CHAPTER 7

Coral Reef Fishes and Fisheries of South Moloka‘i

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Fish provide food, cultural identity, and commerce to a broad majority of the local population of Moloka‘i and are an integral component of the marine environment. Fishes transfer energy from one location to another by their movement and thereby enhance the overall productivity of the ecosystem. Herbivorous fishes help control the spread of alien and nuisance limu (seaweed), while predators help to maintain high turnover rates and increase productivity within the ecosystem. The high proportion of species that are endemic (found nowhere else on earth) makes Hawai‘i an important location for global marine biodiversity.

Importance of Coral Reef Fishes to Hawaiian Culture

Fishing has been a way of life for Hawaiian people for centuries, with fish and shellfish providing the major protein source (Kamakau, 1839; Titcomb, 1977). Native Hawaiians depended on fishing for survival, which motivated them to acquire a sophisticated understanding of the factors that caused limitations and fluctuations in their marine resources (fig. 1). Using their familiarity with specific places and through much trial and error, Hawaiian communities were able to develop ingenious social and cultural controls on fishing that fostered, in modern terminology, “sustainable use” of marine resources (Hui Malama o Mo‘omomi, 1995). The traditional system in Hawai‘i emphasized a code of conduct that was strictly enforced (Friedlander and others, 2002a; Poepoe and others, 2007). Harvest management was not based on a specific amount of fish, but on identifying the specific times and places that fishing could occur so it would not disrupt the basic processes and habitats of important food resources. Understanding when, where, and how to conduct fishing so that it was compatible with local resource dynamics required an intimate knowledge of natural rhythms and processes associated with these resources (Hui Malama o Mo‘omomi, 1995; Poepoe and others, 2007).

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Figure 1. Hawaiians have traditionally harvested the sea for sustenance and cultural purposes. Photos courtesy of Hawai‘i State Archives.

Decline in Coral Reef Fishes in Hawai‘i

A shift from purely subsistence to commercial fishing occurred with the arrival of the British and American whaling fleets during the early 1800s (Schug, 2001). After contact with Westerners, a breakdown of the traditional system of laws and regulations (kapu) and the demise of the watershed (ahupua‘a) as a management unit led to the virtual elimination of traditional Hawaiian fisheries management practices (Smith and Pai, 1992; Lowe, 2004).

Over the past 100 years the coastal fisheries in Hawai‘i have undergone enormous changes (Shomura, 1987, 2004). The early 1900s saw a rapid change from subsistence to a cash economy and large increases in the commercial landing of fish and other marine resources ensued (Cobb, 1905; Schug, 2001). Following statehood, Hawai‘i saw a rapid growth in tourism, an increasingly urban resident population, and the continued development of shoreline areas for tourism and recreation. These changes resulted in another change in the character of the coastal fisheries—they became dominated by recreational anglers and a greater number of part-time commercial fishers, who curtailed their fishing to take advantage of more lucrative economic activities (Friedlander, 2004).

Commercial landings for a number of important species have shown dramatic declines since the 1900s (fig. 2). These declines in fish abundance and size, particularly around the more populated areas of the state, are likely the cumulative result of years of chronic overfishing (Shomura, 1987; Friedlander and DeMartini, 2002). Other factors contributing to the decline of inshore fisheries include a growing human population, destruction or disturbance to habitat, introduction of new fishing techniques (for examples, inexpensive monofilament gill nets, scuba, spear guns, power boats, sonar fish finders, GPS), and loss of traditional conservation practices (Brock and others, 1985; Lowe, 1996; Friedlander and others, 2003).

Importance to Biodiversity Conservation

In addition to food and recreation, the wide variety of fishes observed in Hawaiian waters are also important to the overall health of the coral reefs and ultimately of the islands. Herbivorous parrotfishes and surgeonfishes feed on limu (seaweed) and help to prevent the overgrowth of limu on corals. Other fishes, such as weke (goatfishes), feed on shrimp and crabs in the sand and transfer that energy back onto the coral reef, thus enhancing

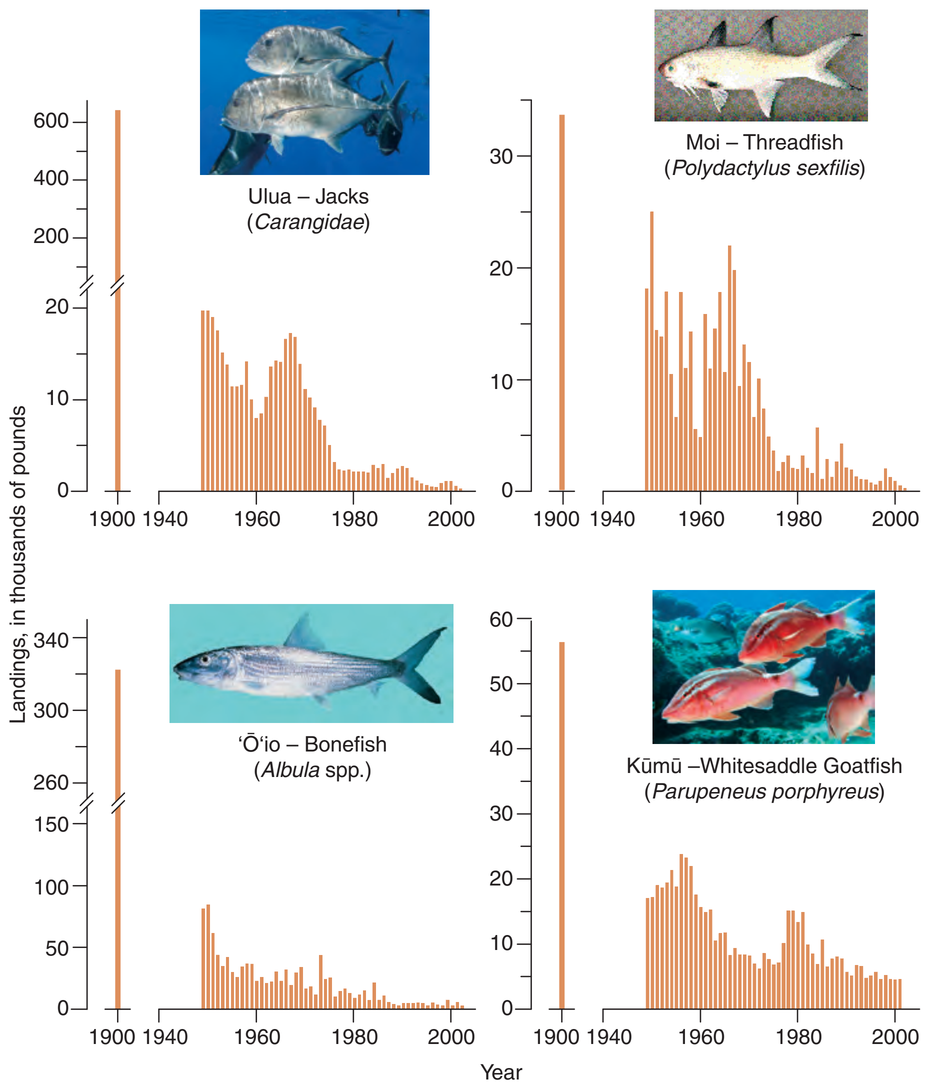


Figure 2. Statewide commercial catch data from Hawaii Department of Land and Natural Resources/Division of Aquatic Resources (DLNR/DAR) from 1948 to 2005. Data for 1990 from market surveys conducted by the United States Fish Commission. Adapted from Friedlander and others, 2005. Data sources: Cobb, 1905; DLNR/DAR, unpublished data.

the productivity of the entire ecosystem. Because fishes move energy from one part of the ecosystem to another, they are good indicators of large-scale ecosystem health.

Conserving coral reef fishes is also important to global marine biodiversity. The faunas of isolated oceanic archipelagos like the Hawaiian Islands represent species conservation hotspots that have become increasingly important because of continual losses of biodiversity on coral reefs worldwide (DeMartini and Friedlander, 2004). Owing to its geographic isolation, the proportion of endemic fishes (found nowhere else on earth) in Hawai'i is the highest of any known tropical marine ecosystem (Randall 1996, DeMartini; and Friedlander, 2004). Many of the endemic fish species in Hawai'i (fig. 3) are some of the most common, like hīnālea lauwili (saddle wrasse, *Thalassoma duperrey*) and kole (goldring surgeonfish, *Ctenochaetus strigosus*). Other endemics are valued food fishes like uhu uliuli (spectacled parrotfish, *Chlorurus perspicillatus*) and kūmū (whitesaddle goatfish, *Parupeneus porphyreus*). The loss of endemic species not only affects Hawai'i but also represents a loss of global genetic diversity.

The purpose of this chapter is to describe the fish and fishery resources of the south Moloka'i reef tract on the basis of information obtained from scientific surveys, as well as fisheries catch data and local knowledge.

Methods

Description of Survey Methods

Sampling Stations

Three permanent monitoring sites (Pālā'au, Kamiloloa, Kamalō) have been established on the south Moloka'i reef tract to measure coral growth and benthic cover (see Brown, this vol., chap. 6). At each site, one fish sampling station was located at 3-m depth and another at 10-m depth. Surveys along four transects, separated by 5-m gaps, were conducted at each station. Additional samples were collected using a stratified random sampling approach, where samples were stratified by major habitat type using NOAA's benthic habitat maps (Coyne and others, 2003) (fig. 4). These additional stations were classified as either shallow (≤5 m) or deep (10–20 m).

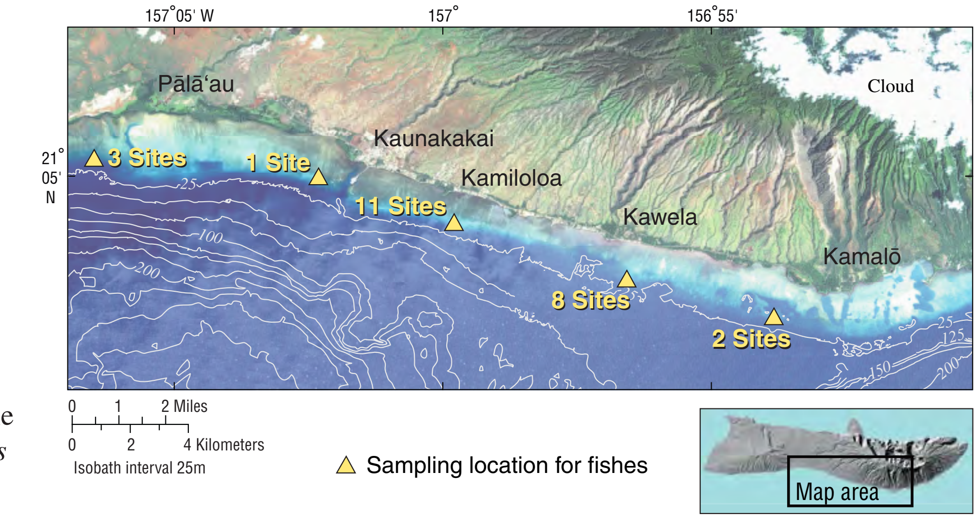


Figure 4. Satellite image showing sampling locations for fishes along the south shore of Moloka'i.

Fish Surveys

At each station, data were collected on fish, habitat complexity (rugosity), and benthic cover. Fish assemblages were assessed using standard underwater visual belt-transect survey methods (fig. 5; V.E. Brock, 1954; R.E. Brock, 1982). A scuba diver swam each 25-m by 5-m transect at a constant speed and identified, to the lowest possible taxon, all fishes visible within 2.5 m to either side of the centerline (125 m^2 transect area).

Total length (TL) of fish was estimated to the nearest centimeter and converted to weight using a standard length-weight conversion. Total length was converted to standard length (SL) using the methodology presented by FishBase (http://www.fishbase.org, last accessed April 29, 2008). An index of relative dominance (percent frequency of occurrence times percent total numbers or percent total biomass) was calculated for comparison among taxa. Fish taxa were categorized into four trophic categories according to various published sources and FishBase. Species diversity was calculated from the Shannon-Weaver Diversity Index (Ludwig and Reynolds, 1988): H'=S (p_i ln p_i), where p_i is the proportion of all individuals counted that were of species i.

Figure 3. Endemic species (found nowhere else on earth) represent some of the most common and economically important fishes found in Hawai'i.

Figure 5. Underwater fish survey method. The left image shows a diver recording information on fishes along a belt-transect. In the right image, a diver is calibrating length estimates using model fishes.

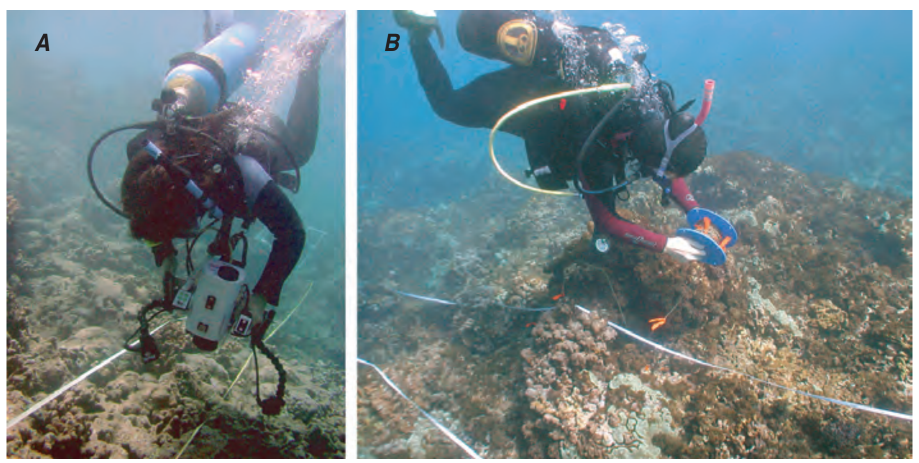


Figure 6. Underwater habitat assessment method on the south Moloka‘i reef. *A*, A diver using an underwater video camera to record benthic cover. *B*, A diver is measuring habitat complexity using a rugosity chain marked with orange flags.

Trophic Categories (primary food items and representative taxa)

- Herbivores: plant eaters; primarily parrotfishes and surgeonfishes
- Invertebrate feeders: feed on crustaceans, mollusks, and other invertebrates; representatives of this group includes goatfishes and trigger fishes
- Piscivores: primarily fish eaters; jacks including kāhala (amberjack, *Seriola dumerili*) and uku (green jobfish, *Aprion virscens*)
- Planktivores: plankton feeders; damselfishes and some unicornfishes

Benthic Habitat Assessments

To assess the characteristics of benthic populations (percent cover, species richness and diversity of corals, algal functional groups, and substrate cover), high-resolution digital images were taken along transects using a digital camera in an underwater housing (fig. 6*A*). To measure reef-surface complexity, a small-link chain (1.3 cm per link) was draped along the full length of the centerline of each transect (fig. 6*B*). Care was taken to ensure that the chain followed the contour of all natural fixed surfaces directly below the transect centerline. The ratio of distance along the reef-surface profile to linear horizontal distance gave an index of spatial relief or rugosity.

Results

Description of Fish Assemblage

Dominant Species

A total of 99 taxa of fishes were recorded on quantitative transects between January 2001 and February 2002. Dominance of fishes on south Moloka‘i reefs was calculated on the basis of contribution of each species to the total biomass or numerical abundance multiplied by the proportion of samples in which that species occurred (fig. 7). The introduced ta‘ape (bluestripe snapper, *Lutjanus kasmira*) accounted for 22 percent of the total fish biomass observed on transects, but this represented a single school of approximately 500 individuals observed on only one transect at Kakahai‘a. The dominant species by weight was the bullethead uhu (Bullethead Parrotfish, *Chlorurus sordidus*) accounting for 10 percent of total fish biomass and occurring on 70 percent of all transects. Mā‘i‘i‘i (brown surgeonfish, *Acanthurus nigrofuscus*) was the most important species by number and second most important by weight. It occurred in 74 percent of the transects and accounted for 13 percent of the numerical abundance and 5 percent of the total biomass observed. The endemic kole (goldring surgeonfish, *Ctenochaetus strugosus*) was also abundant and occurred on 62 percent of the transects and made up 11 percent of the numerical abundance and 6 percent of the total weight. Hīnālea lauwili (saddle wrasse, *Thalassoma duperrey*), also an endemic species, was the most ubiquitous species, appearing on 94 percent of all transects.

Dominant Families

The top five families listed below, plus jacks, accounted for nearly 90 percent of the total biomass observed on transects along the south Moloka‘i reef tract (fig. 8). Surgeonfishes, primarily mā‘i‘i‘i and kole, were the dominant family by both numbers and weight. Several schools of manini (convict tang, *Acanthurus triostegus*) were encountered, ranging in size from 43 to 88 individuals per school. The bullethead uhu was the most important parrotfish species by weight and number, followed by the palenose uhu (*Scarus psittacus*). Triggerfishes were the third most important family by weight and sixth by number. Humuhumu‘ele‘ele (black durgon, *Melichthys niger*), humuhumu hi‘u kole (pinktail durgon, *Melichthys vidua*), humuhumu nukunuku āpua‘a (reef triggerfish, *Rhinecanthus rectangulus*), and humuhumu lei (lei triggerfish, *Sufflamen bursa*) were the dominant species in the family. Hīnālea lauwili made up most of the wrasses by weight and number, while ta‘ape accounted for most of the snappers, followed by uku (green jobfish, *Aprion virscens*).

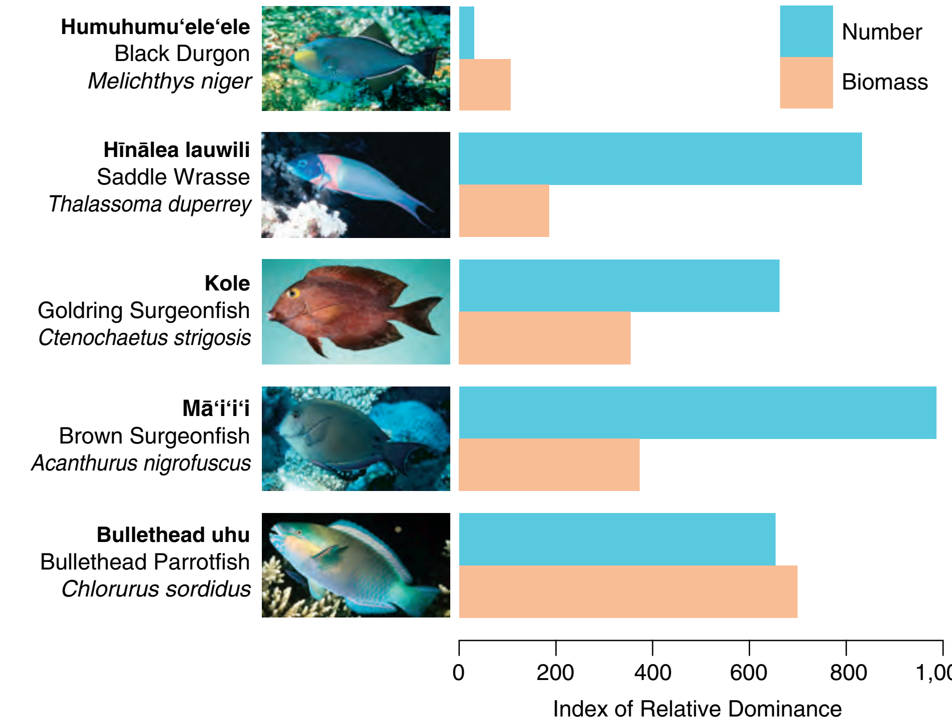


Figure 7. Index of relative dominance (percent frequency of occurrence times percent total number or percent total biomass) for the five most dominant species of fish appearing on transects along the south Moloka‘i coast.

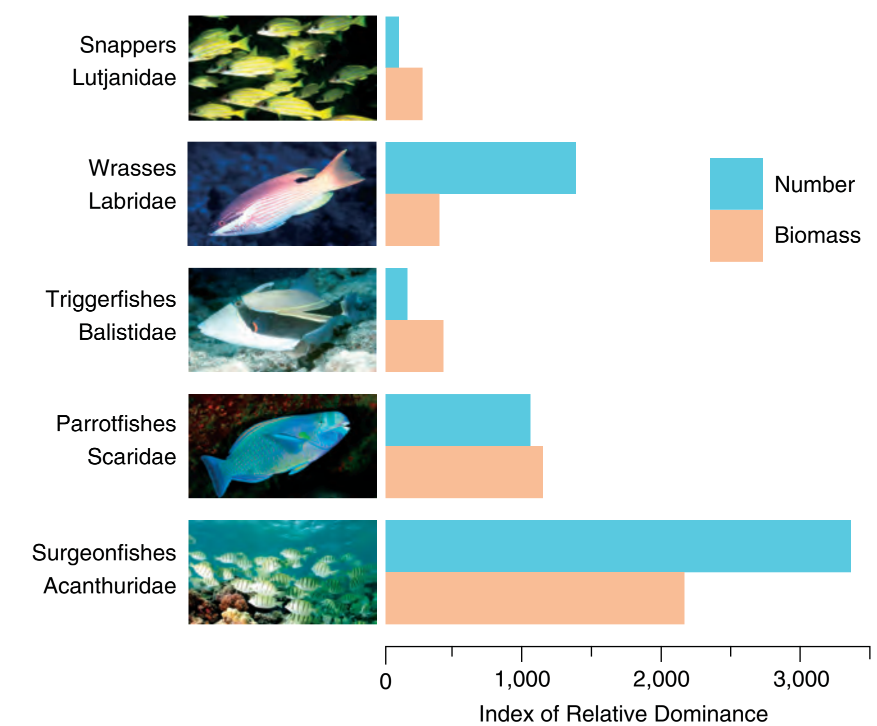


Figure 8. Index of relative dominance (percent frequency of occurrence times percent total number or percent total biomass) for the five most dominant fish families appearing on transects along the south Moloka‘i coast.

Dominant Trophic-Category Guilds

Herbivores were by far the most important feeding guild observed, with parrotfishes and surgeonfishes dominating this group (fig. 9). Bullethead uhu accounted for 23 percent of the total herbivore biomass, followed by kole (13 percent) and māʻiʻiʻi (12 percent). Invertebrate feeders were the next most abundant feeding guild by both numbers and weight, with nearly 70 percent of the biomass consisting of taʻape. Large piscivores were not commonly observed in the survey area, but the few large individuals contributed disproportionately to the overall biomass relative to their numbers. Kāhala (amberjack, *Seriola dumerili*) made up 69 percent of the total piscivore biomass, followed by uku (19 percent), and the introduced roi (peacock grouper, *Chephalopholis argus*, 8 percent). In contrast to piscivores, small planktivores were numerically common (9 percent of total numerical abundance), but accounted for only a small proportion (3 percent) of the total fish biomass.

Native, Endemic, and Introduced Species

A total of 612 native reef and inshore fishes (down to 200 m or ~600 ft) have been identified from the Hawaiian Islands (Randall, 2007). Endemic species (found nowhere else on earth) accounted for 37 percent of numerical abundance and 29 percent of biomass on the south Molokaʻi reef tract (fig. 10). Kole was the most abundant endemic species by both weight and number. Manini (convict tang, *Acanthurus triostegus sandvicensis*) is an endemic subspecies that was the second most important endemic species by weight and third by number. Hīnālea lauwili was numerically the second most common endemic and, despite its small size, accounted for 12 percent of total endemic biomass.

At least 13 species of introduced marine fishes have become established in Hawaiʻi (Eldredge, 1994). Of these species, taʻape, toʻau (blacktail snapper, *Lutjanus fulvus*), and roi have established viable breeding populations in the state. Taʻape and roi have been particularly controversial because they have adapted well to Hawaiian waters and are often blamed for depletion of desirable species by competition or predation (Friedlander and others 2002a; Oda and Parrish, 1981; Randall, 1987). The introduced taʻape accounted for 22 percent of the total fish biomass observed on transects, but, as noted earlier, represented a single school of 500 individuals. Roi accounted for less than 10 percent of the weight of introduced species and was observed on about half of all transects (mean = 0.48 individuals/125m^2).

Spatial Distribution of Fish Assemblage Characteristics

The number of species, biomass (weight of fishes), number of individuals, and diversity (an index that combines number of species and number of individuals) are important characteristics of the fish assemblage and are useful in describing and comparing assemblages among stations. The deep transects at Pālāʻau and Kakahaiʻa had the highest values for most

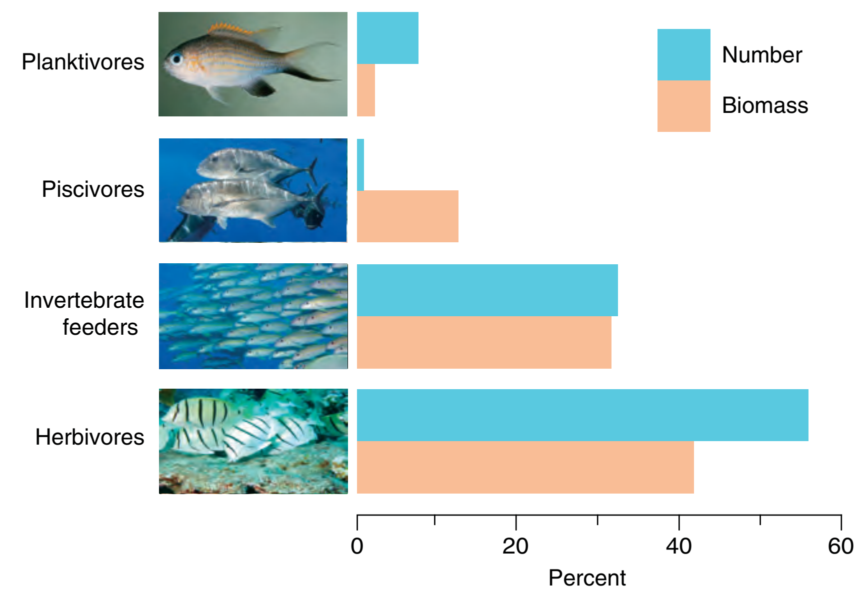


Figure 9. Percentages of total biomass and numerical abundance among major trophic fish guilds along the south Molokaʻi reef tract.

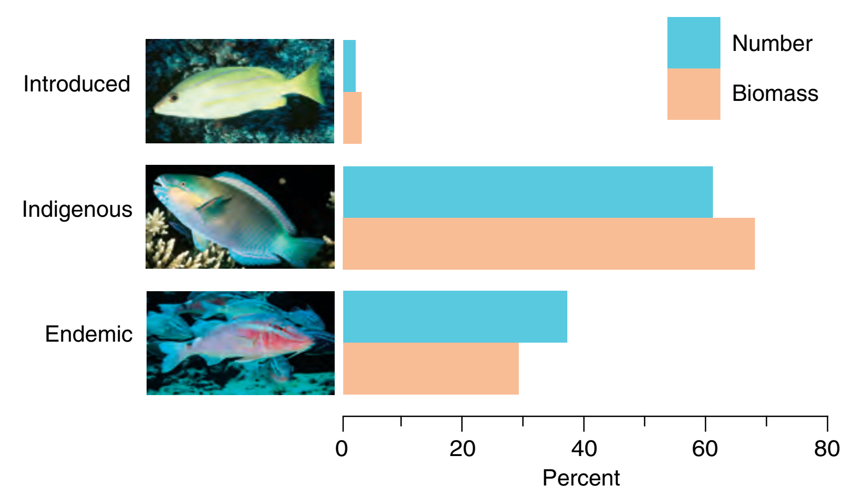


Figure 10. Mean percentages of endemic, indigenous, and introduced species along the south Molokaʻi reef tract.

fish assemblage characteristics (table 1). Diversity was low at Kakahaiʻa, owing to the dominance of a school of 500 taʻape at one deep survey site. Kamiloloa and Kamalō had the lowest values for most assemblage characteristics at both deep and shallow sites.

The number of species was comparable across depth strata, with the lowest values for both depths occurring at Kamiloloa and Kamalō (fig. 11). Biomass was highly variable among, as well as within, stations. The biomass at the deep Kakahaiʻa sites (3.60 t/ha) was more than 12 times greater than at the adjacent shallow sites (fig. 12). The number of individuals observed was fairly consistent among most stations (fig. 13). The exceptions included the deep Kakahaiʻa site, which was dominated by a large school of 500 taʻape, and the shallow Pālāʻau site, where high numbers of surgeonfishes were recorded. Diversity was high among stations, with no apparent trends observed (fig. 14).

Table 1. Ranking of fish assemblage characteristics by survey location.

[Individual variables were given a ranking score from 1 (highest value) to 9 (lowest value). See figures 11–14 for actual values. Overall rank was determined by averaging the ranking scores of the four individual parameters (1 = highest, 9 = lowest).]

Location	Depth	Species	Biomass	Number	Diversity	Overall Rank
Pālāʻau	Deep	1	6	3	1	1
Kakahaiʻa	Deep	2	1	1	8	2
Pālāʻau	Shallow	4[1]	2	2	6	3
Kaunakakai	Shallow	4[1]	3	6	2	4
Kamalō	Shallow	6	5	4	4	5
Kakahaiʻa	Shallow	3	8	7	3	6
Kamiloloa	Deep	7	4	5	7	7
Kamalō	Deep	9	7	8	5	8
Kamiloloa	Shallow	8	9	9	9	9

[1]Tied

Spatial Distribution of Fish Trophic Structure

Herbivores dominated at all shallow sites, with the exception of Kamiloloa (fig. 15). The high percentage of invertebrate feeders there (76 percent) was a function of overall low biomass, primarily herbivores. Low overall biomass at the shallow location at Kakahaiʻa also resulted in a higher proportion of invertebrate feeders (28 percent), primarily a mixture of goatfishes, wrasses, and butterflyfishes. Planktivores were not common at any of the shallow sites.

Although herbivores dominated at the deep stations at Pālāʻau and Kamalō, they were not as abundant overall as at shallow stations. At Kakahaiʻa, invertebrate feeders (almost exclusively taʻape) account for nearly half of the total fish biomass. Kāhala and uku were responsible for the high predator biomass (42 percent) at this location. The relatively high percentage of invertebrate feeders (19 percent), piscivores (19.5 percent), and planktivores (16 percent) at Kamiloloa was a function of overall low biomass, primarily of herbivores.

Comparison with Locations Statewide

Overall species number, biomass (kg), and species diversity along the south Molokaʻi reef tract range near the state median when compared with other locations statewide (Rodgers, 2005). Pālāʻau, Kaunakakai, and Kakahaiʻa possessed values for most fish assemblage characteristics higher than the state average, but most fish assemblage characteristics at Kamiloloa

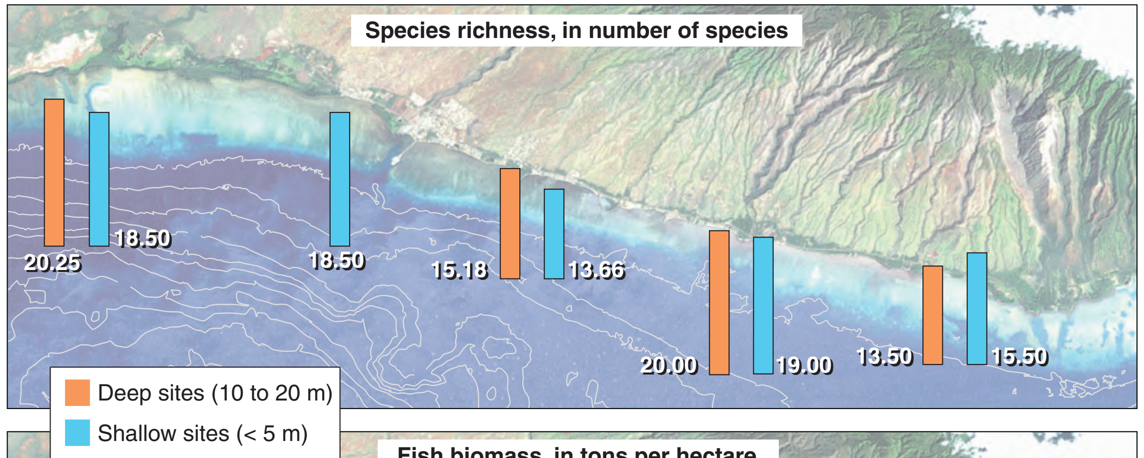


Figure 11. Mean species richness of fishes (number of species) observed on transects along south Moloka‘i reef tract. Orange = deep sites (10 to 20 m), blue = shallow sites (≤5 m).

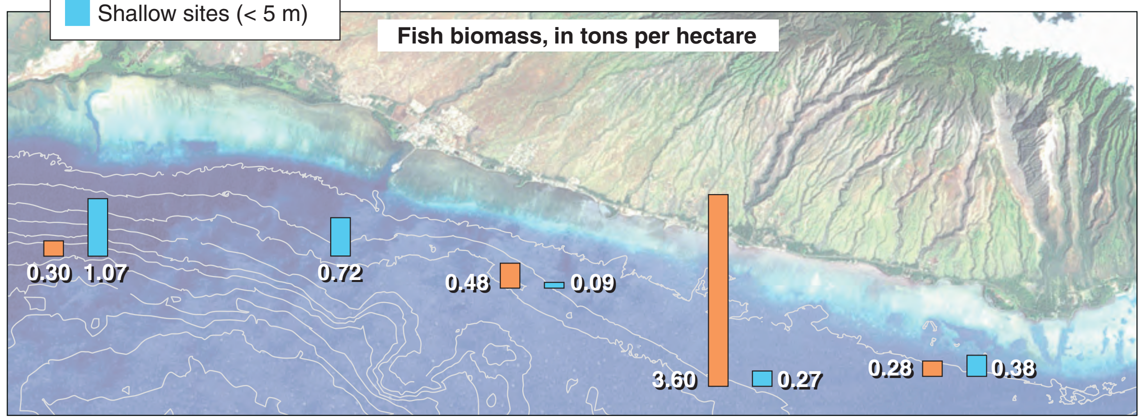


Figure 12. Mean fish biomass (in tons per hectare) observed on transects along south Moloka‘i reef tract. Orange = deep sites (10 to 20 m), blue = shallow sites (≤5 m).

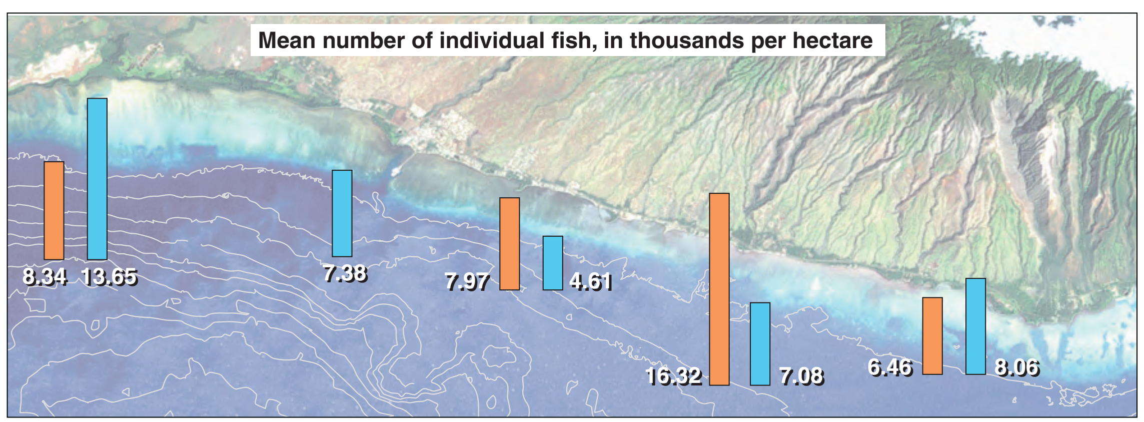


Figure 13. Mean number of individual fish (in thousands per hectare) observed on transects along south Moloka‘i reef tract. Orange = deep sites (10 to 20 m), blue = shallow sites (≤5 m).

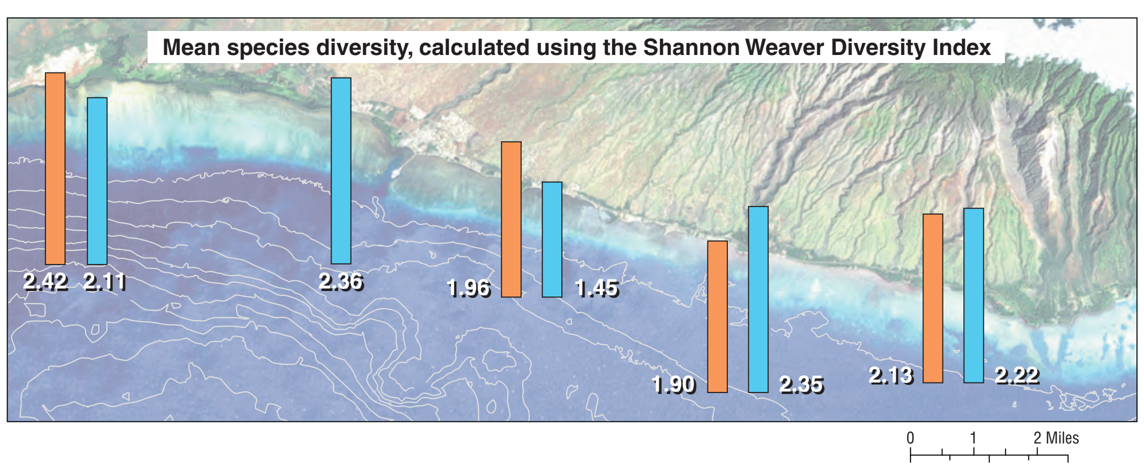


Figure 14. Mean species diversity (calculated using the Shannon Weaver Diversity Index) observed on transects along south Moloka‘i reef tract. Orange = deep sites (10 to 20 m), blue = shallow sites (≤5 m).

and Kamalō were well below the state average (fig. 16). Fish biomass at Kakahai‘a was among the highest observed biomass values in the state, while only 5 km away, Kamiloloa had some of the lowest observed biomass values statewide.

Fisheries of South Moloka‘i

The broad reef fringing the southern shore of Moloka‘i is probably the most productive reef flat for the harvest of reef fishes and invertebrates in the main Hawaiian Islands (Bartram 1992). This extensive area supports a wide variety of commercial, subsistence, and recreational fisheries (table 2). The only consistent long-term source of data on the coastal fisheries of Hawai‘i is the commercial landings database maintained by the State Division of Aquatic Resources (DAR). Commercial landing data between 1998 and 2002 were used to examine characteristics of the commercial fishery along the south coast of Moloka‘i (reporting areas 310 and 314). The average annual commercial harvest during this time period was just less than 10,000 kg (22,000 lbs) This is in sharp contrast to the early 1980’s, when approximately 68,000 kg (150,000 lbs) per year was harvested in the same location (Bartram, 1992).

Fisheries catch statistics alone are unreliable because of underreporting by commercial fishers and a large, resident recreational and subsistence fishing catch that goes unreported. The subsistence reef-fish fishery harvest may be as high as 45,000 kg (100,000 lbs) a year, or more than four times that of the commercial harvest (Bartram 1992). Information on subsistence and recreational components of the fishery was obtained from local knowledge, interviews, and written sources.

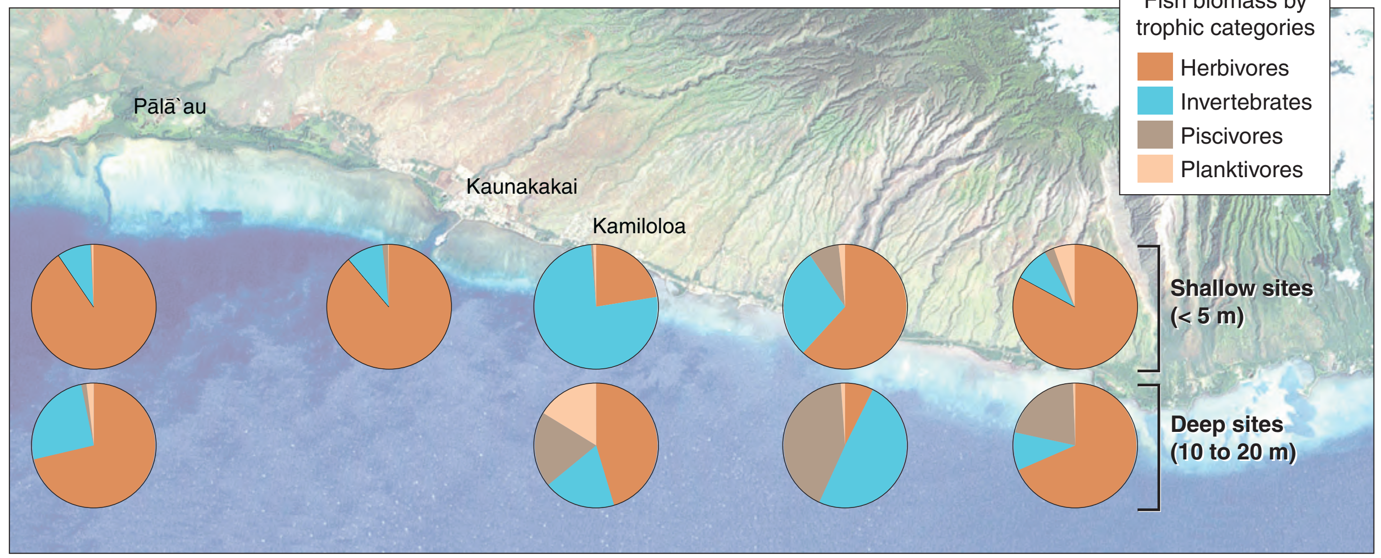
Commercial Landings by Gear Type and Species

Deep-sea handlining, primarily for ‘ula‘ula koa‘e (long-tailed red snapper, *Etelis coruscans*, known more commonly by its Japanese name,

Table 2. Major fishing methods employed along south Moloka‘i reef tract.
[Adapted from Bartram (1992).]

Gear type	Character of fishery	General areas fished
Spearing	Mostly recreation/subsistence	Middle to outer reef flat in areas with coral heads and other vertical relief
Throw netting	Subsistence	Inner reef flat, fishponds, mangrove thickets; water depths to waist-deep
Surround netting	Commercial/subsistence	Harbors, man-made basins, reef channels; water depths >20 ft; targeting akule and other schooling species
Drag netting	Subsistence	Inner reef flat, fishponds
Bullpen netting	Commercial	Outer reef flat (5–10 ft depth) in sandy and other areas of low relief
Gill netting	Commercial/subsistence	Reef flat (usually inner and middle); low-tide depths of 5–6 ft; areas of low bottom relief

Figure 15. Pie charts showing proportions of fish biomass by trophic categories observed at five shallow (depth ≤5 m, top row) and four deep (depth >5 m, bottom row) locations along the south Moloka'i reef tract.



onaga), 'ula'ula (red snapper, *Etelis carbunculus*, known commonly as ehu), and 'ōpakapaka (pink snapper, *Pristipomoides filamentosus*), constituted 16 percent of the total weight landed and 36 percent of the value of catch from 1999 to 2002 (table 3). This was followed in total value (1998 to 2002) by gleaning for limu manauea, also known as ogo (seaweed, *Gracilaria* spp.) (3,837 kg/8,441 lbs., $24,102) and 'opihi (limpets, *Cellana* spp.) (558 kg/1229 lbs., $3,543), which are the major species taken using this method.

The inshore handline catch was dominated by akule (bigeye scad, *Selar crumenophthalmus*) (80 percent by weight and 69 percent by value) with the remaining portion consisting of various reef fishes and invertebrates (fig. 17*A*). Netting caught a diverse assemblage of fishes, with weke (goatfishes, *Mulloidicthys* spp.) and ulua (jacks, *Carganidae*) making up 73 percent of the total catch (fig. 17*B*). Parrotfishes accounted for 30 percent of the catch by diving, followed by kole (23 percent), he'e (octopuses, 20 percent), ula (spiny lobster, *Panulirus* spp., 1 percent), and ulua (8 percent) (fig. 18*A*). The trolling catch consisted of ono (wahoo, *Acanthocybium solandri*, 48 percent), mahimahi (dolphinfish, *Coryphaena hippurus*, 31 percent), ulua (9 percent), aku (skipjack tuna, *Katsuwonus pelamis*, 7 percent), and kawakawa (wavy-back tuna, *Euthynnus affinis*, 5 percent) (fig. 18*B*).

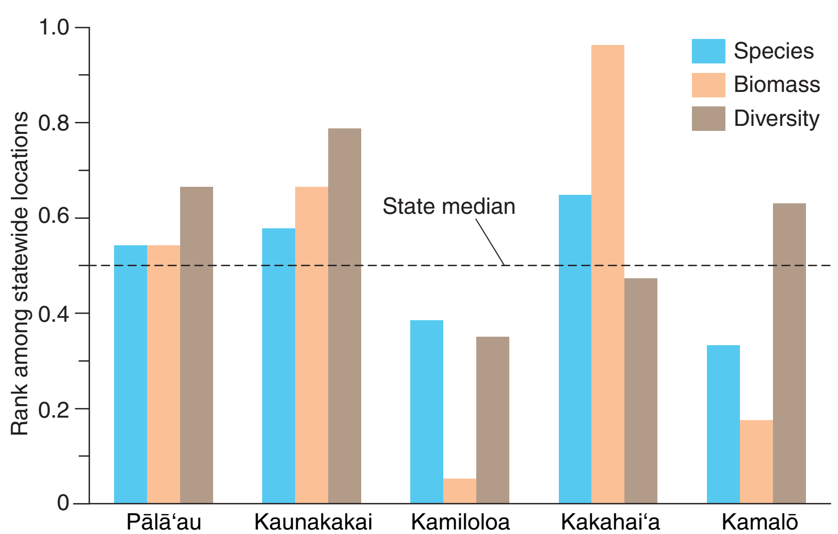


Figure 16. Rank for fish-assemblage characteristics along the south Moloka'i reef tract (see figs. 11, 12, 14 for details) relative to locations statewide (data from Rodgers, 2005). A rank of 0.5 equals the State median.

Table 3. Commercial fisheries landings data from Hawaii Department of Land and Natural Resources, Division of Aquatic Resources for reporting areas 310 and 314 for 1998-2002 by gear type.

[Values are annual means for five-year period.]

Fishing method	No. fishers	No. trips	Kg caught	Lbs caught	Value ($)
Deep-sea handline	6.8	43.0	1,601	3,523	16,555
Gleaning	5.6	185.2	2,400	5,280	7,923
Inshore handline	10.6	64.8	1,697	3,734	7,339
Net	8.6	41.0	1,910	4,203	5,531
Dive	8.0	48.0	1,113	2,449	5,187
Troll	24.4	90.4	1,170	2,573	3,068
Grand Total	64.0	472.4	9,891	21,763	45,603

Noncommercial Fishing Activities

The noncommercial harvest of fish and invertebrates is an important food source for many Moloka'i residents. The Governor's Moloka'i Subsistence Task Force (1994) found that among Hawaiian families surveyed, 38 percent of all food was acquired through subsistence, and Moloka'i residents relied on subsistence to a much greater extent than those of neighboring islands. Interviews conducted with co-op members of the Moloka'i Ice House, Inc., in 1991 indicated average catches of reef fishes and akule to be about 90 kg (200 lbs) per person per year (Bartram, 1992). If this average is applicable to all Moloka'i households with subsistence fishermen, then the subsistence reef fishery harvest may approach 45,000 kg (100,000 lbs) annually (Bartram, 1992).

There are a number of subsistence and recreational fishing activities that Moloka'i residents practice along the south shore. Shore-based fishing includes throw-netting and pole and line fishing. Locals pole fish from shore for pāpio (juvenile jacks, *Caranx* spp.), weke and 'oama (juvenile goatfishes, *Mulloidicthys* spp.), and halalū (smaller sized akule). Crabbing with lantern is still common, but less so than in the past. Throw netters mainly target moi (Pacific threadfin, *Polydactylus sexfilis*), āholehole (Hawaiian flagtail, *Kuhlia* spp.), enenue (chubs, *Kyphosus* spp.), and 'ama'ama (mullet, *Mugil cephalus*). In addition to fishes, other marine resources are locally collected for food. Crabbing with spotlight or flashlight on rocky shores for 'a'ama crab (*Grapsus tenuicrustatus*) is still common. Limu (seaweed) species such as limu kohu (*Asparogopsis taxiformis*) and manauea (*Gracilaria coronopofolia*) are harvested along the beach and upon inshore flats. Collecting of opihi (limpets, *Cellana* spp.) also occurs in rocky shoreline habitats toward the east end of the south shore.

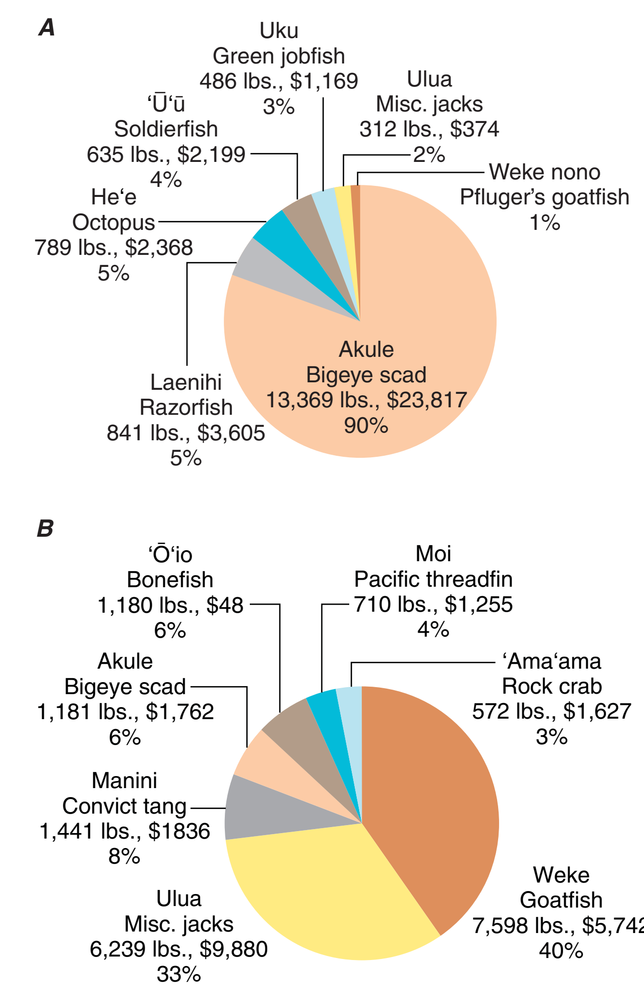


Figure 17. Catch of major species off south Moloka'i between 1998 and 2002 by (*A*) shallow handlining and (*B*) netting. Numbers are weight, value, and percentage of total weight.

Offshore, the extensive reef flat off the south shore of Moloka‘i supports a variety of fishing activities. Diving for kole, he‘e, uhu, manini, kūmū, ‘ū‘ū (soldierfishes and squirrelfishes, Holocentridae), uma-uma lei (orangespine unicornfish, *Naso literatus*), kala (bluespine unicornfish, *Naso unicornis*), palani (eyestripe surgeonfish, *Acanthurus dussumieri*), pualu (yellowfin surgeonfish, *A. xanthopterus*), moana ukali (goatfish, *Parupeneus* spp.), ula and ula papa (slipper lobster, *Parribacus antarcticus*) occurs often. Gill netting and surround netting are common methods as well. Gill netting is most frequent along the inshore edge of the fringing reef. The most common species caught are weke, ‘ama‘ama, pāpio, ō‘io (bonefish, *Albula* spp.), kala, and enenue. Surround netting is frequently used for particular species like akule that are usually found in deeper waters such as channels, bays, and outside the fringing reef. Trolling and boat-based spinning for pāpio along the reef flat and outer reef crest is also a popular activity among residents. Other activities in this area include line fishing in sand channels for o‘io and outside the fringing reef for weke ‘ula (*Mulloidicthys vanicolensis*), pāpio, uku and laenihi or nabeta (razorfish, *Iniistius* spp.). Netting for kona crab (*Ranina ranina*) is also conducted in these sandy areas. Farthest off the south shore, trolling for pelagic species such as ono and mahi mahi and bottom-fishing for onaga, ehu, and ‘ōpakapaka, are performed by both commercial and recreational fishers.

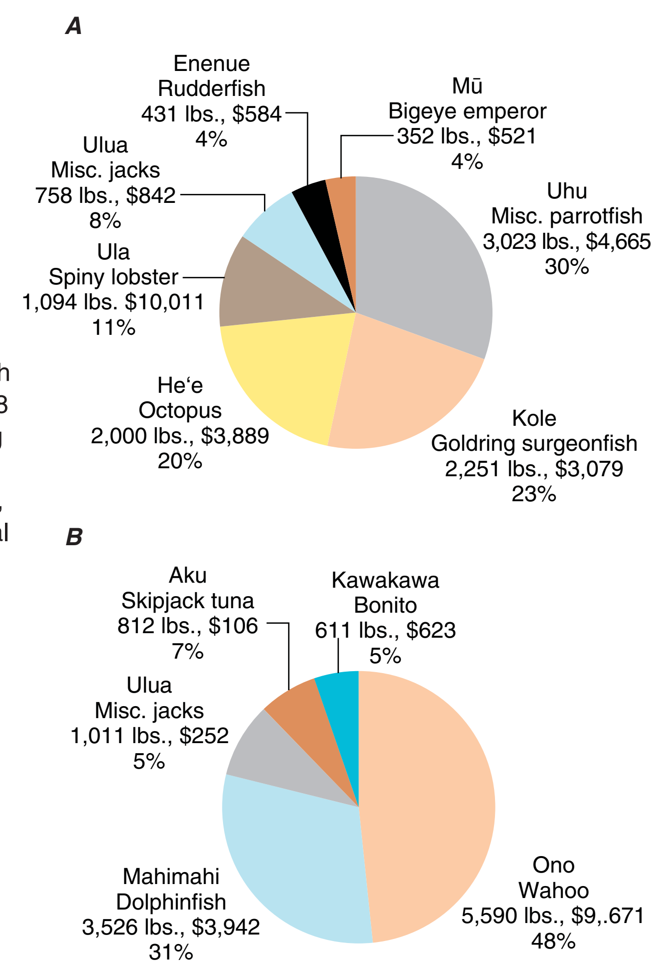


Figure 18. Catch of major species off south Moloka‘i between 1998 and 2002 by (*A*) diving and (*B*) trolling. Numbers are weight, value, and percentage of total weight.

The importance of the fishery resources to the local community is very great. The harvest of marine resources still serves as a considerable supplement to locals’ incomes and is a significant part of local culture. Lū‘au for graduations and birthdays are still events that ‘necessitate’ many customary foods, such as ‘opihi. In the absence of large supermarkets, marine resources are still very much a large part of the local Moloka‘i diet, especially in comparison to other islands such as O‘ahu.

South Moloka‘i Fishponds

Ancient Hawaiian fishponds (loko i‘a), dating back to the 13th century, are unique in the world and have been recognized as the most extensive and productive systems of early aquaculture. It has been estimated that close to 500 fishponds producing more than 900,000 kg (2,000,000 lbs) of fish each year were in use before Western contact in 1778 (Summers, 1971). This phenomenal feat of engineering is evidenced by its longevity, with many of the original ponds still in existence. As a highly efficient form of resource management, fishponds provided a sustainable protein source that could be harvested during rough oceanic conditions and by those no longer able to fish. Representing not only survival, the fishponds had an inseparable relationship to religious beliefs and political practices.

The loko kuapā shoreline pond enclosed by a rock wall, is the most familiar of the four basic types of fishponds. The multipurpose sluice gates (mākahā) evolved into a system of gates and channels that regulated the flow of water, allowed entrance to fingerlings, and facilitated harvest. Within these fish farms, constructed of basalt and coral, numerous fish species and limu (seaweed) were raised and harvested. The most common included awa (milkfish, *Chanos chanos*), ‘ama‘ama, awa‘aua (ladyfish, *Elops hawaiensis*), āholehole, and ulua and pāpio, while some species, such as the moi, kūmū and ō‘io, were reserved for the ali‘i (royality).

This extensive modification of the coastline altered both downslope and alongshore sediment transport while shifting nearshore current patterns (Roberts, 2001; Ogston and others, this vol., chap. 20). Fishpond cultivation rapidly declined with increasing urbanization and coastal development, changes in land tenure, loss of knowledge of pond management practices, and decline in the native population (Hlawati, 2002). Because these events affected Moloka‘i less than the other Hawaiian Islands, more intact fishponds remained there. By 1930, however, grazing and agricultural activities on Moloka‘i contributed to their abandonment as the majority filled with sediment. Today, remnants of more than 70 ponds remain on the south shore of the island of Moloka‘i (fig. 19). Keawanui and ‘Ualapu‘e fishponds have been federally recognized as national historical landmarks. A wetland bird sanctuary has been created with lands surrounding and including the freshwater Kakahai‘a fishpond. Some ponds have been restored and are currently being used by local residents (Wyban, 1992).

Strong advocates of preservation and restoration of the remaining fishponds have renewed community interest in complementing a subsistence

Figure 19. Aerial views of south Moloka‘i fishponds. Houses give indication of scale.

lifestyle. These historic structures provide a significant archeological, spiritual, and cultural link with the past. They hold important significance as an educational resource, in preserving cultural values, and in stimulating economic opportunities within the community.

Traditional Fisheries Management

There has been a renaissance of traditional community-based fisheries management throughout the Pacific, and rediscovery of these traditional techniques offers great promise for improving the management of marine fisheries. In coastal communities, fishermen (and women) combine empirical information on fish behavior, the physical environment, and fish habitats to determine when, where, and how to fish (Ruddle, 1994). This information in some communities has been passed down over many generations, and traditional knowledge can play an important role in designing effective fishery management systems (Johannes, 1997). Many of the management tools used today, such as closed areas, closed seasons, size limits, and restricted access, were used by Pacific Islanders centuries ago to manage their fisheries resources (Johannes, 1978)

A number of communities throughout Hawai‘i are currently strengthening local influence and accountability for the health and long-term sustainability of their marine resources through revitalization of local traditions and resource knowledge (Friedlander and Brown, 2004). The community in the Ho‘olehua Hawaiian Homesteads on the island of Moloka‘i exemplifies this trend (Poepoe and others, 2007). Community-sanctioned norms for fishing conduct are being reinforced through continual feedback based on local resource monitoring, education, and peer pressure (Friedlander and others, 2002b; Poepoe and others, 2007).

The most effective means to elicit proper conduct of fishing is by educating young people in the community to understand that they have responsibilities, as well as rights, for marine resource use. The continuation of traditional Hawaiian practices in and around Mo‘omomi Bay (fig. 20) helps to maintain social and cultural identity and provides reinforcement of values shared by the Ho‘olehua community (Poepoe and others, 2007). The repetition of subsistence fishing activities is one of the ways that knowledge, values, and identity are transferred to succeeding generations. Cultural survival is thus entwined with resource conservation. Each community will have to develop management strategies that are compatible with their own unique situation. Environment, history, and resources will all dictate what type of management regime is best suited for each individual community.

Summary

The fish assemblage of the south Moloka‘i reef tract provides food, recreation, commerce, and cultural identity to the local human population. In addition, it is an integral component of the south Moloka‘i marine environment, helping to maintain a healthy ecosystem. The large number of endemic species on these reefs attests to the unique composition of the ecosystem and its importance in global marine biodiversity.

The broad reef fringing the south shore of Moloka‘i is probably the most productive reef flat in the main Hawaiian Islands for the harvest of reef fishes and invertebrates. The fish assemblage represents a diverse fauna that is healthier than those in more heavily exploited urban areas around the State, but it has shown signs of decline in overall health and quality over time. The average annual commercial catch has declined from a peak of 68,000 kg (150,000 lbs) per year in the early 1980s to roughly 10,000 kg (22,000 lbs) today. In addition, the men and women of the fishing community have expressed concern about the declining size and abundance of several important resource species such as kūmū and moana kale (blue goatfish, *Parupeneus cyclostomus*). There is a great need for more localized control of these resources in order to rehabilitate existing stocks and ensure sustainable harvests in the future. The revitalization of some of the existing fish ponds could help to provide additional food resources for the community as well as revive local culture. To be effective, fisheries management must function within a specific local context. Communities and their individual members should exercise control over local inshore marine resource use and be accountable for the health and productivity of local resources (Poepoe and others, 2007). Wise use and conservation are essential in order to provide improved utilization and appreciation of these resources for future generations.

Figure 20. Local traditions and resource knowledge help to guide fishing practices in the Ho‘olehua community on the north shore of Moloka‘i

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