The Commercial Marine Aquarium Fishery in Hawai`i 1976-2003

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Abstract

The commercial aquarium fishery in Hawai`i has developed over the last 50 years into one of the state's major inshore fisheries, with landings of over 708,000 specimens with a reported value of $1.06 million. The true economic value of this fishery is substantially underestimated. The catch is diverse with a total of over 200 different fish and invertebrates collected. The top 10 species constitute 73% of the entire catch. In the early days of the fishery most collecting activity was centered on the island of O`ahu. This fishery has declined over the years due to hurricane impacts and localized overfishing. Low value invertebrates are increasingly replacing previously caught fishes. In contrast to O`ahu, the aquarium fishery on the island of Hawai`i is expanding and now accounts for 55% of the catch and 68% of the total state value. Recent research shows that collecting activities can significantly affect targeted species. A network of Fish Replenishment Areas (FRAs) has been established on the island of Hawai`i to ensure sustainability of the aquarium fishery and reduce user conflicts. Three years after implementation of the FRAs there are significant increases in several targeted species and the overall value of the fishery is at an all time high. Catch report compliance is low on this island and likely elsewhere within the state. Actual aquarium catch is underreported. Specific management actions increase reporting compliance by collectors.

Introduction

The marine aquarium fish trade has expanded into a multi-million dollar industry with fisheries throughout the tropical world. Total annual catch may exceed 30 million fish (Wood, 2001). Many of the marine ornamentals originating from the U.S. are caught in Hawai`i which is known for its high quality fishes and rare endemics of high value. Fish collected in Hawai`i are done so without chemicals or explosives; instead small-mesh fence and hand nets are used resulting in a high survival rate of collected animals.

Background

Commercial aquarium collectors have been working Hawaiian waters for at least 50 years. The early collectors operated almost exclusively in the nearshore waters along the leeward coast of the island of O`ahu. These collectors were usually experienced watermen skilled at spearing fish for food and many of the same skills proved useful in collecting aquarium animals. Equipment at this time was rudimentary and included primitive goggles (bone and glass), pole spears and cotton or linen nets. Specimens were collected with minimal equipment via breath-hold diving (DAR, undated a).

SCUBA gradually became more commonplace among collectors in the years following World War II. Synthetic nets were also introduced which greatly increased the efficiency of collecting. In 1953 the territorial government of Hawai`i enacted Act 154 which authorized the Board of Agriculture and Forestry to establish a permit system for the use of fine-mesh nets and traps for the taking of aquarium fish. The law permitted the use of such otherwise prohibited gear to take small fish which were not considered to be of food value. In creating the permit system, the legislature apparently anticipated that the aquarium fishery would grow over time and ultimately prove to be a substantial source of employment and export revenue (DAR, undated b).

The early growth of the aquarium fishery was constrained by the lack of airline connections and slow overseas flight times. With the arrival of commercial jet service to Hawai`i in 1959 exporters could now ship expeditiously to the U.S. mainland. Beginning in 1969 there was a rapid increase in the number of aquarium permittees, especially non-commercial ones collecting for their own aquaria. The number of commercial collectors began to increase substantially after 1971. (Table 1).

Table 1. Number of aquarium permits issued statewide for Fiscal Years 1969-1975

Fiscal Year	Non-Commercial	Commercial
1975	218	78
1974	230	82
1973	360	36
1972	238	28
1971	144	6
1970	42	7
1969	55	4

Commercial aquarium collecting was well established on O`ahu by 1973 when public concern about the fishery prompted the Division of Fish and Game (precursor to DAR) to place a moratorium on aquarium collecting and suspend the issuance of aquarium fish permits. This moratorium was to commence July 1, 1973, the start of fiscal year. This suspension was rescinded two days prior to its start. After the suspension was lifted, the ten member State Animal Species Advisory Commission recommended restricting issuance of aquarium fish permits pending "full and extensive study." At a September 1973 meeting called by Fish and Game, a number of university marine scientists recommended the establishment of sanctuary areas and the prohibition of collecting within their confines (Walsh 1999).

Prior to 1973, commercial aquarium collectors reported their catches on the same forms (C-3) as those used by all other commercial fishermen. These forms proved unsuitable for the multi-species aquarium catch and the resulting data is considered unreliable. As part of the lifting of the 1973 moratorium, collectors were required to now report their monthly catch on a separate, more detailed aquarium fish catch report (C-6). The penalty for failing to submit timely catch reports is revocation of the aquarium permit and prosecution of an enforcement action.

Much of the data provided in this report are from monthly catch reports. In 1989 the aquarium permit statue (HRS §188-31) was amended to require a report to the Board of Land and Natural Resources (BLNR) of the monthly catch of each species of aquarium fish. Annual summaries were reported by DAR until 1994. The last catch report was a five year summary for FY 1995-1999 (Miyasaka 2000).

As has been noted, the reliability of this data is dependent upon the sincerity (and integrity) of the permittees (Katekaru, 1978). At present there is no provision for verification of submitted reports. Given there are indications of underreporting (see Kona section), catch numbers and dollar amounts should be regarded as minimum and not absolute values. Data from FY 74 and FY75 are not included in this analysis due to problems with early C-6 versions which produced data not comparable with that of subsequent years. Only commercial data are presented as non-commercial permit holders are not required to submit monthly catch reports. Non-commercial permit holders are also limited to a total take of five fish or aquatic specimens per person per day so their overall potential catch is considerably less than commercial collectors. In FY 2003, 108 non-commercial permits were issued in comparison to 116 commercial ones.

Statewide Perspective

The Hawai`i aquarium fishery developed at an extraordinary rate in the early 1970's. During FY 1973, 36 commercial permit holders reported a catch of 35,556 animals which sold for a value of $74,100 (Ego, 1973). Five years later in 1978 the catch had increased 500% (179,900 specimens) and the value of the fishery had increased 400% to $296,850

($812,900 adjusted value) (Figure 1). There were now 138 commercial collectors. This period of expansion ended at the end of the decade as a recession took hold in Hawai`i and the United States. The recession was closely tied to a substantial cutback in production by oil producing nations resulting in worldwide oil and fuel shortages. Inflation during 1978 to 1981 averaged over 10% further eroding the real value of the catch. The number of commercial collectors fell to 42, the lowest number recorded since reporting began.

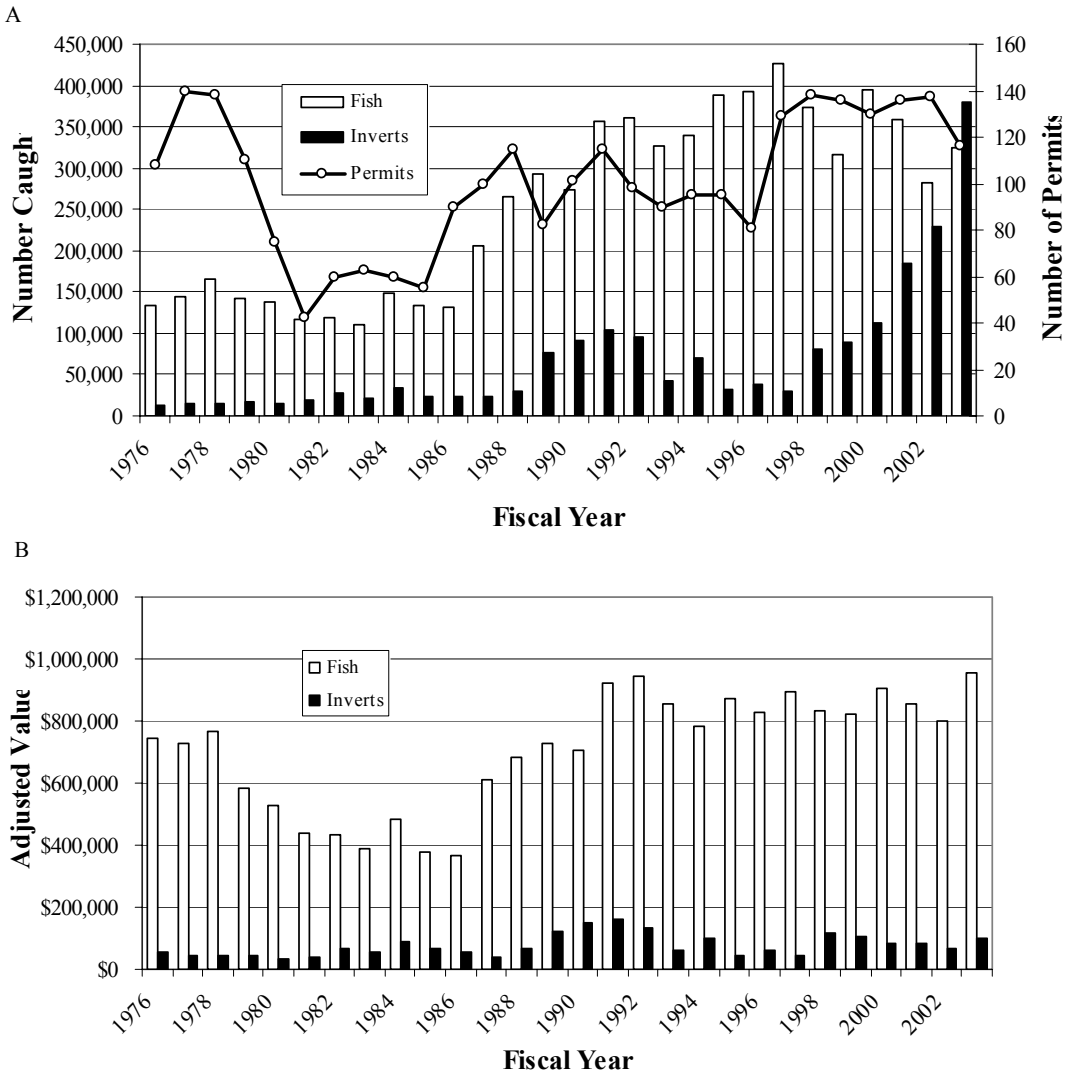


Figure 1. A. Number of commercial aquarium permits issued statewide and the numbers of fish and invertebrates reported caught. B. Dollar value of commercially caught fish and invertebrate aquarium specimens. Value is adjusted for inflation by means of Honolulu Consumer Price Index (Dept. of Labor and Industrial Relations, State of Hawai`i).

The overall aquarium catch has been diverse, comprised of a total of 235 taxa of fish and 37 of invertebrates (Appendix A). A relatively small number of species dominate the catch with the top 10 species constituting 73.3% of the total historical catch (Table 2). Surgeonfishes, Butterflyfishes and wrasses are the most commonly caught fish species while feather duster worms, hermit crabs, and shrimp predominate among the invertebrates. Particularly noteworthy is the substantial increase in invertebrate catch over the last several years (see Island section).

Table 2. Top ten taxa of collected animals over the period FY 1976-2003.

Taxa	Common Name	Total Caught	% of Total
Zebrasoma flavescens	Yellow Tang	3,386,860	37.2
Sabellastarte sanctijosephi	Feather Duster Worm	741,949	8.1
Hermit Crabs	Hermit Crabs	707,654	7.8
Ctenochaetus strigosus	Goldring Surgeonfish	346,944	3.8
Acanthurus achilles	Achilles Tang	337,781	3.7
Naso lituratus	Orangespine Unicornfish	298,884	3.3
Centropyge potteri	Potter's Angelfish	287,668	3.2
Forcipiger flavissimus	Forcepsfish	251,523	2.8
Zanclus cornutus	Moorish Idol	187,662	2.1
Halichoeres ornatissimus	Ornate Wrasse	121,766	1.3

Based upon catch report data (DAR 2001), the value of the aquarium fishery is among the highest of all inshore fisheries in Hawai`i, exceeded only by the Akule (Bigeye Scad - *Selar crumenopthalmus*) hook and line/net fishery (Fig 2).

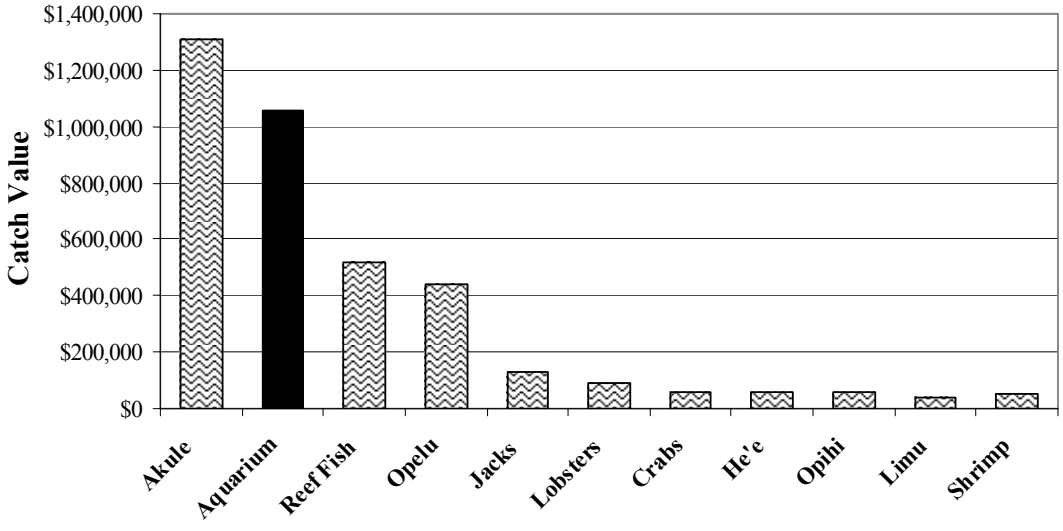


Figure 2. Value of Hawai`i commercial marine landings for FY 2001.

Due to the fact that the aquarium industry is composed of both independent contractors (collectors) and wholesalers, who may or may not be collectors themselves, the overall economic value of the aquarium fishery is estimated to be substantially higher than shown in Figure 2. Cesar et al. (2002) estimated industry gross sales at $3.2 million and industry profits at $1.2 million. A 1993 analysis based on export figures by an aquarium trade group (Hawaii Tropical Fish Association 1993) pegged total sales of Hawaiian fish (inclusive of freight and packing) at $4,909,654. DAR reported total average value for FY 1993 /FY 1994 as only $819,957 (Miyasaka 1994a, 1994b).

It is difficult to precisely compare the scale of the Hawai`i aquarium fishery with other countries around the world. The international distribution network for marine ornamentals is often complex involving a number of intermediaries and record keeping has not been standardized or centralized. Although it is clear that aquarium collecting is one of the most important inshore fisheries in Hawai`i, total catch is substantially less than the major exporting countries such as the Philippines and Indonesia. The Philippines exports 6 million fish a year (Wood, 2001). Aquarium fishery data from Indonesia is scarce but its 40 marine ornamental exporters (NAFED 2002) and a 1999 export value of US$11.4 million (Suara Pembaruan 1998) attest to its international prominence. Hawai`i nonetheless is one of the major exporters among the second tier countries (Fig 3).

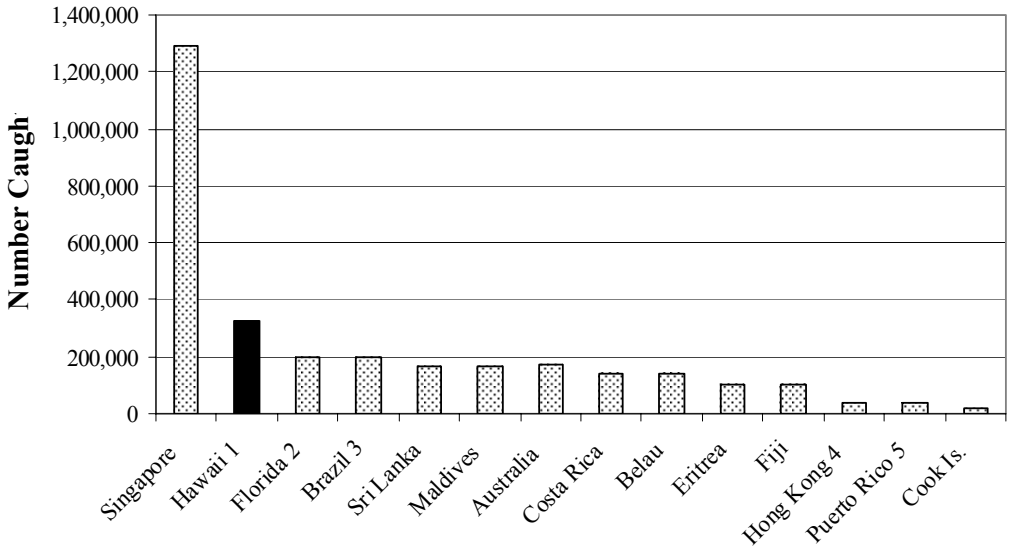


Figure 3. Number of marine aquarium fish caught or exported in recent years. All data from Wood 2001 except for 1-This study; 2- Adams et al. 2001; 3-Cassiano et al. 2003; 4- Chan and Sadovy 1998; 5-Mote 2002.

Island Comparison

Subsequent to the overall contraction of the fishery in the late ‘70s and early ‘80s there has been a trend for an increasing number of commercial permits on all islands (Fig. 4). The largest growth has occurred on the island of Hawai`i which has experienced a 645%

increase over the last two decades. The expansion on Hawai`i island was due to both an influx of new collectors and the relocation of collectors from O`ahu.

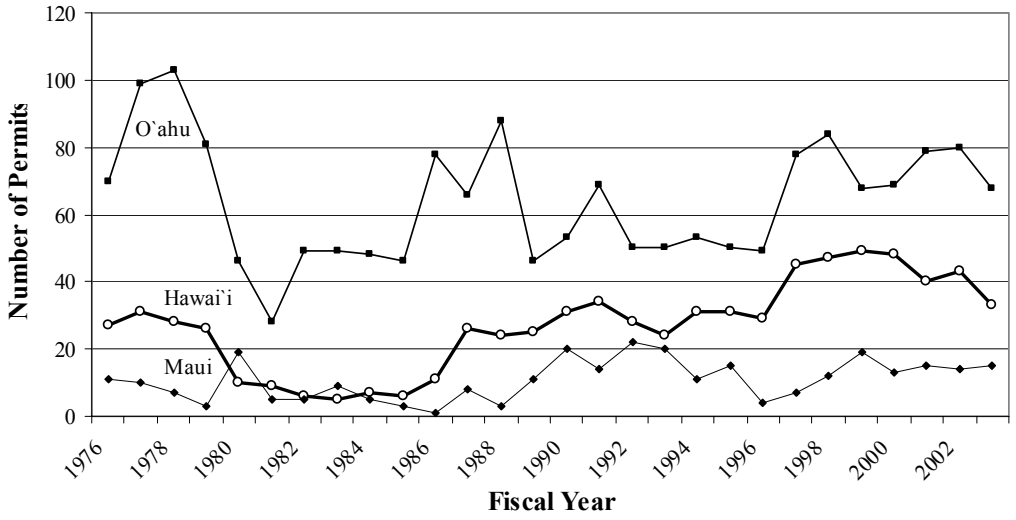


Figure 4. Number of commercial aquarium permits issued on each island per fiscal year. Maui refers to Maui county and includes the islands of Maui, Moloka`i and Lana`i. Kaua`i is not shown due to the low number of permits (mostly 0 and 2, 1 and 3 in the last three fiscal years).

In the early years of the aquarium fishery, O`ahu was the most productive area accounting for between 64% (1976) and 84% (1981) of the fish catch (Fig. 5). The southern and leeward reefs of the island were prime collecting areas. While there is considerable between-year variability in the O`ahu catch, there has been an overall trend for declining catch over time. This is in marked contrast to the catch of the island of Hawai`i which has increased dramatically since the 1980's.

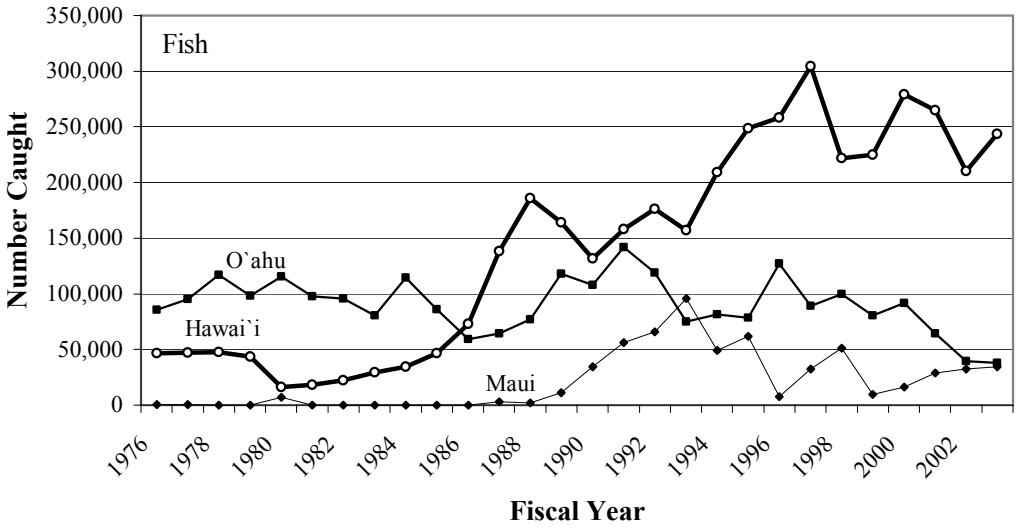


Figure 5. Number of aquarium fish caught on each island per fiscal year. Kaua`i omitted due to low numbers.

At the present time the O`ahu catch represents only 12% of total fish catch in contrast to Hawai`i's 75%. The sharp decline in catch on Maui in FY 1996 may have been due to the temporary closing of the primary exporter on the island (Miyasaka 2000).

While the overall economic value of the fishery in the state has been relatively stable over the last decade (Fig. 2), as with total catch, there have also been substantial changes in value on each of the islands. The value (adjusted for inflation) of the O`ahu fish catch in FY 2003 has declined by 76% while that of Hawai`i has increased 282%.

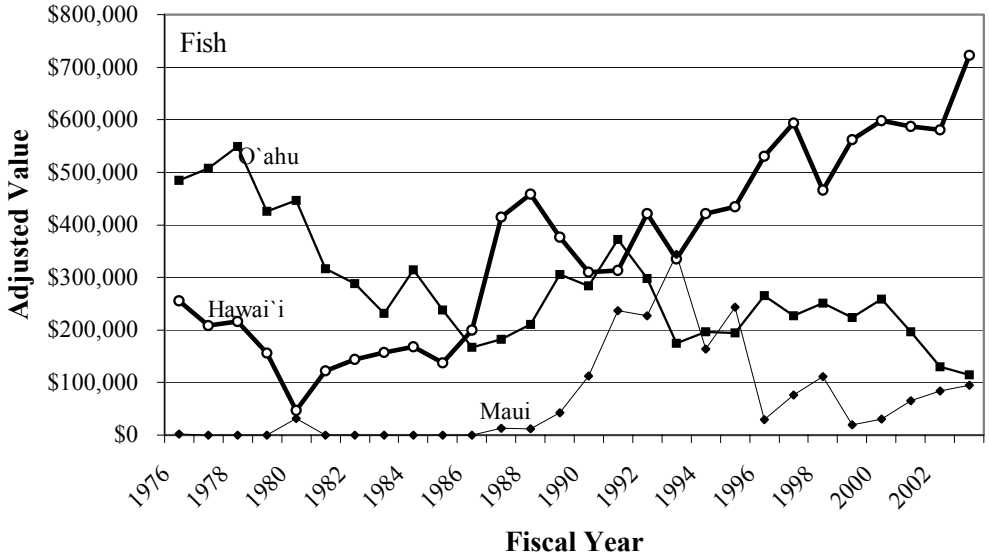


Figure 6. Dollar value (adjusted for inflation) of aquarium fish catch on each island per fiscal year. Kaua`i omitted.

The catch of invertebrates is largely confined to O`ahu. As the number of fish caught has dropped, the number of invertebrates has increased (Fig. 7). Over the last 10 years

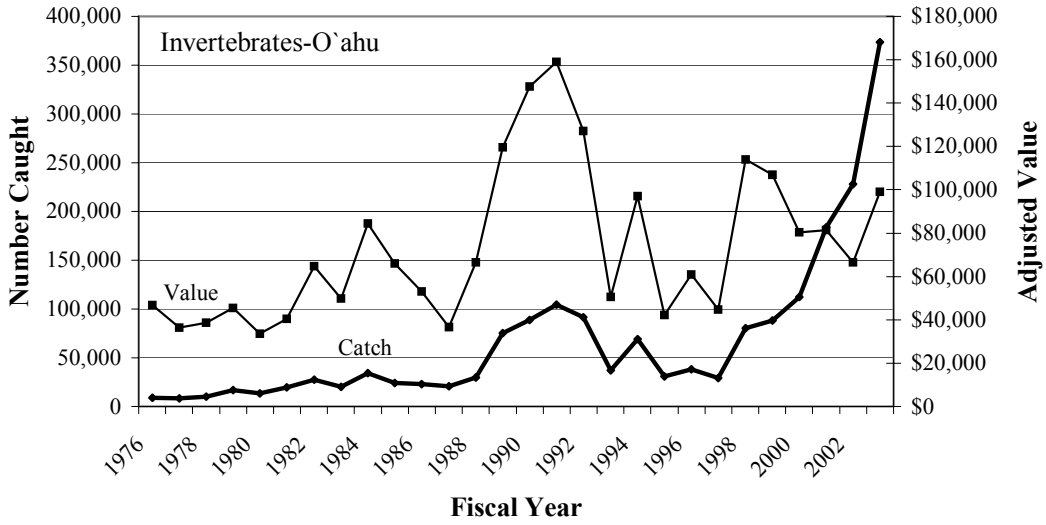


Figure 7. Number of invertebrates caught on O`ahu per fiscal year and dollar value (adjusted for inflation).

99% of all such animals were caught on O`ahu. In 1997 and 1998, 5-6000 invertebrates of 22 species were caught on Hawai`i island but numbers dropped rapidly to just dozens in recent years. The majority of these animals were shrimps, especially the red striped shrimp *Saron marmoratus* (45% of catch). Similarly Maui had short-lived peaks of invertebrate catches around 1993, primarily echinoderms, hermit crabs and pencil urchins and then again in 2003 (hermit crabs collected on Moloka`i).

The O`ahu invertebrate catch has been dominated in recent years by a relatively few species. Over the past 10 years the top 10 species have accounted for 95% of the catch. Two groups in particular are the main target of collectors; feather duster worms (*Sabellastarte sanctijosephi*) and hermit crabs (species not specified) (Fig. 8). The collection of hermit crabs has increased dramatically on O`ahu as well as to a lesser extent on Maui. On O`ahu alone over 291,000 hermits were caught last year alone. The unit value per crab over the last five years has been $.11 while feather dusters bring in $1.15. Feather dusters appear to be collected mostly from in and around Kāne`ohe Bay. It is unclear where on O`ahu hermits are being collected due to non-specified catch report localities but there is some indication that the Kāne`ohe Bay region is key.

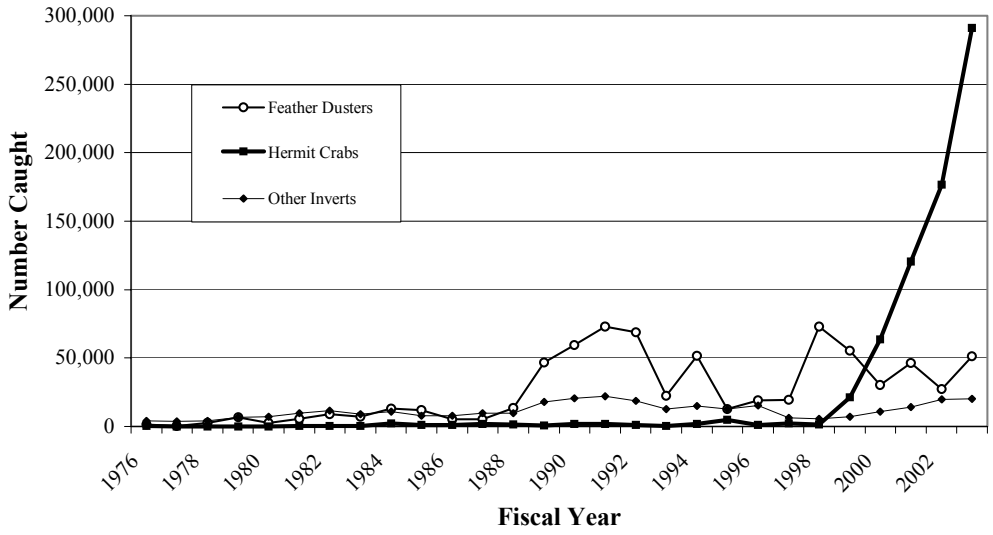


Figure 8. Number of invertebrates caught on O`ahu per fiscal year. "Other Inverts" refers to 3-10th most abundant species caught.

Hurricane Effects

Three major storms struck the Hawaiian Islands during the past twenty-five years. The earliest one was a large 3 day "Kona" storm which occurred during January 1980. This storm was one of the most severe of its type in at least 20 years (Hawai`i County Civil Defense). The effects of this storm on the coral reefs of Hawai`i Island were substantial

(Dollar 1982, Dollar and Tribble 1993) but patchy. Effects on the fish community were ameliorated by the presence of deeper water refuges and remaining undamaged areas (Walsh 1983). The effect of this storm on other islands remains unclear although at least one area of leeward O`ahu (Kahe Pt.) suffered extensive coral damage. Thirty of 32 coral monitoring stations at Kahe showed reductions in coral coverage up to 100% at some stations (Mean = 52±6.4% SE) (Coles and Brown, in prep.).

Subsequent to this storm two major hurricanes stuck the islands with substantial impacts on O`ahu and Kaua`i. On November 23, 1982 Hurricane Iwa passed to the southwest of O`ahu striking Kaua`i. The hurricane generated maximum waves of 9-14.8m (Dengler et al., 1984, Coles and Brown in prep). On September 11, 1992 hurricane Iniki passed to the west of O`ahu again striking Kaua`i. Iniki was the most powerful hurricane to strike the Hawaiian Islands in recent history. The areas most affected on O`ahu were the leeward coast with lesser damage along the south shore (Rosendale web site).

Coral and habitat damage as a result of Iwa were substantial on Kaua`i and parts of O`ahu (W. Aila, pers. comm.). According to an undated, anonymous DAR report Iwa damaged "extensive inshore reef areas, especially the prime aquarium fishing grounds along O`ahu's western coast." Pfeffer and Tribble (1985) similarly noted that Iwa resulted in extensive subtidal damage along the west and south shores of Oahu. The majority of coral 30 to 150' deep were severely damaged and most small coral patch reefs were destroyed. Iniki also impacted coral reef communities on O`ahu (Brock, 1996, Coles and Brown, in prep) but limited evidence suggests the effects may have been less than with Iwa (Miyasaka 1994).

With one notable exception, the overall effects of either of these two hurricanes on the O`ahu aquarium fishery have not been well documented. The exception is the study done by two collectors (Pfeffer and Tribble 1985) on the effects of Iwa on their collection efforts. The data in the study was based upon billing invoices compiled from collecting trips over several years before and after the hurricane. The area collected on the south shore of O`ahu (Ewa) is termed Zone 401 on the monthly catch report forms.

Pfeffer and Tribble reported that their catch (and gross earnings) declined markedly after the storm. This was most apparent for yellow tangs (*Zebrasoma flavescens*) which was one of their primary targets. In the weeks following the storm numerous dead and injured fish were observed and many appeared stunned and disoriented. Shortly after the storm some fish could even be caught by just allowing them to swim into an open collection container. Observations also revealed that many fish had migrated to areas that escaped major damage. Catches at some of these sites increased and remained high after the hurricane. Subsequently however catches declined. The authors attribute this decline to increased fishing pressure in these areas. With the loss of collecting habitat, collectors concentrated their efforts in those sites still economically utilizable. In some cases the numbers of collectors working a particular area also increased. The net result was that storm effects combined with overfishing resulted in the collapse of the aquarium fishery along this portion of the O`ahu coastline.

Catch report data was used to examine possible hurricane effects on the O`ahu aquarium fishery. The first approach specifically examined those areas deemed to be most impacted by the storms (Figure 10). For presentation purposes, the west coast zones were combined into two sections.

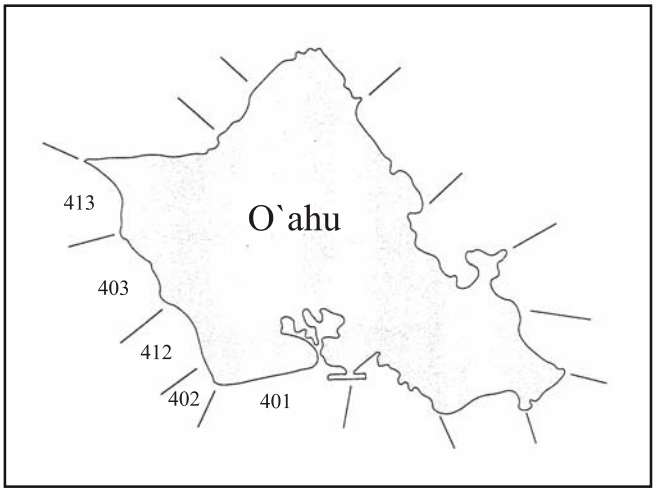


Figure 9. C-6 Aquarium Fish Catch Report zones for southwest O`ahu.

The number of commercial permittees reporting catch in these areas is shown in Figure 10. These zones constituted the heart of the early O`ahu fishery and to a large part determined the overall statewide patterns (e.g. Fig. 1). It's clear that the number of collectors working all these areas declined substantially prior to Iwa. As noted before this contraction may have been due to an economic recession. Subsequent to this period the number of collectors working these areas was relatively stable. This is not to say

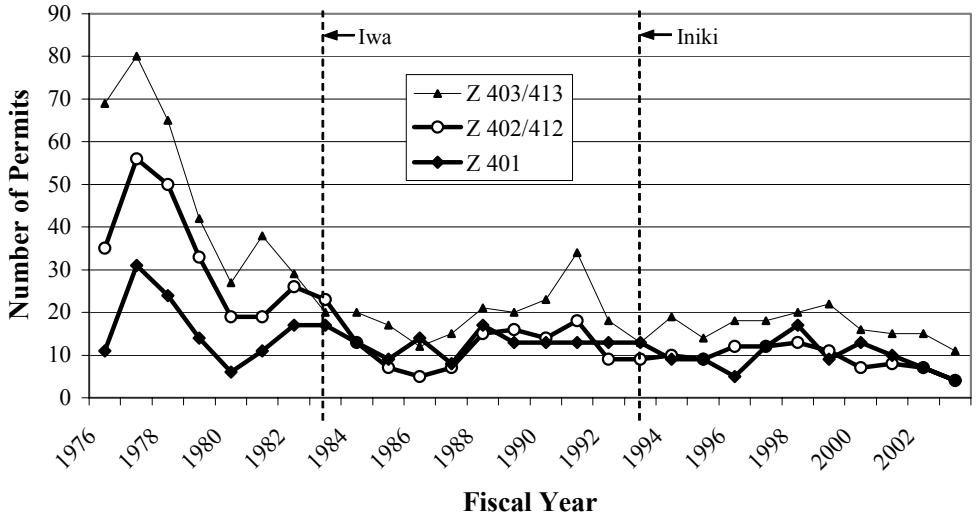


Figure 10. Number of aquarium permittees reporting catch from southwest O`ahu reporting zones.

the same individual collectors were present during this time however. Apparently subsequent to Iwa, several O`ahu collectors relocated to Maui or Hawai`i.

The number of fish caught in these zones varied widely over this time period (Fig. 11). Zone 401, the area reported on by Pfeffer and Tribble showed an overall increase in the year following the storm and then a pattern of valleys and peaks afterwards. Average fish catch in the years after Iwa was quite comparable to the years prior. The maintenance of catch numbers may have been due to a compensatory shift of target species (e.g. *Thalassoma duperrey, Ctenochaetus strigosus*) after more desirable ones such as yellow tangs became less abundant (Fig. 12). A declining trend was apparent after Iniki and again in recent years. Invertebrates now make up the majority of collected animals in this zone.

No consistent storm related decreases are apparent in the other two zones. Both areas had markedly declining catches *prior* to the hurricanes and in three out of the four cases, catch increased over the subsequent year or two. As with zone 401 recent fish catch in these areas is on a decidedly downward trend and in zone 403/413 (Wai`anae), invertebrates now also make up the majority of collected animals.

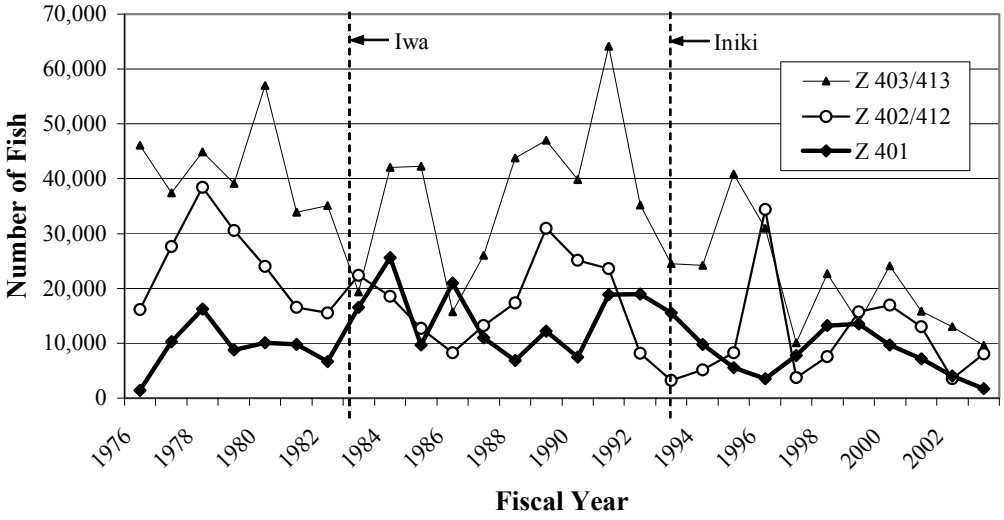


Figure 11. Number of fish caught of all species in southwest O`ahu reporting zones.

The temporal pattern of the yellow tang catch in the pre-Iwa period (Fig. 12) closely tracks that of the total catch, highlighting the importance of this species in the fishery at that time. The highly variable but general tendency for declining catch from the late 70's and early 80's may be due to the reduction in the number of commercial collectors. Although Pfeffer and Tribble reported that their catch of yellow tangs decreased markedly after Iwa, in fact, the overall catch in the area increased both during the year of the storm (FY 1983) and the year after. This apparent contradiction may be due to an increase in the number of collectors working the zone in response to loss of their collecting areas elsewhere. This increase was relatively short-lived however as the number of collected tangs subsequently plummeted with only a single exception, FY 1992, the year before Iniki.

The two other areas along the west coast of the island also showed clear and persistent declines in yellow tang catch after Iwa. Given the desirability of the species within the aquarium trade, these declines undoubtedly reflect low numbers of yellow tangs on the reefs; at least small individuals. The aquarium fishery primarily targets young of the year and small sexually immature individuals. These size classes are strongly associated with finger coral (*Porites compressa)* habitat (Walsh 1984) and may recruit preferentially to them. This habitat is very vulnerable to destruction by unusually large storms such as Iwa and Iniki. It is not unreasonable that substantial reduction in suitable finger coral habitat will result in reduced recruitment and/or increased recruit mortality. Given that even very small (5 cm.), recently recruited yellow tangs are marketable (D. Dart, pers. comm.), it is likely that the overall poor catch in recent years is due to low recruitment levels. The small peaks in the years after Iwa likely reflect recruitment pulses of yellow tangs. It is interesting to note the yearly asynchrony of some of the peaks in these three geographically proximate locales.

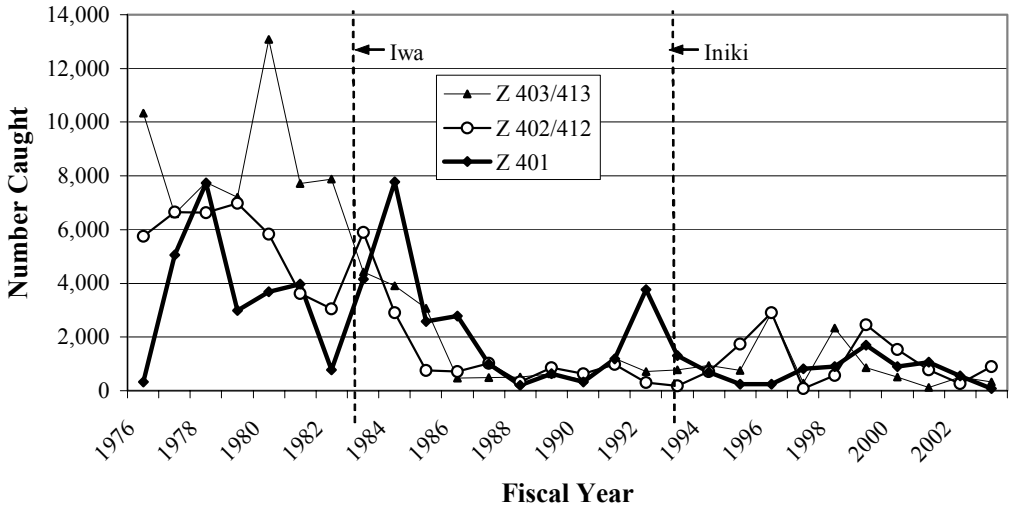


Figure 12. Number of yellow tangs caught in southwest O`ahu reporting zones.

Examination of changes in the effort involved in catching aquarium specimens over time would seem to be an appropriate method to assess the impacts of these hurricanes. Unfortunately Catch per Unit Effort (CPUE) data derived from the aquarium catch reports is fraught with uncertainties. Collectors utilize varying techniques, often work in teams which change over time and some target primarily invertebrates while others fish and some both. Varying interpretations of what constitutes actual (i.e. reported) collecting time further confounds the situation. Nevertheless an attempt was made to pull together CPUE information for the three areas under consideration. In an effort to increase the reliability of the data, two separate CPUEs were calculated, one for fish and one for invertebrates. Only permittees reporting just fish or just invertebrates were included in the CPUE calculations. As the invertebrate fishery is largely a recent development, only fish CPUE data are presented.

Even with these adjustments CPUE values often vary wildly from one year to the next (Fig. 13) and clear and consistent hurricane effects are difficult to discern. In zone 401 and to a lesser extent 403/413 there was an increase in CPUE the year of Iwa which then subsequently decreased. The CPUE was of a similar magnitude however as that which had occurred several years earlier in FY 1980 which was the year of the previously mentioned "Kona" storm. It is possible that both these increases were directly related to storm effects on species catchability. In contrast to these two areas 403/414 showed a slight decrease in CPUE the year of Iwa and then an increase afterwards.

The pattern during Iniki is in marked contrast to Iwa in that all areas had a decline in CPUE followed by a peak two years later (FY 1995). Dramatic declines subsequently followed which in two of the areas have continued to the present time. This is suggestive that in recent years it is getting increasingly more difficult to collect aquarium fishes in these areas.

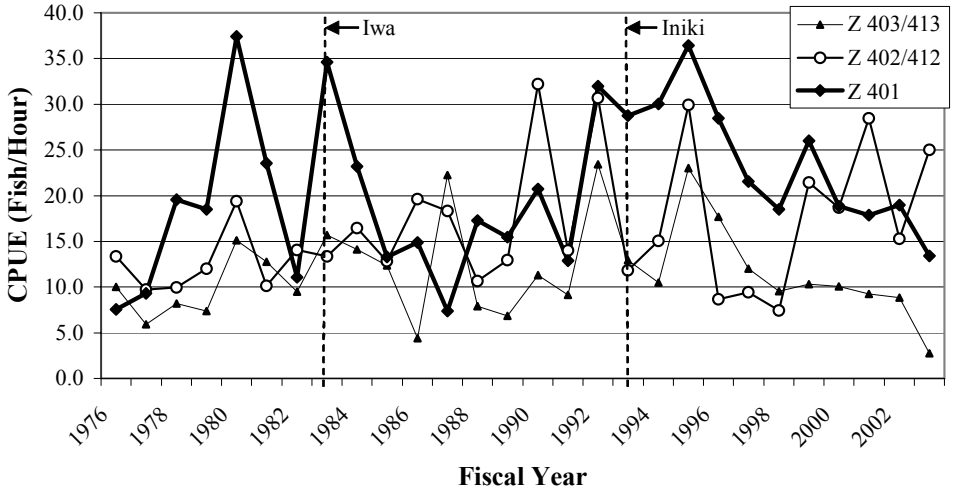


Figure 13. Catch per Unit Effort (CPUE) data for fish in southwest O`ahu reporting zones. CPUE was calculated per permit per area per month, and fiscal year CPUE is the average of all these values.

Although caution is called for in interpreting the CPUE findings, these, along with other indications, seem to clearly indicate the southwest O`ahu aquarium fishery is not what it once was. Indeed the O`ahu fishery as a whole is not static, but rather is a dynamic entity which has changed in response to physical, fishery, market and economic factors. On a geographic basis there has been a major shift in the fishery from the west side to the east over the past 27 years (Fig. 14). The proportion of fish and invertebrates caught along the west coast is significantly less in the present period (1994-2003) than it was in the years 1976-1982 (1 way ANOVA with Tukey's test $P<0.001$, $P<0.012$). Conversely, the east side has significantly increased its proportion of both fish and invertebrate catch during these periods ($P=0.004$, $P<0.001$). The north shore has also become a more important collection area for fish ($P<0.001$). The south shore has not changed significantly.

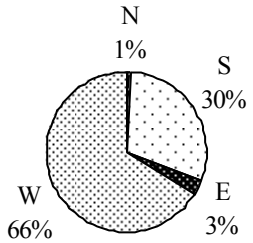
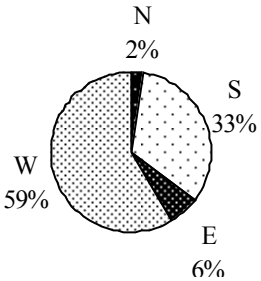
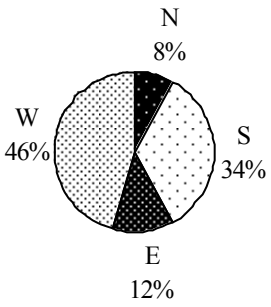
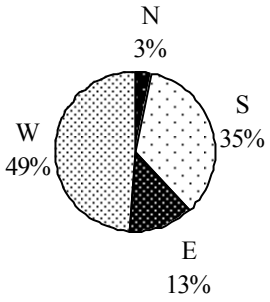
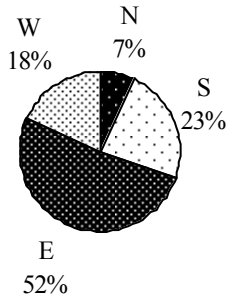
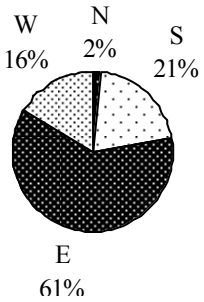
	Pre Iwa	Post Iwa	Post Iniki
	1976 - 1982	1984 -1992	1994 - 2003
Fish			
Invertebrates			

Figure 14. Average proportion of fish and invertebrate catch from four geographic sectors of O`ahu over three hurricane-related time periods. Data from the fiscal years of hurricane Iwa and Iniki are omitted.

The West Hawai`i Fishery

In contrast to O`ahu, the aquarium fishery in West Hawai`i has undergone dramatic expansion over the past twenty years (Table 3, Figs. 5 and 6). The majority of animals caught in the state and resulting value now come from the Big Island and almost all of that (98.6%) from West Hawai`i. Invertebrates constitute a minor component of the West Hawai`i catch (.02% of catch and value).

Table 3. Changes in West Hawai`i aquarium fishery over last twenty Years. Dollar Value is adjusted for inflation.

	FY 1983	FY 2003	Δ
No. Permits	5	33	660% ↑
Total Catch	30,000	243,908	813% ↑
Total Value	$159,756	$722,255	452% ↑
% of State Fish Catch	27%	75%	47%↑
% of State Total Catch	23%	55%	32% ↑
% of State Value	36%	68%	32% ↑

This growth has not come without controversy and conflict however (Walsh, 1978, Randall, 1978, Taylor, 1978, Walsh, 1999). In response to growing public concern over the impacts of collecting on nearshore coral reef communities, a number of initiatives were developed to address the issue. An informal 'Gentlepersons Agreement" was worked out among user groups in 1987 whereby collectors would refrain from collecting in certain areas. In 1991 these areas were incorporated into four no-collecting zones (Kona Coast Fishery Management Area) totaling approximately 4 miles of coastline. The next year a Marine Life Conservation District (MLCD) of 1.3 mi. was established at the Old Kona Airport which also precluded collecting.

Public concern continued escalating as the aquarium fishery further expanded. Despite widespread anecdotal reports of impacts, clear scientific evidence was lacking. An early 1974 attempt to investigate aquarium collecting impact (Nolan 1978) reported no significant effects of collecting. This study was fraught with methodological problems and the results are suspect (Tissot and Hallacher, in press). It was also conducted during a period where there was substantially less collection occurring (Fig. 5). In the mid 1990's DAR contracted with the University of Hawai`i Hilo to conduct research to assess impacts of aquarium collecting along the Kona Coast of Hawai`i. This paired control-impact study (Tissot and Hallacher, 1999, in press) found that 7 of 10 aquarium species surveyed were significantly reduced by collecting. The magnitude of the percent reduction in abundance at collection sites ranged from 38% (*Chaetodon multicinctus*) to 75% (*Chaetodon quadrimaculatus*). In contrast only two non-aquarium species (*Stegastes fasciolatus* and *Paracirrhites arcatus*) exhibited a significant difference.

In response to a perceived lack of success in adequately dealing with aquarium collecting, a grassroots organization of citizens successfully lobbied for legislation to control collecting. In 1998, the state legislature passed Act 306 which established a West Hawai`i Regional Fisheries Management Area to provide for effective management of marine resources. Among a number of provisions was the requirement to establish Fish Replenishment Areas (FRAs) where aquarium collecting would be banned. The West Hawai`i Fisheries Council composed of stakeholders and government representatives developed a network of nine FRAs encompassing 35.2% (including existing protected areas) of the coastline (Walsh, 1999, Capitini, in prep.).

Research is presently underway (WHAP-West Hawai`i Aquarium Project) to evaluate the effectiveness of these reserves and to better understand the ecological dynamics of the nearshore reef environment. Preliminary analysis (Tissot, et al., in press) indicates that three years after closure of the FRAs there have been significant increases in the overall abundance of fishes targeted by collectors. Two species, the yellow tang and Potter's angelfish (*Centropyge potteri*), showed significant (74-80%) increases in FRAs relative to previously protected reference areas. Furthermore, no aquarium fishes declined in abundance in open areas as might be expected if the intensity of harvesting increased outside of the FRAs. In fact, two species displayed significant increases in abundance in the open areas. Thus early results of this study demonstrate that MPAs can be a highly effective strategy for managing these resources (Friedlander, 2001).

After two years of declining yellow tang catch subsequent to the implementation of the FRAs, the numbers caught have increased in FY 2003. This is due primarily to successful recruitment of this as well as several other species in the summer of 2002. Good recruitment was also apparent this past summer (2003). Of special note is the fact that the dollar value of each yellow tang has increased in the past two years. Indeed, the overall value of the West Hawai`i aquarium fishery in FY 2003 is the highest it has ever been (Fig. 6).

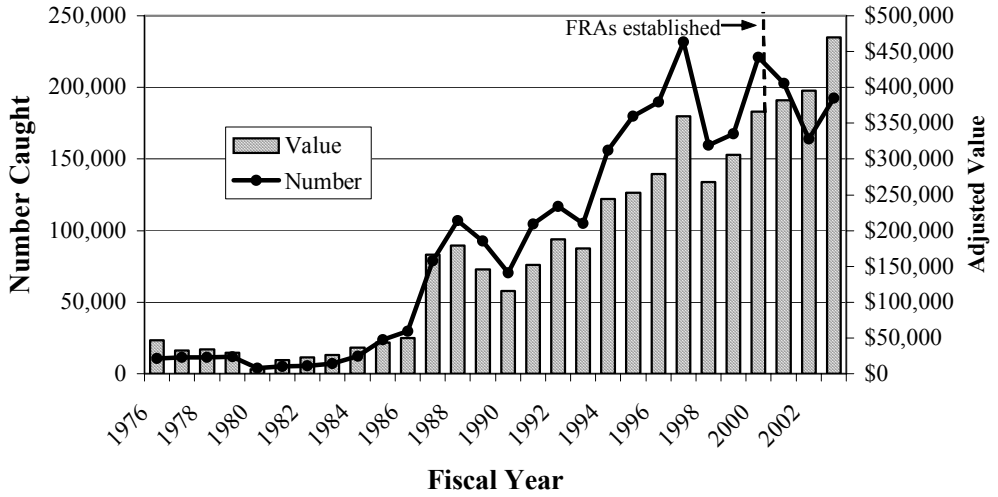


Figure 15. Number and value (adjusted for inflation) of yellow tangs caught in West Hawai'i per fiscal year.

The trends for the four next most heavily collected species are shown below (Fig. 16). Kole (*Ctenochaetus strigosus*) catch has been consistently increasing since the late 1980's and is now the ranks second in collected fishes both in West Hawai`i and statewide. Catch in FY 2003 is the highest it has even been. In contrast, catch of the achilles tang (*Acanthurus achilles*) has been in decline since FY 1990.

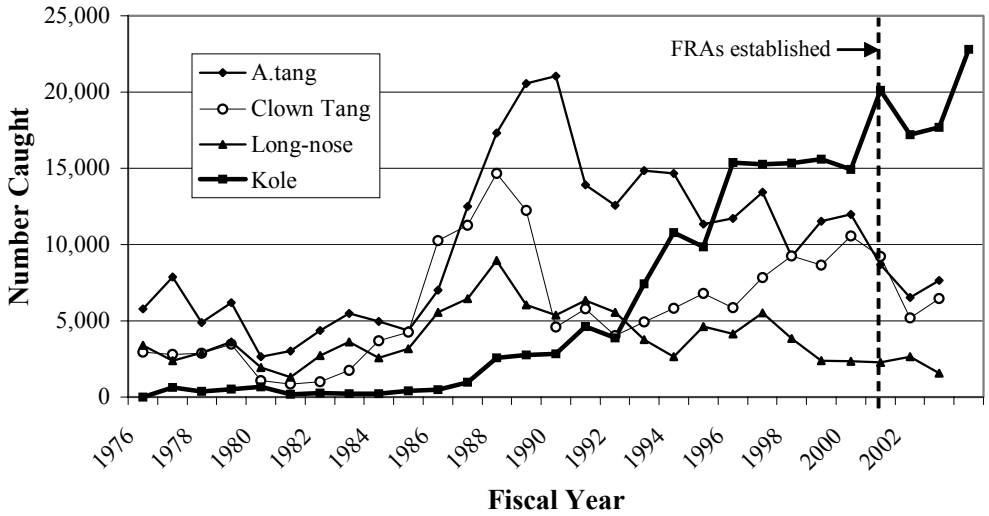


Figure 16. Number caught of top 2nd-5th West Hawai`i species per fiscal year.

CPUE has historically been the highest in West Hawai`i (Fig. 17) due in large part to the abundance of and relative collecting ease of commonly targeted surgeonfishes. There appears to be a substantial decrease in CPUE in West Hawai`i coincident with FRA establishment. This could possibly reflect an increase in travel and dive time as collectors work unfamiliar areas distant from their previous ones. The average CPUE for West Hawai`i over the last ten years (37.7 ±16.8 SD fish/hour) is considerably higher than that reported for other areas such as Australia (20-45 fish/day), Cook Islands (24-36 fish/day), and Sri Lanka (30-50 fish/day) (Wood, 2001). As noted previously CPUE data is by far the weakest part of the aquarium catch report data and these findings must be viewed cautiously.

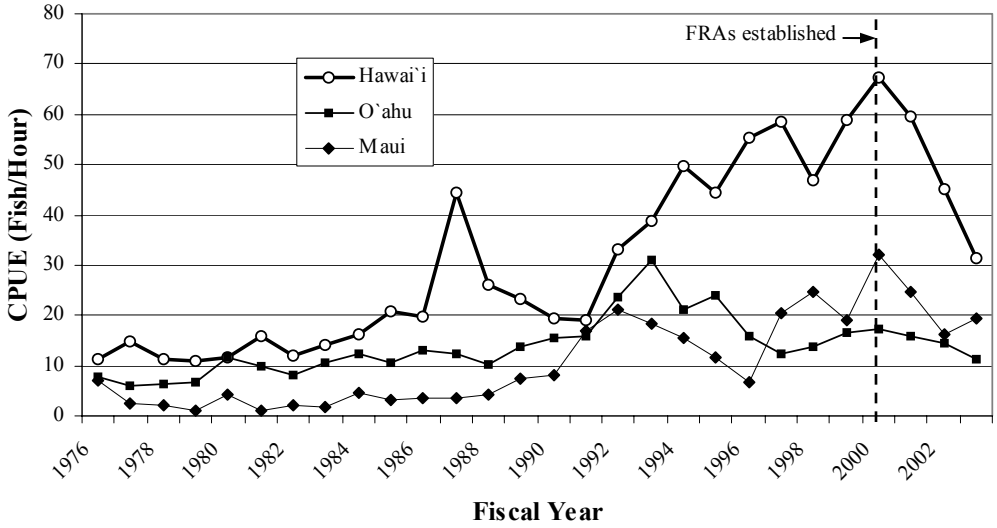


Figure 17. Catch per unit effort for Hawai`i collecting areas. Maui includes the islands of Maui, Moloka`i and Lana`i.

One of the caveats implicit with catch report analyses is that catch report data accurately reflect what is being caught. At present there is no provision or means to verify this information. DAR is working to change this. In an effort to gain insight into the limitations of the catch report data an analysis was done on the West Hawai`i reports. For each month over two time periods, the required catch report was sorted as to whether it indicated catch, no catch or had not been filed (i.e. no report). The two time periods were demarcated by the date of a letter sent to all West Hawai`i collectors from DAR reminding them of the requirement to file monthly catch reports. It is clear a substantial number of collectors are not complying with the reporting requirement. A substantial number of the delinquencies were due to short term and/or part time collectors but several of the more active collectors were included. Of all 97 collectors who were active over these two periods, only 14% filed every required monthly catch report. It is likely that report compliance is as poor or worse on the other islands which have had less attention paid to the fishery. The mailing to the collectors did have a positive effect and significantly improved reporting compliance (X^2=30.18, P<0.001). With additional effort and appropriate enforcement this situation will improve.

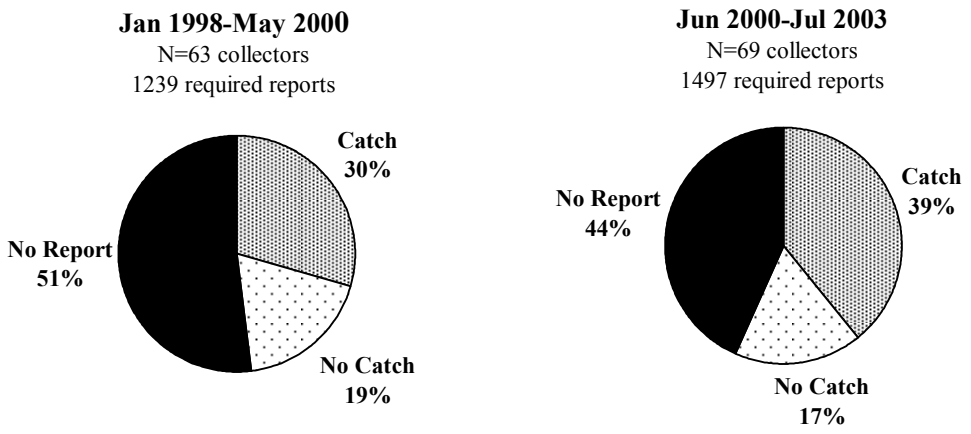


Figure 18. Aquarium catch report compliance for West Hawai`i collectors over two time periods.

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Appendix A. List of all taxa collected statewide for period FY 1967-2003 ranked by number caught. Total value is not adjusted for inflation.

Taxa	Common Name	Type	# Caught	Total Value
Zebrasoma flavescens	Yellow Tang	Fish	3,386,860	$ 5,567,252.60
Sabellastarte sanctijosephi	Feather Duster Worm	Invert	741,949	$ 860,362.09
Hermits Miscellaneous	Hermits Miscellaneous	Invert	707,654	$ 95,341.03
Ctenochaetus strigosus	Goldring Surgeonfish	Fish	346,944	$ 519,922.12
Acanthurus achilles	Achilles Tang	Fish	337,781	$ 1,197,423.19
Naso lituratus	Orangespine Unicornfish	Fish	298,884	$ 888,861.14
Centropyge potteri	Potter's Angelfish	Fish	287,668	$ 845,679.09
Forcipiger flavissimus	Forcepsfish	Fish	251,523	$ 537,155.00
Zanclus cornutus	Moorish idol	Fish	187,662	$ 445,958.61
Halichoeres ornatissimus	Ornate Wrasse	Fish	121,766	$ 190,280.77
Chaetodon multicinctus	Multiband Butterflyfish	Fish	111,454	$ 115,515.53
Chaetodon quadrimaculatus	Fourspot Butterflyfish	Fish	109,021	$ 226,275.92
Chaetodon miliaris	Milletseed Butterflyfish	Fish	105,411	$ 104,052.83
Lysmata amboinensis	Cleaner Shrimp	Invert	86,862	$ 178,283.07
Canthigaster jactator	Hawaiian Whitespotted Toby	Fish	69,869	$ 66,760.97
Chaetodon unimaculatus	Teardrop Butterflyfish	Fish	69,033	$ 142,611.23
Ostracion meleagris	Spotted Boxfish	Fish	63,482	$ 149,856.61
Anampses chrysocephalus	Psychedelic Wrasse	Fish	62,481	$ 179,068.71
Thalassoma duperrey	Saddle Wrasse	Fish	53,220	$ 61,164.90
Labroides phthirophagus	Hawaiian Cleaner Wrasse	Fish	51,650	$ 158,839.06
Coris gaimard	Yellowtail Coris	Fish	51,052	$ 153,698.17
Chaetodon fremblii	Bluestripe Butterflyfish	Fish	50,280	$ 87,290.92
Dascyllus albisella	Hawaiian Dascyllus	Fish	49,930	$ 47,928.05
Crabs Miscellaneous	Crabs Miscellaneous	Invert	49,338	$ 53,798.20
Chaetodon kleinii	Blacklip Butterflyfish	Fish	47,397	$ 45,890.15
Stenopus hispidus	Coral-banded Shrimp	Invert	41,460	$ 45,529.24
Heniochus diphreutes	Pennantfish	Fish	41,320	$ 79,796.57
Forcipiger longirostris	Longnose Butterflyfish	Fish	40,630	$ 82,474.29
Anemones	Anemones	Invert	37,978	$ 57,830.55
Chaetodon lunula	Raccoon Butterflyfish	Fish	37,470	$ 104,793.79
Hippolytidae	Green Shrimp	Invert	34,740	$ 31,708.58
Cirrhitops fasciatus	Redbar Hawkfish	Fish	33,449	$ 47,173.50
Macropharyngodon geoffroy	Shortnose Wrasse	Fish	33,172	$ 44,841.15
Pseudocheilinus octotaenia	Eightline Wrasse	Fish	32,169	$ 56,630.63
Saron marmoratus	Marbled Shrimp	Invert	30,759	$ 37,481.20
Canthigaster coronata	Crown Toby	Fish	30,146	$ 33,046.50
Sea-Stars Miscellaneous	Sea-Stars Miscellaneous	Invert	29,020	$ 29,493.37
Sargocentron xantherythrum	Hawaiian squirrelfish	Fish	27,917	$ 25,988.55
Centropyge fisheri	Fisher's angel	Fish	26,947	$ 72,694.03
Chaetodon auriga	Threadfin Butterflyfish	Fish	25,640	$ 64,284.09
Sea Cucumbers	Sea Cucumbers	Invert	25,030	$ 21,673.05
Pervagor spilosoma	Fantail Filefish	Fish	25,007	$ 27,279.53
Gomphosus varius	Bird Wrasse	Fish	24,799	$ 86,095.56
Ctenochaetus hawaiiensis	Black Surgeonfish	Fish	24,600	$ 265,244.60
Acanthurus olivaceus	Orangeband Surgeonfish	Fish	22,107	$ 40,349.63
Shrimp Miscellaneous	Shrimp Miscellaneous	Invert	20,585	$ 27,297.45
Echinoderms	Echinoderms	Invert	18,845	$ 17,659.35

Pseudojuloides cerasinus	Smalltail Wrasse	Fish	18,807	$ 28,300.50
Chaetodon ornatissimus	Ornate Wrasse	Fish	17,554	$ 31,931.97
Paracirrhites arcatus	Arc-eye Hawkfish	Fish	17,300	$ 21,502.04
Naso unicornis	Bluespine Unicornfish	Fish	17,193	$ 32,968.05
Pseudanthias bicolor	Bicolor Anthias	Fish	16,957	$ 49,190.25
Desmoholacanthus arcuatus	Bandit Angelfish	Fish	16,828	$ 171,041.24
Pseudanthias thompsoni	Thompson's Anthias	Fish	16,716	$ 46,005.55
Holocentridae	Squirrelfish/Soldierfish	Fish	16,109	$ 18,685.90
Taenianotus triacanthus	Leaf Scorpionfish	Fish	15,216	$ 31,089.84
Xanthichthys mento	Crosshatch triggerfish	Fish	15,193	$ 59,861.35
Cirrhilabrus jordani	Flame Wrasse	Fish	13,919	$ 133,166.40
Limu	Limu	Algae	13,483	$ 10,477.50
Heterocentrotus mammillatus	Red Pencil Urchin	Invert	13,310	$ 19,754.03
Labridae sp.	Wrasse	Fish	13,306	$ 22,144.00
Sufflamen bursa	Lei Triggerfish	Fish	12,920	$ 19,620.67
Bodianus bilunulatus	Hawaiian Hogfish	Fish	12,917	$ 22,659.00
Dardanus gemmatus	Jeweled Anemone Crab	Invert	12,878	$ 16,008.10
Hemitaurichthys polylepis	Pyramid Butterflyfish	Fish	11,685	$ 35,316.98
Priacanthus sp.	Bigeye	Fish	11,597	$ 15,829.25
Rhinecanthus rectangulus	Reef Triggerfish	Fish	11,369	$ 32,059.01
Acanthurus triostegus	Convict Tang	Fish	11,294	$ 11,255.65
Stethojulis balteata	Belted Wrasse	Fish	11,290	$ 20,316.37
Aulostomus chinensis	Trumpetfish	Fish	10,827	$ 22,032.55
Urchins Miscellaneous	Urchins Miscellaneous	Invert	10,631	$ 10,017.22
Cantherhines dumerilii	Barred Filefish	Fish	10,452	$ 9,705.10
Acanthurus nigricans	Goldrim Surgeonfish	Fish	9,747	$ 40,236.85
Melichthys niger	Black Durgon	Fish	9,605	$ 25,174.84
Cowries Misc.	Cowries Misc.	Invert	9,198	$ 6,874.40
Pseudocheilinus tetrataenia	Fourline Wrasse	Fish	8,978	$ 35,330.75
Naso sp.	Unicorn sp.	Fish	8,845	$ 31,386.70
Worm	Worm	Invert	8,710	$ 6,754.50
Acanthurus thompsoni	Thompson's Surgeonfish	Fish	8,642	$ 19,236.10
Nudibranchs Miscellaneous	Nudibranchs Miscellaneous	Invert	8,244	$ 8,713.00
Pseudocheilinus evanidus	Disappearing Wrasse	Fish	8,159	$ 10,784.15
Gymnothorax eurostus	Stout Moray	Fish	8,098	$ 23,630.05
Zebrasoma veliferum	Sailfin tang	Fish	7,863	$ 31,468.35
Novaculichthys taeniourus	Rockmover Wrasse	Fish	7,799	$ 27,968.10
Balistidae	Triggerfish Misc.	Fish	7,532	$ 17,089.30
Anampses cuvier	Pearl Wrasse	Fish	7,049	$ 20,579.55
Thalassoma trilobatum	Christmas Wrasse	Fish	6,716	$ 14,921.65
Melichthys vidua	Pinktail Durgon	Fish	6,635	$ 21,074.99
Worms Miscellaneous	Worms Miscellaneous	Invert	6,483	$ 4,654.40
Chromis ovalis	Oval Damselfish	Fish	6,385	$ 4,791.50
Gymnomuraena zebra	Zebra Moray	Fish	6,320	$ 35,248.65
Acanthurus nigrofuscus	Brown Surgeonfish	Fish	6,269	$ 10,468.22
Chaetodon tinkeri	Tinker's Butterflyfish	Fish	6,186	$ 353,240.45
Lactoria fornasini	Thornback Cowfish	Fish	6,165	$ 9,455.05
Molluscs Miscellaneous	Molluscs Miscellaneous	Invert	5,917	$ 1,802.55
Enoplometopus occidentalis	Red Reef Lobster	Invert	5,878	$ 21,028.95
Lutjanus kasmira	Bluestripe Snapper	Fish	5,615	$ 6,967.05
Exallias brevis	Shortbodied Blenny	Fish	5,090	$ 15,472.15
Paracirrhites forsteri	Blackside Hawkfish	Fish	4,999	$ 10,639.10
Acanthurus dussumieri	Eye-stripe Surgeonfish	Fish	4,981	$ 9,597.75
Hymenocera picta	Harlequin Shrimp	Invert	4,731	$ 31,350.80
Centropyge loricula	Flame angelfish	Fish	4,707	$ 44,968.70

Dendrochirus barberi	Hawaiian Lionfish	Fish	4,643	$	9,511.20
Sargocentron diadema	Crown Squirrelfish	Fish	4,624	$	5,201.25
Hemitaurichthys thompsoni	Thompson's Butterfly	Fish	4,511	$	7,237.25
Blenniidae	Blenny	Fish	4,107	$	7,604.70
Coris venusta	Elegant Coris	Fish	4,009	$	8,743.65
Echidna nebulosa	Snowflake Moray	Fish	3,982	$	22,246.50
Coris ballieui	Lined Coris	Fish	3,919	$	7,916.10
Arothron meleagris	Spotted Pufferfish	Fish	3,813	$	8,069.70
Pterois sphex	Hawaiian Turkeyfish	Fish	3,680	$	13,459.45
Medusa worms	Medusa Worms	Invert	3,586	$	5,006.75
Panulirus marginatus	Spiny Lobster	Invert	3,484	$	9,377.30
Parapercis schauinslandi	Sand Perch	Fish	3,416	$	5,522.45
Coris flavovittata	Yellowstripe Coris	Fish	3,337	$	8,529.20
Diodon holocanthus	Spiny Pufferfish	Fish	3,331	$	9,868.25
Canthigaster amboinensis	Ambon Toby	Fish	3,271	$	3,339.65
Cirrhitidae	Hawkfish	Fish	3,151	$	5,134.50
Sea-Slugs Miscellaneous	Sea-Slugs Miscellaneous	Invert	3,094	$	4,298.50
Damselfish	Damselfish	Fish	3,093	$	2,523.20
Arothron hispidus	Stripebelly Pufferfish	Fish	3,048	$	5,686.20
Antennarius sp.	Frogfish	Fish	3,043	$	26,567.50
Pleuronectidae	Right-eye Flounders	Fish	2,878	$	4,118.70
Acanthuridae sp.	Surgeonfish	Fish	2,710	$	5,078.63
Myripristis berndti	Bigscale Soldierfish	Fish	2,485	$	5,750.83
Bothus sp.	Lefteye Flounder	Fish	2,457	$	3,737.30
Chromis vanderbilti	Blackfin Chromis	Fish	2,450	$	1,828.00
Myripristis amaena	Brick Soldierfish	Fish	2,432	$	2,842.25
Ostracion whitleyi	Whitley's Boxfish	Fish	2,408	$	10,329.40
Cirrhitus pinnulatus	Stocky Hawkfish	Fish	2,358	$	3,814.53
Aniculus maximus	Hairy Yellow Hermit Crab	Invert	2,273	$	5,015.50
Mulloidichthys vanicolensis	Yellowfin Goatfish	Fish	2,236	$	2,547.75
Parupeneus multifasciatus	Manybar Goatfish	Fish	2,204	$	2,760.31
Chaetodon trifasciatus	Oval Butterflyfish	Fish	2,202	$	4,425.30
Rhinecanthus aculeatus	Lagoon Triggerfish	Fish	2,190	$	5,845.10
Chaetodontidae	Butterflyfish	Fish	2,149	$	3,701.59
Diodon hystrix	Porcupinefish	Fish	2,050	$	5,794.00
Canthigasteridae	Sharpnose Puffer	Fish	2,039	$	2,537.00
Gymnothorax sp.	Moray eel	Fish	1,915	$	8,742.75
Poecilidae	Mollies/Guppies	Fish	1,908	$	-
Thalassoma ballieui	Blacktail Wrasse	Fish	1,889	$	3,097.85
Echidna polyzona	Barred Moray	Fish	1,864	$	6,476.75
Scarus sp.	Parrotfish	Fish	1,747	$	10,262.55
Chromis verater	Threespot Chromis	Fish	1,703	$	1,529.87
Mullidae	Goatfishes	Fish	1,656	$	2,136.30
Enchelycore pardalis	Dragon Moray	Fish	1,644	$	73,544.00
Gymnothorax meleagris	Whitemouth Moray	Fish	1,636	$	7,039.35
Abudefduf abdominalis	Sergeant Major	Fish	1,588	$	1,420.25
Chaetodon reticulatus	Reticulated Butterflyfish	Fish	1,530	$	3,945.72
Soft Coral Miscellaneous	Soft Coral Miscellaneous	Invert	1,500	$	-
Cones Misc.	Cones Misc.	Invert	1,492	$	987.50
Hexabranchus sanguineus	Spanish Dancer	Invert	1,393	$	3,005.50
Iniistius pavo	Peacock Razorfish	Fish	1,317	$	3,743.10
Lactoria diaphana	Spiny Cowfish	Fish	1,257	$	2,457.50
Oxycirrhites typus	Longnose Hawkfish	Fish	1,241	$	13,515.00
Parupeneus porphyreus	Whitesaddle Goatfish	Fish	1,164	$	2,070.75
Canthigaster epilampra	Lantern Toby	Fish	1,142	$	2,860.50

Canthigaster rivulata	Maze Toby	Fish	1,109	$	1,196.95
Scorpaenopsis sp./ *Scorpaena* sp.	Scorpionfish	Fish	1,107	$	1,608.26
Pseudanthias hawaiiensis	Hawaiian Longfin Anthias	Fish	1,080	$	11,979.50
Snappers	Snappers	Fish	1,057	$	2,136.25
Cheilio inermis	Cigar Wrasse	Fish	1,021	$	1,693.50
Gymnothorax flavimarginatus	Yellowmargin Moray	Fish	991	$	3,566.50
Uropterygius macrocephalus	Largehead Snake Moray	Fish	968	$	3,885.40
Microcanthus strigatus	Stripey	Fish	930	$	1,245.25
Scorpaenopsis diabolus	Devil Scorpionfish	Fish	928	$	1,302.30
Xanthichthys auromarginatus	Gilded Triggerfish	Fish	902	$	20,604.00
Kuhlia sandvicensis	Hawaiian Flagtail	Fish	876	$	159.50
Cirripectes vanderbilti	Scarface Blenny	Fish	852	$	2,379.25
Aluterus scriptus	Scrawled Filefish	Fish	832	$	1,383.05
Chaetodon ephippium	Saddleback Butterflyfish	Fish	810	$	2,919.65
Thalassoma lunare	Lyretail Wrasse	Fish	806	$	1,188.85
Oxycheilinus bimaculatus	Twospot Wrasse	Fish	755	$	989.20
Dactyloptena orientalis	Helmet Gurnard	Fish	752	$	2,446.50
Acanthaster planci	Crown-of-thorns Seastar	Invert	746	$	1,507.55
Scyllarides sp.	Slipper Lobster	Invert	734	$	1,782.25
Sponges Miscellaneous	Sponges Miscellaneous	Invert	730	$	1,920.90
Cephalopholis argus	Peacock Grouper	Fish	675	$	3,874.50
Chaetodon lineolatus	Lined Butterflyfish	Fish	652	$	3,590.75
Acanthurus blochii	Ringtail Surgeonfish	Fish	632	$	2,012.55
Plectroglyphidodon imparipennis	Brighteye Damselfish	Fish	617	$	560.50
Entomacrodus marmoratus	Marbled Blenny	Fish	611	$	1,037.00
Istiblennius zebra	Zebra Blenny	Fish	607	$	818.25
Cirripectes obscurus	Gargantuan Blenny	Fish	600	$	1,392.05
Amblycirrhitus bimacula	Twospot Hawkfish	Fish	599	$	962.00
Iniistius umbrilatus	Blackside Razorfish	Fish	526	$	1,932.15
Cantherhines sandwichiensis	Squaretail Filefish	Fish	517	$	569.75
Cosmocampus balli	Pipefish	Fish	494	$	2,327.00
Chaetodon citrinellus	Speckled Butterflyfish	Fish	474	$	693.25
Fistularia commersonii	Cornetfish	Fish	469	$	61.41
Pervagor aspricaudus	Yellowtail Filefish	Fish	466	$	882.25
Gymnothorax undulatus	Undulated Moray	Fish	449	$	1,796.75
Parupeneus pleurostigma	Sidespot Goatfish	Fish	448	$	537.70
Synodus sp.	Lizardfish	Fish	442	$	544.00
Carangidae	Jack	Fish	430	$	1,880.20
Myripristis kuntee	Epaulette Soldierfish	Fish	401	$	711.50
Scutaria tigrinus	Tiger Moray	Fish	397	$	1,804.75
Sebastapistes coniorta	Speckled Scorpionfish	Fish	394	$	581.75
Stenopus pyrsonotus	Flameback Coral Shrimp	Invert	386	$	1,584.50
Gobiidae sp.	Goby	Fish	382	$	814.75
Chaetodon trifascialis	Chevron Butterfly	Fish	374	$	1,054.40
Foa brachygramma	Bay Cardinalfish	Fish	370	$	486.75
Abudefduf sordidus	Blackspot Sergeant	Fish	355	$	101.50
Acanthurus thompsoni	Thompson's Surgeonfish	Fish	354	$	367.50
Crayfish	Crayfish	Invert	346	$	0.01
Plectroglyphidodon johnstonianus	Blue-eye Damselfish	Fish	335	$	327.25
Cheilodactylus vittatus	Hawaiian Morwong	Fish	329	$	605.55
Apogon sp.	Cardinal fishes	Fish	293	$	281.25
Jellyfish	Jellyfish	Invert	283	$	273.25

Bubble Shells	Bubble Shells	Invert	240	$	259.25
Myrichthys magnificus	Magnificent Snake Eel	Fish	223	$	848.25
Conger cinereus	Mustache Conger	Fish	222	$	711.50
Naso hexacanthus	Sleek Unicornfish	Fish	202	$	311.50
Grammistidae	Soapfish	Fish	195	$	473.00
Octopus cyanea	Day Octopus	Invert	187	$	1,150.00
Thalassoma purpureum	Surge Wrasse	Fish	186	$	540.00
Naso brevirostris	Paletail Unicornfish	Fish	173	$	331.00
Chanos chanos	Milkfish	Fish	169	$	1,171.00
Syngnathidae	Pipefish	Fish	167	$	147.50
Malacanthus brevirostris	Flagtail Tilefish	Fish	160	$	636.60
Sebastapistes coniorta	Speckled Scorpion	Fish	156	$	236.15
Chromis leucura	Whitetail Chromis	Fish	151	$	144.95
Plagiotremus ewaensis	Ewa Fangblenny	Fish	141	$	261.00
Gymnothorax steindachneri	Steindachner's Moray	Fish	124	$	372.50
Gymnothorax rueppelliae	Banded Moray	Fish	123	$	400.00
Monotaxis grandoculis	Bigeye Emperor	Fish	123	$	330.25
Acanthurus leucopareius	Whitebar Surgeonfish	Fish	118	$	172.90
Thalassoma lutescens	Sunset Wrasse	Fish	117	$	344.95
Chromis hanui	Chocolate-Dip Chromis	Fish	109	$	85.00
Stegastes fasciolatus	Pacific Gregory	Fish	100	$	57.50
Ophichthidae	Snake Eel	Fish	97	$	417.50
Iniistius sp.	Razor fish	Fish	97	$	268.05
Acanthurus nigroris	Bluelined Surgeonfish	Fish	94	$	392.00
Gymnothorax melatremus	Dwarf moray	Fish	93	$	3,229.50
Brotulidae	Salt-water Cat	Fish	92	$	197.25
Acanthurus xanthopterus	Yellowfin Surgeonfish	Fish	89	$	200.00
Mulloidichthys flavolineatus	Yellowstripe Goatfish	Fish	86	$	135.00
Blenniella gibbifrons	Bullethead Rockskipper	Fish	86	$	114.50
Caracanthus typicus	Hawaiian Orbicular Velvetfish	Fish	80	$	95.75
Plagiotremus goslinei	Gosline's Fangblenny	Fish	75	$	149.50
Cymolutes lecluse	Hawaiian Knifefish	Fish	70	$	211.50
Upeneus arge	Bandtail Goatfish	Fish	65	$	86.20
Apogon kallopterus	Iridescent Cardinalfish	Fish	63	$	42.50
Doryrhamphus excisus	Blue-stripe Pipefish	Fish	61	$	129.25
Apogon maculiferus	Spotted Cardinalfish	Fish	61	$	23.50
Acanthurus guttatus	Whitespotted Surgeonfish	Fish	60	$	829.50
Parupeneus cyclostomus	Blue Goatfish	Fish	49	$	74.25
Uropterygius sp.	Snake Moray	Fish	47	$	195.00
Istiblennius sp.	Blenny	Fish	44	$	65.50
Spratelloides delicatulus	Delicate Roundherring	Fish	41	$	109.00
Genicanthus personatus	Masked Angelfish	Fish	39	$	2,829.50
Elagatis bipinnulata	Rainbow Runner	Fish	31	$	26.00
Sargocentron punctatissimum	Peppered Squirrelfish	Fish	27	$	15.25
Oxycheilinus unifasciatus	Ringtail Wrasse	Fish	26	$	43.50
Apogon erythrinus	Hawaiian Ruby Cardinalfish	Fish	26	$	32.50
Apogon menesemus	Bandfin Cardinalfish	Fish	26	$	4.00
Cantherhines verecundus	Shy Filefish	Fish	25	$	53.75
Epinephelus quernus	Hawaiian Grouper	Fish	16	$	49.00
Kyphosus sp.	Sea Chub	Fish	12	$	36.00
Parupeneus bifasciatus	Doublebar Goatfish	Fish	12	$	16.00
Decapterus macarellus	Mackerel Scad	Fish	12	$	12.00
Scarus rubroviolaceus	Redlip Parrotfish	Fish	10	$	51.00
Neomyxus leuciscus	Sharpnose Mullet	Fish	5	$	-
Mugil cephalus	Striped Mullet	Fish	4	$	4.50

Hemiramphus sp.	Halfbeaks	Fish	2	$	80.00
Lutjanus fulvus	Golden Perch	Fish	2	$	-
Plectroglyphidodon sindonis	Rock damselfish	Fish	2	$	-
Polydactylus sexfilis	Six-fingered Threadfin	Fish	2	$	-
Tetraodontidae	Pufferfish	Fish	1	$	8.95
Elops hawaiensis	Hawaiian Tenpounder	Fish	1	$	2.00
Pseudocaranx dentex	Thicklipped Jack	Fish	1	$	2.00
Ranina ranina	Kona Crab	Invert	1	$	2.00
Baitfish	Baitfish	Fish	1	$	-
Unknown Fish spp.	Unknown Fish spp.	Fish	7,655	$	17,557.30
Unknown spp.	Unknown spp.	Unknown	5,318	$	5,739.65
Unknown Invert spp.	Unknown Invert spp.	Invert	876	$	953.00