THE SHORELINE FISHERY OF AMERICAN SAMOA in FY92

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ABSTRACT

Due to the cultural and economic importance of the nearshore fish and invertebrate resources of American Samoa, The Department of Marine and Wildlife Resources instituted a program in 1990 to monitor the harvest in these nearshore waters. This study uses comparable methodologies to a similar 1.5 year long study completed in 1979.

Although there has been a nearly 50% increase in the size of the human population on Tutuila since 1979, the overall fishing efforts within the study area have declined, even though catch rates in FY91 were comparable to 1979, and catch rates in FY92 increased almost 70%. The estimated effort in the study area in 1979 was 74,000 person hours, declining to 67,000 in FY91, and 41,000 in FY92. Estimated island-wide catches for these years was 660,000 lbs, 440,000 lbs, and 334,000 lbs respectively. The per capita inshore catch has also declined from 17.8 lbs/person in 1979 to 9.8 lbs/person in FY91 and 7.4 lbs/person in FY92.

The relative use of various types of fishing gear has changed markedly, probably in response to both changes in the socioeconomic structure of the island community, and to changes in the relative abundance of certain key species. In 1979, all hook and line fishing methods accounted for 39% of the effort, raising to 72% in FY91, and dropping back to 23% in FY92. The bamboo pole was the most popular hook and line method in 1979, though this gear type has been largely replaced with the rod and reel, and a simple hand line. The use of handlines was not observed in 1979, though was the most used method in FY91.

Sales of domestically caught reef fish in the local fish markets has declined drastically in the last three years for which market survey data are available. Much of this decline can be attributed to the availability of competitively priced fresh fish air freighted from neighboring island nations of Tonga and Western Samoa. In 1990, 23% of reef fish sold in the local markets was imported. In 1992, this percentage had risen to 78%.

The inshore reef fishery on Tutuila is estimated to account for about 7% of the total annual tonnage of fish, farm and livestock production in American Samoa. Including imported foods, which account for 83% of the Samoan diet by value, the reef fisheries account for less than 2% of the total dollar value of foods consumed in American Samoa.

INTRODUCTION

Throughout their history, the people of American Samoa have relied on fish and shellfish food sources harvested on the reefs surrounding their islands. Prior to western influence, fishing provided a substantial portion of the protein in the Samoan diet. Although technological advances such as refrigeration, the availability of canned goods, and the gradual shift from a subsistence to a cash economy have created new options for meeting protein requirements, fishing remains an important part of the Samoan way of life.

The domestic fishery is comprised of two major components, the offshore commercial fishery and the shoreline subsistence fishery. The offshore fishery, described in detail in Aita'oto et al (1991), and Craig et al (1993), has evolved considerably from historical times. Outrigger canoes and sennit lines have been replaced with outboard driven catamarans and monofilament lines, through the effort of several fishery development programs. However, marketing problems, resource depletion, and difficulties maintaining vessels have been all contributed to the fishery's failure to thrive (Itano 1991). The present day offshore fishery supports both a commercial and a subsistence/recreational component, with approximately 70% of the total harvest being sold.

The shoreline fishery is primarily a subsistence fishery that targets fish and invertebrates from the fringing reef adjacent to the shoreline. Unlike the offshore fishery in which participation is limited by the number of seaworthy boats, the shoreline fishery is highly accessible to the island's populace since most of the narrow, fringing reef can be reached on foot from shore. Fishing takes place at all hours of the day and night by all sectors of the population.

The shoreline fishery is in a state of transition. Traditionally, each village claimed ownership of their adjacent reefs and their associated fishing resources. Permission for non-village residents to use these resources often had to be obtained from the local matai, or village chief. Today, the main public highway follows the coastline all along the southern shore of Tutuila. This road lays between the village structures and the beaches in most areas, allowing convenient public access to most of the village beaches.

In recent history, several villages have attempted to control through traffic along the highway, particularly during the evening "sa" or prayer hour. However, villages have not been allowed to hinder through traffic.

Villages on the northern shore are more isolated, as they are serviced by branch roads from the main highway which terminate in the village, and thus there is no through traffic. These villages maintain a much higher degree of control both in road access and in access to fishing rights on the reef.

Concerns regarding the current status of the shoreline fishery and frequent information requests regarding catch and effort data stimulated DMWR to implement a new monitoring program (Ponwith 1991).

Recent Impacts to Coral Reefs.

Significant natural events have impacted the reef habitats in recent years. Hurricanes have struck the island in 1979, 1990, and 1991, subjecting the reef environment to high winds and violent waves. In addition, heavy rains and damage to the adjacent watersheds caused significant amounts of debris to wash down on the reefs.

Quantitative studies of these effects are lacking, though observations made after these storms shows that the corals suffered considerable damage in these events. Observers stated that the reefs appeared to have been sandblasted. Most of the table-top corals and branching corals were broken off and washed into rubble fields. The massive encrusting corals were also significantly abraded. The topography of the reefs was significantly altered by removing much of the three-dimensional relief.

In 1977-78, Tutuila suffered a massive crown-of-thorns (*Acanthaster planci*) infestation. These starfish were observed to devastate the live corals, leaving huge areas of bleached, dead corals. In response to a bounty program, nearly half a million star fish were removed from the reef and destroyed (Wass 1980).

The reef ecosystem has also been impacted as a result of the significant human population growth that has occurred over the last several years. Rapid development and the accompanying environmental degradation have affected the study area in many ways: (1) coastal roads have been protected with heavily armored banks which encroached on the reef flat. (2) land clearing for new construction, and new plantations on steep slopes have exacerbated the siltation problems which exist in a mountainous island environment. (3) the amount of fish processed at the canneries has increased, which has increased the amount of waste the canneries dispose into Pago Pago Harbor. A clear trend of increasing total phosphorous and total nitrogen levels in the inner harbor occurred over the period 1979 to 1987 (Chamberlin et al. 1989). In addition, low dissolved oxygen content due to high nutrient levels are suspected to be the cause of several fish kills in the inner harbor.

A recent toxicity study of the Pago Pago Harbor confirmed the presence of heavy metals, PCBs and pesticides in fish tissue samples taken from the inner harbor. Lead concentrations as high as 7.9 ppm in fish muscle tissues and 73.8 ppm in fish liver tissues were found (AECOS 1991). Health advisories were issued, recommending that inner harbor fish not be eaten and prompting health officials to test for lead levels in the blood of villagers who have eaten fish from the harbor. The sale of fish caught in the inner harbor area was eventually banned, although this ban has not been enforced rigidly. Local stores say that they will not buy fish from the inner harbor, however several private fishermen still regularly sell fish from the harbor at an outdoor fish market in Fagatogo.

METHODS

The study design for this survey was developed by Bonnie Ponwith in 1990 (Ponwith 1991). It's purpose was to repeat a previous survey done by Richard Wass in 1979, to document changes in this inshore fishery over the intervening 12 years, and to produce a data collection procedure which could be continued indefinitely into the future.

Due to personnel and logistical constraints, an island-wide survey was deemed not feasible (Wass 1980, Ponwith 1991). The study area selected was a 16-km stretch of shoreline, centered around Pago Pago Harbor (Figure 1). It exhibits a range of reef health, from the outer villages such as Lauli'ituai which are impacted primarily by fishing activities, to the heavily developed and polluted industrialized shore of inner Pago Pago Harbor.

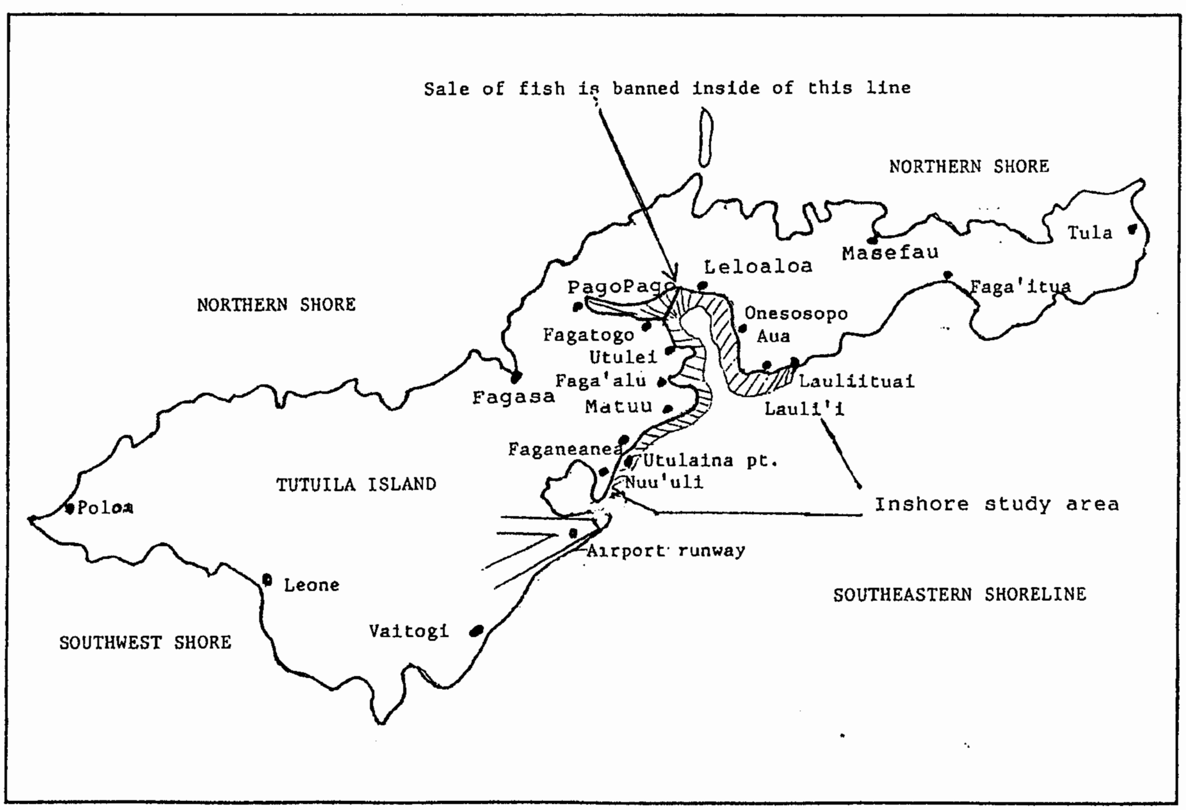


Figure 1. Study area on Tutuila Island, American Samoa.

Individuals or groups fishing were sampled only if they had been fishing at least half an hour. Parties that had no catch were recorded as such and included in the computation of CPUE. Catch data included date, type of day (weekday or weekend-holiday), village, whether the trip was concluded or in progress, time of interview, fishing method used, number of hours fished at the time of the interview, number of gear units (rods, nets, spears, etc.), number of people in the fishing party.

The catch was weighed and counted by species groups whenever possible. When the catch included a large number of small fish, the catch was weighed without counting. The interviewers sampled only the portion of the catch which was kept, no estimate was made of the discarded portion, if any. Fishermen often ate portions of the catch during their fishing trips. No estimate was made of these fish caught but not available for inspection by the creel technician.

Fishermen on Tutuila seldomly headed or gutted their fish in the field, therefore fish weights reported here are in the round. Methods of capture and preparation of shellfish varied, and technicians measured their catch as it appeared at the time of the interview, without any notations as to whether the recorded weight was of the entire animal, or just a portion there of. As most of the animals were taken in the whole, shellfish weights presented here represent whole weights with two notable exceptions: 1) Sea Cucumbers where usually dissected and only the female gonads taken, leading to a severe underestimation of the catch of these species, and 2) Sea anenomies were often taken along with rocks they were attached to, leading to a serious over-estimation of the poundage of sea anenomies taken.

Data collection relied on locally hired technicians who had very limited backgrounds in biology or statistical procedures; however, they were familiar with the locally caught species of fish which they knew by their Samoan names. For this reason, catch data were recorded primarily using the Samoan names. This lead to some unfortunate combining of similar species in the data.

Sociological information was also collected during each interview. Participants were categorized by sex and age (14 or less, 15 or older). Each fishing party was asked how much of the catch was to be sold or kept, and whether or not they were fishing adjacent to their home village.

Palolo Data

Palolo, the coral worm (*Eunice viridis*), is an important species in the shoreline fishery and required an auxiliary sampling effort due to the brevity and magnitude of its appearance in the fishery.

Once a year at the beginning of the last lunar quarter of October or November, these burrowing annelids release egg- and sperm-filled body segments (epitokes) into the surrounding water. The timing of this release usually occurs in a two night time span around the last lunar quarter, (Kraemer 1902, Caspers 1984, Itano 1986, Itano and Buckely 1988).

There is a great deal of speculation and folklore associated with the exact timing of this event, and even an honor bestowed on the persons who could correctly predict the emergence of the worm. Samoans, who consider the epitokes a delicacy, gather in large numbers around midnight on the predicted night to collect the epitokes from shoreline waters using scoop nets or long lengths of screen. People typically wait on the beaches or in their cars, a few will venture out into the water every few minutes to see if the epitokes are present. When epitokes are found, dozens to hundreds of people will rush into the waters for a brief pandemonium of fishing.

Palolo are harvested at various locations throughout the island, with the effort concentrated on several beaches which have been known to produce good harvests in the past.

Typically, a fishing party will consist of two to several people, some who hold lanterns and buckets, and others who scoop the epitokes from the water into the buckets.

A separate sampling effort was applied to the palolo fishery to accommodate its unique attributes. A one-night survey was conducted in 1990 and 1991 (Ponwith 1991). That survey only included the stretch of shoreline from Faga'alu to Nu'uuli which, attracted the greatest number of participants in the inshore survey study area.

In 1992, an expanded palolo survey was conducted to census all the likely palolo harvesting areas on the Southeast and Southwest shores of Tutuila. The palolo survey was also extended to include four nights in both October and November, centered on the last night of the lunar quarter. This increased time was made to insure that the samplers did not miss the night of the palolo, and to obtain a more complete picture of this fishery.

Four crews were used to cover all areas. Crew 1 surveyed from Tula to Aua, Crew 2 from the Rainmaker Hotel to Faganeanea, Crew 3 from Faganeanea to Coconut Point, Crew 4 surveyed the airport reef, and Crew 5 surveyed the Southwestern shore from Leone to Poloa. Crews also sampled returning boat fishermen at the Fagatogo small boat harbor. The harbor villages from Aua to the Rainmaker Hotel were not sampled as it was believed that no Palolo harvest would occur in this area.

Logistics and lack of personnel prevented us from deploying crews to the villages on the northern shore, even though anecdotal reports suggested that high densities of palolo had been seen in isolated spawning in past years. Also, the survey of the southwestern shoreline was discontinued after two nights due to vehicle breakdowns, and that very few palolo fishermen were observed in those areas.

The palolo survey methods used in 1992 were similar to those described by Ponwith, except that both persons in the water and on the shore were counted, and the catch rate was based on a person/night basis rather than on a person/hour basis. These changes were made for the following reasons:

1. The peak fishing activity may last only 1/2 hour or so, making it impossible for limited crews to survey the study area obtaining counts of the number of people in the water. It was also difficult to determine what proportion of the people observed waiting on the shorelines actually intended to fish. If the worms did not appear on a particular night (as was the case), many of the would be fishermen would leave without actually fishing. Also many people waiting on shore never intended to actually fish, but were rather there to accompany people who came to fish, supervise children, or just came to watch the show.

2. Persons who come out at midnight in the anticipation of a palolo harvest could legitimately be considered participants in the fishery, whether their intent was to fish, or just to help or watch from the shore.

3. The cultural importance of the palolo fishery is likely greater than it's biological importance, and it is therefore important to document all participants in it.

4. An hourly catch rate makes little sense for this fishery, as a typical palolo fishing trip consists of a large amount of time spent waiting around on the beach watching for worms, and a short amount of time spent actively fishing. To include the time spent waiting and searching for worms would lead to erroneous catch rates. Consider the following hypothetical example: Year 1, a person comes to a beach and starts watching for worms at 12:00 PM. The worms appear around 12:30 PM. He catches 1 pound of epitokes, and leaves at 1:00 AM. His hourly CPUE would be 1 pound per hour. However in Year 2, the fisherman again starts searching for worms at 12:00 PM, but the worms do not appear until around 1:30 AM. He again catches 1 pound of worms, and leaves at 2:00 AM. His hourly CPUE would be 0.5 pounds/hour, a drop of 50% from year 1. It seems more correct and more practical to consider the night as the unit of effort, and to report that the catch rate for both years 1 and 2 was 1 pound/night.

5. When the spawning was over, people would leave the areas in mass as quickly as possible, as it is the wee hours of the morning and they are wet, cold and tired. Therefore interviews had to be conducted as rapidly as possible as people were leaving. Extraneous questions (such as their age, when they started fishing or when they stopped) were eliminated in order to allow the rapid collection of the catch data. We also found it difficult to interview unsuccessful fishermen as they wanted to leave as quickly as possible, and did not want to stop to discuss their failure with us.

Fish sale data

Some data on fish sales are presented in this report. Vendors report the weight by species, source, and price paid. Since July 1990, DMWR has compiled this information into a database. Some of this data is presented for comparison to the inshore catch on page 50.

Currently, all vendors of fresh and frozen fish, and fish products, (excluding canned imports) in American Samoa are required to report their purchases of fish to DMWR, however DMWR lacks the legal authority at the present time to issue citations to vendors who do not comply with the reporting requirements.

DMWR is currently seeking authority to issue citations. Until this issue is resolved, the fish sale data shown on Table 17 should be considered an underestimation of the total.

ANALYSIS

Data were entered into a database and a series of interactive DBASE IV programs were used to expand the sample data to annual catch and effort estimates for the study area. This methodology is discussed by Ponwith (1992).

The data set from Ponwith was re-analyzed for the FY91 figures shown in this report. Some corrections were made to both the data base and programs, therefore the results reported here for FY91 are somewhat different from those presented in Ponwith's report. All catch and effort figures for 1979 are taken directly from Wass's report, although all CPUE's for 1979 shown here are recomputed based on his catch and effort statistics.

Area Groupings

The study area included 22 coastal villages. This report summarizes the villages into the 8 area groupings shown below. These area groupings were selected as they represent the distinct habitat areas within the study area. This also allowed the pooling of catch data in adjoining villages, as sufficient data was not available in several villages to provide an accurate analysis for the village by itself.

AREA	VILLAGES, HABITAT
Lauli'i	Lauli'ituai, Lauli'ifou. Habitat: Exposed coastline, outside harbor, high wave energy area. Upland areas are residential village areas, with development not severely impacting the reef. Reef top and reef slope appears healthy.

Aua — Onososopo, Aua, Lepua, Leloaloa. Habitat: Protected outer harbor area, low to moderate wave energy. Upland areas are a mix of crowded residential housing and industrial development. Extensive rip-rapping along beach front. Large amounts of silt runoff washes onto the reef. The reef top is impacted by several ship wrecks deposited there by Hurricane Val in 1991, and also by trash which has been dumped on the beaches. The reef top still supports many live corals, though reef face is heavily silted below a depth of about 10 feet.

Inner Harbor — Atu'u, Anua, Satala, Lalopua, Pago Pago, Malaloa. Habitat: Calm, protected areas. Developed industrialized area, includes canneries, shipyard, and small vessel harbor. The coral reefs are almost entirely dead and silted over. Pollution is a serious problem. Sale of fish caught in this area is banned.

Fagatogo — Fagatogo. Habitat: Fuel dock and cargo dock areas. Constant vessel traffic. No reef environment remaining. Oil pollution is a serious problem. This area receives some of the highest fishing pressure of all areas studied, particularly during the atule run. Fishermen favor the dock area due to the ease of access of the dock areas relative to outer reef areas. By fishing from the dock, a fisherman can cast into deeper waters without tangling his line as do reef fishermen. Sale of fish caught in this area is banned.

Utulei — Utulei. Habitat: Semi-protected outer harbor area. Immediate upland area is park land and office buildings. Silt runoff occurs in moderate to severe amounts. Reef top supports some live corals, though reef slope below 10' is heavily silted, and supports few live corals. This area receives high fishing pressure during the atule run, but very low pressure at other times.

Faga'alu — Faga'alu, Fatumafuti. Habitat: A shallow bay outside the main harbor, a broad reef top and, an exposed high energy reef front. Upland areas are developed urban areas. The inner portion of Faga'alu is a protected shallow area with a sandy bottom. The outer shallow reef area supports some of the richest shallow reef habitats on the island. Heavily used, both recreationally and for fishing.

Matu'u	Matu'u, Usa'aiga, Faganeanea. Habitat: Narrow reefs with exposed, high energy fronts. The coastal road infringes on the beaches and reef top. The upland areas are mostly too steep for development, and what little flat areas there are crowded with village housing.
Nu'uuli	Avau, Oneoneloa, Nu'uuli. Habitat: Narrow to broad reefs with exposed, high energy fronts. The Nu'uuli reef is the broadest reef on the island.

Note: The area affected by ban on fish sales due to high levels of lead and other pollutants included all areas inside of a line drawn across the harbor from Samoa Packing's cannery location in Anua to the Rainmaker Hotel in Utulei (Figure 1). This included the areas referred to as "Inner Harbor" and "Fagatogo" in this report.

Participation Analysis

In a deviation from Ponwith (1992), fishing effort estimates are reported both in person-hours and in gear-hours. This change is made for two reasons, 1) to allow for more direct comparisons to the 1979 study, which reported only person-hours, and 2) to present a more accurate picture of the human effort expended in this fishery.

Gear-hour computations are a better biological representation of this fishery, as it is common for a fishing party to include people who are not actively fishing. For example, a fishing party may consist of two people one of whom fishes with a rod and reel while the other holds the catch. The fishing power of that party is better defined by amount of gear they have, rather than the number of people participating.

Separate estimates for fishing effort were calculated for each effort stratum, which consisted of the following:

0) Year (FY91 versus FY92)
1) Time of day (Day-time versus Night time)
2) Day type (Week day versus week end or Holiday)
3) Fishing method
4) Village

The first step in estimating total effort was, for each stratum, to sum the total number of gear units observed and divide it by the total number of hours observed to produce a mean number of gear units per hour. The second step was to multiply this value by the total number of hours possible for each stratum in each 1-year period.

Catch Analysis

Catch estimation involved several steps. First, a CPUE value for each catch that was sampled was calculated by dividing the total number of pounds caught by the total effort (where total effort equalled the product of number of gear units and the number of hours fished).

The interview (catch) database is organized in a hierarchical arrangement of strata, as follows:

Level	Strata
0	Year, (User-selected range of dates for an analysis)
1	Day or night fishing
2	Day type (Week day versus Weekend day or holiday)
3	Fishing technique, (Grouping of like methods)
4	Fishing Method, (Rod and reel, hand-line, (etc.))
5	Habitat (Grouping of similar villages. See page 9)
6	Village name

Total catch, (C), and total effort, (E) were calculated for each stratum and at each hierarchial level. The ratio of these two numbers (C/E) was used to estimate the catch per unit effort, CPUE. Expanded catches were generated by multiplying the CPUE for each stratum by the expanded effort estimate for each respective stratum. In many cases there were not a sufficient number of interviews available in a given stratum at level 6 to compute a CPUE. In these cases, the expansion program would look for a CPUE at level 5 in order to produce an expanded catch for a particular stratum. If a level 5 CPUE was not available, then a level 4 CPUE would be used, (etc).

In this analysis, a minimum of two interviews would be required to complete the analysis.

For example, to estimate the catch by daytime, weekday, rod and reel fishermen fishing in the village of Onososopo, the program would first look for all interviews within the selected time period for day time rod and reel fishermen in Onososopo (Level 6). If two interviews were not found, the program would then look at the level 5 CPUE, which would be all rod and reel fishermen fishing in the Aua area, which includes Onososopo. If two interviews were not found there, then the a level 4 CPUE would be used, which would be all daytime, weekday, rod and reel fishermen within the entire study area.

Species composition estimates (by weight) were then calculated. The proportion of each species in the sampled catch was multiplied by the total estimated catch to get the expanded species composition. Fish weights are expressed as whole fish and shellfish weights include the shell.

Palolo Analysis

Palolo data were analyzed independently from the rest of the data. The procedure used in this study differs somewhat from prior studies described by Ponwith, (1981). Each fishing party interviewed was surveyed upon completion of their fishing trip. The following data were collected: Total number of persons in the group including those who did not actually fish, and amount of catch for the group. Palolo catch rates were then computed on a per person/night basis. The total catch for a village area was estimated by multiplying the mean CPUE from the interview data by the maximum number of persons observed in that area for all the participation counts.

Data limitations

Two data collection problems seriously affect this survey design: (1), logistics made it difficult to interview most reef fishermen who were away from the shore, and (2) it was often difficult to see nighttime fishermen, particularly spear divers.

The first problem made it difficult to obtain unbiased interviews of the fishermen's catch. Most of the reef fishing occurred out on the reef flat, often as close to the reef face as possible. Fishermen are often wading in knee deep water and are a couple hundred feet from shore. Spear divers were usually swimming in deeper waters just past the reef face. It was usually impractical and sometimes hazardous to walk out to these fishermen. These fishermen were generally interviewed only if they happened to be completing their fishing trip and seen returning to the shore by the data collector if he happened to be driving by at the right time. But persons fishing close to shore, or on docks were interviewed on a routine basis. This problem adds an obvious bias to the survey results which is not corrected for in the data analysis. This survey also suffers from low interview rates in several villages. Often, interviews from other villages of persons fishing with the same gear type were used to compute an expanded catch.

Poor visibility due to rain and darkness during evening shifts were the main factor affecting the accuracy of participation data. During sampling shifts on nights surrounding the new moon period, the data collectors often relied on counts of flashlights since the fishermen, themselves, could not be seen. If the lights were submerged and offshore, as was often the case for night divers, they could have been easily missed. Rod and reel anglers who fish the edge of the reef often went for long periods of time without turning on a flashlight, making them difficult to see on dark nights.

Low estimates for nighttime effort would have a ripple affect on the rest of the estimation process. They would result in low expanded catch and effort estimates for selected species, most notably for lobsters, alogo (bluestriped surgeonfish), squirrelfish and soldierfish. Thus, catch and effort estimates for nighttime should be considered conservative, especially for the diving method.

RESULTS AND DISCUSSION

Fishing Methods .

A variety of fishing methods were observed in use. These were classified into seven gear types as follows:

Rod and Reel. This gear type included the typical fiberglass casting rod and mechanical reel available in most sporting goods stores. Baits included lures, live baits, feathers, and jigs. Atule and Jacks were the most commonly targeted species, though other species were taken as well.

Hand line. The hand line consisted of a length of line wrapped around a stick or partially crushed aluminum can. Use of this gear type is not mentioned by Wass (1980) or by Hill (1978), but was the most often used gear type in FY91. Fishing with hand lines is predominantly done off the docks in the Fagatogo area, but was also observed throughout the study area.

Bamboo Pole. This gear type included any bamboo pole or stick with a piece of fishing line tied to it. No reel was involved, which distinguishes it from the rod and reel gear type.

Gleaning. Gleaning is where people simply walk out onto the reef flats and catch or pick up whatever fish or invertebrates they may find. Usually people will walk along the reef top at low tide during day light hours, probing cracks with a piece of wire for octopus, catching fish stranded in shallow tide pools, or simply picking up sea urchins and other invertebrates. This is probably the most traditional fishery that people engage in, and was the most used method in the 1979 (Wass 1980).

Spear diving. Spear divers generally work the outer reef edge, though are frequently seen on the reef tops at high tide. The equipment is simple, using swimmer's goggles or snorkel gear, and using spears of various designs to catch fish. The spears vary from pole spears (Hawaiian Slings) to home made devices which resemble a bow and arrow.

Much of the spear diving is done at night using waterproof flashlights. The fish are stunned and blinded by the lights, and are thus much easier to approach then they are during the day time.

The usage of scuba tanks was not observed within the study area, as this type of gear has not been adopted by most people due to its cost and lack of support on the island. Most of the use of scuba gear at this time is by DMWR personal, or persons who learned the use of scuba equipment while living in Hawaii or the mainland, and may occasionally spear fish recreationally.

Throw net. Throw nets or cast nets were used through out the study area. In reef areas, they were usually used at low tide, often in conjunction with gleaning.

Gill net. The gill nets observed in use in this study consisted of relatively short (100' - 200') lengths of monofilament gill nets. Wass used the term "seines" to include:

> "...[monofilament] gill nets, throw nets, scoop nets and seines that were woven from cord from bark or coconut husks".

Thus Wass's usage of the term "seine" includes a variety of fishing techniques and gear which involved nets. Wass considered "seines" as an active gear type where a net was pulled through the water, or the fish driven into the net, whereas he considered "gill nets" as a passive gear type which was allowed to catch fish more or less unattended. As gill nets are generally used as in an "active" fishing method, Wass called them "seines" in his report, whereas they are called "gill nets" in this report.

The usage of the more traditional materials (nets woven from cord or bark or coconut husks) have not been observed since this study began in 1990.

The usage of gill nets is at times banned in some areas by the village councils. This happened in Utulei and Faga'alu in FY91 during the atule run when there were complaints that too many fish were being caught by gill net fishermen, and not allowing the rod and reel fishermen their "fair share". Enforcement of village rules such as this is not within the jurisdiction of the Department of Marine and Wildlife Resources.

Wass also describes several techniques that were not observed in this study. Most of these involved using pens, weirs, or traps of some variety and large numbers of people to drive the fish into trap where they were harvested.

Wass (1980) states that many of the traditional fishing techniques required a group of people, and much of the enjoyment the Samoan's derived from fishing related to its social aspects.

Island-Wide Catch and Effort

From the data collected in this study, it is estimated that the inshore fishermen on Tutuila harvested an estimated 440,000 pounds of fish and shellfish in FY91, and 334,000 pounds in FY92 (Table 1). This compares to 660,000 pounds in 1979 (Wass 1980).

Table 1. Estimated catch of fish and shellfish for Tutuila Island. The catch/capita for villages in the study area is estimated by dividing the catch per village by the village population. The island-wide catch is then estimated based on the average per-capita catch within the study area times the total island population. Palolo catch and effort are not included.

Area	1990 Population	FY91 Catch (Pounds)	FY91 Pounds/ Capita	FY92 Catch (Pounds)	FY92 Pounds/ Capita
Lauli'i	814	5,314	6.5	9,553	11.7
Aua	2,308	14,844	6.4	27,033	11.7
Inner Harbor	3,992	3,783	0.9	1,219	0.3
Fagatogo	2,323	61,867	26.6	15,203	6.5
Utulei	930	37,094	39.9	10,994	11.8
Faga'alu	1,087	12,457	11.5	20,177	18.6
Matu'u	532	4,487	8.4	7,052	13.3
Nu'uuli	3,893	15,284	3.9	26,688	6.9
Study area total	15,879	155,131	9.8	117,919	7.4
Island Totals	45,043	441,000		333,000	

The per capita catch for 1979 was estimated to be 17.8 pounds/person, and the resulting island wide catch was estimated to be 660,000 pounds.

The island-wide extrapolation should be considered only as a best guess for the following reasons: (1) Villages in the study area are not selected at random, but rather represent a string of villages in the more industrialized harbor area which could be conveniently surveyed. Outlying villages may have considerably different fishing patterns. (2) Catch per capita estimates were made by dividing the total catch by village by the village population. A more accurate estimate would be to include only the catch by residents of the village. (3) The highly populated Inner Harbor areas receive a reduced fishing effort due to the environmental degradation experience there, and due to health advisories which have cautioned residents against eating fish and shellfish taken from the harbor areas, thus observed catch per capita of 0.9 pounds/person is likely to be lower than that of other coastal villages. (4) Villages in the Tafuna Plain and Aasufou regions where a large proportion of the island population lives, essentially have no access to reefs adjacent to their villages. Their fishing efforts are undoubtedly different than that of the study area. (5) The species composition of the catch is likely to be different between the study area and the outlying areas.

Fishing effort within the study area has dropped more than 45% since 1979 (Table 2), in spite of a nearly 50% increase in the human population during the same time period. The cause of this drop cannot be attributed to a decline in the resource, as the catch per unit effort has been seen to increase during the same time period.

Catches of individual species are seen to fluctuated widely from FY91 to FY92. Comparing the pounds landed of each species group presented in Table 4 between FY91 and FY92, it can be seen that in almost all cases, the catch of a particular species will fluctuate by a factor of 2 to 10 in most cases (Table 4).

A number of factors affect the species composition observed in the catch, including natural fluctuations in species composition and abundance, and the variations in fishing methods. Unfortunately, this study can not adequately monitor the variability in fishing methods, and so in unable to make definitive statements regarding fluctuations in the species composition or abundance, other than what was observed in the landings.

Table 2. Effort (person hours), catch (pounds of fish and shellfish), and CPUE (pounds/person hour) by area and gear type for 1979, FY91 and FY92. Catch statistics for palolo are not included. Catch statistics for 1979 are summarized from Wass (1980). Note that the Nu'uuli area was not surveyed in 1979, and totals do not include a correction for this.

	Method	Rod & Reel		Hand line		Bamboo Pole		Gleaning		Spear Diving		Throw Net		Gill Net		Total	
Area		FY91	FY92	FY91	FY92	FY91	FY92	FY91	FY92	FY91	FY92	FY91	FY92	FY91	FY92	FY91	FY92
Lauli'i	Effort	353	321	140	173	24	197	796	1351	445	715	38	116	23	8	1819	2880
	Catch	1194	700	307	124	10	261	1369	6652	2005	1254	152	470	278	93	5314	9553
	CPUE	3.4	2.2	2.2	0.7		1.3	1.7	4.9	4.5	1.8	4.0	4.1			2.9	3.3
Aua	Effort	1569	1377	342	180	747	444	890	1411	1199	1220	495	501	377	1314	5617	6448
	Catch	4037	2290	632	158	455	622	741	7068	3368	5122	3283	1878	2328	9896	14844	27033
	CPUE	2.6	1.7	1.8	0.9	0.6	1.4	0.8	5.0	2.8	4.2	6.6	3.7	6.2	7.5	2.6	4.2
Inner	Effort	423	140	827	0	221	0	21	13	21	103	184	76	42	0	1739	332
Harbor	Catch	787	299	1191	0	113	0	38	79	42	180	1106	661	506	0	3783	1219
	CPUE	1.9	2.1	1.4		0.5					1.8	6.0				2.2	3.7
Fagatogo	Effort	10001	2793	22441	5211	896	215	42	0	0	0	31	0	83	0	33493	8218
	Catch	29594	6956	31340	7928	537	319	76	0	0	0	92	0	228	0	61867	15203
	CPUE	3.0	2.5	1.4	1.5	0.6	1.5									1.8	1.8
Utulei	Effort	6108	1966	1795	240	122	143	257	97	1151	1166	78	124	635	141	10146	3877
	Catch	24622	2572	1380	173	46	189	449	489	620	1839	189	587	9788	5145	37094	10994
	CPUE	4.0	1.3	0.8	0.7	0.4	1.3	1.7		0.5	1.6		4.7	15.4	36.4	3.7	2.8
Faga'alu	Effort	484	516	116	68	266	248	1502	1698	1584	1920	287	192	15	130	4254	4771
	Catch	2425	1116	231	49	52	328	2509	8772	6104	7667	958	778	178	1467	12457	20177
	CPUE	5.0	2.2	2.0		0.2	1.3	1.7	5.2	3.9	4.0	3.3	4.1		11.3	2.9	4.2
Matu'u	Effort	573	608	36	5	136	27	596	636	361	528	197	68	21	43	1920	1915
	Catch	1930	1256	79	4	53	36	976	2875	800	2121	395	274	253	487	4487	7052
	CPUE	3.4	2.1			0.4		1.6	4.5	2.2	4.0	2.0				2.3	3.7
Nu'uuli	Effort	851	744	85	110	44	79	2436	2290	1843	2159	129	122	123	124	5511	5627
	Catch	3799	1603	186	80	19	104	4579	13198	4657	9810	576	493	1467	1399	15284	26688
	CPUE	4.5	2.2		0.7			1.9	5.8	2.5	4.5	4.5	4.1	12.0	11.3	2.8	4.7
Total	Effort	20361	8463	25781	5987	2456	1351	6541	7496	6603	7812	1439	1198	1318	1761	64500	34068
	Catch	68388	16791	35347	8516	1284	1859	10738	39132	17596	27994	6752	5140	15026	18487	155131	117919
	CPUE	3.4	2.0	1.4	1.4	0.5	1.4	1.6	5.2	2.7	3.6	4.7	4.3	11.4	10.5	2.4	3.5

Table 3. Effort (gear hours), Catch (pounds of fish and shellfish), and CPUE (pounds/gear hour) for FY91 and FY92. Catch per unit effort is not computed for strata where there are insufficient data. Palolo catch and effort statistics are not included in these figures. Catch statistics for 1979 are available only in person hours, and so are not included in this table. See Table 2 for 1979 comparative data.

Method		Rod & Reel			Hand line			Bamboo Pole			Gleaning			Spear Diving			Throw Net			Gill Net			Total		
Area		1979	FY91	FY92	1979	FY91	FY92	1979	FY91	FY92	1979	FY91	FY92	1979	FY91	FY92	1979	FY91	FY92	1979	FY91	FY92	1979	FY91	FY92
Laull'I	Effort	427	353	382	0	142	186	571	33	202	3661	807	1488	1216	486	715	555	85	148	679	80	41	7109	1966	3160
	Catch	1175	1194	700	0	307	124	565	10	261	9583	1369	6652	3755	2005	1254	1965	152	470	9887	278	93	26930	5314	9553
	CPUE	2.8	3.4	1.8		2.2	0.7	1.0		1.3	2.6	1.7	4.5	3.1	4.3	1.8	3.5	1.8	3.2	14.8			3.8	2.7	3.0
Aua	Effort	1658	1630	1420	0	353	194	3287	742	463	9687	890	1883	3493	1209	1247	1362	943	800	70	861	5092	19557	6628	11099
	Catch	3010	4037	2290	0	632	158	4213	455	622	19622	741	7068	7346	3368	5122	5559	3283	1878	88	2328	9896	39836	14644	27033
	CPUE	1.8	2.5	1.6		1.8	0.8	1.3	0.6	1.3	2.0	0.8	3.8	2.1	2.8	4.1	4.1	3.5	2.3		2.7	1.9	2.0	2.2	2.4
Inner Harbor	Effort	558	433	140	0	837	0	2964	221	0	45	21	13	57	21	119	667	279	97	0	95	0	4291	1907	369
	Catch	1239	787	299	0	1191	0	2022	113	0	108	38	79	147	42	180	2803	1106	661	0	506	0	6318	3783	1219
	CPUE	2.2	1.8	2.1		1.4		0.7	0.5							1.5	4.2	4.0	6.8		5.3		1.5	2.0	3.3
Fagatogo	Effort	5136	9909	2628	0	22630	5246	6010	956	215	3	42	0	153	0	0	36	31	0	0	125	0	11336	33693	8269
	Catch	8248	29594	6956	0	31340	7928	8065	537	319	11	76	0	785	0	0	0	92	0	0	228	0	17109	61667	15203
	CPUE	1.6	3.0	2.5		1.4	1.5	1.3	0.6	1.5				5.1							1.8		1.5	1.8	1.8
Utulei	Effort	1206	8104	1998	0	1795	240	1596	122	143	1604	257	129	2609	1164	1166	211	83	219	254	1333	654	7480	10858	4549
	Catch	2706	24622	2572	0	1360	173	1439	46	189	4695	449	489	6303	620	1839	779	189	587	1226	9788	5145	17149	37094	10994
	CPUE	2.2	4.0	1.3		0.8	0.7	0.9		1.3	2.9	1.7	3.8	2.4	0.5	1.6	3.7	2.3	2.7	4.8	7.3	7.9	2.3	3.4	2.4
Faga'alu	Effort	1232	473	540	0	116	68	740	362	248	3381	1513	1711	1951	1584	1990	112	493	333	150	30	424	7568	4571	5313
	Catch	1437	2425	1116	0	231	49	521	52	328	7696	2509	8772	4492	6104	7667	1045	958	778	746	176	1467	15939	12457	20177
	CPUE	1.2	5.1	2.1		2.0		0.7	0.1	1.3	2.3	1.7	5.1	2.3	3.9	3.9	9.3	1.9	2.3	5.0		3.5	2.1	2.7	3.8
Matu'u	Effort	1759	616	606	0	36	5	1797	136	27	8825	596	653	3054	361	528	798	300	149	106	53	194	16339	2098	2164
	Catch	,3639	1930	1256	0	79	4	3377	53	36	18005	976	2875	5485	800	2121	2754	395	274	405	253	487	33664	4487	7052
	CPUE	2.1	3.1	2.1				1.9	0.4		2.0	1.6	4.4	1.8	2.2	4.0	3.5	1.3	1.8	3.8		2.5	2.1	2.1	3.3
Nu'uuli	Effort	NS	862	785	NS	65	110	NS	44	61	NS	2436	2292	NS	1875	2159	NS	184	286	NS	123	280	NS	5609	5993
	Catch	NS	3799	1603	NS	186	80	NS	19	104	NS	4579	13198	NS	4657	9810	NS	576	493	NS	1467	1399	NS	15264	26688
	CPUE		4.4	2.0			0.7					1.9	5.6		2.5	4.5		3.1	1.7		12.0	5.0		2.7	4.5
Total	Effort	11976	20380	8701	0	25994	6050	16965	2616	1378	27206	6563	8169	12533	6880	7925	3741	2398	2030	1259	2700	6665	73680	67329	40938
	Catch	21452	88388	16791	0	35347	6516	20203	1264	1859	59721	10738	39132	28314	17596	27994	14905	6752	5140	12353	15026	18487	156948	155131	117919
	CPUE	1.8	3.4	1.9		1.4	1.4	1.2	0.5	1.3	2.2	1.6	4.6	2.3	2.6	3.5	4.0	2.6	2.5	9.8	5.6	2.8	2.1	2.3	2.9

Table 4. Estimated catches of fish and shellfish caught in the study area in FY91 and FY92. The percentage column shows the contribution of each species to the total FY91+FY92 catch excluding atule, and the species are shown in rank order to their percentage contribution. Each species or species group is shown here as identified in the data by their Samoan names. (Continued on next page).

Samoan Name	Common Name	Scientific Name	FY91 Catch Weight (lbs)	FY91 Catch Count	FY92 Catch Weight (lbs)	FY92 Catch Count	% of non atule in catch
Atule	Big-eye scad	Selar crumenophthalmus	81176	253840	35121	298323	
Fe'e	Octopus	Octopus spp.	7637	3405	23250	5997	19.3%
Lupo, ulua	Jacks	Carangidae	18539	26938	5236	33300	14.9
Poge	Brown surgeonfishes	Acanthuridae	1466	5919	10733	10381	7.6
Tuitui	White sea urchin	Ecinometra	3393	6185	8714	44670	7.6
Anae, fuafua	Mullet	Mugilidae	7081	26287	1768	6967	5.5
Sea,lole,mama'o,	Sea cucumbers	Holothuroidea	1174	3313	5181	2986	4.0
Palagi	Yellow surgeonfish	Acanthurus xanthopterus	5433	2742	522	883	3.7
Malau	Squirrelfish	Holocentridae	2050	12140	3872	11888	3.7
Alogo	Lined surgeonfish	Acanthurus lineatus	3155	8077	2126	7274	3.3
Gatala	Groupers	Serranidae	2415	7286	2102	10421	2.8
Ume, ili, ili'ilia	Unicornfish	Naso spp.	425	391	4044	2169	2.8
Palolo	Coral worm	Eunice viridis	3446	na	600	na	2.5
Gatalauli	Peacock grouper	Cephalopholis argus	469	1289	2332	2972	1.8
Fuga, laea	Parrotfish	Scaridae	1583	2404	981	2022	1.6
Pusi gatala	Spotted eels	Gymnothorax spp.	913	1048	1584	1915	1.6
Pa'u malo	Filefish	Monacanthidae	835	713	1371	42	1.4
Tagi	Dogtooth tuna	Gymnosarda unicolor	390	28	1582	4170	1.2
Ga	Mackerel	Rastrelliger spp.	1494	1542	393	206	1.2
Atuleau	Mackerel scad	Decapterus macrosoma	1870	13297	0	0	1.2
Alili, ali'ali	Turban snail	Turbo chrysostomus	315	1555	1403	9427	1.1
Manini	Convict tang	Acanthurus triostegus	882	15321	360	4255	0.8
Sapatu	Barracuda	Sphyraena spp.	1157	368	0	0	0.7
Ta'iva	Onespot snapper	Lutjanus monostigmus	280	1248	869	3207	0.7
Tamala	Flametail snapper	Lutjanus fulvus	530	3027	520	1951	0.7
Tu'u'u	Angels, damselfish	Pomacanthidae, Pomace	418	5221	608	6936	0.6
I'asina	Yellowfin goatfish	Mulloides vanicolensis	811	15278	201	599	0.6
Afulu	Yellowstripe goatfish	Mulloides flavolineatus	767	2390	153	1267	0.6
Vaga	Black sea urchin	Echinoids	709	1919	0	0	0.4
Lai, tavai	Letherback	Scomberoides lysan	659	1315	0	0	0.4
Ula	Spiny lobsters	Panulirus pencillatus	378	524	268	385	0.4
Mala'i	Paddletail snapper	Lutjanus gibbus	229	944	394	714	0.4
Filoa, mata'ele'el	Emperors	Lethrinidae	421	572	154	417	0.4
Lalafutu	Pompano	Trachinotus spp.	560	189	0	0	0.3
Pule, sisi	Seashells	Gastropoda	509	869	0	0	0.3
Sugale	Wrasses	Labridae	341	827	128	295	0.3
Nanue, ganue	Rudderfish	Kyphosidae	421	449	0	0	0.3
Lo	Rabbit fish	Siganidae	386	1999	0	0	0.2

Continued on next page.

Table 4, (Continued). Weights of most species are in the round, (including shells) except for sea cucumbers for which only the female gonads were taken.

Samoan Name	Common Name	Scientific Name	FY91 Catch Weight (lbs)	FY91 Catch Count	FY92 Catch Weight (lbs)	FY92 Catch Count	% of non atule in catch
Continued from previous page.							
Mata'ele	Flagtail grouper	Cephalopholis urodeta	349	803	29	167	0.2%
Maoa'e	Moray eel	Muraenidae	0	0	371	57	0.2
Kavakava, atualo	Little tuna	Euthynnus affinis	360	666	0	0	0.2
Tolai, mumu	Yellowspt emperor	Gnathodentex aureolineat	350	1093	0	0	0.2
Pelupelu	Herrings	Clupeidae	214	895	61	2724	0.2
Tautu	Porcupine fish	Diodon spp.	264	171	0	0	0.2
Fo	Cardinalfish	Apogonidae	5	125	259	173	0.2
Sumu, molua	Triggerfish	Balistidae	243	1005	0	0	0.2
Pipi	Clam	Bivalve sp.	231	3759	0	0	0.1
Gatala	Honeycomb Grouper	Epinephelus merra	88	380	101	250	0.1
I'aui	Conger eels	Congridae	171	345	0	0	0.1
Mumu	Ponyfish	Leiognathidae	52	565	106	1711	0.1
Manifi	Sweepers	Pempherididae	0	0	157	1225	0.1
Matamalu	Sea anenome	Anthozoa	129	2463	0	0	0.1
Tifitifi	Butterflyfish	Chaetodontidae	103	862	24	836	0.1
Ofaofa	Heart urchin	Spatangoids	126	0	0	0	0.1
Ume Lei	Orangespine Unicornfi	Naso Literatus	86	71	38	21	0.1
Malie	Sharks	Chondrichthyes	113	68	0	0	0.1
Ta'uleia	Indian goatfish	Parupeneus indicus	105	166	0	0	0.1
Unident. finfish	Unidentified	Pices wierdus	97	684	0	0	0.1
Papa, velo	Lunartail grouper	Variola louti	77	0	0	0	0.0
Safole, sesele	Mountain bass	Kuhlia spp.	76	467	0	0	0.0
Ise, a'u	Needlefish	Belonidae	47	133	19	126	0.0
Gofu	Scorpionfish	Scorpaenidae	37	46	27	159	0.0
Lalafi, malakea	Wrasses	Cheilinus spp.	63	180	0	0	0.0
Matu	Mojarras	Gerres spp.	62	339	0	0	0.0
Ava'ava	Terapon perch	Terapon jarbua	60	1261	0	0	0.0
Asiasi, To'uo, Ta'	Yellowfin tuna	Thunnus albacares	0	0	55	318	0.0
Ali	Flounders	Pleuronectiformes	0	0	54	21	0.0
Uga	Hermit crab	Coebites spp.	53	278	0	0	0.0
Papata	Slipper lobster	Parribacus caledonicus	0	0	33	62	0.0
Sue	Pufferfish	Tetradontidae	27	303	0	0	0.0
Mutu,Mamo	Seargent major	Abudefduf saxatilis	24	155	0	0	0.0
Pa'a	Crab	Crustacea	22	331	0	0	0.0
Moamoa	Trunkfish	Ostraciidae	12	63	0	0	0.0
Maogo	Whitespotted surgeon	Acanthurus guttatus	7	71	0	0	0.0
Taoto, taotao	Lizzardfish	Synodontidae	2	46	0	0	0.0
I'usina, laulama	Surgeonfish	Acanthurus glaucopareius	2	22	0	0	0.0
Faisua	Giant clam	Tridacnidae	0	0	0	0	0.0
			=====	=====	=====	=====	
Total including atule			156,374	448,675	117,907	483,889	
Total excluding atule			77,198	194,835	82,786	185,566	100.0%

Species analysis

This section presents a comparison of catches between FY91 and FY92 for eight of the dominant species groups that contributed to the inshore catch.

Atule, Big-eye Scad. The atule (*Selar crumenophthalmus*) is thought to be migratory species which moves through the area once or twice a year. The first run generally occurs in March to May, the second in October to November (Ponwith, 1992). The strength and timing of the runs are highly variable. They frequent the harbor areas, forming large schools which are caught by hook and line, gill nets, and throw nets (Table 5, Figure 2)

Participation and effort in the Tutila shoreline fishery appears to be driven largely by two seasonal species, atule and palolo. Atule fishing dominated the fishing effort and catch in FY91 (Tables 4 and 5). High catches of atule were obtained in the Fagatogo and Utulei areas in FY91. However when atule catch rates fell after August of 1991, a general reduction in fishing effort followed, especially in the harbor areas where the atule primarily schooled. There was an increase in gleaning and spear diving efforts in FY92 from FY91 (Table 2), probably as a result of people switching to these methods as there were no atule to be found after the second month of FY92 (Figure 2).

Very little biological information is known about this species in the waters of American Samoa. Preliminary observations on the atule in the harbor area have shown these fish to be actively feeding (personal observation), however fish with mature gonads have not been observed, (Craig, personal communication). Nothing is known concerning where these fish go when they are not in the harbor area.

As shown in Figure 2, these fish have been entirely absent from catches in the study area since August of 1991. The cause of this absence is unknown.

Table 5. Catches of atule (big-eye scad) for FY91 and FY92, (top), and CPUE (bottom).

Atule - Big-eye scad.

Selan crumenophthalmus

FY91 — **Catch (Pounds of fish)**

Area	Rod& Reel	Hand Line	Bamboo Pole	Glean	Spear Dive	Throw Net	Gill Net	Total
Lauli'i	539	12	1				157	709
Aua	3333	156	1				401	3891
Inner Harbor	456	1089	22				286	1853
Fagatogo	23169	22746	1				14	45930
Utulei	14800	581	1				9619	25000
Faga'alu	1050	35					100	1185
Matu'u	1156	3	3				143	1304
Nu'uuli	466	7	2				829	1304
Total	44968	24630	29				11550	81176

FY92

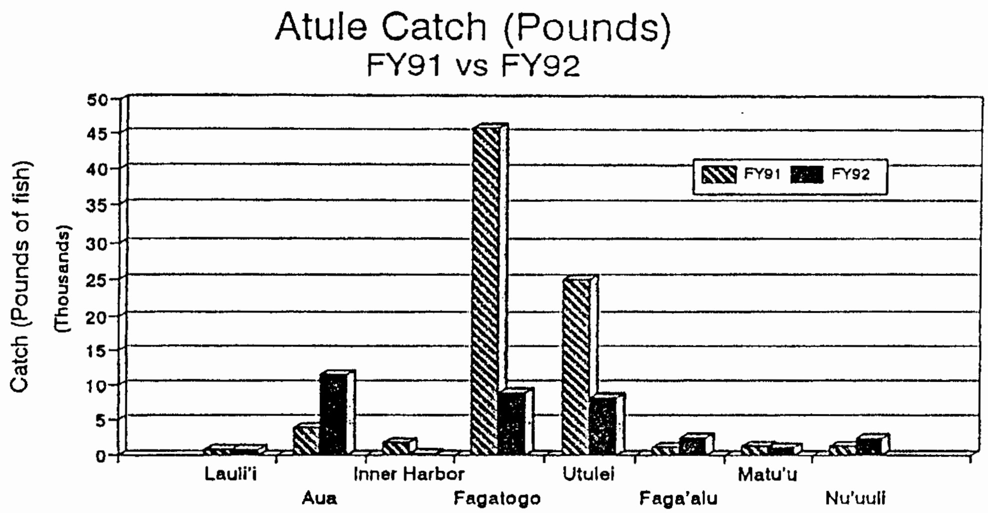
Area	Rod& Reel	Hand Line	Bamboo Pole	Glean	Spear Dive	Throw Net	Gill Net	Total
Lauli'i	264	24	128			279	88	784
Aua	741	53	406			1154	9097	11451
Inner Harbor	108					35		143
Fagatogo	3690	4895	257					8842
Utulei	2506	33	93			479	5082	8192
Faga'alu	415	9	161			463	1394	2443
Matu'u	341	1	17			163	463	985
Nu'uuli	592	15	51			293	1330	2281
Total	8658	5030	1114			2865	17454	35121

FY91 — **CPUE (Pounds/Gear Hour)**

Area	Rod& Reel	Hand Line	Bamboo Pole	Glean	Spear Dive	Throw Net	Gill Net	Mean
Lauli'i	1.52	0.08	0.03				6.76	0.39
Aua	2.12	0.46	0.00				1.06	0.69
Inner Harbor	1.08	1.32	0.10				6.76	1.07
Fagatogo	2.32	1.01	0.00				0.17	1.37
Utulei	2.42	0.32	0.01				15.16	2.46
Faga'alu	2.17	0.30					6.76	0.28
Matu'u	2.02	0.08	0.02				6.76	0.68
Nu'uuli	0.55	0.08	0.05				6.76	0.24
Total	2.21	0.96	0.01				6.76	1.26

FY92

Area	Rod& Reel	Hand Line	Bamboo Pole	Glean	Spear Dive	Throw Net	Gill Net	Mean
Lauli'i	0.82	0.14	0.65			2.41	10.73	0.27
Aua	0.54	0.29	0.91			2.30	6.92	1.78
Inner Harbor	0.77					0.46		0.43
Fagatogo	1.32	0.94	1.20					1.08
Utulei	1.27	0.14	0.65			3.85	36.00	2.11
Faga'alu	0.81	0.14	0.65			2.41	10.73	0.51
Matu'u	0.56	0.14	0.65			2.41	10.73	0.51
Nu'uuli	0.80	0.14	0.65			2.41	10.73	0.41
Total	1.02	0.84	0.82			2.39	9.91	1.03



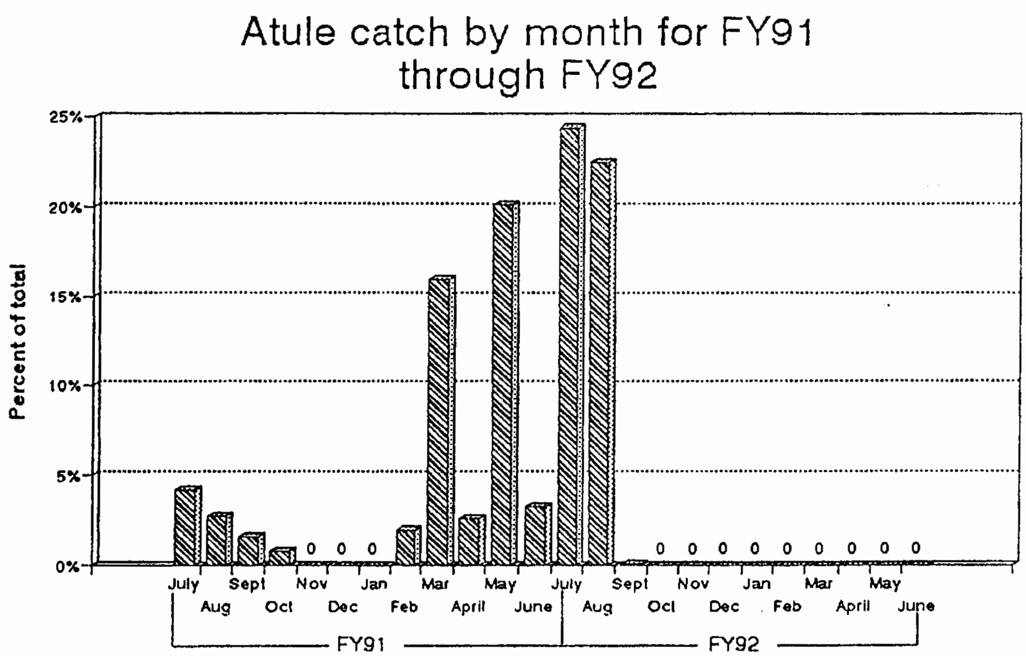


Figure 2. Atule catch by village (top) and by month (bottom).

All other species. Although the migratory atule are the dominant in terms of landings and effort in this fishery, of primary interest to fisheries managers is the abundance of the reef-resident species, as they are presumed to be better indicators of the health of the reef ecosystem.

Unfortunately, it is difficult to factor the atule effort out of the database, as participation counts do not provide direct data about the species a fisherman is targeting (if indeed the fisherman is targeting a specific fish at all), nor does the interviewer ask the fisherman what they are fishing for.

However, as the atule are caught primarily in the Fagatogo and Utulei areas, and caught primarily by hook and line methods, it is possible to look at the CPUE in strata where atule did not dominate the effort and catch statistics. For this analysis, all strata shown in Table 2 where atule contributed 50% or more to the catch were deleted. All strata for the Nu'uuli area and the hand-line method were also deleted, as these strata were not recorded in the 1979 study, and so are not useful for this comparison. What is left for comparison are the gleaning and spear diving strata, and three strata for bamboo pole and throw nets (Table 6, Figure 3).

A large drop in the "non-atule" effort is apparent, dropping about 51-78%% between 1979 and the present (Table 6). According to standard fisheries models, for a fishery that experiences a significant fishing mortality, a decline in effort should be accompanied by an increase in CPUE, as fish stocks recover from the fishing pressure. However, the 1991 non-atule CPUE is virtually identical to the 1979 CPUE, suggesting that the CPUE is independent of fishing pressures at the levels of effort observed for this fishery. From FY91 to FY92 the non-atule effort increased approximately 30% and at the same time the CPUE increased about 67%, again suggesting a lack of correlation between effort and CPUE at these levels of effort.

Whether the observed fluctuations in CPUE are a function of fishing pressure, or are a function of other factors is, unfortunately, almost impossible to say from this study. It is reasonably assumed that the abundance and composition of the reef resident species are a function of the health of the coral reefs that provide the basis for this ecosystem. As previously mentioned, the reefs on Tutuila have been assaulted by a crown-of-thorn invasions just prior to the 1979 study, and by hurricanes during the time of the present study. At this time, the only fisheries data we have is from the reefs during and after times they were subjected to significant natural perturbations. Interpretation of the present data is difficult without a longer time series to look at, which for experimental purposes should include times of a more stable reef environment, and large fluctuations in fishing effort.

Faisua, Giant Clams, (Tridacniadae), were completely absent from surveyed catches in FY91 and FY92. Fishing regulations prohibit the take of clams less than 6" across the longest part of the shell, however allow an unlimited take of larger clams.

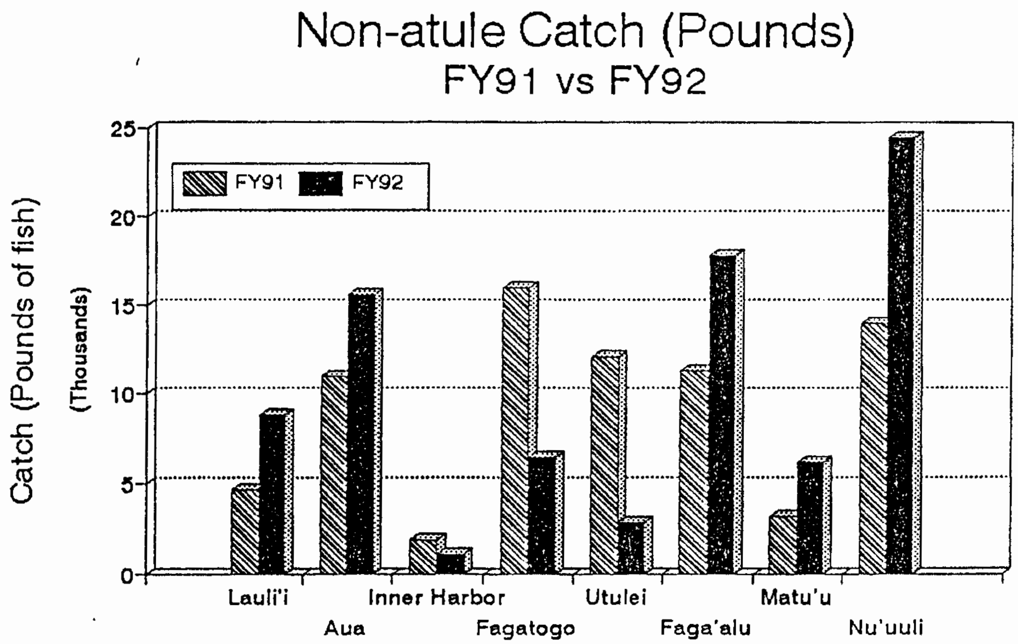
In 1979, 7935 pounds (in the shells) of bivalves of all species were harvested, mostly by gleaners, (Wass 1980). Wass does not provide a breakdown by species for clams, however it is probable that the majority of the 1979 clam catch was tridacna. In FY91, only and estimated 243 pounds of clams were harvested, non of which were tridacna (Table 4). There were no recorded catches of clams of any species in FY92.

Wild tridacna clams are scarce within the study area and throughout the island, though anecdotal reports indicate that they were once much more abundant than they are today. Overfishing and hurricane damage has probably reduced their numbers.

Ula, Papata (Lobsters). Catches of spiny lobster (*Panulirus pencillatus*) and slipper lobster (*Parribacus caledonicus*) are down considerably from their 1979 levels. Wass (1980) estimated that 1580 pounds of all lobster species combined were harvested in 1979. Only 378 and 301 pounds of lobster were taken in FY91 and FY92, respectively (Table 4). Lobster are taken almost entirely by night time spear divers and gleaners.

Table 6. Comparison of the "non-atule" catch (pounds of fish), effort (person hours), and CPUE (pounds per person hour). All strata shown on Table 2 which were either not sampled by Wass (1980), or who's catches were more than 50% atule in either FY91 or FY92 were deleted to produce this table. The 1979 data from Wass was not presented in sufficient detail to determine whether or not each strata met the > 50% test used for the FY91 and FY92 data.

Method		Bamboo Pole			Gleaning			Spear Diving			Throw Net			Total		
Area		1979	FY91	FY92	1979	FY91	FY92	1979	FY91	FY92	1979	FY91	FY92	1979	FY91	FY92
Lauli'i	Effort	571	33	202	3661	807	1488	1216	466	715	555	85	146	6003	1391	2551
	Catch	565	10	261	9583	1369	6652	3755	2005	1254	1965	152	470	15869	3535	8636
	CPUE	1.0		1.3	2.8	1.7	4.5	3.1	4.3	1.8	3.5	1.8	3.2	2.6	2.5	3.4
Aua	Effort				9687	890	1883	3493	1209	1247				13180	2099	3130
	Catch				19622	741	7068	7346	3368	5122				26968	4109	12190
	CPUE				2.0	0.8	3.8	2.1	2.8	4.1				2.0	2.0	3.9
Inner	Effort				45	21	13	57	21	119	667	279	97	769	321	229
Harbor	Catch				108	38	79	147	42	180	2803	1106	661	3058	1186	920
	CPUE									1.5	4.2	4.0	6.8	4.0	3.7	4.0
Fagatogo	Effort				3	42	0	153	0	0				156	42	0
	Catch				11	76	0	785	0	0				796	76	0
	CPUE							5.1						5.1	1.8	
Utulei	Effort				1604	257	129	2609	1164	1166				4213	1421	1295
	Catch				4695	449	489	6303	620	1839				10998	1069	2328
	CPUE				2.9	1.7	3.8	2.4	0.5	1.6				2.6	0.8	1.8
Faga'alu	Effort				3381	1513	1711	1951	1584	1990				5332	3097	3701
	Catch				7698	2509	8772	4492	6104	7667				12190	8613	16439
	CPUE				2.3	1.7	5.1	2.3	3.9	3.9				2.3	2.8	4.4
Matu'u	Effort				8825	596	653	3054	361	528				11879	957	1181
	Catch				18005	976	2875	5485	800	2121				23489	1777	4995
	CPUE				2.0	1.6	4.4	1.8	2.2	4.0				2.0	1.9	4.2
Total	Effort	571	33	202	27206	4127	5877	12533	4805	5766	1222	364	243	41532	9329	12088
	Catch	565	10	261	59721	6159	25934	28314	12939	18184	4767	1258	1131	93368	20365	45509
	CPUE	1.0	0.3	1.3	2.2	1.5	4.4	2.3	2.7	3.2	3.9	3.5	4.7	2.2	2.2	3.8



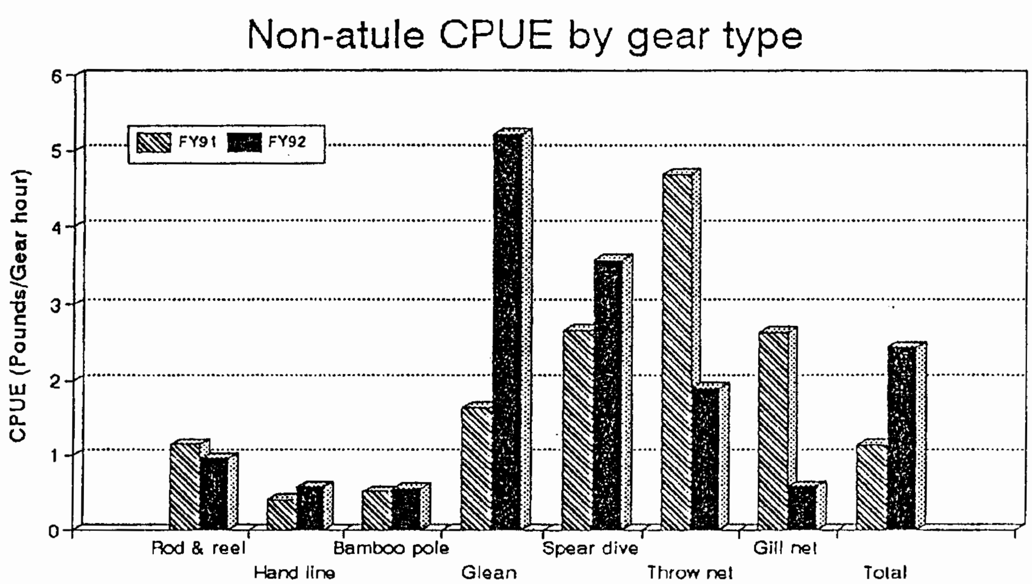


Figure 3. Catch by area (top) and CPUE (bottom) by method of all fish and shellfish that were not atule. For comparison purposes, only the spear diving and gleaning methods were used to compare the non-atule CPUE, due to the problems of separating the "atule" effort from the "non-atule" effort.

Fe'e, Octopus. Octopus are a favored species, taken almost exclusively by gleaners and spear divers, and were the second most abundant species taken by fishermen for FY91 and FY92 combined. Species identification is not known.

Catches of octopus tripled from FY91 to FY92, particularly for fishermen gleaning on the reef tops (Table 7, Figure 4). Gleaners caught nearly 14 times more octopus in FY92 than the did in FY91, even though there was only a modest 24% increase in gleaning effort.

The octopus CPUE for gleaners increased by a factor of 12 between FY91 and FY92, from 0.20 pounds/hour to 2.47 pounds/ gear hour. The CPUE for spear divers however decreased 27% over the same time period, dropping from 0.95 pounds octopus/hour to 0.60 pounds/gear hour (Table 7, Figure 4). Reasons for this discrepancy between gleaning and spear diving CPUE are unclear.

During much of FY92 a small group of Tongan fishermen were observed gleaning for octopus on a sometimes daily basis. Depending on tide, current, and surf conditions, they would typically begin a fishing trip in Usa'aiga (Matu'u area) and end in Faga'alu where they would sell their catch on the roadside.

Octopus fishermen usually walk on the reef top during very low tides, or swim at other times, poking metal rods into crevices to flush out their prey.

Table 7. Octopus catches (top) and CPUE (bottom) for FY91 and FY92.

Fe'e - Octopus

Octopoda sp.

FY91 Catch (Pounds of fish)

Area	Rod& Reel	Hand Line	Bamboo Pole	Glean	Spear Dive	Throw Net	Gill Net	Total
Lauli'i				124	14			138
Aua				33	936			969
Inner Harbor								26
Fagatogo								7
Utulei				42	6			48
Faga'alu				749	2710			3460
Matu'u				79	290			369
Nu'uuli				294	2326			2620
Total				1333	6304			7637

FY92

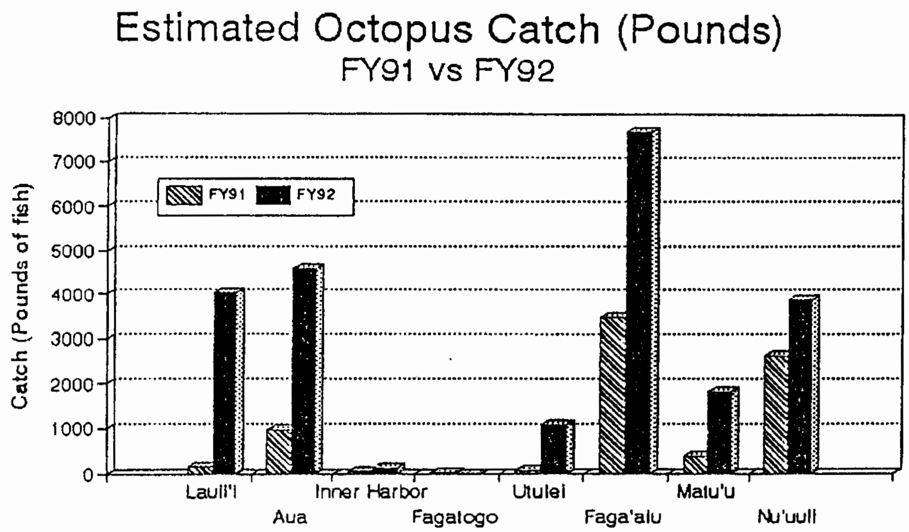
Area	Rod& Reel	Hand Line	Bamboo Pole	Glean	Spear Dive	Throw Net	Gill Net	Total
Lauli'i				3609	444			4053
Aua				3851	754			4605
Inner Harbor								108
Fagatogo								
Utulei				267	806			1073
Faga'alu				6595	1106			7701
Matu'u				1525	304			1829
Nu'uuli				2659	1222			3882
Total				18550	4700			23250

FY91 CPUE (Pounds/Gear Hour)

Area	Rod& Reel	Hand Line	Bamboo Pole	Glean	Spear Dive	Throw Net	Gill Net	Mean
Lauli'i				0.16	0.03			0.08
Aua				0.04	0.78			0.17
Inner Harbor								0.01
Fagatogo								0.00
Utulei				0.16	0.01			0.00
Faga'alu				0.50	1.71			0.81
Matu'u				0.13	0.80			0.19
Nu'uuli				0.12	1.26			0.48
Total				0.20	0.95			0.12

FY92

Area	Rod& Reel	Hand Line	Bamboo Pole	Glean	Spear Dive	Throw Net	Gill Net	Mean
Lauli'i				2.67	0.62			1.41
Aua				2.73	0.62			0.71
Inner Harbor								0.33
Fagatogo								
Utulei				2.75	0.69			0.28
Faga'alu				3.88	0.58			1.61
Matu'u				2.40	0.58			0.95
Nu'uuli				1.16	0.57			0.69
Total				2.47	0.60			0.68



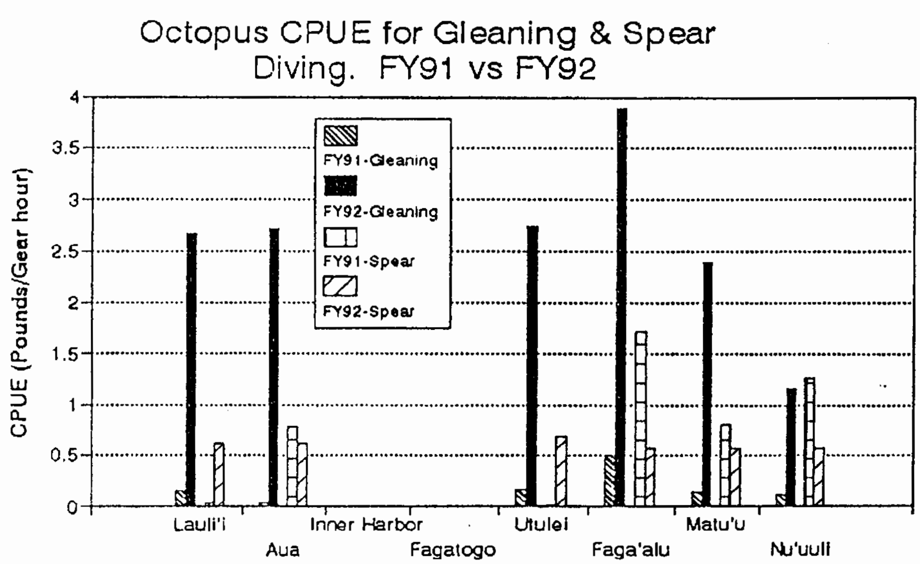


Figure 4. Octopus catch by village, (Top), and Octopus catch per unit effort (Bottom).

Jacks, lupo, lupota, malauli, ulua, sapo'anae (Carangidae). There are 13 genera and 25 species of carangids present in the waters of American Samoa, most of which are not known by specific Samoan names, but rather distinguished by size classes (Wass 1984).

Jacks are taken by all fishing methods in all of the study areas, with the three hook and line methods accounting for the majority of the catch (Table 8). Certain larger jack species are known to follow the atule, and fishermen will sometimes target these fish by baiting their hooks with live atule.

The total pounds landed dropped 72% from FY91 to FY92, however the number of fish increased 23% (Table 4). The jack CPUE for rod and reel fishermen dropped considerably from 0.7 pounds/hour to 0.3 pounds/hour, while the spear diving CPUE for jacks increased from 0.04 pounds/hour to 0.3 pounds/hour (Table 8, Figure 5).

Due to the large number of different species within this category, little can be said about what these changes mean. The average weight of jacks was 0.7 pounds/fish in FY91, dropping to 0.2 pounds/fish pounds in FY92. The likely explanation for this observation is that the species composition in the catch has changed, with fewer larger fish caught in FY92 than in FY91.

Table 8. Catches of jacks (Top), and CPUE (Bottom) for FY91 and FY92.

Lupo, lupata - Jacks

Carangidae sp.

FY91 Catch (Pounds of fish)

Area	Rod& Reel	Hand Line	Bamboo Pole	Glean	Spear Dive	Throw Net	Gill Net	Total
Lauli'i	337	29	3		353	6		728
Aua	398	47	2		157	176	1	781
Inner Harbor	214	20	77		9	29	1	350
Fagatogo	1907	865	5		19	2	<1	2797
Utulei	8528	65	4		124	1		8722
Faga'alu	953	19			142			1115
Matu'u	409	8	10		215	8		650
Nu'uuli	1922	18	8		1348	99	2	3397
Total	14669	1070	109		2367	320	4	18539

FY92

Area	Rod& Reel	Hand Line	Bamboo Pole	Glean	Spear Dive	Throw Net	Gill Net	Total
Lauli'i	142	26				4		172
Aua	640	24	58		569			1291
Inner Harbor	77							77
Fagatogo	536	345	58					939
Utulei		36				14		50
Faga'alu	249	10			812	6		1077
Matu'u	152	1			226	2		380
Nu'uuli	374	17			857	4		1251
Total	2170	458	116		2463	29		5236

FY91 CPUE (Pounds/Gear Hour)

Area	Rod& Reel	Hand Line	Bamboo Pole	Glean	Spear Dive	Throw Net	Gill Net	Mean
Lauli'i	0.95	0.21			0.79			0.40
Aua	0.25	0.14	0.00		0.13	0.36	0.00	0.14
Inner Harbor	0.51	0.02	0.35			0.16	0.02	0.20
Fagatogo	0.19	0.04	0.01					0.08
Utulei	1.40	0.04	0.03		0.11			0.86
Faga'alu	1.97	0.17			0.09			0.26
Matu'u	0.71		0.08		0.60	0.04		0.34
Nu'uuli	2.26				0.73	0.77	0.02	0.62
Total	0.72	0.04	0.04		0.36	0.22	0.00	0.29

FY92

Area	Rod& Reel	Hand Line	Bamboo Pole	Glean	Spear Dive	Throw Net	Gill Net	Mean
Lauli'i	0.44	0.15				0.03		0.06
Aua	0.47	0.13	0.13		0.47			0.20
Inner Harbor	0.55							0.23
Fagatogo	0.19	0.07	0.27					0.11
Utulei		0.15				0.11		0.01
Faga'alu	0.48	0.15			0.42	0.03		0.23
Matu'u	0.25				0.43			0.20
Nu'uuli	0.50	0.15			0.40	0.03		0.22
Total	0.26	0.08	0.09		0.32	0.02		0.15

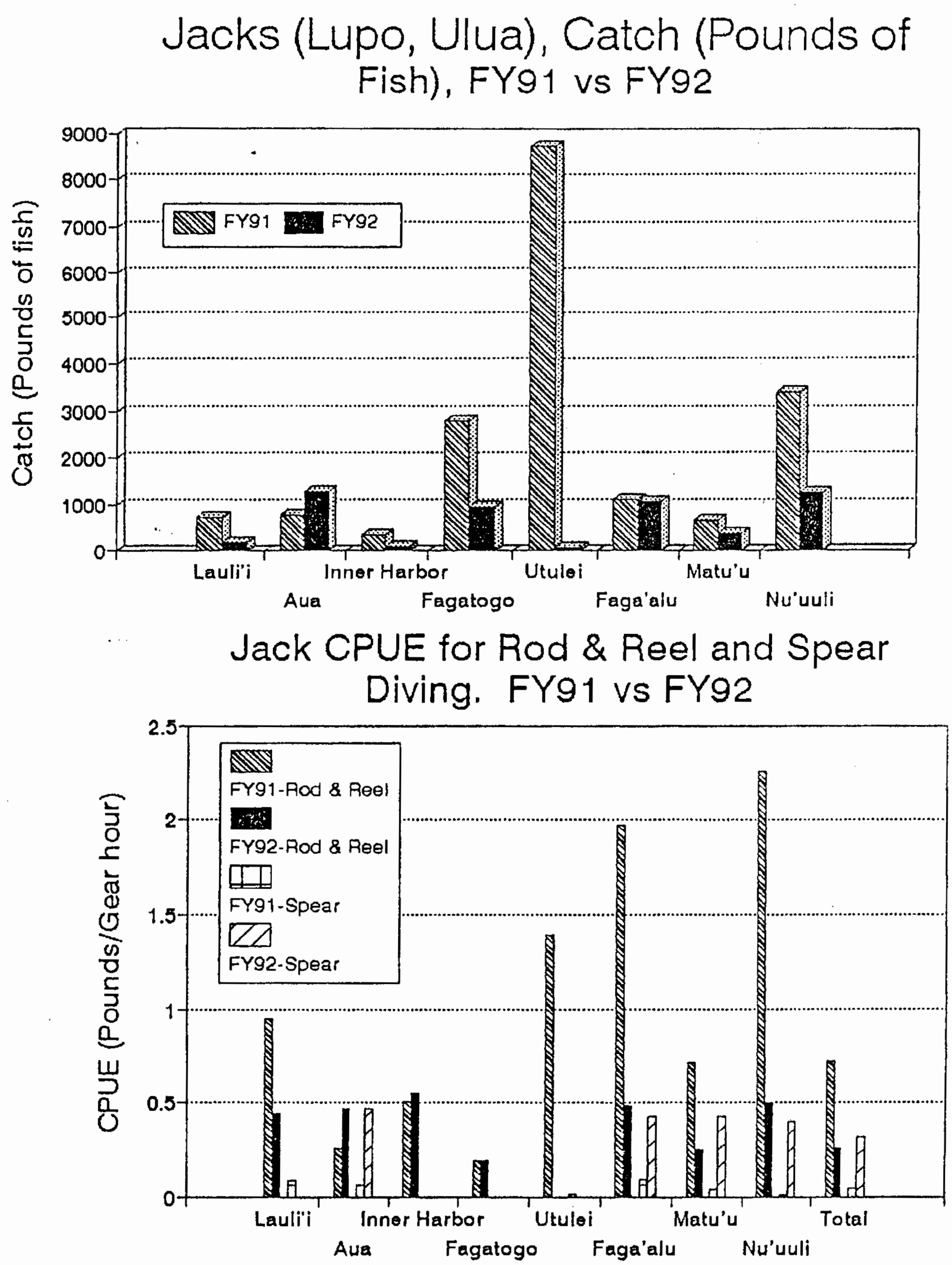


Figure 5. Jack (Carangidae) catch by area (top), and Jack CPUE for Rod and Reel and Spear fishing methods (bottom).

Pone and Palagi (Small and large Brown Surgeonfish). Samoans commonly refer to any small brown surgeonfish as "pone", and the larger surgeonfish as palagi (Wass 1984). However these terms are also commonly applied to many dull-colored or less abundant surgeonfish or unicornfish for which a specific name is not known. This choice of terminology makes it difficult to provide accurate statistics on many of the acanthurds by species.

The Pone and Palagi categories do not include some of the distinctively colored, more common or more popular such as the alogo (bluebanded surgeonfish), manini (convict tang), kolama (achilles tang), mamo (sergeant major), and pe'ape'a (moorish idol).

In the harbor area, most of the "palagi" caught were of one species, the yellowfin surgeonfish, *Acanthurus xanthopterus*. Catches of palagi, dropped dramatically between FY91 and FY92 (Table 9, Figure 6). This is an important reef species, targeted both by hook and line fishermen and spear divers, and often sold in the market place and fish stores around the island. Reasons for the drop in catches are unknown. The drop may reflect a decline in abundance of this species, although it could simply reflect a lack of targeting on this species, since palagi were usually caught in the harbor area where the sale of fish has been banned due to pollution, (see also "Recent impacts to coral reefs" on page 3).

Hook and line fishermen often target palagi by using a clump of rice on a hook, then snagging the fish as they come to eat the bait. Although this fishing method differs from other hook and line methods, this choice of baits used by fishermen is not recorded in this survey, making extraction of this fishing method from the database difficult.

Anecdotal evidence suggest that spear diving can deplete the Palagi from an area. While collecting fish samples for heavy metal analysis, two department divers speared 14 *A. xanthopterus* off the reef in Utulei. When this dive was repeated a week later, only one palagi was seen.

Catches of pone have increased in all areas, especially Nu'uli, for gleaners and spear fishermen (Figure 6).

Table 9. Catches of pone (top) and palagi (bottom) for FY91 and FY92. The Samoan terms "pone" and "palagi" refer to any of a number of dark colored non-descript surgeonfish species. "Pone" refers to smaller fish and "palagi" refers to larger fish.

Pone - Small brown surgeonfish.
Acanthurus sp.

FY91 Catch (Pounds of fish)

Area	Rod& Reel	Hand Line	Bamboo Pole	Glean	Spear Dive	Throw Net	Gill Net	Total
Lauli'i				36	223		1	260
Aua				10	254		2	265
Inner Harbor				1	4		1	6
Fagatogo				2				2
Utulei				12	133			146
Faga'alu					257	11		269
Matu'u				23	48		1	72
Nu'uuli				192	251		3	447
Total				276	1171	12	8	1466

FY92

Area	Rod& Reel	Hand Line	Bamboo Pole	Glean	Spear Dive	Throw Net	Gill Net	Total
Lauli'i				1139	87			1226
Aua				1215	399			1614
Inner Harbor				14	13			27
Fagatogo								
Utulei				84	274			359
Faga'alu					627		6	633
Matu'u				481	174		2	657
Nu'uuli				5610	602		6	6218
Total				8543	2175		15	10733

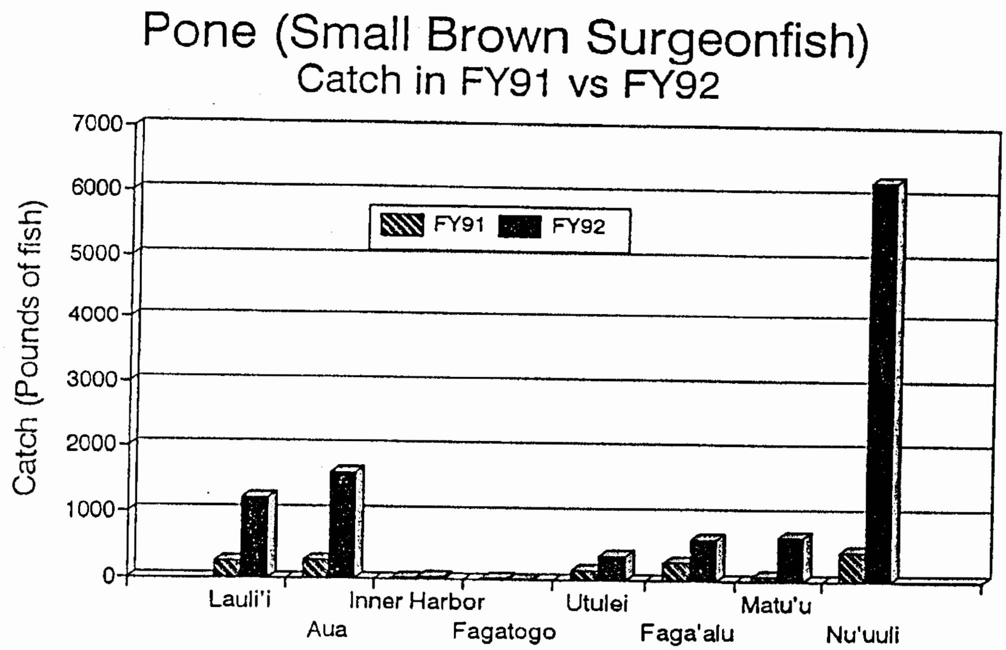
Palagi - large Yellowfin surgeonfish
Acanthurus xanthopterus (adults only).

FY91 Catch (Pounds of fish)

Area	Rod& Reel	Hand Line	Bamboo Pole	Glean	Spear Dive	Throw Net	Gill Net	Total
Lauli'i	174	157			8			340
Aua	104	231			16			351
Inner Harbor	50							50
Fagatogo	2858	1343						4201
Utulei					4			4
Faga'alu	22	100			32			154
Matu'u	163	41			3			206
Nu'uuli	32	95						127
Total	3403	1967			64			5433

FY92

Area	Rod& Reel	Hand Line	Bamboo Pole	Glean	Spear Dive	Throw Net	Gill Net	Total
Lauli'i		39					1	40
Aua		33					226	259
Inner Harbor								
Fagatogo		83						83
Utulei		54						54
Faga'alu		15					19	35
Matu'u		1					8	8
Nu'uuli		25					18	43
Total		250					272	522



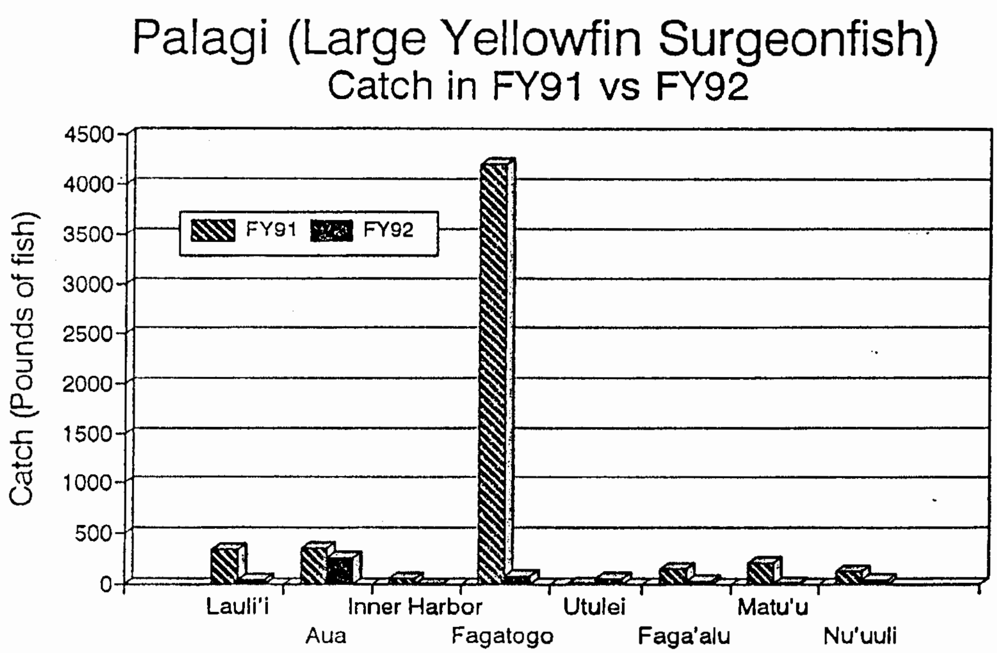
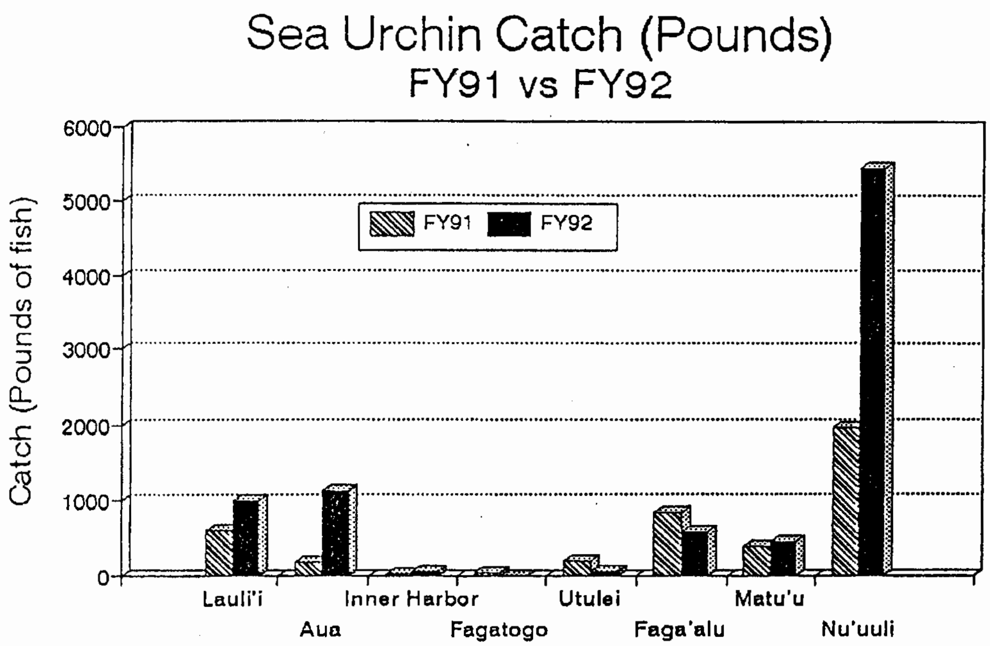


Figure 6. Catch by village area for pone surgeonfish (top), and palagi (bottom).

__Sea Urchins, Tuitui, Vaga, Ofaofa (Ecinometra)__. Three species of sea urchins where taken by inshore fishermen: tuitui, a white short spined urchin, vaga, a long-spined black urchin, and ofaofa, the heart urchin. Urchins are primarily taken by gleaners, and to a lesser extent by spear divers.

The tuitui catch accounted for 4.3% of the non-atule catch in FY91 and 10.5% in FY92 (Table 4), an increase of 256% in their total landings, (Figure 7, Table 10). Whereas the catch of tuitui may be related to its abundance on the reef tops, catches of vaga, the long-spined black sea urchin, are clearly not. Vaga are commonly in abundance on reefs throughout the island, but yet they were absent from catches in FY92.



Tuitui, vaga, ofaofa - Sea Urchins

Ecinometra

FY91 — Catch (Pounds of fish)

Area	Rod& Reel	Hand Line	Bamboo Pole	Glean	Spear Dive	Throw Net	Gill Net	Total
Lauli'i				597				597
Aua				186				186
Inner Harbor				18				18
Fagatogo				35				35
Utulei				201				201
Faga'alu				837				837
Matu'u				392				392
Nu'uuli				1963				1963
Total				4227				4227

FY92

Area	Rod& Reel	Hand Line	Bamboo Pole	Glean	Spear Dive	Throw Net	Gill Net	Total
Lauli'i				683	322			1006
Aua				729	393			1122
Inner Harbor				8	46			55
Fagatogo								
Utulei				50				50
Faga'alu					582			582
Matu'u				289	159			448
Nu'uuli				3366	2085			5451
Total				5126	3588			8714

Figure 7 and Table 10. Catches of all sea urchins by village area for FY91 and FY92.

Mullet, anae, fuafua, poi, moi (Mugilidae). Seven species of mullet are reported in Samoan waters, of these *Liza melinoptera* (giantscale mullet), *Valamugil seheli* (bluespot mullet), and *V. engili* (Engel's mullet) predominate in inshore catches. The general name for mullet is "anae" which is usually applied to fishes measuring 20-40cm; other names are "fuafua", usually 12-15cm, and "poi" (5-8cm), and "moi" (< 5cm). Mullet are a popular food fish in Samoa and the third most abundant fish caught during the FY91-FY92 study period, and represented 5% of the non-atule catch (Table 4).

Catches and catch rates for mullet have been seen to drop considerably from FY91 to FY92 (Table 11, and Figure 8). Mullets are most often caught by throw net and gill net fishermen. Fishing pressure by gill net and throw net methods has also declined over the study period, with the exception of gill net fishing in the Aua area where a four fold increase was observed (Table 3).

Mullet were of prime interest to DMWR staff, as samples of these fish from the inner harbor area were found to have the highest concentrations of lead in their tissues of all species examined (AECOS 1991).

DMWR staff repeatedly sampled the inner harbor area from July through October of 1992, in an attempt to catch fish (particularly mullet) for further heavy metal analysis. Juvenile mullet (< 15cm were found in abundance, however only one large mullet (37cm) was captured in spite of repeated efforts. Fishermen in the harbor interviewed during this time period also reported that they had not seen or caught any large mullet.

Table 11. Catch of mullet (top) and CPUE (bottom) for FY91 and FY92.

Anae, fua'fua - Mullet.

Mugilidae sp.

FY91 — **Catch (Pounds of fish)**

Area	Rod& Reel	Hand Line	Bamboo Pole	Glean	Spear Dive	Throw Net	Gill Net	Total
Lauli'i			2			82	98	182
Aua		3	43			1997	1201	3243
Inner Harbor			4			794	177	976
Fagatogo		548	506			72	9	1135
Utulei			22			187		208
Faga'alu		1				242	62	305
Matu'u			17			71	89	177
Nu'uuli						341	514	855
Total		552	594			3785	2150	7081

FY92

Area	Rod& Reel	Hand Line	Bamboo Pole	Glean	Spear Dive	Throw Net	Gill Net	Total
Lauli'i						138		138
Aua						493		493
Inner Harbor						535		535
Fagatogo								
Utulei						64		64
Faga'alu					37	228		265
Matu'u					10	80		91
Nu'uuli					39	145		183
Total					85	1683		1768

FY91 — **CPUE (Pounds/Gear Hour)**

Area	Rod& Reel	Hand Line	Bamboo Pole	Glean	Spear Dive	Throw Net	Gill Net	Mean
Lauli'i			0.08			2.16	4.19	0.10
Aua			0.06			4.03	3.19	0.58
Inner Harbor			0.02			4.31	4.19	0.56
Fagatogo		0.02	0.56			2.34	0.11	0.03
Utulei			0.18			2.39		0.02
Faga'alu		0.01				0.84	4.19	0.07
Matu'u			0.13			0.38	4.19	0.09
Nu'uuli						2.64	4.19	0.16
Total						2.63	1.63	0.11

FY92

Area	Rod& Reel	Hand Line	Bamboo Pole	Glean	Spear Dive	Throw Net	Gill Net	Mean
Lauli'i						1.19		0.05
Aua						0.98		0.08
Inner Harbor						7.09		1.61
Fagatogo								
Utulei						0.51		0.02
Faga'alu						1.19		0.06
Matu'u						1.19		0.05
Nu'uuli						1.19		0.03
Total						1.40		0.05

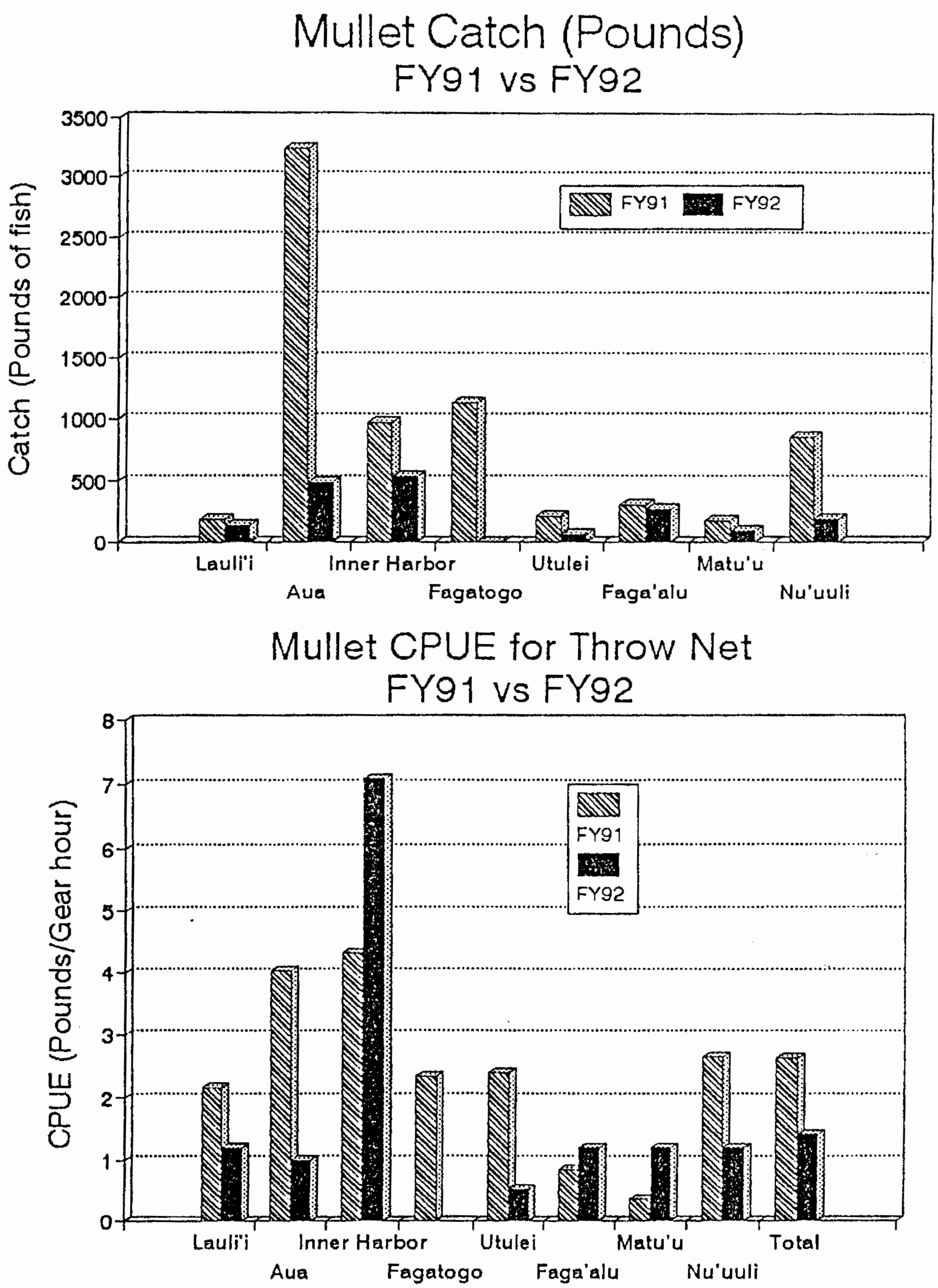


Figure 8. Mullet (Muglilidae) catch by village area, (top) and CPUE for throw net (bottom).

Alogo, Bluebanded surgeonfish (*Acanthurus lineatus*). Alogo, are locally abundant on reef tops and the upper portions of reef faces throughout the tropical Pacific (Myers 1991). This is a popular eating fish in Samoa and was the 7th most abundant fish species in the fishermen's catch. They accounted for 3.3% of the non-atule catch. Alogo are easily distinguished from other surgeonfish by their distinctive coloration. If the species groups discussed above could be separated into individual species, then alogo could well be the 2nd or 3rd most commonly harvested fish species in the inshore catch.

Alogo are caught almost entirely by spear divers. Catches and catch rates of alogo declined somewhat in most areas in FY92 (Table 12, Figure 9).

Over the past three years, alogo was the number one reef fish purchased by local stores, accounting for 28% of the total reef fish volume. Of the alogo, 75% were locally caught, compared to only 51% locally caught for all reef fish species (see "Sales of fish in Local Markets" section starting on page 50).

Table 12. Catches of alogo, the bluebanded surgeonfish (*Acanthurus lineatus*) (top), and CPUE (bottom) for FY91 and FY92.

Alogo - Bluebanded surgeonfish

Acanthurus liniatus

FY91 Catch (Pounds of fish)

Area	Rod& Reel	Hand Line	Bamboo Pole	Glean	Spear Dive	Throw Net	Gill Net	Total
Lauli'i					689		1	689
Aua					708		2	710
Inner Harbor					4		1	5
Fagatogo								
Utulei					130			130
Faga'alu					1127			1127
Matu'u					145		1	145
Nu'uuli					344		<1	348
Total					3146		9	3155

FY92

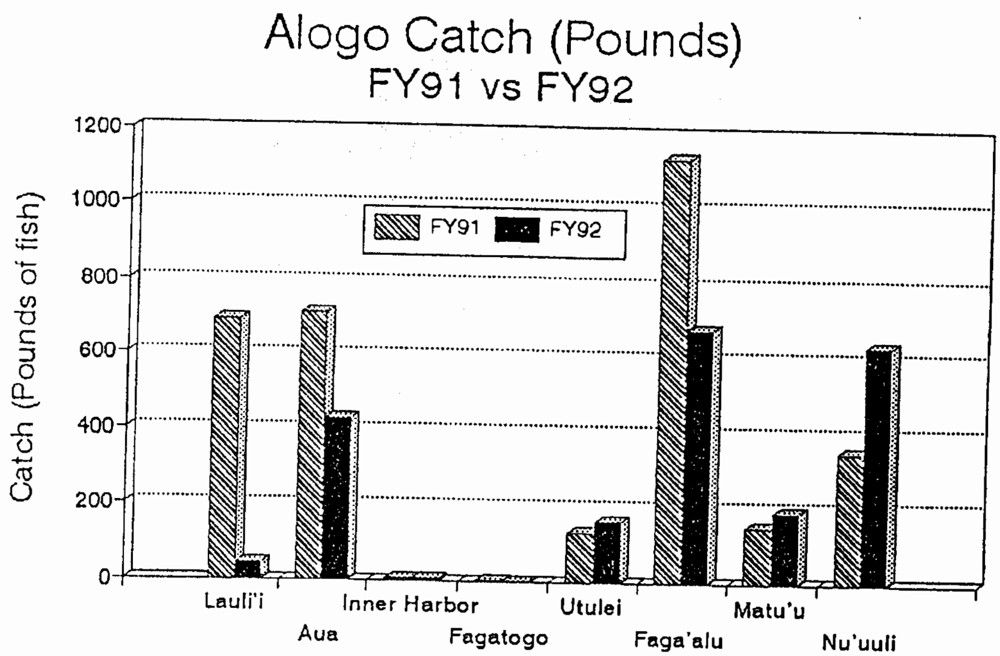
Area	Rod& Reel	Hand Line	Bamboo Pole	Glean	Spear Dive	Throw Net	Gill Net	Total
Lauli'i					43		1	44
Aua					427			427
Inner Harbor					6			6
Fagatogo								
Utulei					158			158
Faga'alu					659		13	672
Matu'u					183		4	187
Nu'uuli					619		13	632
Total					2095		31	2126

FY91 CPUE (Pounds/Gear Hour)

Area	Rod& Reel	Hand Line	Bamboo Pole	Glean	Spear Dive	Throw Net	Gill Net	Mean
Lauli'i					1.5			0.4
Aua					0.6			0.1
Inner Harbor					0.2			0.0
Fagatogo								
Utulei					0.1			0.0
Faga'alu					0.7			0.3
Matu'u					0.4			0.1
Nu'uuli					0.2			0.1
Total					0.5			0.0

FY92

Area	Rod& Reel	Hand Line	Bamboo Pole	Glean	Spear Dive	Throw Net	Gill Net	Mean
Lauli'i					0.1			0.0
Aua					0.3			0.1
Inner Harbor					0.1			0.0
Fagatogo								
Utulei					0.1			0.0
Faga'alu					0.3			0.1
Matu'u					0.3			0.1
Nu'uuli					0.3			0.1
Total					0.3			0.1



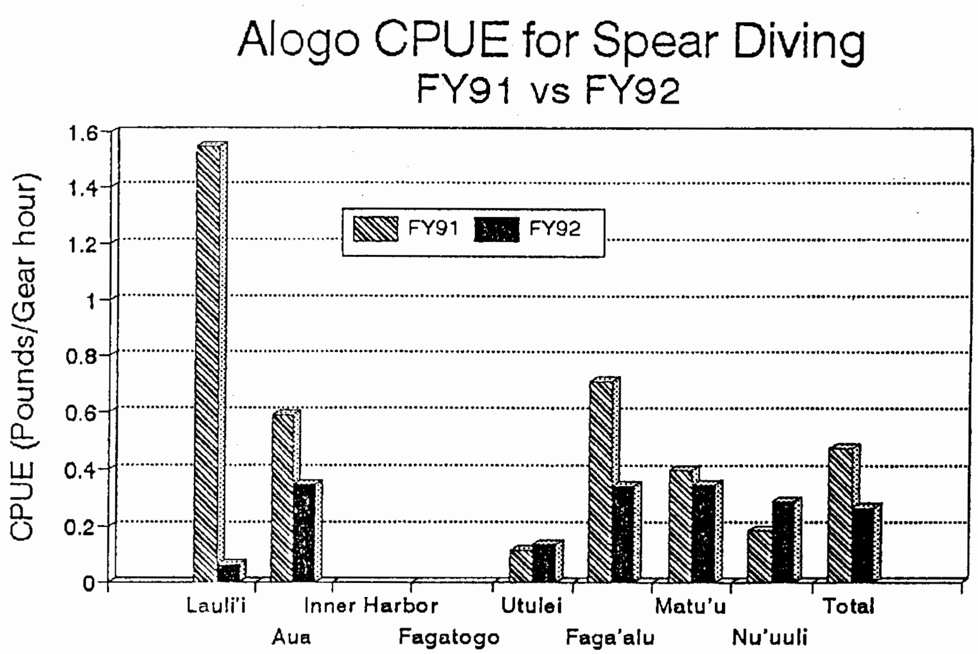


Figure 9. Catches of alogo, the bluebanded surgeonfish, *(Acanthurus lineatus)* (top), and CPUE for spear diving (bottom), for FY91 and FY92.

Palolo

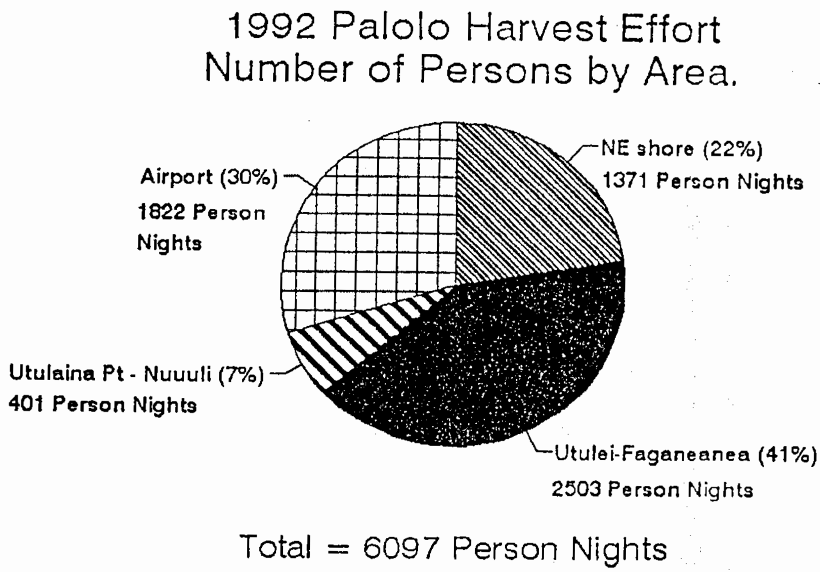
Although very brief, the palolo fishery represents a significant portion of the total inshore fishing effort. If we assume the average palolo fishing trip lasts three hours, then the 2818 person-trips observed in the inshore study area in FY93 (Table 13), represent approximately 8400 person hours. This figure represents approximately 17% of the total fishing effort estimated to have occurred in the study area in FY92 (Table 2), however the palolo catch represents only 2.5% of the non-atule catch (Table 4).

Boat fishermen had much higher catch rates than did shoreline fishermen (Figure 10). This is because the palolo epitokes will swim toward the surface, but otherwise are poor swimmers and by and large drift with the currents. The general flow of water on the reef is for waves to push water up onto the reefs tops along the reef face. This water then flows parallel to the beach until it reaches a channel or "ava" where it can flow out. Floating debris, including the epitokes, are floated along and concentrated on the reef top until they reach the channels and are flushed out. Boats will anchor in these channels, and so are able to filter a great deal more epitoke rich water with less effort than are the shore fishermen.

Palolo worms are found in the greatest abundance in the surf zone and in the shallower waters immediately off shore of the reef face. (Larry Madregal, personal communication).

Table 13. The 1992 (FY93) palolo harvest. Only the nights which had significant fishing effort and catch are shown in this table. Total figures include a small amount of effort recorded on surveys of October 16th and 19th (157 fishermen) and on November 15th (63 fishermen) which resulted in zero catch. No effort was observed on November 18.

		Shoreline Harvest			Boat Harvest				Total
Date	Area surveyed	Number Fishermen	Catch/ Person (Lbs)	Estimated Harvest (Lbs)	Number Boats	Number Boat Fishermen	Catch/ Person (Lbs)	Estimated Harvest (Lbs)	Boat + Shoreline Harvest
October 17	NE shore	374	0.1	32	16	51	10.4	532	564
	Utulei-Faganeanea	478	1.4	676	10	41	13.4	548	1224
	Utulaina Pt - Nuuuli	73	0.8	60	3	10	8.2	82	143
	Airport	550	0.4	236	1	4	10.7	43	279
	Total Oct 17	1475	0.7	1005	30	106	11.4	1205	2209
October 18	NE shore	527	0.0	14	3	10	0.0	0.1	14
	Utulei-Faganeanea	1582	0.1	94	2	8	0.0	0.1	94
	Utulaina Pt - Nuuuli	221	0.1	13	2	6	0.0	0.1	13
	Airport	975	0.7	695	0	0			695
	Total Oct 18	3305	0.2	816	7	24	0.0	0	816
October Total	NE shore	954	0.0	46	20	63	8.4	532	578
	Utulei-Faganeanea	2143	0.4	771	12	49	11.2	548	1318
	Utulaina Pt - Nuuuli	303	0.2	73	5	16	5.2	83	156
	Airport	1537	0.6	931	1	4	10.7	43	974
	October total	4937	0.4	1821	38	132	9.1	1205	3026
November 16	NE shore	105	0.0	4	16	66	0.1	6	10
	Utulei-Faganeanea	98	0.1	8	3	12	0.1	1	9
	Utulaina Pt - Nuuuli	14	0.1	1	0	0	0.0	0	1
	Airport	168	0.0	1	0	0	0.0	0	1
	Total Nov 16	385	0.0	14	19	78	0.1	7	21
November 17	NE shore	120	0.1	10	12	34	0.1	3	13
	Utulei-Faganeanea	157	0.1	13	1	4	0.0	0	13
	Utulaina Pt - Nuuuli	63	0.0	0	0	0	0.0	0	0
	Airport	111	0.0	0	1	2	0.0	0	0
	Total Nov 17	451	0.1	24	14	40	0.1	3	27
November Total	NE shore	248	0.1	14	29	106	0.1	9	23
	Utulei-Faganeanea	290	0.1	22	5	21	0.0	1	23
	Utulaina Pt - Nuuuli	82	0.0	1	0	0	0.0	0	1
	Airport	279	0.0	1	1	2	0.0	0	1
	November total	899	0.0	38	35	129	0.1	10	47
1992 Total	NE shore	1202	0.1	60	49	169	8.5	540	601
	Utulei-Faganeanea	2433	0.3	792	17	70	11.2	549	1341
	Utulaina Pt - Nuuuli	385	0.2	74	5	16	.5.2	83	157
	Airport	1816	0.5	931	2	6	10.7	43	974
	Grand Total	5836	0.3	1858	73	261	4.7	1215	3073



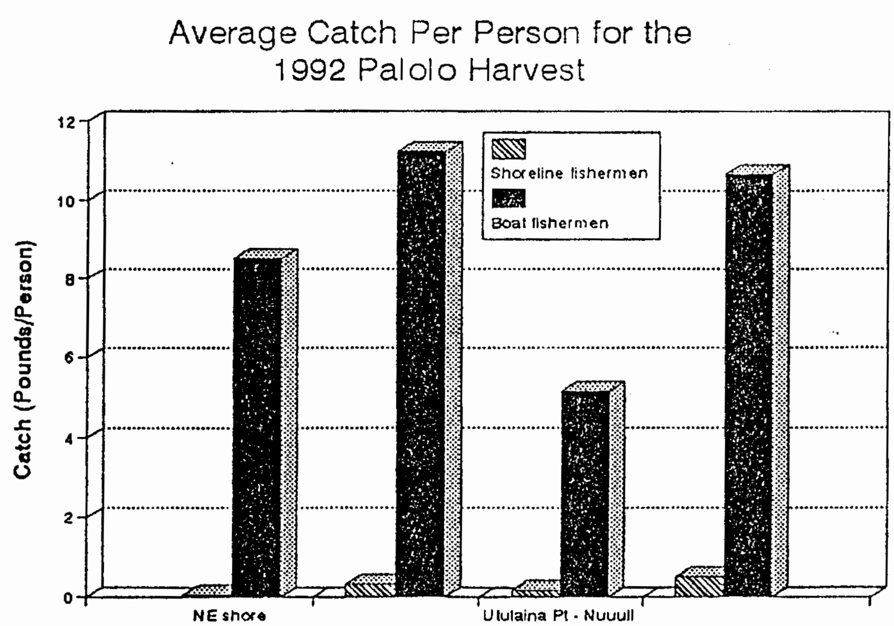


Figure 10. 1992 palolo fishing effort (person nights) by area (top), and average catch per person (pounds) by area for boat and shoreline fishermen (bottom).

A comparison of palolo fishing for the past three years within the study area is shown in the table below. This comparison is rough because only one night was sampled in 1990 and 1991, which was predicted before hand to be the peak night of the palolo harvest and effort, whereas 8 nights were sampled in 1992. In the process of sampling four nights in October 1992 (Table 13), we discovered that the night of peak effort does not necessarily coincide with the peak harvest, and that the palolo spawning event is not as neatly predictable as folklore would have us believe.

Table 14. Palolo fishing effort and catch by shoreline fishermen only within the inshore study area between the villages of Utulei and Nu'uuli (Figure 1).

Year	Nights Sampled	Shoreline participants in the Study Area	Catch (Pounds)	Pounds per Person
1990	Nov 8	764	3446	4.5
1991	Nov 30,	1463	600	0.4
1992	Oct 16-19 Nov 15-18	2818	867	0.3

Overall, palolo catches have been low, and local fishermen consider the past three years as being very poor for palolo on Tutuila. People tell stories of catching buckets of palolo in years past (one 5 gallon bucket = 43 pounds approx). Harvest success is dependant on the strength of the spawning event and the presence of light onshore winds that concentrate the epitokes near the shoreline, making them more accessible to the fishermen. For example, strong winds on October 18, 1992 created surf conditions which made it difficult to fish in many of the desired locations all along the southeast side of the island. Few boats even attempted to fish outside of the harbor on that night. Fishermen at the airport, who had a more extensive reef to block the waves, actually did better on October 18 than they did on the 17th (Table 13).

Sales of fish in local markets

Fishermen were asked whether they intended to sell their catch or keep it for personal use. In FY91, 7% of all fishing parties interviewed indicated that they intended to sell their catch. This figure increased 24% in FY92 (Table 15).

Table 15. Percentage of the inshore fishermen interviewed who intended to sell their catch.

Method / Year	Rod & Reel	Hand line	Bamboo Pole	Glean	Spear Dive	Throw Net	Gill Net	Total
FY91	8	3	0	0	29	0	23	7
FY92	0	0	25	25	33	29	71	24

The 1979 study did not ask fishermen if they intended to keep or sell their catch, however a 1980 survey by the Development and Planning Office found that less than 9% of the inshore catch was sold, and that most of it was consumed by the fishermen's family and relatives (Wass 1980).

Although total fishing effort has reduced considerably since 1979, there was a considerable increase in the percentage fishing for commercial purposes in FY92 (Table 16). The reason for this shift is not clear, though two contributing factors are; 1) fishing for personal use has dropped due to changes in Samoan life styles which have reduced the amount of free time to fish, and reduced peoples dependency on personally caught fish, 2) higher prices paid for reef caught fish encouraged increased exploitation.

Table 16. Amount and value of the fish and shellfish taken by the inshore fishery. Sale value is based on price paid by retail stores for fish.

Year	Total Island-wide Catch (Pounds)	Wholesale Price/ Pound[1]	Percent sold	Value of fish sold ($)	Value of fish kept. ($)	Total value of inshore catch ($)
1979[2]	660,000	1.00	9%	59,400	600,600	660,000
FY91	440,051	1.57	7%	48,362	642,518	690,880
FY92	334,494	1.73	24%	138,882	439,793	578,675

Footnotes:

1. Prices not adjusted for inflation.
2. 1979 data from Wass 1980.

Anecdotal evidence suggests that a large percentage of inshore fishing for commercial purposes is done by people from Tonga and Western Samoa, rather than by long-term residents.

In spite of the local harvest and availability of reef species of fish, over 50% of the fresh fish sold in local stores is imported, primarily from Tonga and Western Samoa (Table 17, Figure 11). For reef fish species there has been a sharp increase in imports. In 1990, 23% were imported, whereas in 1992 78% were imported.

In 1990 and 1991, imported reef fish had only a 1¢/lbs price advantage, but this difference increased to 13¢/lbs advantage in 1992. The price difference was much more apparent in the pricing of bottomfish species. In 1992, locally caught bottomfish cost 61¢ per pound more than imported fish. Store owners complained that the local fishermen wanted too much for their fish and that the supplies are less consistent than for imported fish.

Competition from frozen fish bartered off the distant-water purse seine and longline fleets has depressed prices for pelagic fish (Pelagics Plan Team 1992). Domestic pelagic landings have been relatively stable in the past few years while the bottomfish fishery has nearly collapsed in American Samoa (Bottomfish Plan Team 1992).

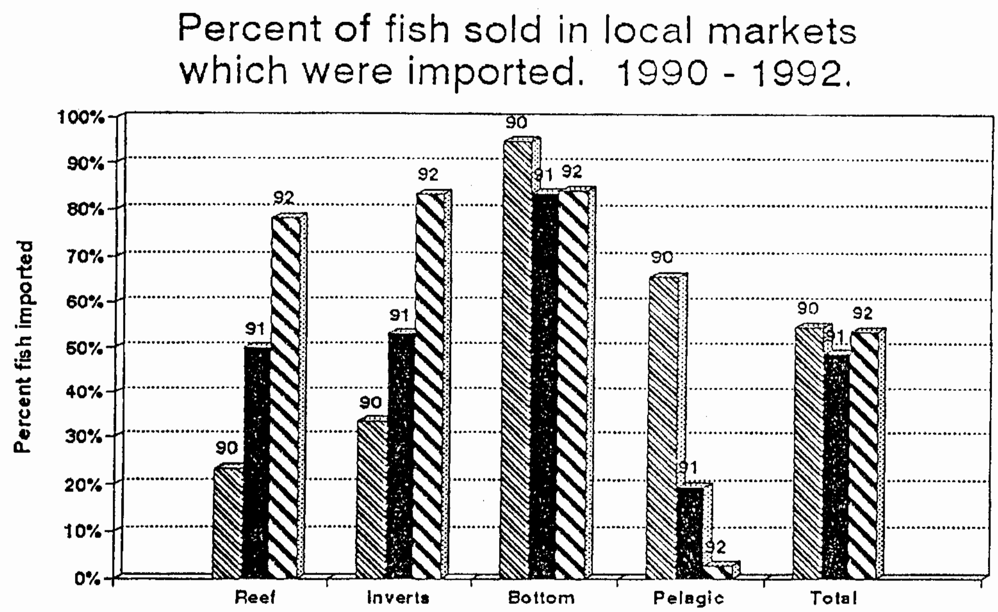
Table 17. Sales of domestically caught and foreign caught fish to local markets, 1990-1992. Data are from market surveys (see page 9). Totals shown here are not complete. 1990 includes July - December only, and 1992 includes January - August only. (Continued on next page)

	Pounds of fish						Average price per pound.					
	1990 July-Dec only		1991 Jan-Dec		1992 Jan-Aug only		1990 July-Dec only		1991 Jan-Dec		1992 Jan-Aug only	
Species	Dom	Imports	Dom	Imports	Dom	Imports	Dom	Imports	Dom	Imports	Dom	Imports
Bottom fish species.												
Onaga (longtail snapper)	206	3,181	305	12,232	0	3,524	$2.37	$1.56	$2.13	$1.68	—	$2.46
Bottomfish (Assorted)	5	682	2,140	2,384	1,014	4,271	1.68	1.55	2.21	1.92	2.68	1.61
Emperors (misc)	27	576	202	1,222	292	1,231	1.50	1.48	1.53	1.56	1.88	1.84
Ehu (squirrelfish snap.)	6	356	454	278	778	1,182	1.75	1.83	2.42	2.88	3.32	2.47
Lehi (silverjaw)	0	567	0	846	25	1,064	—	1.41	—	1.49	1.90	2.28
Opakapaka	0	898	127	468	33	519	—	1.56	1.54	1.58	1.91	2.21
Gindai (flower snap)	81	3	34	51	71	803	2.50	1.50	1.67	1.57	1.93	2.30
Blue lined snapper	1	110	68	426	93	16	1.54	1.53	1.64	1.59	1.90	1.75
Hawaiian opakapaka	6	0	0	0	103	92	1.50	—	—	—	1.91	2.30
Amberjack	0	0	162	0	0	0	—	—	2.65	—	—	—
Eels	15	0	39	0	0	15	1.50	—	1.62	—	—	1.80
Black jack	0	0	0	33	0	0	—	—	—	2.00	—	—
Oilfish	0	0	0	0	0	22	—	—	—	—	—	2.30
Rainbow runner	0	0	13	0	0	0	—	—	2.50	—	—	—
Total Bottom Fish	348	6,374	3,543	17,941	2,409	12,739	2.26	1.55	2.17	1.71	2.69	2.08
Invertebrates												
Spiny lobster	1,134	887	1,268	1,525	290	794	$2.54	$3.31	$3.02	$3.46	$3.46	$3.60
Octopus	545	0	102	0	78	81	1.42	—	1.64	—	1.78	1.80
Giant clam	15	0	8	85	0	610	2.67	—	2.75	1.45	—	4.20
Invertebrates	0	0	0	0	0	201	—	—	—	—	—	3.30
Crabs	75	0	50	0	0	0	1.30	—	1.85	—	—	—
Sea urchins	0	0	0	0	0	88	—	—	—	—	—	3.05
Limu, algae	0	0	0	0	0	68	—	—	—	—	—	3.34
Miscellaneous	0	0	13	12	0	0	—	—	1.50	1.50	—	—
Total Invertebrates	1,768	887	1,441	1,622	368	1,843	2.14	3.31	2.86	3.34	3.10	3.65
Pelagic fish species.												
Wahoo	609	9,213	9,367	731	2,757	166	$0.75	$0.86	$0.90	$0.55	$0.78	$1.63
Yellowfin tuna	507	396	7,444	1,157	8,475	168	1.80	0.85	2.43	1.13	2.43	1.77
Skipjack tuna	2,875	0	2,200	266	2,585	0	0.95	—	1.00	1.50	1.49	—
Bigeye tuna	1,464	0	566	2,561	0	0	0.50	—	0.89	0.55	—	—
Dolphin (mahimahi)	170	1,316	1,669	199	805	14	2.11	1.00	1.51	2.58	2.47	2.50
Albacore	0	0	367	161	0	0	—	—	2.69	4.00	—	—
Troll fish	16	2	13	238	87	39	1.25	1.00	2.16	1.50	2.58	1.50
Dogtooth tuna	36	16	236	0	0	0	1.50	1.50	2.39	—	—	—
Blue marlin	0	0	115	0	142	0	—	—	1.50	—	2.50	—
Tunas	36	0	83	0	10	0	0.75	—	2.50	—	2.00	—
Swordfish	0	0	0	65	0	0	—	—	—	1.30	—	—
Sharks	5	0	50	0	0	0	1.25	—	2.50	—	—	—
Trevally	0	16	0	0	0	0	—	1.55	—	—	—	—
Mackerel	0	0	7	0	0	0	—	—	1.50	—	—	—
Total Pelagics	5,717	10,960	22,115	5,378	14,860	387	0.93	0.88	1.53	0.95	1.96	1.71

(Continued on next page)

Table 17, (Continued from previous page). There is a considerable discrepancy between the amount of fish reported by store owners, and the amounts presented elsewhere in this report.

	Pounds of fish						Average price per pound.					
	1990		1991		1992		1990		1991		1992	
	July-Dec only		Jan-Dec		Jan-Aug only		July-Dec only		Jan-Dec		Jan-Aug only	
Species	Dom	Imports	Dom	Imports	Dom	Imports	Dom	Imports	Dom	Imports	Dom	Imports
Reef fish species.												
Bluebanded surgeonfish	3,531	655	5,744	1,702	390	989	$1.50	$1.55	$1.80	$1.53	$1.67	$1.57
Parrotfishes	2,014	899	2,627	2,126	556	2,019	1.50	1.54	1.58	1.53	1.71	1.54
Reef fish (Assorted)	270	566	471	4,429	160	1,348	1.60	1.50	1.32	1.55	1.65	1.57
Striped bristletooth	1,725	64	705	517	147	480	1.50	1.55	1.59	1.54	1.70	1.53
Squirrelfish	941	81	331	398	157	193	1.50	1.55	1.56	1.55	1.72	1.59
Humpback snapper	232	123	42	699	104	747	1.70	1.71	1.51	1.72	1.89	1.73
Jacks (misc)	165	184	224	315	164	659	1.66	1.46	1.55	1.52	1.69	1.55
Mullets	2	66	50	524	22	885	1.50	1.50	1.52	1.68	2.00	1.67
Groupers (misc)	16	189	160	516	110	254	1.50	1.55	1.51	1.58	1.77	1.93
Inshore groupers	510	18	268	145	49	45	1.50	1.55	1.59	1.52	1.71	1.57
Unicornfishes (misc)	284	31	297	0	200	24	1.50	1.45	1.64	—	1.70	1.65
Gray jobfish	4	65	177	93	108	68	1.50	1.21	1.18	1.54	1.69	2.05
Flagtail grouper	0	0	13	69	0	202	—	—	1.50	1.50	—	1.60
Bigeye scad	0	40	201	0	0	0	—	1.40	1.50	—	—	—
Small barracuda	2	19	213	0	0	0	1.50	1.55	1.50	—	—	—
Lunartail grouper	9	0	86	61	0	11	1.50	—	1.50	1.60	—	2.30
Wrasse	12	0	105	0	0	0	1.50	—	1.61	—	—	—
Yellowfin surgeonfish	40	0	39	0	0	0	1.50	—	1.50	—	—	—
Halfbeaks	0	0	0	78	0	0	—	—	—	1.75	—	—
Bigeye squirrelfish	0	0	0	0	58	0	—	—	—	—	2.65	—
Needlefish	0	0	0	39	0	0	—	—	—	1.60	—	—
Ambon emperor	0	0	0	33	0	0	—	—	—	1.55	—	—
Goatfish	11	0	0	0	0	19	1.50	—	—	—	—	1.60
Bigeye emperor	0	0	8	0	0	0	—	—	1.50	—	—	—
Rabbitfish	2	0	4	0	0	0	1.50	—	1.50	—	—	—
Barracudas	0	0	2	0	0	0	—	—	1.50	—	—	—
Total Reef fish	9,768	3,000	11,766	11,745	2,224	7,942	1.51	1.53	1.57	1.56	1.73	1.60
Summary												
Bottom fish	346	6,374	3,543	17,941	2,409	12,739	$2.26	$1.55	$2.17	$1.71	$2.69	$2.08
Crabs, lobsters, clams	1,768	887	1,441	1,622	368	1,843	2.14	3.31	2.86	3.34	3.10	3.65
Pelagic fish	5,717	10,960	22,115	5,378	14,860	387	0.93	0.88	1.53	0.95	1.96	1.71
Reef fish	9,768	3,000	11,766	11,745	2,224	7,942	1.51	1.53	1.57	1.56	1.73	1.60
Grand Total	17,600	21,220	38,865	36,685	19,861	22,912	1.40	1.27	1.65	1.62	2.05	2.03
Percent imported.							**Price/Pound difference, (import - domestic)**					
Bottom fish		95%		84%		84%		-0.71		-0.46		-0.61
Crabs, lobsters, clams		33%		53%		83%		1.16		0.48		0.55
Pelagic fish		66%		20%		3%		-0.05		-0.58		-0.25
Reef fish		23%		50%		78%		0.01		-0.01		-0.13
Grand Total		55%		49%		54%		-0.13		-0.03		-0.01



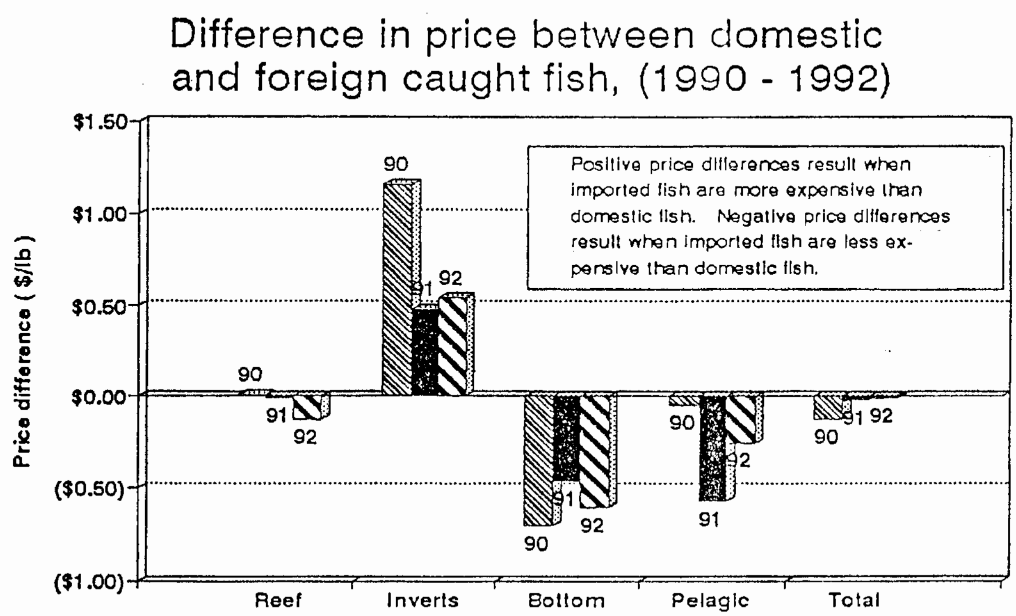


Figure 11. Percent of fresh fish sold in local markets which were imported, (top), and price differences between domestic and foreign caught fish, (bottom). There has been an increasing trend to import reef fish in spite of the relatively small price difference.

Food consumed in the territory comes from three major sources, 1) Local fisheries, consisting of the inshore reef fishery, and the offshore bottomfish/pelagic fishery, 2) farms, gardens and livestock, the majority are small-scale family farms, and 3) imported food, the majority of which comes from the United States (Economic Development Planning Office, 1991).

Additionally, some fish comes from the distant water fleet, either sold directly to local persons and stores, and also canned by the two canneries and sold on the local market. The volume of this is unknown.

In 1990, American Samoa's local fisheries accounted for approximately 9% of the domestic food production by weight, with the inshore reef catch accounting for the majority of the local fish production (Table 18).

In 1990, American Samoa imported $36.0 million worth of food and beverage products, of which $2.3 million was fish products . With the value of fish from the local fisheries estimated at $859,000 this means that the domestically caught fish account for about 27% of the total value of fish consumed in the territory, or about 2% of the value of all food consumed (Table 18).

Table 18. Estimated annual amount and value of fish, farm and imported food products consumed in American Samoa. Cannery tuna production, which is almost entirely produced by the distant water fleet, and exported, is not included in this table. The locally produced fish and farm products are almost entirely consumed locally.

	Estimated Pounds	Value ($$$)	Percent of Total Value
Annual Production of local fisheries [1]			
FY91 Reef fisheries [2]	440,051	690,880	1.7
1991 Offshore fisheries [3]	150,446	167,817	0.4
	590,497	858,697	2.1
1990 American Samoa Farm production [4]			
Livestock and Poultry	1,074,889	1,973,668	4.8
Taro	1,948,547	656,209	1.6
Bananas	1,213,298	619,644	1.5
Other crops	1,715,236	608,107	1.5
	5,951,971	3,857,628	9.5
1990 Imports of Fish and Shellfish [5]			
Fish baits, Frozen	na	209,217	0.5
Fish, Canned	na	1,162,991	2.8
Fish, Fresh	na	135,633	0.3
Fish Frozen	na	662,399	1.6
Shellfish, canned	na	5,420	0.0
Shellfish, Fresh	na	5,370	0.0
Shellfish, Frozen	na	73,177	0.2
		2,254,207	5.5
1990 Imports of Other Food and Beverages [5]			
Bear, wine, liquor	na	1,901,215	4.7
Other beverages	na	3,286,656	8.1
All other food	na	28,653,305	70.2
	na	33,841,176	82.9
Total annual food consumption	na	40,811,708	100%

Sources and notes:

1. Value estimates are calculated from the total pounds produced times the average price of the portion which was sold.

2. This report. Value is estimated from the average price paid for fish by local stores, multiplied by the total estimated catch.

3. 1992 reports from the Pelagic and Bottom Fish Plan Teams of the Western Pacific Regional Fishery Management Council. Value is Ex-vessel values.

4. U.S. Department of Commerce 1987 Census of Agriculture. Only farms which sold more than $100 of produce in 1990 are reported on. The production of the numerous family farms which did not sell their production are not included in these statistics.

5. Economic Development and Planning Office, 1991. Reports show value figures only, statistics on tonnage of imported food and beverage products are not available.

RECOMMENDATIONS

Monitoring Program. This survey does provide reasonably reliable data on shoreline fishing efforts on Tutuila. However, catch/effort surveys such as this are able to produce only a crude indicator of stock abundance, particularly for a shoreline fishery as complex and species diverse as this one. Its value for estimating species abundance and total fishing mortality is extremely limited without independent data to estimate these parameters. More accurate and reliable data for both management and scientific purposes has to come from other sources.

If the primary purpose of this study is to provide baseline biological data, then it is recommended that this study not be continued. While this project provides reasonably reliable data on fishing effort, the catch data collected are insufficient, biased, and unreliable for a variety of reasons. Biological inferences based on this data such as CPUE and catch composition are highly questionable.

Options for this project include 1) discontinuing altogether, 2) continue, however with emphasis on the fisheries cultural and economic importance, rather then as of a biological study.

If this project is continued, it is recommended that:

1. Inadequate interview data severely hampers the accuracy of the data analysis. Interview rates simply must be increased to get a valid sample size. Two years of continuous effort by both principal investigators to increase catch data collection has not yielded the desired results.

   Deployment of additional crews whose primary purpose would be to collect interviews would help correct the studies defeciencies. This should not bias the expansions of the effort data as expansions are done on each strata separately. It is unlikely that the catch estimates will be significantly biased by this either because it is unlikely that weekend fishermen experience significantly different CPUE's than week day fishermen.

   The nature of the fishery and the design of this survey produces a bias and under sampling in the sampling of catch data, particularly for spear diver fishermen. The fishing effort is probably also underestimated due to the fact that it is often difficult to see and therefore count persons who are often skin diving at night and at some distance from the shore line. Biases result as the sampling of these spear diver fishermen includes only those who are easily sampled due to their closeness to the shore, or who happen to be seen exiting the water when the creel technician is in the area.

2. Island-wide expansion factors need to be validated. Currently the island-wide catch estimates are estimated by multiplying

the study area per capita catch by the total island population. This method assumes that the study area's catch rates and fishing patterns resemble those of the rest of the island, an assumption which may be inaccurate for the reasons listed in the fishery profile section, (page 16).

3. Information on recreational and other uses of the inshore reef areas should be collected. A large number of people are often seen swimming, bathing, surfing, and mining sand, who are not counted in the normal participation counts as they are not fishing. Obtaining estimates of non-fishing related uses of the beaches and reefs will provide a more complete picture of the uses of these resources.

   In February 1993, data forms were modified, and technicians were instructed to start collecting this information. This entailed only a nominal increase in survey efforts. Data collectors record the numbers of persons seen swimming, surfing and sand mining on their participation data sheets during the normal participation counts. They also make visual estimates of the quantity of sand removed from the beaches without actually interviewing the participants.

4. The data analysis programs used for generating this report were highly obtuse, cryptic, and lacking in reasonable documentation. Fortunately, they are in the process of being rewritten.

   A possible major logic was identified in the current program, when corrected will probably change much of the "expanded" catch and CPUE data shown in this report. (Effort data shown here is probably correct, however). The operation of the analysis programs needs to be streamlined, and adequate documentation needs to be prepared.

   The catch estimation program used in this analysis needs to be modified to insure that data swamping does not occur in the annual estimates in cases where brief pulse fisheries produce large amounts of both catch and effort compared to the rest of the year. This is very likely a problem with the Atule in the FY92 data set (see Figure 2). In FY92, there was high catch and effort for Atule for the first two months of the year, followed by no Atule catches for the rest of the year. The current program expands data on an annual basis, and this brief pulse is averaged into the data for the entire year.

   Basically, the expansion program implicitly assumes that catch rates are constant throughout the time period selected for analysis. The correction for this would be to add a "season" stratum in the catch expansions hierarchy for selecting a CPUE to use for expanding a particular effort.

<u>Management Plan</u>: The following issues were identified by Ponwith (1991) as items which would need to be addressed in a management plan. To date, these issues have not been addressed:

1) Overall management objectives for the fishery.

2) Objectives and options for fishery monitoring.

3) Policies on issues such as commercial versus recreational/subsistence use, stock rebuilding, and resource use in protected areas.

4) A plan for implementing additional regulations should they become necessary.

5) Background information on key species taken in the inshore fishery.

The following issue was also identified by Ponwith, and has been partially answered by this study, and continued monitoring of this fishery would provide additional detail:

1) Identification of key species taken in the inshore fishery.

Future research: Little quantitative data exists describing the factors affecting the abundance of various key species. Managers would benefit from more basic biological information including the following:

1) Atule. Basic biological information on the migratory Atule. Where do they go, what do they do when they're not in Pago Pago Harbor? What stocks of fish are being fished on in Samoa? Are the seasonal runs we see part of a much larger stock? Or is this a small local stock of fish which may be endangered by the intense pressure put on it by the Atule fishermen in Pago Pago Harbor?

2) Size and age of maturity studies. Size at maturity and the size composition of the harvest for groupers, snappers and parrot fish would be valuable, considering the small size at which they are currently harvested.

3) Studies of virgin populations. Comparative studies of species composition and size structure in areas of different exploitation rates would provide data on the effects of fishing pressure on the community structure.

   Few areas on Tutuila offer good "virgin stock" controls to compare to the heavily used areas. The Fogagogo area, and the Tula are two possibilities, although topographical and environmental variables would confound the comparison between "virgin" and heavily fished areas.

4) Migrations and offshore movements. Tagging fish species which are caught by both the shoreline and offshore fisheries, such as some of the groupers and snappers, to study movements between the areas exploited by the two fisheries would be of interest. For example, are the reef habitats replenished by fish from offshore when the stocks are fished down?

5) **Exchange of reef fish over large distances**. Knowing the amount of interchange between stocks of fish between the various islands would provide managers with a valuable tool for assessing the effects of over fishing or an environmental catastrophe which may deplete a local stock.

Most of the reef-resident species observed in American Samoa have a planktonic larval stage, suggesting that brood stocks for these species could reside at considerable distances from the areas that the adults are observed.

A study of the assessing the degree of genetic relatedness between reef fish species among the various island groups could shed some insights on this question. A genetic study on Yellowfin Tuna in various locations in the Western Pacific region have shown a high degree of relatedness among the presumed stocks of fish. Indications are that these fish are highly migratory, and localized depletions could potentially be replenished from other populations in a relatively short period of time, (assuming that the Pacific wide yellowfin stocks remained healthy).

Larval distribution studies, and genetic studies assessing the degree of relatedness between various Pacific island stocks could help answer this questions.

7) **Impacts of spear divers using SCUBA**. Spear diver fishermen observed in the study area use snorkel gear almost exclusively, often using only swimmers goggles and no fins. Their efficiency and ability to target deeper fish would increase dramatically should they switch to scuba gear. Managers need to monitor this potential gear change, as breading stocks of parrot fish, lobster, bluebanded surgeonfish, and many others are highly vulnerable to night spear divers using scuba.

8) **Aquarium fishery**. The department has denied aquarium permits to several recent applicants, on the grounds that the coral reefs in the area have been damaged and are in need of a recovery period. However, the department is currently lacking scientific data to support the contention that an aquarium fishery would be detrimental to the reefs, or to the fish populations.

As species targeted by the aquarium trade would be different in the most part than those taken by subsistence and commercial fishermen, an aquarium fishery would probably not compete or interfere with the more traditional reef fisheries.

An aquarium fishery also has the potential to provide a much higher value fishery than traditional fisheries. As an example, a 2 ounce butterfly fish can sell from $2 to $50 depending on the species, whereas the same fish is worth only about $0.22 assuming an average price of $1.73 for reef fish in 1992 applied to the small aquarium fish.

An aquarium fishery would probably have low environmental impacts as well, assuming fishermen were restricted to only those methods that are currently legally allowed.

The department should initiate a study to substantiate it's contention that an aquarium fishery would adversely impact the reefs resources.

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APPENDICES

Appendix 1. A) Summarization of differences in the methods used by Wass (1980) and the current study.

	Wass Study	Current Study
Study area	Lauli'i to Faganeanea and 4 outer villages: Fagasa, Masefau, Faga'itua, Vaitogi	Lauli'i to Nu'uuli
Field sampling	sampled participation and catch on separate days	sampled both partcipation and catch during each shift
Effort Units	person-hour	gear-hour and person-hour
CPUE used internally for catch expansion	for each strata, sum of kilograms divided by sum of person-hrs	for each strata, the average of the CPUEs for all interviews within the strata.
CPUE shown in report tables and figures	for each stata, sum of kilograms divided by sum of person-hours.	for each strata, the sum of pounds divided by sum of either gear hours or person hours.
CPUE units	Kgs/person hour.	lb/gear-hour and lb/person-hour

Appendix 2. Number of fishermen interviews conducted by data collectors by area and gear type for FY91 and FY92.

FY91	Rod & Reel	Hand line	Bamboo Pole	Glean	Spear Dive	Throw Net	Gill Net	Total
Lauli'i	1	0	0	1	2	1	0	5
Aua	5	1	5	4	2	12	2	31
Harbor	6	6	4	0	0	7	0	23
Fagatogo	60	93	6	0	2	2	2	165
Utulei	30	8	0	1	3	3	6	51
Faga'alu	6	0	2	8	7	5	1	29
Matu'u	0	0	1	0	5	9	1	16
Nu'uuli	5	0	0	14	17	4	1	41
Total	113	108	18	28	38	43	13	361

FY92	Rod & Reel	Hand line	Bamboo Pole	Glean	Spear Dive	Throw Net	Gill Net	Total
Lauli'i	0	0	0	0	1	1	0	2
Aua	4	0	0	0	2	4	13	23
Harbor	0	0	0	0	1	4	1	6
Fagatogo	8	20	2	0	0	0	0	30
Utulei	11	1	1	0	3	5	6	27
Faga'alu	1	0	0	2	2	0	0	5
Matu'u	4	0	0	1	2	0	0	7
Nu'uuli	1	0	1	5	7	0	1	15
Total	29	21	4	8	18	14	21	115