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Subsistence harvest of coral reef resources in the outer islands of American Samoa: modern, historic and prehistoric catches.

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Introduction

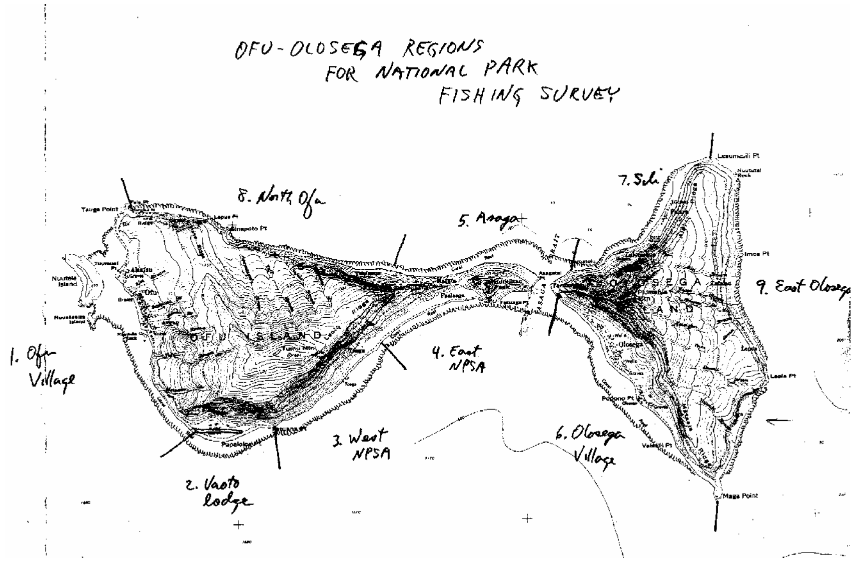
Fishing pressure on coral reefs is a major concern throughout the tropics yet it is often difficult for managers to quantify harvests. When such fisheries are subsistence or artisanal in nature, they can be time-consuming to monitor due to their small but widespread and continuous effort, use of a variety of gear types, targeting of multiple fish and invertebrate species, and diffuse landing locations.

American Samoa provides an opportunity to examine a subsistence fishery that is generally uncomplicated by other common sources of fishing mortality such as commercial activities, sport fishing by non-villagers, aquaculture, or aquarium trade collections. Although subsistence fishing is declining in the main island (Tutuila) in American Samoa due urbanization (Coutures 1994, Zeller et al. 2005), it continues to be an important activity for the more distant villages. This utilization is particularly evident in the outer islands of the territory where coral reef resources continue to provide a significant contribution to the family diet. The present study examined this fishery on two of the outer islands, Ofu and Olosega.

We examined the subsistence fishery from four angles: current harvest, pre-historic harvest, elder interviews, and an in-water assessment of fish abundance. Study objectives were to characterize the fishery in terms of resources harvested and compare quantities harvested to the abundance of coral reef fishes in nearshore waters around the islands. We also wanted to compare current fishing conditions to that in former times at two temporal scales: (1) about 30-50 years ago through discussions with elder fishermen in the villages, and (2) about 2000 years ago based on an archeological study conducted on Ofu Island (Nagaoka 1993). Additionally, we wanted to determine what proportion of the fishery occurs within two marine protected areas where subsistence fishing is a permitted activity.

Study area. American Samoa consists of seven small islands in the South Pacific, with 96% of the territory's population of 65,000 inhabiting the main island of Tutuila. Ofu (7.3 km^2) and Olosega (5.3 km^2) islands lie 100 km east of Tutuila and are small, steeply sloping volcanic islands connected by a short bridge (Fig. 1). Population sizes in the three villages on these outer islands are small: Ofu Village (289 people), Olosega Village (206) and Sili (10). Village populations there have been gradually declining over the past few decades as the islanders move to Tutuila for jobs or schooling. Lifestyles in the outer islands remain somewhat more traditional than that occurring on the main island of Tutuila. The islands are serviced by small aircraft and a weekly supply boat.

Figure 1.



Fringing coral reefs surround most of Ofu and Olosega islands and form a single, continuous reef. In some areas, backreef moats (1-2 m deep at low tide) support a diverse assemblage of corals and fishes and are popular fishing areas for villagers. Percent coral cover averaged 43% in the moat and 14% on the reef slope at the 10-m depth in 2002 (Green 2002). The distribution of coral reefs around the islands has not been mapped, but the total extent of potential coral reef habitat to the 50-m depth are 7.0 km^2 (Ofu) and 5.2 km^2 (Olosega). The 100-m depth being reached about 1 km offshore. As an indication of the small size of these islands and reefs, a small fishing boat can circumnavigate both islands together in about one hour. On the southern shore of Ofu Island, there are two marine protected areas, Vaoto Marine Park (0.4 km^2) and the National Park of American Samoa (1.5 km^2); both extend seaward about 0.4 km to the 20-33 m depth.

Most fishing by villagers was a shore-based activity by individuals or groups. Few boats were operational: nine outrigger canoes (*paopao*) and two intermittently active 10-m aluminum catamarans (*alia*). Most fish were consumed locally although some were shipped to family members on Tutuila Island. Small catches of offshore pelagic fish (primarily tuna) were occasionally made by boats but these are not included as part of the coral reef harvest in this report. The level of fishing effort by villagers was greatly influenced by local events -- fishing often declined during social activities (bingo, volleyball) or increased when there was a need to catch food for large groups of visitors during inter-island church gatherings, etc.

Methods

Data limitations: boats undersampled, fish consumption does not include pelagics or tinned fish

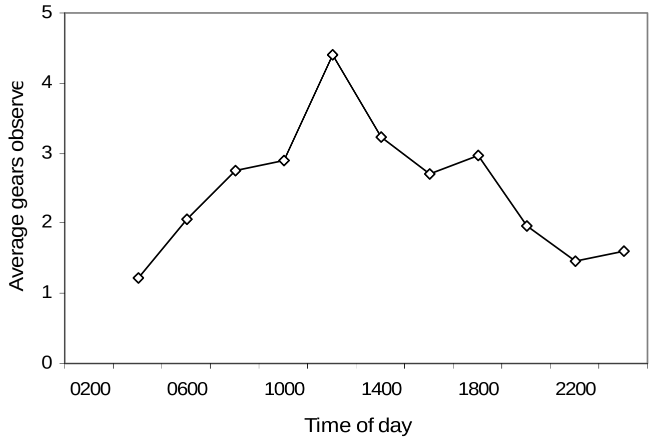
Fisheries surveys included (1) hourly fishing effort, (2) creel census to determine catch composition, (3) interviews with village elders to learn about changes in marine resources from their perspective, and (4) comparisons of current catches to fish bones found in a nearby archeological excavation (Nagaoka 1993). Four local villagers, two of whom fished regularly, assisted with the surveys and conducted creel interviews. Additionally, underwater visual surveys (fisheries-independent surveys) of reef fish were conducted by scuba divers in nearshore waters for comparison to harvest data.

Fishing effort. Fishing effort (number and location of fishers and gear types used) was recorded during standardized roadside surveys conducted approximately one week per month from March 2002 to May 2003 (data were pro-rated to a 1-year period where appropriate). Estimates of fishing effort were partitioned into four time strata: daytime fishing (0600-1859) and night-time fishing (1900-0559) for both weekday and weekend categories. Friday evenings after 1900, and holidays, were included in the weekend category. Little fishing occurred on Sundays due to village rules, thus Sundays were not included in subsequent calculations.

Fishing effort was viewed over a 4-6 day period each month, with surveys being conducted during an 8-16 hour period each day regardless of weather or tidal stage. Surveys were conducted at 2-hour intervals, with each survey taking approximately 1 hour to complete the 6 mile length of the islands' road system (from Ofu harbor to the end of the road in Olosega Village). Between surveys, the crew would drive back to the starting point at Ofu Harbor and prepare for the next survey, thus all points were viewed at about 2-hr intervals. The island shoreline was divided into 8 sections (each 1.3-3.8 km) for fishery reporting (Fig. 1). Where the coastline could not be viewed from the road, observers walked to 11 specific vantage points along the beach to scan for fishers (using binoculars where needed). The non-inhabited east side of Olosega and northwest side of Ofu could not be seen during surveys, so the visible coastline amounted to 17.8 km (73%) of the 24.4 km of coastline around both islands. No data expansion was made for the non-visible areas because they were less accessible except by boat or hiking. Fishers reported that relatively little fishing occurred there so the exclusion of these areas is not thought to significantly affect calculations of total catch.

In all, 472 surveys of fishing effort were conducted during which 1248 fishing gears were observed. Coverage of the fishery was lower at night than day (28% vs. 72%), particularly between midnight and 4 am, but available data suggest that fishing effort was presumably low during this period (Fig. 2) and local fishermen agreed with this assessment. For this period, we used the mean nighttime effort and catch rate. Surveys were distributed equally over tidal conditions: 34%, 35% and 32% at high, medium and low tides, respectively. Actual number of hours surveyed compared to total annual hours in time strata were: weekdays (237 hrs surveyed, 3237 hrs in stratum), weeknights (111 hrs, 2427 hrs), weekend days (63 hrs, 832 hrs) and weekend nights (61 hrs, 1016 hrs). The overall coverage of possible hours was 6%.

Fig. 2. Average fishing effort by time of day (n=1248 gears observed), excluding two palolo nights.



An estimate of annual fishing effort (by gear type) in each of the four time strata above was determined by multiplying the average number gears observed during 1-hour surveys by the total number of hours in that stratum. The values for all strata were summed to produce an annual estimate. Data are presented as fishing effort per gear-hour except for catches of palolo, palai'a, and atule which were caught by groups of fishers and are listed as effort per person-hour.

Catch composition and catch per unit effort (cpue). To determine catch composition and cpue for each gear type, we conducted creel surveys on an opportunistic basis and interviewed 594 fishers or fishing groups who had each fished for at least one hour. This represented combined fishing time of 4660 hours and a catch of 4182 kg (10% of the annual harvest). During interviews, the number of fishers, time fished, and catch weight were recorded. Interviews were generally conducted in the Samoan language and Samoan names were used to identify fish and invertebrates caught, consequently many fish names describe fish groups (e.g., fish families) rather than individual species. Fish were measured to the nearest millimeter (fork length) and weighed by spring balances to the nearest 10 g for small fish or 100 g for large fish or groups of fish. Shellfish weights were converted to body weights by using the following conversion factors: 21% for turban snails (n = 85), 25% for giant clams (n = 104), and 15% for sea urchins (visual estimate). A mean cpue for each gear type was calculated as the sum of individual cpues from each interview divided by the number of interviews [correct?]. Catch rates were calculated separately for day and night fishing, except where night data were insufficient (i.e., for boat fishing, throw netting).

Calculation of total catch. The catch in each time stratum was obtained by multiplying the average cpue per gear type by the expanded fishing effort in that stratum. The annual fish catch was calculated as the sum of catches during all time strata. Exceptions to this are that total shoreline catches of atule (*Selar crumenophthalmus,* bigeye scad, locally called atule) and pulses of palolo polychaetes (*Eunice viridis*), newly recruited juvenile striped bristletooth surgeonfish (*Ctenochaetus striatus,* "palai'a") and juvenile goatfish (*Mulloidichthys flavolineatus*, "i'asina"), were calculated separately. For atule, we monitored every catch (n = 10) that occurred during the study period. Villagers typically divided each catch into about 60 piles of fish (one for each family). Total weight was estimated by expanding the average weight of 1-3 fish piles to the total number of piles. For the other species, catch expansions were made only for the duration of their availability: palolo (2 nights), surgeonfish recruits (8 days), and goatfish recruits (6 weeks).

Elder interviews. Most fishing methods, except gleaning the reef flat for mollusks, etc. were conducted by males. Therefore, to gain information on current and past fishing conditions, we interviewed 20 adult males (mean age 58, range 43-72) from the three villages. Conversations were in Samoan and were freeform, after which the interviewer filled out the questionnaire used.

Fisheries-independent surveys. Reef fish were surveyed in March 2002 using scuba visual census techniques at five sites along the reef slope (10-m depth) of Ofu and Olosega islands and at two shallow sites in the backreef moat along the southern shoreline of Ofu Island. This was part of a broader survey that included 22 sites around the other populated islands in the territory in both 1996 and 2002 (Green 2002), which provides a means to compare results obtained at Ofu and Olosega islands with the more populated island of Tutuila. At each site, 3-5 replicate transects (3x50 m) were conducted. Transect lengths were measured using 50-m tapes, and transect widths were measured using known body proportions. Fish size (total length in cm) was estimated visually. Fish were surveyed by three passes over each transect, counting different species in each pass. The first count was of large, highly mobile species that are most likely to be disturbed by the passage of a diver (such as parrotfishes, snappers and emperors). The second count was of medium-sized mobile families (including most surgeonfishes, butterflyfishes and wrasses) that are less disturbed by the presence of a diver. The third count was of small, site-attached species (mostly damselfishes) that are least disturbed by the presence of a diver. Fish biomass was calculated using length-weight relationships for each species (Kulbicki, unpubl data or rept?).

One variation to this methodology was that a wider transect (20x50 m) was used for large species that are patchy in distribution, diver wary and/or particularly vulnerable to exploitation due to the large sizes they can attain (70-200 cm): sharks, maori wrasse (*Cheilinus undulatus*), large parrotfish (*Bolbometopon muricatum, Cetoscarus bicolor, Chlorurus microrhinos, Scarus rubroviolaceus*) as well as any other fish larger than 50 cm. Large fish were counted in the wide transect at the same time that the first pass along the 3x50 m transect was conducted. A comparison of large fish densities counted along the 20x50-m transects with predicted values based on an expansion of the densities recorded along the 3x50-m transects indicated that the wide transect underestimated densities of all but the largest fish (Fig. x), consequently, we restrict our use of the data from the 20x50 cm transect for fish >69 cm.

Results

Fishing Effort. Subsistence fishing was a daily activity that was modest in scope when viewed on an hourly basis but substantial when totaled over an annual period. On average, only 3 villagers were seen fishing during a standardized 1-hr survey of both Ofu and Olosega islands (Fig. 2 and 3), which equates to a seemingly benign effort of 1 fisher per 6 km of visible shoreline at any one time. Nonetheless, this continued level of fishing adds up to 72 fishing hours per day or 22,536 hours per year (with no fishing on Sundays) on these small islands. One way to visualize the annual effort is that it equates to one person fishing continuously day and night for 1.7 months along each kilometer of shoreline, thus the potential impact on nearshore resources is not inconsequential.

Fig. 3. Monthly average of observed gears per hour (March 2002 - May 2003).

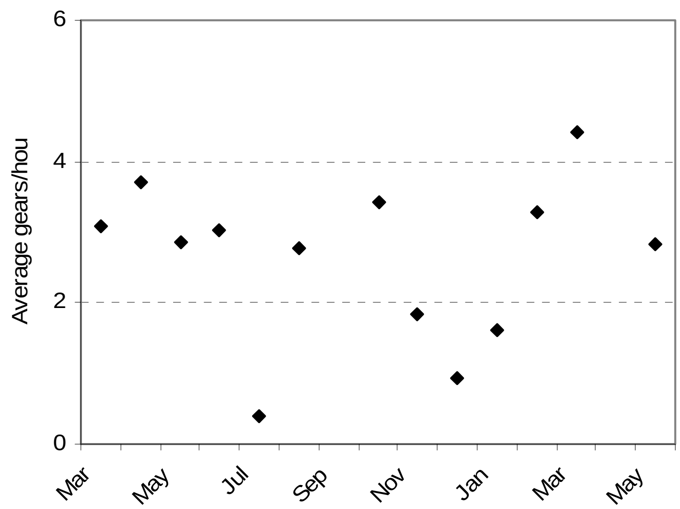
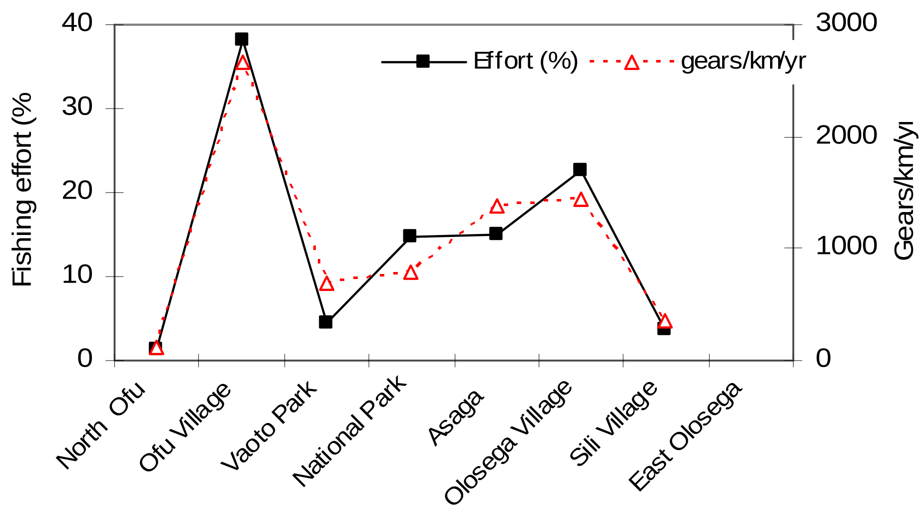


Fig. 4. Location of fishing effort-year period prorated over a 1-year period. Note that East Olosega and part of North Ofu were not visible to observers.



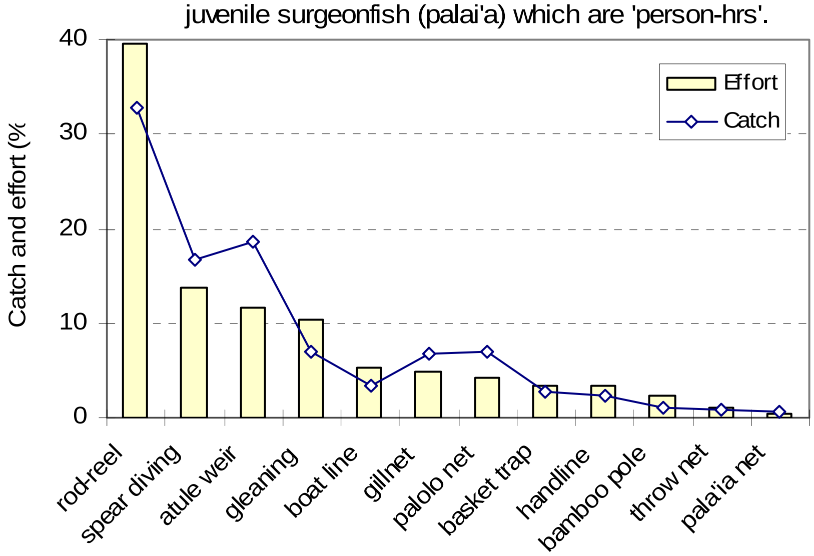
Almost all effort was shore-based fishing in the backreef moats and on the reef flats and upper reef slopes, with only 5 % of fishing occurring in deeper waters using boats. Most fishing (61%) occurred near the villages of Ofu and Olosega (Fig. 4, Table 1). A similar pattern of effort is seen when the unequal-sized 8 study sites are standardized by shoreline distance (Fig. 4, Table 1). The high effort in Ofu Village was due in part to the presence of a small boat harbor where villagers frequently fished. Only 20% of fishing effort occurred within the two Marine Protected Areas: 15% in the National Park and 5% in Vaoto Marine Park.

Table 1. Distribution of fishing effort on Ofu and Olosega islands, March 2002 to May 2003.

	Coastline	Gears observed		
Sector	(km)	N	%	ear-hours/km/yr
Ofu Village	2.9	485	38.1	2662
Olosega Vill	3.2	288	22.6	1432
Asaga	2.2	190	14.9	1374
National Par	3.8	188	14.8	787
Vaoto Park	1.3	57	4.5	698
Sili Village	2.2	48	3.8	347
North Ofu	2.2[a]	16	1.3	116
East Oloseg	0[a]	0	-	-
	15.0	1272	100	

[a]Visible portion of coastline

Fig. 5. Catch and effort by gear type. Effort is presented as 'gear-hours' except for atule, palolo polychaetes and newl recruited juvenile surgeonfish (palai'a) which are 'person-hrs'.



Most fishing effort and catch was by rod and reel, free-diving with spears, atule weir and gleaning (Fig. 5). The coastal pelagic atule (*Selar crumenphthalmus*) were plentiful on the back reefs in 2002 but were absent in 2003-2005. Catching them was a coordinated group effort as 50-100 villagers waded in the water and herded the schools of atule through a V-shaped weir (made of piled stones) into a large hand-woven mat-basket. The average catch of atule was large: 786 kg per event (n = 10). Gleaning involved hand-picking the reefs at low tide primarily for octopus, giant clams (*Tridacna maxima*), and turban snails (*Turbo* spp.).

Catches of some species were highly seasonal. Palolo polychaetes (*Eunice viridis*) swarm late at night (about 0130-0230) during one or two nights in October or November and are eagerly harvested with scoop nets or window screen. In March 2002, villagers also took advantage of large but annually sporadic recruitment events of both juvenile goatfish (*Mulloidichthys flavolineatus*) and bristletooth surgeonfish (*Ctenochaetus striatus*). The small goatfish were caught in traditional hand-woven baskets each year (2002-2005); the schools of small surgeonfish (which occurred only in 2002 and 2005) were scooped up with various nets and window screens.

Annual catch and cpue. Catch rates by gear type ranged from 0.8 to 4.8 kg/hour, with highest rates observed in the pulse fisheries for atule, palolo and juvenile recruits of goatfish and surgeonfish (Table 2).

Table 2. Catch rates by gear type.

Time	Gear	Interviews	CPUE kg/gear-hr	CPUE kg/person-hr	SD
Daytime					
	atule weir	10		4.8	4.2
	juv. surgeon.[1] netting	4		3.6	3.2
	juv. goat.[2] basket trap	67	3.3		2.5
	gillnet	22	3.0		3.0
	throw net	15	1.9		1.4
	rod & reel	112	1.8		1.5
	free diving-spear	44	1.5		1.3
	gleaning[3]	63	1.4		1.0
	boat lines	15	1.3		1.1
	handline	16	1.1		1.9
	bamboo pole	20	0.8		1.0
Nighttime					
	palolo				
	-boat	6		4.7	3.0
	-shore-based	8		1.0	0.8
	free diving-spear	80	3.3		2.1
	bamboo pole	6	1.7		1.1
	handline	4	1.7		0.9
	rod & reel	81	1.6		1.7
	gleaning[3]	17	1.3		1.4
	gillnet	4	0.9		0.5

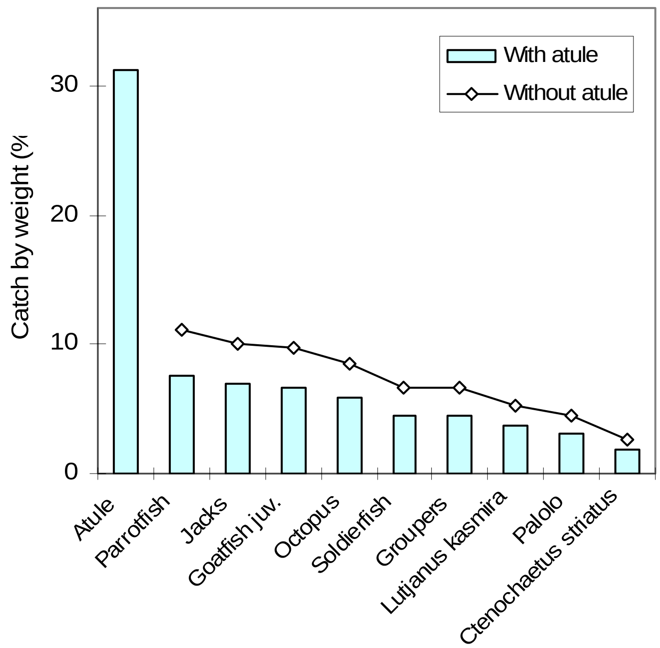
[1]Newly recruited *Ctenochaetus striatus*.
[2]Newly recruited *Mulloidichthys flavolineatus*.
[3]Shucked weight.

Table 3. Annual catch and compostion of fish and invertebrates in 2002, including estimates without atule, the sporadically available coastal pelagic species (e.g., atule were absent in 2003-2005).

Fish and invertebrates	common name	Annual harvest kg	%	without atule %	fish, inverts. separate %
Fish					
Carangidae-atule	atule	13078	31.3	-	-
Mullidae	goatfish	3432	8.2	11.9	14.4
Scaridae	parrotfish	3427	8.2	11.9	14.4
Carangidae	jacks	3068	7.3	10.7	12.9
Serranidae	groupers	2615	6.3	9.1	11.0
Lutjanidae	snappers	2264	5.4	7.9	9.5
Acanthuridae	surgeonfish	2239	5.4	7.8	9.4
Holocentridae	soldierfish	2029	4.8	7.1	8.5
Scombridae	tunas	708	1.7	2.5	3.0
Mugilidae	mullet	699	1.7	2.4	2.9
Carcharhinidae	sharks	595	1.4	2.1	2.5
Belonidae	needlefishes	566	1.4	2.0	2.4
Lethrinidae	emperors	486	1.2	1.7	2.0
Balistidae	triggerfishes	302	0.7	1.1	1.3
Bothidae	flounder	152	0.4	0.5	0.6
Muraenidae	moray eels	100	0.2	0.3	0.4
Sphyraenidae	barracudas	88	0.2	0.3	0.4
Labridae	wrasses	78	0.2	0.3	0.3
Priacanthidae	bigeyes	66	0.2	0.2	0.3
Polynemidae	threadfins	52	0.1	0.2	0.2
Unidentified fish		855	2.0	3.0	3.6
			88.2	82.8	100
Invertebrates					
Octopus cynea	octopus	2555	6.1	8.9	51.8
Eunice veridis	palolo	1172	2.8	4.1	23.8
Panulirus penicillatus	lobster	680	1.6	2.4	13.8
Turbo spp.	turban snail	264	0.6	0.9	5.3
Tridacna spp.	giant clam	226	0.5	0.8	4.6
Diadema spp.	sea urchin	39	0.1	0.1	0.8
		41835	100	100	100

The annual subsistence catch, 41.8 metric tons (92,076 lb), consisted of a diverse array of coral reef fishes and invertebrates but atule dominated the catch in 2002 (Table 3, Fig. 6). Atule were caught by weir on the back reef (67%) and by shoreline angling (33%). Given that this species does not occur on reefs every year, the catch composition was also calculated without atule (Fig. 6) which shows a more even harvest of fish and invertebrate groups, with each group accounting for less than 10% of the catch. The major species taken were: parrotfish (misc. species), goatfish (86% juvenile *Mulloidichthys flavolineatus*), jacks (*Caranx melampygus*), groupers (commonly small *Epinephelus hexagonus* and *E. merra*) snappers (46% *Lutjanus kasmira*), surgeonfish (51% *Ctenochaetus striatus*, 24% *Acanthurus lineatus*). Invertebrates (without shells) accounted for 17% of the annual harvest (excluding atule), mostly octopus (*Octopus cyanea*) and palolo polychaetes (*Eunice viridis*).

Fig. 6. Subsistence catch composition of the 10 most common taxa taken (out of 45 species or species groups), calculated with and without atule, 2002.



The overall per capita harvest was 82 kg/person (181 lb/person), but the calculation of per capita consumption needs to account for the portion of the catch that was not locally consumed. Our observations indicate that about 20% of the catch from the atule weir and 10% of the general reef catch were sent to family members on Tutuila Island or as gifts of atule to neighboring Ta'u Island. Taking these into account, the per capita consumption of nearshore resources in 2002 was 73 kg/person or 1.4 kg per person per week (160 lb/yr, 3.1 lb/week). Note that this does not include consumption of offshore pelagic fish or tinned fish purchased at local stores.

Size of species caught. Most fish and invertebrates harvested were small, averaging 0.2-1.2 kg (Table 4). Of the giant clams measured (n = 107 *Tridacna maxima*), 35% were smaller than the territorial harvest regulation of 15.2 cm minimum shell length, but only 3% of the spiny lobsters (n = 33 *Panulirus penicillatus*) were smaller than the minimum carapace length of 8.2 cm.

Historical and prehistoric perspective. All of the 20 elder male villagers interviewed had been fishermen and most were still engaged in fishing activities (80% of interviewees). There was a consensus that fishing today is similar to that when they were younger (100%). The abundance of resources was generally good: fishing (85% of those interviewed considered fish resources to be good), palolo (100%), atule (95%), sea turtles (67%), giant clams (50%). Few felt that any species had become rare or lost (93%). Many sold some fish to local villagers at least occasionally (60%), but all sent fish to family members at least occasionally. All mentioned that destructive fishing methods (dynamite, fish poisons) were commonly used 20-30 years ago, but none occurs now – it is prohibited by the village councils.

Table 4. Average weight of harvested fish and invertebrates in subsistence fishery, 2002.

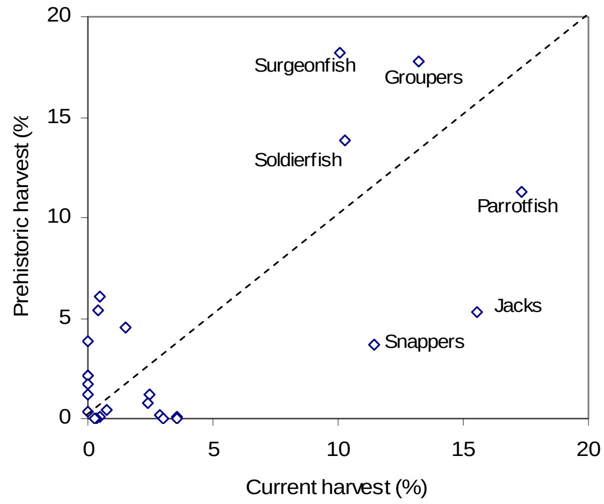
Fish		n	Average weight (kg)	(lb)
Acanthuridae	surgeonfish	1144	0.2	0.4
Balistidae	triggerfish	77	0.4	0.8
Carangidae	atule	95	0.2	0.4
Carangidae	jacks	132	1.1	2.5
Holocentridae	soldierfish	1190	0.2	0.4
Labridae	wrasses	31	0.4	0.9
Lethrinidae	emperors	53	0.6	1.3
Lutjanidae	snappers	783	0.3	0.7
Mugilidae	mullet	88	0.6	1.3
Mullidae	goatfish	163	0.3	0.7
Scaridae	parrotfish	639	0.6	1.3
Serranidae	groupers	1101	0.2	0.5
New recruits to reef				
juvenile goatfish[1]		270	0.009	0.02
juvenile surgeonfish[2]		60	0.005	0.01
Invertebrates				
giant clam in shell		53	1.0	2.3
octopus		236	1.2	2.6
spiny lobster		186	0.5	1.0

[1] *Mulloidichthys flavolineatus*

[2] *Ctenochaetus striatus*

An archeological excavation on the southern coastline of Ofu Island provides a rare opportunity to compare the modern harvest to prehistoric catches. In buried strata dated 1000-3000 years old, 93% of all bones collected were of fish, representing a diverse group of 19 fish families (Nagaoka 1993). To compare modern and ancient catches, we first excluded pufferfish spines from the archeological dataset to avoid over-emphasizing the catch of pufferfish, and second, in modern catches we did not include the small, newly recruited surgeonfish and goatfish because their bones would be to small to be collected in the mesh sizes used by the archeologists, and we excluded the atule catch because atule are not present every year. The results show a strong similarity in catches -- the four most abundant fish taxa found (surgeonfish, groupers, soldierfish, parrotfish) are still among the principal groups harvested (61% vs. 51% of catches, respectively)(Fig. A). Some offshore fishing is indicated by the presence of tuna, representing 3.6% of the bones found. Invertebrate shells were also abundant at the archeological site. Of the 169 kg of shells collected, over 50 species were identified. Most (76%) consisted of turban snails (mostly *Turbo setosus*), trochus snails and giant clams, as in modern times.

Fig. A. Relative abundance of fish taxa in prehistoric and current harvests. The dashed line indicates equal values.



Catch and standing stocks of fish. Fisheries-independent surveys on the reef front around Ofu and Olosega islands documented a predominance of parrotfish, surgeonfish, wrasses and snappers, while in the backreef moat, fish abundance and diversity were lower (Fig. 7). These four taxa accounted for 34% of the fish harvest (excluding atule)(Fig. 8). The main exception was that wrasses were underutilized in proportion to their abundance, probably due to their small size -- 69% were less than 10 cm long. Four other fish taxa were targeted beyond their relative abundance on the reef: goatfish (mostly due to a large recruitment event of juveniles that are harvested along shorelines), jacks (under-represented in scuba surveys but commonly caught by angling along shorelines), and soldierfish (nocturnal fishes not usually seen during daytime scuba surveys).

Fig. 7. Biomass comparison of fish on the reef slope (5 sites) and in a backreef moat (2 sites), March 2002.

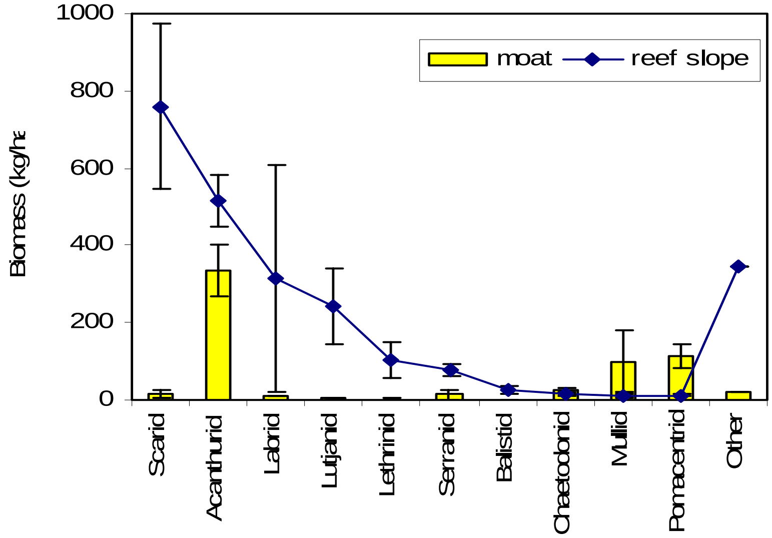
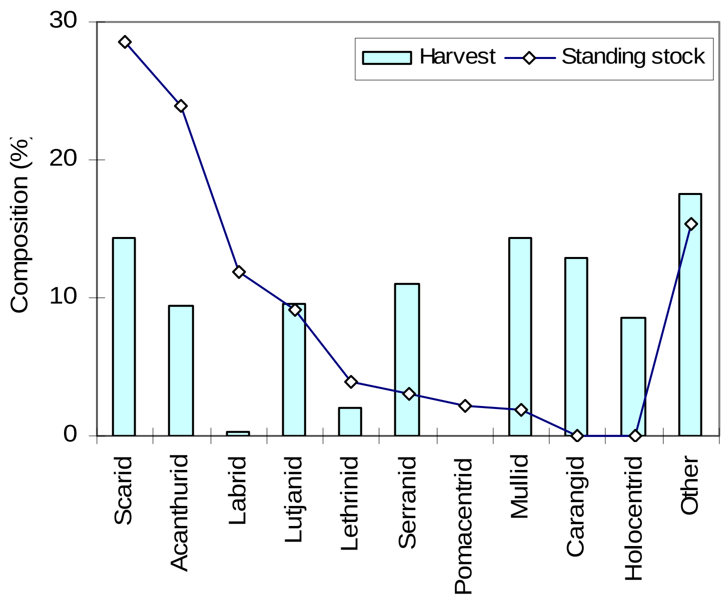
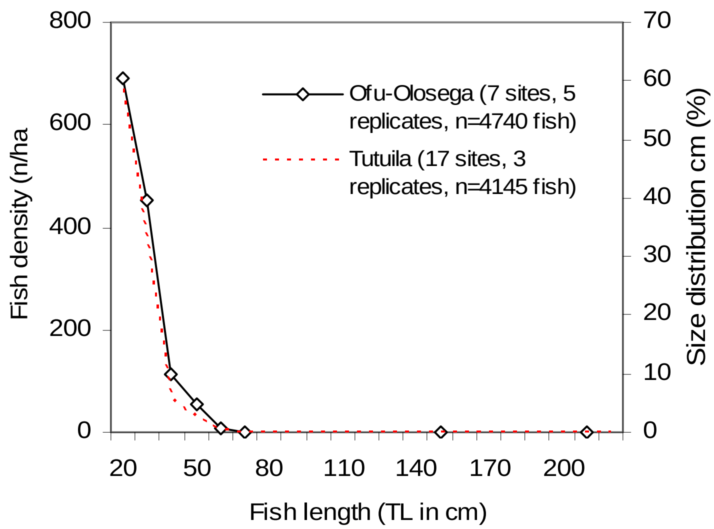


Fig. 8. Comparison between abundance and harvest biomasses of fish (excluding atule).



Conspicuously uncommon on the reef front were large fish of any species (Fig. 9). Figure 9 shows the pooled lengths of all fish species, including sharks, sighted during extensive surveys on the reef slope at the 10-m depth (fish <20 cm are not included here to avoid swamping the graph with juvenile recruits and naturally small species). Similar findings applied to the main island of Tutuila (Fig. 9). While these data were derived from belt transects of typical dimensions used in underwater visual surveys (3 x 50m), we also used wider transects (20 x 50 m) to focus on species that are patchy in distribution, diver wary and/or particularly vulnerable to exploitation due to the large sizes they can attain (about 2 m). However, the same size pattern emerges: only 6 fish or sharks >69 cm were sighted along the larger transects, which amounts to only 1.7 large fish or sharks per hectare in Ofu and Olosega islands. On Tutuila, no fish or sharks >69cm were sighted along the wide transects in 2002.

Fig. 9. Density and size frequency of fish and sharks (>19 cm) tallied on 3x50 m transects on the reef slopes of Ofu-Olosega (5 sites) and Tutuila islands (17 sites), 2002. Two shallower sites on Ofu are also included.



Discussion

This study presents an opportunity to (a) compare a contemporary subsistence fishery with both historic and prehistoric catches in the same area, and (b) evaluate a contradiction between village perception of good fishing conditions versus fisheries-independent assessments of fish depletion.

A resource oasis? Both modern, historic and prehistoric lines of evidence point to sustainable catches of nearshore coral reef fish. Ofu Island was colonized by Samoans 2900-3200 years ago (Kirch and Hunt 1993). The archeological findings, dated at between 1000-3000 years old, indicate that fish were the villagers' main source of protein (93% of bones were from fish), most of those fish bones were from nearshore rather than pelagic species (Nagaoto 1993), and the four most common fish taxa found (surgeonfish, groupers, soldierfish, parrotfish) are still among the principal groups harvested now (61% vs. 51% of catches, respectively).

Furthermore, in modern times it is unusual to hear village elders say that fishing now is as good as some 30-50 years ago when they were young, but all 20 of the elders from Ofu and Olosega shared this viewpoint. Of course this does not exclude the possibility that the resources might have been overfished then as well, but 85% of the elders felt that fishing was currently good, in direct contrast to the results from a similar survey conducted on Tutuila Island in 1995 where 70% of the 100 people interviewed felt that marine fish resources had significantly declined compared to when they were young (Tuilagi and Green 1995). A major contributing factor to these findings is that the population sizes of Ofu and Olosega islands are relatively small and have been declining over the past few decades, whereas there has been a burst of population growth on Tutuila Island where 96% of the territory's inhabitants live (ref.).

Overfished reefs? The picture above of sustainability is clearly at odds with the assessment of fish abundances measured on the reefs. Our main reason for considering that the coral reefs around Ofu and Olosega islands, and throughout the main populated islands in the territory, is the absence of large fish on the reef slopes. Fisheries-independent surveys found few fish larger than 50 cm. This situation is even worse around the main island of Tutuila (Green 2002, Craig and Green 2005). Territory-wide surveys in 1996 and 2002 (Green 2002) and 2004 (R. Brainard, NOAA, pers. com) indicate that this condition has occurred for at least the past 8 years. Given the dearth of all large among all species, overfishing seems to be the most straightforward explanation and/or at least raise the flag for precautionary principal of reef management.. Further, elder interviews on Tutuila Island in 1995 felt that there are fewer fish present now than when they were young. Mention: parrotfish (Page), giant clams (Green & Craig), alogo (Craig et al.)??

As an independent test of this conclusion, we hypothesized that the one fish species that is often avoided in American Samoa should be proportionally larger than the other species – that's the bohar snapper (*Lutjanus bohar*) which can be locally ciguaritoxic. ……..

Comparisons to other areas.

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