Lanai and Kahana, Waikiki and Hanauma Bay on Oahu. Information is sketchy for the islands of Niihau, Kauai, Kahoolawe and most of Lanai.

Protected coral communities offer the best recreational diving sites in Hawaii, where aesthetics, fish, shells, underwater photography and scientific research are avidly pursued. However, they are much less commonly distributed than wave exposed reef communities and require greater protection and more comprehensive management.

DEEP BENTHOS. The deep benthos refers to a relatively poorly described but extensive area below approximately 100 meters. The Hawaiian islands lack a true transitional shelf and great depths are reached at relatively short distances from the shoreline. At these depths, coral reef communities are no longer capable of flourishing, water movement is greatly reduced and the deeper forms of animal life begin to appear.



DEEP BENTHOS

Much information on the deep benthic biota is confined to commercial or recreational species. Precious corals such as black coral, gold coral and pink coral are found here. These precious corals, a variety of non-reef building corals and the bivalve *Pinna* feed on falling detrital material. Crustacea, such as the Kona crab, adult haole crabs, and the shrimps *Penaeus marginatus* and *Heterocarpus ensifer*, and demersal fish species, including the grouper *(Hapuupuu)*, the pink snapper *(opakapaka)*, the red snapper *(onaga)*, and the amberjack *(kahala)*, are commercially fished.

Figure 2.2

Key to Maps of

Shoreline and Offshore Physical Characteristics

SHORELINE PHYSICAL CHARACTERISTICS

Sand

Lava Rock

Artificial Structures

OFFSHORE PHYSICAL CHARACTERISTICS

Protected Coral Communities

Nearshore Reef Flat

Offshore Reef Flat

Tide Pools

Solution Benches

Wave Exposed Reef Communities

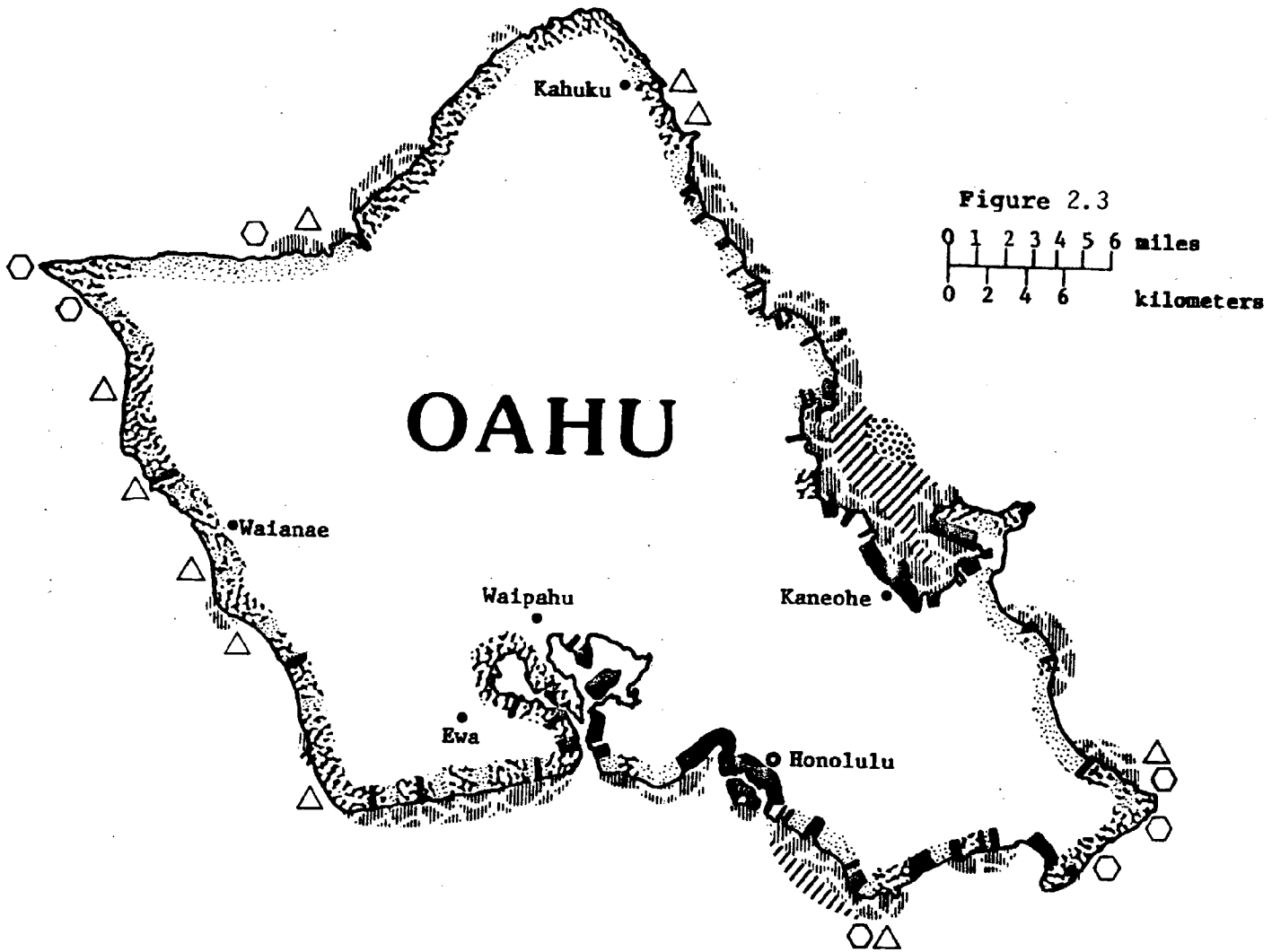

Kahuku
OAHU
Waianae
Waipahu
Kaneohe
Ewa
Honolulu
0 1 2 3 4 5 6 miles
0 2 4 6 kilometers

Figure 2.3

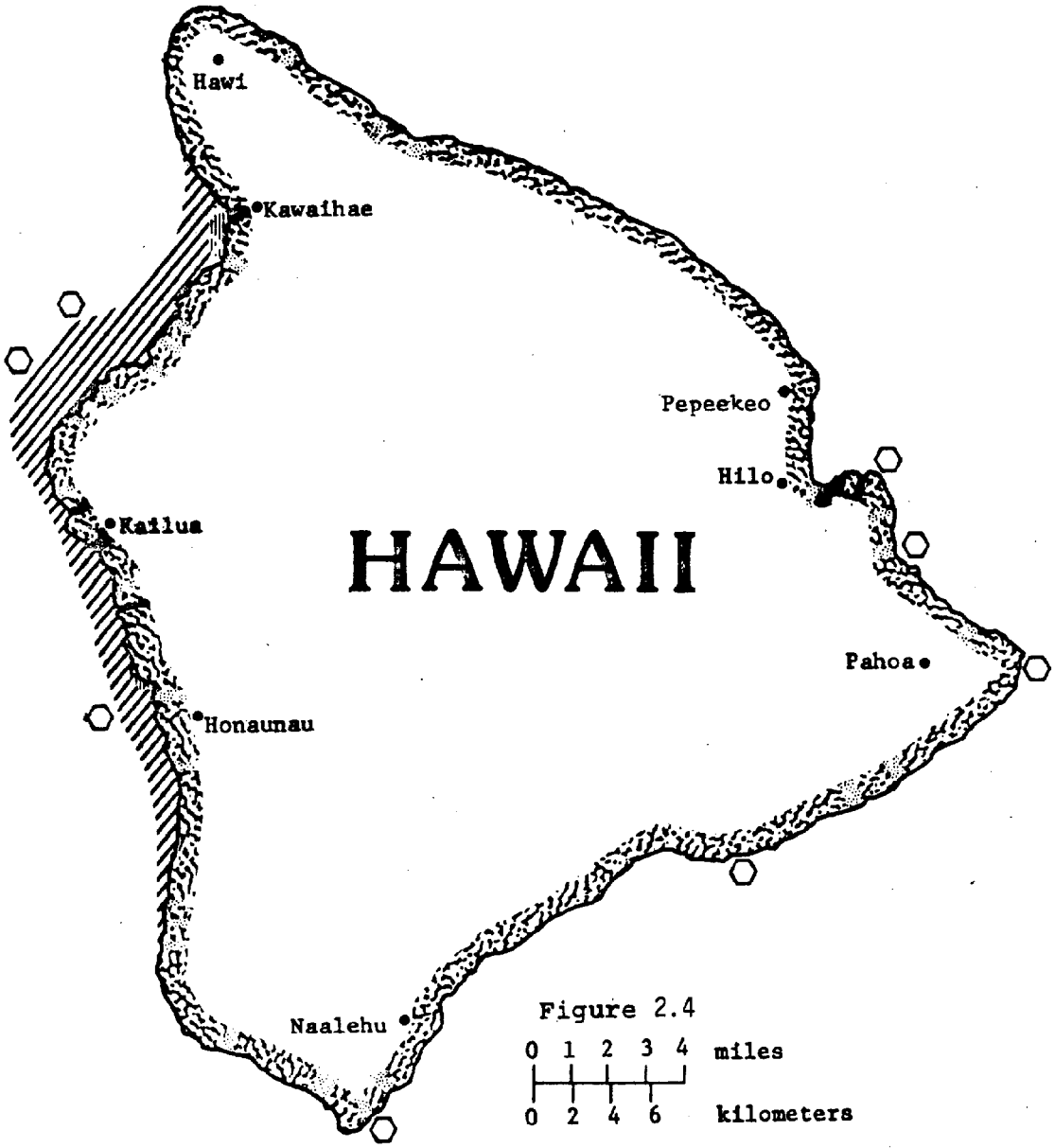

Hawi
Kawaihae
Pepeekeo
Hilo
Kailua
HAWAII
Pahoa
Honaunau
Naalehu
0 1 2 3 4 miles
0 2 4 6 kilometers

Figure 2.4

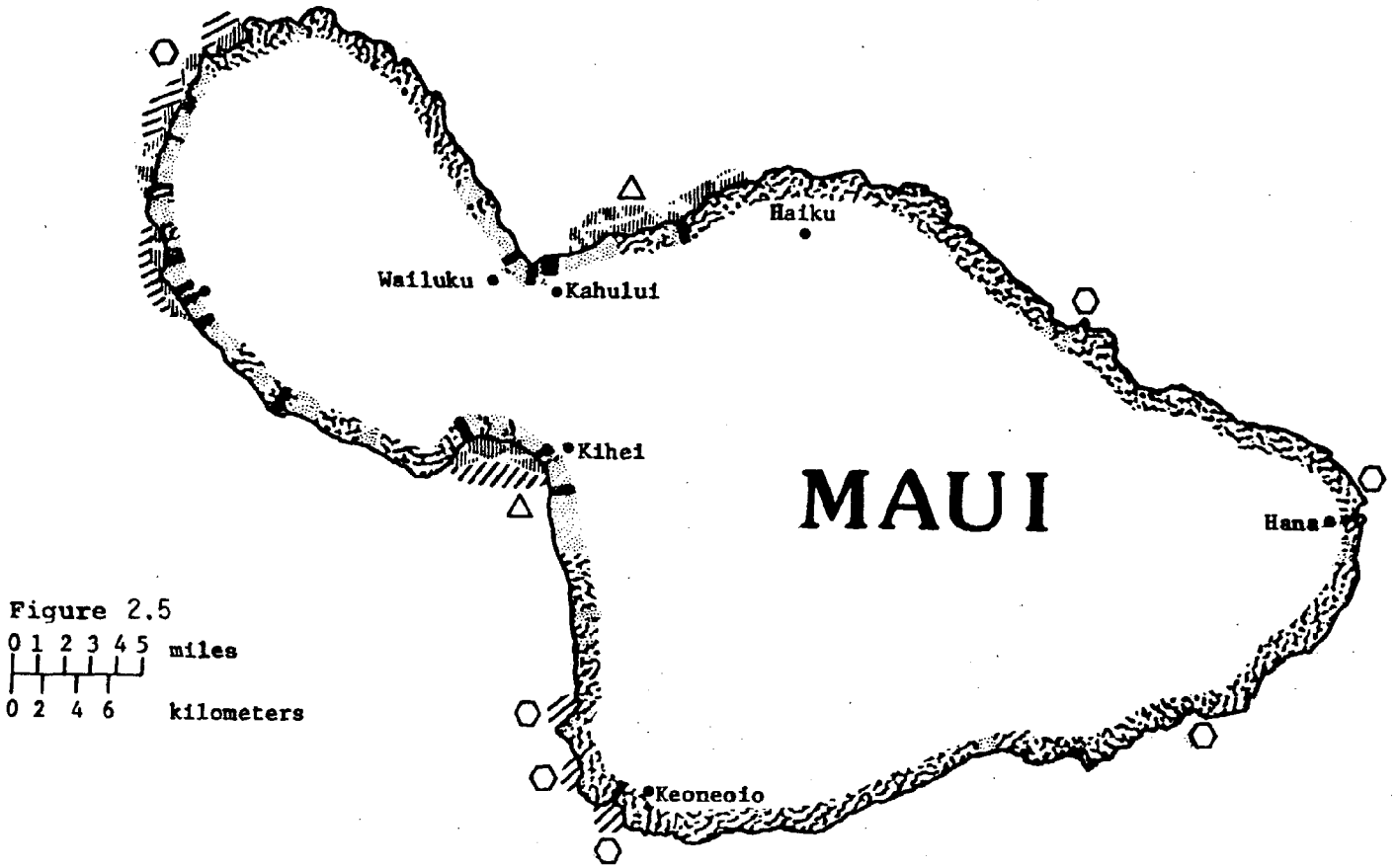

Haiku
Wailuku
Kahului
Kihei
MAUI
Hana
Keoneoio
0 1 2 3 4 5 miles
0 2 4 6 kilometers

Figure 2.5

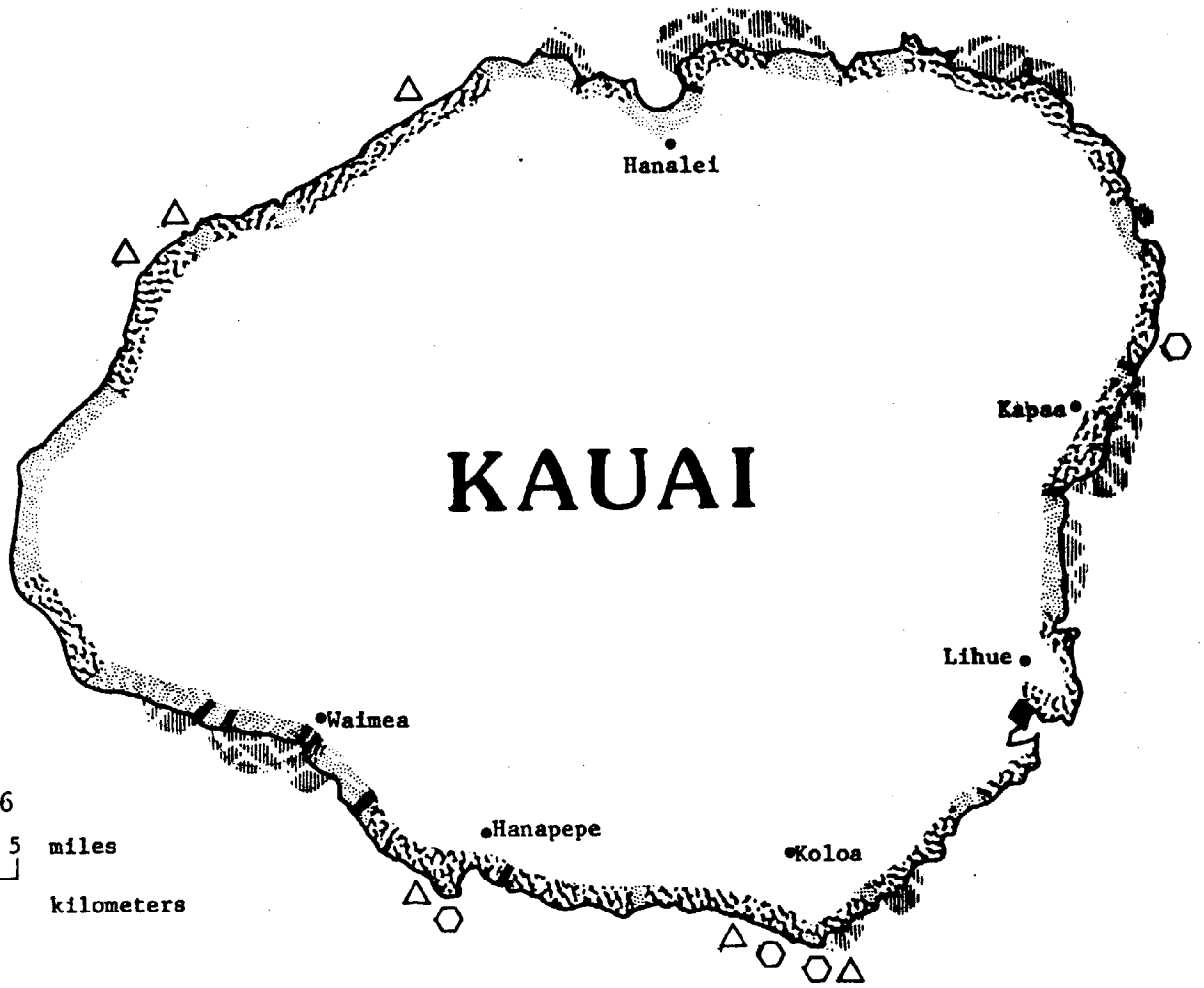

KAUAI
Hanalei
Kapaa
Lihue
Waimea
Hanapepe
Koloa
0 1 2 3 4 5 miles
0 2 4 6 kilometers

Figure 2.6

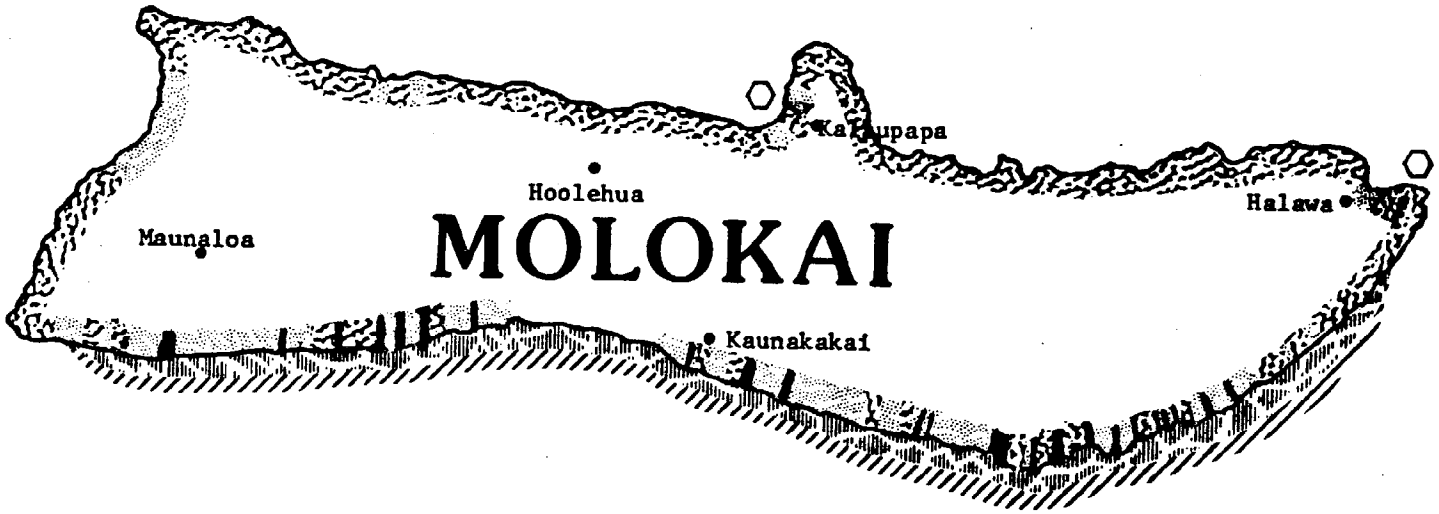

Hoolehua
MOLOKAI
Maunaloa
Halawa
Kaunakakai
0 1 2 3 4 5 miles
0 2 4 6 kilometers

Figure 2.7

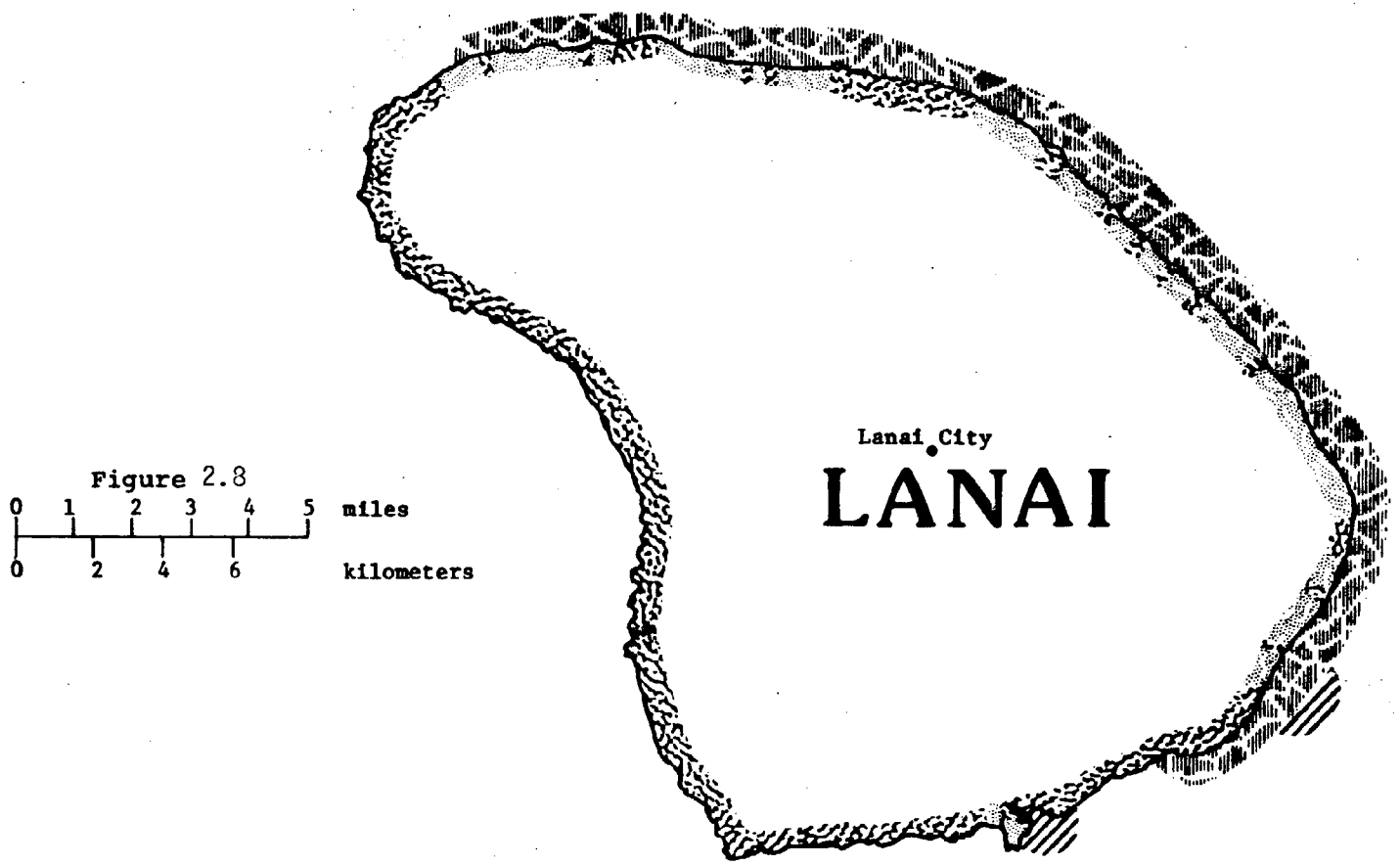
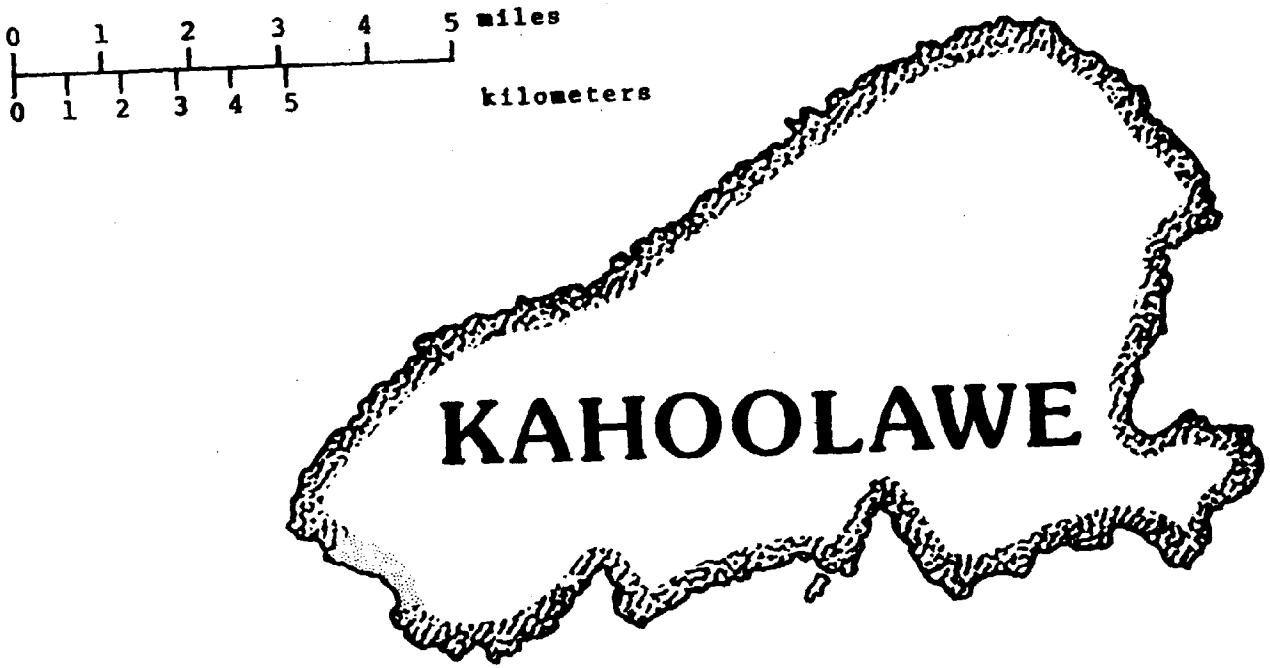


Figure 2.8

Figure 2.9



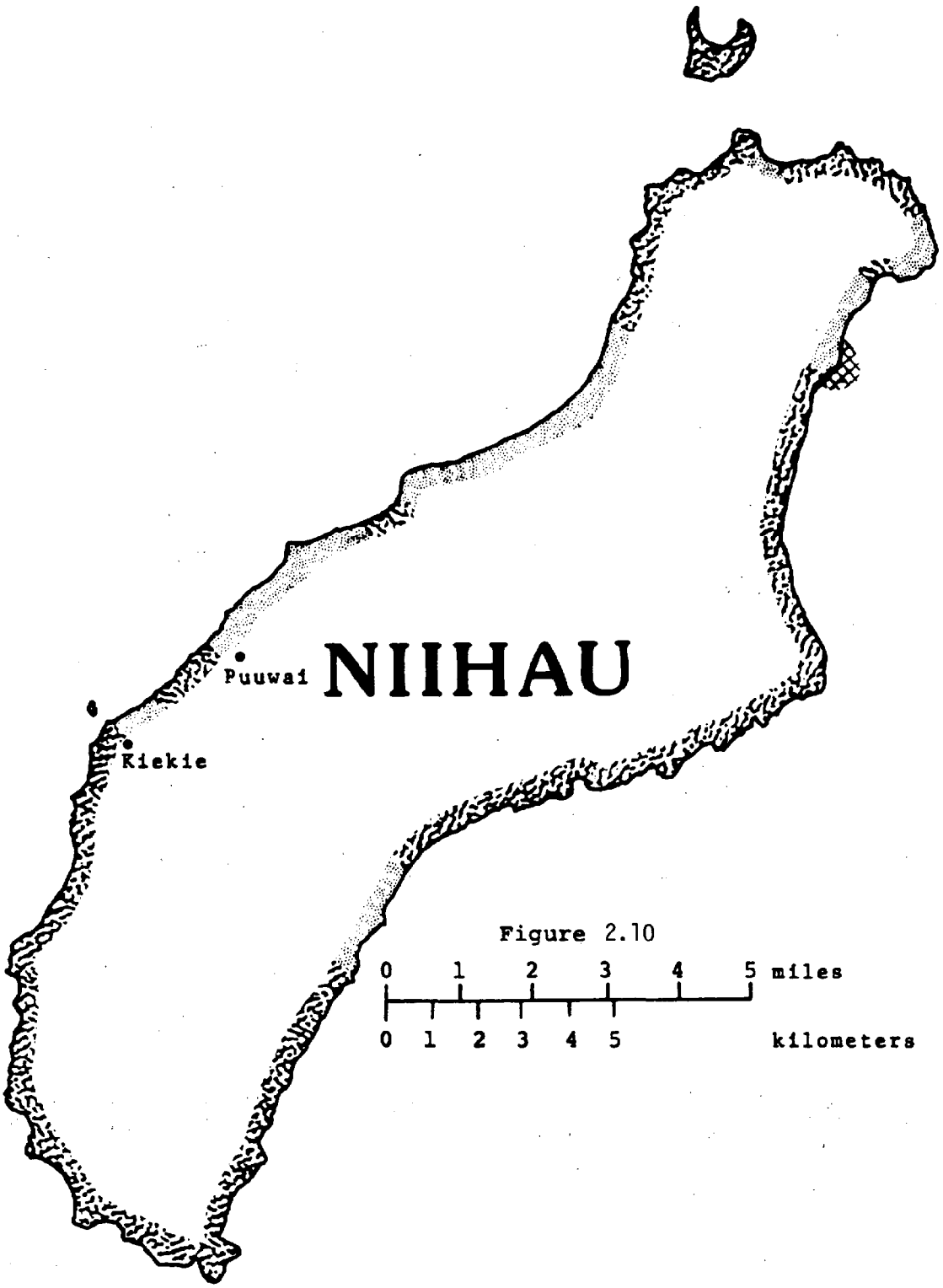


Figure 2.10

III

COMPETING USER GROUPS

CHAPTER III

COMPETING USER GROUPS

One of the more difficult problems with which fisheries managers will have to contend is the problem of meeting the needs of competing users of the fishery. Competing users can be fishermen, who fish for different types of fish as well as for different purposes (Table 3.1) Harvest by one type of fisherman may directly or indirectly affect the harvest by other types of fishermen. In a complex fishery consisting of many fishermen types, who have a variety of motives in fishing, unique management decisions must be employed.

COMMERCIAL FISHERMEN

There are approximately 2,500 commercial fishermen presently licensed with the State Division of Fish and Game. Only licensed commercial fishermen are legally allowed to sell their catch. There are untold numbers of others who sell without purchasing the $10.00 license.

The commercial fishermen of Hawaii can be characterized based on their fishing license applications. Most of the commercial fishermen (69%) filling out the forms consider themselves boat captains. Very few call themselves shore fishermen (7%). For FY 1978-79, 2,447 commercial fishermen registered with the State of Hawaii Fish and Game Division. This is down from the previous years total of 2,574 but higher than any other year since 1952 (Fig. 3.1).

Table 3.1 -- Competing User Groups

Type of Fishing	Purpose	End Result
Commercial *	livelihood	$$$$$
Traditional **	subsistence, self-sufficiency (techniques and gear have remained virtually unchanged	food, a way of life
Recreational **	diversion/amusement	mostly fun, being outdoors, catch a fish
Charter **	to catch a big fish (many tourists)	a photograph, catch a large fish

* must obtain a fishing license

** an unknown quantity of fishermen in this group purchase commercial fishing licenses

LICENSED COMMERCIAL FISHERMEN IN THE STATE OF HAWAII

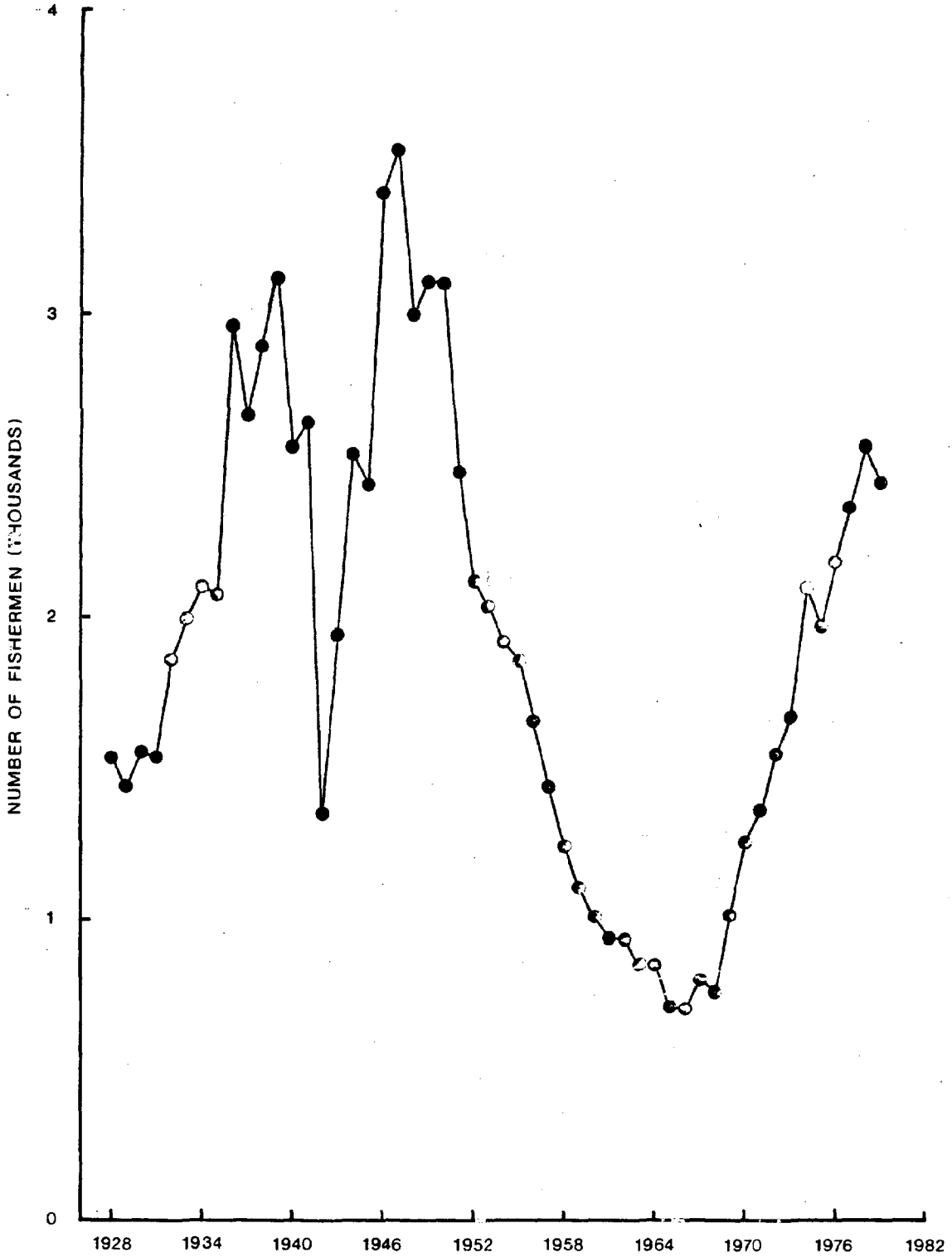


Figure 3.1

According to these license forms the median age of our commercial fishermen is 40 years old. Most of them have lived in Hawaii most of their lives. Eighty-four percent have lived here all their lives. Non-citizens account for only 4% of the data. Approximately 5% of our commercial fishermen (fishers) are female.

Table 3.2 depicts the types of preferred commercial fishing activities separated by island. The patterns of commercial fishing for each of the islands are relatively consistent. In 1978, over $12 million worth (13 million pounds) of fish were reported sold in the State of Hawaii (Fig. 3.2). However, most will agree that as much as 2 to 3 times that reported amount were actually sold. Although over 100 species are sold, the top dollar value fishes, *aku* (skip jack tuna), *ahi* (yellow-fin tuna), *ono* (wahoo), *akule* (big-eyed scad), *opelu* (mackerel scad), and *opakapaka* (pink snapper) make up 80% of the catch.

CHARTER SPORT FISHERMEN

Because of the steepness with which the bottom drops off to great oceanic depths (Fig. 3.3), sport fishermen can readily reach the highly oceanic and migratory fish species, such as marlin and tuna. Trolling for these and other pelagic migratory species results in world famous trophy fishing and year-round charter boat operations. These boats fish over waters between one and two thousand fathoms deep for *a'u* (blue, black and striped marlin), *ahi* (yellow-fin tuna), *mahimahi* (dolphin fish), and *ono* (wahoo).

Table 3.2--Licensed Commercial Fishermen by Island and Gear Type[1]

Type of Fishing	Oahu	Hawaii	Maui	Kauai	Molokai	Lanai
aquarium	83	21	1	1		1
fish pond	2	1	1			
hand	3	22	15	6	8	2
handline	510	547	139	139	26	13
longline	65	30	4	4	2	1
pole & line	140	28	22	6	1	
net						
gill	153	8	9	27	26	5
throw	4	15	5	5		6
purse	5	1	1	3		
surround	33	5	4	4		
hukilau			1			
cross		9				
fence	5					
ʻaʻ	21	1				
akule	27	1	3		1	
opelu		15	5		2	
crab	7	10	6	5		
lobster		1	2			
unspecified	14	21	14	6	2	2
Total net	269	87	50	50	68	13
trap	88	9	4	3	4	1
trolling	510	458	77	159	28	15
other						
diving	69	2	10	12	1	
spearing	16	4	2			1
squiding			1	1	1	
coral	19		1	3		
shoreline	2	1	4	1		
bottom	5	10	8			

[1] Hawaii Fish and Game Data, FY 1978-79. These numbers represent gear preferences not actual numbers of fishermen. Total number of licensed commercial fishermen = 2,447.

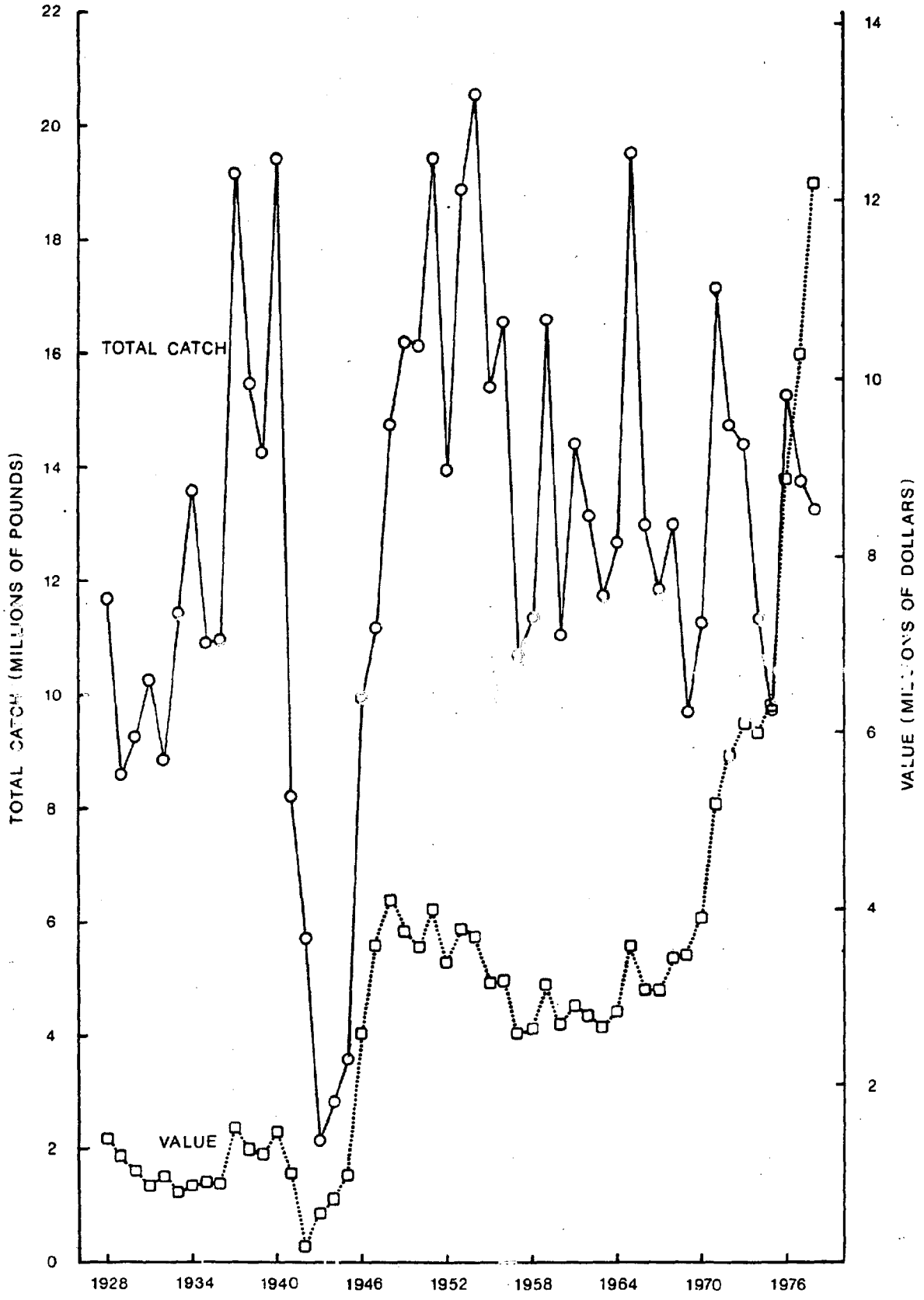

TOTAL CATCH
VALUE
TOTAL CATCH (MILLIONS OF POUNDS)
VALUE (MILLIONS OF DOLLARS)
0
2
4
6
8
10
12
14
16
18
20
22
2
4
6
8
10
12
14
1928
1934
1940
1946
1952
1958
1964
1970
1976

Figure 3.2

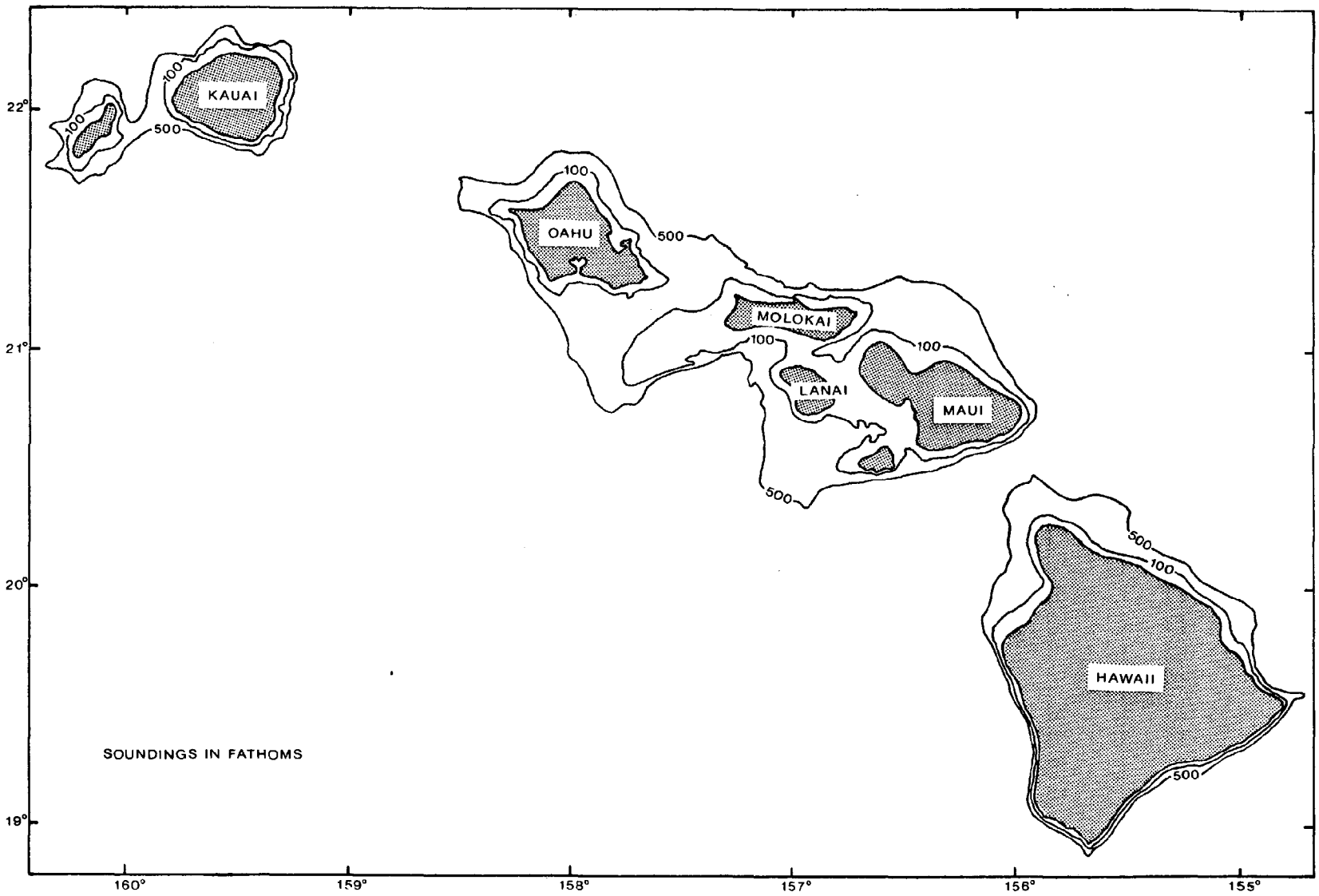

KAUAI
100
100
500
OAHU
100
500
MOLOKAI
100
LANAI
100
MAUI
500
500
100
HAWAII
500
SOUNDINGS IN FATHOMS
22°
21°
20°
19°
160°
159°
158°
157°
156°
155°

Figure 3.3

The charter sportfishing fleet consists of close to 200 vessels, most of which are moored on the Kona coast of the Big Island and at Kewalo Basin and Pier 7 on Oahu. Others are moored at Lahaina and Maalaea on Maui, Pokai Bay and Haleiwa on Oahu and Nawiliwili Harbor on Kauai. When charter business is slow, some charter boats switch to the deepsea handline fishery for various species of bottomfish. Unlike California, marlin catches may be legally sold commercially in Hawaii. It is estimated that 74% of the charter boat catches are sold on the market and that over one million pounds of pelagic fish are caught annually by our charter fishing fleet. Charter boat customers in Hawaii spent an estimated $2.5 million in charter fees during 1977. The number of charter boat customers is related to the tourist activity in Hawaii. It is not yet known whether charter boat fishing is an important ~~factor~~ in drawing charter boat customers to the State.

SUBSISTENCE FISHERMEN

Although the challenge and excitement of trophy fishing draws many to the Hawaiian offshore fishing grounds, most of the recreational/subsistence fishing in the State has been directed toward the variety of smaller tropical fishes inhabiting inshore reefs and rocky, sandy shores. Many of the preferred eating fishes are not necessarily the larger ones. The people of Hawaii have a variety of other criteria by which to judge their fishes, not the least of which are strong traditions associated with catching and preparing them.

Traditional or subsistence fishing is ingrained in the very fabric of the Hawaiian lifestyle. The techniques and gear have remained virtually the same except for the use of monofilament line. Fishing has become an art form as well as a way to feed the family. This artisanal fishing is a way of life. Unfortunately, descriptive and quantitative information about this group is limited since most of these fishermen are neither licensed nor required to report information concerning their fishing activities. Many of the subsistence fishermen are reluctant to discuss their activities and object to programs which might in any way hinder their traditional fishing lifestyle.

RECREATIONAL FISHERMEN

The last major competing fisheries participant is the recreational fisherman. This is a poorly studied, but substantial group of people. It is estimated that there are 93,000 recreational fishermen as well as 20,000 scuba divers (Sea Grant, Marine Advisory Program). They enjoy the beautiful climate of Hawaii by participating in water related activities including fishing. Their major interest is in having fun, being outdoors, and; if possible, to catch or spear a fish. They spend substantial sums of money, are growing significantly in numbers, and should be considered a major contender in the fisheries arena.

Shoreline fishing is apparently the most common recreational fishing activity. It is estimated that 68% of all sports fishermen claim to be shoreline fishermen. The gear type most commonly used is pole and line. A variety of nets are also used by shoreline

fishermen as well as diving gear. Divers set gill nets and use spears to collect *tako, menpachi, manini, kumu, uhu,* etc. and fine mesh hand nets (permit required) to collect aquarium fish. Lobsters must be taken by hand or net only, although flagrant violations of the law occur.

Many boating recreational fishermen help comprise the "mosquito fleet" which actually is a combination of recreational, subsistence, and commercial activities. Their appearance on the water as tiny dots in large numbers helped create the term mosquito fleet. Many of them fish for recreational/subsistence reasons but sell a portion of their catch to help defray the costs of their activities. Consequently, many hold a commercial fishing license.

Much of the confusion could be eliminated by improved licensing procedures which more clearly identify the user groups. A substantial increase in commercial license fees would likely separate the full-time commercial fisherman from the part-time commercial/recreational fisherman. Other criteria for identifying the true commercial fisherman could be that used by DPED in their rules and regulations for vessel loan applications. According to their criteria, a commercial fisherman must earn 51% of his income from commercial fishing activities.

The recreational aspects, however clearly dominate the small boat fishermen. Trolling is the primary gear type used. The species caught are similar to the charter boat catches, but with fewer billfish. The number of fishermen identifying trolling as a primary gear

type has increased more rapidly than any other gear type (Table 3.3). This suggests a substantial increase in the part-time recreational/ mosquito fleet component. Very few of these fishermen would characterize themselves as full-time commercial fishermen, although they hold licenses. Sales of these fish are made primarily to independent fish dealers, small retail outlets and restaurants. Since most of these boats are trailered, boat ramp usage has become more heavily burdened.

A few examples of conflict (real or imagined) between competing user groups have begun to surface and may be expected to increase with time. The most successful nearshore fishery may well be the aquarium fish industry which collects reef fish for sale. This is a primarily commercial fishery whose activities since 1973 have been reported to the State Division of Fish and Game. Growing concern is being voiced over the numbers of fish being collected by this user group. Glass bottom tour boats require large quantities of reef fish near shore for viewing purposes. Aquarium fishing in the State is predominantly confined to Oahu and Hawaii. Over 300,000 aquarium fish were caught in a three year period primarily in a few concentrated areas around Oahu and Hawaii. The average catch per unit of effort on a statewide basis is 8.5 fish caught per manhour of effort. It has been feared by a number of groups that the commercial aquarium fishery is applying significant enough pressure in a few selected areas, in addition to pressures normally exerted by recreational fishing, to cause damage to those biological communities.

Table 3.3--- Preferred Commercial Fishing Activities

TYPE OF GEAR		NUMBER OF FISHERMEN PARTICIPATING*	
		1977	1979
Pole and line		223	197
flagline (longline)		111	106
handline		1143	1374
trolling/charter		832	1247
trap		81	109
hand		79	56
spear		13	23
diving		60	64
coral		15	23
ponds		2	4
aquarium		123	107
nets	opelu	26	22
	gill and lay	210	228
	throw	31	35
	akule (bag)	17	32
	TOTAL NETS	284	317

* Totals do not reflect numbers of actual fishermen but the number of times a fisherman checked this gear type. Fishermen frequently check several gear types.

Other studies have suggested that habitat destruction is more damaging than aquarium fish collecting to reef fish populations.

Akule are presently sought by commercial fishermen and by recreational interests as well. Since a pole and line fisherman cannot compete with a large *akule* net in catch efficiency, growing antagonism is surfacing over the division of the *akule* resource and the ability of the resource to withstand heavy commercial fishing pressure. Fortunately, analysis of commercial *akule* catch data suggests that these stocks remain in good condition.

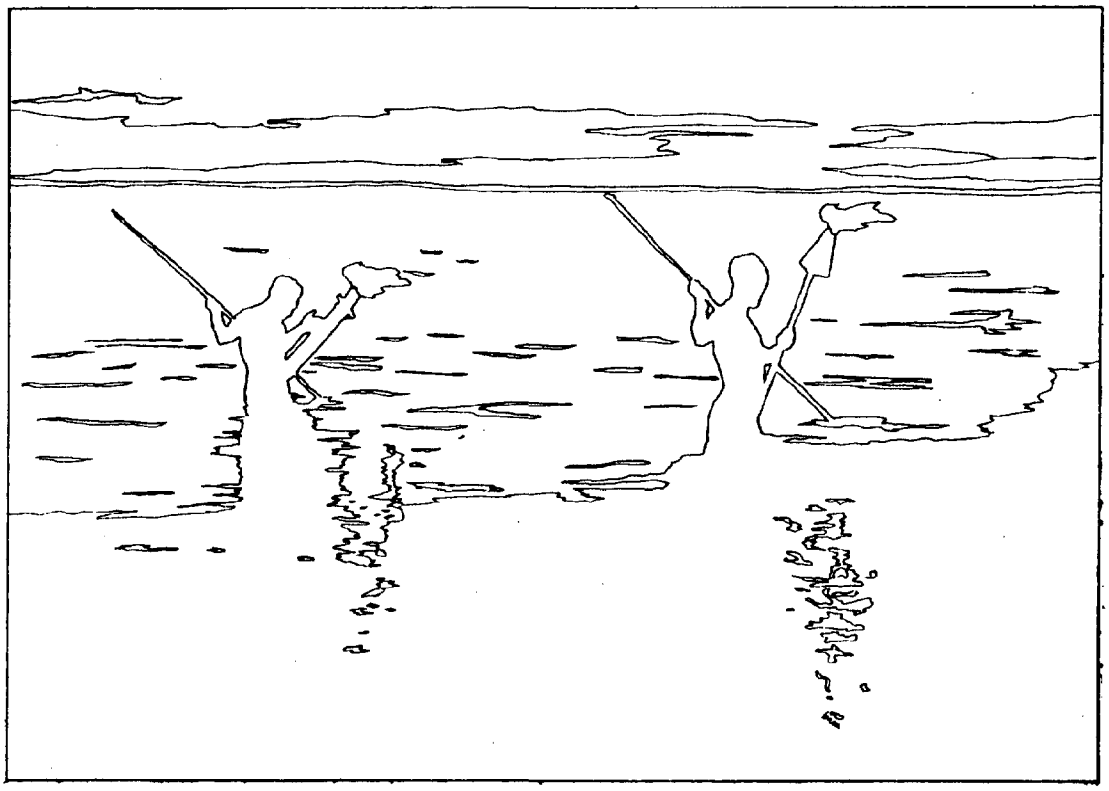
Other problems associated with the use of nets are more prevalent. "Save the Ulua" campaigners are already quite vocal in insisting that fine mesh nets are depleting the stocks of small *papio* and other fish before they can mature to sport fishing size. In addition, charterboat fishermen are growing more concerned over the amount of *mahimahi* and marlin incidentally captured by foreign longline fishermen targeting for tunas. If tourism continues to remain Hawaii's major source of income, charter fishing will continue to grow and conflicts with commercial interests (both domestic and foreign) will increase.

There are many more examples of conflicting opinions concerning the proper use of Hawaii's fisheries resources. Airplane spotters searching for schools of fish are angering fishermen lacking sophisticated fishing techniques. Full-time commercial fishermen resent the impact that part-time fishermen have on the market. Prices can fluctuate dramatically as a result making it difficult for the

full-time commercial fisherman to predict his future. Native Hawaiians are beginning to voice demands for "rights" to fish anywhere for food use. The Maui chapter of the Sierra Club has gone on record opposing the return of inter-island hydrofoil boats near Maui for fear it would impact adversely on the endangered humpback whale populations. There are many more examples of conflicting opinions concerning the proper use of Hawaii's coastal zone and its resources.

According to a recent University of Rhode Island study of commercial fishermen, management plans, if not considered carefully, can alter the characteristics of fishing which fishermen value most highly. According to the study, the three most important needs of the fishermen were self-fulfillment and the creation of a meaningful life, economic security, and time for family and social life. Those involved in inshore fisheries did not find their work as financially rewarding but were compensated by a way of life allowing them time with their families. On the other hand, offshore fishermen felt their work was economically satisfying but that it strained family relationships.

IV



HISTORICAL ASPECTS OF FISHING

CHAPTER IV

HISTORICAL ASPECTS OF FISHING

Hawaiian fisheries statistics were first compiled in 1900. The U.S. Fish Commission sent John Cobb to Hawaii to assess the commercial fisheries. His highly detailed and descriptive report outlines individual island fisheries (Cobb, 1903). Surprisingly, most of the types of fishing that Cobb reported are still carried on today. One notable exception is the malolo (flying fish) fishery which at one time accounted for over 573,082 pounds of fish landed, but is no longer of any commercial significance.

The Division of Fish and Game of the Hawaii Department of Land and Natural Resources is the fisheries data collection body for the State. The Division first implemented a permanent data collection program, focusing almost exclusively on commercial fishing activities, in the late 1940's. All commercial fishermen were then and are still required to purchase an annual license in order to sell their catch (Fig. 4.1). In addition, they are required to submit one of a variety of catch reports depending on the type of commercial fishing activity (Table 4.1).

Major emphasis is placed on the monthly catch reports which are key punched onto cards for data processing (Fig. 4.2). The area codes which provide identification of fishing grounds can be seen in Figure 4.3. This chart aids the fisherman in filling out his catch report

Figure 4.1

FG-1 (Rev. 7/78)

State of Hawaii
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF FISH AND GAME

LICENSE NO. 79 —

Effective: Date of Issue to June 30, 1979

1 ☐ NEW
2 ☐ RENEWAL
3 ☐ MAIL

COMMERCIAL FISHING LICENSE
1978 – 1979

LICENSE FEE
1 ☐ RESIDENT* $10.00
2 ☐ NON-RESIDENT $20.00

Name (LAST, FIRST, MIDDLE INITIAL)	Sex M☐ F☐	Birth Date	Weight	Height	Color of Hair	Color of Eyes

Mailing Address	City	County/State	Zip

Residence Street No. & Name	City	County/State	Zip

Birth Place	Length of Residence in Hawaii	U.S. Citizen? 1☐Yes 2☐No	Business Phone	Home Phone

CHECK ONE:

1 ☐ CREW MEMBER — Name of Boat

2 ☐ BOAT CAPTAIN — Name of Boat
HA No.:
Documented No.:
Number of Crew:
Port of Anchorage:

3 ☐ SHORELINE FISHERMAN

Monthly Fish Catch Report Required? 1☐ Yes 2☐ No

PRIMARY TYPE OF FISHING
(Check no more than 2)

A ☐ Aquarium
B ☐ Fish Pond
C ☐ Hand (LIMU, OPIHI, ETC.)
D ☐ Handline (DEEP SEA, INSHORE)
E ☐ Longline (AHI BOATS, FLAGLINE, SET LINE, KAKA LINE)
☐ Nets _____ SPECIFY (GILL, THROW, TRAWL, PURSE, SURROUND, HUKILAU, ETC.)
F ☐ Pole & Line (AKU BOATS, SHORELINE)
H ☐ Traps (POTS)
I ☐ Trolling
☐ Other _____ SPECIFY

X _____ SIGNATURE OF LICENSEE

If Minor below age 18 _____ PARENT OR GUARDIAN

VALIDATION (FISH AND GAME USE ONLY)

_____ AGENT

DATE _____ ISLAND _____

*ANY PERSON WHO HAS RESIDED IN THE STATE FOR ONE YEAR OR LONGER (HAWAII REVISED STATUTES § 189-2)

"ORIGINAL TO LICENSEE"

TABLE 4.1

SUMMARY OF DATA REQUIRED
BY HAWAII FISH AND GAME
MONTHLY REPORT FORMS

	Fish Catch	Flagline Catch	Aku Catch	Aquarium Fish Catch	Pond Operators
Catch					
Pounds by Species	x	x	x		x
Number by Species	x	x	x	x	x
Area	x	x	x	x*	
Effort					
Gear Used	x	x	x		
Days Fished**	x				
Total Days Fished				x	
Total Hours Fished				x	
Day of Landing		x			
Number Days at Sea		x			
Number of Baskets		x			
Number Crew		x			
Depth Caught				x	
Economic					
Pounds Sold By Species	x				x
Number Fish Sold by Species				x	
Total Value Sold by Species	x	x	x	x	x
Port of Landing	x	x	x		

*Zone Fished
**Results must be detailed for each day

Figure 4.2

DEPARTMENT OF LAND AND NATURAL RESOURCES

FISH CATCH REPORT

DIVISION OF FISH AND GAME STATE OF HAWAII

1. Name of Licensee .... 2. Commercial Fishing License No. .... 8 ☐ - ☐☐☐☐

3. Name of Boat .... 4. HA No. H A - ☐☐☐☐ - ☐☐ 5. Federal No. ☐☐☐☐☐☐

6. Month Fished .... 7. Year Fished—19 ☐☐

8. Day Fished	9. Area Fished	10. Type of Fishing Gear Used		11. Species Caught		12. No. Caught	13. Lbs. Caught	14. Lbs. Sold	15. Value of Lbs. Sold		16. Port of Landing

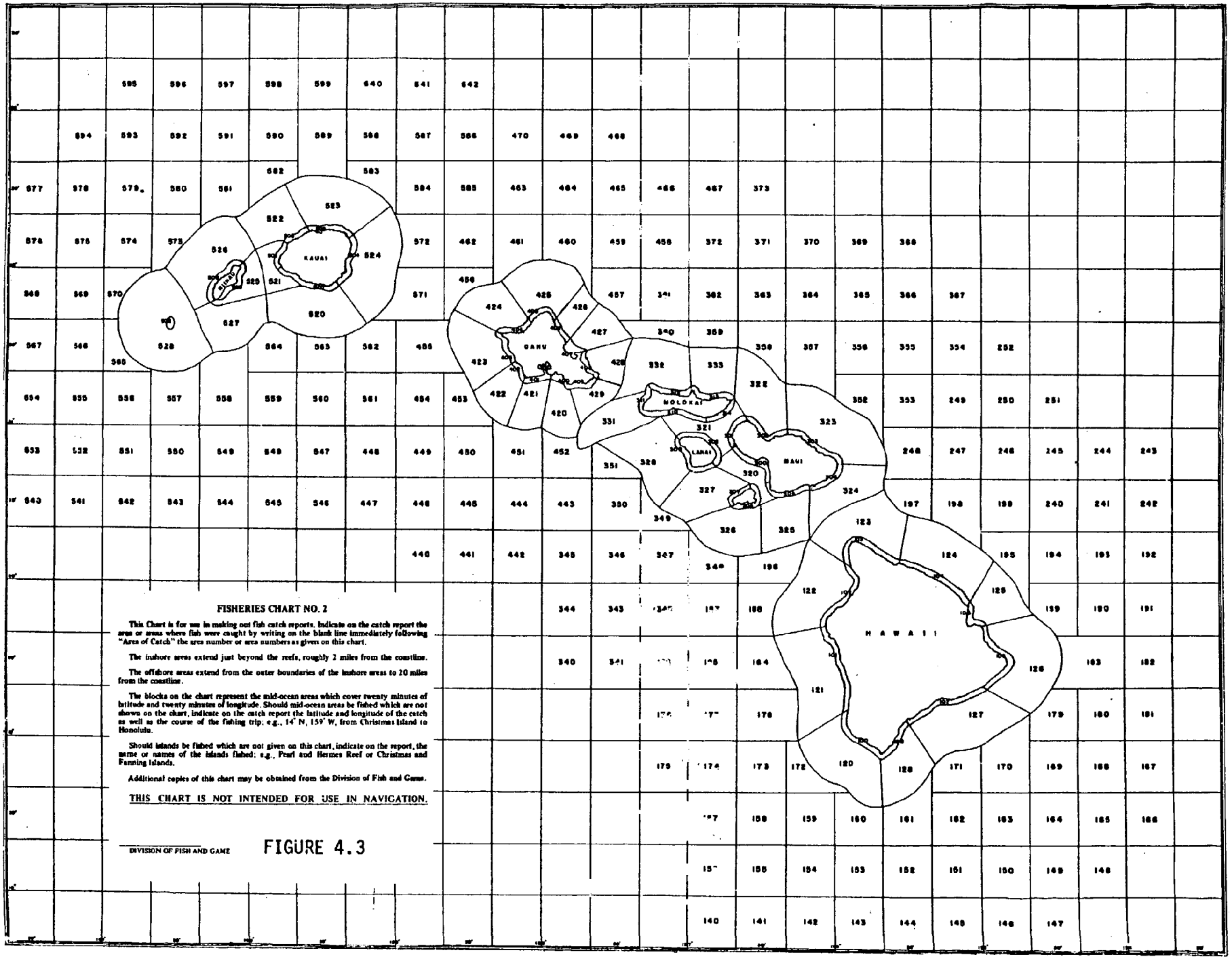
See Instructions on Inside of Cover

The above report is true, correct, and complete to the best of my knowledge and belief.

C-3 (Rev. 4-76)

17. Signature ....
Licensee or Authorized Agent

SEND THIS IN



FISHERIES CHART NO. 2

This Chart is for use in making out fish catch reports. Indicate on the catch report the area or areas where fish were caught by writing on the blank line immediately following "Area of Catch" the area number or area numbers as given on this chart.

The inshore areas extend just beyond the reefs, roughly 2 miles from the coastline.

The offshore areas extend from the outer boundaries of the inshore areas to 20 miles from the coastline.

The blocks on the chart represent the mid-ocean areas which cover twenty minutes of latitude and twenty minutes of longitude. Should mid-ocean areas be fished which are not shown on the chart, indicate on the catch report the latitude and longitude of the catch as well as the course of the fishing trip; e.g., 14° N, 159° W, from Christmas Island to Honolulu.

Should islands be fished which are not given on this chart, indicate on the report, the name or names of the islands fished: e.g., Pearl and Hermes Reef or Christmas and Fanning Islands.

Additional copies of this chart may be obtained from the Division of Fish and Game.

THIS CHART IS NOT INTENDED FOR USE IN NAVIGATION.

DIVISION OF FISH AND GAME

FIGURE 4.3

regarding area of catch. The majority of commercial fishing is confined to within 20 miles of the coastline.

These commercial catch reports represent the only fisheries data available for analysis. Consequently, they form the basis for fishery management programs. The data, however, is frequently open to question in terms of accuracy and reliability. Fishermen are notorious everywhere for protecting the privacy of their fishing activities as well as not seeing the benefits to data collection. Hawaii is no exception.

Not surprisingly, the island of Oahu always leads in the number of commercial fishermen, fishing vessels, and total landings. In 1903, Oahu led in fishermen (1,478) followed by Hawaii (827), Kauai (314), Molokai (300), Maui (279), Lanai (22), Niihau (827), and Kahoolawe (9). In 1978, Oahu once again led in numbers of licensed fishermen (1,235), followed by Hawaii (712), Maui (217), Kauai (215), Molokai (44), and Lanai (24).

In 1903, *akule* was the most abundant species landed. *'Ama'ama* had the greater dollar value. *Aku* was second in quantity and sixth in value of catch. Other important species were *ulua, awa, opelu, oio, kawakawa, ahi, kumu, moi, awaawa, hapuupuu, weke, opihi, he'e, papai,* and *ula.*

Hawaiians predominated in the fisheries of Hawaii in 1900. Only one-fourth of the fishermen were Japanese. In 1903, the situation reversed itself, and the Japanese became the dominant ethnic group fishing in Hawaii. Other ethnic groups occupy insignificant proportions of the total. At the same time, the Japanese became dominant in the

fishery market place, maintaining this position to the present day.

The Japanese influence on fishing has become so great that Japanese names for fish are, in some cases, more frequently used than the Hawaiian names. There are frequently four different names for our Hawaiian fish. For example, albacore tuna (common name) is called *ahipalaha* (Hawaiian name), *tonbo* (Japanese name), and *Thunnus alalunga* (scientific name). Squirrel fish (common name) is called *u'u* (Hawaiian name), *menpachi* (Japenese name) and *Myripristis argyromus* (scientific name). A list of fish names is appended to this report. In general the local name of the fish will be used in this report. The reader is requested to refer to the appendix for additional names.

A more detailed comparison of the 1903 statistics with those of the present day (1978) reveals some interesting and thought provoking contrasts and similarities. The several islands tended to specialize in different kinds of fisheries, with only a few taken commercially at all of the islands — *moi*, *'amaama*, *kala*, *oio*, *uku*, *ulaula*, and *ulua*. Kauai, Molokai, and Lanai played much larger roles in Hawaii's fisheries than they do today. Maui and Hawaii were close rivals in total landings, and each produced nearly half as much fish as Oahu.

Some species, many of which have always been prized as table fish in Hawaii, were landed in much greater quantities in 1903 than they are at present (1978): *ulua* (461,760 versus 121,530 lb), flying fish (36,000 vs. 0 lb), mullet (714,705 vs. 17,848 lb), *moano* (151,970 vs. 7,658 lb), *moi* (109,719 vs. 1,934 lb), *oio* (210,212 vs. 10,878 lb), moray eels (66,279 vs. 5,087 lb), lobster (81,414 vs. 33,719 lb) and *kole*, reputed to have been a "royal fish" (28,282 vs. 2,613 lb). Besides the

malolo (flying fish) many more categories were listed in 1903 that have ceased to be taken in commercial quantities. In total, Cobb listed 130 categories (species or products) in his catch statistics, compared with the presently reported 87 categories.

A dramatic change in the pond catch is obvious from the data. The Chinese were the major ethnic group engaged in operating fish ponds. This unique form of fisheries and aquaculture has been almost abandoned (672,953 vs. 23,293 lb). See Table 4.2 for a comparison.

Landings of most offshore pelagic species, such as *mahimahi, aku* and other tunas, were very small compared with the present, but *kawakawa,* the most coastal in occurrence of the tunas in this region, was caught in greater quantity than it is now (165,714 vs. 78,506 lb). *Akule* landings were much higher in 1903 than they are at present (1,390,225 vs. 367,324 lb). Among deepsea bottomfish, the present *opakapaka* landings are more than 30 times those of 1903, and *hapuupuu* landings have increased by 10 times. *Uku, ulaula (onaga)* and *kahala* catches have not changed greatly in three-quarters of a century. Other categories which have remained much the same are *limu* (edible seaweeds), sharks, *u'u (menpachi), weke, kala* and *opelu.*

Some of the large decreases in production over the past three-quarters of a century probably reflect real reductions of inshore resources by fishing pressure, while others are due to changes in consumer tastes, reduced effort in catching low-priced fish or data reporting methods. The 1978 data is from commercial fish catch data only. We are as yet unable to determine the extent of fish catch by the recreational/subsistence or charter fishing users unless they sell and report their catches

Table 4.2--Comparative Pond Catches

Island	1903[1] Pounds	1903[1] Value	1978[2] Pounds	1978[2] Value
Hawaii	218	$ 54	4,003	$ 6,497
Maui	38,982	5,400	-	-
Lanai	2,400	600	-	-
Molokai	43,361	10,279	-	-
Oahu	578,292	93,568	19,290	26,241
Kauai	9,700	1,420	-	-
TOTAL	672,953	$111,321	23,293	$ 32,738

[1] Cobb, 1903

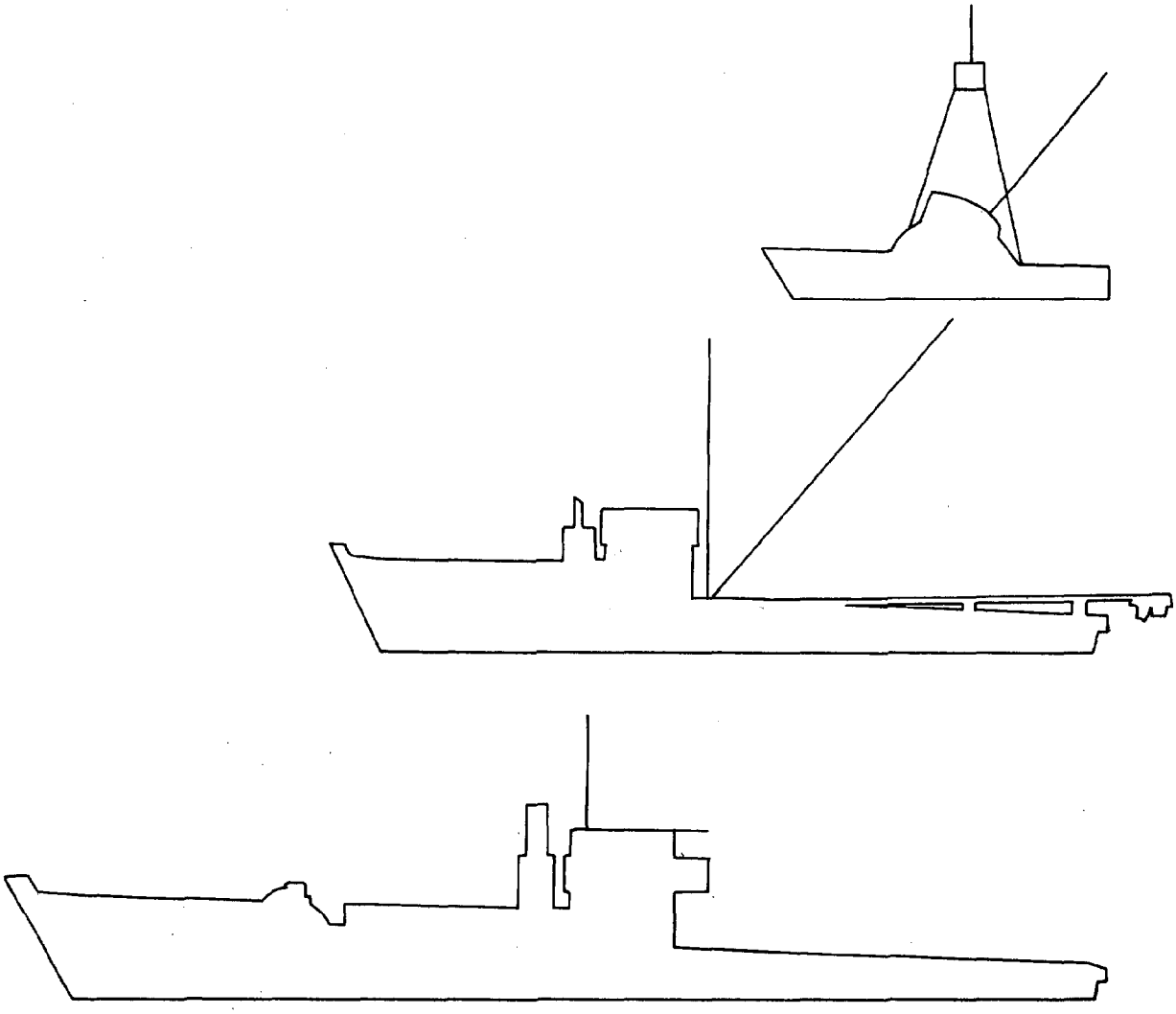
[2] Hawaii Fish and Game Data, 1978

as commercial fishermen. Consequently, it is difficult to make strict comparisons between catches at the turn of the century with more recent catch data without some qualifications. The big increases in the catches of offshore pelagic species and the deeper bottomfish doubtless have been brought about by larger, faster boats and more efficient equipment and methods.

Catch statistics for the 1927-28 fiscal year are presented in a manuscript report apparently based on articles which were published about that time in a local Japanese language newspaper. During that period, approximately 50 years ago, a total annual catch of about 11 million pounds was reported, which is not very different from some recent years. The *aku* catch was less than half the recent level, but *ahi* (large tuna) landings were only slightly lower than they are now. According to the manuscript, there were many more flagline boats in the tuna fishery than there are now. The *akule* and *opelu* catches were about the same as in fiscal year 1977-78. Among bottomfishes, *opakapaka* and *ulaula* (*onaga*) were about half the current levels, but *ulua*, *uku* and *kahala* production was roughly twice what it is now. *Mahimahi* was produced in quantities comparable to the present, which is rather surprising in view of the great increase in trolling in recent years. *Ono* (wahoo) landings, on the other hand, were much less than at present, and may have been less esteemed by the earlier consumers than it is now. As in John Cobb's time, inshore species of mullet, *moi*, and *oio* were produced in much greater quantities than they are today.

To what extent have state policies been reflected in type of catch?

V



FISHING FLEET PROFILE

CHAPTER V

FISHING FLEET PROFILE

The subject of boating in Hawaii generally stimulates great public interest. The interest reflects the great diversity of boaters and their boats — with a wide variety in types and sizes and individual requirements.

Hawaii's coastline is not very hospitable to most boating. This is due in part to the lack of protected waters and inland waterways. Consequently, berthing and mooring facilities for boats are at a premium and waiting lists of up to 4 years are not uncommon for public berthing facilities. Perhaps as a result, Hawaii ranks last among coastal states in registered boats. Hawaii is not alone in its struggle to moor its boats. Nationally, a place to moor one's boat is a scarce commodity and about 85% of all boating in America is consequently by trailered power boats.

With an expanding population and as leisure time increases, the boating population will also increase. The major curtailing influence on boating has been and will potentially again be fuel shortages. The Hawaii Water Resources Regional Study of 1979, projects estimates of berthing and launching requirements barring major fuel shortages (Table 5.1). The small boat harbors in the State are detailed with respect to existing and potential berths in Table 5.2. The State's

Table 5.1--Projected Demand for Small Boat Berths
Year 2000[1]

Island	Existing Harbor Capacities	Projected Wet Stored Requirements
Hawaii	241	440
Maui	156	457
Lanai	21	70
Molokai	31	111
Oahu	2,130	5,197
Kauai	88	831
TOTAL	2,476	7,106

Projected Demand for Boat Launching Ramps
Year 2000

Island	Existing Ramp Lanes	Projected Demand 2000
Hawaii	17	28
Maui	8	17
Lanai	1	3
Molokai	1	5
Oahu	32	156
Kauai	12	18
TOTAL	71	227

[1] *Hawaii Water Resources Plan*, 1979

Table 5.2--Small Boat Harbors[1]

Location	Number of Berths Existing	Potential
Hawaii		
Radio Bay	12	12
Wailoa Harbor	35	
Reeds Bay	27	270
Keahou Harbor	13	
Kailua-Kona Harbor	49	
Honokohau Harbor	57	
Kawaihae Harbor	48	300
Maui		
Lahaina Area		268
Lahaina Harbor	93	
Maalaea Harbor	63	198
Kahului Harbor	(anchorage)	
Lanai		
Makaiwa		n/a
Manele Harbor	21	97
Molokai		
Kalaupapa Harbor	(anchorage)	
Kaunakakai Harbor	31	250
Oahu		
Kaneohe Bay Area		n/a
Heeia Kea Harbor	75	300
Kaneohe Bay Marina	90	
Kaneohe Marine Corps Air Station	25	
Kaneohe Yacht Club	200	
Kailua Area		300
Waimanalo Area		n/a
Hawaii Kai Marina	40	
Maunalua Bay		250
Ala Wai Harbor	705	30+
Waikiki Yacht Club	135	
Kewalo Basin	n/a	
Keehi Harbor	342	n/a
La Mariana	50	
Pearl Harbor	100	
Barbers Point		300
Waianae Area (Pokai Bay)	89	
Waianae Harbor	n/a	300
Haleiwa Harbor	88	200
Kauai		
Hanalei Bay		180
Nawiliwili Harbor	28	166
Kukuiula Harbor	9	
Port Allen Harbor	43	
Kiliaola Harbor	8	130

[1] *Hawaii Water Resources Plan*, 1979

most crowded and desirable harbors are the Ala Wai and Kewalo on Oahu, Lahaina on Maui, and Honokohau on Hawaii.

Of the 13,695 vessels (including sail) registered with the State of Hawaii Department of Transportation (undocumented), 1,100 are identified as principally commercial or charter fishing vessels. The vast majority (12,192) of boat owners identify pleasure as the principal use. Fishing, undoubtedly, is a substantial component of this pleasure.

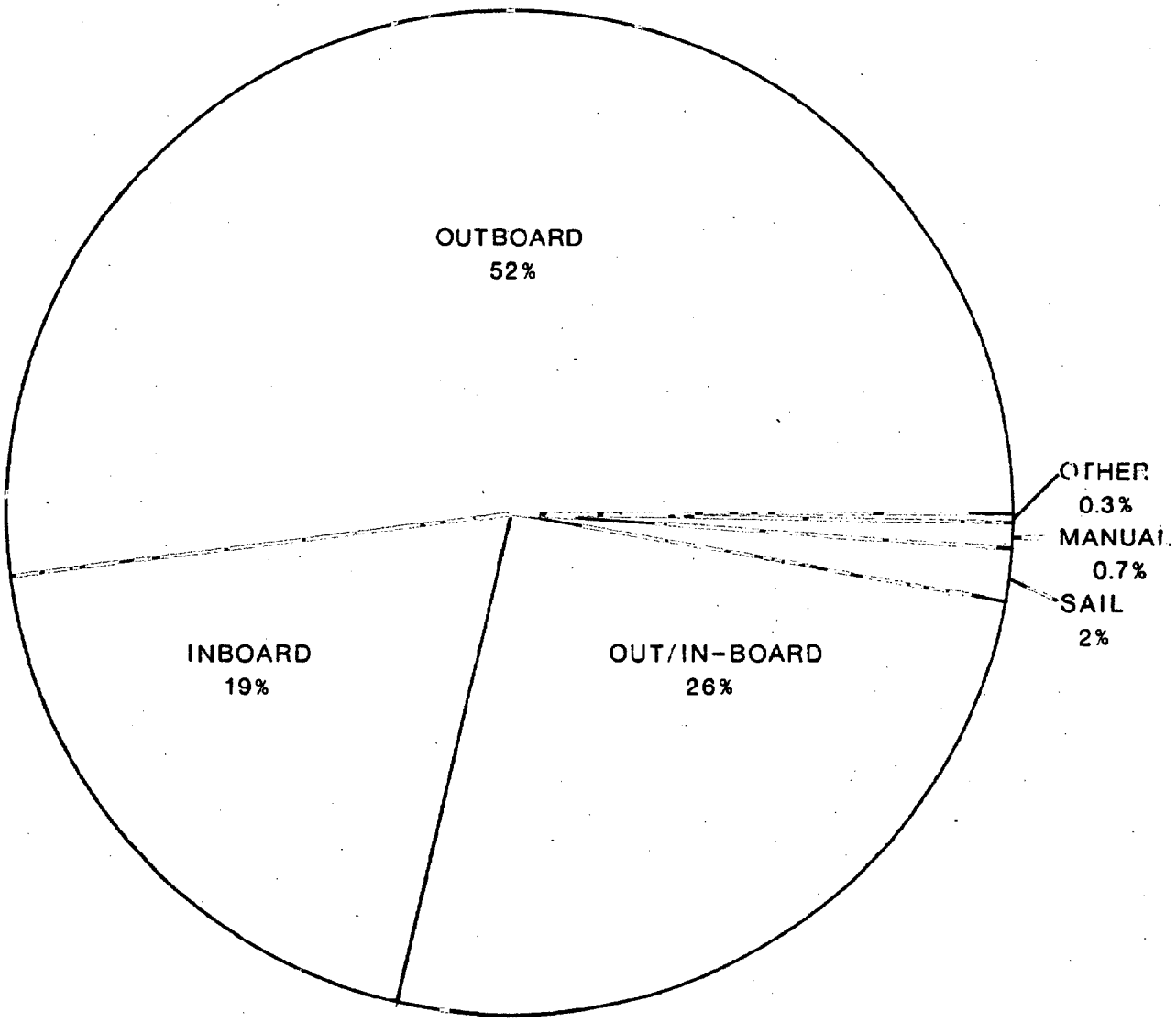
The undocumented vessels are primarily outboard (Fig. 5.1), fiberglass-hulled (Fig. 5.2) vessels, although wood hulls and other propulsion types are well represented. Most of the undocumented fishing vessels are between 16 and 25 feet in length (Fig. 5.3) and are consequently of the trailerable size. A much smaller percentage of these are moored on water. Table 5.3 gives a break down by island of the storage of undocumented fishing vessels.

Twenty percent of the fishing vessels in Hawaii are documented with the U.S. Coast Guard. Commercial fishing or charter passenger fishing is identified as a primary activity for 277 of the 1,015 documented vessels (Table 5.4). All commercial vessels over 5 net tons must be documented and must conform to both state and federal laws. They consequently receive a number of benefits not afforded undocumented vessels. These include public health benefits to crew and preference in mortgage loan approvals.

There are a number of additional boating needs that should be addressed, including the problems of sail boats and outrigger canoes. There are over 40 canoe clubs in Hawaii and, although not considered

Figure 5.1

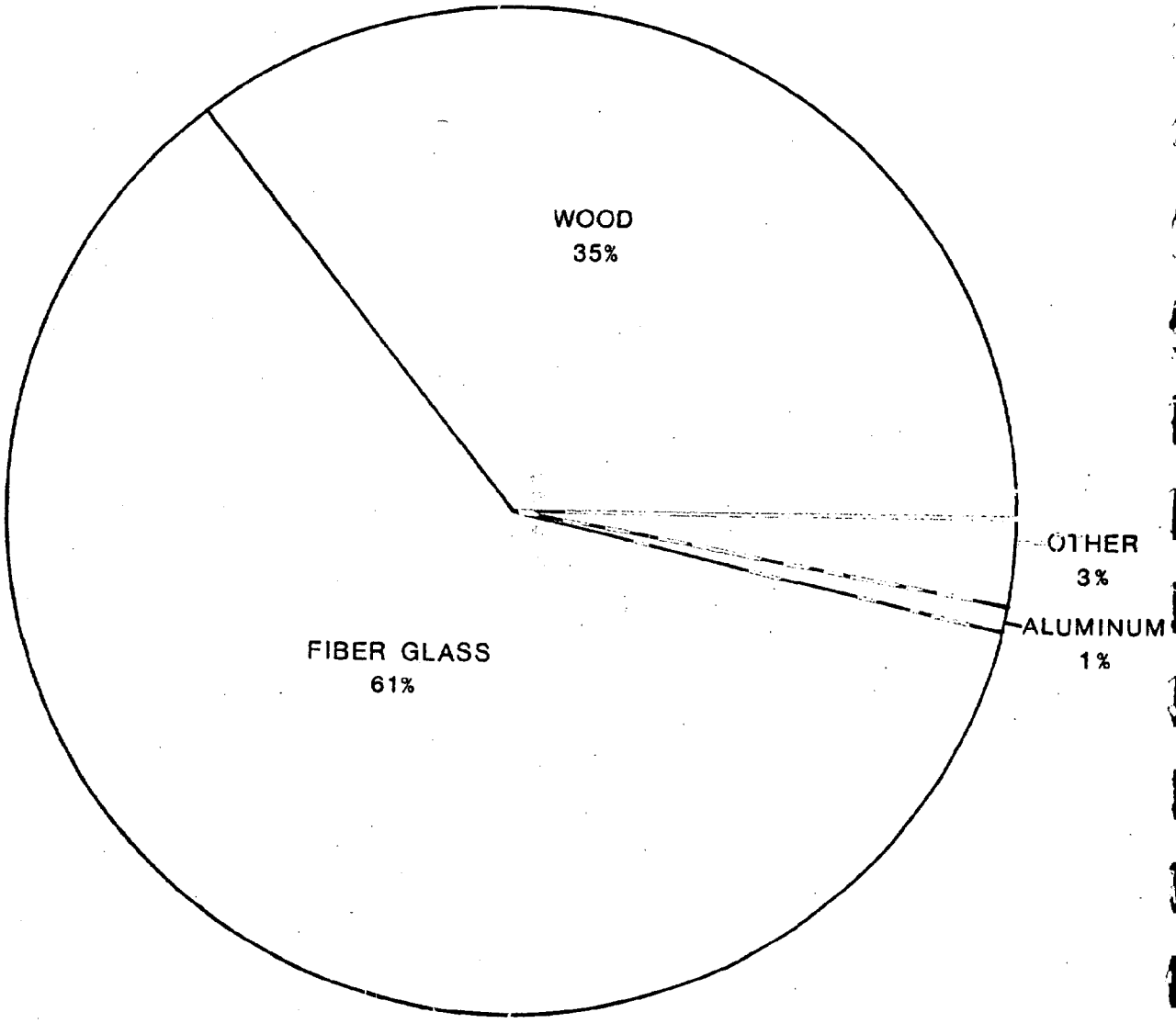
Undocumented Fishing Vessels- PROPULSION



Source: State of Hawaii, DOT, 1979

Figure 5.2

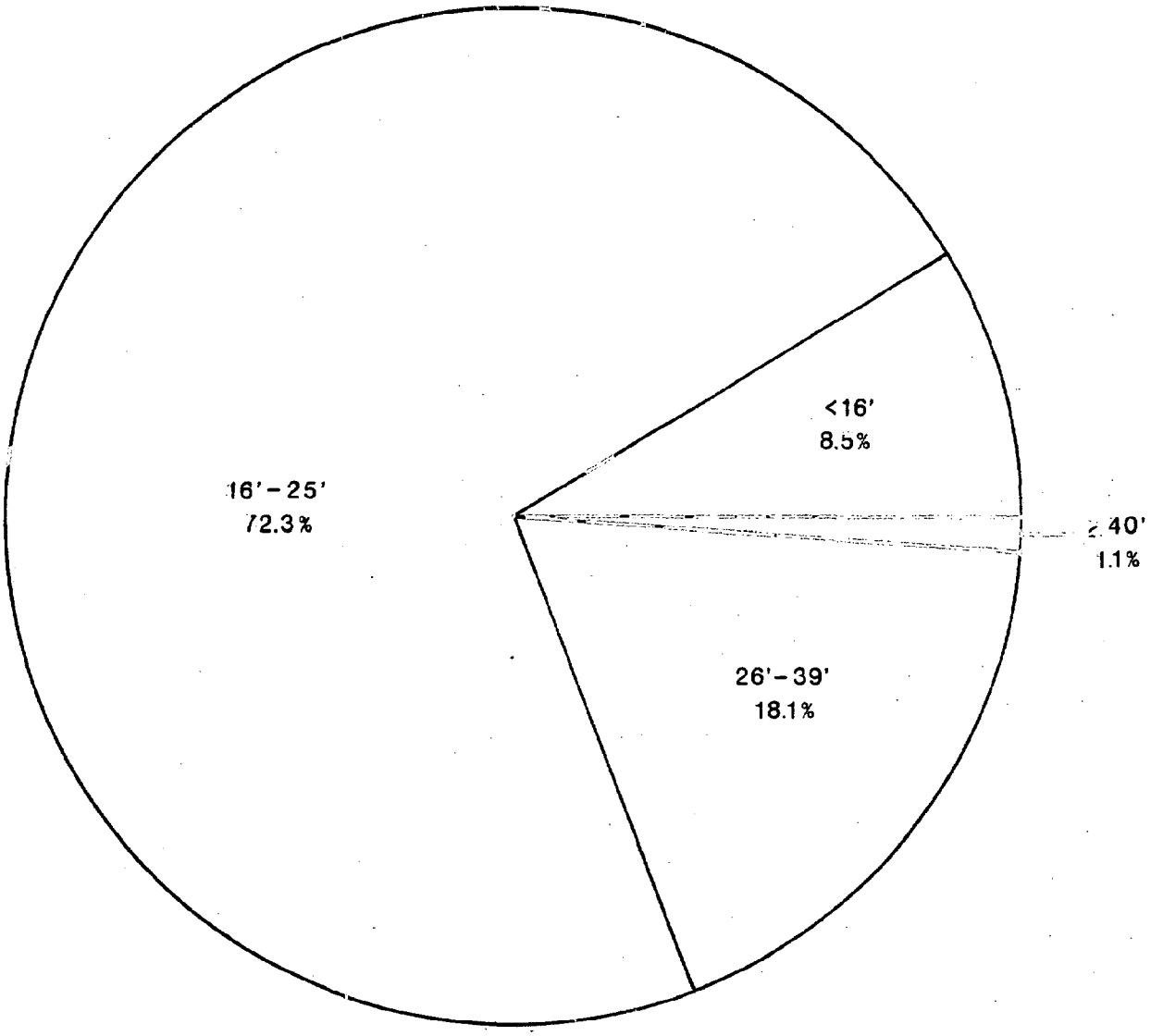
Undocumented Fishing Vessels- HULL TYPES



Source: State of Hawaii, DOT, 1979

Figure 5.3

Undocumented Fishing Vessels- LENGTHS



Source: State of Hawaii, DOT, 1979

Table 5.3
HAWAII DEPARTMENT OF TRANSPORTATION
UNDOCUMENTED FISHING VESSELS

	Oahu	Maui	Kauai	Hawaii	Molokai	Lanai	Total
Stored on land	292	77	174	239	16	2	800
Moored on water	141	49	39	55	13	3	300
TOTALS	433	126	213	294	29	5	1100

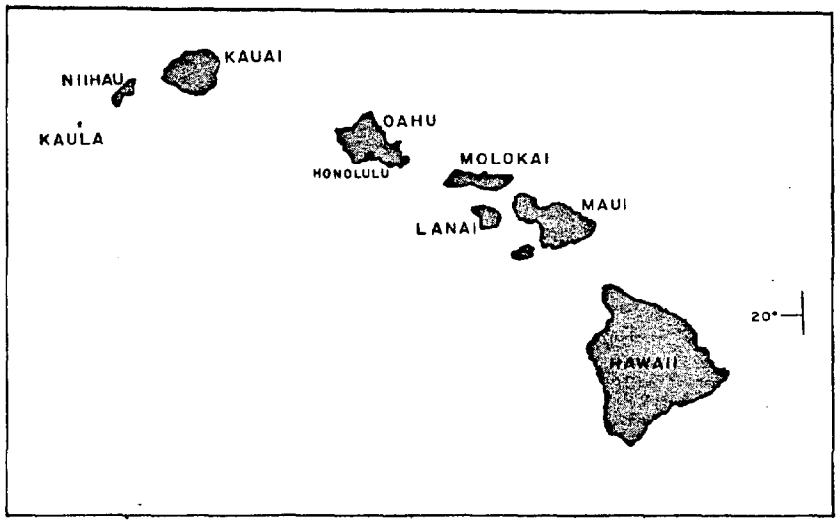
Table 5.4

U.S. COAST GUARD
DOCUMENTED FISHING VESSELS
1979

	Fishing		Charter Passenger		
	< 40'	> 40'	< 40'	> 40'	TOTAL
Oahu	28	54	33	40	155
Maui	7	3	15	9	34
Hawaii	14	8	47	6	75
Kauai	2	1	4	2	9
Molokai	0	0	1	1	2
Lanai	0	0	2	0	2
TOTALS	51	66	102	58	277

of relevance to the fishing vessel question, their growing numbers vie for space and compete successfully for funds and support facilities with the larger commercial vessels.

VI



FISHERIES BY ISLAND

CHAPTER VI

FISHERIES BY ISLAND

There are enough similarities between individual islands regarding the problems of fisheries that one could lump most situations into statewide issues. All islands suffer from a lack of good safe harbors, launching ramps and trailer parking, inadequate fuel, ice and storage facilities, competition between fishermen, scarcity of Fish and Game enforcement officers, dwindling nearshore resources, and poorly understood marketing procedures.

Nevertheless, there are apparent individual island differences which justify examining the fisheries of Hawaii from an island to island basis as well. There exists a sense of island pride which results in a desire to "do our own thing" with regard to fisheries, though there are still more similarities than dissimilarities between islands with regard to fishing.

The following list represents the fisheries problem areas for the Hawaiian Islands, as outlined by the University of Hawaii Sea Grant Marine Advisory agents. These agents, stationed on the islands, work with a variety of marine related issues including fishing. Although the list is extensive, it is by no means comprehensive or prioritized. It does show a variety of issues and impediments of concern to the fishing community which should be addressed.

FISHERIES PROBLEM AREAS AS PERCEIVED BY MAP AGENTS

East Hawaii

Local fishermen waste time and fuel in locating schools of migratory and bottom fish.

Fish quality, especially ahi burn, is still a problem.

Small boaters need better dock facilities, such as fuel pumps, ice machines, reefers, etc.

Need for better and more stable prices and new markets for commerical catches and underutilized species, especially squid.

Need for information on new fishing techniques, equipment, safety devices.

Need for legislation to allow fishermen to send their catches more cheaply (via lower air freight rates) to mainland, foreign countries.

Protection against others flooding the market and undercutting prices.

Regulation of fishing around buoys -- conflicts among gear type users.

West Hawaii

Availability of fish to local consumers at reasonable prices.

Vessel/equipment/maintenance costs.

Need for south Kona launch ramps.

Commercial/recreational fishermen conflict.

Marlin utilization/marketing.

Management/enforcement — more visibility needed for Fish and Game.

Maui

Lack of support facilities — dockside fuel and ice.

Effects of *taape* on older fisheries.

Ignorance of financial assistance availability.

Effects of "Honolulu Style" fisheries on Maui.

Baitfish of *aku* — minnow culture, improvement of *nehu* stocks, illegal harvesting of *iao*.

Launching ramps:
- Maui has the least?
- Most lack shower/toilet facilities.

Artifical reefs — why not make more?

Kauai

Marketing — prices being cut by casual "commerical" fisherman.

Gas — inadequate allocations for fishermen.

Ice/refrigeration/freezing — need ice facilities in Hanalei, Lihue, West Side; need flash freezer capability.

Taape — will wipe out bottom fishery in near future if uncontrolled.

Reef conservation — all reef areas drastically overfished; massive kapuku plan needed immediately.

Boat loan money is needed with less red tape.

Sharks — high population is resulting in major losses to fishermen, especially in the Niihau, Kauai area.

Net fishing in bays — controversy is high over the multiple use of bays and harbors between recreational and commercial fishermen, recent regulations are not enough.

Aggregation buoys — more are needed in plan for Kauai area, especially Hanalei area.

Enforcement — inadequate number of officers, too lax a court system.

Oahu

Conflicts between netters and other fishermen.

Illegal practices (e.g., clorox, chlorine, F&G violations, and weak court action).

Underutilization of selected species (e.g., *taape*).

Not enough fish to go around — need stock enhancement/management.

Oahu - continued

Need data for better management.

Need money for improving F&G management/enforcement.

Financial assistance and business management education.

Shore-based facilities (harbors, ramps, storage, etc.).

Developing seafood market (home consumption, restaurants).

Figure 6.1 depicts the top ten fishing areas in the State based on average pounds of fish reported. Interestingly, not all the top areas are offshore areas (area 102 is ranked second in the state). This suggests that inshore (0-2 miles) fishing pressure is considerable, despite the presence of offshore tuna grounds. Figures 6.2 and 6.3 show the relationship of the skipjack tuna catches (a highly migratory species) for all the islands as compared with the other species reported in these same areas. The separation of the *aku* catch from the rest of the catch provides a better indication of consistent patterns of fishing pressure around the Hawaiian Islands.

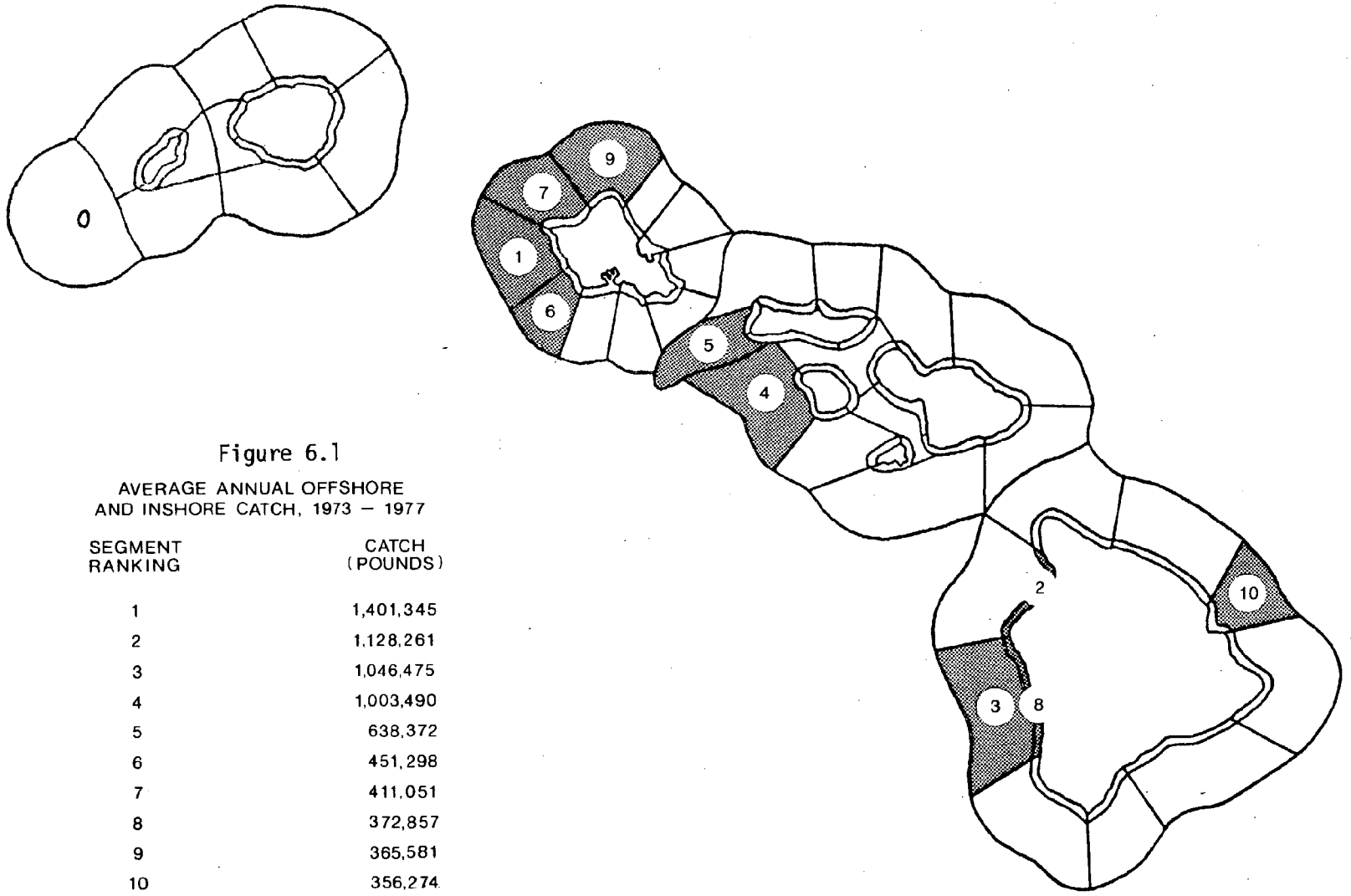


Figure 6.1

AVERAGE ANNUAL OFFSHORE AND INSHORE CATCH, 1973 – 1977

SEGMENT RANKING	CATCH (POUNDS)
1	1,401,345
2	1,128,261
3	1,046,475
4	1,003,490
5	638,372
6	451,298
7	411,051
8	372,857
9	365,581
10	356,274

Figure 6.2

AVERAGE ANNUAL CATCH OF SKIPJACK TUNA

FROM 1973 TO 1977

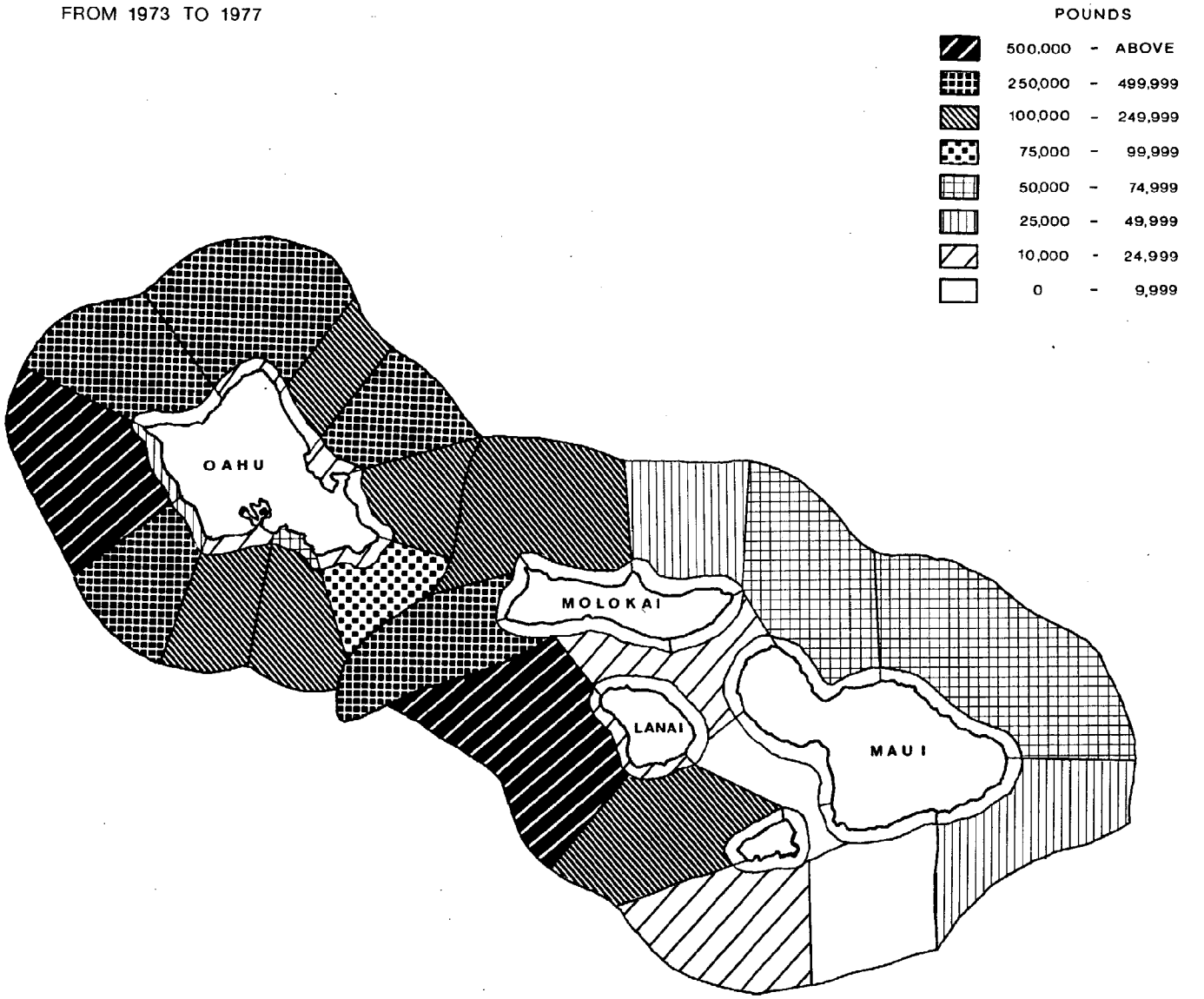


Figure 6.2

AVERAGE ANNUAL CATCH OF SKIPJACK TUNA

FROM 1973 TO 1977

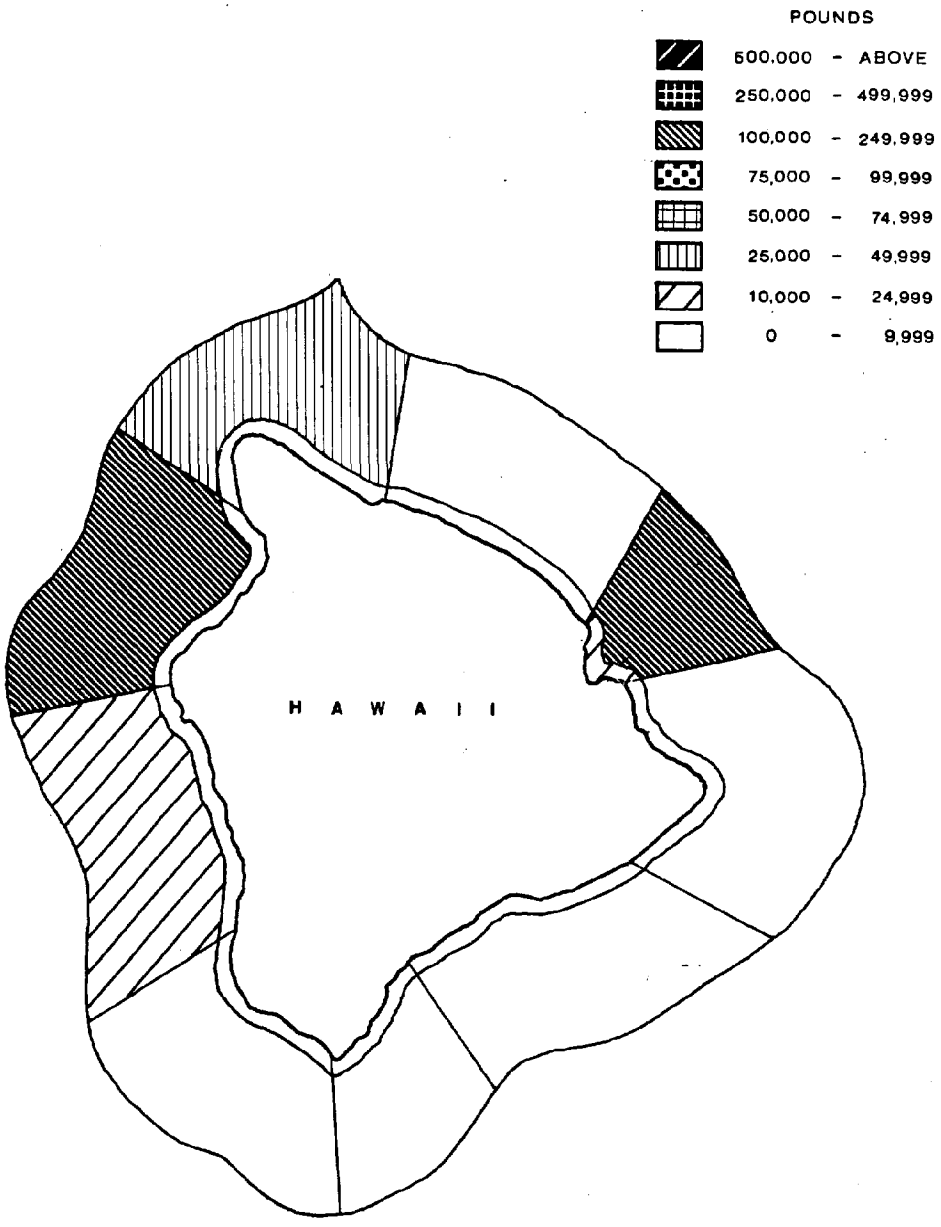
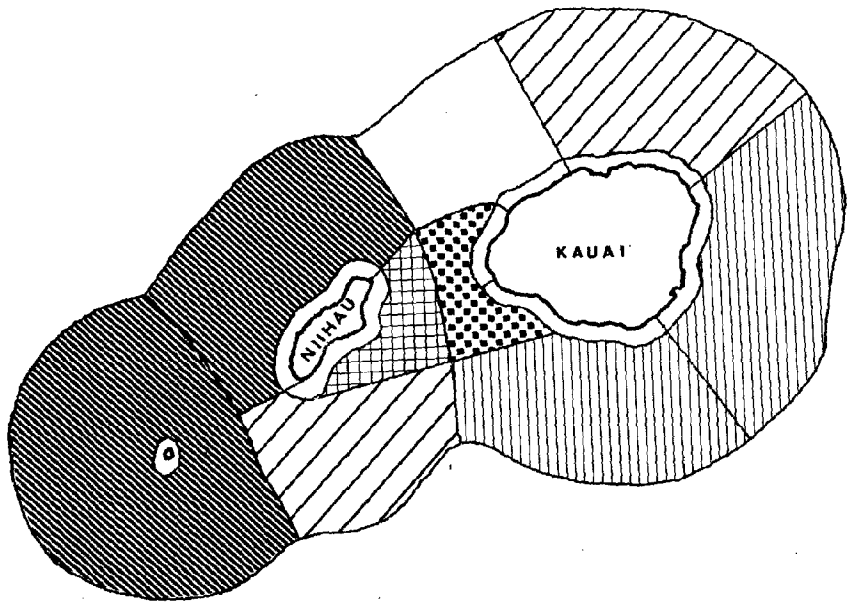


Figure 6.2

AVERAGE ANNUAL CATCH OF SKIPJACK TUNA

FROM 1973 TO 1977



POUNDS

500,000	- ABOVE
250,000	- 499,999
100,000	- 249,999
75,000	- 99,999
50,000	- 74,999
25,000	- 49,999
10,000	- 24,999
0	- 9,999

Figure 6.3

AVERAGE ANNUAL CATCH EXCLUDING SKIPJACK TUNA

FROM 1973 TO 1977

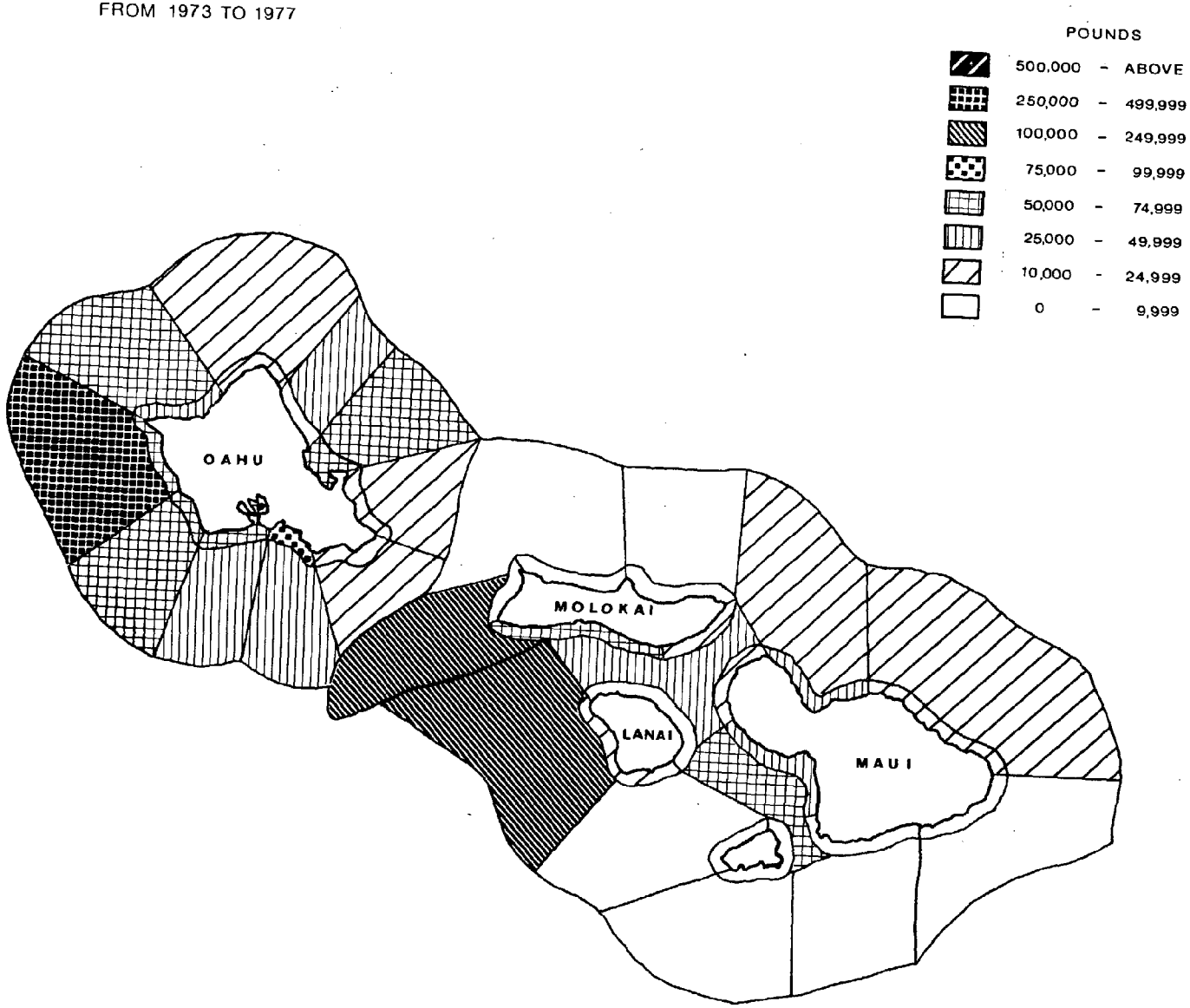


Figure 6.3

AVERAGE ANNUAL CATCH EXCLUDING SKIPJACK TUNA

FROM 1973 TO 1977

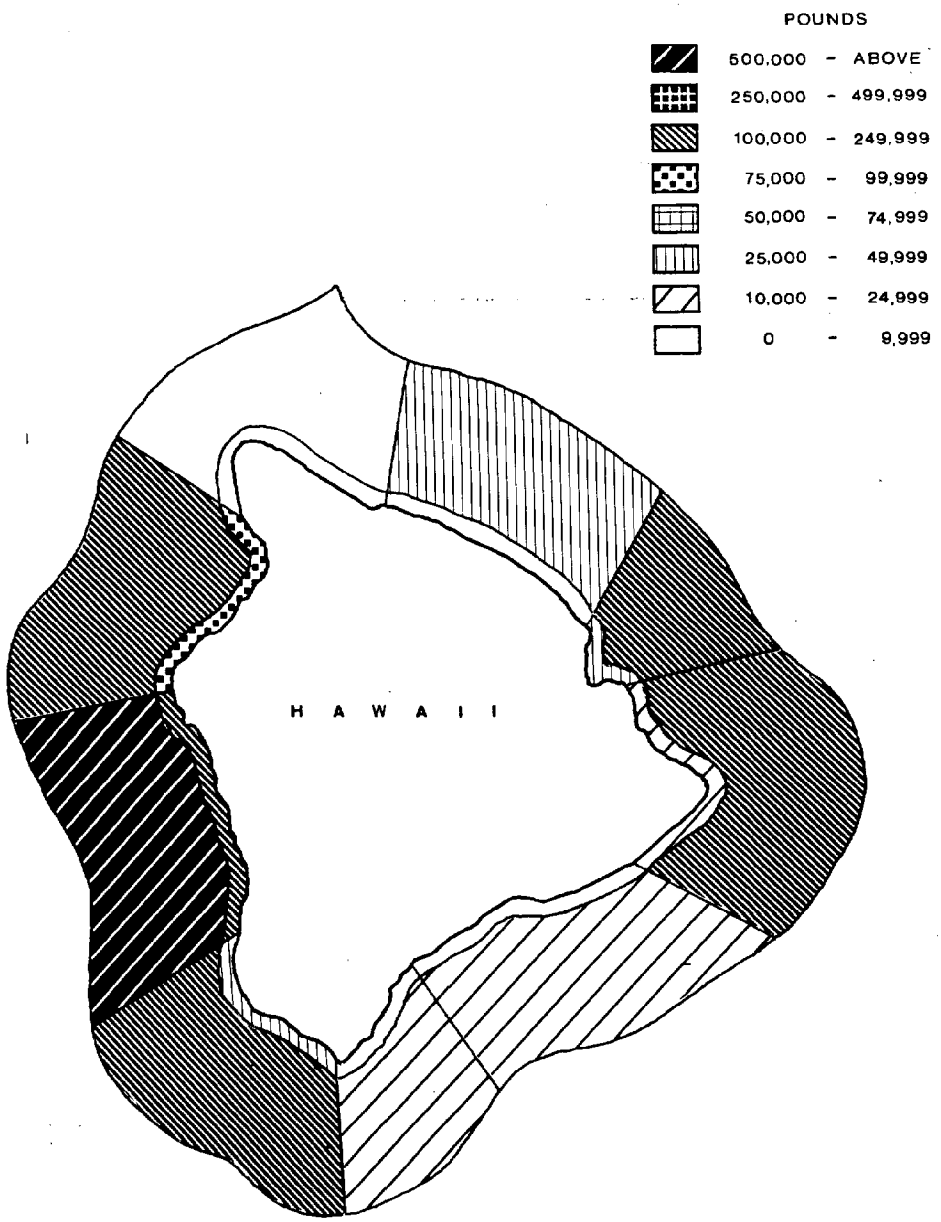
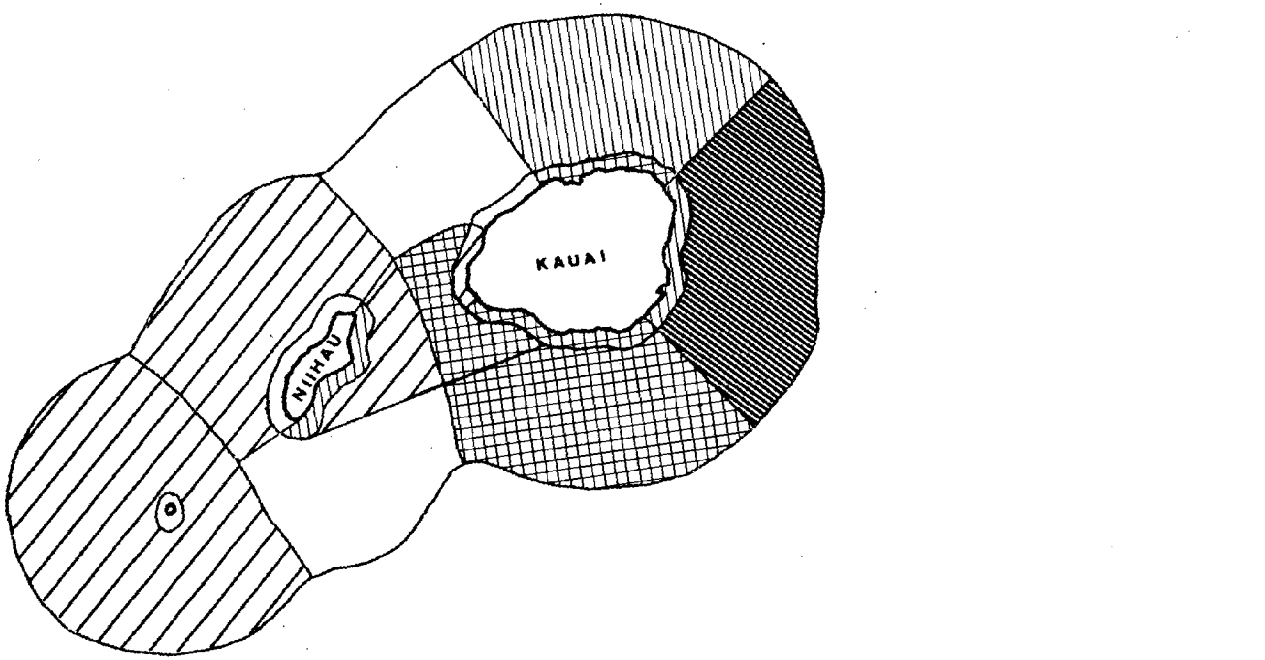


Figure 6.3

AVERAGE ANNUAL CATCH EXCLUDING SKIPJACK TUNA

FROM 1973 TO 1977



Fisheries of Oahu

Oahu stands alone in many respects from a fishing perspective. With over 80 percent of the state's population residing here, it is clear that greater fishing pressure and demand for facilities exists. This fishing pressure is evidenced by the many shoreline recreation spots, within easy access, along the highway that circles the island. The majority (70-75%) of the commercially caught fish are landed on Oahu. This is due more to the abundance of Oahu fishermen, location of markets, harbors, and other infrastructure than to resource availability around the island; though Oahu has the two best baiting grounds for the aku fishery, Pearl Harbor and Kaneohe Bay.

Kewalo Basin is the center of commercial fishing activitiy in Honolulu. Hawaiian Tuna Packers (a subsidiary of Bumble Bee) is located on the west side of Kewalo Basin. The cannery also owns and operates the ice plant and provides temporary cold storage. A marine railway with excellent repair facilities, the Honolulu fish auction, and a frozen fish processing facility are also located in Kewalo Basin. No fueling facility is available at present. Kewalo Basin provides berths for 122 commercial fishing vessels. There are also 28 charter fishing boats and a number of pleasure craft in Kewalo Basin making it one of the most desireable and crowded of the state's harbors.

Berthing is also available inside Honolulu Harbor at piers 15 and 17 for an additional 21 vessels. Three other marine railways are located in Honolulu at the Dillingham yard in Honolulu Harbor, at Keehi

Lagoon, and at the Ala Wai Marina.

Smaller scale commercial activities as well as recreational fishing activities also take place out of the other smaller boat harbors around the island, including Ala Wai, Heeia-Kea, Haleiwa, and Pokai Bay small boat harbors. The need for additional moorage and launching facilities for small boats around Oahu has prompted the Department of Transportation in cooperation with the U.S. Army Corps of Engineers to hold public hearings regarding a number of proposed sites. The public hearings are frequently arenas for open discussions concerning coastal zone use conflicts between the variety of boating interests and the other competing recreational and private shoreline interests. These conflicts will be discussed in greater detail in Coastal Zone Issues (Chapter VII).

In 1903, Oahu landed 3,515,850 pounds of fish, primarily with the use of lines. Gill nets were also a significant gear type. Since then, Oahu's landings have ranged from a high of 15,591,527 pounds in 1965, to a low of 6,408,569 pounds in 1975 (Figure 6.4). As it is today, *aku* was the leading species in the fishery with other important species being *amaama*, *akule* and *awa*. Offshore and inshore catches from 1966-77 are shown in Figures 6.5 and 6.6. The migratory nature of the *aku* may result in broad fluctuations in the catch from one year to the next. The contributing influence of the tuna catch to the total offshore catch is apparent by comparing the non-tuna catch in Figure 6.5. Conversely, the tuna catch had little impact on the total inshore statistics (Figure 6.6).

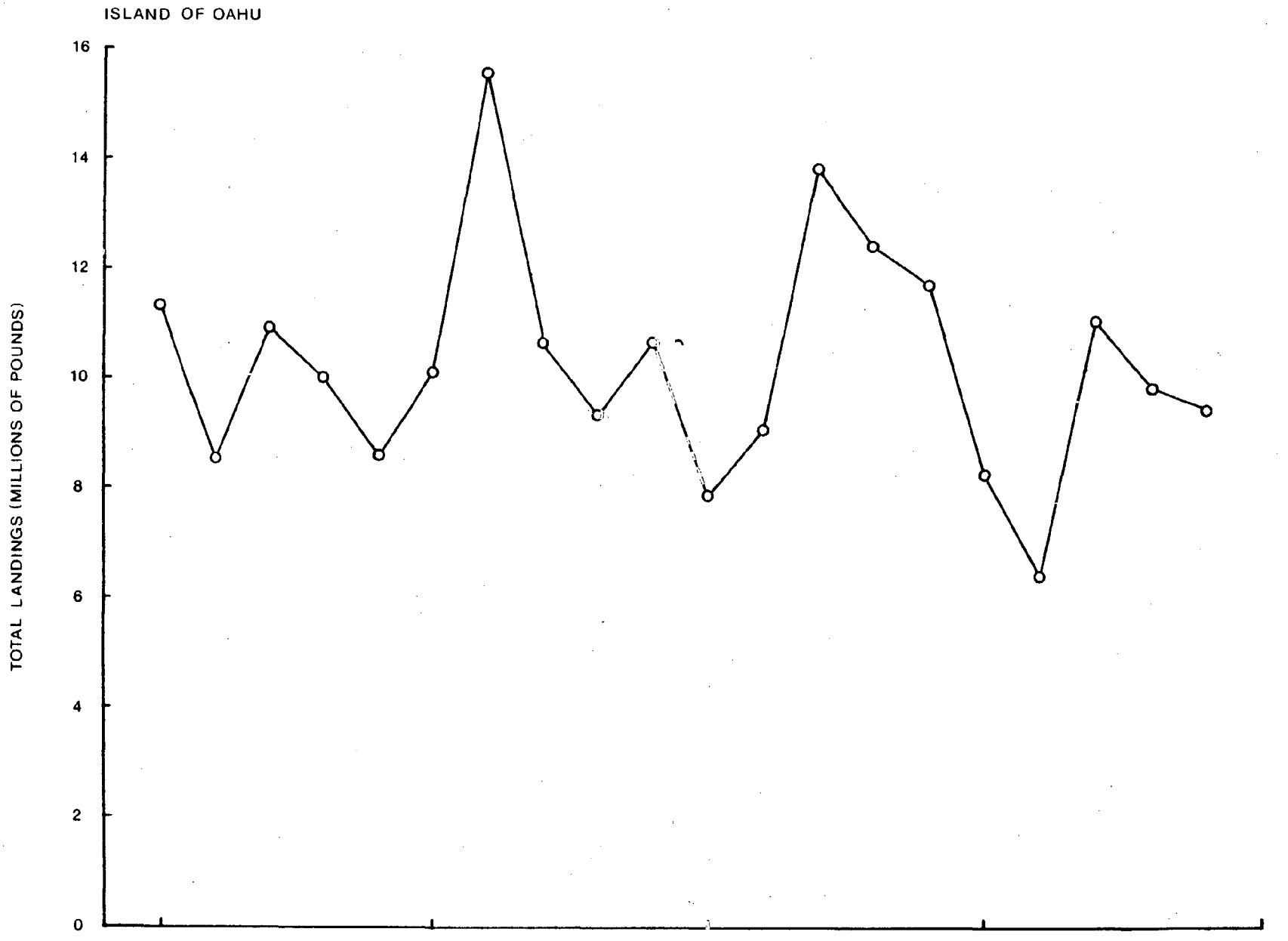

ISLAND OF OAHU
TOTAL LANDINGS (MILLIONS OF POUNDS)
16
14
12
10
8
6
4
2
0
1959
1964
1969
1974
1979

Figure C.4

Figure 6.5

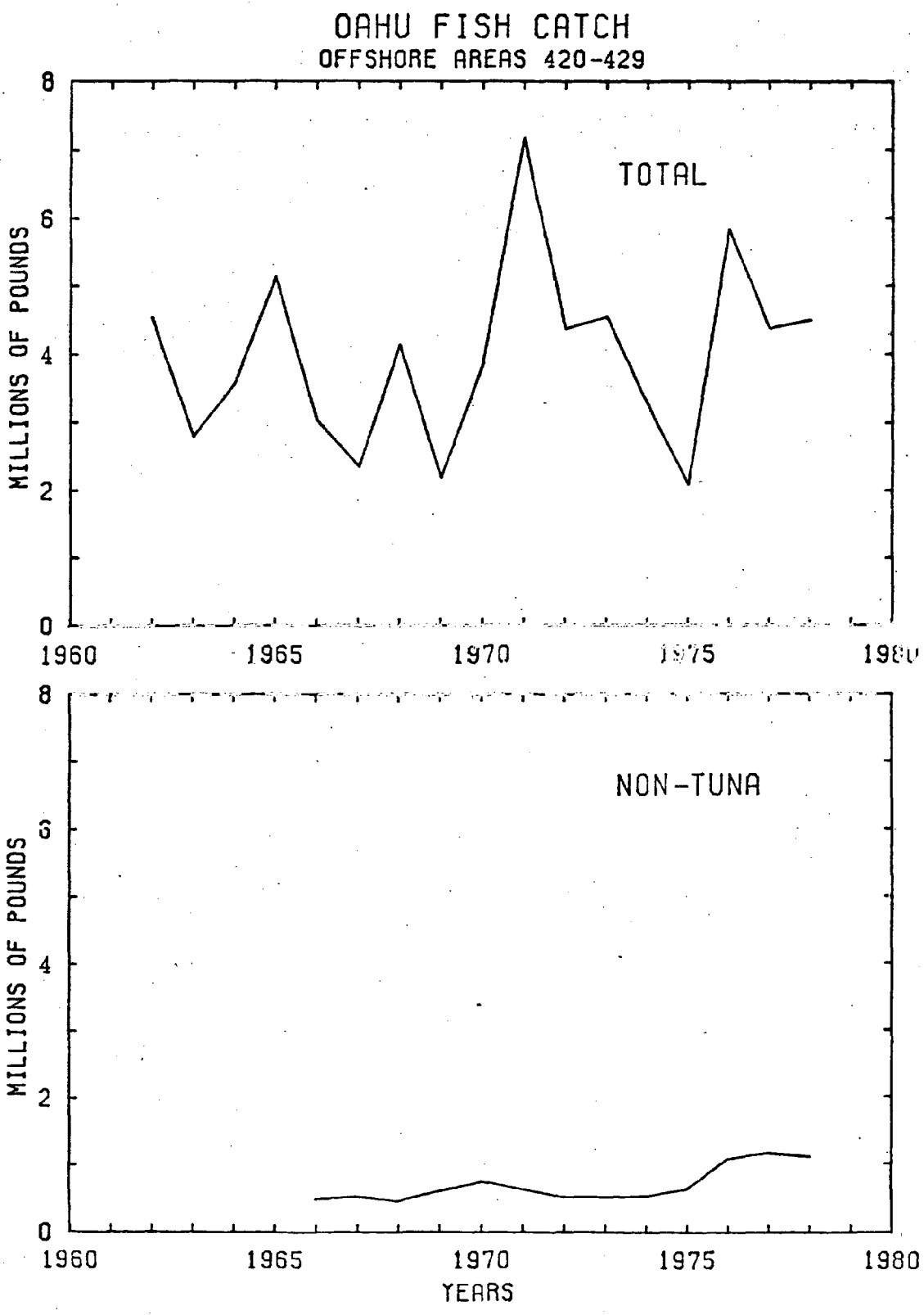
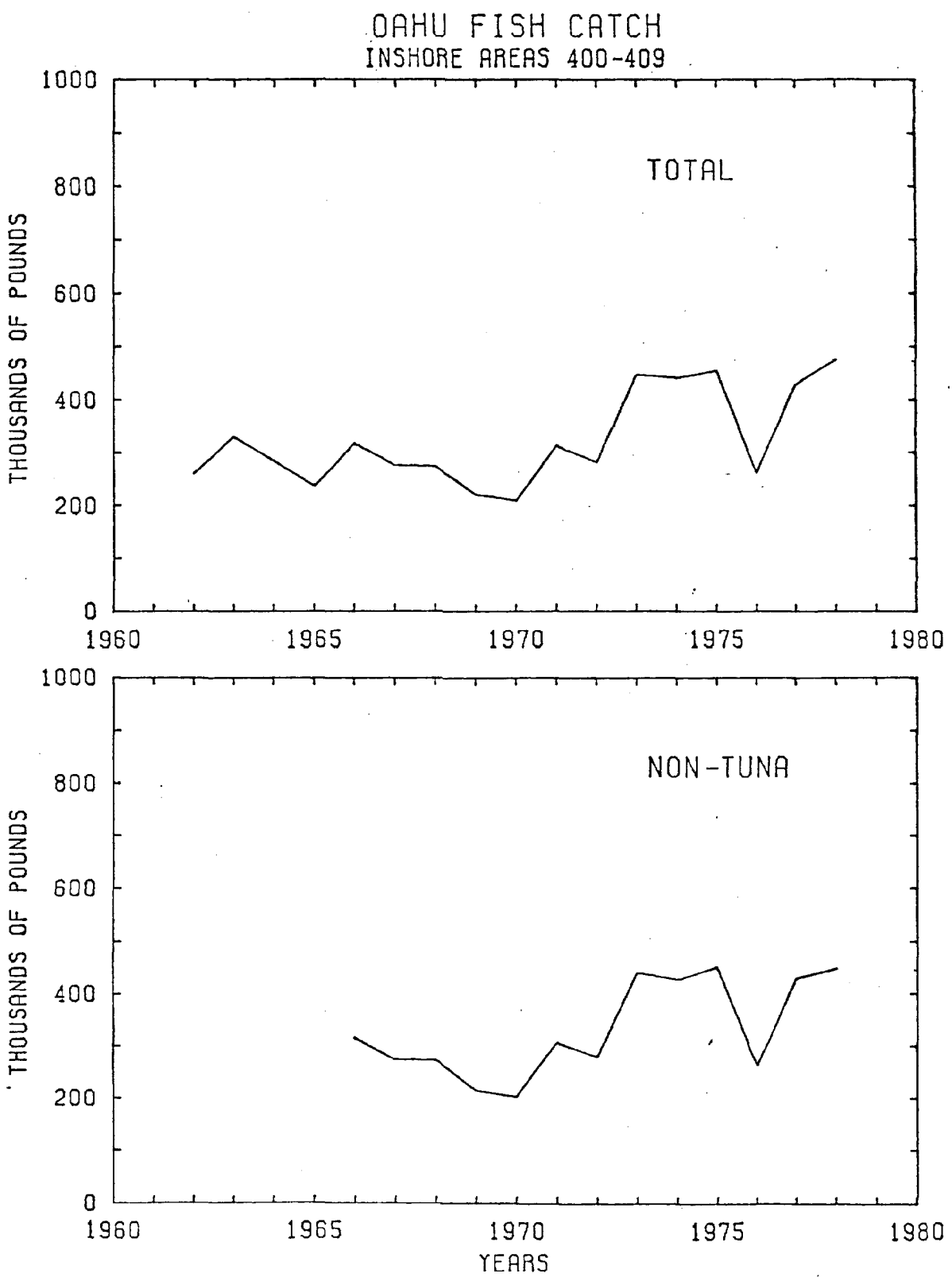

OAHU FISH CATCH
OFFSHORE AREAS 420-429
TOTAL
NON-TUNA
MILLIONS OF POUNDS
0
2
4
6
8
1960
1965
1970
1975
1980
YEARS

Figure 6.6


OAHU FISH CATCH
INSHORE AREAS 400-409
TOTAL
NON-TUNA
THOUSANDS OF POUNDS
1000
800
600
400
200
0
1960
1965
1970
1975
1980
YEARS

In Table 6.1, the top 5 species are listed for each of the 30 fishing areas surrounding Oahu. Refer to the map in Figure 4.3 for the location of these areas. Area 423 off of the Waianae coast is the highest ranking area by poundage in the entire state (Figure 6.1). This is due mostly to the comfort of fishing in the calm lee of the island and the promise of *aku, ahi,* or marlin catches. *Aku, ahi, akule,* and blue marlin were the principal species of fish reported from Area 423 in 1977 (Table 6.1). Reports also show that this area had the greatest landings of striped marlin, albacore, *aku*, bigeye *ahi*, broadbill swordfish, sailfish, and *mahimahi* in the entire state. Figures 6.7 and 6.8 show the catches and catch rates, or, catch per unit effort (CPUE), for *mahimahi* and striped marlin in this area for the years 1966-78. CPUE, a statistic used by fisheries managers to inidicate the abundance of a particular fish stock, is determined by the pounds of fish caught per fisherman trip. One can see, in the years 1969-75, that when the absolute catch increased, the catch per unit of effort similarily increased, and vice versa. This suggests that the effort expended had remained fairly constant. Figures 6.9 through 6.11 present the CPUE and catch curves for *aku*, blue marlin and *omilu* in area 423 for the years 1966-78.

Table 6.1--Top Ranking Species by Total Pounds Caught in 1977
Oahu

Area*	#1	#2	#3	#4	#5
400	limu	hahalalu	akule	palani	amaama
401	hahalalu	akule	uku	ulua	weke-ula
402	aku	akule	weke	limu	hahalalu
403	aku	akule	opelu	weke-ula	hahalalu
404	white crab	akule	hahalalu	kala	uku
405	akule	weke	palani	hahalalu	uhu
406	akule	weke	tako	kona crab	menpachi
407	limu	amaama	akule	kala	weke
408	weke	palani	akule	limu	uhu
409	weke	palani	ahi-yf	akule	manini
420	aku	ahi-yf	blue marlin	mahimahi	akule
421	aku	ahi-yf	blue marlin	mahimahi	hahalalu
422	aku	ahi-yf	blue marlin	mahimahi	kawakawa
423	aku	ahi-yf	ahi-be	akule	blue marlin
424	aku	ahi-be	ahi-yf	blue marlin	mahimahi
425	aku	ahi-yf	ahi-be	mahimahi	blue marlin
426	aku	ahi-yf	ahi-be	blue marlin	mahimahi
427	aku	ahi-yf	akule	limu	mahimahi
428	aku	ahi-yf	mahimahi	blue marlin	kala
429	aku	akule	weke	ahi-yf	palani

*See Figure 4.3 for location of areas.

Figure 6.7

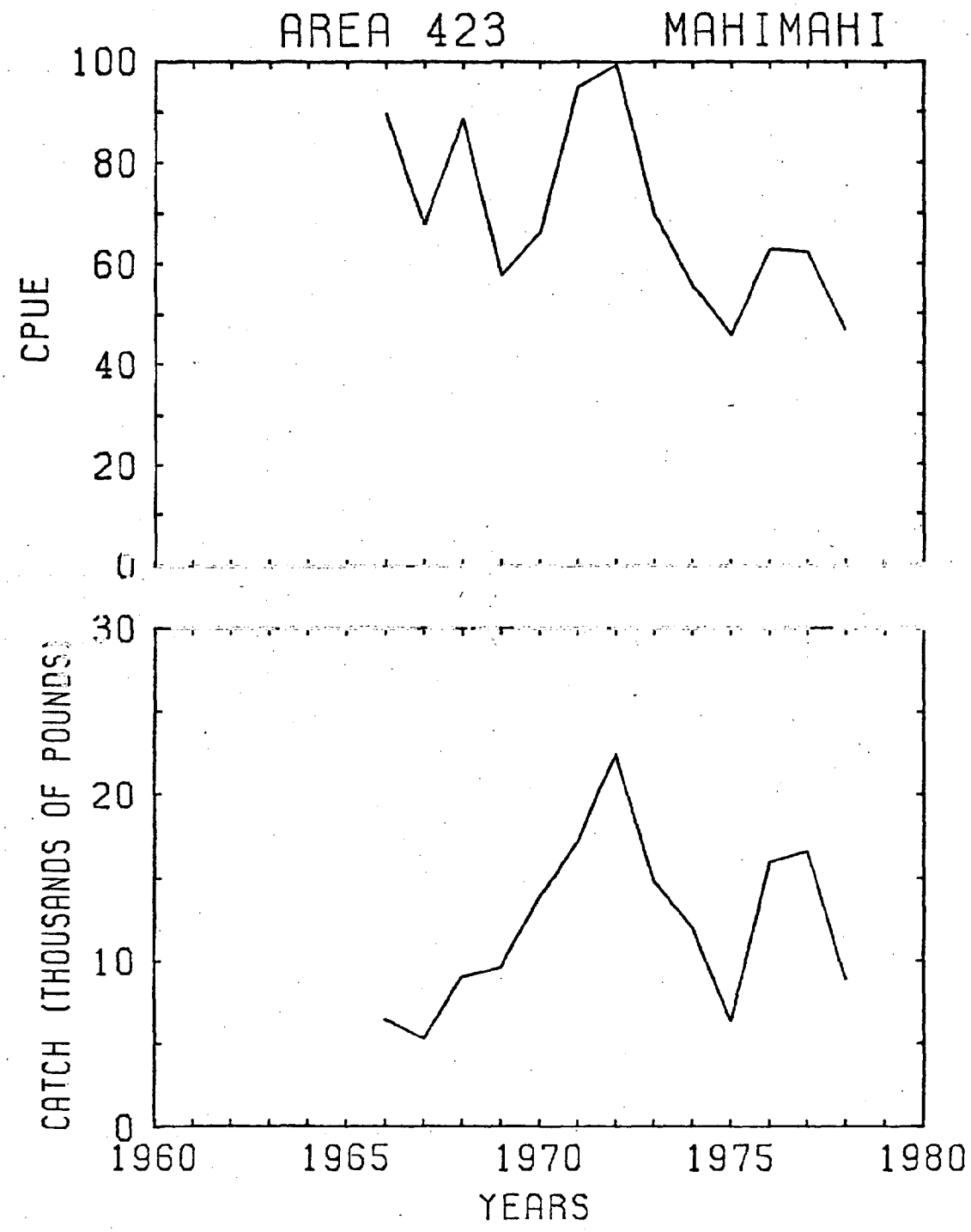

AREA 423
MAHIMAHI
CPUE
100
80
60
40
20
0
CATCH (THOUSANDS OF POUNDS)
30
20
10
0
1960
1965
1970
1975
1980
YEARS

Figure 6.8

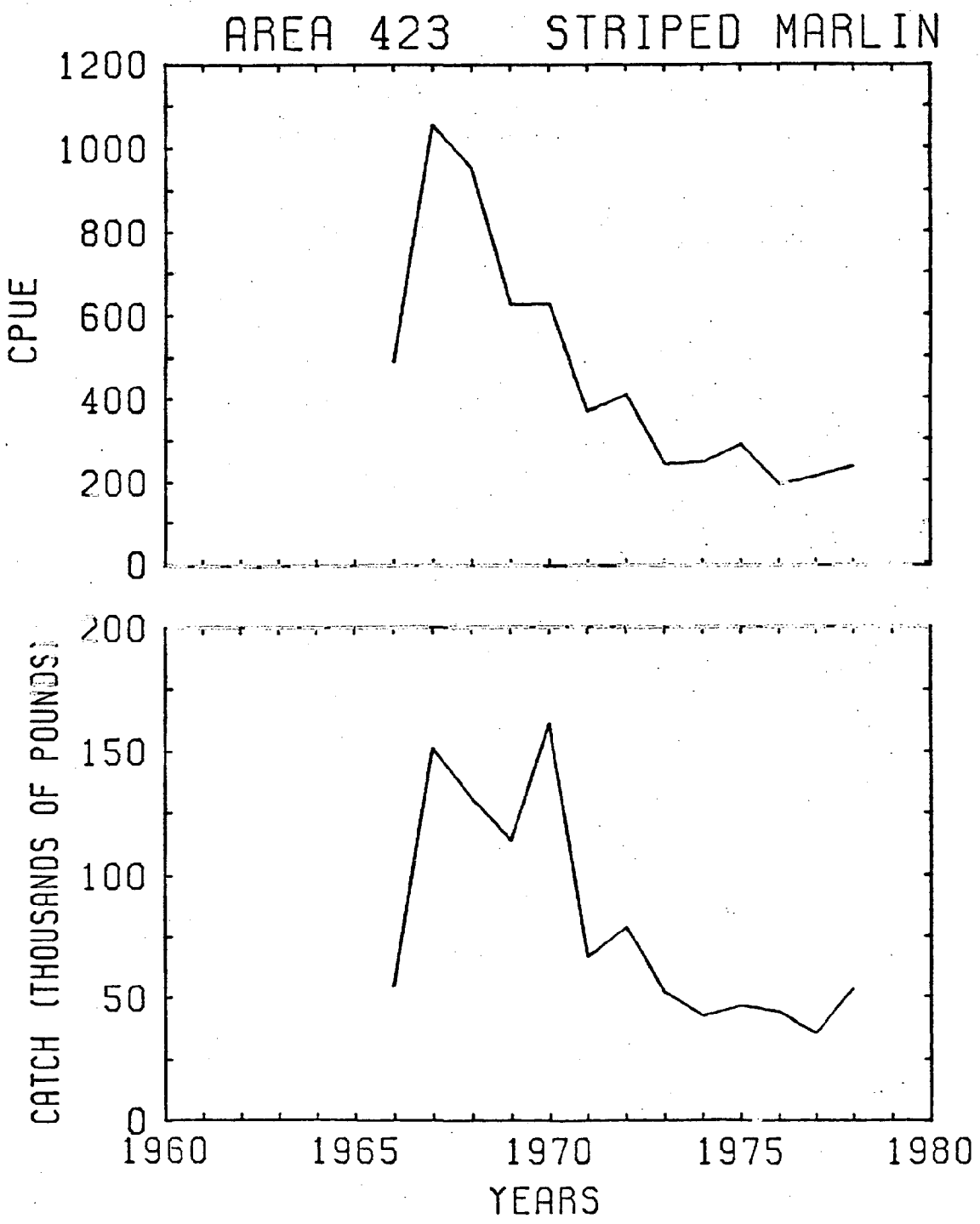

AREA 423 STRIPED MARLIN
CPUE
1200
1000
800
600
400
200
0
CATCH (THOUSANDS OF POUNDS)
200
150
100
50
0
1960
1965
1970
1975
1980
YEARS

Figure 6.9

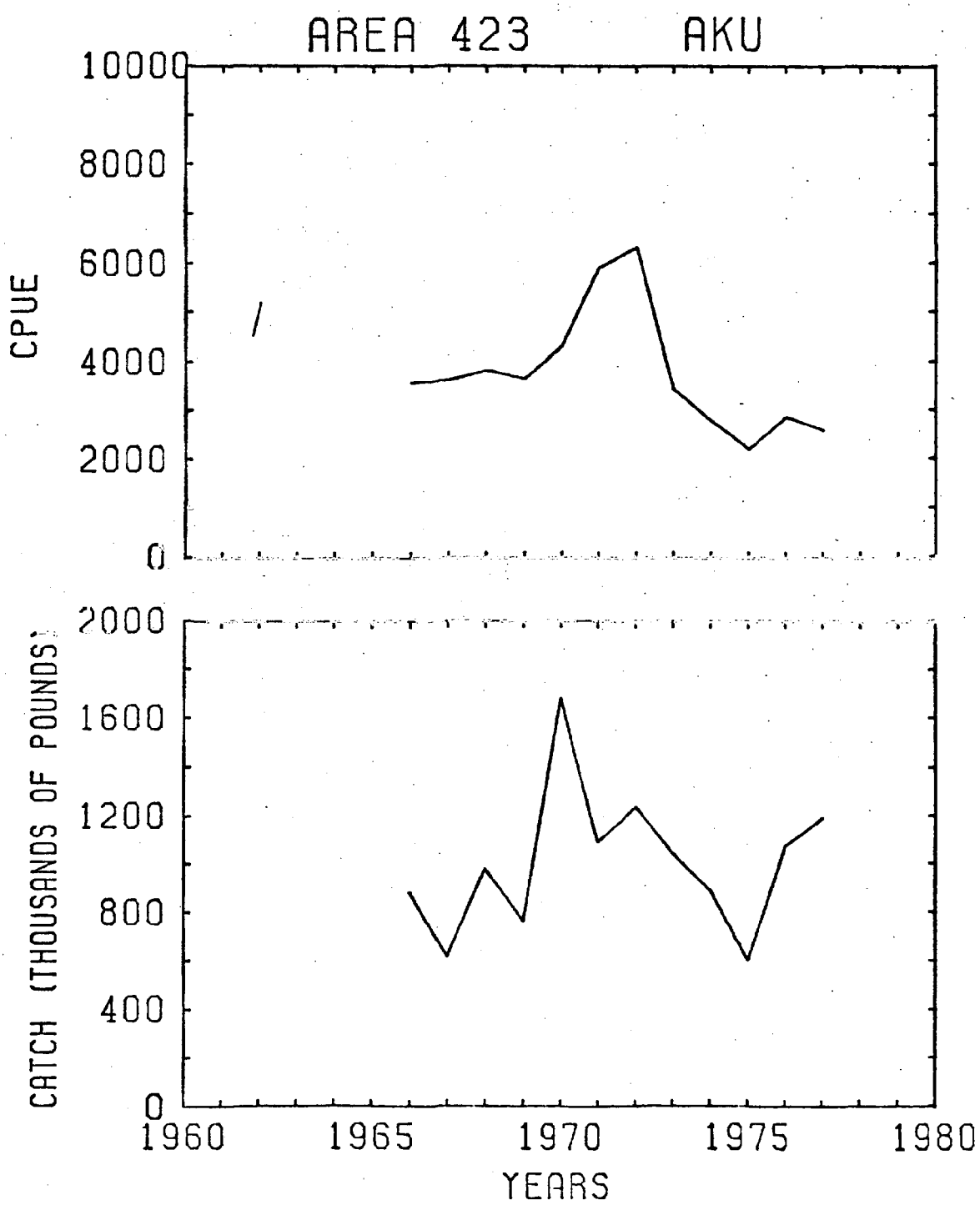

AREA 423
AKU
CPUE
10000
8000
6000
4000
2000
0
CATCH (THOUSANDS OF POUNDS)
2000
1600
1200
800
400
0
1960
1965
1970
1975
1980
YEARS

Figure 6.10

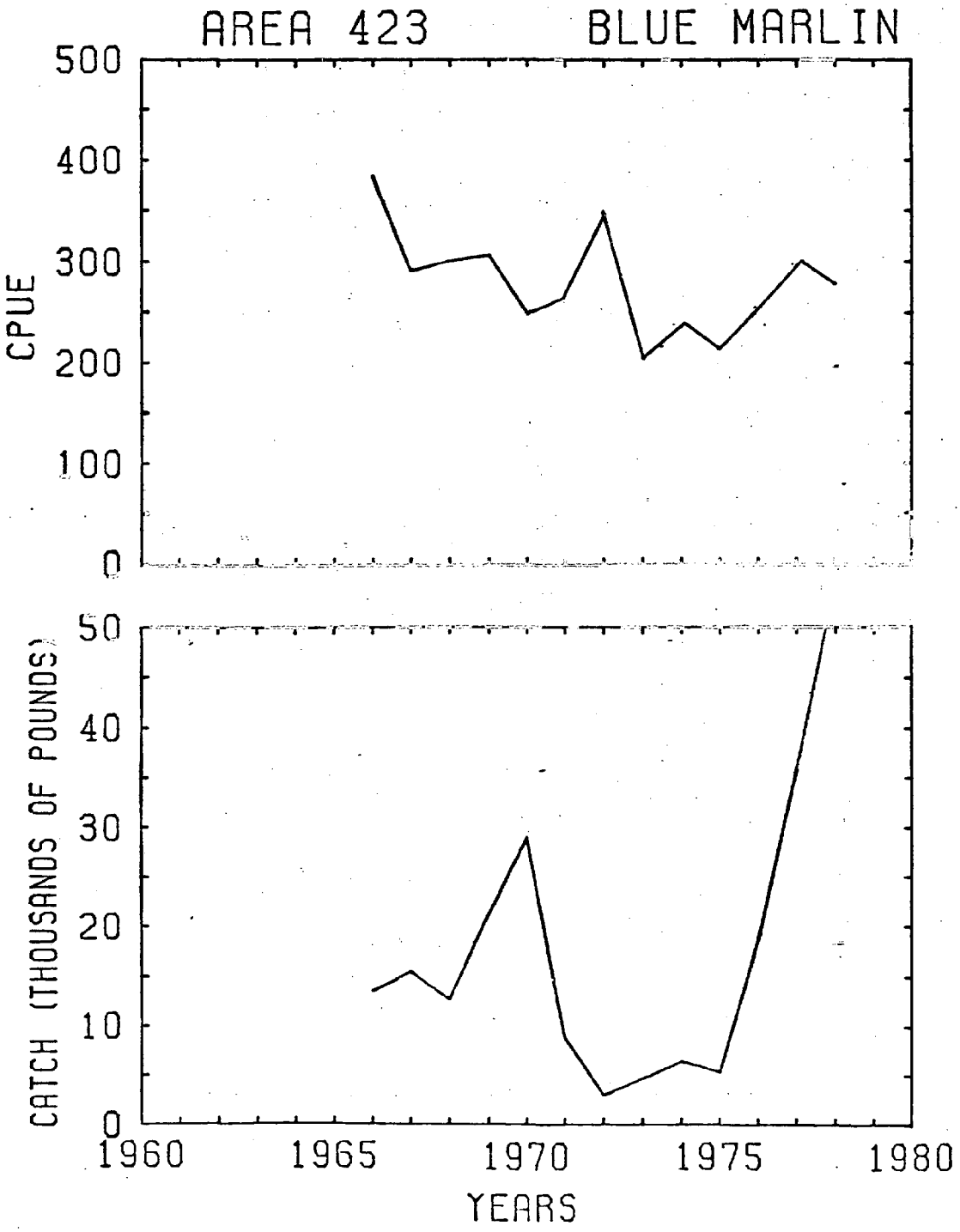
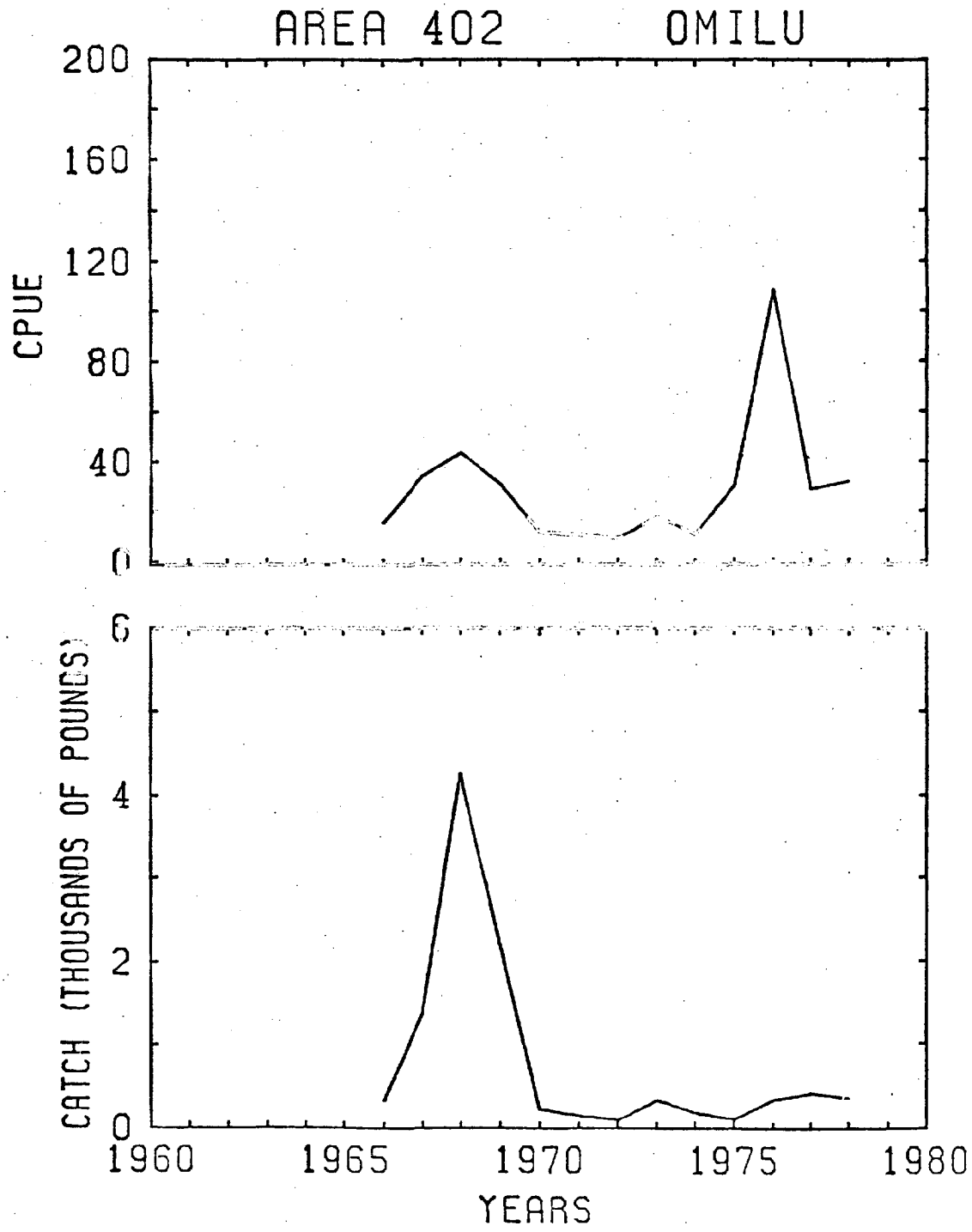

AREA 423
BLUE MARLIN
CPUE
500
400
300
200
100
0
CATCH (THOUSANDS OF POUNDS)
50
40
30
20
10
0
1960
1965
1970
1975
1980
YEARS

Figure 6.11


AREA 402 OMILU
CPUE
200
160
120
80
40
0
CATCH (THOUSANDS OF POUNDS)
6
4
2
0
1960
1965
1970
1975
1980
YEARS

Fisheries of the Island of Hawaii

Hawaii is the largest island in the Hawaiian chain and the youngest from a geological standpoint. Two of its volcanoes are still active. In addition to having a population of almost 85,000[1] it is the fastest growing island in the State. With this growth, fishing activity on the Big Island has also been increasing dramatically in recent years.

Unfortunately, the island is typically lacking in good harbors. Hilo harbor, on the windward side, is rather open and only partially protected by offshore coral reefs. Many fishermen, unable to moor their boats safely must launch them from trailers at various points around the island during calm weather.

Commercial fishing activity is located primarily in Hilo and Kona. Though Hilo has been the center for commercial fishing for many years, Kona has grown very rapidly and now competes quite favorably for commercial fishing activity. In addition, Kona is the site for the largest sport fishery in the islands and has therefore attracted many fishing support facilities as well as an internationally famous annual billfish tournament.

Generally speaking, on the Hilo side, fuel must be trucked in since there are no fueling docks. Fishermen must pick up their own ice, dockage is limited, and repair facilities are rare. The "Big Island" is well known for its *ahi* catches and will be expected to increase its *ahi* landings with improved icing facilities.

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[1] State of Hawaii Data Book. 1978.

On the Kailua-Kona side, fishing vessels moor at the Honokohau Harbor, the safest harbor on the coast and the most crowded. Other moorage (on dolphins or on anchors) is available in Kailua and Kealekekua Bay. These bays are safe for most of the year. Kealekekua Bay is now a marine life conservation district which restricts various fishing and boating operations. Ice, available in town at two suppliers, must be picked up by the fishermen themselves.

Kawaihae on the northwest coast is a commercial deepwater port but facilities are inferior to Hilo and Kailua-Kona. It contains a small boat harbor with 2 launching facilities but ice must be trucked from Hilo or Kona and there is no fuel dock.

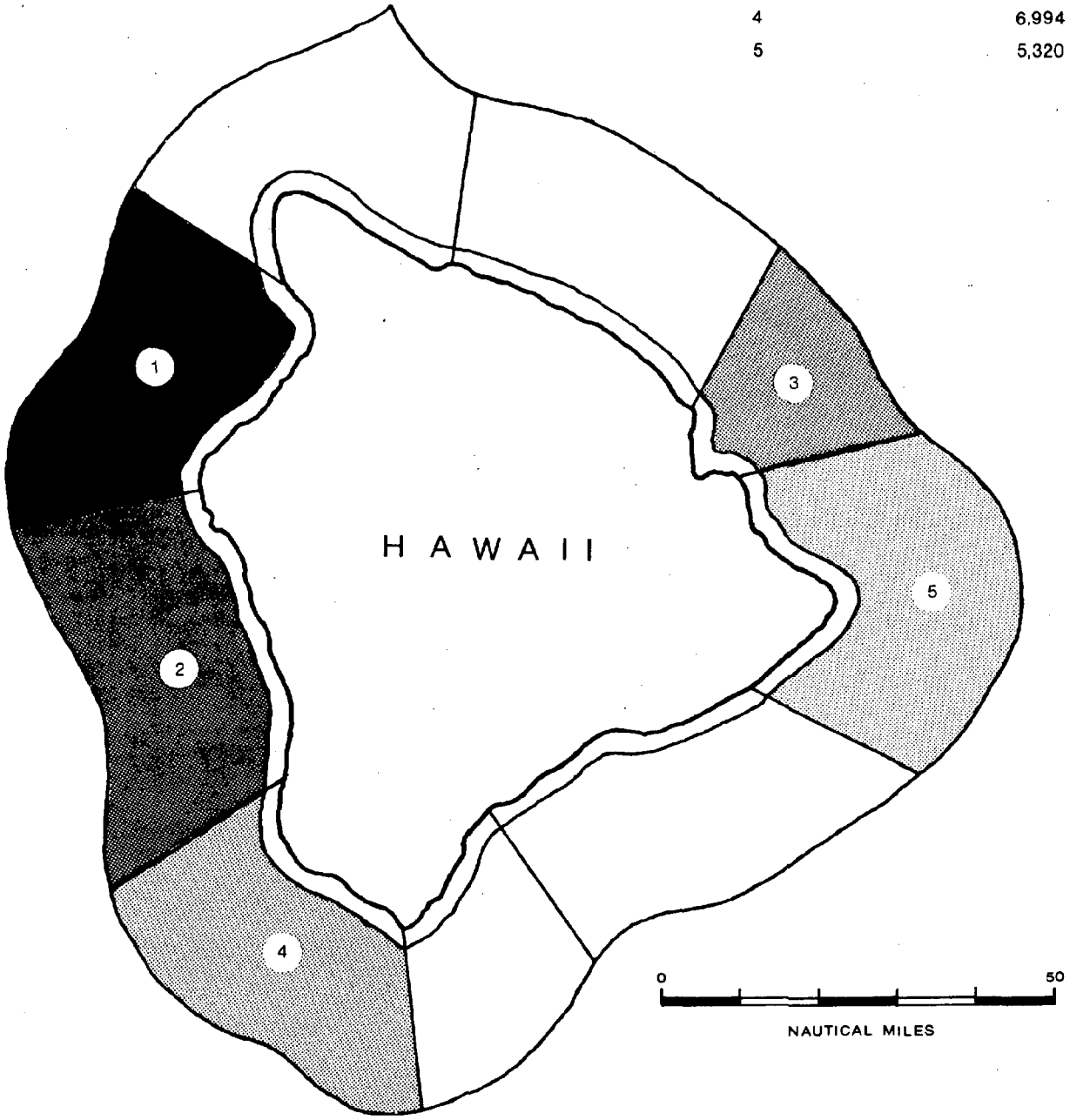
The combination of rough weather and the lack of good harbors is a serious drawback to the fisheries of the "Big Island" and results, very likely, in the lopsided area distribution of fish catches as evidenced by the map depicting the bottomfish catches for Hawaii (Fig. 6.12). Fishermen appear to concentrate their fishing activities to a few areas close to safe harbors.

The total catch landed on the "Big Island" in 1903 was 1,404,794 pounds valued at $101,149. The hand-line gear type was responsible for 4/5 of this amount. Gill nets, seines, cast nets, spears, dip nets, hands, baskets, bag nets, and snares followed in that order. The *akule* (big-eyed scad) was the main species taken by the Hawaii fisheries, composing over 1/3 of the total catch. Other important species were *aku, ulua, moano, kawakawa, oio, opelu,* and *puhi.*

Figure 6.12

AVERAGE ANNUAL CATCH OF MAJOR BOTTOM FISHES FROM 1973–1977

SEGMENT RANKING	CATCH (POUNDS)
1	24,398
2	12,631
3	7,629
4	6,994
5	5,320



In 1977, the "Big Island" landed 2,591,467 pounds of fish (excluding pond catch) valuing $2,327,835, second only to the island of Oahu. The major gear type remains the handline, followed by trolling. The *ahi* were the major species taken followed by *opihi, ono, opelu, akule,* and blue marlin. See Table 6.2 for a listing of major species by area.

Skipjack tuna *(aku)* is a highly migratory tuna species of great commercial importance to the State. The variability in the catches of this tuna species can frequently mask the general trends in catches of other less-migratory species of fish when the totals are lumped together. Figures 6.13 and 6.14 consequently distinguish between the skipjack and non-skipjack catches for inshore and offshore statistical areas around the "Big Island".

Area 121 reports the greatest catches of *ahi* (YF), blue marlin and *ono* in the State. Catch and catch rate (CPUE) curves for these species are shown in Figures 6.15 through 6.17. Of note, CPUE curves have been relatively flat in recent years in Area 121 while total catches have made steep rises. This is indicative of a marked increase in fishing effort. Catch and catch rate (CPUE) curves for some of the other major species are shown by area in Figures 6.18 through 6.20.

Table 6.2--Top Ranking Species by Total Pounds Caught in 1977
Hawaii

Area*	#1	#2	#3	#4	#5
100	opelu	ahi-yf	menpachi	aweoweo	moana
101	opelu	ahi-yf	akule	ono	ulua
102	ahi-yf	opelu	ono	menpachi	uhu
103	ono	mahimahi	opihi	miscellaneous	opelu
104	opihi	akule	menpachi	saba	opelu
105	ahi-yf	akule	amaama	kahala	onaga
106	opihi	taape	moana	aawa	hage
107	ono	menpachi	taape	ehu	opihi
108	opihi	ahi-yf	menpachi	opelu	ono
120	ahi-yf	blue marlin	opakapaka	opelu	kahala
121	ahi-yf	blue marlin	opelu	ono	ahi-be
122	ahi-yf	blue marlin	aku	ono	opakapaka
123	aku	ono	opelu	opakapaka	blue marlin
124	ahi-be	broadbill	striped marlin	ahi-yf	ono
125	ahi-yf	aku	albacore	ahi-be	ono
126	ahi-yf	albacore	ono	ahi-be	mahimahi
127	ahi-yf	ono	ehu	ulua	opakapaka
128	ahi-yf	ono	opakapaka	onaga	kahala

*See Figure 4.3 for location of areas.

Figure 6.13

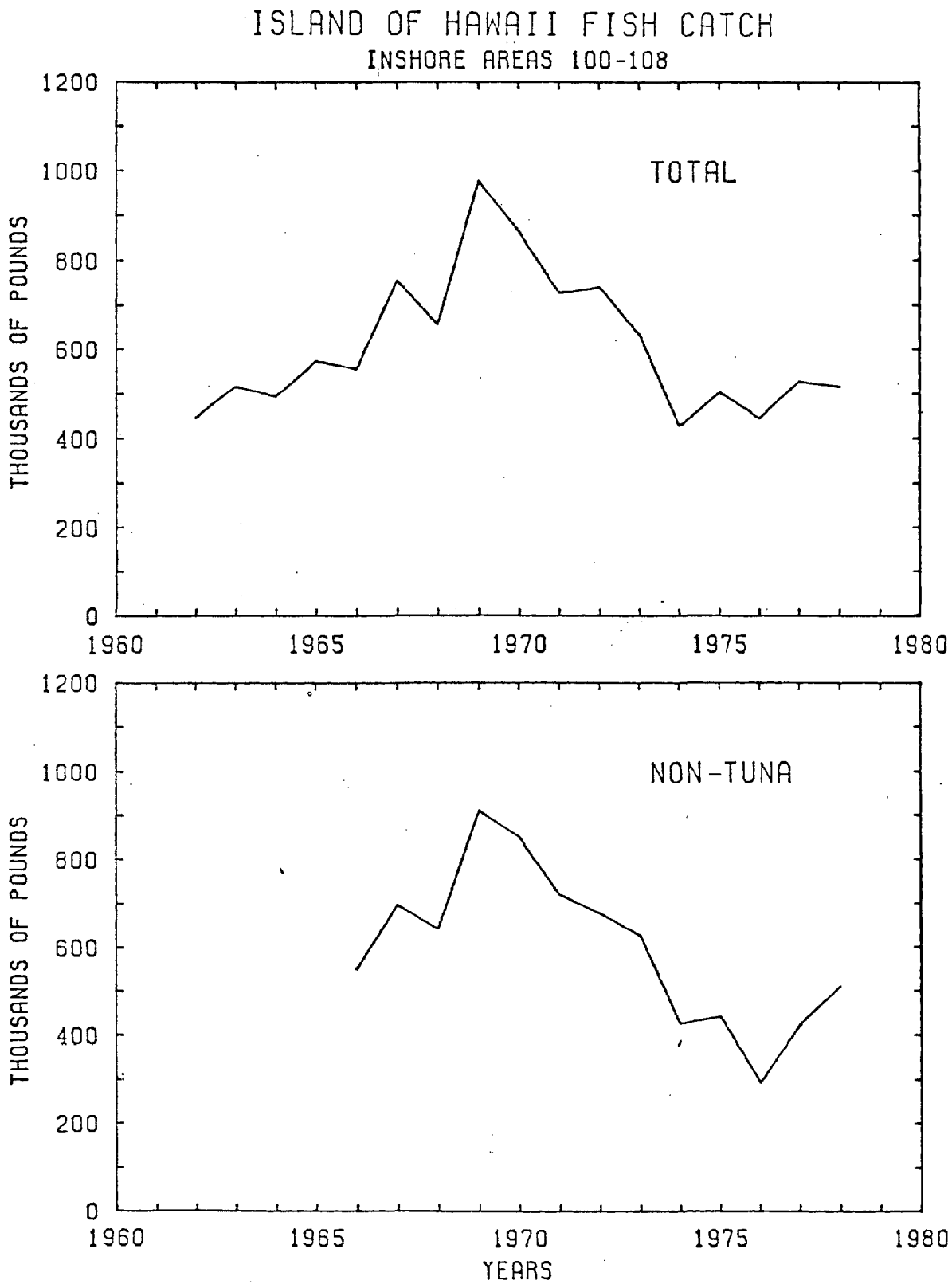

ISLAND OF HAWAII FISH CATCH
INSHORE AREAS 100-108
TOTAL
NON-TUNA
THOUSANDS OF POUNDS
1200
1000
800
600
400
200
0
1960
1965
1970
1975
1980
YEARS

Figure 6.14

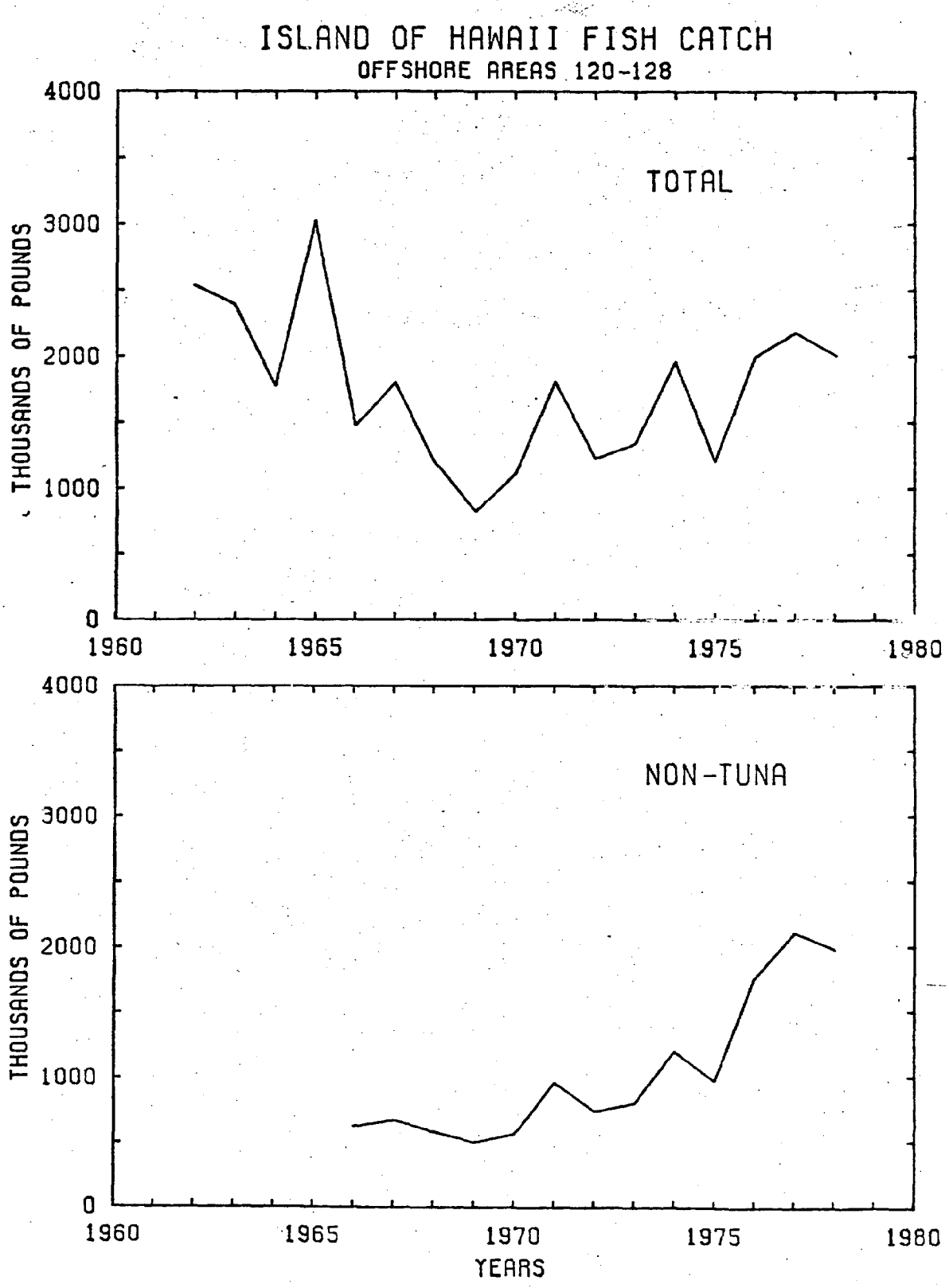

ISLAND OF HAWAII FISH CATCH
OFFSHORE AREAS 120-128
TOTAL
NON-TUNA
THOUSANDS OF POUNDS
4000
3000
2000
1000
0
1960
1965
1970
1975
1980
YEARS

Figure 6.15

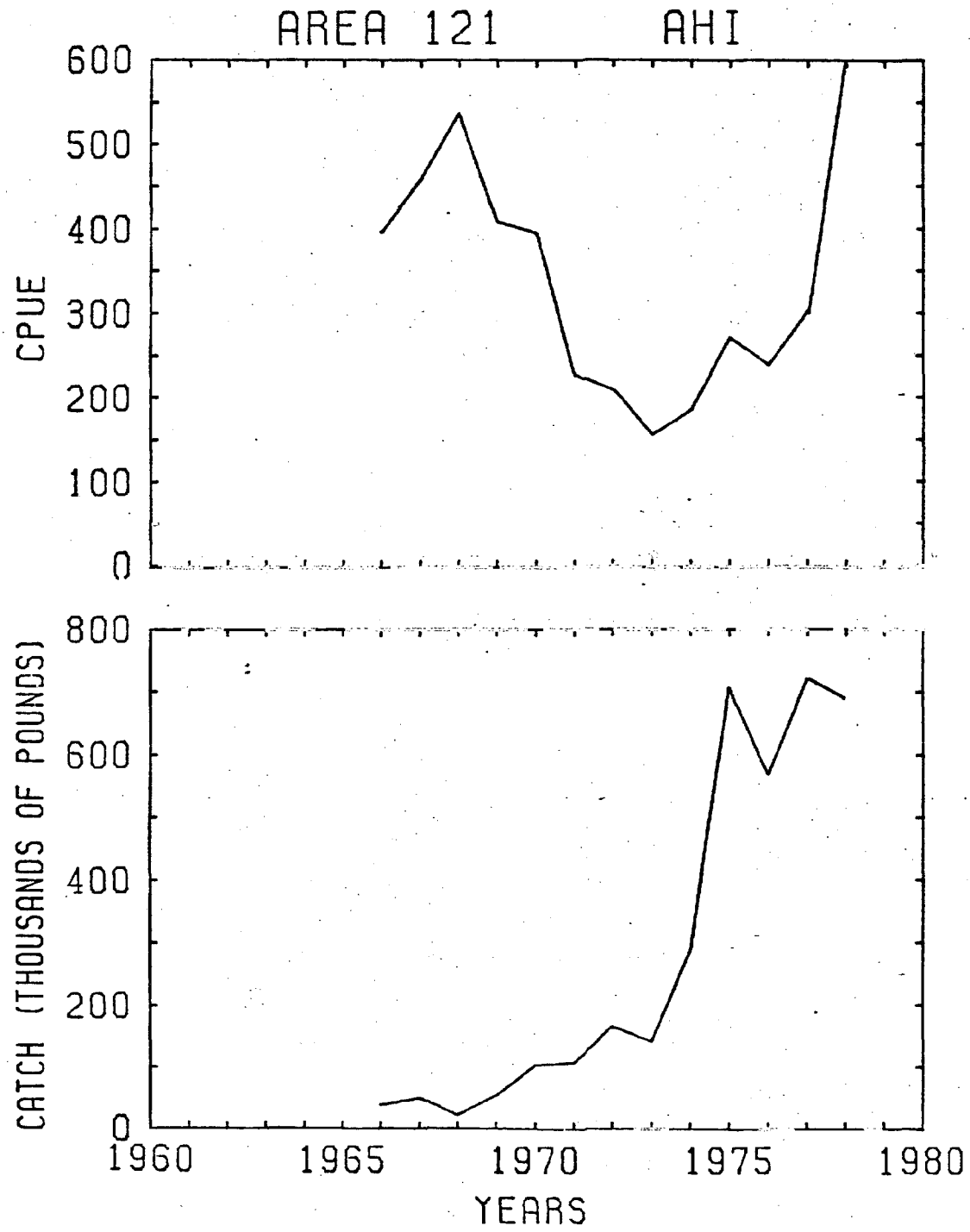

AREA 121 AHI
CPUE
600
500
400
300
200
100
0
CATCH (THOUSANDS OF POUNDS)
800
600
400
200
0
1960
1965
1970
1975
1980
YEARS

Figure 6.16

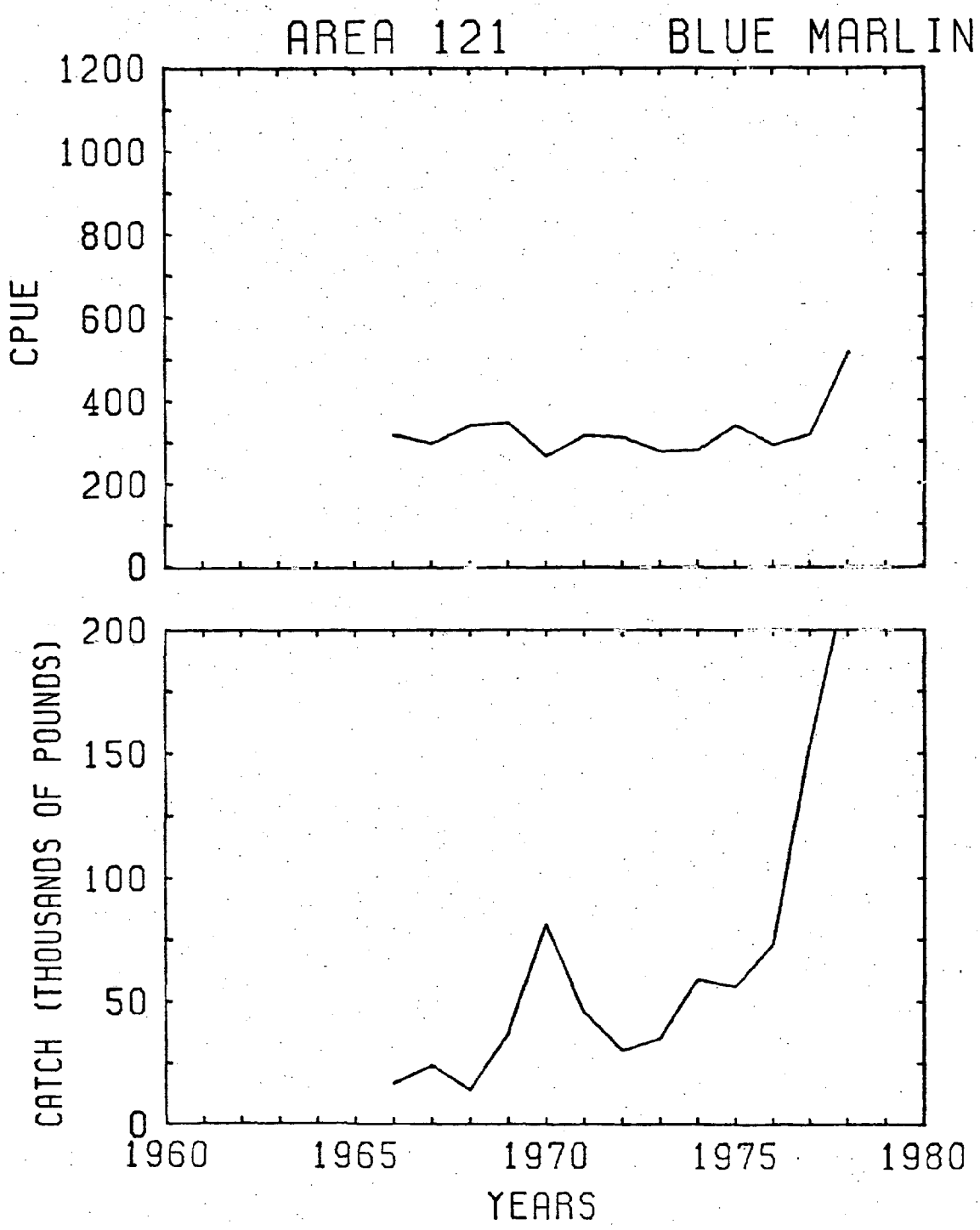

AREA 121
BLUE MARLIN
CPUE
1200
1000
800
600
400
200
0
CATCH (THOUSANDS OF POUNDS)
200
150
100
50
0
1960
1965
1970
1975
1980
YEARS

Figure 6.17

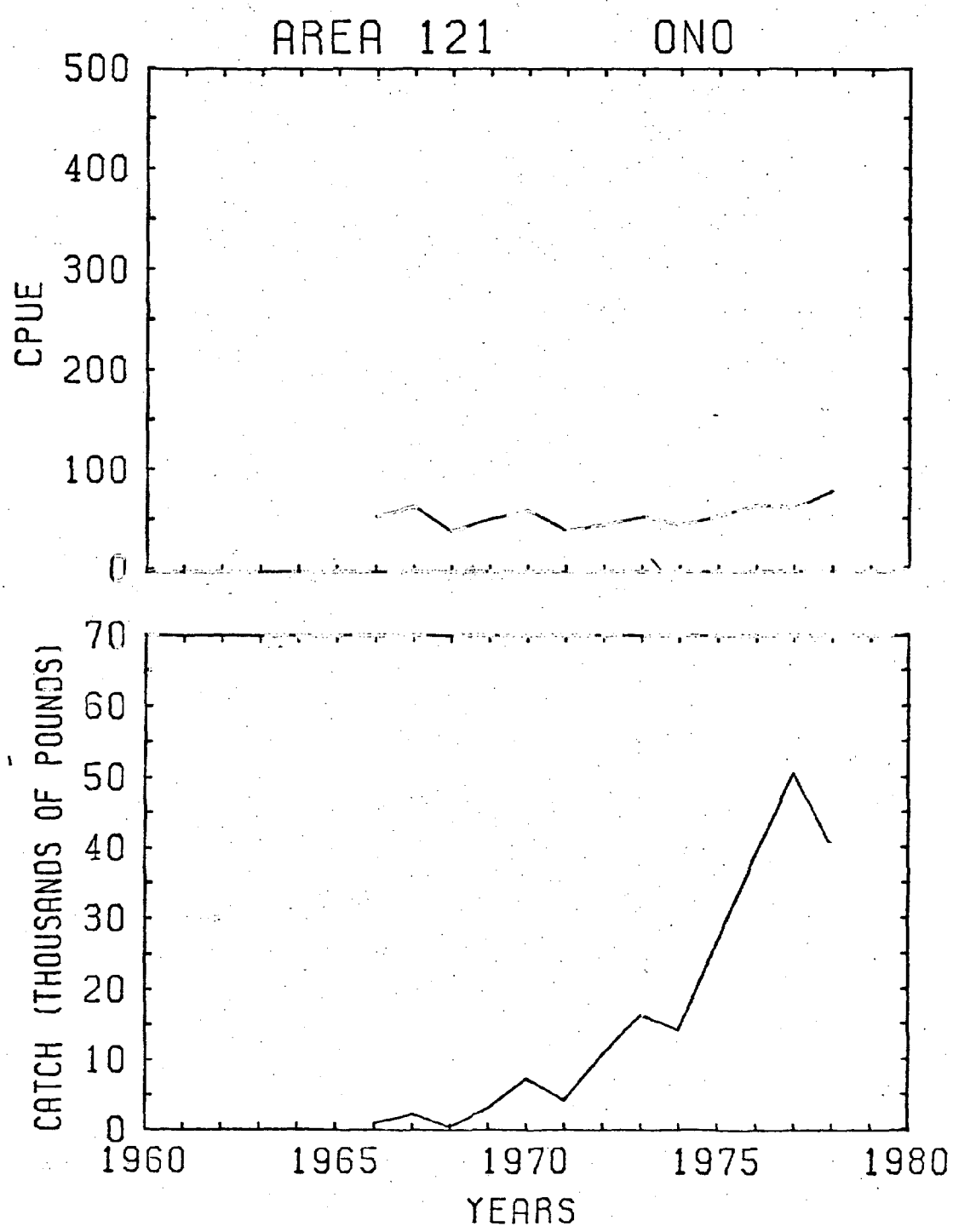

AREA 121 ONO
CPUE
500
400
300
200
100
0
CATCH (THOUSANDS OF POUNDS)
70
60
50
40
30
20
10
0
1960
1965
1970
1975
1980
YEARS

Figure 6.18

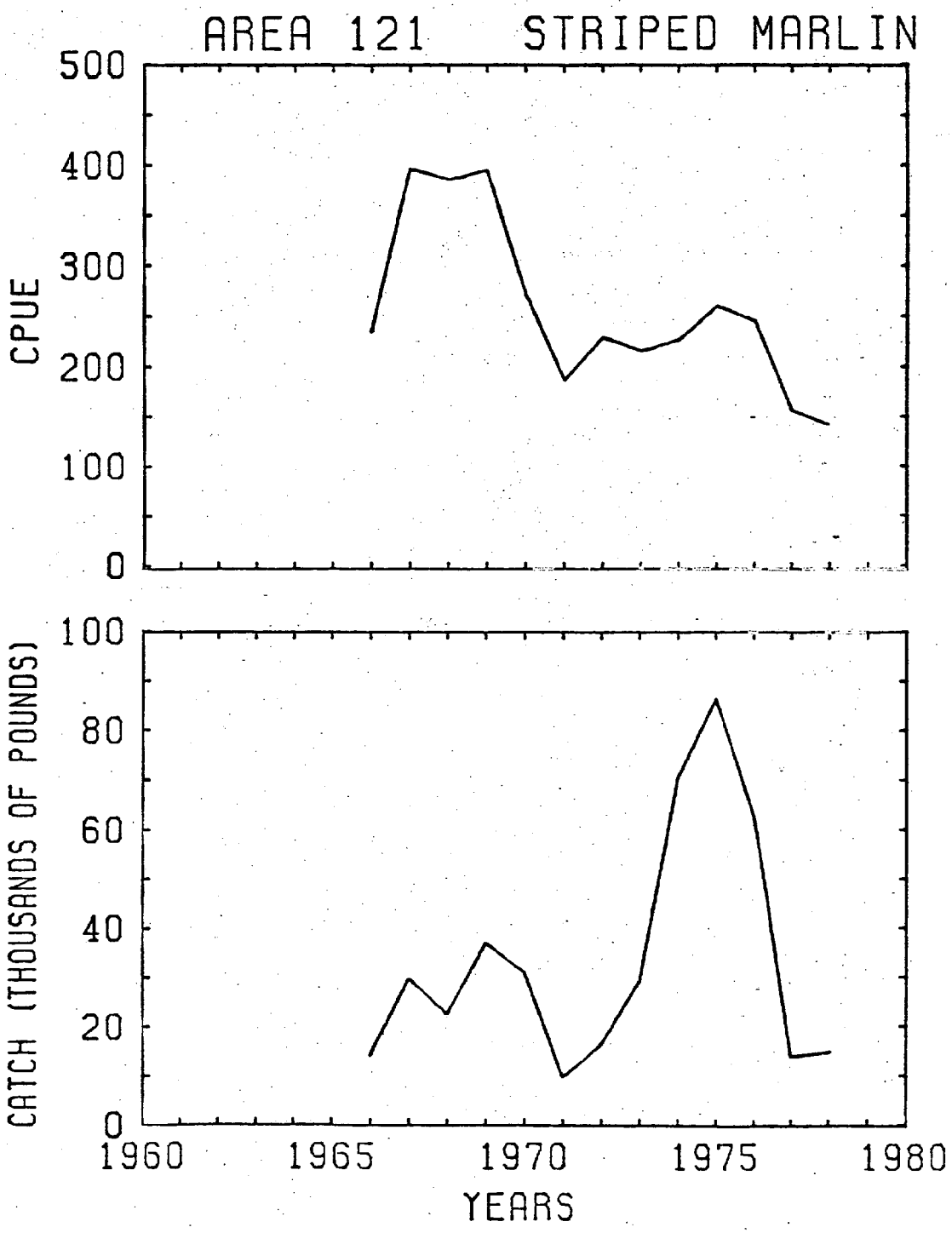

AREA 121 STRIPED MARLIN
CPUE
500
400
300
200
100
0
CATCH (THOUSANDS OF POUNDS)
100
80
60
40
20
0
1960
1965
1970
1975
1980
YEARS

Figure 6.19

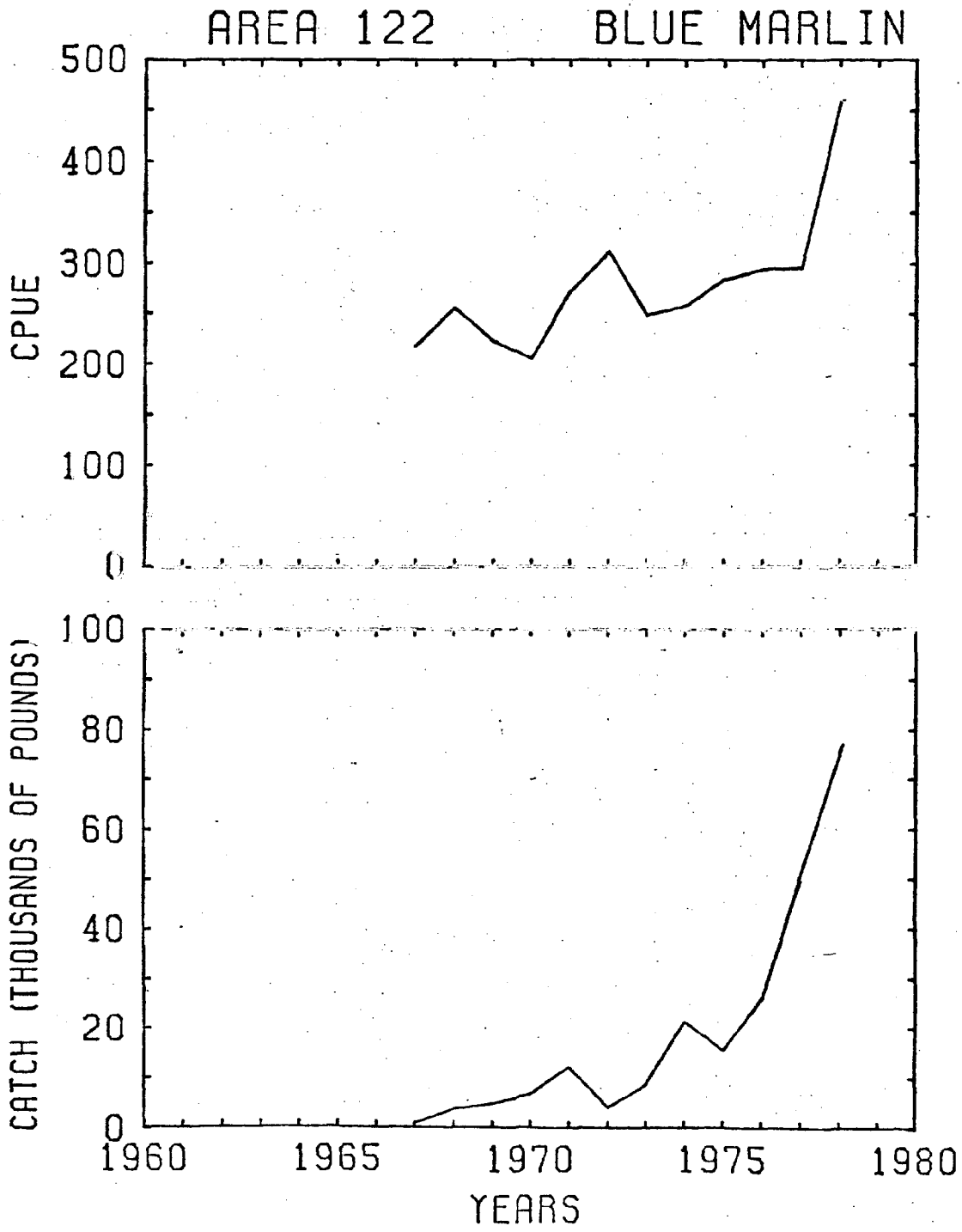
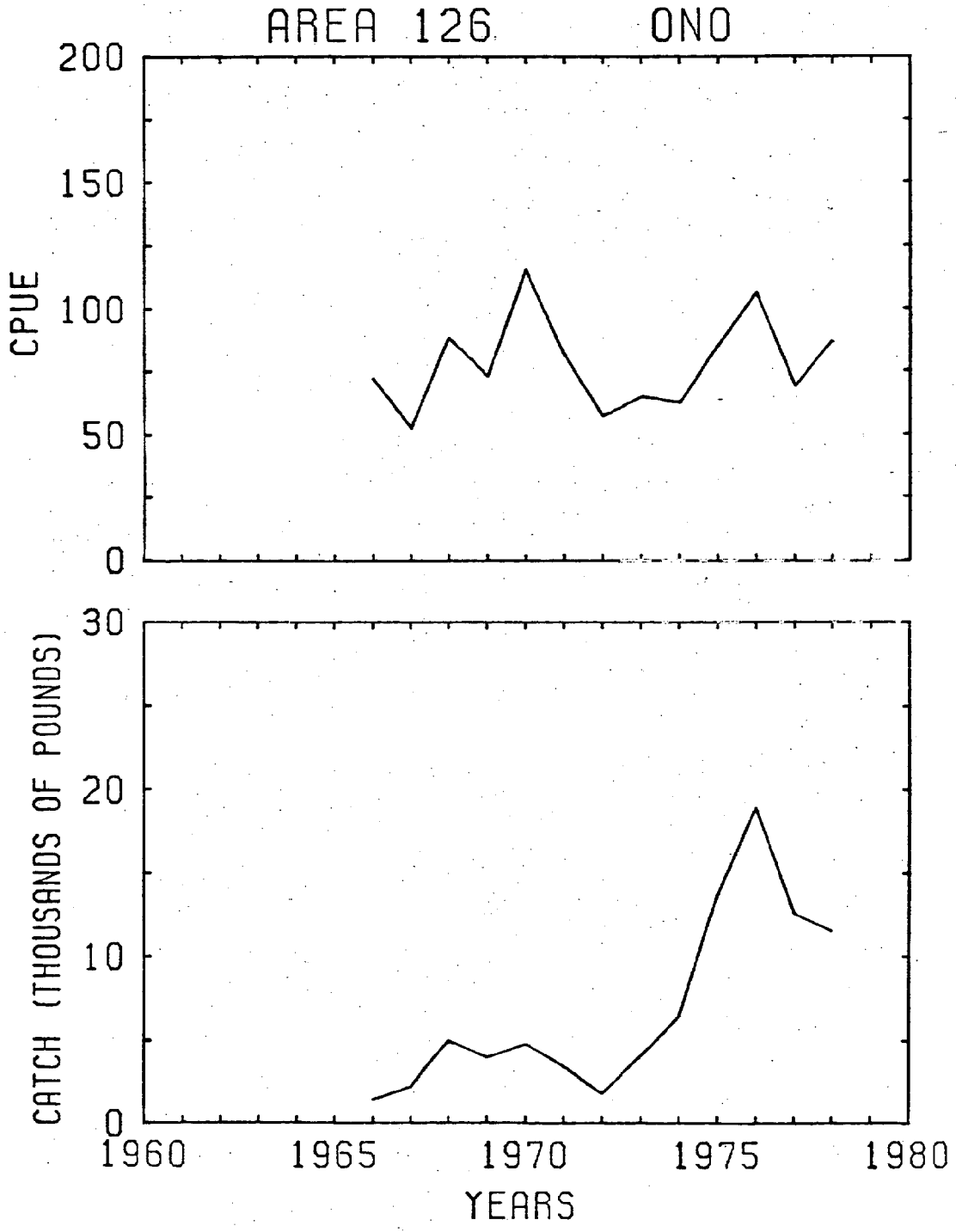

AREA 122
BLUE MARLIN
CPUE
500
400
300
200
100
0
CATCH (THOUSANDS OF POUNDS)
100
80
60
40
20
0
1960
1965
1970
1975
1980
YEARS

Figure 6.20


AREA 126 ONO
CPUE
200
150
100
50
0
CATCH (THOUSANDS OF POUNDS)
30
20
10
0
1960
1965
1970
1975
1980
YEARS

Fisheries of Maui

Maui is the second largest of the Hawaiian islands with an area of 728 square miles and a population of approximately 67,000. Maui is identified as the fresh fish capital of the State. The heavy tourist industry there provides a market for fresh fish which is unequalled on the other islands. In fact, Maui cannot get enough fresh fish and must import fresh fish from Kona which has yet to develop an equivalent demand. As a result, a highly successful fishermen's co-op has evolved. The preferred fish on Maui are *mahimahi, ono,* and various species of bottomfish. *Aku* is preferred over *ahi* on the island.

As is the case with the other islands, the fisheries of Maui are greatly influenced by the lack of good harbors and berthing facilities around the island. Many feel that Maui has the worst harbor problems of any of the islands. The acute shortage of berthing facilities has reached the point where a black market now exists for public harbor slips (Hollis, 1979). Although Kahului harbor is the major commercial port of the island, most of the fishing boats moor at Maalaea and Lahaina, both of which lack fuel and ice facilities.

Maalaea harbor is the home port of a relatively large charter sportfishing fleet and a small commercial fishing fleet. South swells occasionally damage boats within the harbor. This same swell which causes surge in the harbor generates excellent waves for board surfing outside the entrance to the harbor. Maalaea is considered the best surfing site on Maui's leeward coast. Efforts to reduce the surge for boaters are being

attempted without altering the wave pattern so desirable to surfers.

Boat launching facilities are extremely limited on the island of Maui. Maalaea has a boat ramp for trailerboat fishermen with a winch operated by the Maalaea Boat and Fishing Club and fishing vessels can be hauled out for repairs by the fishermen. The Lahaina boat harbor and launch ramp and the Mala ramp provide berths for numerous charter boats and access for the trailerboat fishermen of West Maui. Several sportfishing vessels are also moored in the shallow waters outside the harbor which acts as a departure point for many fishing, sailing, glass bottom, and diving charter boats. A boat launch ramp at the west margin of Kahului harbor is rarely used by small boat fishermen since the rough waters detract from pleasure boating. However, *akule* and *opelu* are netted within the harbor as well as *nehu* and *iao*. These same species, especially the *akule* and the *hahalalu* (young *akule*), are taken by pole and line fishermen from the harbor pier and breakwaters. Conflicts are growing between pole and line fishermen and net fishermen over the fish resources in the harbor.

There are a number of proposed improvements to the harbors of Maui, in particular to Maalaea and Kahului. Work is currently underway to improve the Kahului shoreline area between piers 1 and 2 for foreign fishing boat usage. Construction of a new boat harbor between Maalaea and Kihei has been proposed in the past. The protected nature of this area makes it highly desirable as a harbor. It is presently the site of a temporary aquaculture facility and a valuable habitat for resident and migratory waterbirds. With the possible exception of the

wetlands of Niihau, more Hawaiian coots breed in Kealia Pond than in any other single habitat in the State. As a result, the U.S. Fish and Wildlife Service desires approximately 500 acres of Kealia Pond for a National Wildlife Refuge. The shallow waters fronting Kealia Pond provide the major supply of baitfish for Maui commercial tuna fishing boats.

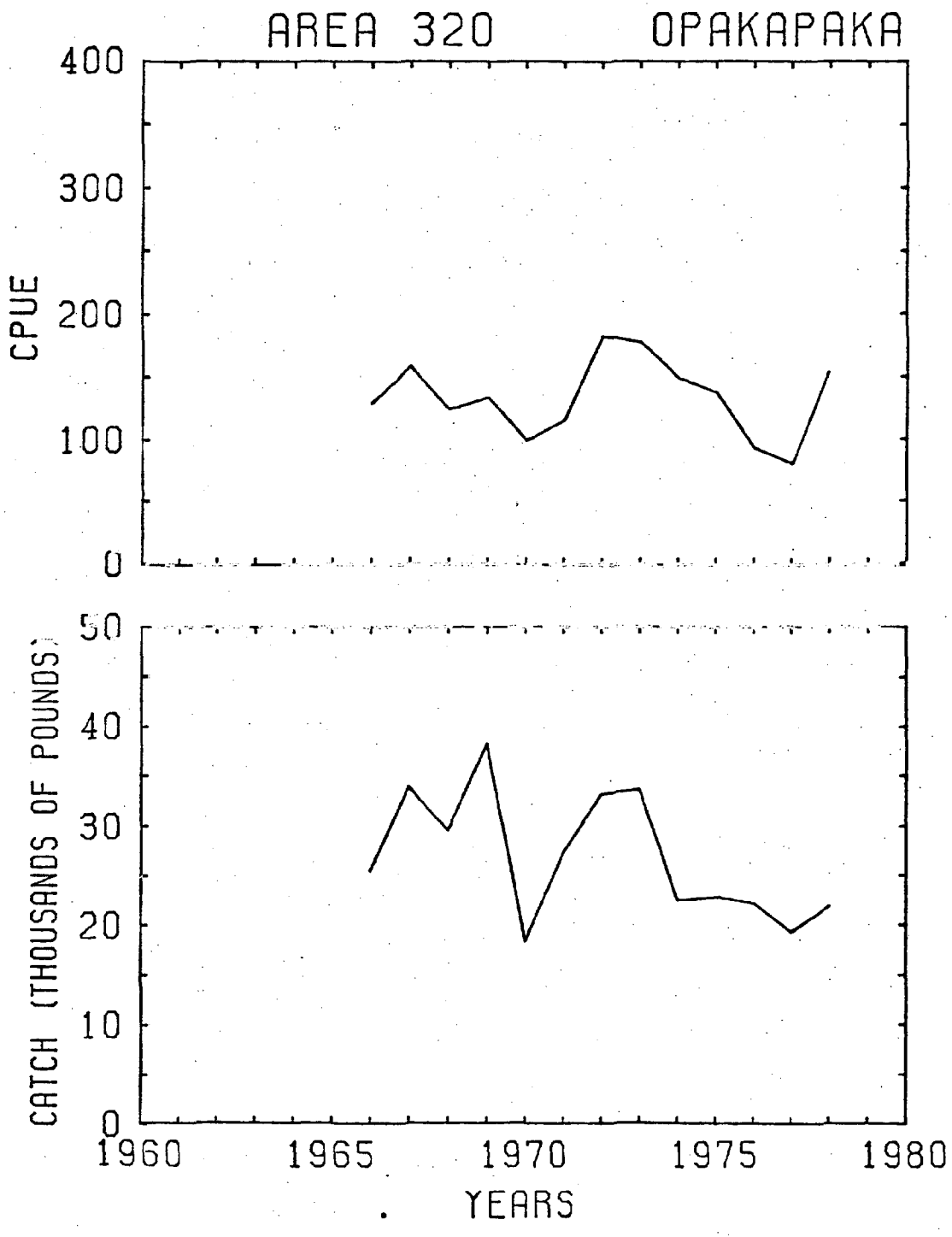
As a result of the relatively poor boat launching and mooring conditions on the island, fishing is largely confined to a few miles in the vicinity of the two larger harbors. Table 6.3 outlines the top ranking species by area in 1977 for the island waters surrounding Maui, Molokai, and Lanai. In 1903, the island of Maui contributed 1,212,445 pounds of fish compared with 921,012 pounds in 1977. In 1903, as well as 1977, handlines were the most frequently used gear type. The principle species taken in the 1903 fisheries were *akule, opelu, nehu, ulua, oio, aku, amaama, kawakawa,* and *opakapaka.* Area 320 yields the largest catch of *opakapaka* in the State. See Figure 6.21 for the catches and catch rates for this species in area 320.

Table 6.3--Top Ranking Species by Total Pounds Caught in 1977
Maui, Molokai, Lanai

Area	#1	#2	#3	#4	#5
300	akule	opelu	moelua	tako	nabeta
301	hahalalu	akule	moelua	lobster-sp	nabeta
302	akule	tako	awa	nenue	lobster-sp
303	akule	opihi	nenue	kole	manini
304	akule	opihi	uku	ulua	moelua
305	akule	oio	moelua	opihi	menpachi
306	mahimahi	ono	kawakawa	menpachi	ahi-yf
307	moelua	ono	uku	ulua	mahimahi
308	aku	hahalalu	akule	ono	kawakawa
309	uku	opakapaka	kalikali	ulua	miscellaneous
310	akule	aku	weke	ulua	amaama
311	ulua	uku	kaku	kumu	menpachi
312	menpachi	hanui	manini	taape	aawa
313	opihi	uhu	miscellaneous	ono	menpachi
314	kala	weke	opihi	manini	weke-ula
320	opakapaka	moelua	aku	ono	uku
321	aku	opae	akule	opakapaka	ono
322	aku	opakapaka	ono	weke	tako
323	aku	opihi	opakapaka	uku	akule
324	aku	uku	opakapaka	ahi-yf	mahi & ono
325	blue marlin	uku	taape	kawakawa	ahi-yf
326	aku	opakapaka	blue marlin	ono	onaga
327	aku	opakapaka	kawakawa	blue marlin	ono
328	aku	onaga	ahi-be	opakapaka	albacore
331	aku	kona crab	opakapaka	mahimahi	ehu
332	aku	kawakawa	opakapaka	mahimahi	ulua
333	aku	opakapaka	blue marlin	kahala	ahi-yf

See Figure 4.3 for location of areas.

Figure 6.21


AREA 320
OPAKAPAKA
CPUE
400
300
200
100
0
CATCH (THOUSANDS OF POUNDS)
50
40
30
20
10
0
1960
1965
1970
1975
1980
YEARS

Fisheries Of Kauai

Kauai is the oldest of the main islands of Hawaii with a land area of 547 square miles and a population of approximately 36,500. The fisheries of Kauai are exploited primarily by part-time fishermen. The commercial fishing activity is relatively small today compared with the other islands.

Many of the fishermen use trailerable boats which are fueled and iced on the way to the launching ramp. Nawiliwili harbor and Port Allen are the major harbors on the island. A boat ramp for haul out is available at the small boat harbors at both ports. Repairs are made by the fishermen themselves and ice and fuel must be trucked in. Although there have been efforts to locate an ice facility on Kauai, this is yet to actually materialize.

In 1903, there were 314 people engaged in the Kauai fisheries. In 1977, there were 192. The total catch was 377,946 pounds (1903) compared with 421,752 in 1977, a remarkably stable production rate. Interestingly, more than half of the catch was taken by seines and nets in 1903 compared with trolling and handlines in 1977. The principal species reported in 1903 were *amaama, akule, oio, ulua,* and *moi*. The principal species reported in 1977 were *ahi, aku, akule, menpachi,* and *ono*. See Table 6.4 for a list of top-ranking species by area. Area's 523 and 527 yield the second largest catches in the state of *hapuupuu* and *uku,* respectively. Catch and CPUE curves for these areas and fish are shown in Figures 6.22 and 6.23.

Table 6.4--Top Ranking Species by Total Pounds Caught in 1977
Kauai

Area*	#1	#2	#3	#4	#5
500	akule	ahi-yf	menpachi	aku	hahalalu
501	menpachi	ahi-yf	akule	taape	blue marlin
502	ahi-yf	aku	ono	kala	manini
503	opelu	akule	ono	ahi-yf	hahalalu
504	akule	oio	weke	ulua	aku
505	menpachi	weke	taape	uhu	opihi
506	menpachi	kona crab	opihi	uku	uhu/taape
508	menpachi	kona crab	opihi	uku	uhu/taape
520	ahi-yf	aku	ahi-be	blue marlin	ono
521	akule	aku	ahi-be	kawakawa	ono
522	aku	ahi-yf	ono	kawakawa	mahimahi
523	ahi-yf	akule	aku	kawakawa	onaga
524	ahi-be	aku	ahi-yf	broadbill	ono
525	aku	ahi-yf	ono	striped marlin	ulua
526	aku	ahi-yf	ono	kawakawa	uku
527	ahi-yf	aku	ono	uku	onaga
528	aku	ahi-yf	uku	miscellaneous	mahimahi

*See Figure 4.3 for location of areas.

Figure 6.22

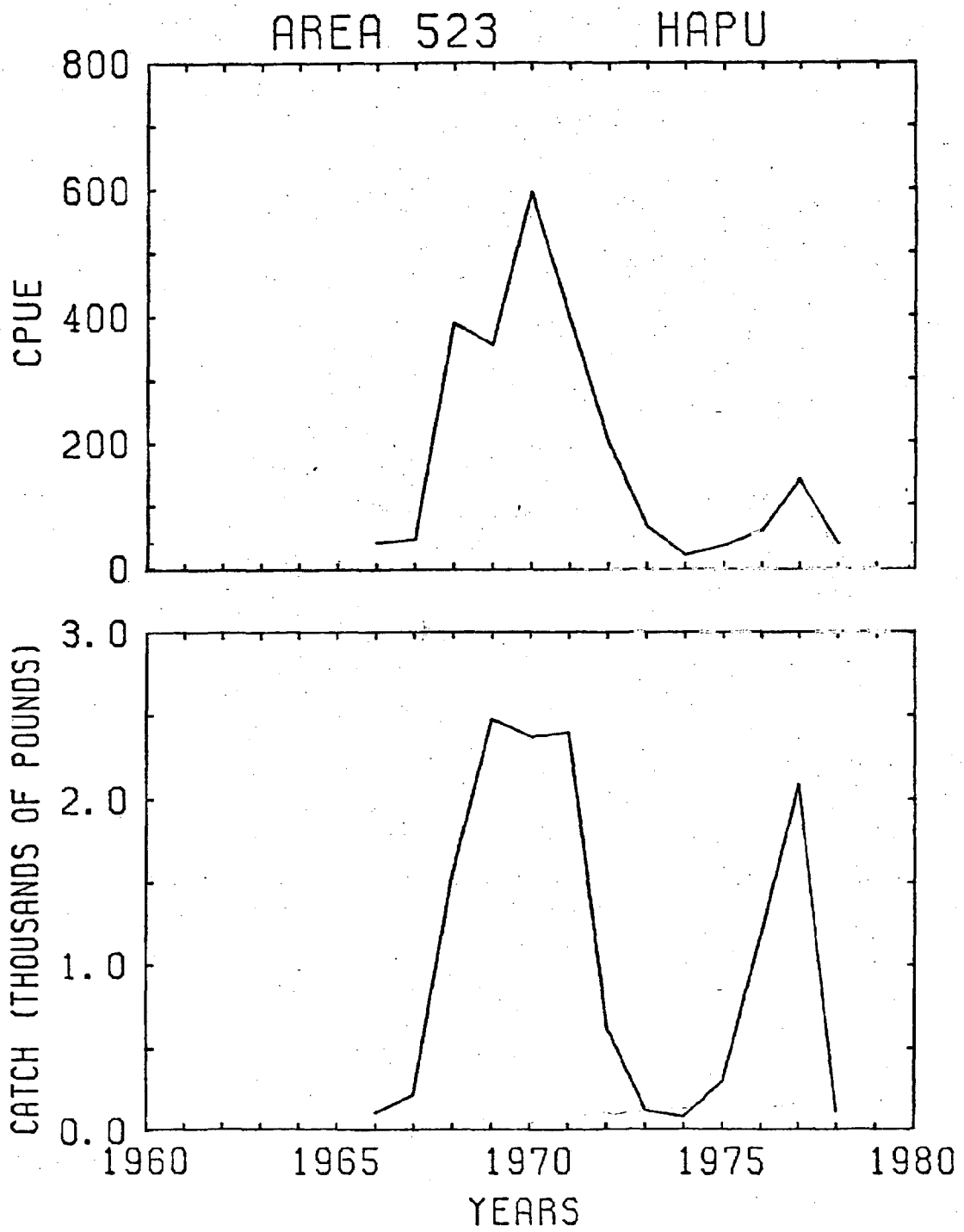
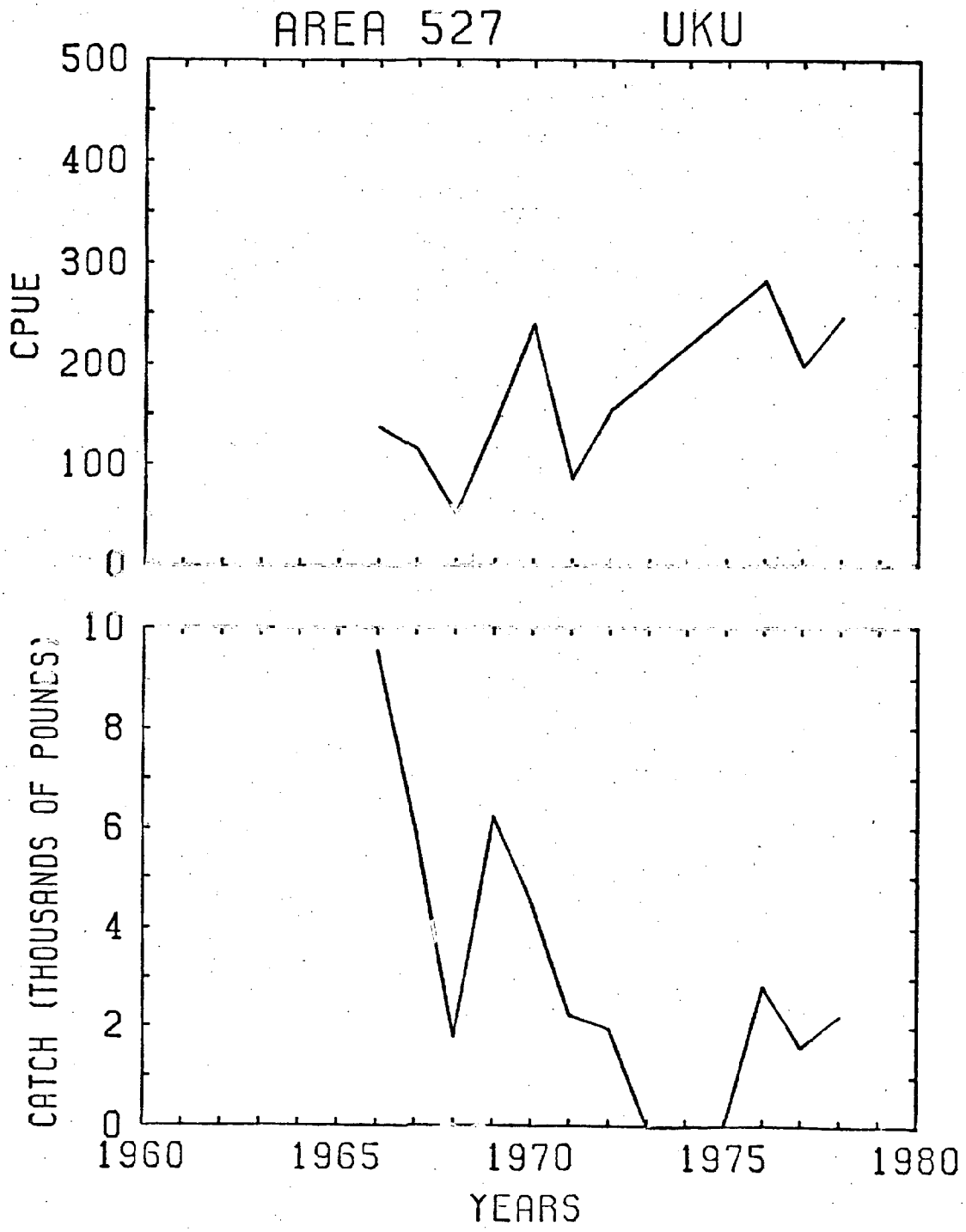

AREA 523
HAPU
800
600
400
200
0
CPUE
3.0
2.0
1.0
0.0
CATCH (THOUSANDS OF POUNDS)
1960
1965
1970
1975
1980
YEARS

Figure 6.23


AREA 527 UKU
CPUE
500
400
300
200
100
0
CATCH (THOUSANDS OF POUNDS)
10
8
6
4
2
0
1960
1965
1970
1975
1980
YEARS

Fisheries of Molokai

The island of Molokai lies midway between Oahu and Maui with an area of 261 square miles and a population of approximately 6,000. The windward side is quite precipitous and most of the population is located on the leeward side of the island. Ninety percent of Molokai's shoreline is undeveloped and privately owned. About 55% of Molokai's shoreline is physically inaccessible by land which includes 14 miles of sea cliffs which in some cases soar more than 1,000 feet. The remaining 45% of the shoreline is accessible by land, about half from sandy beaches which stretch along most of the western Molokai shores. Molokai is quite renowned for its fish ponds which dot the shores on the south and eastern sides of the island.

The demand for fish on Molokai is easily filled, supplying such a small population and a minimal tourist industry. Many people catch their own fish. Fishing and hunting, are the primary leisure/subsistence activities of the local populace.

Kaunakakai harbor is the major port, capable of handling a variety of craft. This harbor has poor protection from Kona storms but the value of improving this harbor remains unclear. It is presently the site of a large recreational and subsistence pole and line fishery which target primarily for *akule* and *hahalalu*. Additional anchorages for small boats are at Haleolono and Kolo on the southwest coast, Kalaupapa on the north, Kamalo on the south, and Pukoo on the southeast coast.

Molokai is famous for its fishing banks which have sustained a variety of fisheries from the earliest days. In 1903, there were 300 commercial fishermen from Molokai, today there are less than 50. Molokai landed 274,331 pounds of fish in 1903 compared with 26,810 pounds in 1977 (equivalent to what the 30 Kalaupapa residents alone caught in 1902). In 1903, seines and nets were the primary gear type followed by pole and line. The principle species taken were *akule, amaama, aku, oio,* and *ulua.*

In 1977, handline, trolling, and gill nets were the primary gear types. The primary species were *akule, ulua, menpachi, opihi, kala,* Kona crab, *aku, opakapaka,* and *onaga.*

The Molokai-Penguin Banks area produces the greatest bottomfish catches in the State (Table 6.5). The vast majority of these catches are reported from offshore waters (2-20 miles) and are taken primarily with deepsea handline gear. Figure 6.24 graphically clusters the various species of bottomfish according to the likelihood of catching one species with another species. For instance, a fisherman is more likely to catch a *kahala* while fishing for *hapuupuu* than he is *kalikali, ehu,* or *onaga.*

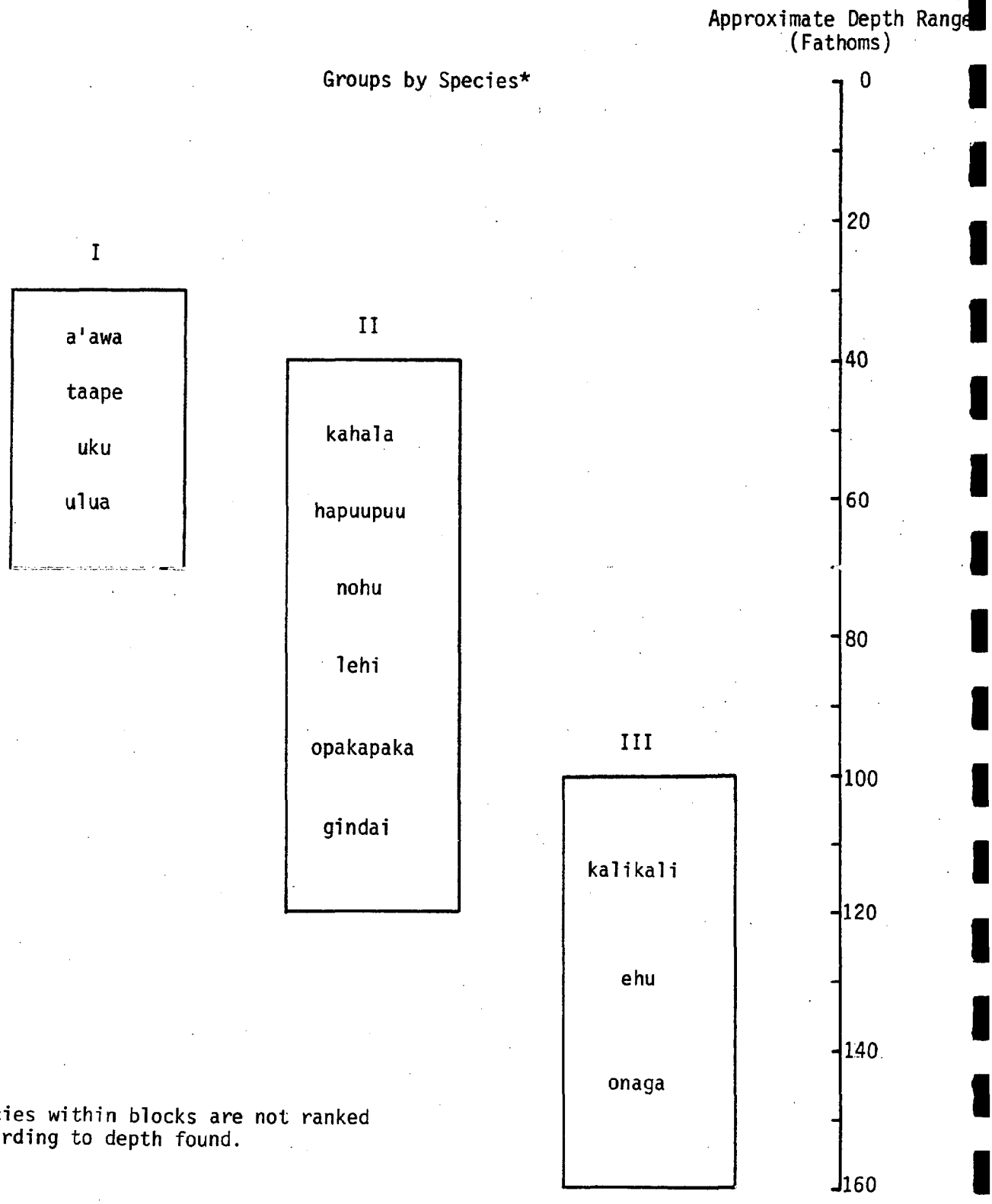
Area 331 is the fifth ranking area in the State with regard to total pounds reported (Fig. 6.1). The highest landings of *uku, kawakawa,* and *kahala*; and the second highest landings of *kalikali, ehu, mahimahi, opakapaka,* and *gindai* are reported from area 331. Catch and CPUE curves are shown for *kalikali, ehu, mahimahi,* and *opakapaka* in Figures 6.25 through 6.28.

Table 6.5-- Distribution of the bottomfish catches by island areas for the years 1966-77. (after Ralston, 1979)

Species	Hawaii	Maui, Lanai Kahoolawe	N. Molokai, Penguin Bank	Oahu	Kauai, Niihau	Necker
Opakapaka	20.2%	39.2%	25.8%	7.8%	1.6%	5.2%
Kalikali	23.8%	6.6%	50.5%	3.6%	9.6%	5.0%
Onaga	12.6%	13.1%	64.9%	3.6%	4.7%	1.1%
Ehu	17.6%	8.6%	40.4%	4.6%	8.6%	19.3%
Uku	13.1%	11.0%	47.8%	12.0%	13.5%	2.4%
Lehi	45.7%	48.2%	4.4%	1.6%	0.1%	-
Gindai	24.4%	8.2%	24.7%	3.5%	15.4%	21.8%
Taape	42.1%	7.5%	11.3%	31.4%	7.7%	-
Hapuupuu	10.4%	6.8%	12.5%	3.5%	12.7%	51.8%
Kahala	30.9%	5.9%	20.9%	13.4%	20.1%	8.7%
Ulua	20.4%	19.1%	8.9%	16.5%	8.4%	26.5%
Weke-ula	10.2%	1.5%	6.1%	68.3%	13.8%	0.1%
Moelua	-	99.4%	0.1%	0.5%	-	-
TOTAL	18.7%	19.9%	29.4%	10.6%	8.9%	12.1%

Figure 6.24

BOTTOMFISH CLUSTER ANALYSIS
Fish & Game Data
(Ralston 1980)



*Species within blocks are not ranked according to depth found.

Figure 6.25

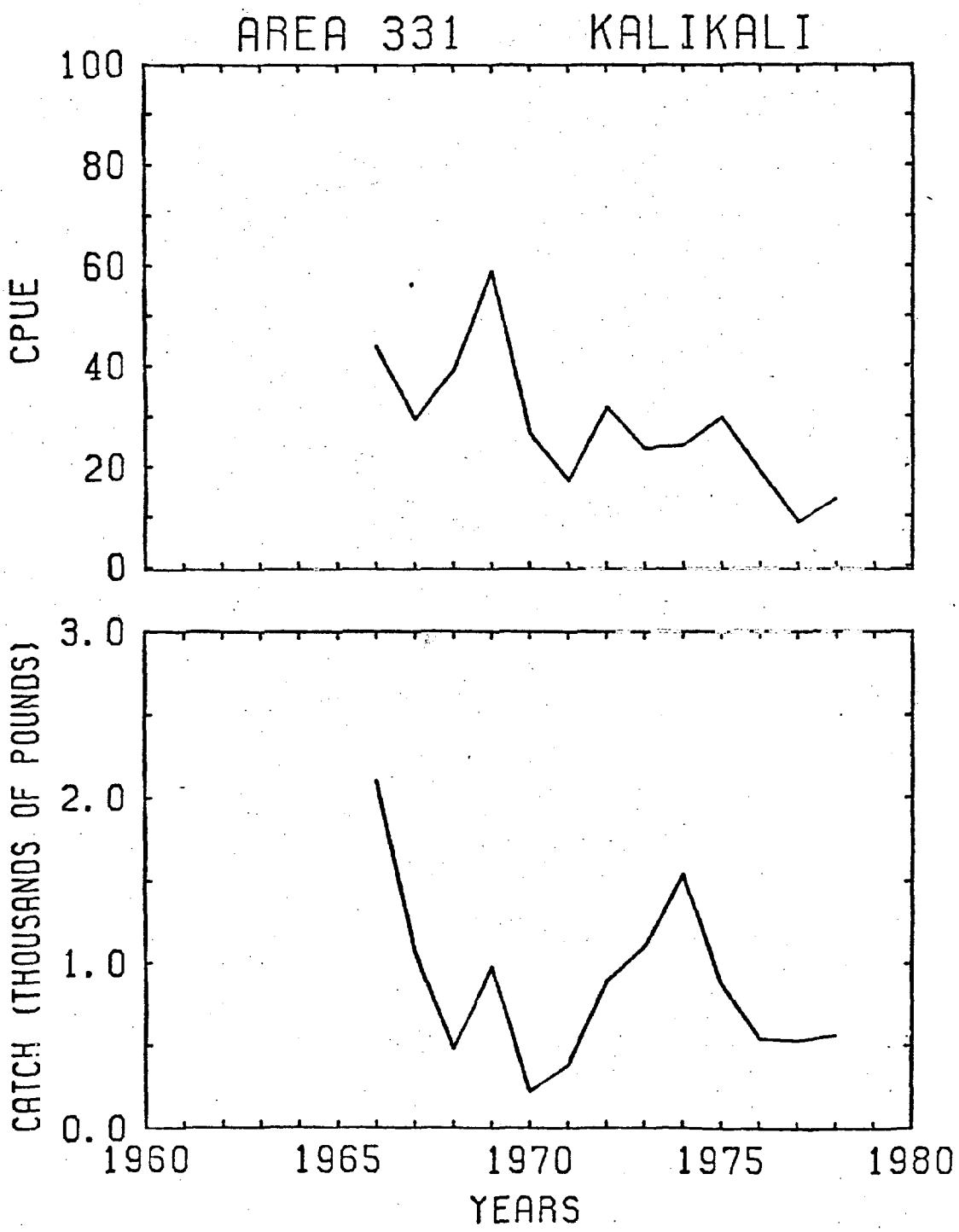

AREA 331 KALIKALI
CPUE
100
80
60
40
20
0
CATCH (THOUSANDS OF POUNDS)
3.0
2.0
1.0
0.0
1960
1965
1970
1975
1980
YEARS

Figure 6.26

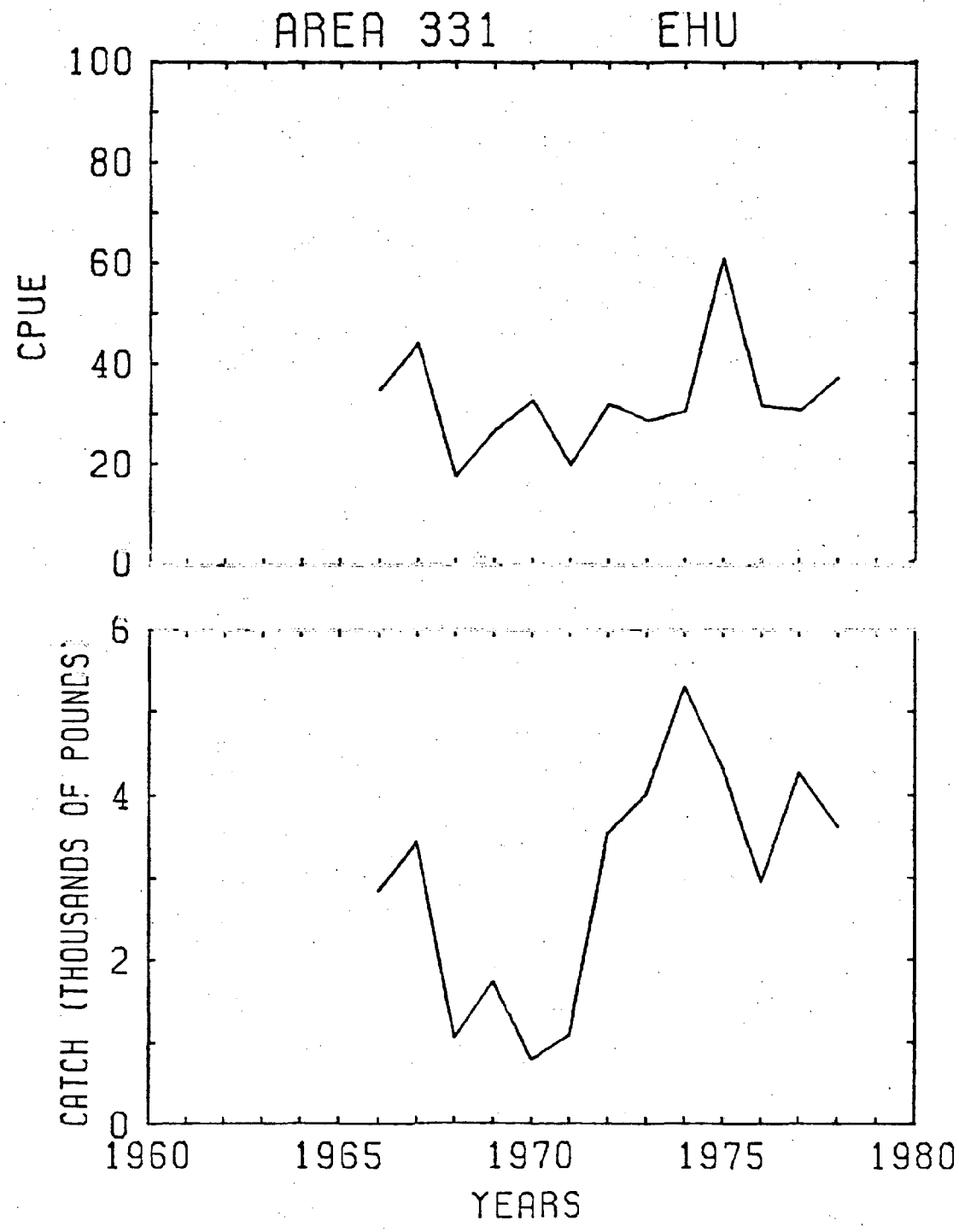

AREA 331 EHU
CPUE
100
80
60
40
20
0
CATCH (THOUSANDS OF POUNDS)
6
4
2
0
1960
1965
1970
1975
1980
YEARS

Figure 6.27

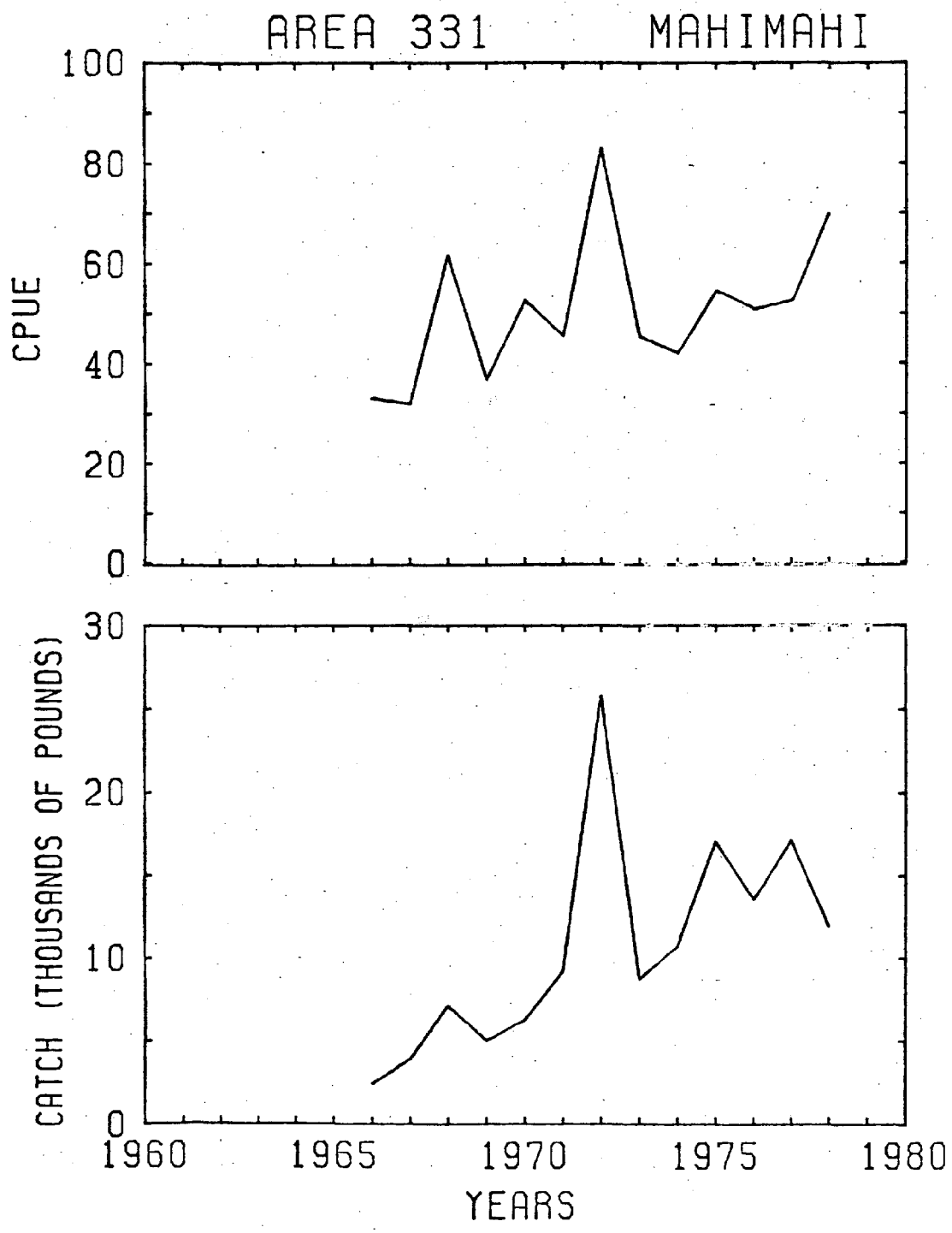
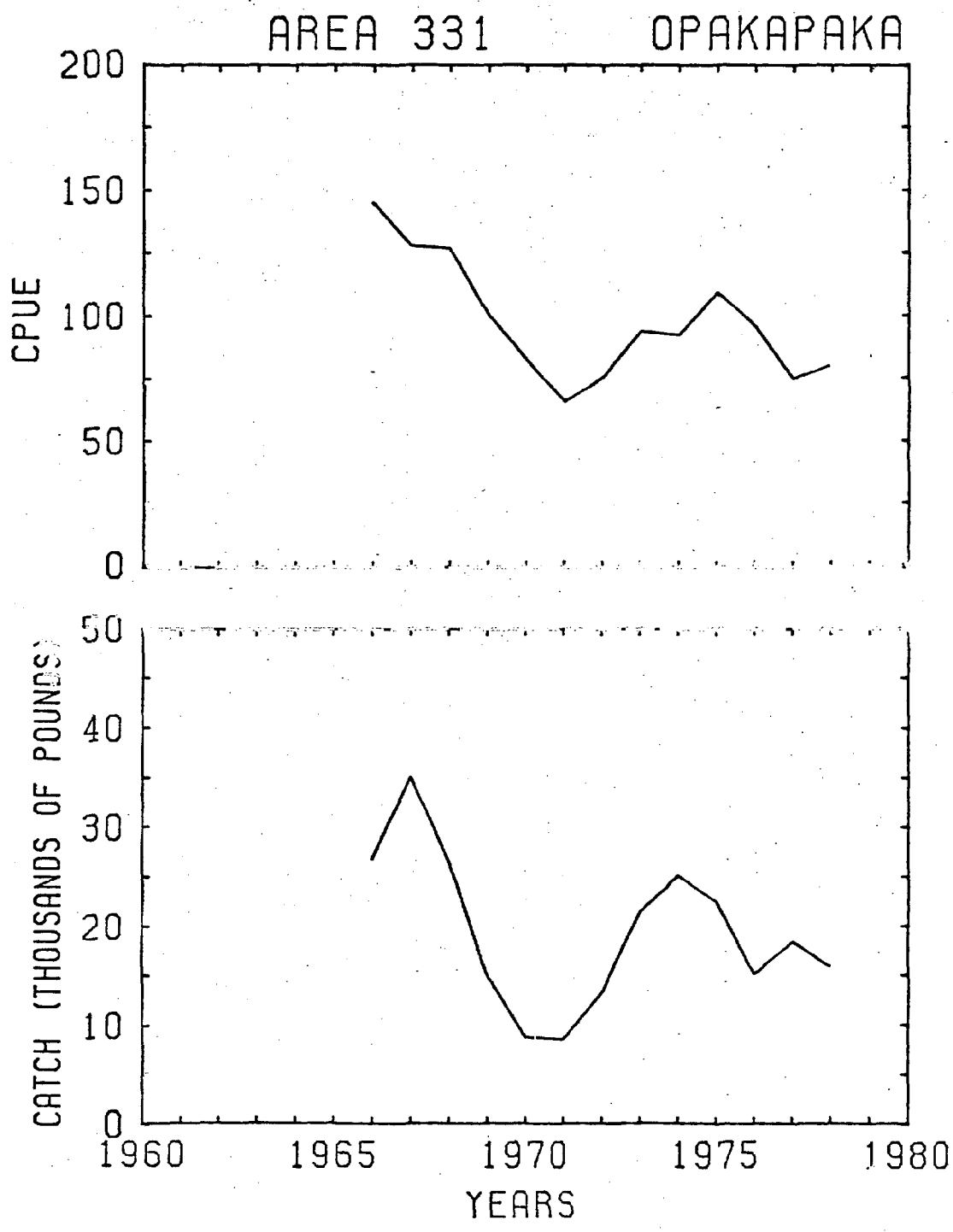

AREA 331
MAHIMAHI
CPUE
100
80
60
40
20
0
CATCH (THOUSANDS OF POUNDS)
30
20
10
0
1960
1965
1970
1975
1980
YEARS

Figure 6.28


AREA 331 OPAKAPAKA
CPUE
200
150
100
50
0
CATCH (THOUSANDS OF POUNDS)
50
40
30
20
10
0
1960
1965
1970
1975
1980
YEARS

Fisheries of Lanai

The people of Lanai love fresh fish, but, as in the case of Molokai, demand is quickly filled by the available supply. Lanai is known as the pineapple island and much of the leisure time of the people there corresponds to the pineapple schedule.

There are no perennial streams which reach the coast and, although there are some valleys, there are no bays at their mouths and, consequently, little protection for boating operations. Stretches of sandy beach with no fringing reefs provide beach landing for small craft. Kaumalapau Harbor, on the west side of Lanai, is the best harbor available in all but westerly and kona weather and is generally used for pineapple transport to Oahu. Many of the local fishing craft moor to buoys in the harbor where fuel is available. Small craft may be hoisted by derrick to a wharf for repairs.

Manele Bay houses a small-boat harbor which was the first joint state-federally funded small-boat harbor to be constructed in Hawaii. Launching facilities are available as well as berthing facilities for about 20 boats. Many of the Lanai residents enjoy fishing for *akule* and *hahalalu* in this harbor. Manele-Hulopoe is a marine life conservation district which restricts certain fishing activities.

In 1903, seines and lines were used exclusively by the commercial fishermen of Lanai. The principal species were *akule, ulua, amaama,* and *nehu.* In 1977, trolling was the major gear type followed by nets and handlines. The principal species taken were *uku, akule, opakapaka, ono, aku, onaga,* and *kawakawa.* See Table 6.3 for a list of top-ranking species by area in 1977.

Area 328 is the fourth ranking area in the State with regard to total pounds reported (Fig. 6.1). This area has the highest yields of *kalikali*, *ehu*, *onaga*, *hapuupuu*, and *gindai*, and the second highest yield of big-eye *ahi*. Most of the landings are by Oahu-based fishermen. Catch and CPUE curves for most of these species in this important fishing area are found in Figures 6.29 through 6.32.

Figure 6.29

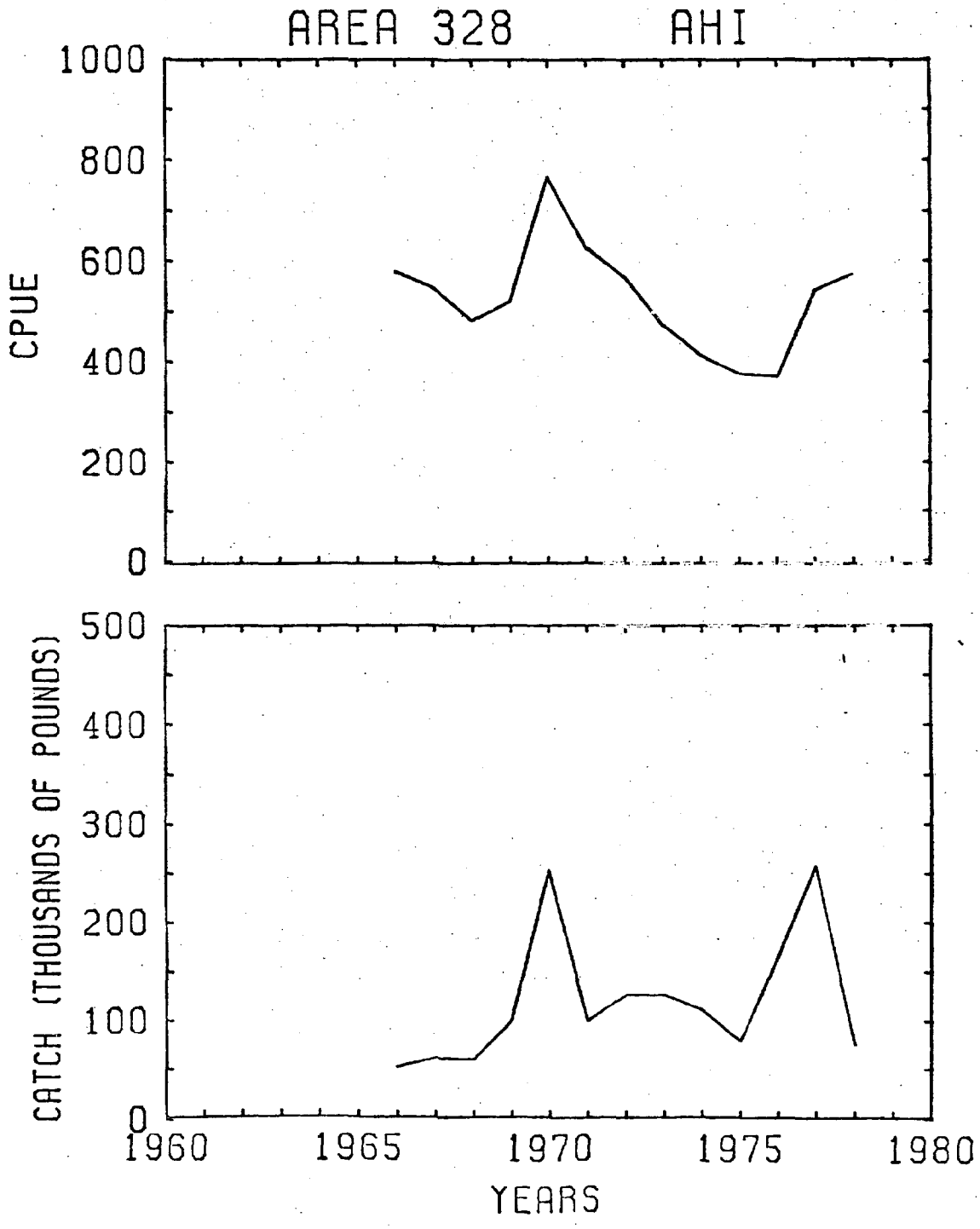

AREA 328
AHI
CPUE
1000
800
600
400
200
0
CATCH (THOUSANDS OF POUNDS)
500
400
300
200
100
0
1960
1965
1970
1975
1980
YEARS

Figure 6.30

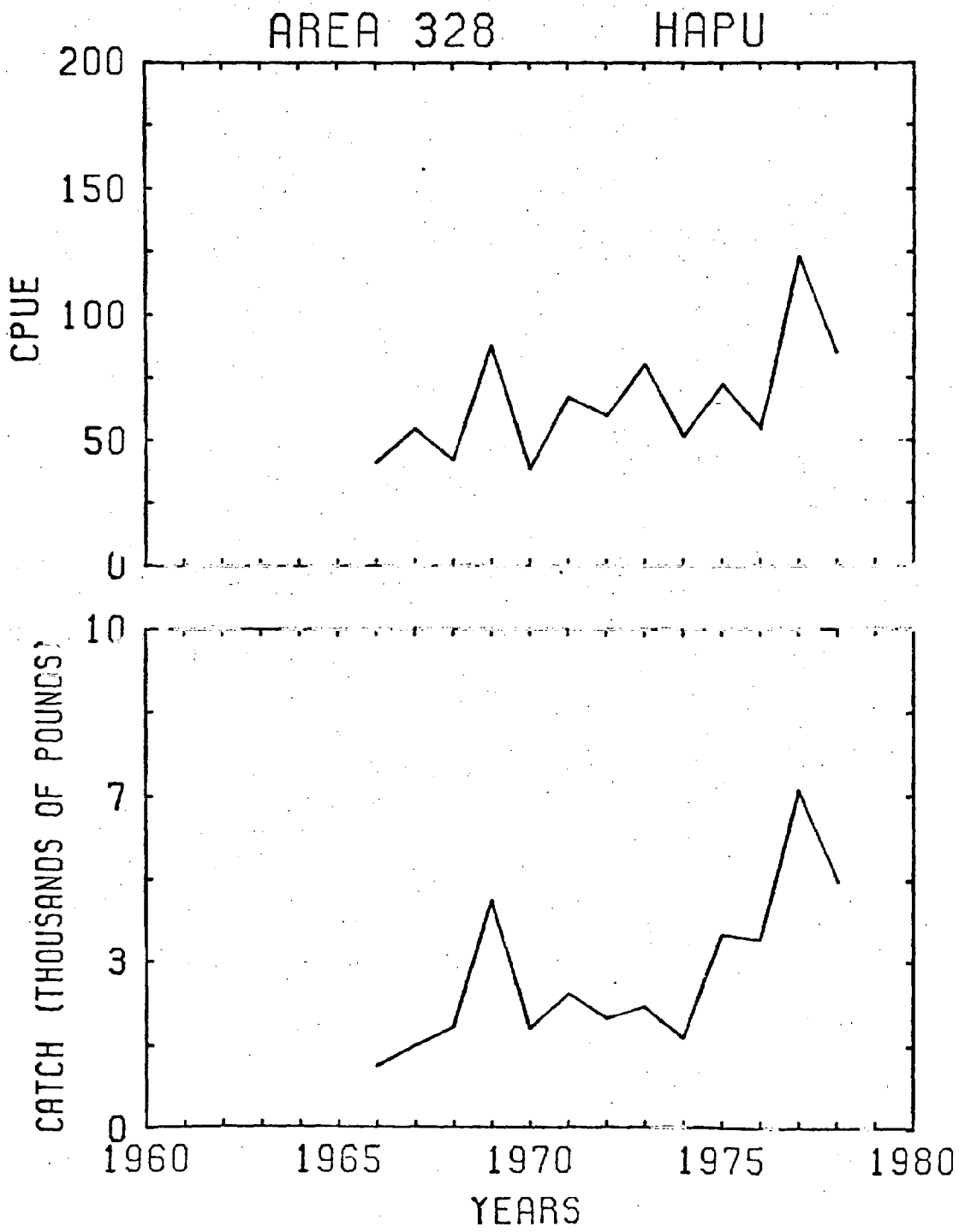

AREA 328
HAPU
200
150
100
50
0
CPUE
10
7
3
0
CATCH (THOUSANDS OF POUNDS)
1960
1965
1970
1975
1980
YEARS

Figure 6.31

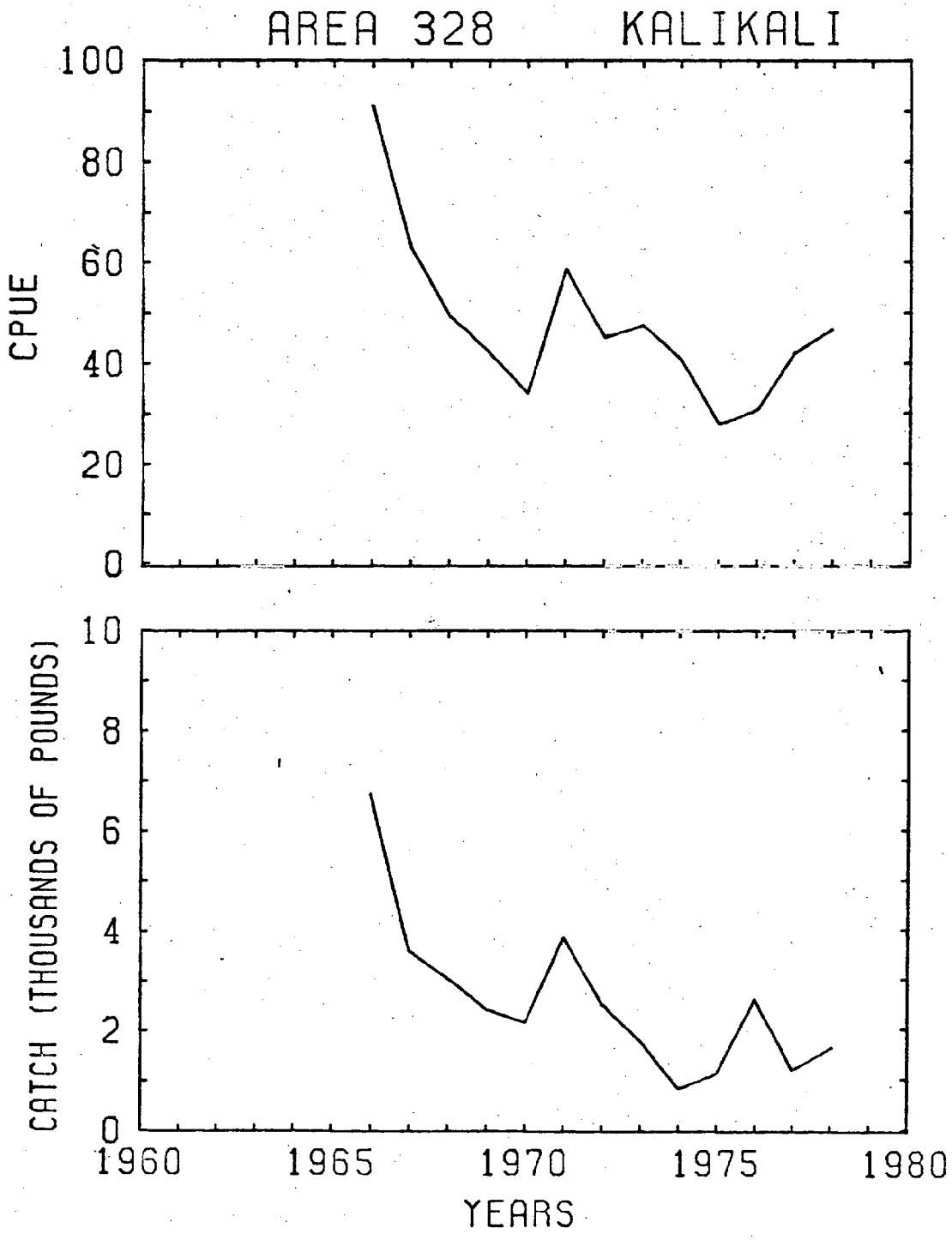
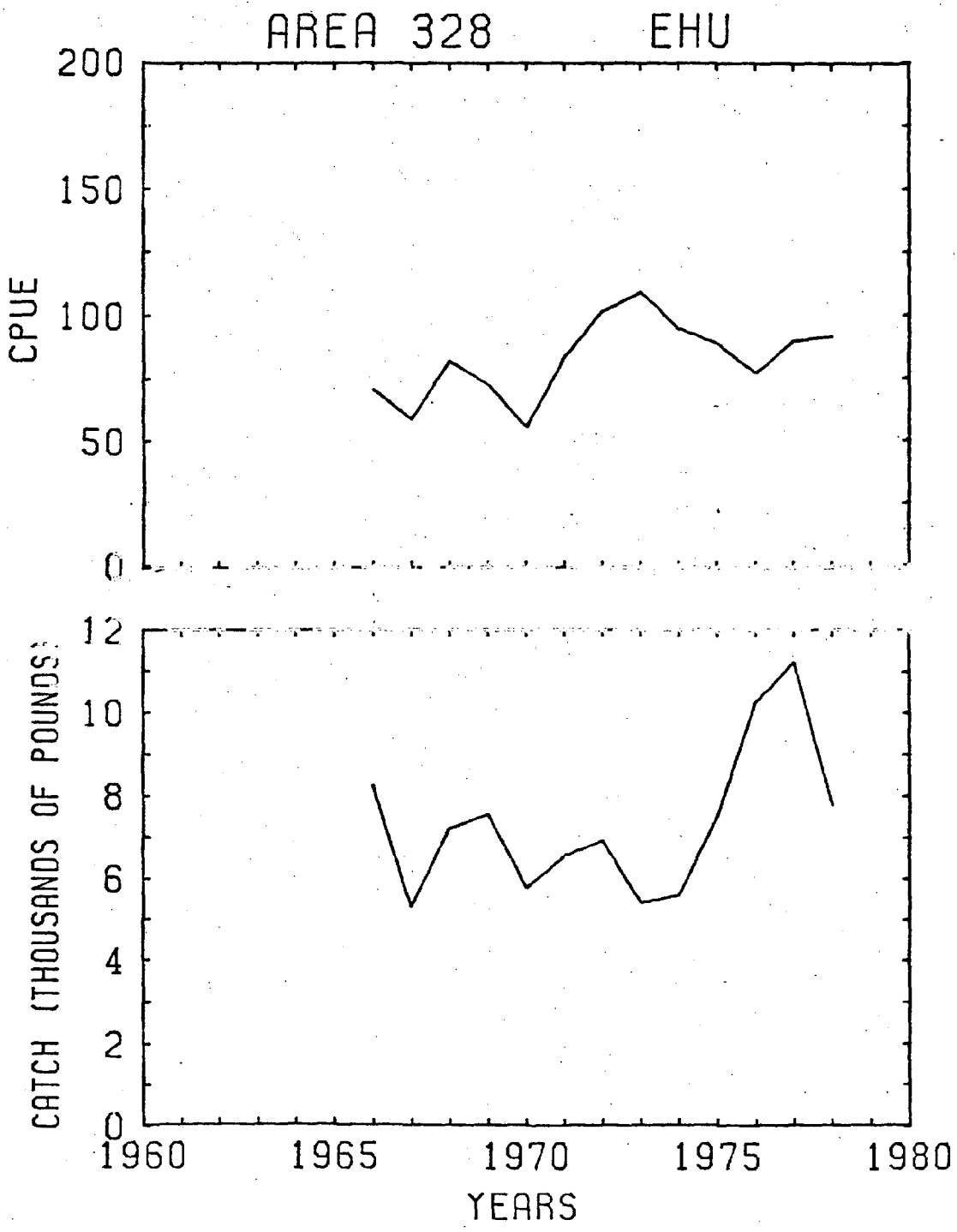

AREA 328 KALIKALI
CPUE
100
80
60
40
20
0
CATCH (THOUSANDS OF POUNDS)
10
8
6
4
2
0
1960
1965
1970
1975
1980
YEARS

Figure 6.32


AREA 328 EHU
CPUE
200
150
100
50
0
CATCH (THOUSANDS OF POUNDS)
12
10
8
6
4
2
0
1960
1965
1970
1975
1980
YEARS

VII

COASTAL ZONE ISSUES

CHAPTER VII

COASTAL ZONE ISSUES

Perhaps Hawaii's greatest physical attribute is the place where the land meets the sea - the coastal zone. It is also at this interface that the land and ocean worlds are most vulnerable. The shorelines are a dynamic, ever-changing area and the sea, at this point, is most susceptible to man's influence from the land. This unique environment has attracted the artists, poets, and musicians who have been inspired by the beauty of this area; the tourists who associate Hawaii with the Pacific beaches; the developers and builders who wish to construct houses, condominiums or hotels on this land; the recreational enthusiasts who enjoy surfing, fishing, picnicking, boating, and swimming; the birds, crabs, fish and other shore life which make their homes in this habitat; sewage disposal and urban and industrial runoff which utilize this water to dilute their waste products; and the commercial fishermen who make their livelihood from the sea.

It can easily be seen that the place where land meets sea is fraught with a variety of competing coastal use demands, all vying with each other for a foothold. Frequently, these competing uses are unable to coexist peacefully since they either share too limited a commodity, or one use alters or destroys the area needed by another.

For instance, there are a number of potential conflicts between fishermen and endangered or protected species which may surface with the possible designation of a marine sanctuary for humpback whales in

Hawaii. Other potential restrictions to fishermen may occur should a critical habitat for monk seals be designated in the Northwestern Hawaiian Islands.

Conflicts among the variety of interests in the nearshore environment are growing significantly. The difficulties are frequently magnified on Waikiki beach during unexpected fish runs. At that time, one might see the comical, and discordant sight of local fishermen with their nets and poles, swimmers, surfers, outrigger canoe teams and moored sail boats framed against the backdrop of strolling tourists and mammoth hotels and condominiums. The contemplation of resolving all this elbowing of one another on the same territory seems overwhelming. In some cases, conflicts between fishermen themselves have been resolved by the State by dividing off areas around piers to separate net from pole and line fishermen.

In other parts of the island, coral harvesters, boat anchors, and pollution all work together to destroy the coral reefs of Hawaii. Hawaii's pollution stems largely from sewage discharge and water runoff, with relatively low levels of industry-related substances in the water. However, polychlorinated biphenyls (PCB's), heavy metals, pesticides and radioactivity have been found in our marine sediments in such places as the Ala Wai Canal, Kapalama Canal, Pearl Harbor, and in Hilo Bay but do not exceed federal limits. There is no commercial production of oysters from our marine waters. The oysters and clams found in the waters of Kaneohe Bay and Pearl Harbor are prohibited from being taken due to high bacterial contamination.

Destruction of our nearshore environment also occurs through dredging and filling operations which artificially alter the natural shoreline. Sediments deposited in these areas reduce the amount of

light which normally penetrates into the sea and can affect photosynthesis. The water quality its thereby affected and can have an impact on the species of fish (primarily juvenile) found there. See figures 7.1-7.6 for maps depicting red water runoff areas. Many fishermen fear that any major alteration of the marine environment may shift the ecological balance sufficiently to create conditions favorable for toxic organisms which produce ciguatera in fish. Human interference with the environment has been implicated, although not conclusively, to ciguatera toxin production.

Other fishermen, meanwhile, have found certain benefits to habitat alteration (sugar cane bagasse disposal) when their preferred fishes are attracted to the altered sites. Unknown benefits or losses to fishing activities may result from the proposed OTEC (offshore thermal energy conversion) facilities presently scheduled for siting either off the Kona coast (area 122) or off the Oahu coast (area 423). Present indications are that the mini-OTEC facility attracts fish and is a boon to fishermen. Whether or not this trend will persist with larger scale operations is presently unknown.

Coastal development in Hawaii holds the promise of high economical gains. Recent shoreline setback laws and special shoreline management area permit applications are acting to somewhat retard the rampant shoreline transformation. Even destruction of coastal wetlands near, but not on, the shoreline is known to degrade the marine environment which, invariably, impact on our fisheries. At some point, it may even become desireable to maintain the difficulties in accessing the shoreline to help reduce the pressures on the nearshore environment.

Distinction, of course, should be made between consumptive and non-consumptive uses of the nearshore waters with preference being given to activities which are least destructive to the environment. However, non-consumptive uses often require support facilities and even recreational interests can create stresses on the environment when heavily concentrated.

The development of Hawaii's Coastal Zone Management Program was born of these conflicts and issues and has as its chief purpose to "lead to an improved decision-making process for determining appropriate coastal land and water uses in light of resource considerations." Almost one-half of Hawaii's total land area is within five miles of the shoreline with no point in the State more than 29 miles from the ocean. Hawaii is uniquely an ocean state with ever increasing challenges to protect and enhance its oceanic environment.

Fisheries as a component of Coastal Zone Management. Fishing is in many respects the central thread weaving through all phases of coastal zone issues. The need to protect Hawaii's valuable coastal ecosystem, an objective of the CZM program, is paramount to the fisheries of the State. These ecosystems, outlined in a previous section, serve as essential natural environments for a variety of fish and other wildlife providing the basis for the recreational and commercial fishing industries. The commercial fishing industry grosses approximately $11 million per year with projections as high as $100 million. The value of the recreational fishing industry, estimated at over $16 million in 1970, is probably closer to 25 million today.

Attempts are being made to improve the marine environment for a variety of fishermen by creating fish habitats in the form of artificial reefs and aggregating devices. Many of these objects work to congregate the more migratory species of fish which orient themselves to the artificial structures in an otherwise featureless environment. The fish aggregating buoys should significantly reduce the amount of time spent by fishermen in search of fish.

Each island shares common problems regarding shoreline ownership and corresponding use needs. These similarities can be seen in Table 7.1 which outlines the shoreline characteristics of each island and the relationship of fishing activities to other coastal land use features.

Figure 7.1-- Oahu red waters after a storm

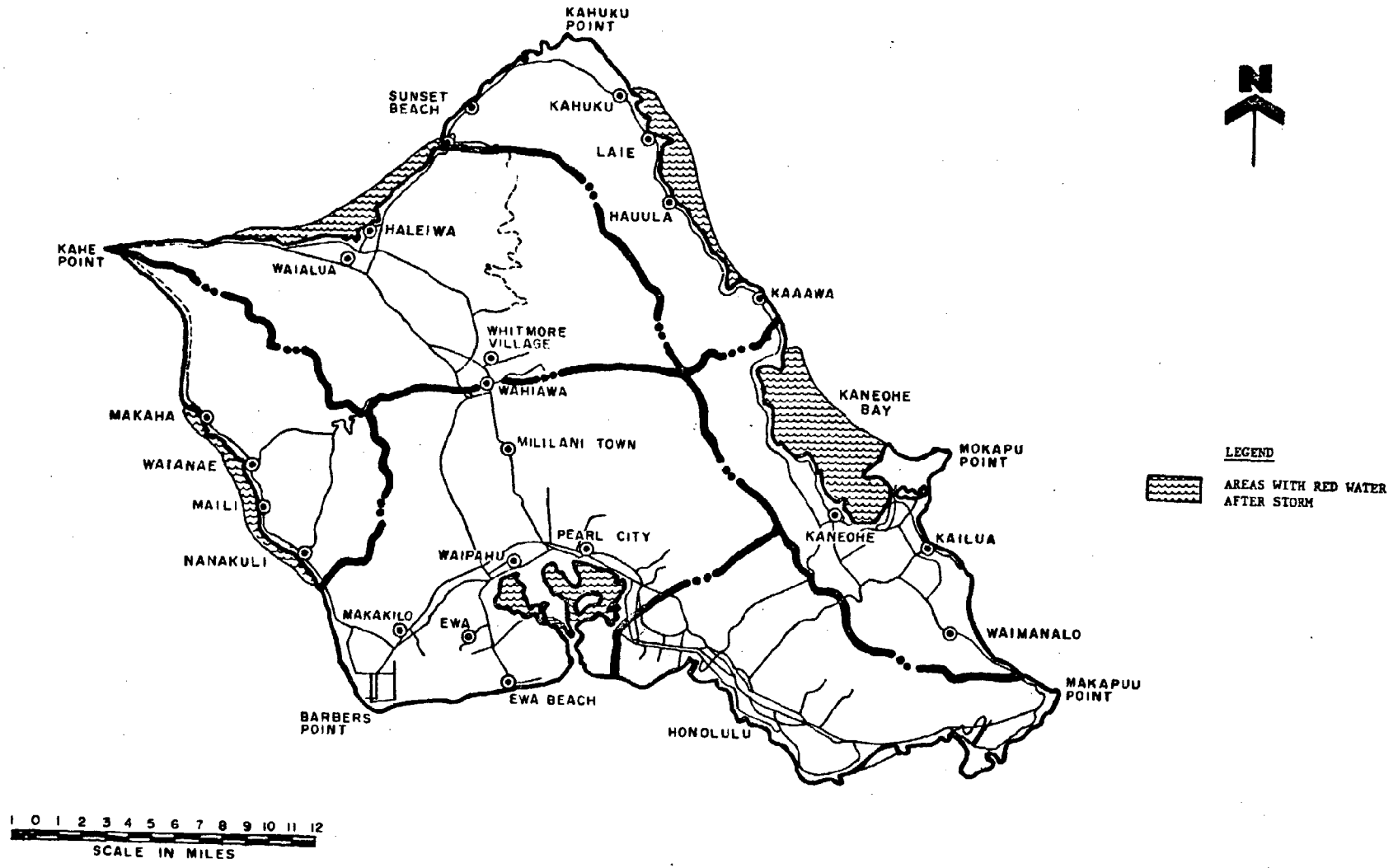


Figure 7.2-- Hawaii red waters after a storm

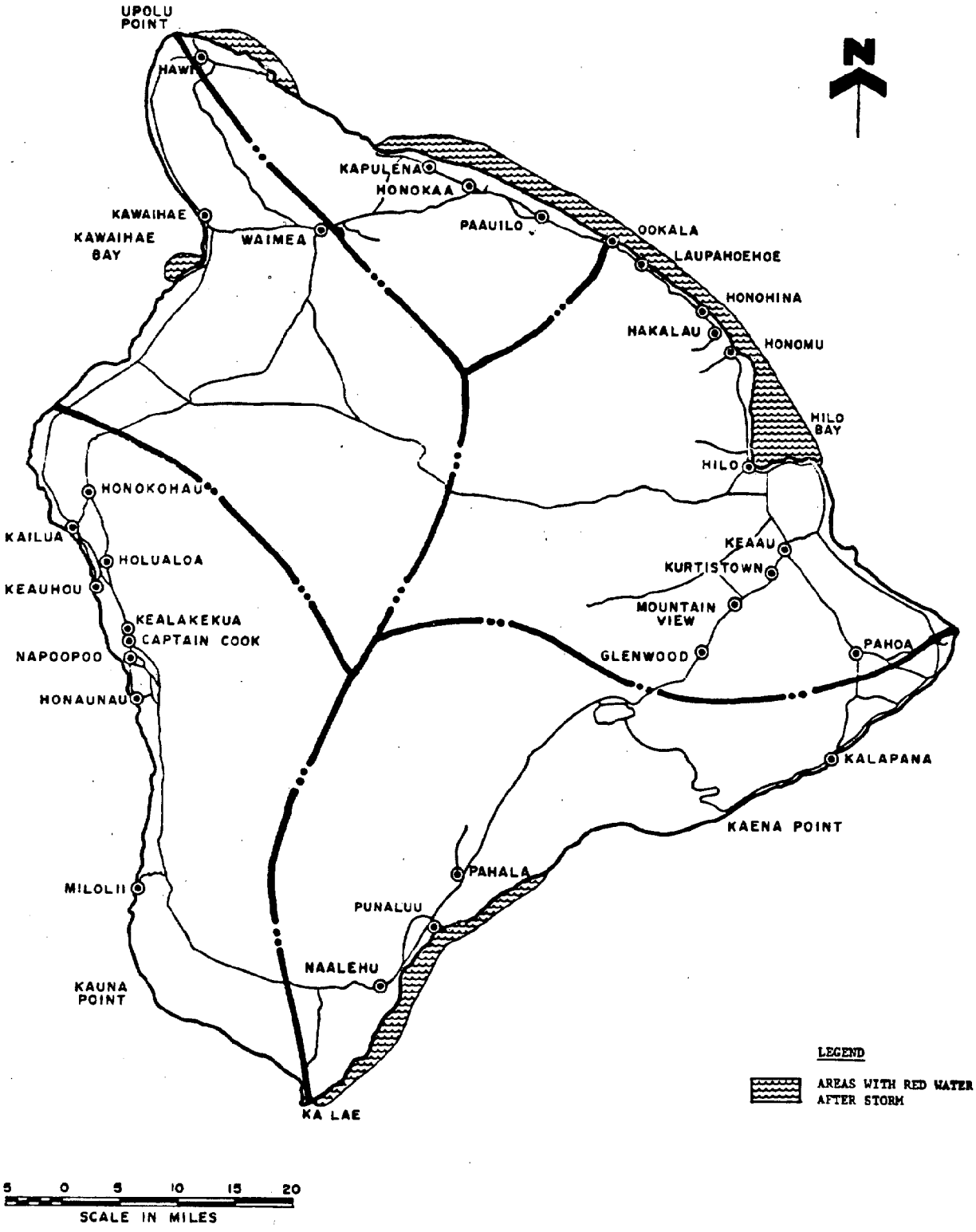


Figure 7.3-- Maui red waters after a storm

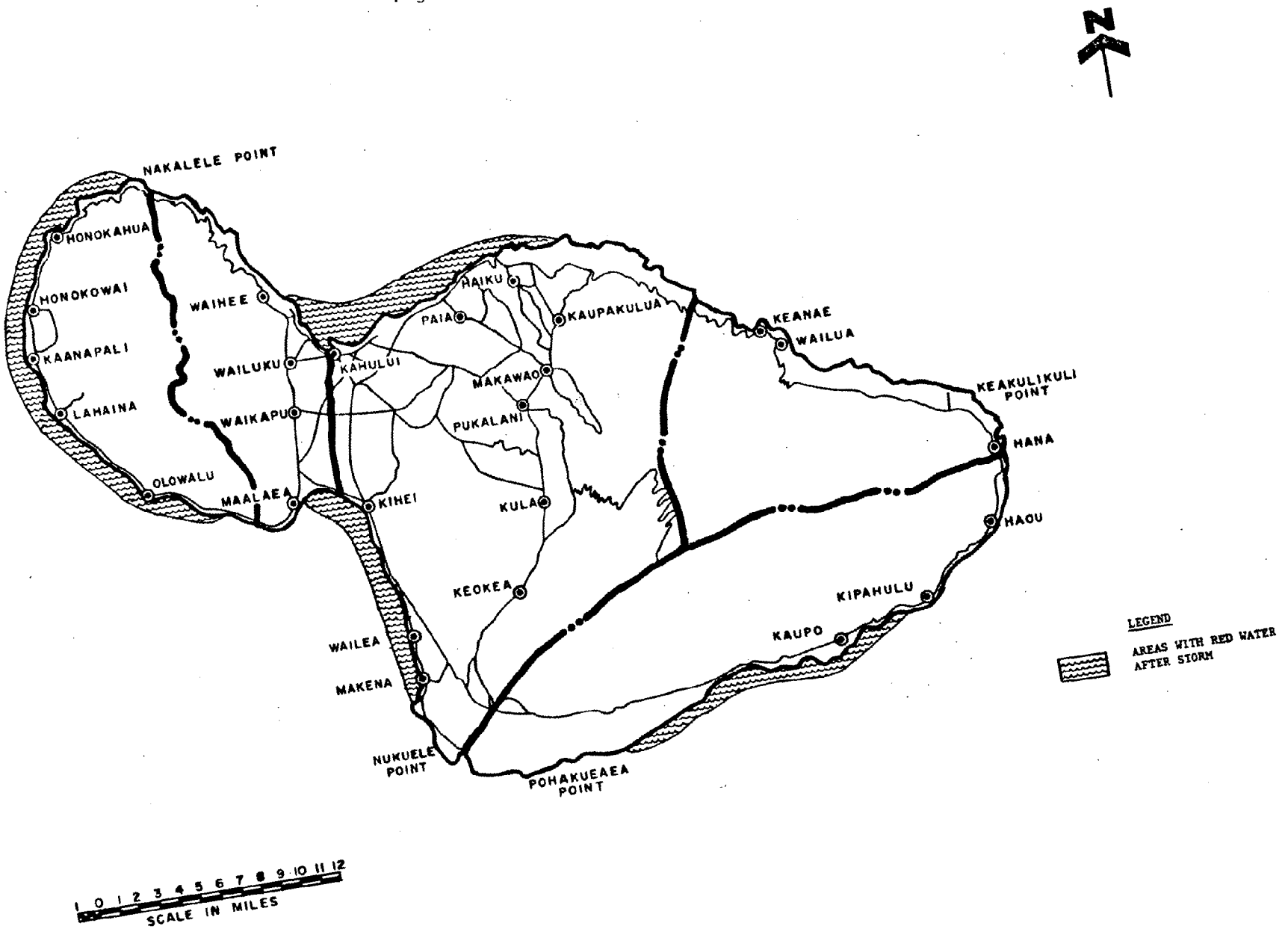


Figure 7.4-- Kauai red waters after a storm

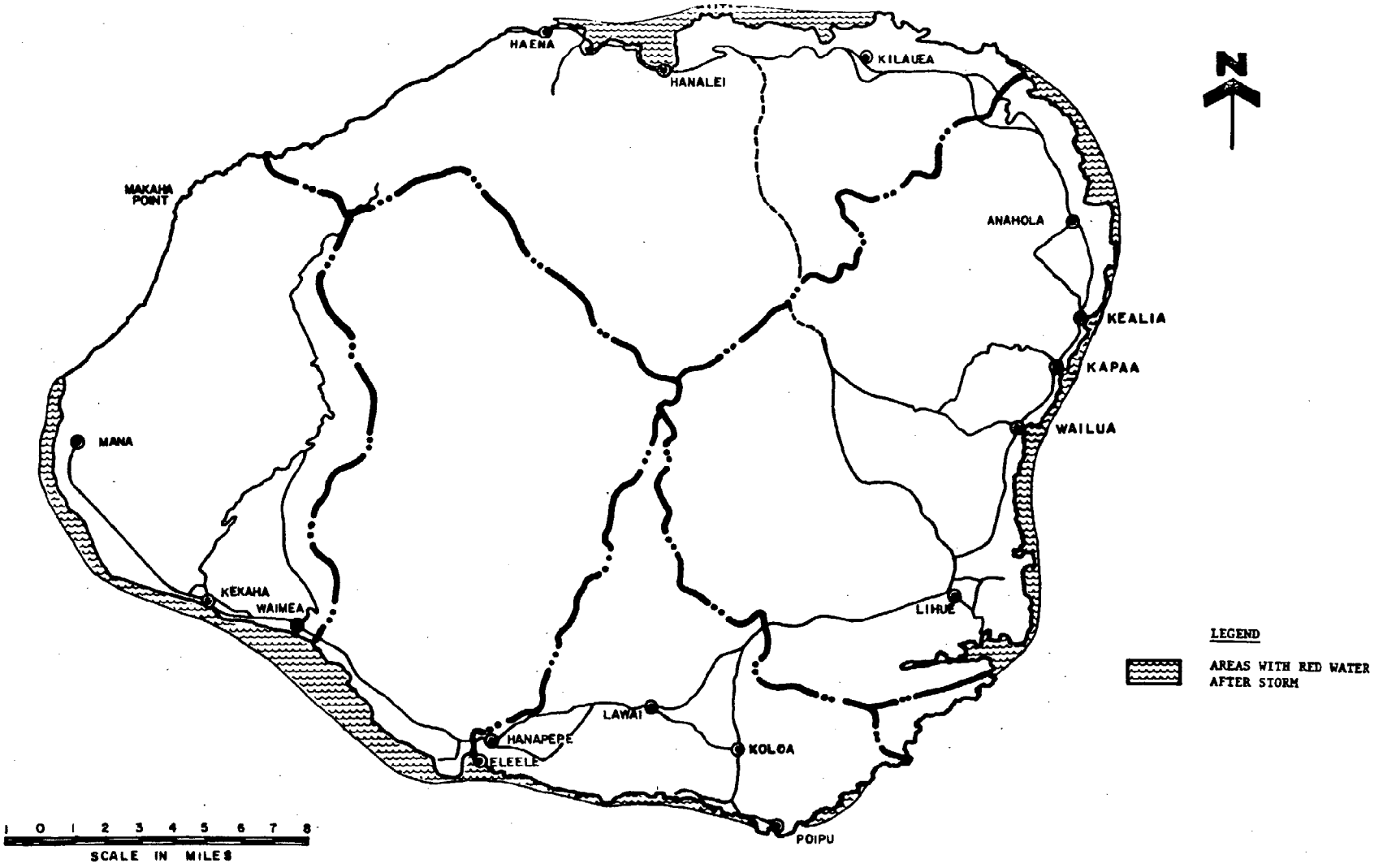


Figure 7.5-- Molokai red waters after a storm

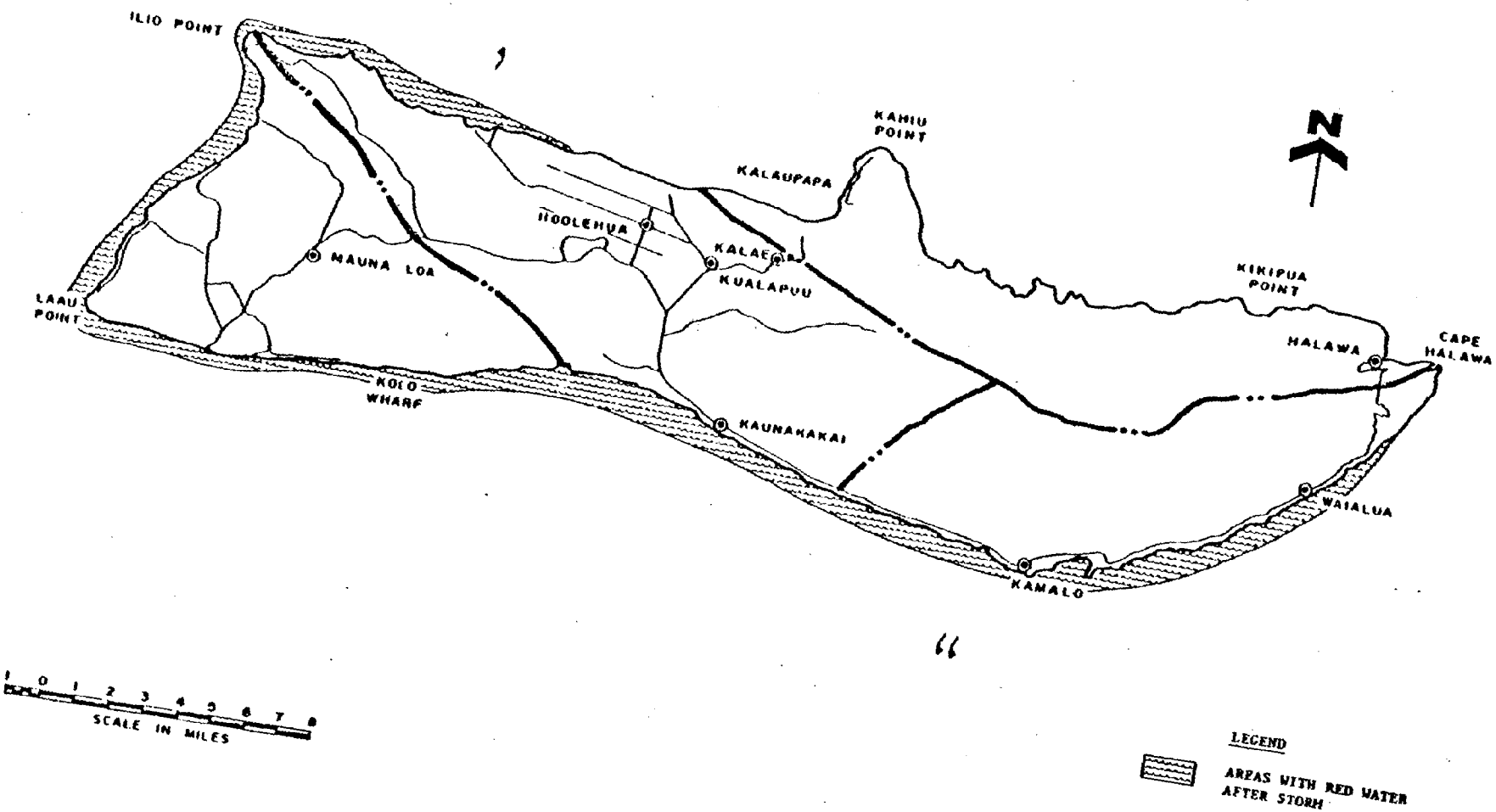


Figure 7.6-- Lanai red waters after a storm

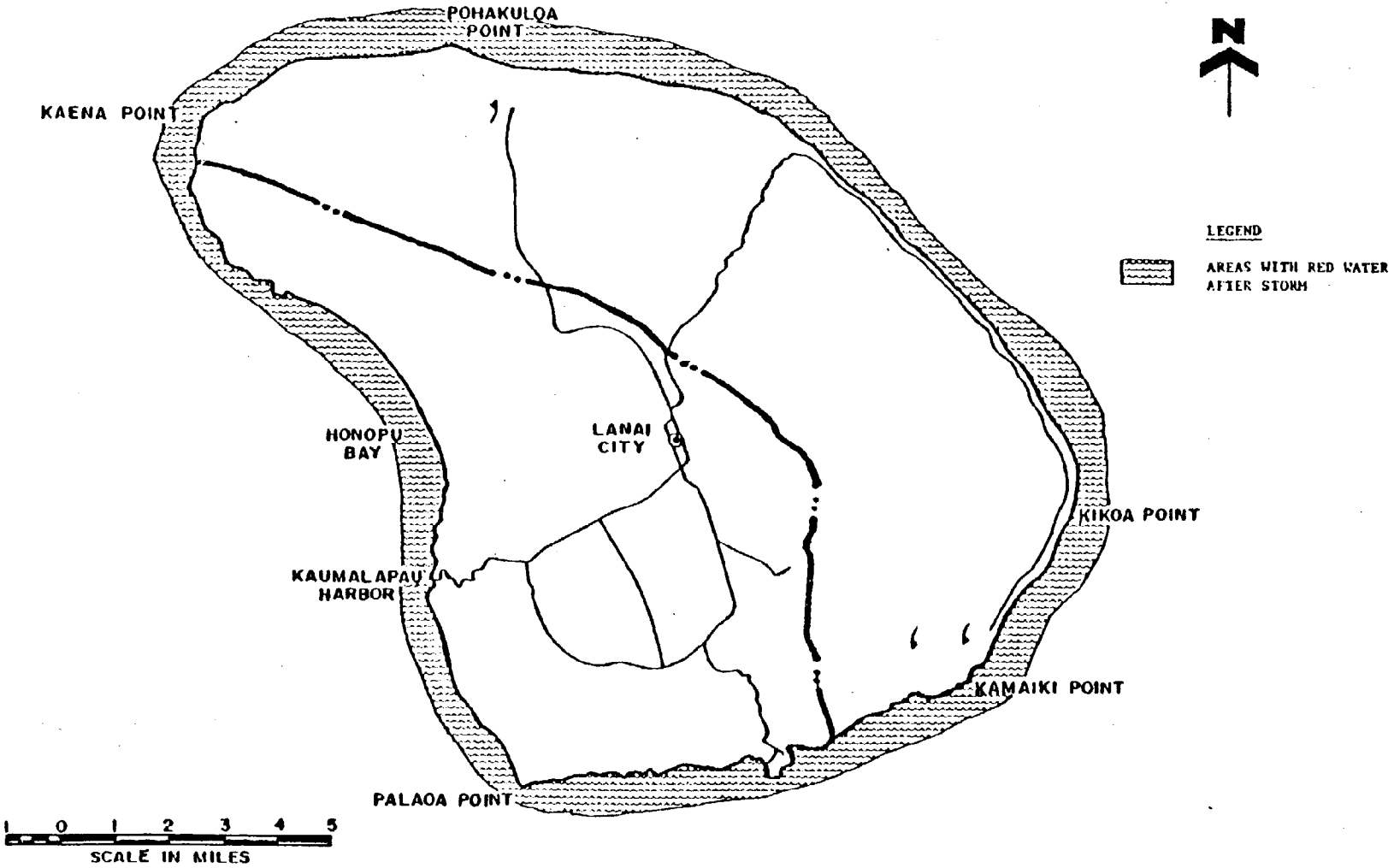


Table 7.1

ISLAND	POPULATION [1]	TOTAL MILES OF SHORELINE	LAND USE--% OF SHORELINE [2] RECREATIONAL Public	RECREATIONAL Private	NON-RECREATIONAL Developed	NON-RECREATIONAL Undevelp	LAND OWNERSHIP-% OF SHORELINE FEDERAL	PUBLIC (non-Fed	PRIVATE	#of commer fishing licenses	Number of Ports	Number of Fishing Vessels	Value of Landings	Pounds
LANAI	2,000	52.3	1.3%	0	1.5%	97.2%	0.5%	0.3%	99%	24	5	7	$14,912	27,137
MOLOKAI	6,000	105.9	0.9%	0	7.4%	91.7%	2.1%	15.6%	82.3%	44	12	31	$23,923	29,933
KAUAI	36,500	113.4	9.7%	0	19.9%	70.0%	9.0%	40.0%	51.0%	215	25	222	$342,355	468,676
MAUI	67,000	158.8	5.1%	0	9.6%	85.3%	0.9%	38.2%	60.9%	217	27	160	$511,817	902,108
OAHU	685,933	198.5	16.2%	2.3%	55.7%	25.8%	30.7%	21.0%	48.3%	1,235	47	588	$7,727,731	9,500,565
HAWAII	85,000	305.5	13.4%	0	15.3%	71.3%	10.3%	33.6%	56.1%	712	34	369	$2,519,474	2,730,408
										Total: 2,247 (F & G, 1978/79)	Fish and Game (not all utilized)	documented and undocumented	Fiscal 1978	fiscal 78-sea catch

[1] State of Hawaii Data Book, 1978 (projection for 1980)

[2] Hawaii Regional Inventory of the National Shoreline Study, 1971

VIII

RECOMMENDATIONS

RECOMMENDATIONS

It would be premature to establish a rigid set of recommendations for managing our nearshore fisheries since a variety of evolving issues are still shaping the fisheries of Hawaii. In addition, management recommendations, if not considered carefully, could alter those characteristics of fishing which people value most highly. These characteristics differ among the various user groups and we are still woefully ignorant of the impact each of the user groups has on the fisheries. Some user groups may feel that economic security is their greatest need while others may feel that fishing for relaxation or subsistence living are more important needs.

The following recommendations are appropriate to all user groups and identify problem areas of common interest to all.

PLANNING:

There is a great need for a unified approach to the management and development of Hawaii's fisheries. This requires improved governmental agency coordination. Long range planning can help predict potential problems before they arise and promote the development of possible solutions. Conflicts can be avoided if there is input from all fisheries user groups. A system of checks and balances would be useful whereby the fisheries cannot be dominated by any particular user group without general agreement. Should conflicts arise, a mechanism should exist to settle them which is rapid and politically insulated. Enforcement of the outcome must occur.

ACTION:

Frequently, action must be taken to protect resources and resolve conflicts at early stages. Decisions may need to be made before a completely satisfactory level of confidence is reached. Severe declines in the fishery should not be the "sufficient evidence" needed to support regulations. No decision, in times of crisis, is, in itself, a decision by default. Appropriate management must be concerned with socio-economic as well as environmental points of view.

ENFORCEMENT:

There exists a great need for an improved enforcement program. This could include in-service officer training programs, emphasizing training in conservation laws and regulations as well as training in law enforcement. The development of volunteer programs to supplement existing enforcement activities should be extremely valuable.

PUBLIC INFORMATION AND EDUCATION:

Enforcement officers can never be present at all locations where violations occur. Even with increased numbers of officers, violators will persist. Consequently, enforcement activities will perpetually lag in effectiveness without better public information and marine education programs. Greater emphasis should be placed on programs in public schools which deal with fisheries conservation, and teach concern for protecting our natural resources.

DATA:

One of the most important aspects which lies at the very heart of fisheries management, concerns the need for improved fisheries data collection and processing. Part of this problem has evolved in the fisheries community itself, which has failed to recognize the value of statistical data. This is understandable, since all too often, the data are collected with minimal explanation and/or feedback to the fishermen and resentment has surfaced because of it. Aside from this issue, many commercial fishermen, fearing the IRS, rebel by either not reporting accurately or by not reporting at all.

Although the fish dealers are required to report their fish purchases, the major emphasis is placed on the reporting system of the commercial fishermen. Consideration should be given to placing greater emphasis on the reports of fish dealers, as has the State of California. Special logbooks, which simplify the reporting of information, should be developed.

There are a variety of weaknesses in the existing fisheries data reporting and collection process, not the least of which concerns the data accuracy question. Improvements in data collection and processing are presently being planned and are the subjects of interest to both state and federal fisheries managers. The existing data collection section of the State Division of Fish and Game is understaffed and heavily burdened with a variety of data responsibilities. Only with increased budgeting and staffing for programs concerning fisheries data, can advancements be made in this important area. Maximum authority at the State level should be maintained in the area of data collection and enforcement.

Initially, the need exists to determine how the present fisheries data collection program can be improved to be more reflective of state, federal, regional council, industry, and general public concerns. These needs would range from the desire to obtain an MSY (maximum sustainable yield) for each fishery, as outlined by the Fishery Conservation and Management Act of 1976, to simplifying record-keeping procedures essential to enforcement activities of the State. Data should also be provided for research purposes which have historically lacked sufficient biological and environmental fisheries information.

There are a number of additional sound reasons for improving the collection and evaluation of fisheries statistical data. These include the desire to:

1. evaluate the extent of pressure placed upon our fisheries resources by the multiple user groups, including the non-commercial sector. Much of the confusion could be eliminated by improved licensing procedures which more clearly identify the user groups. A substantial increase in commercial license fees would likely separate the full-time commercial fisherman from the part-time commercial/recreational fisherman. Consideration should also be given to implementing a saltwater fishing license in Hawaii for both commercial and recreational fishermen. By licensing all marine fishermen, a better understanding of the amount and type of pressure being placed on our nearshore resources can be developed. Harvest guidelines could then be established. Fees from this increased licensed population could

be used to further recreational and commercial fishing programs in the State.

2. design management plans to permit increased commercial and recreational fishing efficiency and lower production costs.
3. understand the fundamental biology of a particular species.
   a. size structure (age, length, weight)
   b. growth characteristics
   c. catch by area (reflective of carrying capacity)
4. continue assessment of the impact of fishing on stocks of fish.
   a. catch per unit of effort (CPUE)
   b. size and age structure changes of the stocks
5. predict and forecast.
   a. prediction of available and future harvests
   b. forecast changes of harvest regulations on fish catches
6. establish programs to enable the fishery to enlarge its share of markets through increased productivity, lower costs, and increased acceptability of fishing products to the consumer.
7. broaden stock assessment activities especially with presently underutilized stocks.
8. serve economic purposes which enhance net economic yield and maximize fleet efficiency:
   a. quantity and value of catch
   b. market values by area and season
   c. improve distribution and marketing benefits to fishermen and public alike

Of course, along with an improved data collection and evaluation program, there exists the need for a faster feedback reporting system. Considerable delays have always existed between the time data is received and the time use is made of it in a practical sense. Much of the problem lies in outdated forms which require personal interpretations and lengthy hand calculations. A more sophisticated catch data reporting and processing system would be invaluable in improving data reliability and processing efficiency.

Log books which aid the fishermen and fish dealers as much as possible in accurately depicting their catches and transactions would minimize the all too prevalent rumors that reported information is not representative. Certainly, the historical custom of protecting the confidentiality of this information must be continued with greater emphasis on reducing the fears of fishermen.

Much of the need for accurate information and data is shared by a number of state and federal agencies whose duties are to follow our fisheries and recommend management schemes when appropriate. Efforts are presently underway to outline the data needs of various agencies, including State Fish and Game, National Marine Fisheries Service, Western Pacific Regional Fisheries Management Council, Sea Grant, and the University of Hawaii, in order to accomplish appropriate data sharing with minimal redundancy and in a spirit of cooperation.

POSSIBLE MANAGEMENT STRATEGIES:

As nearshore fish stocks continue to receive heavy pressure, a number of strategies will need to be explored to further protect these

resources. Presently, there are a number of fishing laws and regulations for managing our nearshore species. These include seasonal closures for a number of crustaceans, mollusks, and fishes; minimum sizes; bag limits; and a variety of other restrictions including a ban on spearing of lobster, and use of small net sizes, poisons, explosives and firearms. A number of marine life conservation districts have been established to preserve marine resources in especially sensitive or unique habitats in the State.

An innovative management scheme called the Kapuku Plan (Hawaiian translation - "to restore life"), is in its trial phase for Hawaii. There are a number of difficulties associated with the conventional management practices dealing with species by species regulation. A proliferation of countless fishing laws and regulations is self-defeating in light of inadequate education and enforcement activities. The Kapuku solution being tried off Waikiki is based upon control of indiscriminate and excessive fishing effort. Implementation of this program permitting closing and opening of certain areas to fishing on a rotating basis may offer a simple control mechanism.

There are additional management programs which may prove successful to our commercial fishing industry, especially in light of potential Northwestern Hawaiian Islands fisheries expansion. One of these programs involves the concept of limited entry.

Economic viability is the primary motivating force for suggesting a limited entry program into a fishery. The major issues deal with the fact that the fishermen have no control over the entrance of other fishermen into the same fishery, as well as their lack of ownership rights

over fish resources. Consequently, there are numerous examples of economic declines and impoverished resources associated with overcapitalization and overfishing.

The incentive for a commercial fisherman to enter the industry is profit. The profit is available to all those who wish to fish, due to the lack of exclusive property rights. Fishermen, as individuals, will carefully manage their favorite fishing spots year after year until others discover the grounds. At such time, the incentive to self-management is lost and fishing pressure increases immediately. As long as everyone is free to enter the fishery, there is no incentive for any individual or groups of individuals to control fishing intensity. That would just leave larger catches and greater profit for someone else.

Fishermen tend to respond to other resource management regulations with strategies designed to increase their personal share of the catch by using faster boats or better gear. Much of this leads to overcapitalization and poorer prospects for fishermen to make a decent living.

The two types of fisheries which would profit most by utilizing limited entry are: 1) the traditional high dollar value fishery; and, 2) a newly developing fishery in which considerable growth of fishing effort is expected.

There are a number of reasons why limited entry may be appropriate for some of the developing fisheries in the Northwestern Hawaiian islands:

1. There is already some thought that the new lobster fishery is overcapitalized with six large vessels expected to fish lobster in the near future.

2. The NWHI contain a U.S. National Wildlife Refuge which may result in conflicts over protection versus utilization of fisheries resources.

3. The State of Hawaii has some precedents to help it establish such a program (special licensing permits for seasonal freshwater fishing).

4. Bait fishing programs and tournament participation may eventually become limited entry programs.

The issue of limited entry is fraught with difficulty and constitutional uncertainty. Nevertheless, there may be a number of ways to accomplish this goal with as much equity and fairness as possible. The concept of limited entry has been presented here as food for thought.

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APPENDIX

Local, Common and Scientific Names of Fishes and Other Aquatic Animals Commonly Caught in Hawaiian Waters[1]

Local Name	Common Name	Scientific Name
a'awa	spot wrasse, table bass	Bodianus bilunulatus
ahaaha	needle fish	Belonidae (3 species)
ahi (menpachi shibi)	bigeye tuna, menpachi	Thunnus obesus
ahi (maguro)	bluefin tuna	Thunnus thynnus
ahi	yellowfin tuna	Thunnus albacares
ahipalaha (tonbo)	albacore tuna	Thunnus alalunga
aholehole	mountain bass	Kuhlia sandvicensis
aku (katsuwo)	skipjack tuna	Katsuwonus pelamis
akule (aji)	bigeyed scad	Trachurops crumenopthalmus
alaihi	squirrel fish	Holocentridae (15 species)
'ama'ama	mullet	Mugil cephalus
a'u (kajiki)	Pacific blue marlin	Makaira nigricans
a'u (naraigi)	striped marlin	Tetrapterus audax
a'u	broadbill	Xiphias gladius
a'u (hebe)	shortnosed spearfish	Tetrapterus angustirostris
a'u	black marlin	Makaira indica
a'u (misc.)	unclassified	Istiophoridae
a'u lepe	sailfish	Istiophorus platypterus
awa	milkfish	Chanos chanos
awa'awa	ten pounder, lady fish	Elops hawaiiensis
aweoweo	red bigeye	Priacanthidae (4 species)
e'a	wrasse	Labridae
hanui	parrot fish	Scaridae
hapu'upu'u	sea bass	Epinephelus quernus

Local Name	Common Name	Scientific Name
hauliuli	snake mackerel	Gempylus serpens
hihimanu	ray	Dasyatidae
hilu	wrasse	Coris flavovittata
hinalea	wrasse	Labridae
humuhumu	triggerfish	Balistidae
'iao (togoro)	silverside	Pranesus insularum
iheihe	halfbeak	Hemiramphidae
kahala	amberjack	Seriola dumerilii
kaku	barracuda	Sphyraena barracuda
kala	surgeon fish	Naso unicornis
kalikali	pink snapper	Pristipomoides sieboldii
kamanu	Hawaiian salmon	Elagatis bipinnulatus
kawakawa	little tuna	Euthynnus yaito
kawelea	Japanese barracuda	Sphyraena helleri
kihikihi	Moorish idol	Zanclus cornutus
kole	surgeon fish	Ctenochaetus strigosus
kumu	red goat fish	Parupeneus porphyreus
kupipi	damsel fish	Abudefduf sordidus
kupoupou	mongoose fish	Cheilio inermis
lae	leatherback	Scomberoides lysan
laenihi (nabeta)	razor fish	Hemipteronotus pavoninus
lauwiliwili (Y. manini)	long nose butterfly fish	Forcipiger flavissimus
lehi	snapper	Aphareus rutilans
mahimahi	dolphin	Coryphaena hippurus
mai'i	surgeon fish	Acanthurus nigrofuscus
maiko	surgeon fish	Acanthurus nigroris

Local Name	Common Name	Scientific Name
makoiko	surgeon fish	Acanthurus leucopareius
makiawa	sardine	Etrumeus micropus
malolo	flying fish	Exocoetidae
malu	goat fish	Parupeneus pleurostigma
manini	convict tang	Acanthurus triostegus
mano	shark	
mano kihikihi	hammerhead shark	Sphyrna lewini (S. zygaena)
maomao (mamo)	sargeant major	Abudefduf abdominalis
moano (moana)	goat fish	Parupeneus multifasciatus
moano kali(kea)	goat fish	Parupeneus cyclostomus
moelua	red goat fish	Mulloidichthys pflugeri
mola mola	ocean sunfish	Molidae (Mola mola)
moi	thread fin	Polydactylus sexfilis
mu	porgy	Monotaxis grandoculis
munu	goat fish	Parupeneus bifasciatus
na'ena'e	orange spot tang	Acanthurus olivaceus
nehu	anchovy	Stolephorus purpureus
nenue	rudder fish	Kyphosus bigibbus
nohu (hogo)	common scorpin	Scorpaenopsis cacopsis and gibbosa
nunu	stick or trumpet fish	Aulostomus chinensis
oililepa	file fish, broom tail	Alutera scripta
oio	bonefish	Albula vulpes
omaka	yellow tailed scad	Caranx mate
ono	wahoo	Acanthocybium solandri

Local Name	Common Name	Scientific Name
'o'opuhue	balloon fish	Arothron hispidus & Diodontidae
opah	ocean moonfish	Lampris guttatus
opakapaka	pink snapper	Pristipomoides filamentosus
opelu	Mackerel Scad	Decapterus macarellus
opelu	Mackerel Scad	Decapterus maruadsi
opule	spotted wrasse	Anampses cuvieri
pakii	flounder	Bothus mancus, B. panterinus
pakuikui	achilles tang	Acanthurus achilles
la'ipala	yellow tang	Zebrasoma flavescens
palani	surgeon fish	Acanthurus dussumieri
panuhunuhu	parrot fish	Scarus perspicillatus (female)
paopao	yellow ulua	Caranx speciosus
papio	jack crevalle	Carangidae
pau'u	squirrel fish	Myripristis chryseres
piha	small round herring	Spratelloides delicatulus
po'ou		Cheilinus rhodochrous
pualu	surgeon fish	Acanthurus xanthopterus and A. mata
puhi	eel	Muraenidae
puhi (tohe)	white eel	Conger cinereus
roi	blue spotted grouper	Cephalopholis argus
saba	Japanese mackerel	Scomber japonicus
taape	blue-lined snapper	Lutjanus kasmira
toau	snapper	Lutjanus fulvus
uhu	parrot fish	Scaridae

Local Name	Common Name	Scientific Name
ukikiki (Gindai)	snapper	Pristipomoides zonatus
uku	gray snapper	Aprion virescens
ulaula (ehu)	red snapper	Etelis marshi
ulaula koae (onaga)	red snapper	Etelis carbunculus
ulua	jack crevalle	Carangidae
ulua kihikihi (kagami)	thread crevalle	Alectis ciliaris and A. indica
ulua omilu (hoshi)	blue crevalle	Caranx melampygus
uouoa	false mullet	Neomyxus leuciscus
upapalu	cardinal fish	Apogon kallopterus
u'u (menpachi)	squirrel fish	Myripristis amaenus, M. murdjam, M. kuntee
u'ukanipo	squirrel fish	Holocentridae
walu	oil fish	Ruvettus pretiosus
weke	goat fish	Mulloidichthys sp.
weke a'a	spotted goat fish	Mulloidichthys flavolineatus
weke-pueo (pahula)	goat fish	Upeneus arge
weke-ula	red goat fish	Mulloidichthys pflugeri, and M. vanicolensis

1
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