UNIVERSITY OF CALIFORNIA
Santa Barbara

Decision Support for Coral Reef Fisheries Management: Community Input as a Means of Informing Policy in American Samoa

---

Project Plan for American Samoa's Department of Marine and Wildlife Resources

---

A Group Project submitted in partial satisfaction of the requirements for the degree of
Master's in Environmental Science and Management
for the
Donald Bren School of Environmental Science & Management

By

Stacey Kilarski
Daniel Klaus
Jennifer Lipscomb
Kimbrely Matsoukas
Robert Newton
Abigail Nugent

Committee in Charge:

Dr. Christopher Costello

April 24, 2006

Decision Support for Coral Reef Fisheries Management:
Community Input as a Means of Informing Policy in American Samoa

As authors of this Group Project report, we are proud to archive it on the Bren School's web site such that the results of our research are available for all to read. Our signatures on the document signify our joint responsibility to fulfill the archiving standards set by the Donald Bren School of Environmental Science & Management.

Stacey Kilarski

Daniel Klaus

Jennifer Lipscomb

Kimbrely Matsoukas

Robert Newton

Abigail Nugent

The mission of the Donald Bren School of Environmental Science & Management is to produce professionals with unrivaled training in environmental science and management who will devote their unique skills to the diagnosis, assessment, mitigation, prevention, and remedy of the environmental problems of today and the future. A guiding principal of the School is that the analysis of environmental problems requires quantitative training in more than one discipline and an awareness of the physical, biological, social, political, and economic consequences that arise from scientific or technological decisions.

The Group Project is required of all students in the Master's of Environmental Science and Management (MESM) Program. It is a four-quarter activity in which small groups of students conduct focused, interdisciplinary research on the scientific, management, and policy dimensions of a specific environmental issue. This Final Group Project Report is authored by MESM students and has been reviewed and approved by:

Dr. Chris Costello

Dr. Ernst Ulrich von Weizsäcker

April 24, 2006

Acknowledgements

We would like to thank the American Samoa Coral Reef Advisory Group for their generosity and assistance in the development of our research, and extend gratitude to the following individuals for their considerable involvement with the project:

Lelei Peau,CRAG Chair, Deputy Director DOC
Christianera Tuitele, Education and Outreach Coordinator
Virginia Farmer, NOAA Coral Management Fellow
Troy Curry, GIS Specialist

We also thank our partners with the American Samoa Department of Marine and Wildlife Resources for their assistance and support with our study:

Mr. Ufagafa Ray Tulafono, Director
Dr. Karl Brookins, Chief Fishery Biologist
Selaina Vaitautolu, CBFMP Manager
Afa, Pora, Tasha, Champ, CBFMP Assistants
Leslie Whaylen, Coral Reef Monitoring Coordinator
Risa Oram, MPA Coordinator
Douglas Fenner, Chief Coral Biologist

We are grateful to the following individuals for providing information vital to our research:

Nancy Daschbach, Fagatele Bay National Marine Sanctuary Manager
Allamanda Amituanai, Education Specialist/Advisory Council Coordinator Fagatele Bay National Marine Sanctuary
Gerry Davis, Assistant Regional Administrator for Habitat Conservation, NOAA Fisheries
Fatima Sauafea, PIRO Coral Reef Ecologist, NOAA Fisheries
Dr. Peter Craig, National Park Ecologist

Lastly, we would like to thank our advisors for their extensive guidance and contributions throughout the project:

Oran Young, Professor of International Governance and Co-Director of Bren Program on Governance for Sustainable Development, Bren School of Environmental Science & Management
Gail Osherenko, Research Faculty, Bren School of Environmental Science & Management
Robert Warner, Marine Ecology Professor, Ecology, Evolution & Marine Biology
Bruce Kendall, Associate Professor of Applied Ecology, Bren School of Environmental Science & Management
Satie Airame, PISCO Policy Coordinator
And a special thanks to our faculty advisor, Chris Costello, Associate Professor of Resource Economics and Renewable Resources, Bren School of Environmental Science & Management.

Table of Contents

List of Figures and Tables

Abstract

Fishing in American Samoa has historically been important for cultural and subsistence purposes. Recent studies of the territory, however, showed declines in both subsistence fishing activity and coral reef fish abundance (Coutures 2003, Green 2002). As the agency responsible for managing American Samoa's fishery resources, the Department of Marine and Wildlife Resources employs several strategies to manage near shore fishing. A comprehensive near shore fishery management plan, however, has never been developed. To assist in developing and implementing new management techniques, this study uses socioeconomic data to examine three policy themes: 1) Regulations; 2) Fishery education; and 3) Geographic prioritization. To incorporate local input about the current usage of the fishery into our analysis, we developed a community survey to answer specific questions within each policy theme. Statistical methods, including regressions, t-tests, and chi squared analyses were used to analyze the survey results and provide managers with baseline data concerning future fishery management. Demographic and environmental characteristics were included to create a thorough representation of what is occurring in the fishery. Our results indicate that an increase in near shore fishery regulations will likely be accepted by the majority of American Samoans. Fishery education from media sources was found to be the most frequently received while also reaching the widest audience. Utilization of baseline information collected along with our developed geographic maps will provide resource managers with the means for developing future fishery management policies throughout the territory.

Executive Summary

Problem

Over the past two decades reef fish and invertebrates have declined in both abundance and size in American Samoa. To address this decline, the Coral Reef Advisory Group (CRAG) was developed, linking territorial agencies to facilitate coral reef management in American Samoa. CRAG identified four areas of concern associated with the fishery decline: overfishing, land-based pollution, overpopulation, and global climate change and designed Local Action Strategies (LAS) to support the management of these problems. The Department of Marine Wildlife and Resources (DMWR) is the lead agency in the development of the overfishing LAS with a mission of "restoring fish stocks and other exploited biota that are commercially, ecologically, and culturally important to the American Samoan way of life (*fa'a samoa*) and to prevent non-sustainable harvesting methods". Our study addresses the overfishing LAS by creating a decision support tool based on socioeconomic and geographic data for DMWR.

Objectives

The intent of our study is to use data and statistics derived from community surveys to support future fishery management decisions of DMWR. In particular, our research focuses on public perceptions and opinions in order to identify management concerns. Incorporation of socioeconomic factors in fishery management decisions is recognized as an important aspect of effective policy development. To focus management strategies, we identified three policy themes: regulation, education and geographic prioritization. Within these policy themes we addressed the following specific research questions:

Regulation

- What is the current perception of fishery regulation? With which types of regulations are people most likely to comply? What are the factors that influence people's agreement level with regulations? Is there a difference between user groups regarding attitudes and opinions towards fishery regulations and management policies? What spatial level of management is most preferred?

Education

- Where do American Samoans currently receive most of their coral reef fishery education? Specifically, from which sources and how frequently do user groups receive fishery education?

Geographic Prioritization

- How can DMWR incorporate spatial variation in demographic and environmental factors in order to enhance fishery management strategies?

Methods

Our analysis incorporates data from community surveys, local knowledge, collaboration with experts, and spatial models to provide local resource mangers with a decision support tool to aid in the implementation of sustainable fishery management strategies. We developed and administered a community survey in collaboration with local managers to address various factors concerning fishery use and management. We asked specific questions about demand for fish, community attitudes towards fishing regulations, and community preferences towards fishery resources. Our objective was to examine general trends in survey responses to draw conclusions based upon our analysis.

Over an 8 week period in the summer of 2005 we conducted a survey of a cross section of villages. We used a stratified sampling technique that was aimed at capturing the average community member by representing the varying degrees of urbanization, geographical isolation, and access to coral reef fishing grounds. From this random sampling, 34 villages across the territory were selected to survey. The villages were urban and rural, coastal and inland, and in both remote and well-serviced locations throughout the Territory. With the aid of local Samoan translators, we administered a total of 425 surveys in English or Samoan. We conducted at least 12 surveys in each village. To analyze our data, we used a variety of statistical methods, including summary statistics, analysis of variance tests (ANOVA), chi-squared tests, and multivariate regression analysis. A regression analysis determines the factors which potentially influence a response to a question by evaluating each variable while holding all other factors constant.

Results and Discussion

Fishery Use

One of the aims of our survey was to give DMWR basic information about the frequency of different uses of the fishery as well as determine community fish and invertebrate preferences. To support a bottom-up approach, we elicited community opinions about which uses of the fishery respondents perceived as important. The vast majority of survey respondents felt that maintaining a healthy ecosystem and fishing for food were important uses of the fishery. A substantial majority also felt cultural use of the fishery was important, while commercial use of the fishery (buying and selling) and recreational fishing were considered important by significantly less number of respondents.

Regulation

To maximize effectiveness of management, stakeholder perceptions, attitudes and experiences regarding regulations should be considered while formulating decisions to fishery management problems. Built into the context of regulatory regimes, identification of user groups and their agreement levels with management strategies can assist in promoting compliance. To evaluate the types of regulations which will have the highest level of compliance in the future, we asked village members to categorize their level of agreement with eight different statements regarding potential regulation types. In general, the response is in favor of each of the eight regulation types, with at least 61% of respondents in agreement with each regulation. Based upon this initial analysis, compliance is estimated to be greatest with the following four regulation types:

"DMWR should regulate what is caught"
"DMWR should regulate how people fish"
"DMWR should regulate where people fish"
"DMWR should regulate during spawning events"

User group perceptions about current and proposed regulation strategies can also provide valuable insight for managers in the development of a community-driven management framework. For example, within the fishing user group, the above average fishers are least likely to agree with regulation. Therefore, it is important for fishery managers to collaborate with fishers when determining the regulation strategies that will receive the greatest level of compliance.

Our initial analysis also examined the perception of current regulations and enforcement strictness. Forty-six percent of the respondents think current regulations are too lenient, while only 8% expressed that they are too strict. Indicating that a future increase in regulations of the near shore fishery will likely be accepted by the majority of American Samoans

Education

Well conceived and adaptive public education programs are an integral component in maintaining fishery resources. They can promote sustainable use of the resource base and teach people to become stewards of their surrounding environment. Education and outreach can also be a way to establish a working connection between managers and the community. Based on our survey, the most frequently accessed fishery education sources (those with a frequency of most days) are TV and Radio (with 43% respondents), newspapers (41%), and school (41%). Family, as a source of fishery education, is also a frequently used source, with 37% of the respondents receiving this source most days.

In our study we used regressions analysis to determine factors that affect the frequency of fishery education from media, social, and workshop sources. The statistically significant variables in the regression on social education were age, gender, and curfew. These results are notable because the regulation regressions indicate that people with more social education are more likely to disagree with regulations, but people who attend workshops are more likely to agree with regulations. Therefore, if American Samoa chooses to increase regulations and enforcement as a management tool, then the nature of social education will need refining in order for those tools to be more accepted. Further implementation of workshops targeting the sources of social education (heads of families, village leaders, matai) could be an effective means of influencing community opinions towards fishery resources.

Both the summary statistics and regressions for this policy theme indicate that media education is not received significantly more by any particular demographic group. Therefore, media sources might be an effective means of disseminating fishery information to the general public. Media sources are also currently the means by which fishery education is received most frequently. However, our research did not address the quality or effectiveness of any of the education sources. Therefore, if media sources of fishery education continue to be used frequently, managers should carefully consider the type of information distributed.

Geographic Prioritization

As a method of prioritizing geographic management areas, we analyzed our data by exploring the variation in each policy theme across villages. We also incorporated some biophysical characteristics into the analysis in order to present ways for managers to integrate the socioeconomic aspects of fisheries management into their decision processes. To show the variations between villages, we used GIS to create maps of American Samoa that show each of the villages surveyed. Each individual map focuses on a possible area of concern for fishery managers and indicates how each surveyed village compares to the average value. Examples of the areas of concern that we mapped are habitat complexity, population density, total fishing effort, and agreement with regulations. In all, 11 maps were made that cover a range of fishery concerns involving fishery resource potential, population related pressures, and sociological information. These categories correspond to the quality of the fishery, the amount of resource exploitation, and the general perceptions of residents regarding different types of management actions.

Managers can use results from our model to estimate the effects of future management actions on individual villages, appraise the success of specific policy on specific villages, assess how villages may be affected by the activities of other villages, and predict the effects of territory-wide trends based on the current spatial variability. Additionally, managers can examine either the variability of a specific management concern across all villages, or they can distinguish the interactions of different management actions within villages.

Conclusions

Our research provides valuable information regarding socioeconomic aspects of near shore coral reef fisheries management in American Samoa. It highlights current conditions and explains significant influences in fishery use, education, and regulatory perceptions. Moreover, it proposes a spatially explicit model of resource availability, resource use, and sociological concerns. Finally, it presents a conceptual representation of how this information fits into the broader scope of fisheries policy development. By analyzing the sociological component of fisheries in American Samoa, this research provides beneficial decision support for local fisheries managers. While the findings of this report are important, they must be balanced with other available information regarding the coral reef resources in American Samoa. This research should enhance the knowledge of local resource managers and allow them to make more informed decisions toward the fisheries.

Introduction

Coral reefs are biologically diverse ecosystems that support nearly 500 million people worldwide by providing food, coastal protection, cultural items, and tourism income (Wilkinson 2004). Pressure imposed by over-exploitation, pollution, habitat destruction, invasive species, disease, bleaching and global climate changes through human activities have threatened the long-term sustainability of these sensitive environments (CRTF 2000). The rapid decline of these complex ecosystems in American Samoa nearshore waters has significant social, economic and environmental impacts on the local communities (Spurgeon et al. 2004).

Consistent with other Polynesian cultures, coral reef resources have historically been an important aspect of the culture and livelihood of American Samoa (Dalzell 1996). Over the past two decades reef fish and invertebrates have declined in both abundance and size in American Samoa. To address this decline, the Coral Reef Advisory Group (CRAG) was developed, linking territorial agencies to facilitate coral reef management in American Samoa. CRAG identified four areas of concern: overfishing, land-based pollution, overpopulation, and global climate change and designed Local Action Strategies (LAS) to support the management of these problems. The Department of Marine Wildlife and Resources (DMWR) is the lead agency in the development of the overfishing LAS with a mission of "restoring fish stocks and other exploited biota that are commercially, ecologically, and culturally important to the American Samoan way of life (*fa'a samoa*) and to prevent non-sustainable harvesting methods". Our study addresses the overfishing LAS by creating a decision support tool for DMWR based on socioeconomic and geographic data.

Objectives

The intent of our study is to use socioeconomic data and statistics derived from community surveys to support future fishery management decisions. In particular, our research focuses on public perceptions and opinions in order to identify management concerns. Incorporating socioeconomic analysis and community input in fishery management decisions is recognized as an important aspect of effective policy development (Bunce et al. 2000). Using literature

review and input from local managers, we focused our research into the three main policy themes: regulation, education, and geographic prioritization. Within these policy themes we addressed specific research questions as follows:

Regulation

- What is the current perception of fishery regulation?
- With which types of regulations are people most likely to comply?
- Which factors influence people's agreement level with regulations?
- Is there a difference of opinion between user groups regarding attitudes and opinions towards fishery regulations and management policies?
- At which spatial level of management do villagers want the fishery resources to be managed in the future?

Education

- Where do American Samoans currently receive most of their coral reef fishery education?
- From which sources and how frequently do user groups receive fishery education?

Geographic Prioritization

- How can DMWR incorporate spatial variation in demographic and environmental factors in order to enhance fishery management strategies?

Our analysis incorporates data from community surveys, local knowledge, collaboration with experts, and spatial models to provide local resource mangers with a decision support tool. The baseline data, statistical analysis of survey results and the geographic decision support tool created will aid and assist in the development creation of sustainable fishery management policies for the Territory.

Background

Location

American Samoa is a U.S. Territory located in the South Pacific, approximately 2,600 miles southwest of Hawaii. The territory encompasses five volcanic islands and two coral atolls within the Samoan archipelago (Figure 1). Of the populated islands, Tutuila is the largest and most populated (Table 1). Aunu'u lies off the south east of Tutuila and the remote islands of Ofu, Olosega and Ta'u (Manu'a group), lie 63 miles northeast of Tutuila. Swains Island is a privately owned atoll 220 miles northwest of Tutuila and Rose Atoll lies 65 miles west of the Manu'a group.

Figure 1: The Islands of American Samoa
(Used with permission of the American Samoa GIS Working Group 2005[1])

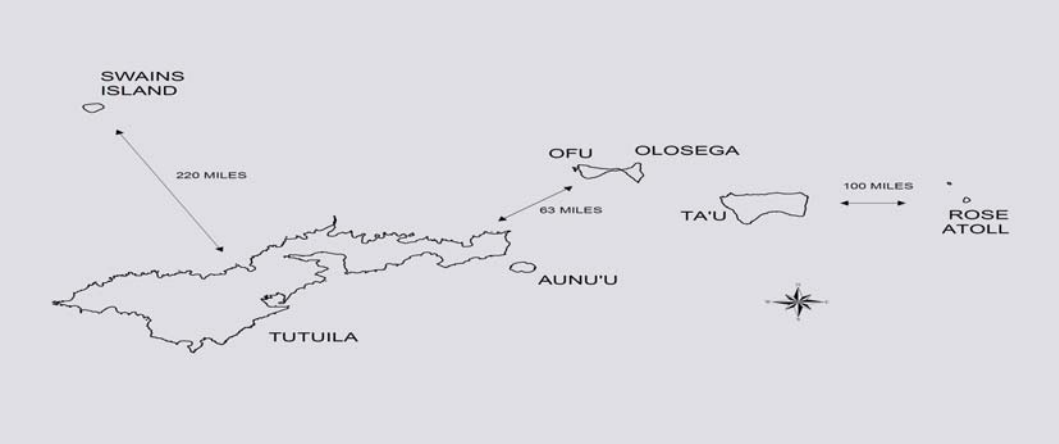


Table 1: Island Characteristics (US Census Data 2000)

Island or Atoll	Area (km^2)	Population	Population Density (per/km^2)
Tutuila	137.4	55,400	403.20
Aunu'u	1.53	476	311.11
Ofu	7.33	289	39.43
Olosega	5.26	216	41.06
Ta'u	45.51	873	19.18
Rose Atoll	0.08	0	0
Swains Atoll	3.57	37	10.36
Total	200.68	57,291	285.48

[1] See American Samoa GIS working group website for further details, http://doc.asg.as/Default.htm

Culture

As in many other Pacific Islands, family and religion are central aspects of daily life for Samoans. Maintaining *fa'a samoa* or "the Samoan way" is considered a fundamental value within the culture and was recognized by the territorial constitution as a priority. The basic unit within the social structure is the *aiga* or extended family (Fitzgerald and Howard 1990). Each aiga appoints at least one *matai* (chief) for life, with the title being passed down within each family. The matai dictates various aspects of the aiga's daily life including mediating disputes and punishing misbehavior. It has historically been considered a great honor to receive a matai title, and matais are highly regarded and respected throughout the territory (McDade and Worthman 2004).

Villages in American Samoa usually consist of several aiga. The matai from each aiga form the village council, who decide on social and economic matters within the village, including resource management. Village councils also elect a *pulenu'u*, or a village mayor, who has the final say in village matters (Tuitule 2005 pers. comm.). Communal sharing of land and resources is practiced within each village and 90% of all land in the territory is owned by aiga and passed on through generations (Osman 1997). This is a key consideration for resource managers because this set of values differs greatly from the American approach of ownership and the protection of private property rights.

Daily customs and routines in American Samoa have developed over time from a combination of traditional Samoan values and Christianity, the dominant religion of the territory[2]. For example, many villages still observe an evening prayer time or curfew, during which villagers are forbidden from leaving their homes and *amuaga,* or village policemen, do not allow cars to pass through the village. Another example is the observation of Sundays as a day of rest for family and for going to church. On this day, villagers must refrain from most recreational and commercial activities. Within the church, the *faifeau,* or minister is as highly regarded in the community as the village matai (Tuitule 2005 pers. comm.).

[2] The local government estimates the percentage of Christians in the territory to be 98%: http://www.asg-gov.net/

Political Structure

American Samoa is an unincorporated and unorganized US territory. As an unorganized territory, American Samoa has not adopted all parts of the US constitution and lacks an organic act with the US government. Consequently, the governmental structure mirrors that of the US, while also incorporating important elements of traditional Samoan social structure.

Economy

American Samoa's economy relies mainly on tuna fishing and processing, as well as grants from the US government, with 93% of the economy based on these two sectors (DOI State of Islands Report 1999). The world's two largest tuna processing plants are located in Pago Pago Harbor and employ approximately 33% of the territory's workforce. The other 67% is more or less equally distributed between the government and the general service industry (WPFMC 1999).

The territory's per capita income ($4,357) and median household income ($18,219) are very low compared to the US mainland (Census 2000), but almost twice the average of all Pacific Island economies (DOI State of the Islands Report 1999). The government of American Samoa has sought to diversify its economy over the past two decades, but economic development in the territory continues to be hindered by its remote location, lack of infrastructure, and lack of a skilled labor force (Osman 1997). Given these limitations, near shore fisheries continue to be an important resource for American Samoa.

Coral Reef Ecosystem

Extent

Coral reefs, and the fish populations they support, are quite limited in American Samoa due to the small size of the islands and their steeply sloping sides that drop quickly in the water within 2-8 km from the shoreline. According to a 2003 UNESCO report, the total area of American Samoa's reef habitat to 100m depth is only 296 km^2 compared to 490 km^2 in

Samoa and 1180 km^2 in Hawaii (Whittingham et al. 2003). The majority of the Territory's coral reefs are fringing reefs (85%), the remainder being offshore banks (12%) and atolls (3%) (Craig et al. 2001). This is important because fringing reefs provide a relatively limited area of shallow water coral habitats, which make fish populations, and the ecosystem as a whole, vulnerable to natural and anthropogenic disturbances.

Habitat

Despite their limited extent, coral reefs in American Samoa support a high diversity of corals assemblages (Craig 2004; Craig et al. 2001). High temperatures and environmental stressors coupled with a myriad of anthropogenic disturbances including coastal development, sedimentation, and pollution have put corals reefs in peril (Craig et al. 2004). While the extent of each of these disturbances' effect on coral reefs has not been fully assessed, there have been several studies which attempt to find correlations between these factors and the degradation of the coral reef habitat in American Samoa. In 2005, Houk et al. found that non-point source pollution and, more specifically, human population density is negatively correlated with coral density. This current state of the reefs and the associated impacts are important considerations when developing local management policies, given the fact that American Samoa's population has doubled in the past 20 years and is projected to double again in the next 30 years (Craig et al. 2000).

Fish Assemblage

American Samoa's coral reef ecosystem supports a high diversity of fish and invertebrates, consistent with its geographic location (Caley and Schulter 1997). A fish survey documented in Wass (1984) listed 991 fish representing 113 families, 890 of which are considered reef dwelling species. The list includes 40 species found only in Samoan waters, bringing the total number of reef fish species found in American Samoa to 850 (Skelton et al. 2000).

State of the Fishery

Historical Importance of Fishing Near Shore

Like other Pacific Island cultures, limited terrestrial resources has led to historical dependence on coral reef resources for survival throughout Samoan history. As a consequence, the relationship between man and the marine environment has exerted a strong influence in the development of Samoan culture and shaped many cultural beliefs and practices (Johannes 1978). Though systematic data on catches in the near shore before 1950 are not available, anecdotal evidence and the existence of Samoan myths suggest that Samoans have relied heavily on marine resources throughout their history, though Western contact has eroded the traditional use of marine resources (Severance et a1. 1989; Bindon 1997). Given this historic importance, assessments of fisheries in American Samoa must also include the socio-cultural contributions of fishing in addition to its economic and nutritional benefits (WPFMC 1999).

Declines in the Fishery

While the fisheries have supported American Samoa for thousands of years, two trends of concern in coral reef fisheries have recently been documented: subsistence fishing activity has declined over the past two decades (Coutures 2003) and coral reef fish and invertebrates have declined in abundance and size (Green 2002). Beginning in 1991, near shore catches have been measured using inshore creel surveys along a 16 km stretch of shoreline on the south side of the main island of Tutuila (Ponwith 1992). The analyzed creel survey data from 1991 to 1995 shows a steady drop in catch, value of landings, effort and catch per unit effort (CPUE) (Adams and Dalzell 1995). The use of interpolation techniques to reconstruct coral reef fisheries catches in Zeller et al. (2005) between 1950 and 2002 found that total catches throughout the territory decreased by 79% over this time period, though the change in effort over this same time period was not consistently measured.

Current Management Regime

The Department of Marine and Wildlife Resources (DMWR) is the Territorial agency mandated with the management of all living marine resources in territorial waters (0-3 nm). As such, they are the sole agency in charge of managing near shore fisheries. Though a comprehensive near shore fishery management plan has never been developed, several regulations have been established, consisting mostly of rules on gear restrictions and regulations targeting specific species (Appendix A). Other mandates include a ban on fishing at recreational moorings, required record keeping by fisher sellers and buyers, and areas of limited or closed fishing, such as Fagatele Bay National Marine Sanctuary and Rose Atoll National Wildlife Refuge.

All regulations listed are enforceable by deputized DMWR officers or American Samoa Government Public Safety Officers. Individual violations are class B misdemeanors carrying a punishment of up to $500 or a 15 day to 6 month prison term. Businesses that break these laws are assessed fines of at least $1,000 per violation. All property used for fishing illegally or obtained by fishing illegally is confiscated by the government until a civil hearing is scheduled (ASCA § 20944-20945). Currently DMWR employs 10 enforcement officers, 2 whom patrol near shore areas at randomized schedules throughout the day and night, and Fagatele Bay National Marine Sanctuary is monitored 2 times a week (pers. comm.). Patrols are conducted by car and officers note activity occurring on relevant forms. As of July 2005, 8 fishing violations were recorded, none of which were near shore violations (pers. comm.).

Several areas in the near shore have been identified as management districts under different federal and territorial agencies, each with varying degrees of protection (Oram 2005 (draft); Appendices B-E). The only completely protected no-take Federal MPA in the territory is Rose Atoll National Wildlife Refuge, a remote unpopulated atoll under federal jurisdiction. In the territorial waters surrounding the populated islands, only the regulations at Fagatele Bay National Marine Sanctuary are codified into territorial law (ASCA § 24.0907). The establishment of the National Park MPAs came about via an agreement between the National Park Service in American Samoa and local villagers (Oram 2005(draft)). Territorial MPAs

include the Vaoto Territorial Marine Park and 3 areas designated as Special Management Areas under the Department of Commerce Coastal Zone Management Program (ASCMP) (Appendix C). Laws regarding management of territorial MPAs are also written into territorial law and enforceable by deputized officers (ASCA § 18.0214 and ASCA § 26.0221). Eight villages are currently participating in DMWR's Community Based Fishery Management Program (CBFMP) (Appendix E). This is a co-management program designed to "to improve fishing and sustainable development of marine resources in participating villages as well as the territory" (Saufea and Curren 2000). As such, goals and regulations vary amongst participating villages and are stated in the aforementioned appendix.

Coral Reef Advisory Group

In light of the ever-increasing anthropogenic impacts on the territory's coral reef ecosystems, in 2003 the governor of American Samoa created an interagency task force called the Coral Reef Advisory Group (CRAG) to act as the working body of the national Coral Reef Initiative (CRI). In order to facilitate collaboration in research and management between agencies, CRAG aims to link the 5 main territorial and federal agencies (Table 2) that have a significant part in coral reef ecosystem management. Projects related to coral reef management, research and education are proposed to CRAG, voted upon by CRAG member agency representatives and funded through the CRI annual grant program.

Table 2: American Samoa Coral Reef Advisory Group (CRAG) members

Agency	Management Jurisdiction
Department of Marine and Wildlife Resources (DMWR)	All living resources in territorial waters
Department of Commerce (DOC)	Coastal development via the American Samoa Coastal Management Program; Fagatele Bay National Marine Sanctuary Office
American Samoa EPA (ASEPA)	Water quality and land-based pollution
National Park of American Samoa	Area designated by National Park Service, including marine resources adjacent to land
American Samoa Community College Sea Grant Extension Program	Promotion of marine science education and sustainable aquaculture

.

Methods

Approach

We developed a community survey in collaboration with local managers to address various factors concerning fishery use and management. We asked specific questions about demand for fish, community attitudes towards regulations, and community preferences towards fishery resources. Our objective was to examine general trends in survey responses to draw conclusions based upon our analysis.

Sampling Design

Over an 8 week period in the summer of 2005 we conducted a survey of a cross section of villages in American Samoa. We used a stratified sampling technique that was aimed at capturing the average community member by representing the varying degrees of urbanization, geographical isolation, and access to coral reef fishing grounds. From this random sampling, 34 villages across the territory were selected to survey. The villages were urban and rural, coastal and inland, and in both remote and well-serviced locations throughout the Territory.

We obtained a list of local population and demographic information from the Census Data Report of 2000 (Census 2000). This data indicates that most of the villages are on the large island of Tutuila, with only a small number of villages on the Manu'a District island chain. We used the existing geographically divided political level of "county" as our stratum to conduct the villager survey as this would ensure a wide distribution of samples from across all districts. We classified the counties into small, medium, and large based upon the number of villages within each county (Table 3). A county containing fewer than 5 villages we classified as small, a county with between 5-8 villages we classified as medium, and a county with more than 8 villages we classified as large. Based upon this technique, we categorized 6 small counties, 3 medium counties, and 2 large counties. This method assured that each district was sampled and that a representative number of villages were surveyed.

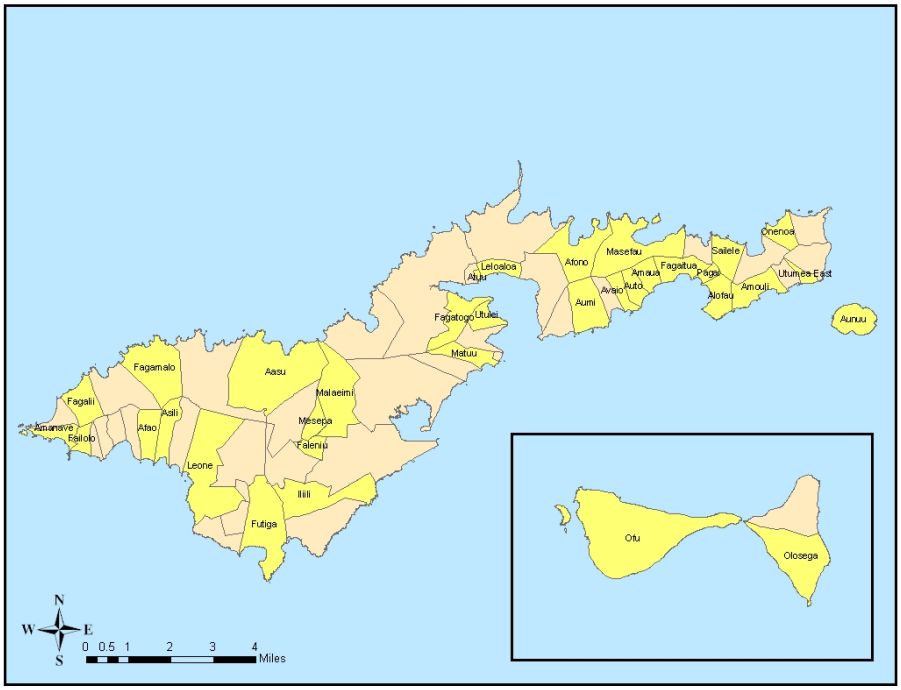
Excluding those villages participating in the Community Based Fishery Management Plans (CBFMP), we randomly selected 1 village from small counties (1*6), 4 villages from medium counties (4*3), and 6 villages from large counties (6*2) for a total of 30 villages. For the purposes of our analysis, inclusion of villages with a CBFMP was mandatory to make reasonable comparisons between villages with a CBFMP and villages without the program. To eliminate this risk of not having CBFMP villagers represented, we conducted a separate random sampling of villages in the CBFMP program. At the time of the sampling, there were 7 CBFMP villages, so 4 villages were randomly chosen. Villages of Ta'u Island were excluded from the sampling due to visiting limitations and monetary and time constraints. The new inclusion brought the total to 34 villages across the territory selected to be surveyed. The villages were urban and rural, coastal and inland, and in both remote and well-serviced locations throughout the Territory, representing all demographic regions of the territory. We administered a total of 425 surveys, with at least 12 surveys conducted at each village (except at Avaio village, where only 11 people could be found).

Table 3: Categorization of counties (small, medium, and large based on number of villages) with the corresponding villages sampled within each.

Stratum	County	Selected Villages
SMALL	Ituau	Matu'u
	Vaifauna	Onenoa
	Leasina	Aasu
	Tualati	Futiga
	Ofu*	Ofu
	Olosega	Olosega
MEDIUM	Ma'oputasi	Fagatogo, Leloaloa Atu'u, Utulei
	Sa'ole	Aunu'u, Utumea East, Amouli. Pagai
	Tualauta	Mesepa, Faleniu, Malaeimi, Illi'ili
	Community Based Fishery Management Program**	Amaua, Alofau Fagamalo, Auto
LARGE	Sua	Masefau, Avaio, Afono, Aumi, Faga'itua, Sa'ilele
	Lealataua	Amanave, Asili, Failolo Leone, Fagali'i, Afao

* Ofu village was randomly chosen, but because of our efforts to reach this separate Island and village, the adjacent village of Olosega was also surveyed.
** CBFMP villages were treated as a separate "medium county", and 4 villages were randomly selected.

Figure 2: Distribution of villages surveyed throughout Tutuila Island and Manu'a. Those highlighted are the sample villages.



Survey Design

We developed the questionnaire in collaboration with local managers of DMWR, Fagatele Bay National Marine Sanctuary, American Samoa National Park, and CRAG to integrate their key issues and considerations. The survey focused on the following socio-economic factors:

- Household demographics
- Fishing frequency
- Fish type preference and consumption patterns
- Perceived strictness of the current regulations
- Opinions of future regulations
- Sources of fishery education

We designed several questions to identify the distribution of different user groups of the coral reef fishery across the community. Personal demographic questions (ethnicity, citizenship, and income) were asked at the end of the survey, as opposed to the beginning, to reduce their influence on the answers and rejection by the respondents, based upon common survey

techniques (Burger et al. 1999; Passfield et al. 2001). Careful consideration was given to designing the questions in a manner that would obtain useable data from the public, while also being culturally sensitive. Surveys of this design and methodology have been previously conducted in American Samoa and Samoa which support our survey design strategy (Passfield et al. 2001; Sauafea and Curren 2000).

Our survey included mostly closed-ended questions with ordered or categorical choices in order to gather data capable of quantitative analyses. We designed these types of questions to facilitate completion by the respondent and to encourage participation. Open-ended questions were also used to obtain spontaneous answers without bias by forcing the respondents' attention on predetermined items (Arlinghaus and Mehner 2003). For instance, one multi-series question asked respondents to identify important fish and invertebrate species for five different types of use. This question aimed to capture an inventory of the top species important to the community at large while not forcing respondents to choose from a predetermined list. Qualitative techniques of content analysis could then be used to draw inferences from the responses. For further review, the survey is in Appendix G.

Language

The questionnaire was written first in English, translated into Samoan, and then back translated to English by a different translator. This method ensured that the Samoan translations accurately conveyed the English meaning and intent of the question. The survey was carried out in the language most preferred by the respondent. For Samoan surveys, one of thirteen local American Samoans conducted the translation with oversight from one of our group members.

Survey Methodology

We administered a pilot survey prior to entering the field to evaluate the clarity, comprehensiveness, and acceptability of the questionnaire. Following this pretest, we revised the questionnaire to incorporate suggestions and clarify ambiguous questions. We held a debriefing session with several of the translators and survey administers to collaborate on the

intentions of the survey and establish a standard set of methods for conducting the survey at each village and with each survey participant. Also, prior to entering the field, we notified the Office of Samoan Affairs and attended the Samoan Affairs Meeting. Our presence at the meeting, at which all village mayors were present, gave us the opportunity to announce our research goals and objectives. A Samoan translation of our survey plans was presented to the meeting attendants to request their cooperation and permission to enter their villages. Village mayors where also contacted on the day of the survey visit to ensure cooperation from the village members.

Two group members, accompanied by local translators, conducted one-on-one, interview style surveys with individuals older than fifteen years at arbitrarily selected households. Gathering locations, such as bus stops, *fales* (traditional Samoan housing structures) and markets were also used to meet village members. Interviews were conducted Monday-Saturday, dawn to dusk, from 21 July until 31 August 2005. Efforts were made to interview only one person from each household. Due to village, time, and human resource constraints, this was not always an option in the selected villages (particularly in Ofu and Olosega villages).

Comparison to Census Data

To corroborate that our survey was a random and representative sample of the population of American Samoa, we compared the demographic data from our survey to that of the 2000 census data. Table 4 compares the demographic statistics of the survey with the 2000 census data for language preference, gender, household size, matai status, and citizenship. As can be observed, the information gathered from survey closely matches the data of the census. Matai status is not available from the census data, thus no comparison can be made.

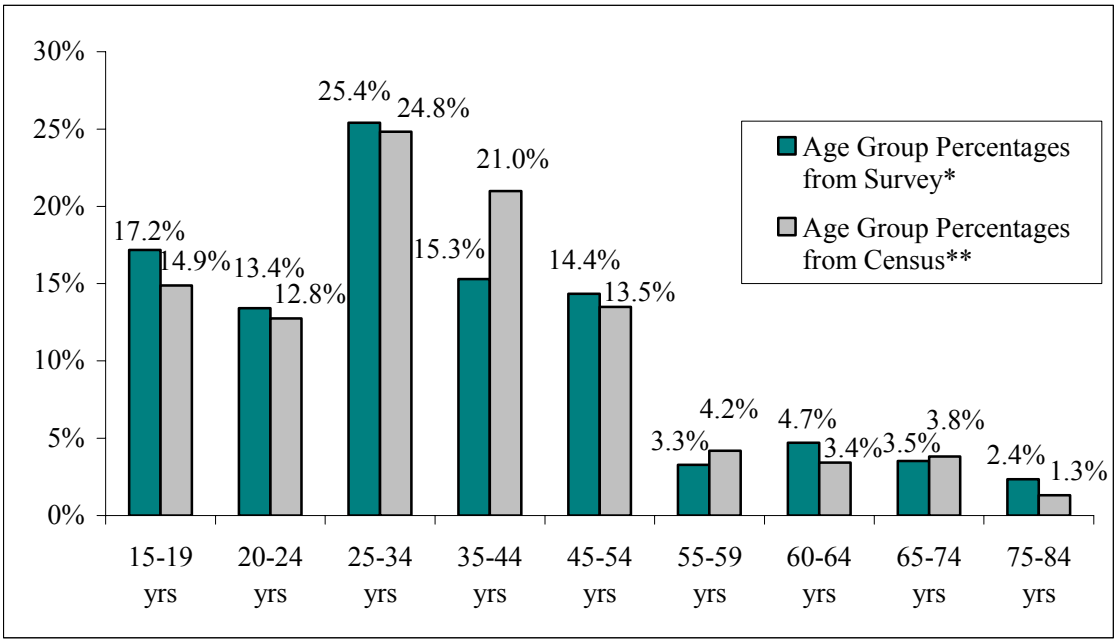
Table 4: Demographic statistics of survey compared to 2000 Census. Data corresponds to the language in which the survey was conducted and questions 1, 17, 18, and 20.

Demographic Information	Survey Statistics	Census
% Preferred Samoan Language	65.2	68.6*
% Female	48.9	48.8
Average Household Size	7.44	6.05
% Matai	17.0	Unavailable
% American Samoan citizens	55.0	57.4

* This percentage was calculated by multiplying the percent of people who spoke a language other than English (97.1%) by the percent of people who preferred to speak that language more than English (78.0%) by the percent of people of those whose other language was Samoan (90.6%).

Figure 3 represents the age distribution from the survey in comparison to the census data. As noted from the graph, in both our sample and the census data, the 25-34 year old age group makes up the greatest percentage of the population.

Figure 3: Age distribution of survey compared to 2000 Census.
This data only includes individuals older than 15 years. Data corresponds to survey question 1.



*Percentage of 425 respondents.
**Percentage of 8581 respondents.

Table 5 compares the income distribution from our survey with the census data. As can be observed in the table, the greatest number of people in our sample (30%) fall in the <$7500

range, as compared to 17% captured for this range within the census. The income range >$25000 contains the greatest number of people (36%), and our sample results in 12% of the respondents. The discrepancy between the income distributions of both the upper and lower income bracket may be explained by the addition of the no answer responses, assuming that those in the highest or lowest income bracket were most likely not to respond to the question in our survey. Alternative reasons for the discrepancies are the time of day that our surveys were conducted (afternoon when people are at work), or how we divided the Census income brackets.

Table 5: Number of Respondents in Specified Income Range*

Income Range	From Survey	Percentage	From Census	Percentage
<$7500	93	30%	1551.5	17%
$7500-$14999	98	31%	2327.5	25%
$15000-$24999	84	27%	2079	22%
>$25000	37	12%	3391	36%
Total Respondents	312		9349	

* The Census included more categories (under $5000, $5000-$9999, $10000-$14999) than our survey. For comparison purposes, we added all Census data categories under $5000 and divided the counts from the $5000-$9999 and $10000-$149999 in half to match the income brackets used in the survey.

Survey Limitations

Though the survey was designed to be clear and unbiased, there are always inherent flaws with socio-economic surveys that can lead to imprecise results. Some of these limitations have to do with the questions themselves. There is no certainty in whether the respondent fully comprehended the question asked. For example, respondents could have been confused about the difference between frequency of fishing for food and fishing for fun, where the distinction being made between subsistence fishing and recreational fishing might not have been clear. Another vague example was the lack of specificity in the differentiation between fresh and canned tuna when asking about fish preferences.

An additional concern with surveys is that there is often no incentive for respondent to tell the truth. In particular, the questions in our survey about regulations, enforcement, and perceptions of illegal fishing could have misleading results if some respondents answered

what they thought would be the best answer as opposed to their actual opinion. For example, when asked about their perception of illegal fishing in American Samoa, respondents who fish illegally might have been inclined to say that they do not partake in it or that it does not occur. Consequently, the results would indicate that illegal fishing is not a problem, when in reality, there is illegal activity.

Some final limitations to the survey have to do with logistic matters, such as the time, place, and language of the survey. Most surveys were administered during mid-day hours, thereby minimizing the number of available respondents who work during normal business hours. Additionally, due to limitations in accessibility, some villages were not selected for surveying. The small sample size from each village (12 people) also limits the ability to draw results specifically between villages. The language difference between English and Samoan is another limitation to consider. Despite our translation efforts, there is likely to remain some imprecision in the final conversion from English to Samoan. Finally, there may have been a bias associated with the survey conductors. It is possible for people conducting the surveys to unintentionally lead a respondent to a particular answer or suggest a possible answer. Although we aimed to reduce the chances of all of these limitations and sources of bias in our survey design and methods, the possibility of their occurrence should be considered when interpreting results.

Data Analysis and Definition of Terms

To analyze our data, we used a variety of statistical methods, including summary statistics, analysis of variance tests (ANOVA), chi-squared tests, and multivariate regressions. Statistical analyses were performed in Excel and JMP 5.1 software. The responses to the survey questions were first evaluated using summary statistics such as histograms, bar graphs, and tables. We then defined a series of user groups towards which to focus management strategies. These user groups were initially analyzed using ANOVA and chi-squared tests, which compare the mean value of a response, such as level of agreement with a type of regulation. The user groups and other factors, such as coastline and regulation agreement, were then further evaluated using regression analysis. Regression analysis determines the factors which potentially influence a response to a survey question by holding

all other factors constant and evaluating each factor separately. The influential factors can then be used to support management decisions. Significant factors, as identified in the regressions, were then further evaluated at the village level by comparing mean values between villages using ANOVA and z-scores. A z-score is the difference between each value and the mean for all villages, divided by the standard deviation for each variable. The z-scores were then normalized and visually represented using ArcGIS 9.0. The user groups and factors used are defined below:

Definition of Terms and User Groups

Frequency of Fishing

Question 5 in the survey asked the respondent to specify the frequency, in units of times per month, with which they utilized or fished reef fish for a variety of specified reasons. The following terms define the specific uses we considered in our analysis.

> *Subsistence Fishing* – Refers to the frequency with which the respondent catches fish and/or shellfish for their family to eat. The average frequency of subsistence fishing is 2.8 times a month.
> *Gleaning* – The activity of collecting invertebrates and tidal species when the tide is low is referred to as gleaning. Respondents were grouped into two user groups based on whether or not they gleaned.
> *Recreational Fishing* – Refers to the frequency with which the respondent catches fish and/or shellfish for enjoyment. The average frequency of subsistence fishing is 3 times a month.
> *Using Fish for Cultural Purposes* – Refers to the frequency with which the respondent eats fish and/or shellfish for cultural purposes.
> *Fishing Frequency* – Refers to the frequency with which the respondent catches fish and/or shellfish for their family to eat combined with the frequency with which they catch fish and/or shellfish for enjoyment. The average fishing frequency for subsistence and recreational purposes is 5.4 times a month.

Fishing User Groups

Those who fished for subsistence and recreational purposes were then grouped into fishing user groups according to the average fishing frequency.

> *Above Average Fishers* – Those who indicated a fishing frequency of 6 or more times a month for subsistence or recreational purposes.
> *Below Average Fishers* – Those who indicated a fishing frequency of 5 or less times a month for subsistence or recreational purposes.
> *Non-Fishers* – Those who indicated that they did not fish for either subsistence or recreational purposes.

Preferred Level of Fishery Management

Preferred level of fishery management refers to survey question number 9, in which the respondents were asked to indicate how they would like DMWR to formulate the rules for fishing the coral reefs in the future. Respondents were asked to choose one of the following: village, district, island, territory wide, or other.

Perception of Illegal Fishing

Perception of illegal fishing refers to survey question number 10, in which the respondent was asked: "Out of every 100 days coral reef fishing occurs in American Samoa, how many of those days do you think coral reef fishermen are involved in illegal fishing activity?" For the summary statistics, we grouped the respondents' perception of illegal fishing into bins of no answer, zero, and twelve equal distributions of 1-10, 11-20; to 100 times per 100 days. For regression analysis, we evaluated this factor in a nominal format, grouping the respondents into two categories; one group of respondents who gave an estimate for the frequency of illegal fishing, and the other group of respondents who provided no answer, did not know, or answered zero.

Level of Agreement with Regulations

Questions 12 and 13 in the survey asked the respondent to indicate their level of agreement with a series of statements regarding the implementation of 8 different regulation types. These statements are as follows:

- DMWR should regulate who is allowed to fish (permits, licenses).
- DMWR should regulate what kind of fish and/or shellfish is caught.
- DMWR should regulate what is done with the catch after it is caught.
- DMWR should regulate when people can fish.
- DMWR should regulate where people can fish.
- DMWR should regulate how people can fish (gear regulations and boat regulations)
- DMWR should regulate fishing during fish and/or invertebrate spawning events.
- Fishing regulations should be placed on individuals younger than eighteen.

Respondents were asked to choose among five levels of agreement: agree, somewhat agree, neutral, somewhat disagree, and disagree. For the regression analysis, the responses for each regulation type were combined into two groups; agree and disagree. To do so, we grouped the respondents who answered somewhat agree and agree, discarded the neutral responses (which did not exceed 4% of total respondents for each regulation type), and grouped the respondents who answered somewhat disagree and disagree. This yields a division of two agreement levels to indicate an overall disagreement or an overall agreement with the regulation type. For a full report of all the responses see Appendix H. For the regression analysis, we evaluated the responses using nominal logistic regression. We also composed a variable for agreement level with all regulations, termed *overall agreement*. This variable was created by assigning a numerical value for the two groups, agree (1) and disagree (0), and summing the responses for all 8 regulation types (referred to as a binary sum method). Therefore, the respondent's overall agreement with the 8 regulation types, or the total number of regulations with which the respondent agreed, are indicated on a scale of 0 to 8, from disagree to agree.

Sources of Fishery Education

Question 15 in the survey requests the respondent to indicate the frequency with which they receive fishery education from a series of sources. These sources of fishery education are as follows:

- School
- College
- Fishery Workshops
- Television/Radio
- Newspapers
- Pamphlets
- Family
- Other (please specify)

Five different frequencies were provided for the respondent to choose from: most days, once a week, once a month, once a year, and never. We then assigned numerical values to the responses as follows:

- In all cases, "most days" was assumed to be at least 80% of a year.
- For fishery education from School and College, the year was considered 180 days, which is the typical number of days in a school year. Thus "most days" was 80% of 180, or 144 days; once a week was 36 days; and once a month was 9 days.
- For fishery education from Television/Radio, Newspapers, Pamphlets, and Family, the year was considered 365 days, therefore "most days" was assumed to be at least 80% of 365 days, or at least 292 days.

We divided the fishery education sources into four categories:

Workshop Education –This term refers to the frequency with which respondents had attended a fishery workshop. The respondents were grouped into two categories, those who had attended 1 or more fishery workshops, and those who had not attended a fishery workshop.

Fishery Education from Media Sources – This term indicates the sum of the frequency of fishery education from Television/Radio, Newspapers, and Pamphlets. This source is also referred to as *Media Education*.

Fishery Education from School – This term indicates the sum of the frequency of fishery education from School and College. This source is also referred to as *School Education.*

Fishery Education from Social Sources – This term indicates the frequency of fishery education from family and other social/informal sources. This source is also referred to as *Social Education*.

Community Based Fishery Management Program

The community based fishery management program factor refers whether or not a respondent is from a village with a Community Based Fishery Management Program, also shortened to CBFM.

Curfew

Local government officials suggested the use of curfew as a proxy for the strength of each village's social structure. In American Samoa, curfew refers to the presence or absence of an evening prayer time in the village. During this prayer time, villagers are prohibited from leaving their homes and cars are not allowed to pass through the village. We specify three types of village curfews as variations in the strength of the social structure

Enforced Curfew – This term refers to a village with an enforced prayer time with a designated *amuaga,* or village policemen, for enforcement.

Unenforced Curfew – This term refers to a village with a prayer time, but one that is poorly enforced with no designated *amuaga* for enforcement.

No Curfew – This term refers to a village without a specified prayer time.

Age Division

We divided the respondents into quartiles based upon age. Four age categories were used in the analysis:

Group A: 15-22 years old
Group B: 23-30 years old
Group C: 31-35 years old
Group D: 46 years old and up

Population Density of Village (in people/m^2)

We estimated population density of each village surveyed as the number of people per square meter of potentially developable land. Developable land is considered to be any land with a slope area of a grade of thirty percent or less, as determined by Craig et al. (2004) in the Status of Coral Reefs Report. The developable land area was calculated using Digital Elevation Model slope data[3]. These values were converted from degrees to percentage, and 30% was used as the cut-off between developable and undevelopable land. Using the "tabulate area" tool in GIS, developable and undevelopable land was calculated for each village. For the regression analyses, we evaluated this factor as continuous data.

Limitations

As in any data analysis, there are limitations concerning the use of data. For many of the factors affecting the fishery and fishery use, such as fishing effort, water quality, and the quality and effectiveness of fishing education, there was little to no data available. Additional data would be useful to DMWR to support management decisions. The incorporation of several other factors would give managers a thorough understanding of the resources and stakeholders involved and help to provide a clearer picture of how to manage marine resources.

[3] Accessed from USGS; http://www.usgs.gov

An additional gap in our data analysis is a result from respondents failing to answer all the survey questions. For example, many respondents did not indicate their income level. In regression analysis, the lack of a data point causes the responses for that individual to be discarded for all factors, thus altering the effects of other factors. Due to the lack of consistency with the income data, this factor was not considered in all analyses.

Our division of user groups may also limit the analysis. The user groups defined were based on literature review and logical differentiation, but are not the only way to distinguish the users of the fishery and focus management strategies. A final consideration is the low R^2 values in the regression analyses. In general, R^2 values for statistical analysis of surveys are low, and it should be noted that the effects postulated are general trends.

Community Use, Opinions, and Preferences of Fishery Resources

One of the crucial steps in developing a fishery management plan in a small island setting is to determine the use of the fishery as well as elicit community input about their preferences and priorities (Fiske 1992). Therefore one of the aims of our survey was to provide DMWR basic information about the frequency of different uses of the fishery and the community fish and invertebrate preferences. To support an approach that is bottom-up, we elicited community opinions about which uses of the fishery respondents perceived as important.

Community Opinions about Fishery Resource Use

To assist DMWR in prioritizing management strategies, one of our objectives in conducting this survey was to determine which coral reef fishery uses the community thought were important. Table 6 shows that the vast majority of survey respondents felt that maintaining a healthy ecosystem and fishing for food were important uses of the fishery. A substantial majority also felt cultural use of the fishery was important, while commercial use of the fishery (buying and selling) and recreational fishing were considered important by significantly less number of respondents. In contrast, it is also worth noting that both fish for recreation and fish for the aquarium trade are two uses considered unimportant by a large percentage of the respondents (32% and 44%, respectively).

Table 6: Importance of Fish Use as a Percentage of 425 Respondents.
Data corresponds to survey question 11.
For individual representation of each fish use importance, see Appendix F.

	Importance of Fish for Food	Importance of Fish to Buy	Importance of Fish to Sell	Importance of Fish for Recreation	Importance of Fish for Cultural Use	Importance of Fish for Aquarium Trade	Importance of Fish to Maintain a Healthy Ecosystem
Important	90%	32%	46%	45%	73%	25%	91%
Somewhat Important	5%	36%	19%	16%	13%	20%	4%
Neutral	2%	2%	5%	4%	3%	6%	1%
Somewhat Unimportant	1%	5%	3%	3%	1%	4%	1%
Unimportant	2%	24%	26%	32%	8%	44%	3%
No Answer	0%	0%	1%	1%	1%	1%	0%

Fish Preference

The determination of community preference of fish and invertebrates is another component which helps DMWR to prioritize fishery management strategies. This information may be used for species-specific regulations like size limits and seasonal harvest. As seen in Figure 4, the majority of respondents had no preference towards a particular type of fish. Likewise, the three specific fish types (reef fish, tuna and bottom fish) display a similar percent preference, indicating indifference among the types. This type of response is expected, given the multi-species nature of the coral reef fishery. Similar to the fish type preference results, greater than half of the respondents (56%) reveal no preference in invertebrate type. Among those respondents who gave a preference, lobster was the most preferred invertebrate with 22% of the respondents.

Figure 4: Fish Type Preference as a Percentage of 425 Respondents.

Data corresponds to survey question 2.

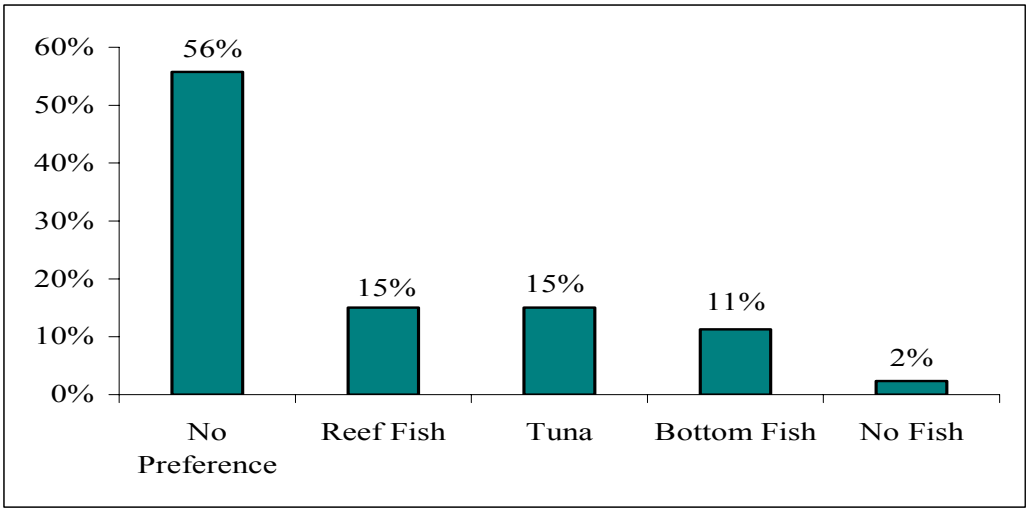
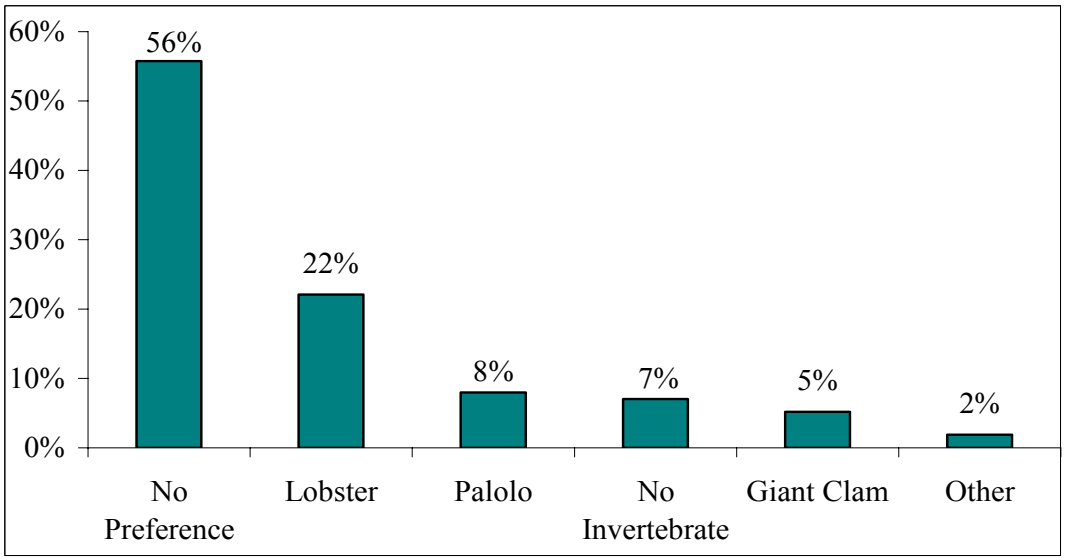


Figure 5: Invertebrate Type Preference as a Percentage of 425 Respondents.

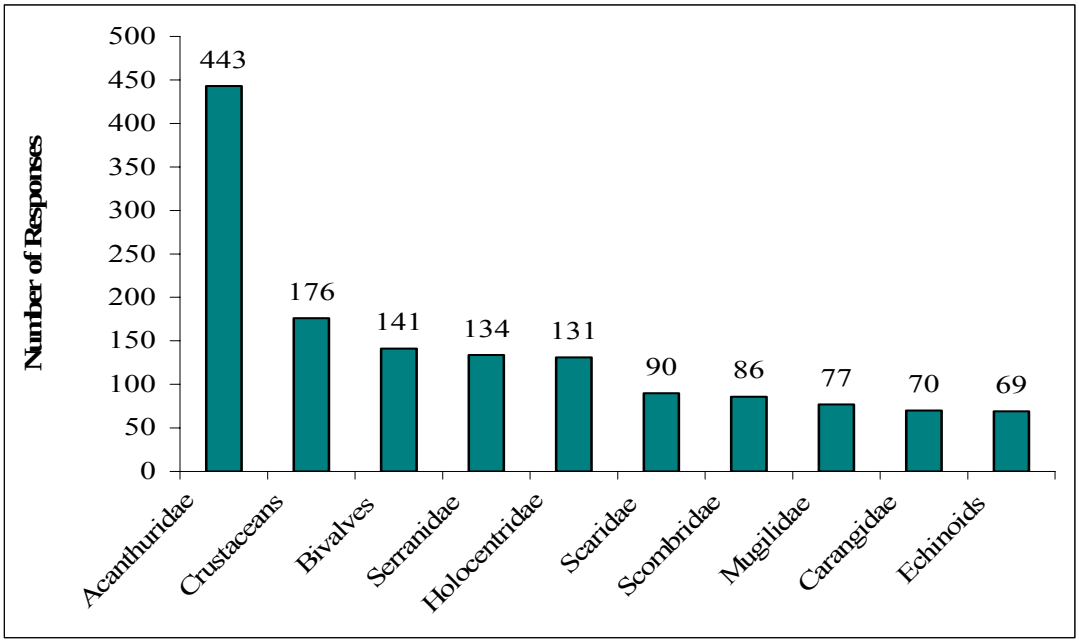
Data corresponds to survey question 3.



Finally, we wanted to know, specifically, which types of fish the community felt were important for different uses of the fishery. Figure 6 displays the top 10 responses to the open-ended question regarding which types of fish respondents felt were important to catch for food. We found that the most popular answer were species from the family *Acanthuridae*,

commonly known as surgeonfish. This is consistent with the coral reef monitoring program results, which found that the top 5 species with the highest sighting frequencies were from the *Acanthuridae* family (Whalen and Fenner 2005).

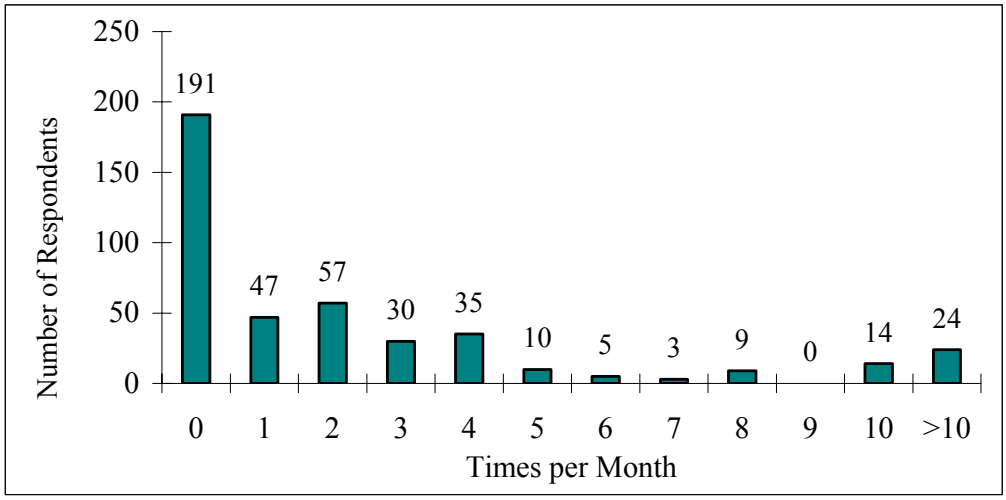
Figure 6: Top 10 most Important Fish and Invertebrates for Subsistence Fishing
Data corresponds to survey question 8.



Use of the Fishery

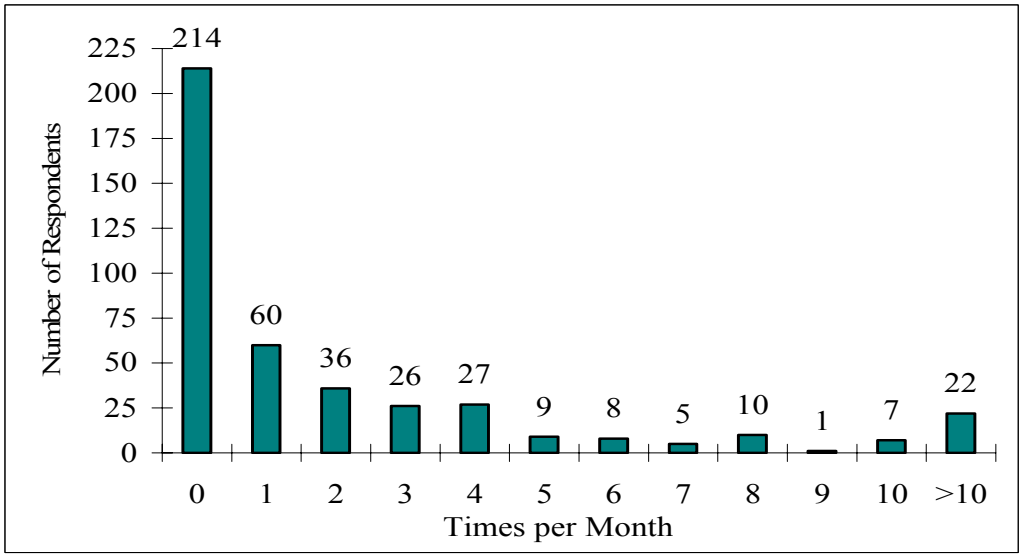
To determine the current use of the fishery, we asked the survey respondents to indicate the number of times per month they used the fishery for various purposes. Figures 7 through 9 display the frequency of use for subsistence + recreational fishing and cultural purposes. Although a vast majority of respondents felt subsistence fishing was an important use of the resource, a significant portion (191 of 425) also responded that they never fished for food (Fig.7). Of those respondents who did fish for food, the majority fished less than 5 times/month, with most (57 of 234) fishing 2 times/month.. It is important to note that there is a significant amount of respondents (24) that fish more than 10 times/month. Additionally, it is important to consider that these results indicate the number of people who fish, but does not include other members of the household and village who rely on the catch from these activities.

Figure 7: Frequency of Subsistence Fishing for 425 Respondents.
Data corresponds to survey question 5.



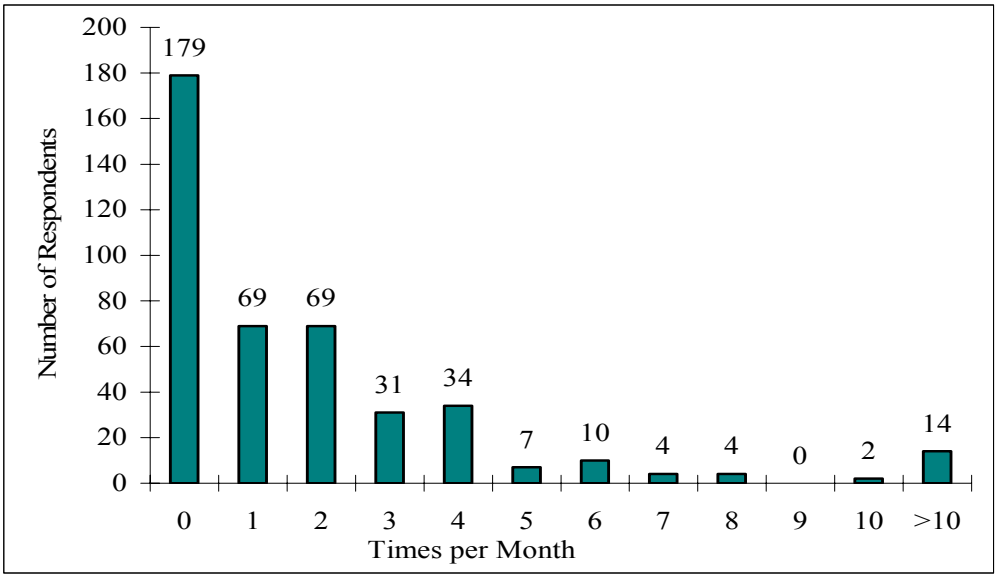
As seen in figure 8 below, the majority of respondents (214 of 425) indicated that they never fish for recreational purposes. Of those respondents that did recreationally fish, most fished less than 5 times/month, with most (60 of 206) fishing 1 time/month.

Figure 8: Frequency of Recreational Fishing for 425 Respondents.
Data corresponds to survey question 5.



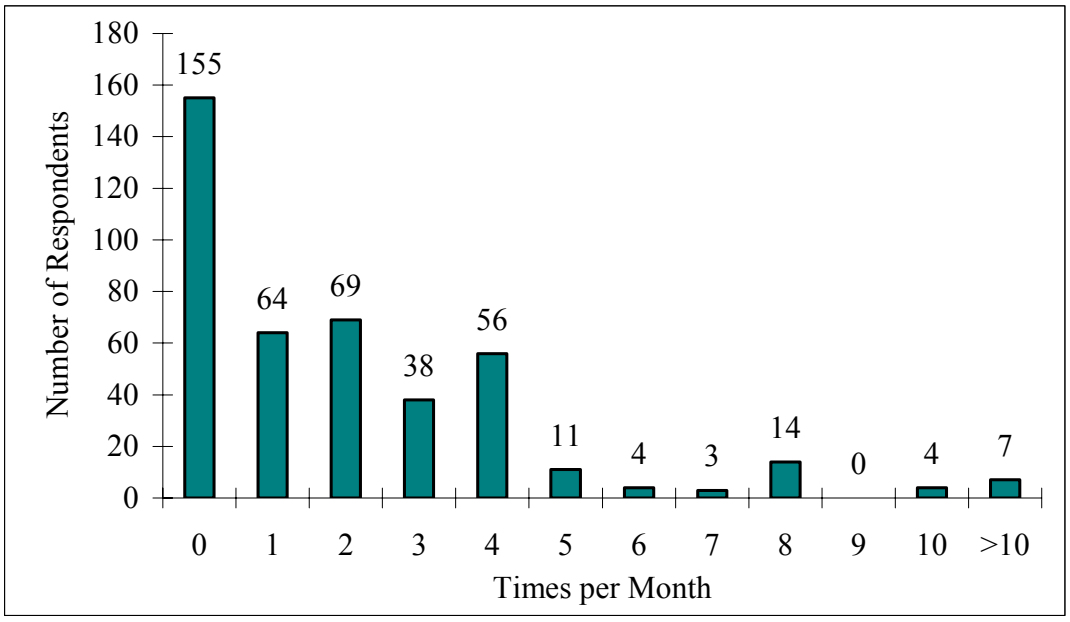
In contrast to the low recreational use, a substantial number of respondents (244 of 425) used fish for cultural purposes at least 1 time/month (Figure 9). A small number of respondents (14) used fish for cultural purposes more than 10 times/month.

Figure 9: Frequency of Using Fish for Cultural Purposes for 423 Respondents.
Data corresponds to survey question 5.



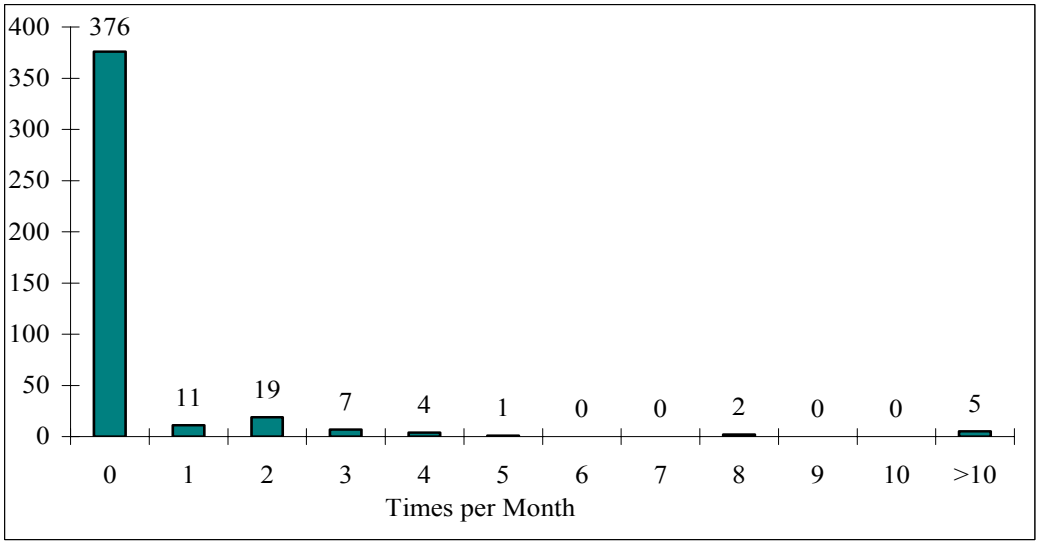
As for commercial use of fish, over half of all respondents answered that they bought fish at least 5 times/month (Figure 10). However, because reef fish are imported from neighboring Samoa, this result does not necessarily reflect the use of American Samoa's fishery resource.

Figure 10: Frequency of Buying Fish for 425 Respondents.
Data corresponds to survey question 5.



Finally, a vast majority of respondents (394 of 425) did not sell fish (Figure 11). Of those respondents that did sell fish, a very small number (5) sold fish more than 10 times/month, suggesting that most commercial sellers are not economically dependent on the resource.

Figure 11: Frequency of Selling Fish for 425 Respondents.
Data corresponds to survey question 5.



Trends in Fishery Use

In addition to measuring the current use of the American Samoan community, we also used regression analysis to determine the environmental and socioeconomic factors that affect their fishery use. A regression can be a valuable tool when developing long-term fishery management strategies by helping to determine the factors that influence the way people use the fishery. This measurement can be utilized to model how fishery use can vary with changes to natural ecosystem processes of the fishery as well as the socioeconomic context of fishery use. For example, if household income is determined to be negatively correlated to the frequency of subsistence fishing activity, managers can infer that as average household income of possible fishermen increases, the level of subsistence fishing activity will subsequently decrease by an amount estimated by the model. In this way, meaningful predictions regarding the levels of fishing activity can be made as updated environmental and socioeconomic data becomes available. This in turn facilitates the development of long-term fishery management strategies that are adaptive to constantly changing environmental and socioeconomic data.

In this analysis, we separated subsistence and recreational fishing because 90% of survey respondents said that catching fish for food was important, while only 45% said fishing for fun was important (Table 6). The factors we hypothesized to be significant in both subsistence and recreational fishing are:

- Age
- Gender
- Curfew
- Citizenship
- Matai Title
- CBFM Participation
- Media Education
- Social Education
- School Education
- Workshop Education
- Habitat Complexity
- Coastline
- Population Density
- Income

We used a nominal logistic regression to estimate the probability of being in the above average subsistence fishing group, leading to the final model:

Probability of being in the above average subsistence fishing group$_i$ = $1/(1+exp(\alpha_0 + \alpha_1*(Age) + \alpha_2*(Gender) + \alpha_3*(\text{Curfew}) + \alpha_4*(\text{CBFM}) + \alpha_5*(Coastline) + \alpha_6*(Citizenship) + \varepsilon_i))$

Holding all else constant, Table 7 shows the probabilities of individuals falling into each of the subsistence fishing frequency groups.

Table 7: Final Model for Subsistence Fishing Frequency

Variable	User Group	Probability of being a non-fisher	Probability of being a below average fisher	Probabiliaty of being an above average fisher	Effect
Age	15-22	57%	26%	17%	People between 23-30 have the highest probability of being above average subsistence fishers. People 15-22 have the highest probability of not subsistence fishing.
	23-30	39%	28%	32%	
	31-45	55%	18%	27%	
	46 and up	56%	22%	22%	
Gender	Female	67%	20%	13%	Males are more likely to be below average and above average subsistence fishers. Females are more likely to not subsistence fish.
	Male	35%	25%	40%	
Curfew	No	58%	21%	21%	People in villages with an unenforced curfew are most likely to be above average subsistence fishers and the least likely to not subsistence fish.
	Enforced	58%	26%	16%	
	Unenforced	38%	22%	40%	
Coastline	800 meters	59%	21%	21%	People living in villages with larger coastlines are more likely to subsistence fish more frequently.
	4000 meters	48%	25%	27%	
	8000 meters	35%	29%	35%	
Citizenship	Non-Samoan	62%	20%	17%	Non-Samoans are more likely to not subsistence fish. Samoans are more likely to be below average and above average subsistence fishers.
	Samoan	41%	27%	32%	

The final model for recreational fishing is as follows:

Probability of being in the above average recreational fishing group$_i$ = $1/(1+exp(\alpha_0 + \alpha_1*(Curfew) + \alpha_2*(CBFM) + \alpha_3*(\text{Social}) + \alpha_4*(\text{Coastline}) + \alpha_5*(Population\ Density) + \varepsilon_i))$

Holding all else constant, Table 8 shows the probabilities of individuals falling into each of the subsistence fishing frequency groups.

Table 8: Final Model for Recreational Fishing Frequency

Variable	User Group	Probability of being a non-fisher	Probability of being a below average fisher	Probabiliaty of being an above average fisher	Effect
Social Education	60 days	41%	29%	30%	People who receive the most social education are the most likely to be above average recreational fishers. People who receive the least amount of social education are most likely not to fish recreationally.
	120 days	40%	27%	33%	
	180 days	38%	26%	36%	
CBFM Participation	No	53%	24%	23%	People living in CBFM villages are more likely to fish recreationally more frequently.
	Yes	27%	29%	43%	
Curfew	No	46%	30%	24%	People living in a village without a curfew are most likely to not recreationally fish. People living in villages with an unenforced curfew are most likely to be above average recreational fishers.
	Enforced	42%	22%	35%	
	Unenforced	30%	30%	40%	
Coastline	800 meters	40%	29%	31%	People living in villages with the most coastline are most likely to be above average recreational fishers.
	4000 meters	44%	25%	32%	
	8000 meters	41%	23%	37%	
Population Density	0.0005 people/meter^2	41%	28%	31%	People living in villages with higher population densities are most likely to be above average recreational fishers. People living in villages with low population densities are more likely to not recreationally fish.
	0.0015 people/meter^2	39%	27%	34%	
	0.004 people/meter^2	35%	24%	41%	

Discussion

Village curfew is a significant correlative factor for both the frequency of subsistence fishing and the frequency of recreational fishing. For subsistence fishing, individuals in villages that have an unenforced curfew are most likely to be above average subsistence fishers and least likely to be non-fishers. Results for recreational fishing are similar, with people living in villages with an unenforced curfew as the most likely to be an above average recreational fishers. For subsistence fishing, respondents living in villages without a curfew are the least likely to be recreational fishers.

Our analysis also reveals that individuals living in villages participating in the CBFM program are more likely to fish recreationally more frequently than respondents from villages not in the CBFM program. A possible explanation for this is that prior to entering the program, the people in the village fish frequently and therefore find it necessary to manage their resource. In other words, the regression does not imply that CBFM participation causes

individuals in those villages to fish more frequently, but it does indicate the significance of this program in relation to fishing frequency.

Policy Themes

Regulation

Significance

To maximize effectiveness of management, stakeholder perceptions, attitudes and experiences regarding regulations should be considered while formulating decisions to fishery management problems. Built into the context of regulatory regimes, identification of user groups and their agreement levels with management strategies can assist to ensure compliance (Pomeroy 1995). User group perceptions about current and proposed regulation strategies can provide valuable insight for managers in the development of a community-driven management framework (Rhoads et al. 1999).

To provide current baseline data on opinions and perceptions of several different types of regulations among user groups of the near shore fishery in American Samoa, we aim to answer the following policy questions:

What is the current perception of fishery regulation?
With which types of regulations are people most likely to comply?
Which factors influence people's agreement level with regulations?
Is there a difference of opinion between user groups regarding attitudes and opinions towards fishery regulations and management policies?
At which spatial level of management do villagers want the fishery resources to be managed in the future?

Our objective within this policy theme is to provide DMWR with an assessment of user group perceptions and agreement levels with fishery regulation strategies. Additionally, we define the socio-economic factors that influence such perceptions and opinions. Identification of

these factors allows DMWR to focus future management decisions regarding optimal regulatory mechanisms.

Policy Theme Analysis

What is the current perception of fishery regulation?

Prior to making decisions about future changes in fishery management, it is important to understand the current opinions towards the existing regulations and enforcement. To assess the current perceptions of the strictness of regulations, we asked respondents to categorize existing enforcement and regulation as one of the following: "too strict", "about right", or "too lenient". The purpose of this survey question is to tease out whether or not respondents feel that the fishery is currently being managed in a satisfactory manner. As can be seen in Figure 12, 46% of the total respondents perceive the current regulation as too lenient. DMWR can use this finding to support future regulation implementation based on the fact that current management is perceived as not strict enough. Similarly, fifty percent of the total respondents perceive the strictness of current enforcement as too lenient, reinforcing the need for increased fishery management (Figure 13).

Figure 12: Perceived Strictness of Regulation

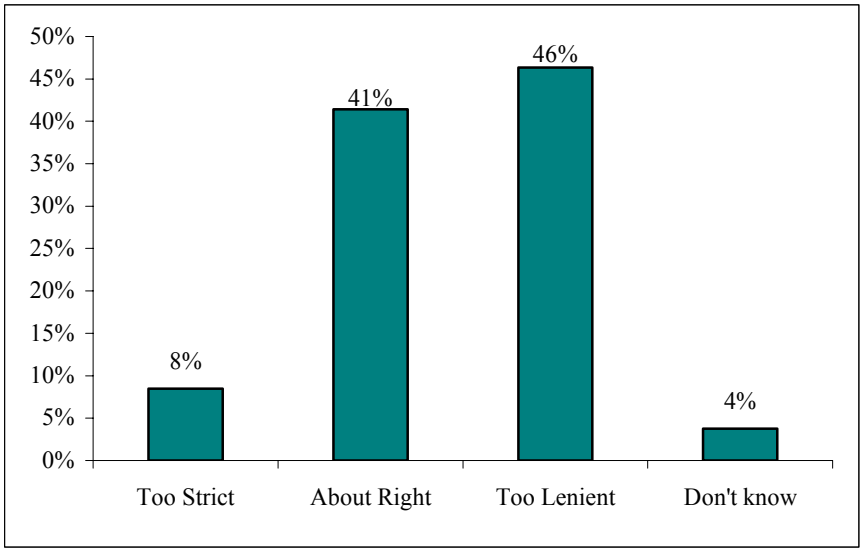
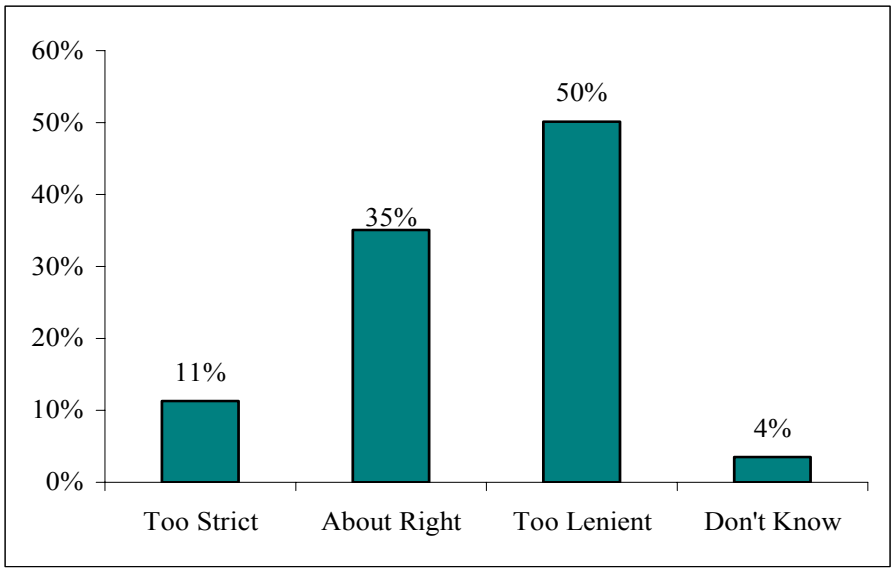


Figure 13: Perceived Strictness of Enforcement.



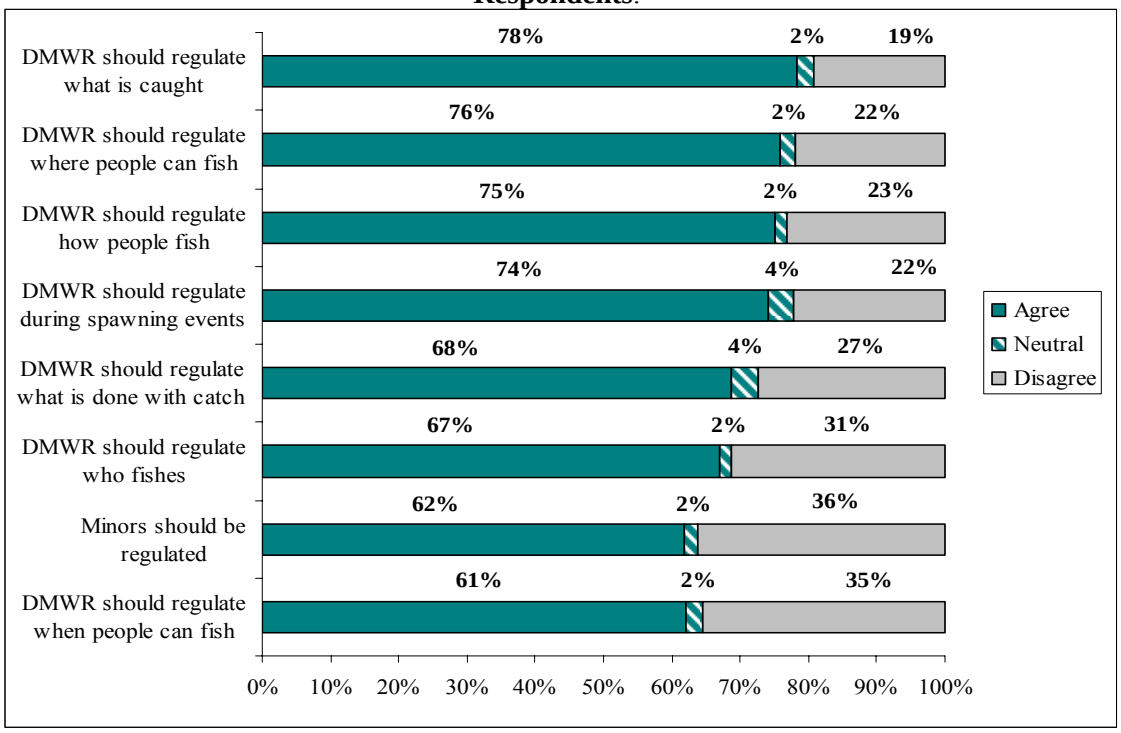
With which regulation types are people most likely to comply?

To evaluate the types of regulations which will have the highest level of compliance in the future, we asked village members to categorize their level of agreement with eight different statements regarding potential regulation types. If we assume that people's acceptance with a type of regulation is highly correlated with their compliance, then we can effectively derive the types of regulations with which people are most likely comply.

Our primary results below display an overall agreement level with each regulation type from the 425 respondents (Figure 14). In general, the response is in favor of these regulation types, with at least 61% of respondents in agreement with each regulation. Based upon this initial analysis, compliance is estimated to be greatest with the following four regulation types:

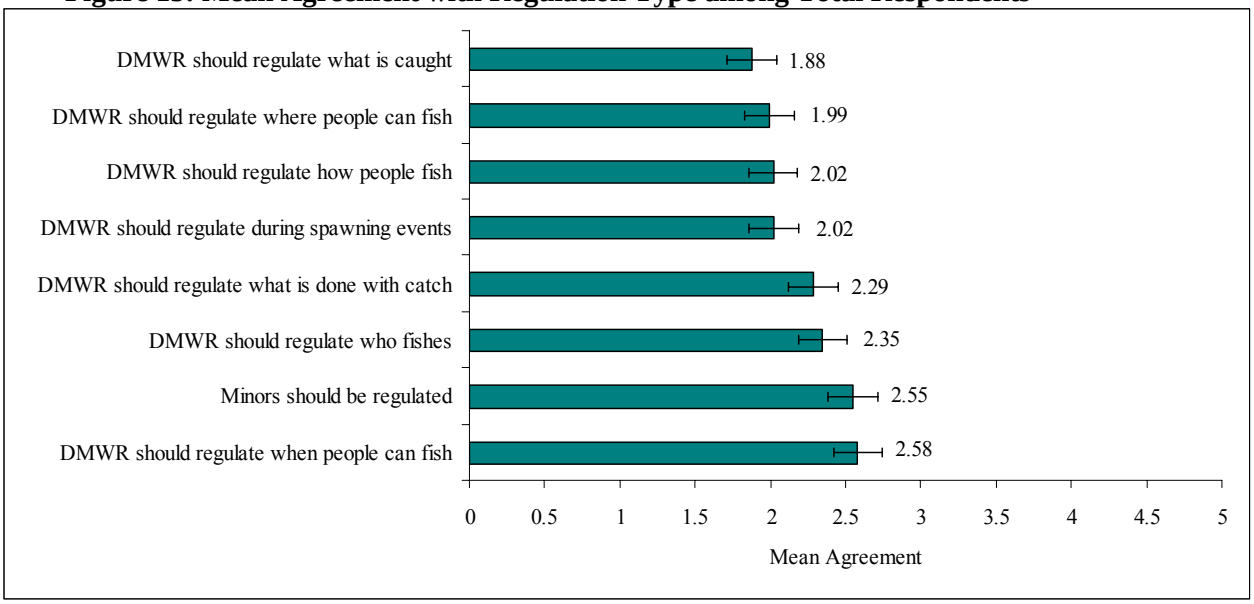
- "DMWR should regulate what is caught" (78% agreement).
- "DMWR should regulate where people fish" (76% agreement).
- "DMWR should regulate how people fish" (75% agreement).
- "DMWR should regulate during spawning events" (74% agreement).

Figure 14: Level of Agreement with Regulation Type as a Percentage of 425 Respondents.



While our initial analysis considers the difference in percentage agreement between regulation types, we also ran an ANOVA test to compare the mean agreement levels (on a scale of 1-5; from agree to disagree) with each regulation type. The mean agreement level for the four most agreed upon regulation types, as indicated above, are statistically different from the mean agreement levels of the four other regulation types (Figure 15).

Figure 15: Mean Agreement with Regulation Type among Total Respondents*



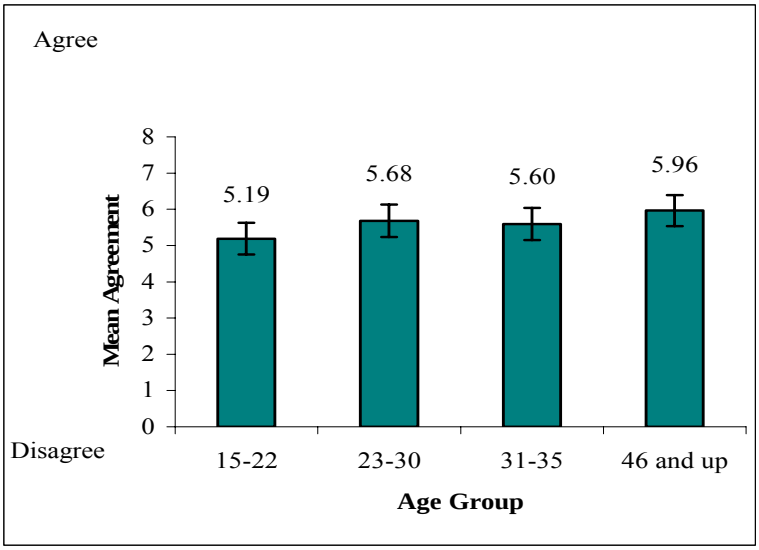
*ANOVA; $p<0.001$

What are the factors that influence people's agreement with regulation?
Is there a difference of opinion between user groups regarding fishery regulations and management policies?

To identify the factors that influence agreement levels with specific regulation types, we initially analyzed the differences of opinions within the earlier defined user groups. Using ANOVA tests, we compared the mean overall agreement between the defined divisions for each user group. Our intention was to highlight select groups which may necessitate specific management efforts. Following these evaluations, we then conducted more sophisticated regression analyses to identify the specific factors that influence agreement.

In terms of agreement with regulations overall, the general response is a high level of agreement, which is similar across all age groups. However, there is a significant difference between age group divisions, fishing frequency groups, respondents of different citizenship (Samoan and non-Samoan), and status of curfew and enforcement in the village. Within the age group divisions, people over the age of 46 display the greatest level of agreement, (5.96 on a scale from 0-8) while the youngest age group, people ages 15-22, display the least level of agreement (5.19 on a scale from 0-8) (Figure 16).

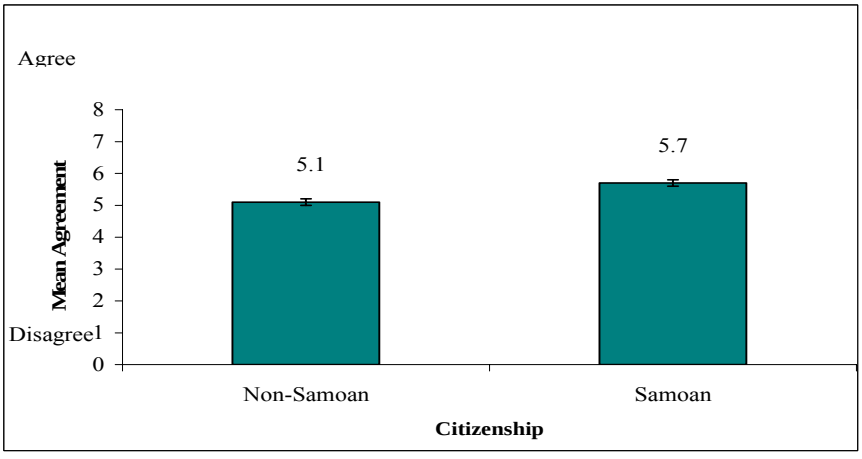
Figure 16: Mean Agreement Level with Regulations Among Age Groups*



*ANOVA; p<0.001

To assess whether opinions regarding regulations vary between respondents of differing citizenship, we compared the mean agreement level of respondents with differing citizenship. Based upon the groupings we made, there is a statistical difference in agreement with regulations between Samoan citizens and non-Samoan citizens (Figure 17). Respondents who are either a Samoan or American Samoan citizen agree with all regulation types more than citizens from other countries.

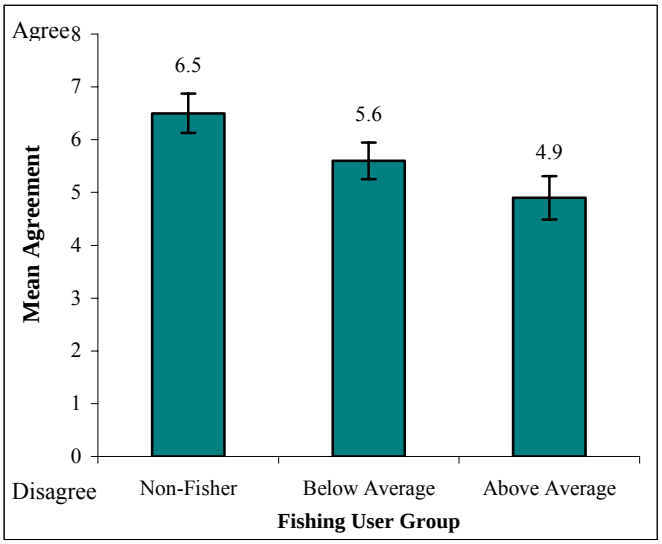
Figure 17: Mean Agreement Level with Regulations among Groups of Different Citizenship*



*ANOVA; p=0.1

Based upon the fishing frequency divisions we made for the analysis, there is a statistical difference in regulation perceptions between the three fishing user groups (Figure 18). It is interesting to note that respondents with an above average fishing frequency have a lower mean agreement level (4.95 out of 8) than both the non-fishers and the below average fishers (6.15 and 5.61 out of 8., respectively). Those individuals who fish more than 5 times a month agree with the least number of regulation types. In contrast, those respondents who do not fish display the highest level of agreement with regulations. Therefore, the people who are active in the fishery reveal an unwillingness to be regulated, while those individuals who do not take part in the fishery are the most accepting of regulations on fishing activity.

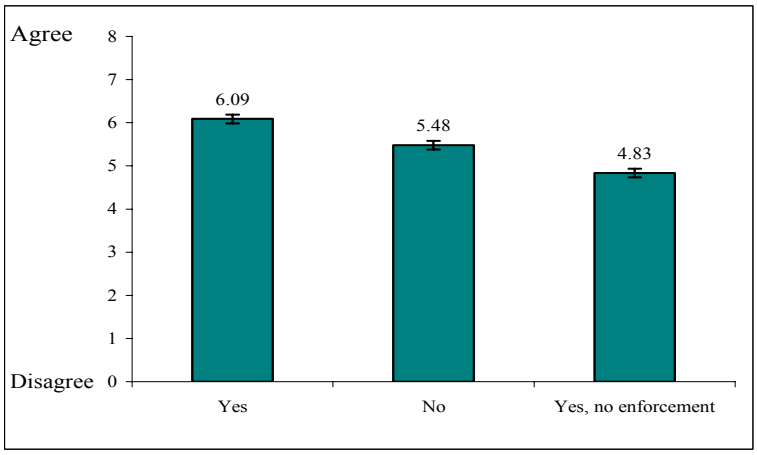
Figure 18: Mean Agreement Level with Regulations among Fishing User Groups*



*ANOVA; p=0.0001

There is also a significant difference in the mean agreement level with regulations between the three types of village curfew systems (Figure 19). The villages that have an enforced curfew display the greatest amount of agreement, with a mean value of 6.09 (on a scale of 0-8), followed by villages with no curfew, with a mean agreement level of 5.48. Villages that have a curfew that is not enforced have the lowest agreement level of 4.83.

Figure 19: Mean Level of Agreement with Regulations among Respondents with Different Village Curfew Systems*



*Chi-Squared, p<.0001

Further Analysis

While the data gathered by the survey presents current representation of the respondents' opinions and practices, it does not necessarily provide long-term information about trends in their opinions and practices. To develop management strategies that are effective in the long-term, it is fundamental to evaluate the significant factors which influence people's opinions about fishery regulations and enforcement. Knowledge of these factors will enable managers to help shape the attitudes toward regulation and increase compliance. To determine these factors, we ran regressions on the responses to the 8 different regulation types, as well as the on the overall agreement level, or the sum of agreement with all regulation types. For all of the regressions, 11 factors were initially considered as influential variables:

- Media Education (Continuous)
- Social Education (Continuous)
- Workshop Education (Nominal)
- Age Division (Nominal)
- CBFM (Nominal)
- Citizenship (Nominal)
- Matai title (Nominal)
- Curfew (Nominal)
- Perception of Illegal Fishing (Nominal)
- Fishing Frequency Group (Nominal)
- Gender (Nominal)

The overall agreement level was evaluated as continuous data with an ordinary least squares regression analysis. The final model, which only includes factors that are significant, is as follows:

$$Overall\ Agreement\ with\ Regulations = \alpha_0 + \alpha_1*(Fishing) + \alpha_2*(Social) + \alpha_3*(Workshop) + \alpha_4*(Curfew) + \alpha_5*(Age) + \alpha_6*(Citizenship) + \alpha_7*(Illegal\ Fishing) + \varepsilon_i$$

The influencing variables and their predicted effect are listed in Table 9 below. The difference from the average column describes the variable effect on the identified user group, holding all other factors constant.

Table 9: Significant Factors in Agreement with Regulation

Overall Agreement			
Variable	**User groups**	**Difference from Average**	**Effect**
Fishing Frequency	Above Average Fishers	-0.521	The less frequently the respondent fishes, the more likely they are to agree with a greater number of regulation types.
	Below Average Fishers	0.093	
	Non-Fishers	0.429	
Social Education		-0.003	The greater the frequency of fishery education from family and friends, the less likely they are to agree with the regulation types.
Workshop Education	Attendance	0.203	If the respondent has attended a fishery education workshop, they are more likely to agree with the regulation types.
	Non-Attendance	-0.203	
Curfew	Enforced Curfew	0.409	A respondent in a village with an enforced curfew is more likely to agree with a greater number of regulation types than a respondent in a village with an unenforced curfew or no curfew.
	Unenforced Curfew	-0.496	
	No Curfew	0.087	
Age	15-22	-0.538	A respondent who falls into the youngest age group is more likely to agree with a fewer number of regulations. In contrast, a respondent who falls into the oldest age group is the most likely to agree with a greater number of regulation types.
	23-30	0.155	
	31-45	0.122	
	46 and up	0.261	
Citizenship	Samoan	0.306	A respondent who is a Samoan citizen is more likely to agree with a greater number of regulation types.
	Non-Samoan	-0.306	
Perception of Illegal Fishing	No Estimate	-0.316	If the respondent did not give an estimate for their perception of illegal fishing, they are more likely to disagree with the regulation types.
	Estimate	0.316	

The responses to the 8 different regulation types were evaluated with a nominal logistic regression, leading to an initial model as follows:

$$Probability\ of\ disagreeing\ with\ regulation\ type_i = 1/(1+ e^{\wedge}(\alpha_0 + \alpha_1*(Media) + \alpha_2*(Social) + \alpha_3*(Workshop) + \alpha_4*(Age) + \alpha_5*(CBFM) + \alpha_6*(Citizenship) + \alpha_7*(Matai) + \alpha_8*(Curfew) + \alpha_9*(Illegal\ Fish) + \alpha_{10}*(Fishing) + \alpha_{11}*(Gender) + \varepsilon_i))$$

For each regression on the regulation types, the factors determined to be significant vary, leading to a final model which includes only the significant factors[4]. The influencing factors and their predicted effect on the respondent's opinion are listed in the tables below. The three factors; Social Education, Curfew, and Fishing Frequency, are consistently significant factors in the regressions on regulation types. The probability of agreement column describes the effect the variable has on the likelihood of agreement with the identified user group, holding all other variables constant. For a detailed account of results, refer to Appendix H.

Table 10: Significant Factors in Agreement with Regulation Types

"DMWR should regulate who fishes"			
Variable	**User groups**	**Probability of Agreement**	**Effect**
Fishing Frequency	Above Average Fishers	57%	An above average fisher is the least likely to agree with this regulation type.
	Below Average Fishers	70%	
	Non-Fishers	69%	
Social Education	80 days	68%	The greater the frequency of fishery education from family and friends, the more likely the respondent is to disagree with this regulation type.
	120 days	65%	
	160 days	63%	
Curfew	Enforced Curfew	74%	A respondent in a village with an enforced curfew is more likely to agree with this regulation type than a respondent in a village with an unenforced curfew or no curfew.
	Unenforced Curfew	57%	
	No Curfew	64%	
Perception of Illegal Fishing	No Estimate	59%	If the respondent did not give an estimate for their perception of illegal fishing, they are more likely to disagree with this regulation type.
	Estimate	72%	

[4] A statistically significant influence is determined by a p-value of 0.1 or less.

"DMWR should regulate what is done with catch"			
Variable	**User groups**	**Probability of Agreement**	**Effect**
Social Education	80 days	74%	The greater the frequency of fishery education from family and friends, the less likely they are to agree with the regulation types.
	120 days	72%	
	160 days	70%	
Workshop Education	Attendance	76%	If the respondent has attended a fishery education workshop, they are more likely to agree with the regulation types.
	Non-Attendance	68%	
Fishing Frequency	Non - Fisher	79%	Non - fishers are more likely to agree with regulating what is done with catch than below average fishers. Above average fishers are least likely to agree.
	Below Average Fisher	75%	
	Above Average Fisher	61%	
Perception of Illegal Fishing	No Estimate	66%	If the respondent did not give an estimate for their perception of illegal fishing, they are more likely to disagree with the regulation types.
	Estimate	77%	

"DMWR should regulate what is caught"			
Variable	**User groups**	**Probability of Agreement**	**Effect**
Fishing Frequency	Above Average Fishers	69%	An above average fisher is the least likely to agree with this regulation type.
	Below Average Fishers	72%	
	Non-Fishers	82%	
Social Education	80 days	76%	The greater the frequency of fishery education from family and friends, the more likely the respondent is to disagree with this regulation type.
	120 days	75%	
	160 days	73%	
CBFM	Attendance	66%	A respondent in a village with a Community Based Fishery Management Plan is more likely to disagree with this regulation type.
	Non-Attendance	82%	
Curfew	Enforced Curfew	83%	A respondent in a village with an enforced curfew is more likely to agree with this regulation type than a respondent in a village with an unenforced curfew or no curfew.
	Unenforced Curfew	62%	
	No Curfew	77%	
Age	15-22	59%	A respondent who falls into the youngest age division is least likely to agree with this regulation type.
	23-30	81%	
	31-45	81%	
	46 and up	76%	
Perception of Illegal Fishing	No Estimate	68%	If the respondent did not give an estimate for their perception of illegal fishing, they are more likely to disagree with this regulation type.
	Estimate	81%	

"DMWR should regulate when people can fish"			
Variable	**User groups**	**Probability of Agreement**	**Effect**
Fishing Frequency	Above Average Fishers	56%	Non-fishers are most likely to agree with regulating when people fish. Above average fishers are least likely to agree.
	Below Average Fishers	61%	
	Non-Fishers	73%	
Workshop Education	Attendance	70%	If the respondent has attended a fishery education workshop, they are more likely to agree with regulating when people fish.
	Non-Attendance	57%	
Curfew	Enforced Curfew	73%	A respondent in a village with an enforced curfew is more likely to agree with regulating when people fish than a respondent in a village with an unenforced curfew or no curfew.
	Unenforced Curfew	55%	
	No Curfew	62%	

"DMWR should regulate where people can fish"			
Variable	**User groups**	**Probability of Agreement**	**Effect**
Fishing Frequency	Above Average Fishers	62%	An above average fisher is the least likely to agree with this regulation type.
	Below Average Fishers	70%	
	Non-Fishers	81%	
Social Education	80 days	73%	The greater the frequency of fishery education from family and friends, the more likely the respondent is to disagree with this regulation type.
	120 days	72%	
	160 days	70%	
Curfew	Enforced Curfew	81%	A respondent in a village with an enforced curfew is more likely to agree with this regulation type than a respondent in a village with an unenforced curfew or no curfew.
	Unenforced Curfew	61%	
	No Curfew	71%	
Citizenship	Samoan	78%	A respondent who is a Samoan citizen is more likely to agree with this regulation type.
	Non-Samoan	64%	
Perception of Illegal Fishing	No Estimate	64%	If the respondent did not give an estimate for their perception of illegal fishing, they are more likely to disagree with this regulation type.
	Estimate	78%	

"DMWR Should Regulated How People Fish"			
Variable	**User Group**	**Probability of Agreement**	**Effect**
Media Education	200 dyas	81%	The more fishery education from the media that the respondent has received, the more likely they are disagree with this regulation type.
	250 days	80%	
	300 days	79%	
Workshop Education	Attendance	74%	A respondent who is attended a workshop is less likely to agree with this regulation type.
	Non Attendance	83%	
Social Education	80 days	81%	A respondent in a village with an enforced curfew is more likely to agree with this regulation type than a respondent in a village with an unenforced curfew or no curfew.
	120 days	79%	
	160 days	77%	
Age	15-22	69%	A respondent who falls into the youngest age division is more likely to disagree with this type of regulation.
	23-30	77%	
	31-45	82%	
	46 and up	85%	
Perception of Illegal Fishing	No Estimate	72%	If the respondent did not give an estimate for their perception of illegal fishing, they are more likely to disagree with this regulation type.
	Estimate	84%	
Fishing Frequency	0	86%	The more frequently a person fishes, the less likely they are to agree with this regulation type.
	Below Average	79%	
	Above Average	70%	

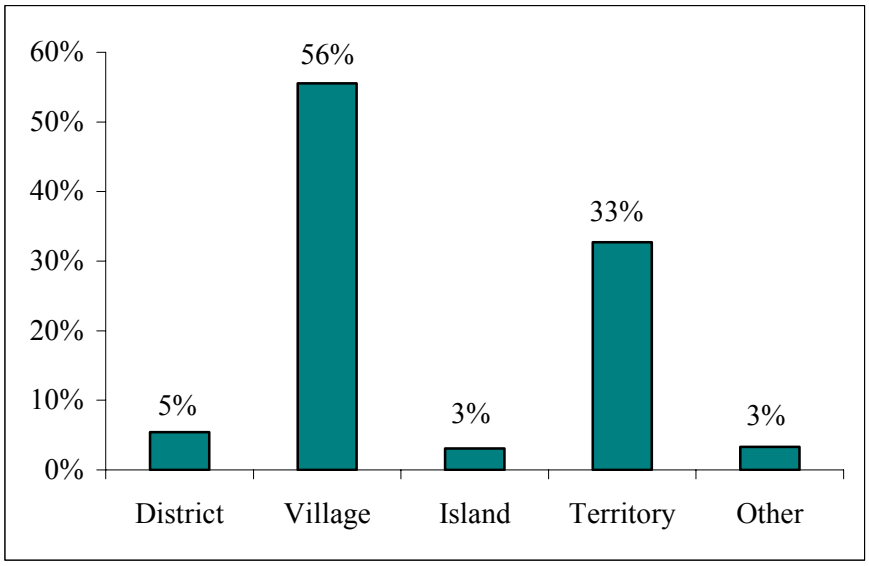
"DMWR Should Regulated During Spawning Events"			
Variable	**User Group**	**Probability of Agreement**	**Effect**
Social Education	80 days	73%	The greater the frequency of fishery education from family and friends, the more likely the respondent is to disagree with this regulation type.
	120 dyas	71%	
	160 days	70%	
Citizenship	Samoan	64%	A respondent who is a Samoan citizen is more likely to agree with this regulation type.
	Non-Samoan	78%	
Curfew	No	73%	A respondent in a village with an enforced curfew is more likely to agree with this regulation type than a respondent in a village with an unenforced curfew or no curfew.
	Enforced	78%	
	Unenforced	61%	

"Minors Should Be Regulated"			
Variable	**User Group**	**Probability of Agreement**	**Effect**
Social Education	80 days	61%	The greater the frequency of fishery education from family and friends, the more likely the respondent is to
	120 dyas	58%	
	160 days	54%	
Citizenship	Samoan	50%	A respondent who is a Samoan citizen is more likely to agree with this regulation type.
	Non-Samoan	65%	

At which spatial level of management do villagers want the fishery resources to be managed in the future?

To assess the spatial management level preferred by people for American Samoa in the future, we asked respondents to specify which level they preferred from a given list: "district", "village", "island", "territory", or "other". This analysis provides the general preference of the spatial management levels among all respondents. A majority of the total respondents (56%) show a preference for village level management (Figure 20). Territory-level management was the second most preferred, with 33% of the respondents' selection.

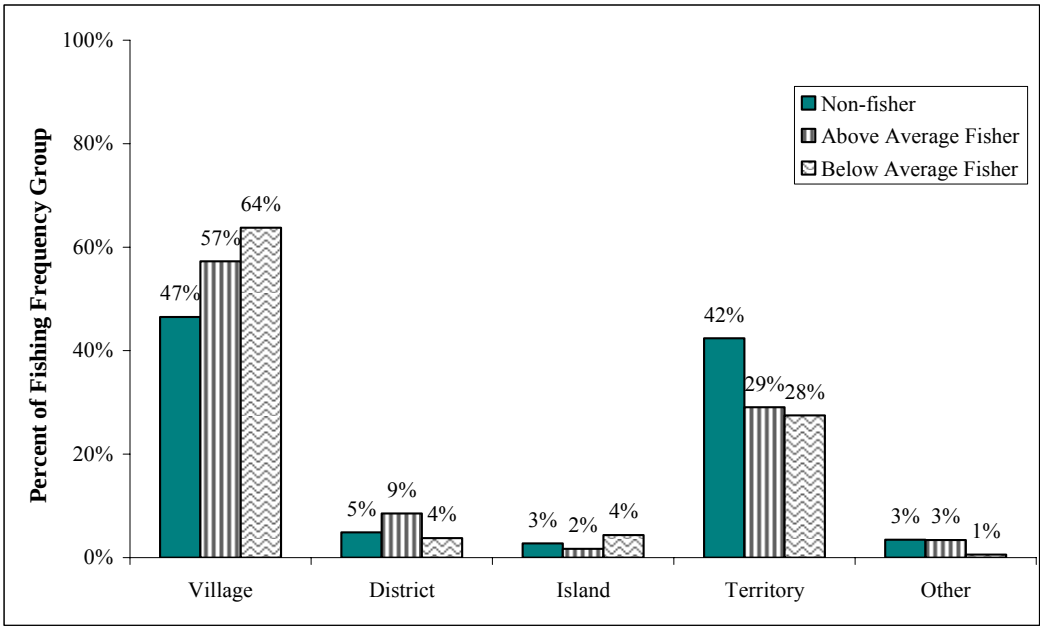
Figure 20: Fishery Management Level Preference as a Percentage of 425 Respondents



In addition to summary statistics, our initial analysis includes chi-squared analysis of spatial management level preference among user groups. Of particular interest are the preferences among the fishing user group divisions and age division because the preferences among these user groups reveal a statistically significant difference (p=0.01, and p=0.06, respectively).

Within the fishing user groups, village level management is the preferred level by each division (Figure 21). Fifty-seven percent of the above average fishers and 64% of the below average fishers show a preference for management at the village level, while only 47% of the non-fishers prefer the village as the spatial level of management. It is interesting to note that Territory-level management is the second most preferred method among all fishing user groups. In particular, the non-fishing group displays a near equal distribution between village and territory-level management.

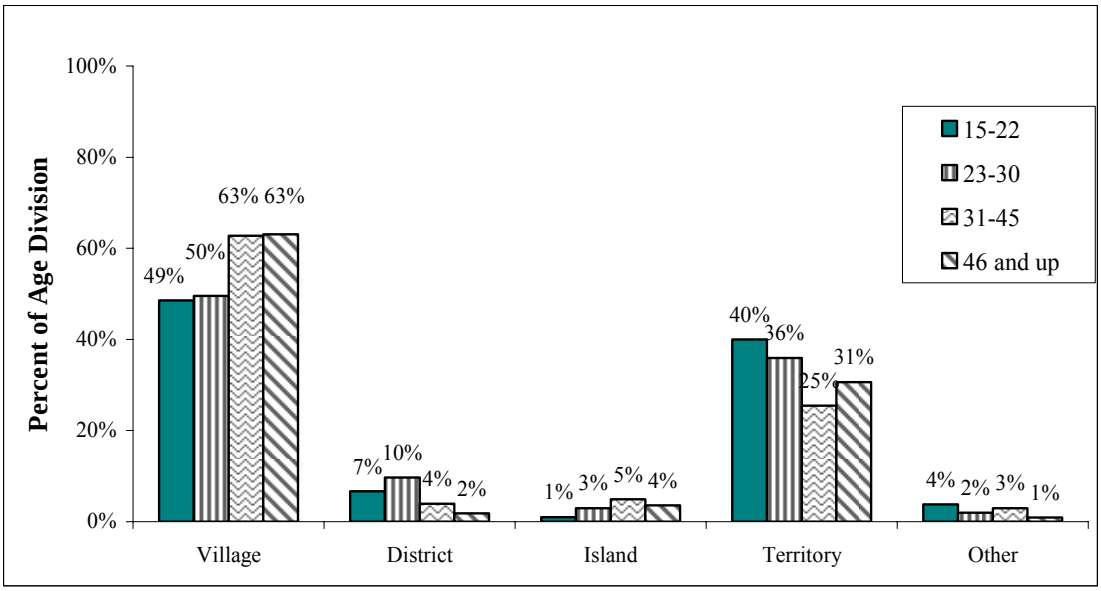
Figure 21: Fishery Management Level Preference by Percentage among Fishing Group*



*Chi-squared; p-value = 0.01

Village level management is the most preferred by each of the four age divisions; at least 49% of each age division selected village as their preferred level of management (Figure 22). The two older age groups, (ages 31-45 and 46 and up), display the greatest preference towards village level, with 63% of the respondents in each division.

Figure 22: Fishery Management Level Preference by Percentage among Age Divisions*



*Chi-squared; p-value = 0.06

Although our initial analyses offer a description of the current preferences for spatial management among the user group divisions, a more thorough regression analysis highlights the factors that are influential in shaping these opinions. Perception of illegal fishing, fishing frequency and citizenship are the significant factors in this regression analysis. The influential factors and their predicted effect on the respondent's opinion are listed in the Table 10. The final model is as follows:

Probability of preferring village as the level of fishery management = 1/ (1+ e^(α_0 + α_1(Fishing Frequency) + α_2*(Age) + ε_i))*

Table 10: Significant Factors in Spatial Level of Management Preference

Spatial Level of Management Preference				
Variable	**User Group**	**Probability Agreement with Village Management**	**Probability Agreement with Territory Management**	**Effect**
Fishing Frequency	Non-Fishers	46%	44%	The more a respondent fishes, the more likely they are to prefer village level management.
	Below Average Fishers	67%	26%	
	Above Average Fishers	58%	30%	
Age	15-22	48%	41%	The younger the respondent, the more likely they are to have similar preferences for village and territory management. In contrast, the older generation displays a significant preference for village level management.
	23-30	47%	39%	
	31-45	65%	24%	
	46 and up	65%	29%	

Discussion

Current perception

Our initial analysis examined the perception of current regulations and enforcement strictness. Forty-six of the respondents think current regulations are too lenient, while only 8% expressed that they are too strict. One interpretation of this result is that the current management regime is perceived as inadequate by the community, implying a need for a more comprehensive management plan for the Territory. Furthermore, as revealed in the community use, opinions, and preferences of the fishery section, the vast majority of respondents (90%) feel that reef fish are important for the health of the ecosystem, as well as

for their food needs. Therefore, people regard reef organisms as essential components of their diet and for maintaining the overall health of the ecosystem, but acknowledge that the current system of protection is not sufficient. Therefore, DMWR may consider this as support from the community to develop more formalized management strategies for the reef resources.

With which types of regulations are people most likely to comply?

To assess the regulation types with which people are most likely to comply, we made the assumption that compliance can be derived from the respondent's level of agreement for each regulation type. There are four regulation types with which at least 74% of the respondents agreed. Under our assumption, these are the regulations with which most people are likely to comply:

DMWR should regulate what is caught; 78% of respondents
DMWR should regulate where people fish; 76% of respondents
DMWR should regulate how people fish; 75% of respondents
DMWR should regulate during spawning events; 74% of respondents

There are several hypothesized reasons why these particular types of regulations received the greatest level of agreement. It is common for people to agree with concepts and ideas with which they are most familiar. Therefore, because these regulation types are common management practices in other areas throughout the region and world, respondents may associate with them, thereby increasing their agreement levels. In addition to the fact that the regulation of what is caught is a common method of fishery management worldwide, in American Samoa, there is currently a set of restrictions on the harvesting of giant clams, mangrove crabs, coconut crabs, slipper lobsters, and spiny lobsters in the Territory (see Appendix A). This may help explain the higher agreement level with the regulation on what is caught.

The regulation of where people fish is also a method of fishery management currently in–use throughout the Territory. There are four territorial MPAs in place, in addition to the federally protected Rose Atoll MPA (see appendix for MPA description). Additionally, several of the community- based fishery management plans in the Territory include regulations on where people fish by restricting non-village members from fishing. For example, Auto and

Fagamalo each have restricted fishing areas in their management plans which exclude people from outside the village from fishing in their waters. Furthermore, there appears to be a tension between villagers and 'outside fishers', possibly influencing a preference for this regulation type.

The regulation of how people fish is also a regulation type currently in-use in American Samoa. There are several fishing gear restrictions in-place, including the ban on dynamite fishing, poisonous substances, electrical devises, and SCUBA-assisted fishing (see Appendix A). Due to the fact that these types of regulations are in effect on the island, they may be a relatively familiar concept to the respondents, subsequently increasing their agreement level with regulation on how people can fish.

Regulation during a spawning event may also be a popular type of regulation because of the cultural significance of the spawning of the palolo. The palolo spawn once a year, during which time they are harvested to be eaten as a cultural delicacy. Due to the importance of this event, Samoans may want this event to be regulated as a way to prevent the over harvest of this resource.

Although we identified the top most agreed with regulations, it is important to note that this analysis does not consider the feasibility, management capacity, distributional effects on user groups, enforceability, or costs associated with these regulation types. The purpose of revealing this finding is simply to provide DMWR with the local perceptions and opinions of regulation types and how they may be included in future management strategies.

It is also important to note that despite the fact that there is an overall agreement with each regulation type, the existence of at least 19% of the respondents in disagreement with each regulation should not be overlooked. Although the percentage of individuals in disagreement with each regulation type is small, this minority could have the potential to exhibit a disproportionate amount of non-compliance with future management strategies. The small assemblage in disagreement needs to be taken into consideration when construction future regulations.

Which factors influence people's agreement with regulation?
Is there a difference of opinion between user groups regarding attitudes and opinions towards fishery regulations and management policies?

To make effective management decisions DMWR can use the patterns in agreement levels among identified user groups to facilitate improved compliance with future regulations. Our intention with this analysis is to provide the data set for DMWR to use as a tool for making management decisions. We found the following factors to be significant in influencing people's overall agreement with regulation: fishing frequency, social education, workshop education, curfew, age group divisions, citizenship, and perception of illegal fishing [5].

Fishing Frequency

Due to the fact that the fishing user groups associate with the fishery on various levels of dependency, their preferences are fundamental for establishing cooperative management systems. We chose to examine differences of opinions and preferences within the fishing user group divisions since the activities of the people who fish frequently will be most impacted by any future regulations. Consistent with this concept, fishing frequency is a significant factor not only in influencing overall agreement with regulations, but is also influential in shaping the opinion of the specific regulation types (except regulation on spawning events and regulation of minors). Holding all other factors constant, as the frequency of fishing increases, the less likely the respondent is to agree with regulations. This is a valid result, considering that individuals who fish most frequently desire the least amount of restrictions on their activity. It is logical for those individuals who will be most impacted by regulations to express the least level of agreement, as indicated by the frequent fisher division. Because the agreement with regulation decreases with fishing frequency, it is important to collaborate with fishers to determine the regulation strategies that will receive a greater level of compliance in the future.

[5] Factors with a p-value of less than 0.1

Social Education

Social education is inversely related to the level of agreement with the regulations; the greater the frequency of fishery education from social sources, the more likely the respondent is to disagree with all the regulation types. This relationship is true for the overall agreement level and for all of the regulation types, (except for the regulation of when a person can fish). It is probable that fishery education from social sources is distributed through the fishers themselves; therefore fishers could be less likely to agree with regulation strategies in order to maintain their current lifestyle and frequency of fishing. A possible way to increase agreement with regulation from frequent fishers would be to focus fishery education towards that specific user group, with the goal of influencing their opinions toward regulations.

Workshop Education

If a respondent had attended a fishery workshop, the likelihood of agreement with regulations is greater than a respondent who did not attend a workshop. Based on this finding, fishery workshops would also be an important strategy to increase agreement and compliance with regulation and improve overall attitudes toward the regulation of the fishery resource.

Curfew

The absence or presence of a curfew is a significant factor in a respondent's perception of all types of regulations, (except the regulation of minors, regulation of how people can fish, and the regulation of what people can fish). For overall regulation and each specific regulation type in which curfew is significant, a respondent from a village with an enforced curfew is more likely to agree with the regulation type than one from a village without a curfew or one with an unenforced curfew. A probable explanation for this relationship is that the respondents from a village with a strong traditional social structure are more accustomed to a regulated lifestyle. Therefore, they are likely to be more accepting of regulations. Due to this relationship, the preservation of a strong traditional structure, by means of an enforced curfew, for example, is one viable way to encourage agreement with fishery regulations.

Age

In addition to the frequently significant factors of fishing frequency, social education, and curfew, the consideration of each age division and citizenship category is important for DMWR to appropriately accommodate the needs of fishery users currently and in the future. Considering the rapid population growth and immigration rates, it is constructive for DMWR to understand the preferences of management levels across the groups to make necessary adjustments and plan for long term goals.

Age is a significant factor influencing a respondent's agreement towards overall regulation as well as with the specific regulations of what is caught and how people can fish. One possible explanation for the higher agreement with regulations among the older generation (above 46 years) may be due to the fact that the older generation is familiar with a near shore fishery that was productive during their lifetime. Consequently, individuals over the age of 46 years may be more aware of the need for management to help replenish and recover the fish populations, corresponding to a higher level of agreement with regulations. In contrast, the youth of American Samoa have not been exposed to abundant fish supplies, and thus fail to acknowledge a decrease in fish supply from that of previous years. Accordingly, this younger generation displays a lack of agreement with all regulation types. The adjusted behavior to scarcity of fishery resources and subsequent low expectations about productive capability of the reef system has been described as a 'shifting baseline' (Pauly 1995; Sheppard 1995). The shifting baseline syndrome, in which generations set expectations based on direct experiences that discount experiences of previous age groups, may help to explain the fact that younger generations agree less with regulations than older generations. Since the frame of reference of the near shore fishery for the youth of American Samoa is different from that of the older members, regulations overall may seem unwarranted and may be a reason for the disagreement. Considering that the 15-22 year old age group holds the least amount of agreement with regulations, careful enforcement attention may need to be made toward this group in the future. Since these individuals and the opinions they hold are the future generation of American Samoa, any potential fishery policies from DMWR may require enhanced enforcement efforts. It is also important to consider the fact that this age

bracket composes roughly 20% of the total population. As such, the amount of compliance or lack there of, will contribute substantially to the overall compliance.

Citizenship

The influence of citizenship is significant on overall regulations, in addition to regulation on spawning events, regulation on where people can fish, and regulation of minors. For these regulation types, a respondent who is of Samoan citizenship is more likely to agree with regulations than a respondent who is non-Samoan. This finding indicates a general acceptance among Samoan citizens of the need for more formalized rules and regulations of the coral reef fishery. This pattern also highlights the fact that Samoan citizens are willing to accept future regulations of fishing activity. In contrast, those respondents in the non-Samoan category tend to disagree with regulations, which suggests that DMWR may need to focus enforcement efforts and support towards visitors and immigrants to the Territory.

One possible explanation for the influence of citizenship on the specific regulation of where people can fish may be that people of Samoan citizenship are more accustomed to the concept of reserved fishing grounds than people of other citizenships. This form of regulation is in place within several locations on the island and may be regarded as a familiar and tolerable method of regulation among Samoans. As addressed earlier, many villages throughout the Territory prohibit people from outside the village from fishing in their village waters. A regulation on where people can fish may have been interpreted as a method of keeping the "outsiders" out of the village waters, which would correspond to the high agreement among Samoans and high disagreement among non-Samoans. Therefore, it is logical that people of non-Samoan citizenship or "outsiders" reveal a disagreement with this regulation type, since this regulation poses considerable inhibition on the amount of their fishing activity.

Perception of Illegal Fishing

The respondent's perception of illegal fishing was significant in the overall agreement with regulation, as well as with the individual regulation types (besides the regulation of when people fish, spawning, and minors). While the respondent's perception of illegal fishing

cannot be managed, it may reveal a significant relationship. As outlined in Table 10, if the respondent did not give an estimate for their perception of illegal fishing, they are more likely to disagree with the regulation type. Although many of the respondents did not give an estimate because they either did not know or did not think that there was any illegal fishing, a possible reason for this could also be the respondent's reluctance to give support evidence for a need for regulation by stating the occurrence of illegal fishing.

Other Factors

CBFMP

Residence in a village with a Community Based Fishery Management Program decreased the respondent's agreement with regulation of what is caught. A possible explanation for this is related to the fact the Community Based Fishery Management Program does not include the regulation of which types of fish are caught. Subsequently, the respondent may be less likely to agree with the addition of this regulation type. Once again, workshop education is also a significant factor, this time in the respondent's agreement level with regulation of where people fish and of how people fish; increasing the respondent's agreement level with the regulation.

Matai

Considering that matai members hold an influential role in the Samoan community, we predicted a matai status to have a significant effect on a person's agreement with regulation. It is worth noting that in an ANOVA analysis between matai and non-matai respondents, a statistical difference in agreement with regulations in general is observed. The respondents who hold a matai title reveal a mean level of agreement with regulations that is greater than the mean agreement level of non-matai. However, in our regression analyses matai status is not a significant variable. This indicates that holding a matai title does not necessarily affect a respondent's agreement level with regulations although there is a statistical difference in agreement between matai and non-matai.

Gender

It is interesting to note that gender is not a significant factor influencing agreement levels among any of the regulation types, despite the fact that males are more likely to be an above average fisher than females (as indicated by the fishing frequency regression). One possible reason for this result may be due to the fact that a clear distinction between gender roles is not discernible. Although men are more likely the fishers in the household, the women in the family may be responsible for making the food choices for the family. Consequently, there is no differentiation between males and females in terms of agreement with fishery regulation.

At what level of management do villagers want the fishery resources to be managed in the future?

The majority of respondents reveal a preference for management of the fishery resources at the village level. Within each user group this method of management is also the most preferred, indicating the potential for future community-based management programs throughout American Samoa.

As recognized previously, the preferences of the fishing user groups are essential for establishing a successful cooperative management system. Owing to their frequent use of the resource, a high level of noncompliance within this group would undermine the effectiveness of the regulatory system. Furthermore, the likeliness of a respondent preferring village based management increases with the frequency of fishing. Management at the village level, as preferred by 57% of the above average fishing user group, would allow for a greater level of interaction between the users of the resource and the managers; ideally leading to a higher level of compliance.

Additionally, for DMWR to appropriately accommodate and adapt to the management needs of current and future fishery users, consideration of each age division is important. The higher percentage of preference for village level management by older generations may be related to the historical reliance on coral reef resources coupled with the corresponding relationship with the marine environment, which encouraged responsibility for the resources

at the village level. Regardless, an overall preference among all age groups is displayed, which indicates that villagers want managerial responsibility of the reef resources. Therefore, DMWR should consider the possibilities of enhancing the community based management plans based upon these findings.

Education

Justification

Well conceived and adaptive public education programs are an integral component in maintaining fishery resources (Veitayaki 1996). Public education programs can promote sustainable use of the resource base and teach people to become stewards of their surrounding environment. Educating the public on the importance of coral reefs can promote sustainable use and protection of the reefs to increase the desire to protect and conserve marine environment.

Management of near shore fisheries resources must be directed largely by the cooperation between policy makers, managing agencies and villagers (Fiske 1992). Education and outreach is a way to establish a cooperative alliance between managers and the public. Previous studies have shown that successful educational activities have a high profile within a community and maintain compliance in a cost efficient manner (Lemay and Hale 1989). In addition, education has the potential to increase visitor experiences, reduce negative resource impacts, gain support for management practices, promote public participation, and reduce management costs (Alder 1994).

In order to provide insight into the current use of education in fishery management in American Samoa, survey questions were asked about the sources and amounts of fishery education received by each respondent. The objective of obtaining this data was to try to determine how accessible fishery education is, how abundant it is, and if possible, where there might be gaps in the imparting of fishery education to the public. This data not only shows the current status of fishery education in American Samoa, but it also serves as a baseline for future comparisons of the frequency and sources of education in fishery management.

Where do American Samoans currently receive most of their coral reef fishery education?

Table 11 displays eight individual coral reef fishery education sources that were identified in the survey and the percent of respondents that said they received education from each source for each frequency category. Based on our survey, the most frequently accessed fishery education sources (those with a frequency of most days) are TV and Radio (with 43% respondents), newspapers (41%), and school (41%). Family, as a source of fishery education, is also a frequently obtained source, with 37% of the respondents receiving this source most days. The majority of respondents surveyed were not of a school going age, so amounts of fishery education from college were expectedly low. Responses to the 'Other' category included the internet and off-island information, but this is not a significant source of education with 70% of the respondents never accessing this type.

Table 11: Frequency of Coral Reef Fishery Education from Various Sources as a Percentage of 425 Respondents.
Data corresponds to survey question 15. For individual representation of frequency of education type, see Appendix F.

	School	College	Fishery Workshops	TV Radio	Newspapers	Pamphlets	Family	Other
Most Days	41%	16%	6%	43%	41%	11%	37%	6%
Once/Wk	12%	5%	6%	21%	16%	8%	12%	3%
Once/Mo	12%	7%	11%	17%	13%	11%	14%	4%
Once/Yr	8%	4%	15%	6%	4%	6%	9%	3%
Never	27%	67%	62%	13%	25%	63%	26%	70%
No Answer	1%	2%	1%	0%	1%	1%	0%	14%

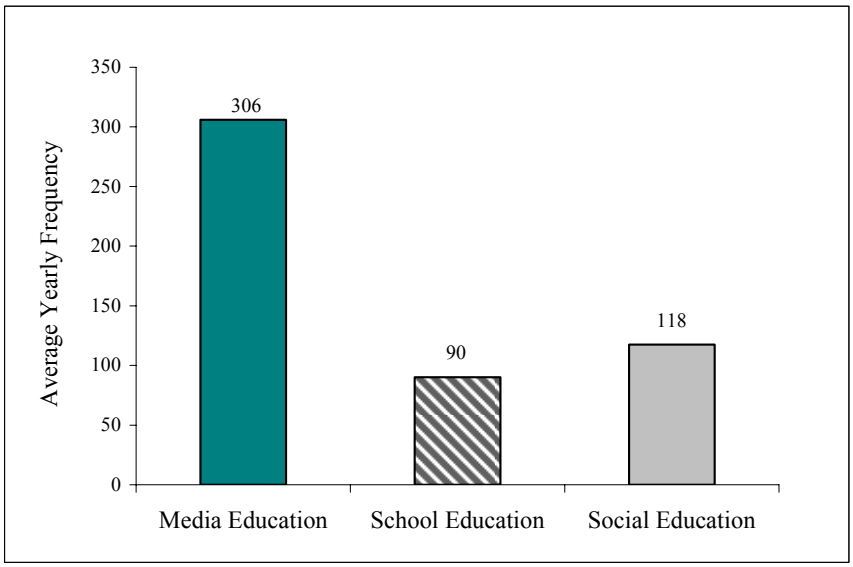
Figure 23 displays the average frequency in days per year of coral reef fishery education for the broader categories consisting of:

- Social Education (Family)
- School Education (School and College)
- Media Education (TV, Radio, Newspapers, Pamphlets)
- Fishery Workshops

As can be seen, media education was received much more than social and school education. For the category of fishery workshop attendance, responses were categorized as either having

attended a workshop or not. Approximately 37% of respondents reported attending at least one fishery workshop.

Figure 23: Average Amount of Fishery Education Received (Days per Year) from Social, School, and Media Education Sources



From which sources and how frequently do user groups receive fishery education?

Answering this question involved an analysis of how the four education categories above differed within specific demographic and user groups as defined in our "Definition of Terms" section. The groups we chose to analyze were:

- Age
- Gender
- Fishing Frequency
- Gleaning
- Matai Status
- Curfew (Strength of Social Structure)
- Participation in CBFM

The analysis consists of two parts: 1) simple summary statistics which compare education amounts within each user group individually and 2) regression analysis which examines the

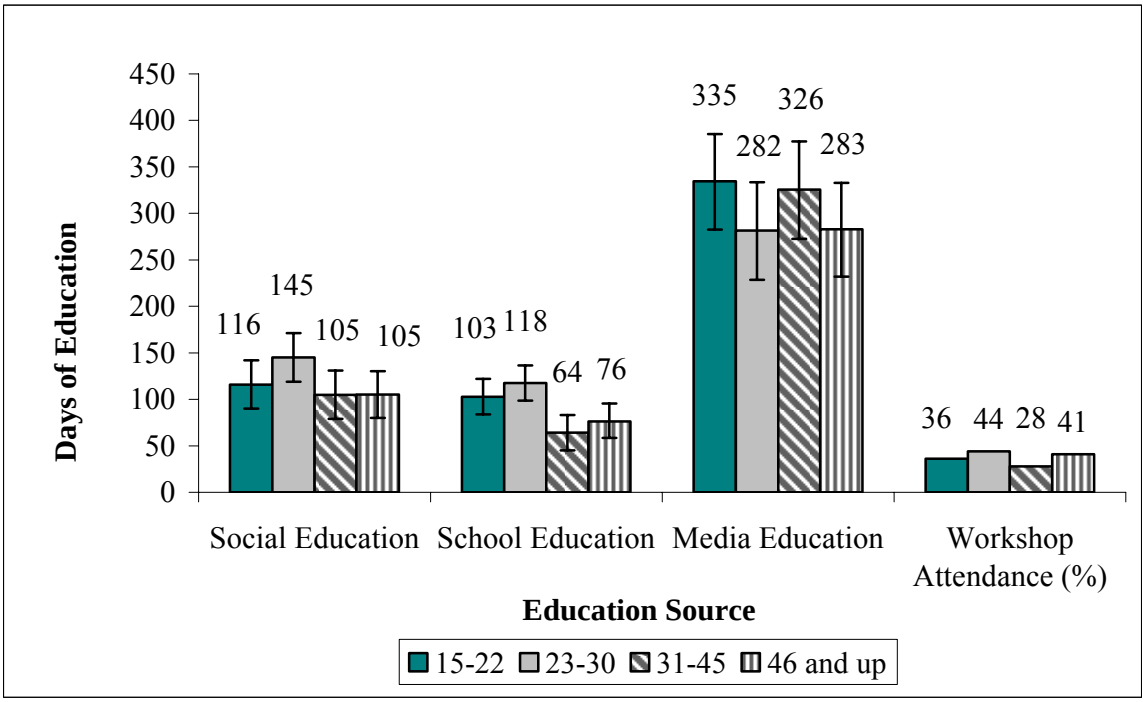
effect of each individual user group on education while considering, but holding constant, all of the other user group categories.

User Group Summary Statistics

Age

The mean amounts of social and media education received by each age group were not statistically different (ANOVA, p=0.11 and 0.34, respectively), which indicates that fishery education from these sources is not directed at any particular age group. School education, however, was statistically greater for the younger two age groups than the older two (p=0.0003). This finding is plausible, given that younger individuals are more likely to be in school and exposed to environmental education. Workshop attendance was also statistically different between the age groups (Chi-Squared, p=0.07), with the younger groups attending workshops more often than the older age groups.

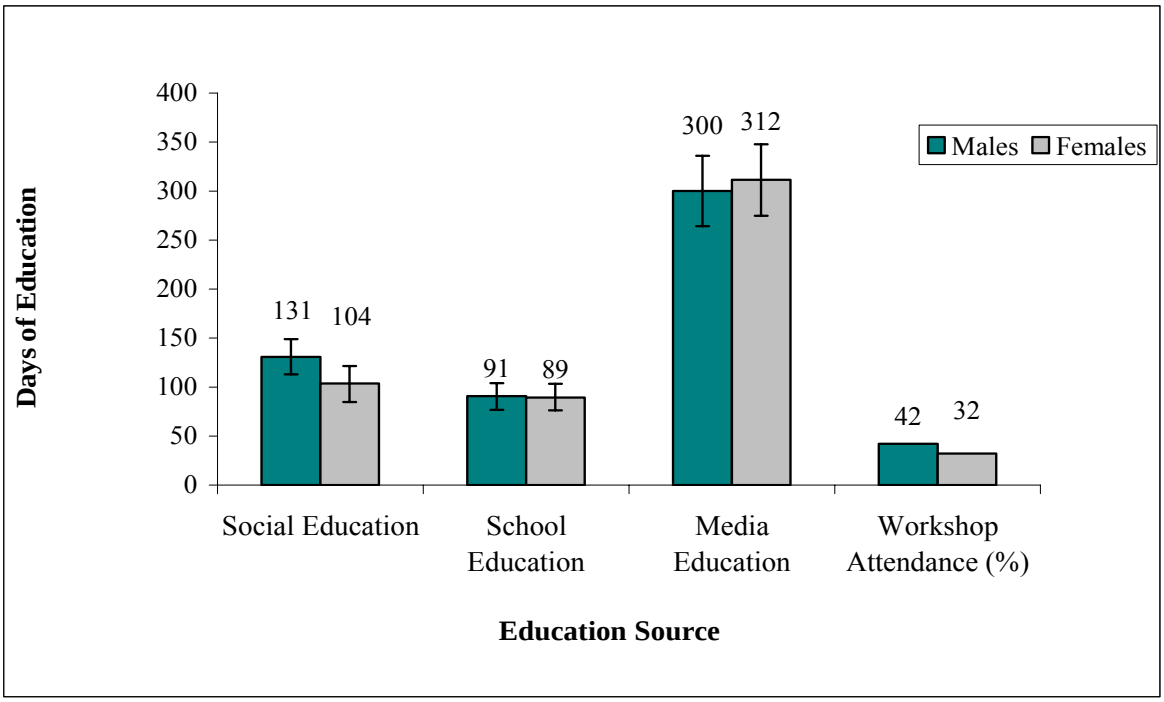
Figure 24: Days of Education Received by Different Age Groups



Gender

Of the four education categories, education amounts were statistically different between males and females in social education and workshop attendance (t-test, p=0.02 and Chi-Squared, p=0.03, respectively). The average number of days of social education received by males was approximately 131, whereas females only received an average of 104 days. Similarly, 42% of males had attended a fishery workshop, as opposed to 32% of females. The difference in media and school education between males and females was not statistically significant (t-test, p=0.44 and 0.66, respectively). This is reasonable because both school and media education are distributed publicly without the opportunity for choice or selection.

Figure 25: Days of Education Received by Each Gender

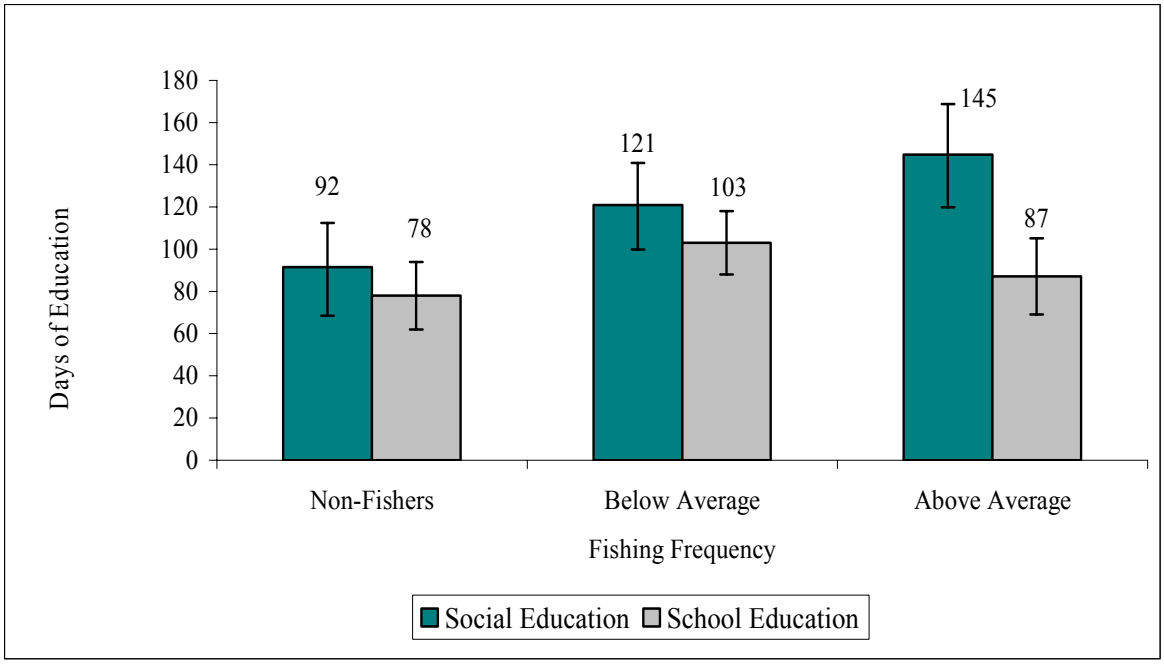


Fishing Frequency

In the fishing frequency division, social education was statistically different between the user groups (ANOVA, p=0.01). Based upon this analysis, non-fishers received the least amount of social education, and above average fishers received the most. This supports the concept

that fishing is a traditional family activity and that individuals who fish together learn from one another about fishing and the coral reef environment. School education was also statistically different among the user groups (ANOVA, p=0.09). However, the analysis shows that school education is received the most by below average fishers, followed by above average, and then the non-fishers. This is likely a result of a correlation between age and fishing frequency rather than a selection for the amount of school education by below average fishers. Media education and workshop attendance were not statistically different among the different groups (ANOVA, p=0.59 and Chi-Squared, p=0.43, respectively).

Figure 26: Days of Education Received by Fishing User Groups

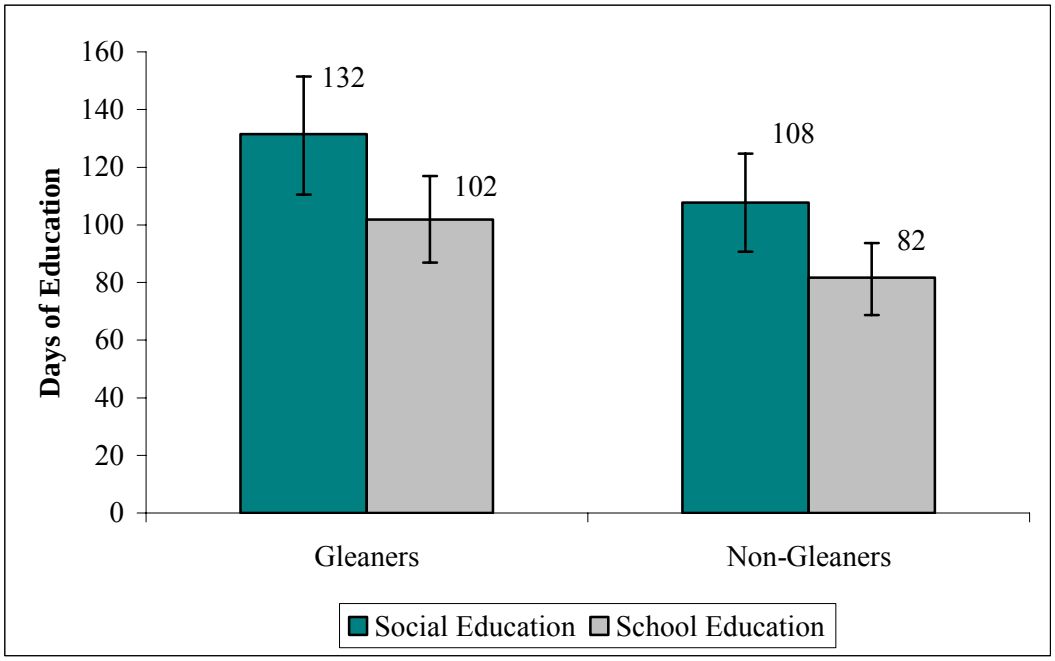


Gleaning

Similar to fishing frequency, social education and school education were both statistically different between gleaners and non-gleaners (t-test, p=0.04 and 0.02, respectively). As seen in Figure 27, gleaners reported approximately 132 days of social education compared to 108 for non-gleaners. This result is also consistent with the idea of gleaning being a family activity or tradition in which knowledge is passed on through the gleaning activity. Gleaners also reported more school education than non-gleaners. Media education and workshop

education were not statistically different (t-test, p=0.74 and Chi-Squared, p=0.82, respectively).

Figure 27: Days of Education Received by Gleaners and Non-Gleaners



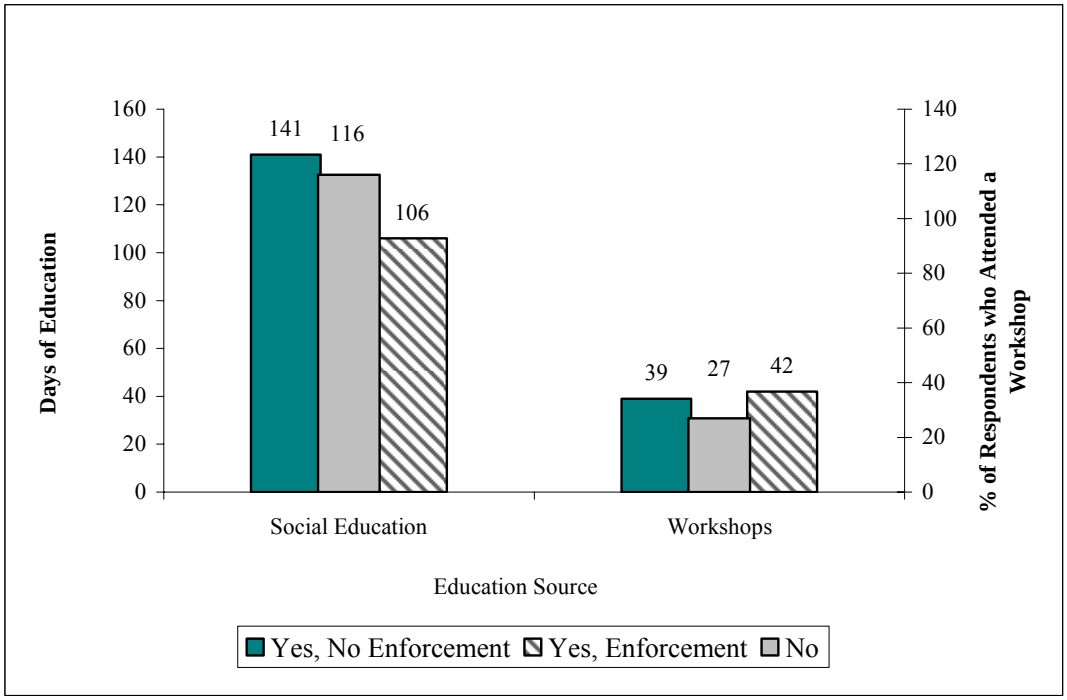
Matai Status

Our comparison between matai and non-matai shows that the amount of fishery education from school received by matai is statistically lower than non-matai respondents (t-test, p=0.02). This is likely due to the fact that most matai are not young enough to be in school. Workshop attendance by matai, however, was statistically greater than that of non-matai (Chi-Squared, p<0.0001). Sixty-four percent of the matai reported having been to a fishery workshop, whereas only 32% of non-matai individuals had attended a workshop. This result may reflect the matai sense of duty to attend public functions and their responsibility to be educated on fishery issues. Social education and media education were not statistically different between matai and non-matai (t-test, p=0.48 and 0.77, respectively).

Curfew

The amount of fishery education received from social sources and from workshops was significantly different between the three curfew groups (p = 0.09 and 0.02, respectively). As seen in Figure 28, the amount of social education received was highest for respondents from villages with an unenforced curfew and lowest from villages with an enforced curfew. The greatest percentage of respondents that had attended at least one workshop was highest for villages with an enforced curfew and lowest for villages with no curfew at all. School and media education were not significantly different between the curfew groups (p = 0.63 and 0.98, respectively).

Figure 28: Education Received by Respondents from Varying Curfew Types



CBFM Participation

Examining the influence of community based fishery management plans, only fishery workshop attendance was statistically different between respondents who lived in a village participating in the CBFM program and those who lived in villages not participating in the program (p = 0.008). Social, school, and media education were not significant for CBFM participation (p = 0.38, 0.75, and 0.29). For fishery workshop attendance, 55% of

respondents participating in the CBFM program reported attending at least one workshop. Of those respondents not in the CBFM program, only 35% had attended a workshop.

Regression Analysis

In order to determine what factors affect the amount of fishery education a respondent receives, we ran regressions for social, media, and workshop education. School education was excluded from the analysis because not all members of each user group are in school. In the regression of fishery education from media, none of the independent variables were significant. This result corresponds with the summary statistics and further indicates that media education is received more or less equally by members of each different user group.

The independent variables used in the education regressions were:

- Age
- Gender
- Fishing Frequency
- Gleaning
- Matai Status
- Curfew
- CBFM Participation

The whole model regressions can be found in Appendix I. By removing the least significant user groups from these whole models, we developed final models that include only those user groups whose significance (as indicated by the p-value) was less than 0.1. For social education, the significant user groups were Age, Gender, and Curfew. The final model is as follows:

$$Social\ Education = a0 + Age_i + Gender_i + Curfew_i;$$

Table 12 displays the marginal effects for each user group compared to a baseline assigned arbitrarily to the first user group of each variable. These marginal effect values indicate how much more or less social education one group receives compared to the other. For example, people between the ages of 23-30 receive approximately 27 more days of social fishery education than 15-22 year olds. The 31-45 year old age group receives approximately 15 few days of fishery education than 15-22 year olds. For gender, women receive approximately 26 fewer days of social education than men.

Table 12: Final Model for Social Fishery Education

Social Education				
Variable	**p-value**	**User Groups**	**Marginal Effects**	**Effect**
Age	0.088	15-22	Baseline	People between the ages of 23 and 30 receive the most social education. People between 31 and 45 receive the least.
		23-30	27	
		31-45	-15	
		46 and up	-14	
Gender	0.049	Male	Baseline	Males receive more social fishery education than females.
		Female	-26	
Curfew	0.033	No Curfew	Baseline	People from villages with an un-enforced curfew receive the most social education. People from villages with enforced curfew receive the least social fishery education.
		Un-enforced Curfew	27	
		Enforced Curfew	-16	

For the workshop education regression, the significant user groups were Age, Matai, and CBFM participation. The final model, in terms of the probability of attending at least one workshop, is:

$$Prob(Yes\ Workshop) = 1 / (1 + exp(a0 + Age_i + Matai_i + CBFM\ Participation_i))$$

The probabilities of attending a workshop for each user group are given in Table 13 below.

Table 13: Final Model for Workshop Education

Workshop Education				
Variable	**p-value**	**User Groups**	**Probability of Attending a Workshop**	**Effect**
Age	0.054	15-22	58%	People between the ages of 23-30 are most likely to attend a fishery workshop. People between the ages of 31-45 are least likely.
		23-30	65%	
		31-45	44%	
		46 and up	53%	
Matai	> 0.0001	Yes	72%	People holding a matai title are more likely to attend fishery workshops than people without a matai title.
		No	37%	
CBFM Participation	0.030	Yes	63%	A person in a village participating in community based management is more likely to attend a fishery workshop than a person in a village not participating in the program.
		No	46%	

Discussion

Both the summary statistics and regressions for the education policy area indicate that media education is not received significantly more by any particular demographic group. Therefore, media sources might be an efficient means of disseminating fishery information to the general public. Media sources are also currently the means by which fishery education is received most frequently. Consequently, if media sources continue to be used to this degree, careful consideration should go into the type of information distributed through the media.

Information about the current and future use of education as a fishery management tool can be inferred from both the summary statistics and regression models. First, the survey results suggest that much of the fishery education in American Samoa is reaching the people who

most benefit from it. On average, people who fish and glean are receiving more social and school education than people who don't fish or glean. The strong presence of people holding a matai title at fishery workshops also suggests that the individuals with leadership on the islands take an interest in the management of fisheries.

The education regressions have some other interesting results that are worth noting. First, males receive significantly more social and workshop fishery education than females. In a regression on factors effecting frequency of fishing (see Trends in Fishery Use Section), males were shown to be more likely to fish than women, which suggest that males might benefit more from fishery education than females. Despite the fact that males are more likely to fish, women are often in charge of planning meals and therefore may have a greater say in what is caught and when the catch is needed and performed (Lambeth et al. 2001). Therefore, the difference in education received between genders might be an area on which policy makers need to focus their attention.

The education regressions also show that people between the ages of 31-45 receive the least social education and are least likely to attend workshops. This age group is composed mostly of working adults who are less likely to fish (as seen in the Trends in Fishery Use Section) and therefore not as concerned with or available to obtain fishery education. Alternatively, it is possible that people in this age group are the heads of their families who pass on their fishery knowledge to others. This, however, suggests that this age group might be the most in need of workshop education. Through fishery workshops, attendees can gain knowledge of both the biological and managerial aspects of the fishery from experts. Directing these workshops to the 31-45 year old age group might be a way of improving the quality of social education.

The connection between age, social education, and workshop education becomes particularly important when considering the results of the regulation regressions (see Regulations Section), which show that people with more social education are more likely to disagree with regulations, but people who attend workshops are more likely to agree with regulations. If American Samoa chooses to increase regulations and enforcement as a management tool, then the nature of social education will need refining in order for those tools to be more

accepted. Workshops targeting the sources of social education (heads of families, village leaders, and matai) could be a means of influencing social education.

According to the workshop education regression, the presence of a matai title was a significant factor affecting workshop attendance. Furthermore, 64% of people holding matai titles reported attending fishery workshops. Therefore, it appears that increasing matai attendance at workshops may not be a significant issue to encourage village support of fishery management. The bigger challenge is in empowering the matai and other leaders in the villages to pass on both accurate and useful fishery knowledge to the rest of their villages and into families. This may involve not only educating village leaders about the fishery, but also equipping them with the tools necessary to teach that information. As leaders of their communities, matai have the ability to positively influence the activities within their villages and this source of power and respect should be utilized to the fullest.

A final finding from the education regressions is that people participating in the community based fishery management program are receiving more workshop education than individuals from villages not in the program. This was expected because the community based management program was designed to provide participants with greater fishery knowledge and therefore tries to provide these communities with more fishery workshop opportunities. The results indicate that people from the CBFMP villages choose to attend the workshops, suggesting that they take a more active interest in the fishery than people from non-participating villages. That being said, this might be an indication that more effort needs to be placed on providing workshops and general fishery education to villages not participating in the CBFM program.

Limitations

Alhough the above information may be useful in shaping future fishery management in American Samoa, there are some drawbacks that should be noted. First of all, although the amount of education received by respondents from four different sources was analyzed, we made no judgments as to the value of one source of education over another. For example, even though media is an abundant source of education, we have no means of inferring how

much media education is needed to be the equivalent of one fishery workshop. Managers and educators of American Samoa have the responsibility to evaluate the quality and content of the education of each source. Similarly, the information presented above does not establish guidelines on what should be taught. Curriculum, advertisements, or programs that are used in fishery education will depend largely on the state of the fishery and the choice of tools that American Samoa utilizes in its management. As such, fishery education will have to be adaptive and responsive to the needs of the resource users.

Geographic Management

How can DMWR incorporate spatial variation in demographic and environmental factors in order to inform fishery management strategies?

Justification

In the above sections, we outlined resource use patterns, community perceptions of regulations, and sources of education across the island. We then used regressions for each of these policy areas to explain some of the factors that directly influence them. In this section, we analyze the data at a finer resolution. Specifically, we explore the variation in each policy area across villages. We also incorporate several biophysical characteristics into the analysis in order to present ways for managers to integrate the socioeconomic aspects of fisheries management into their decision processes.

Geographic Information Systems (GIS) can be an extremely useful way to interpret fisheries related information at different spatial scales. GIS allows managers to visualize the resource as a whole and compare areas under a variety of site-specific factors. In American Samoa this is important, as both human and coral fish populations in American Samoa are highly spatially variable (Census 2000; Spurgeon et al. 2004). In their 2004 economic valuation of American Samoa's reefs, the Jacobs Engineering Group found that the benefits from coral reef systems are distinctly location specific and vary by orders of magnitude (Spurgeon et al. 2004). Since American Samoa currently has insufficient data to create an accurate historical baseline of the fish populations and use of the resource, we design a geographically-based

decision support tool that identifies the current conditions and potential management concerns.

In this model we consider fishery resource potential, population related pressures, and sociological information for the 34 surveyed villages. We chose the village as the level of spatial differentiation since it is an easily identifiable and distinct management unit. This does not, however, imply the need to manage the fisheries in American Samoa solely at the village level.

After selecting the spatial management unit, we ran an ANOVA test on the different socioeconomic factors to determine if there was a significant variation in the mean responses for each village. We found that all of the variables were significantly different ($p < 0.01$ except for workshop education, $p = 0.025$). We then calculated a z-score for each of the twelve management concerns in order to make comparisons between the values. The z-score is the difference between each value and the mean for all villages, divided by the standard deviation for each variable. This z-score transformation normalizes the data with a mean of zero, to make comparison between the factors easy. That is, the z-score represents the number of standard deviations above or below the mean value for that variable. Subsequently, we mapped all of the z-score values using GIS to visually see the distribution across the villages. Scaling the values in this way does not suggest that each management concern has an equal weight for management purposes. With this tool, however, resource managers have the ability to focus on the terms independently (e.g., choosing areas for protection due to habitat complexity alone) or holistically (e.g., concentrating management efforts on villages or regions with several values that are significantly different from the mean).

The map-based model highlights the spatial variation in multiple management concerns by identifying the areas that have significantly high or low values. The current mean values become a baseline across the territory to which managers can compare other geographical areas. Additionally, these values can be tracked through time to determine if there is a general shift in the baselines. The associated map-based outputs provide visual representations of the analyses which will potentially aid managers in identifying broader regions of concern.

Managers can then use this information when considering the effects of any policies in order to anticipate the possible effects or responses in different regions. Alternatively, they can prioritize specific locations and focus their efforts appropriately.

Management Concerns

We divide management concerns into three broad areas of interest: fishery resource potential, population related pressure, and sociological influence. Within each category we choose specific variables based on the available data that represent those broader concerns.

Fishery Resource Potential

We measure fishery resource potential using habitat complexity and the length of the coastline. We select habitat complexity as a proxy for estimating fishery resource potential, since previous studies have found that increased habitat complexity supports higher fish diversity and biomass (McClanahan 1994). In 2004, the Jacobs Engineering Group used habitat complexity as a substitute for calculating fisheries yield because they assumed it represented feeding opportunities, breeding grounds, and refuge from predation (Spurgeon et al. 2004). Additionally, habitat complexity was the only source of available information with sufficient data that corresponds directly with fish stocks. The length of the coastline is an important factor for each village because it is related to the amount of near shore reef area under the jurisdiction of that village. Moreover, the marine tenure customs of the Samoan culture gives a village ownership over the reefs directly adjacent to that village (Zann 1999). In general, villages with higher values of fishery resource potential can be expected to have better quality habitat for fisheries or more reef fisheries area.

Population Related Pressure

Population related pressures include both direct fishing and indirect effects of higher populations such as non-point source pollution on the reefs. Management concerns within this category include total population, population density, total fishing effort, per capita subsistence fishing, and per capita recreational fishing. Population and effort are directly

related to the amount of harvest and impact that each village has on its adjacent reef area. For our analysis, total fishing effort is based on average individual fishing frequencies within each village (See Current Data section). Therefore, higher values of population related pressures may represent greater exploitation of the reefs and the fisheries they support.

Sociological Influence

Sociological information represents how village residents might respond to different management actions. This includes the percent of people who prefer village level management, the average number of days in which residents receive fisheries education from media and social sources, the percent of individuals who received fisheries workshop education, and the average agreement with fisheries regulations. The interpretation of these values varies with the type of management action considered. For example, higher values for the percent of people who prefer village level management may be important when considering potential participants in the community based fishery management program or they may even be of more concern when implementing territory-wide regulations.

Current Data

Calculation of Variables

We derive data from three sources: 2000 DOC Census Data, 2004 NOAA island reef area maps, and the surveys we conducted in each of the 34 villages. We calculate habitat complexity of the near shore habitat to 30m depth through the use of GIS. Our procedures are based on a similar analysis conducted in the Jacobs Engineering Group 2004 coral reef valuation (Spurgeon et al. 2004). Specifically, we classify American Samoa's habitat types into high, medium and low complexity weighting them by a factor of 0.5, 0.35, and 0.15 respectively. This weighting method corresponds to studies of fish yields for each habitat type (Spurgeon et al. 2004). Aggregated reef, patch reef, individual patch reef, and spur and groove compose the high complexity habitat type, scattered coral/rock, and artificial reefs make up the medium habitat, and rock, boulder, pavement, and rubble make up the low complexity reef category. We calculate the total reef area for each village within a one mile

buffer from the shoreline and then sum the weighted values to determine overall habitat complexity. Thus, habitat quality is correlated with the length of the coastline since the buffer area is derived from a one mile extension from the shoreline.

The 2000 DOC Census Data provides the basis for population estimates and total fishing effort. We use total population of people over the age of 15, which corresponds to the surveyed population. For each individual, we multiply the population of their village by their frequency of fishing for food. We then sum these individual estimates of fishing effort, and divide it by the number of respondents for that village to estimate the mean total effort for each village. Sociological information, agreement with regulations and education sources defined in the above sections, are also incorporated in this analysis.

We use the values for each village to calculate the z-scores (Table 11) for comparison purposes. However, one caution is that the z-scores are calculated using the standard deviation of the available data. The result is that skewed distributions can mask the difference in values on the other end of the spectrum due to the high variance. This is especially a problem with the habitat and population data. For example, the large coastlines of Ofu and Olosega skew the distribution such that the z-scores for them are several deviations greater than the mean, while z-scores for land-locked villages such as Faleniu are less than one standard deviation from the mean. The high levels of skewness make it important to view values below zero with additional discernment. Consequently, we report skewness for each variable in addition to the z-scores.

Results

For all of the variables compared across villages, there are villages at least 2 standard deviations from the surveyed mean, indicating that each variable is location specific. However, variance of each variable does differ as mentioned in the previous section.

Several interesting results can be derived from the maps. For example, we found that the villages where the percentage of people who preferred village level management above the surveyed mean where located in more remote villages on the east and west ends of the main

island of Tutuila as well as in the remote outer islands of Ofu and Olosega (Figure 35). It is also important to note that one of the villages with higher agreement levels, Alofau, is already part of the CBFM program. Conversely, villages with a lower percentage of respondents who prefer village level management are more centrally located to Pago Pago harbor or are inland villages like Mesepa and Faleniu. This is intuitive because management at the village level may prevent those living in landlocked village from accessing the fishery. Managers may need to consider this difference in preference and many other differences when looking to expand the CBFM program or enacting territory-wide regulations.

We also found that mean agreement with proposed regulations is highly variable across villages (Figure 39). In particular, the agreement level in villages on the main island of Tutuila is either within 1 standard deviation from the mean or is 1 standard deviation above the mean. On the contrary, in the outer island villages of Ofu and Olosega, the agreement level with regulations is 2 and 3 standard deviations below the mean, respectively. This may be due to the state of the resource, the lack of perceived legitimacy of DMWR, or a combination of these and other factors.

Table 14: Z-scores of management concerns by village. The yellow values represent values within one standard deviation from the mean. Dark yellow, orange, red, and plum represent increasing standard deviations, while light green, dark green, and blue values are below the mean.

Village Name	Habitat Complexity	Length of Coastline	Total Population over Age 15	Population Density	Total Effort	Per Capita Fishing for Food	Per Capita Recreational Fishing	% of People who Prefer Village Management	Media Education	Social Education	Workshop Education	Agreement with Regulations
Aasu	-0.15	0.80	-0.32	-0.64	0.14	0.48	0.04	-0.76	-0.48	0.56	-2.20	-0.74
Afao	-0.39	-0.66	-0.53	-0.61	-0.80	-0.41	-0.78	-0.30	-0.29	-0.09	-0.93	0.33
Afono	-0.39	0.68	-0.16	-0.60	0.13	-0.25	-0.02	0.74	-0.38	1.22	1.43	-0.06
Alofau	0.14	0.12	-0.13	-0.57	-0.35	-0.31	-0.94	1.06	1.85	-1.11	0.75	-0.38
Amanave	0.32	-0.10	-0.41	-0.53	0.49	1.60	0.70	1.51	0.64	-0.82	-0.23	1.05
Amaua	-0.12	-0.69	-0.63	-0.46	-0.34	1.46	1.93	-0.76	-0.44	0.55	0.26	0.41
Amouli	0.04	0.02	-0.09	-0.56	0.85	1.10	-0.53	0.15	0.83	-1.72	0.26	-0.60
Asili	-0.27	-0.55	-0.46	-0.54	-0.62	-0.30	-0.50	-0.61	-0.47	0.49	0.75	0.14
Atuu	-0.57	-0.80	-0.27	2.36	-0.33	-0.75	-0.04	-1.21	-1.83	-1.42	-0.23	0.48
Aumi	-0.23	-0.40	-0.47	-0.50	0.93	1.75	3.42	2.00	-0.79	1.04	-0.84	0.00
Aunuu	1.98	0.84	-0.17	-0.55	0.53	0.05	0.49	0.60	-0.06	-0.47	1.73	-0.60
Auto	-0.28	-0.70	-0.43	-0.19	0.01	0.19	0.89	-1.77	-0.47	0.76	0.07	0.53
Avaio	-0.36	-0.66	-0.69	-0.12	-0.95	-0.86	0.34	0.44	-1.99	-0.08	-0.59	0.88
Fagaitua	-0.03	-0.42	-0.14	-0.47	-0.72	-0.88	-0.97	0.32	1.24	-1.12	-0.38	0.99
Fagalii	-0.35	-0.28	-0.47	-0.51	-0.72	-0.49	-0.65	0.15	-0.27	0.58	0.26	1.12
Fagamalo	-0.30	0.92	-0.71	-0.56	-0.89	0.63	0.90	0.15	-0.70	0.41	2.71	-0.45
Fagatogo	-0.57	-0.10	2.02	-0.39	3.88	-0.42	-0.08	-0.76	-0.93	-0.70	1.24	0.41
Failolo	-0.23	-0.48	-0.62	-0.01	-0.56	1.98	-0.59	0.38	0.86	-0.52	-0.36	-0.47
Faleniu	-0.58	-0.90	1.66	-0.35	1.21	-0.56	-0.90	-2.12	-0.89	-0.24	-0.72	0.26
Futiga	-0.13	0.94	0.19	-0.58	-0.72	-0.85	-1.23	-0.30	1.33	-1.01	-0.72	0.19
Iliili	-0.43	-0.21	2.46	-0.28	0.27	-0.93	-1.10	-1.66	1.24	-0.93	0.75	0.05
Leloaloa	-0.52	-0.41	-0.12	0.75	-0.17	-0.46	-0.49	0.15	0.10	0.15	-0.23	-0.38
Leone	0.39	0.15	3.78	-0.25	2.43	-0.71	-0.93	-0.10	1.01	-0.36	0.07	0.40
Malaeimi	-0.57	-0.90	0.54	-0.52	0.19	-0.71	-0.69	-0.76	0.71	0.49	-0.23	-0.74
Masefau	-0.21	1.44	-0.22	-0.50	0.00	-0.02	-0.28	1.06	0.25	-0.84	1.73	0.84
Matuu	-0.49	-0.59	-0.26	0.30	-0.50	-0.64	-0.57	-0.30	-0.05	0.04	0.26	0.84
Mesepa	-0.58	-0.90	-0.20	0.10	-0.63	-0.89	-0.69	-1.21	0.16	2.15	0.26	-0.95
Ofu	4.38	3.56	-0.39	-0.57	0.00	0.16	0.53	1.06	0.42	0.87	-0.23	-2.96
Olosega	2.34	2.63	-0.53	-0.49	0.56	3.26	1.76	1.06	0.57	2.14	-0.72	-3.24
Onenoa	-0.27	-0.35	-0.54	0.11	-0.53	-0.35	0.58	1.51	1.57	-1.61	-1.22	0.76
Pagai	-0.52	-0.72	-0.64	2.51	-0.78	-0.31	0.49	0.60	1.05	-0.29	-1.22	-0.10
Sailele	-0.17	-0.19	-0.63	0.01	-0.76	-0.61	0.89	0.32	-1.48	1.76	0.52	-0.26
Utulei	-0.49	-0.44	0.28	1.89	-0.39	-0.96	-0.78	-1.21	-1.88	-0.47	-0.72	1.55
Utumea East	-0.36	-0.68	-0.67	3.33	-0.88	0.01	-0.20	0.60	-0.42	0.58	-1.22	0.69
Skewness	**4.89**	**2.11**	**2.53**	**2.27**	**2.34**	**1.68**	**1.56**	**-0.23**	**-0.17**	**0.43**	**0.59**	**-1.64**

Figure 29: Spatial Variation in Habitat Complexity in Surveyed Villages

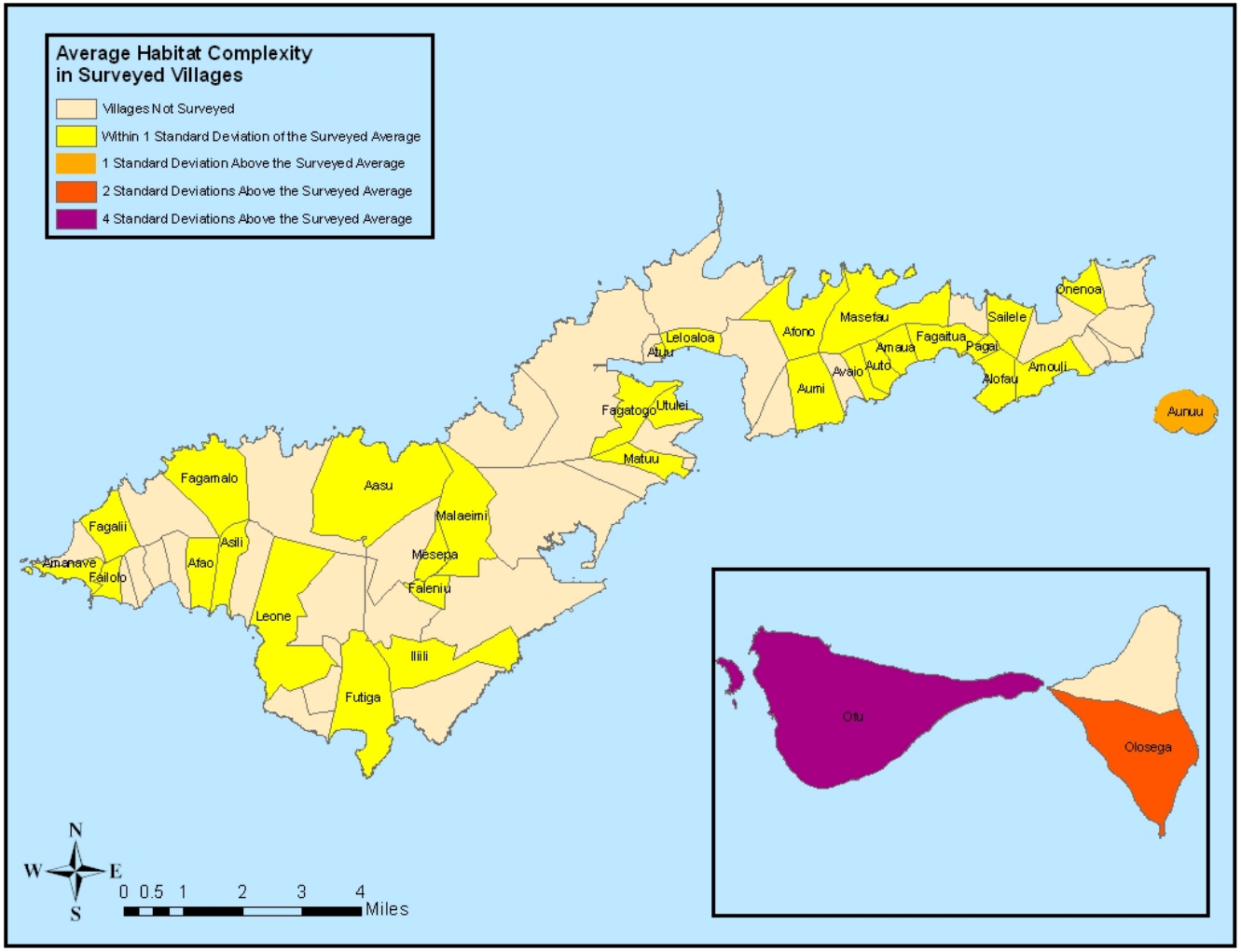


Figure 30: Spatial Variation in Total Population over 15 years old in Surveyed Villages

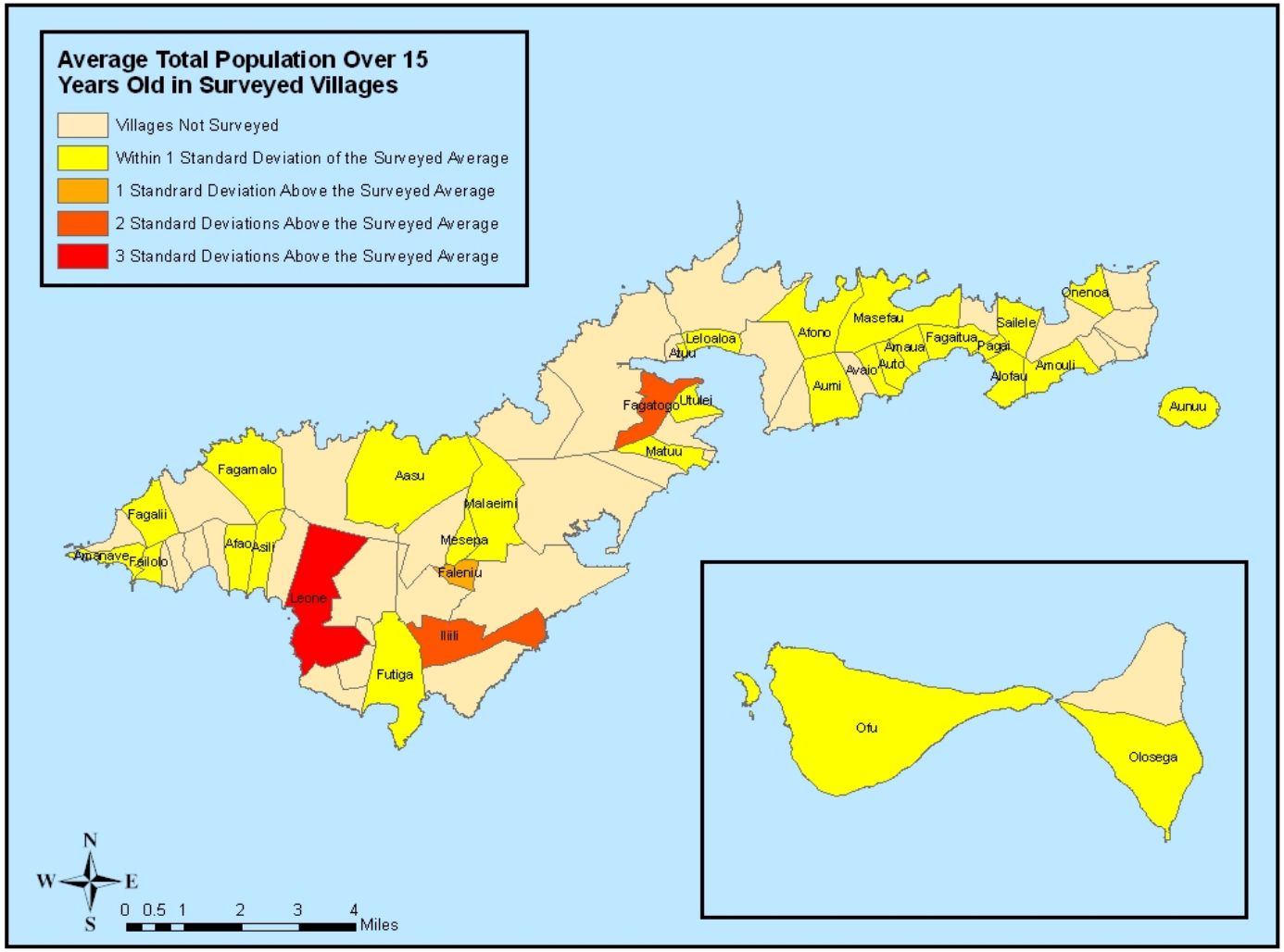


Figure 31: Spatial Variation in Population Density in Surveyed Villages

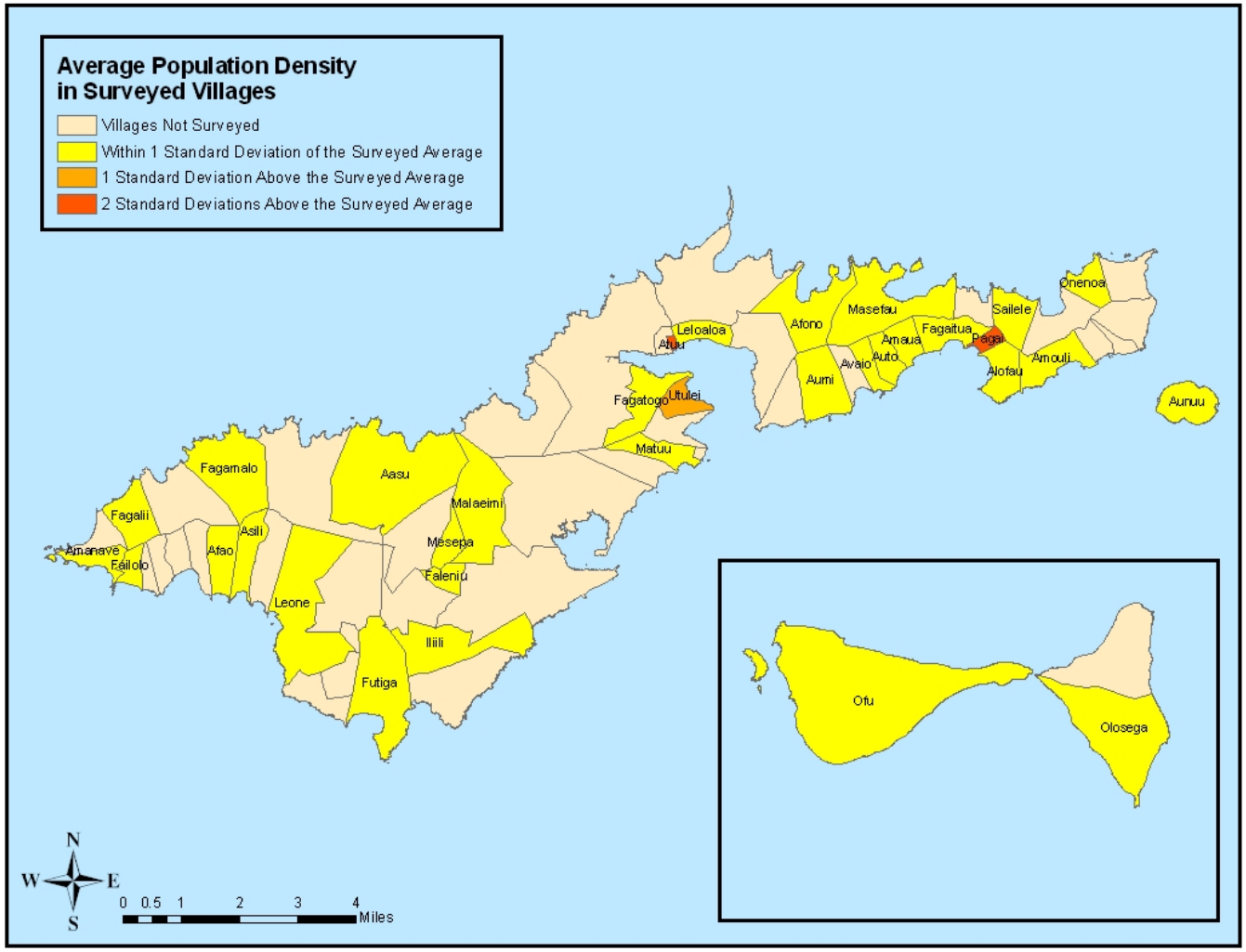


Figure 32: Spatial Variation in Total Fishing Effort in Surveyed Villages

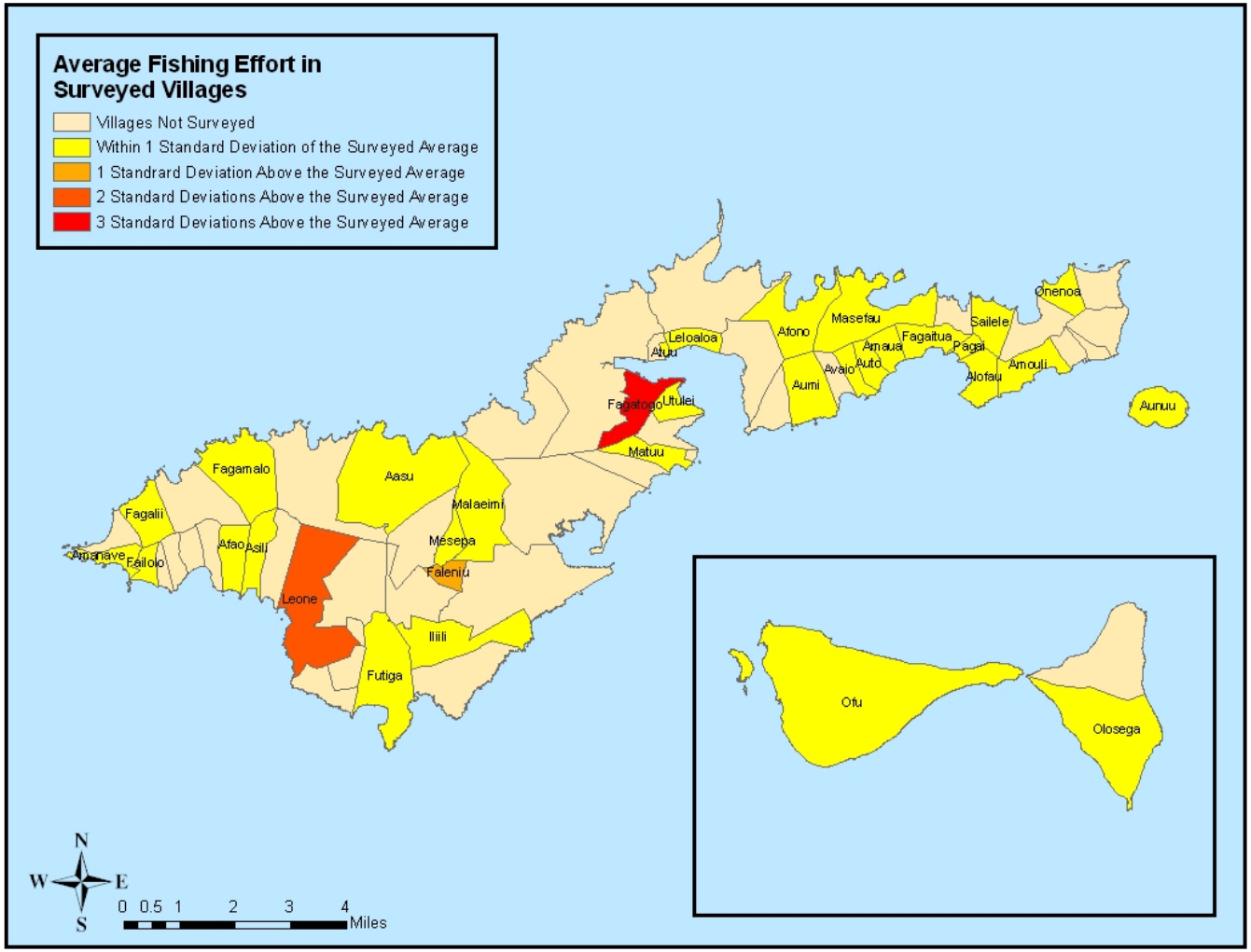


Figure 33: Spatial Variation in Per Capita Subsistence Fishing Frequency in Surveyed Villages

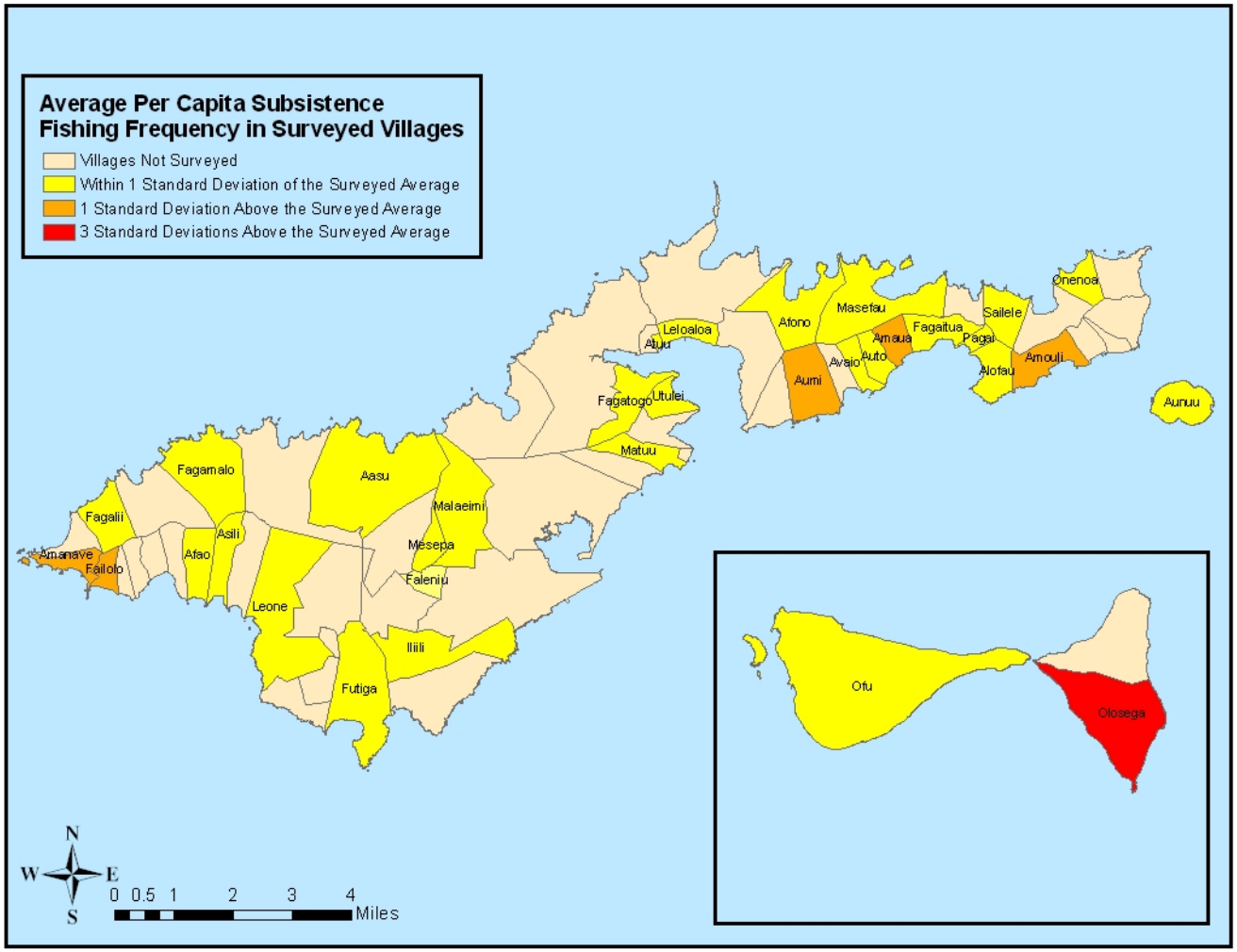


Figure 34: Spatial Variation in the Per Capita Recreational Fishing in Surveyed Villages

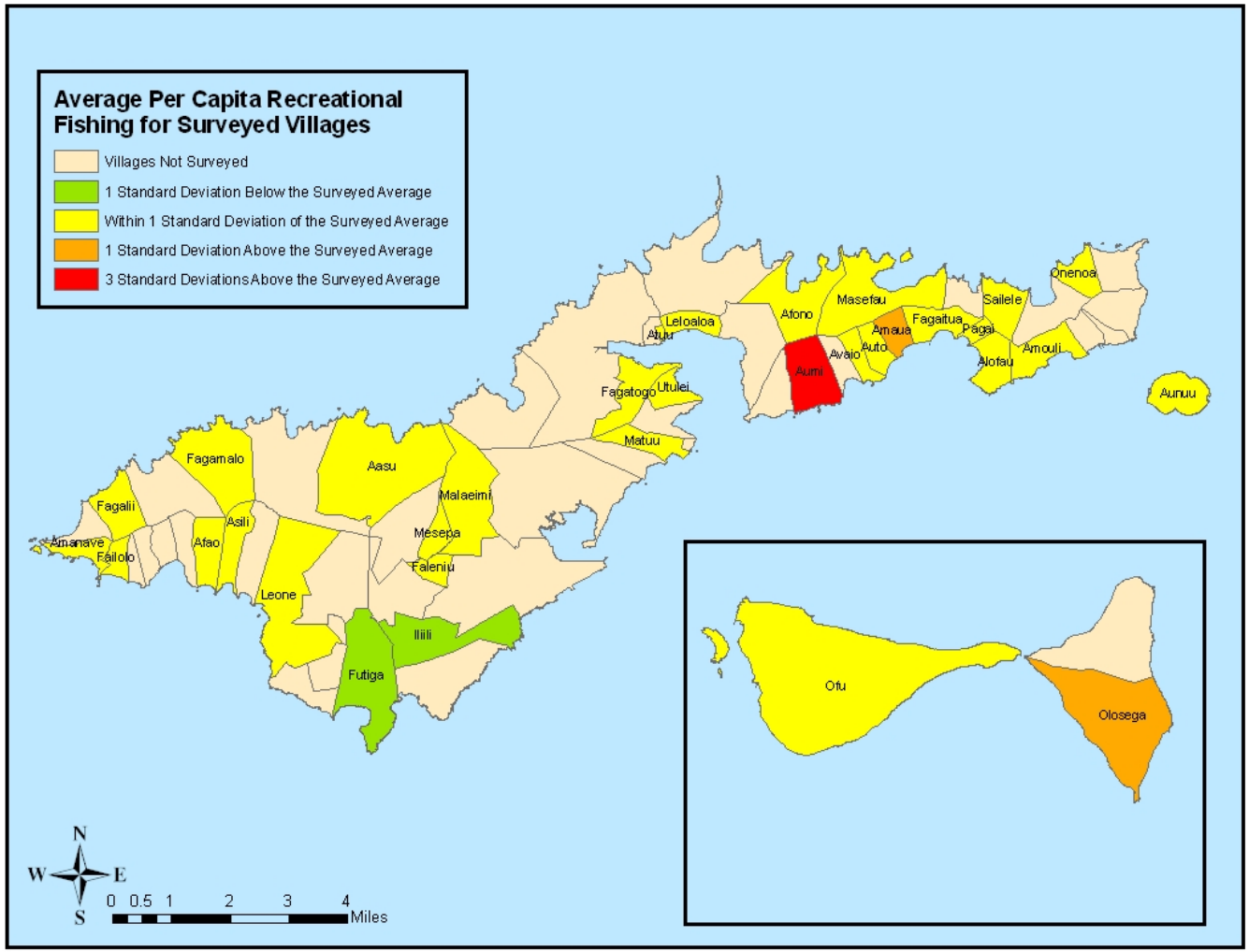


Figure 35: Spatial Variation in the Percentage of People Who Prefer Village Level Fishery Management

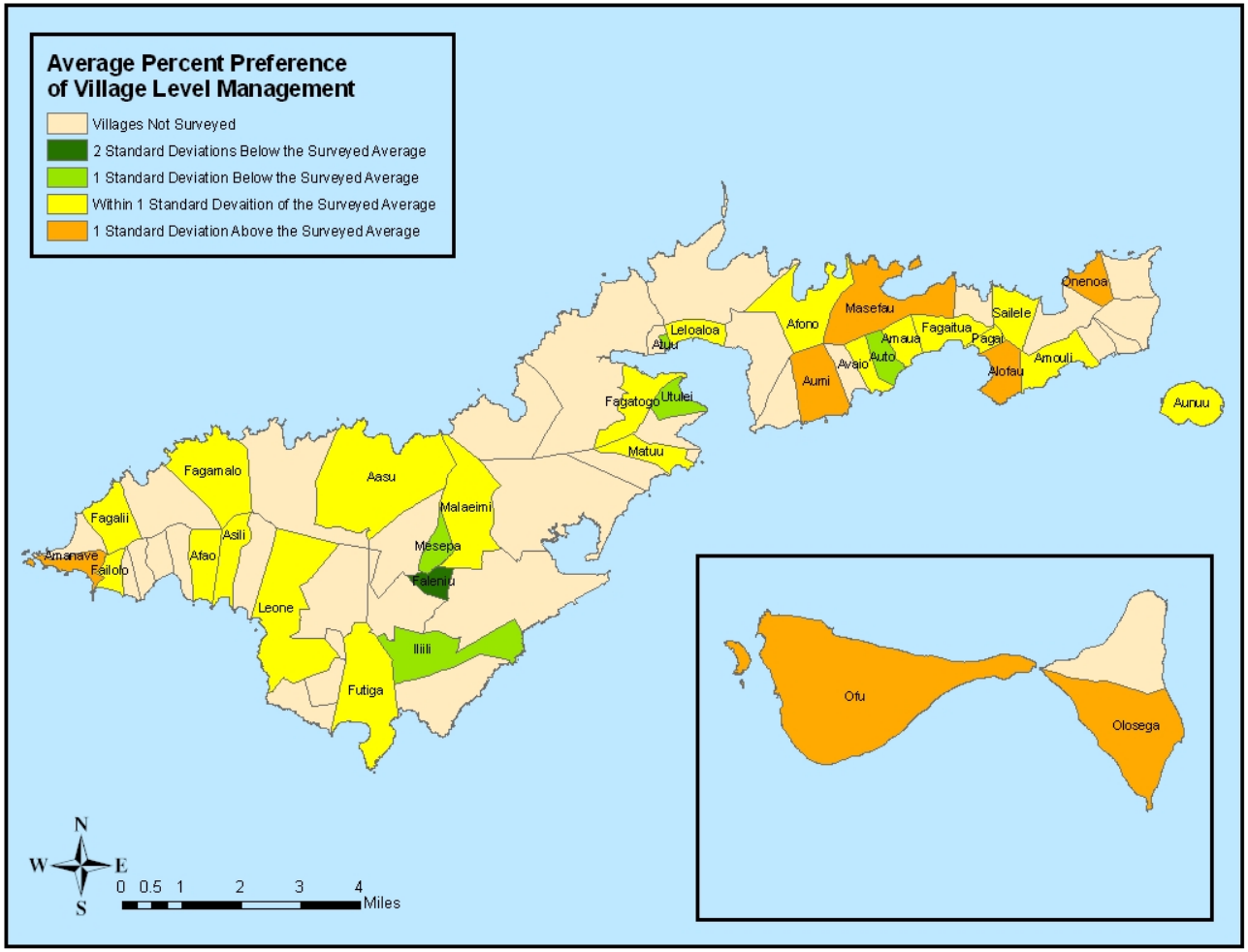


Figure 36: Spatial Variation in the Amount of Fishery Education Received from Media Sources in Surveyed Villages

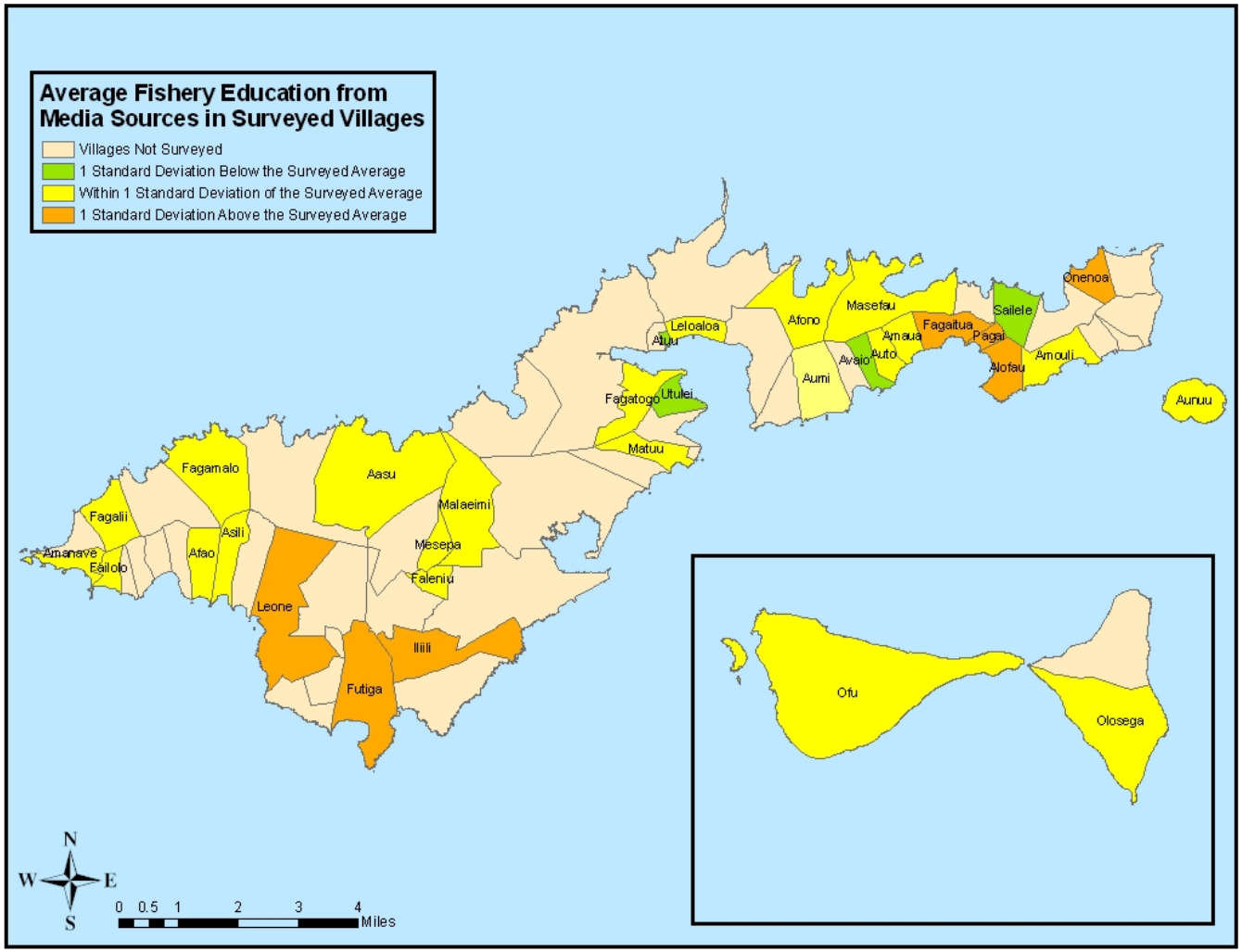


Figure 37: Spatial Variation in the Amount of Fishery Education Received from Social Sources in Surveyed Villages

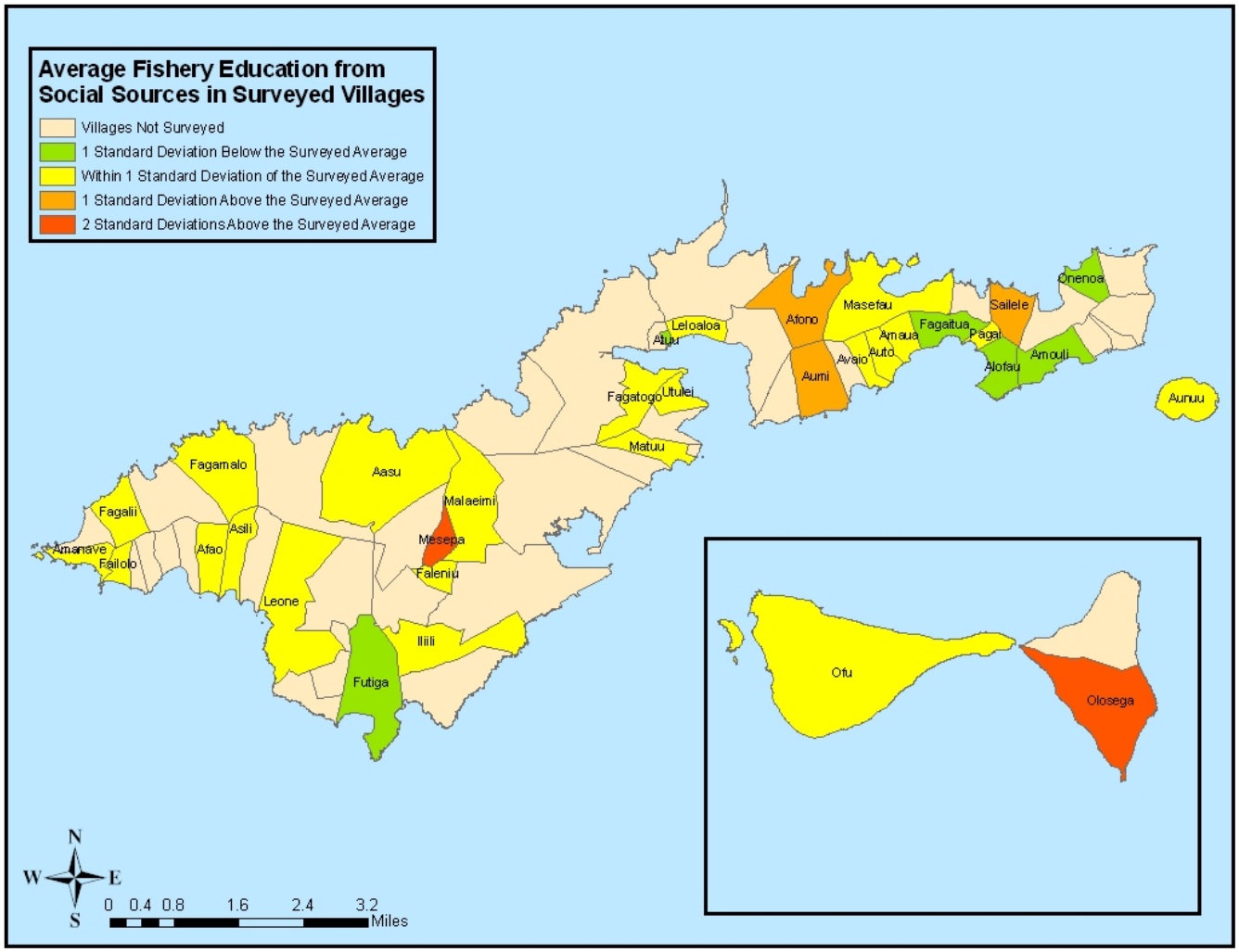


Figure 38: Spatial Variation in the Amount of Fishery Education Received at Workshops in Surveyed Villages

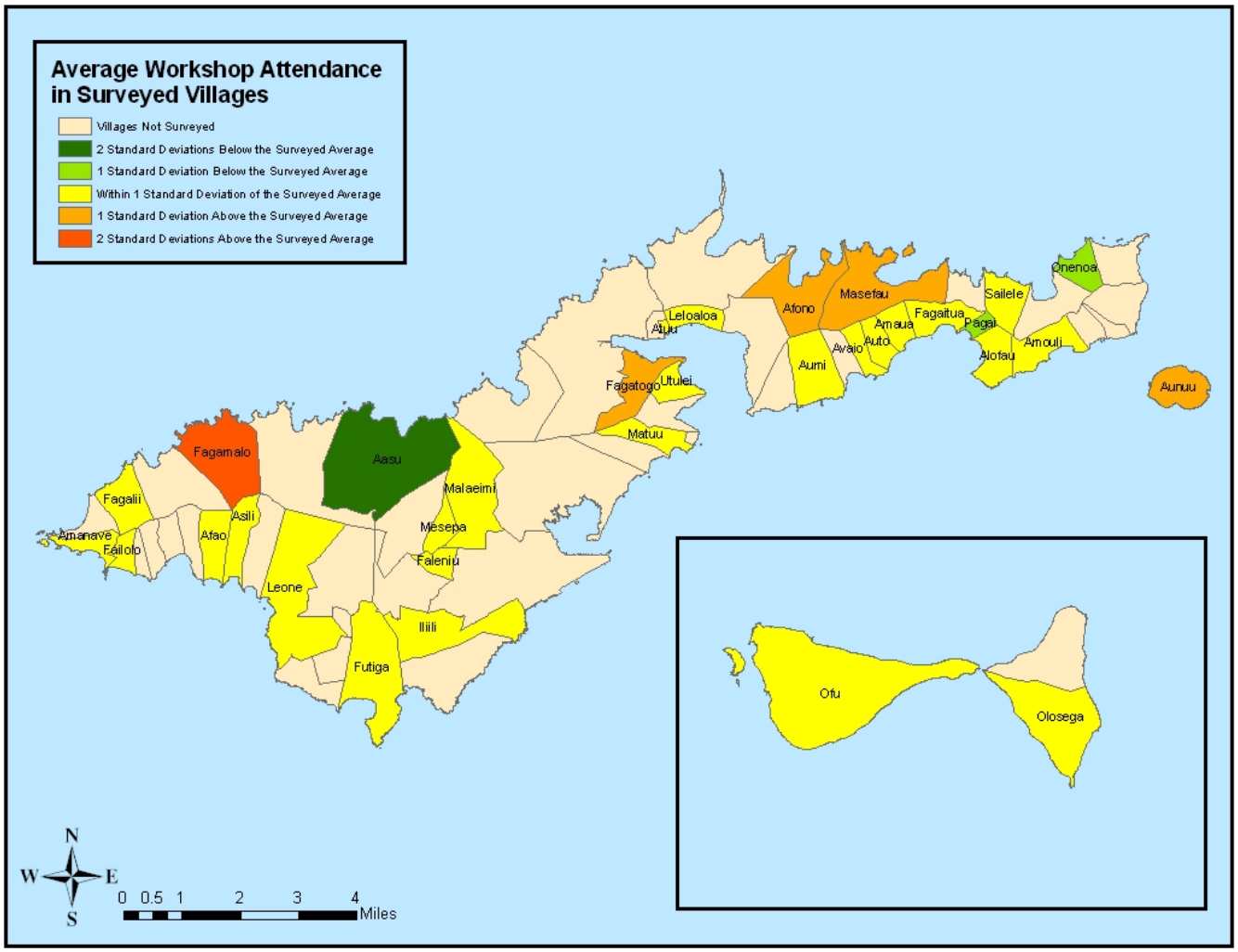
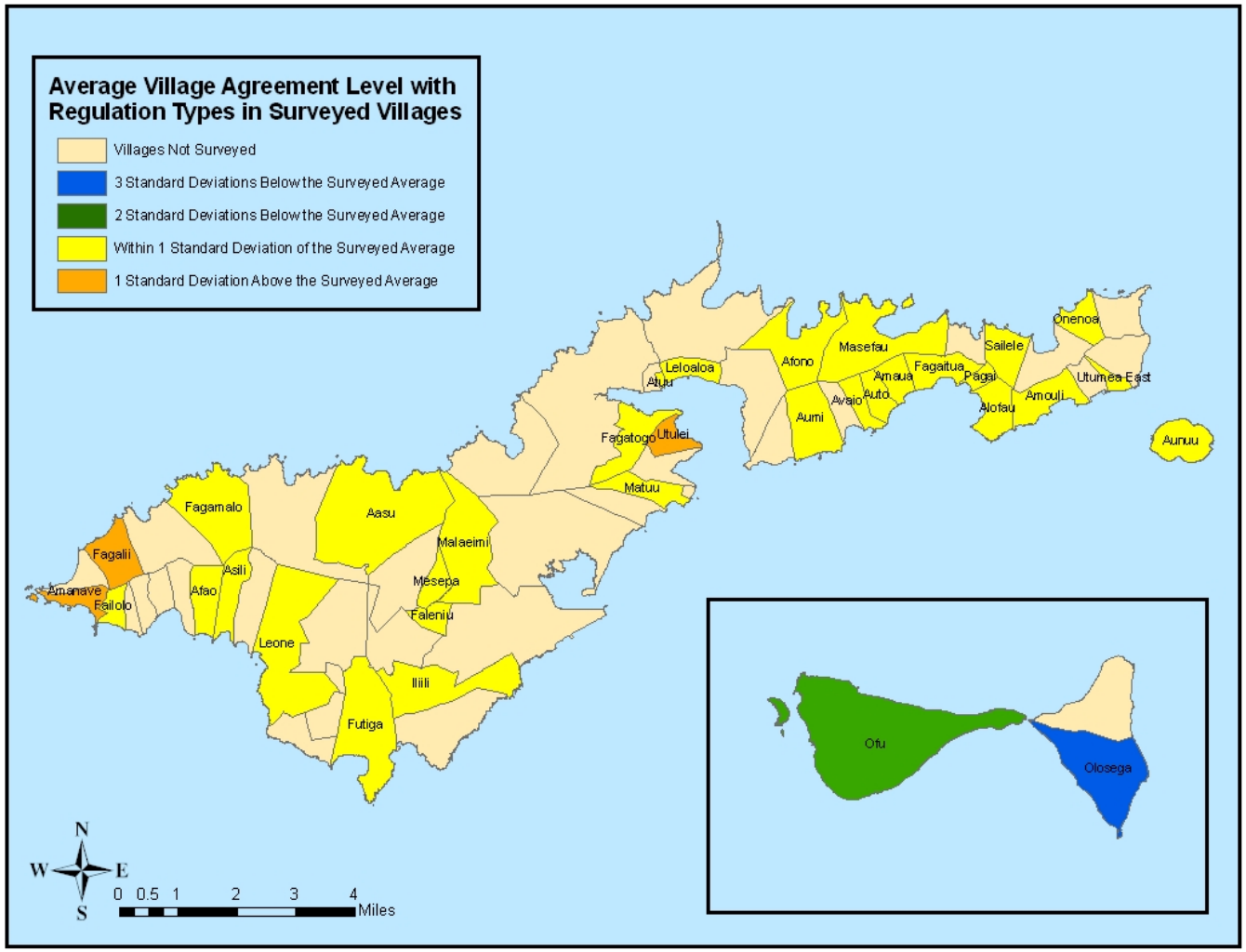


Figure 39: Spatial Variation in the Average Level of Agreement with Possible Fishery Regulations in Surveyed Villages



Analysis

Interpretations from the model

Our spatial analysis model can provide useful insight into the interaction between fishery users in each village and their resources. For example, Ofu and Olesega have the highest reef complexity, greater than average social and media education, and average to above average per capita effort both for food and recreation. However, their residents have by far the lowest mean agreement with regulations. One explanation for this is the fact that people living on these more remote islands depend heavily on their fisheries and do not want them regulated, especially since their high quality habitat does not imply a current threat of overexploitation. Moreover, high proportions of the populations prefer village level management, and so due to their remote location they may prefer to manage their near shore fisheries themselves rather than be subject to territory-wide regulations.

Adjoining villages, Auto and Amaua share authority of the reefs under the Community Based Fishery Management Program. Both villages display lower than average percentages of people who prefer village level management, while only Auto is statistically significant different from the Territorial mean (Table 14). Additionally, these two villages have lower levels of workshop education and higher agreement with DMWR regulations than the two other CBFMP villages that were surveyed (Alofau and Fagamalo). Based on this data, DMWR may want to evaluate the effectiveness of the community management program in Auto/Amaua.

Faleniu is a land-locked village with a high population density. However, due to its relatively large population, Faleniu has a high total fishing effort. The high level of effort implies that the residents must fish in other villages, which may increase the impacts on the fisheries in those areas. Since residents do not have tenure over their own resource and they do not want to be excluded from fishing by another village's restrictions, it is logical that a low proportion of the community prefers fisheries management at the village level. Moreover, the residents have a greater than average agreement with regulations, which suggests that they may depend on the regulations of DMWR to protect their right to fish.

All of the villages with greater than average populations (Fagatogo, Faleniu, Iliili, Leone, Maleimi, and Utulei) display lower than average per capita fishing effort. This could be due to a shift towards a cash economy and away from subsistence fishing (Coutures 2003). That is, in villages with larger populations and more commerce, residents may be more likely to buy foods and make substitutions for fish they have caught. However, due to the high populations, some of the villages (Leone, Fagatogo and Faleniu) have very high total effort. Managers should consider these effects of population growth on a village's fishery harvest.

The above examples demonstrate different ways in which managers can use the spatial analysis model to examine various components of the near shore fisheries in American Samoa. Managers can use results developed from the model to estimate the effects of future management actions on individual villages, appraise the success of specific policy on specific villages, assess how villages may be affected by the activities of other villages, and predict the effects of territory-wide trends based on the current spatial variability. Additionally, managers can examine either the variability of a specific management concern across all villages (columns in Table 14), or they can distinguish the interactions of different management actions within villages (rows in Table 14).

Limitations of the model

While the spatial analysis model may prove to be a useful tool for DMWR, the lack of historical trends and available data limit its effectiveness. First, the current model only calculates z-scores for surveyed villages, as they are the only ones with all of the available data. Additionally, the model does not place any qualitative value on the current mean conditions. That is, if the total subsistence fishing effort is high compared to the historical effort or compared to other Pacific Island nations, it does not take this condition into account. Likewise, the model is also limited in determining whether or not the current mean effort is too high for the fishery to support. Managers must, therefore, incorporate the current spatial variation with their knowledge of the current conditions compared to other regions or time periods. Finally, future additional data including water quality, fish biomass, fish diversity, reef health, and direct fishing effort by village can help to better quantify the fishery resource potential and its use.

Extensions and future analysis

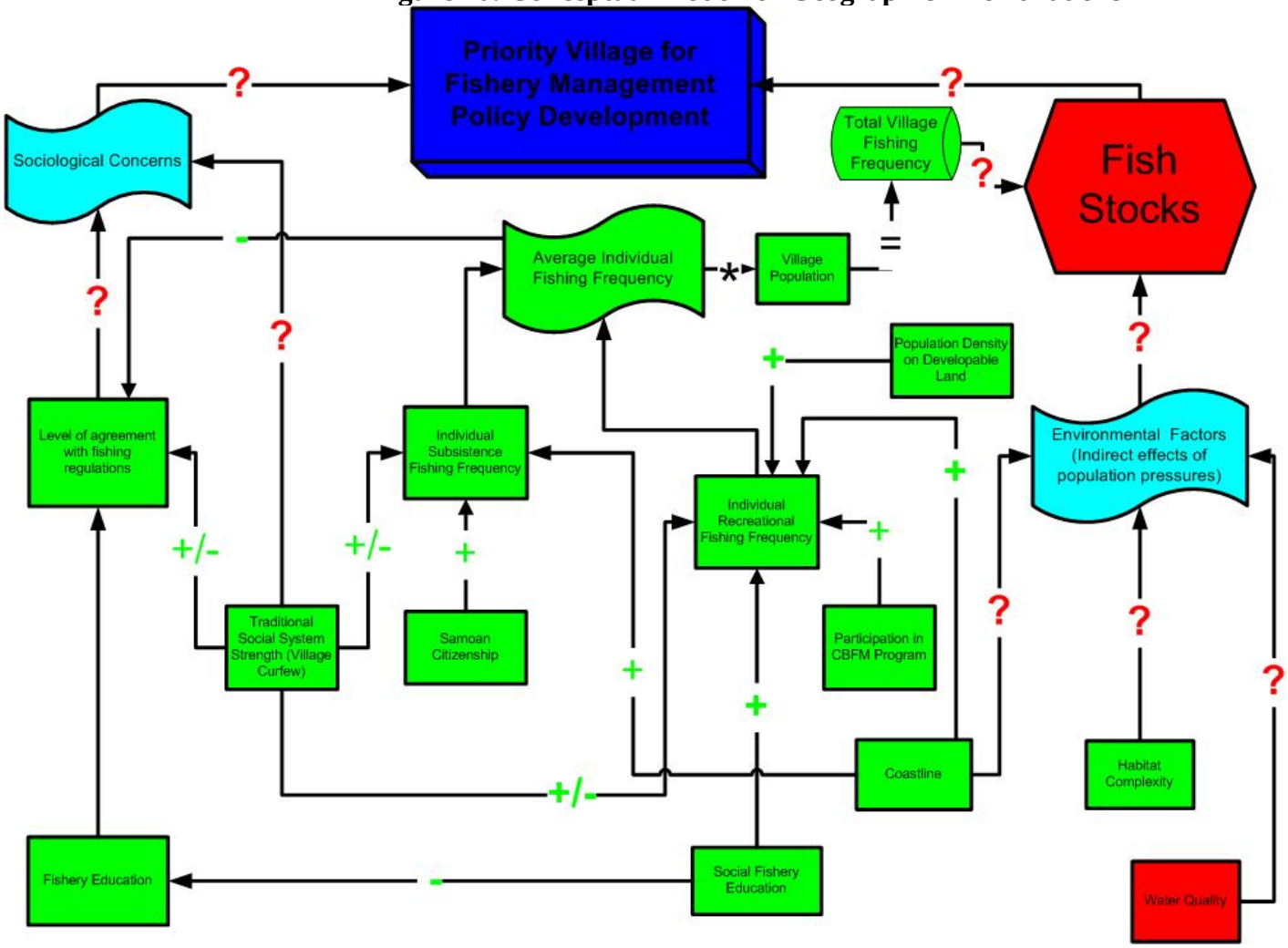
As shown in the previous section, using basic data about the social and environmental factors and measurements of the use of the fishery, local managers can determine priority geographical areas for fishery management policy development. Although a one-time analysis is useful in the short-term, it does not provide long-term trends about geographically important areas, nor can it be employed to create a comprehensive model for future geographic policy development. Therefore, an important component when developing long-term fishery management strategies is determining how changes in social and environmental factors and fishing frequency will vary spatially. Meaningful decisions regarding the geographically important areas for fishery management policy development can be made as new environmental and socioeconomic data become available. This, in turn, facilitates the development of long-term fishery management strategies that are spatially adaptive to changing environmental and socioeconomic data.

In the context of the coral reef fisheries in American Samoa, knowledge of how social and environmental factors influence different geographical areas is especially important given the rapidly increasing population, the dynamic socioeconomic situation, and the relatively large subsistence population. A spatial model that adapts to changing socioeconomic trends, cultural practices, and environmental factors is essential in creating effective long-term management strategies for coral reef fisheries. With this model, DMWR can use existing data to determine the areas towards which they should focus long-term policy development.

A fully comprehensive model in which the direction and magnitude of all social and environmental factors are known is beyond the scope of this study. However, using regression analysis, we determined several important socioeconomic factors that influenced different types of fishing frequency as well as people's opinions of possible fishery regulations. In addition, several studies have been published regarding how different social and environmental factors affect coral reef ecosystems (Fiske 1992; McCook 1999).

Using our results and evidence from previous studies, we constructed a conceptual model that can be used to prioritize geographical areas for fishery management policy development in the future (Figure 40). The model below illustrates socioeconomic and environmental factors we found to be important in our regression analysis in green along with a corresponding direction of influence. Factors in aqua are subjective, in that they may be measured differently or may contain other information not captured in our analysis. For example, environmental factors may also include land use adjacent to the coral reefs or the amount of pollutants. Those figures in red are those that we chose to be important but which lack sufficient data to determine the direction of influence. In other words, they represent gaps in data that are needed for a more complete analysis of the state of fishery resources in particular geographical areas. In summary, managers can use this model to visualize some of the complex interactions between social and environmental factors in order to effectively prioritize management areas of concern.

Figure 40: Conceptual Model for Geographic Prioritizations



Conclusions

This study aims to inform American Samoa's Department of Marine and Wildlife Resources about the socio-economic conditions related to their nearshore coral reef fisheries. We conducted a community survey to collect valuable baseline data related to fishery use, regulations, and education. We summarized the results in graphs and utilized basic statistical tests to determine the differences in perceptions of regulations and sources of fishery education among user groups. We then ran multivariate regressions to determine the factors that explain the user group differences. Next, we normalized the data and created maps that display the regional distribution of fishery resource pressures and community opinions. Finally, we developed a conceptual model of how socio-economic information fits into the design of fishery management strategies.

We found that American Samoan residents value the reef highly for ecosystem health and subsistence fishing. However, nearly half of the residents never engage in fishing, and only a small fraction are so dependent on the reef that they fish more than twice a week. Individuals in their twenties were more likely to fish than other age groups, and males were much more likely to engage in fishing activities. Other factors that increased the likelihood that an individual fishes include access to the fishery, residence in a village with an unenforced curfew, and Samoan citizenship. These findings reveal how much subsistence fishing occurs and which user groups are most likely to fish, which is important in identifying who is most dependent on the reef and who is most likely to be affected by regulation.

In general, we discovered that American Samoans favored fishery regulations. Nearly half of the survey respondents believed that fishery regulations are too lenient. In terms of the types of regulations with which individuals are in agreement, respondents agreed the most with regulations on what is caught, where people fish, how people fish, and during spawning events. Additionally, most people, especially people who fish, matai, and Samoan citizens, stated that they prefer management at the village level. Despite the fact that the majority of respondents favored fishery regulations, at least one fifth of the respondents disagreed with the role of DMWR in regulating the fishery. Overall disagreement with regulations was correlated to residents of villages without an enforced curfew, individuals without a matai title, above average fishers, and

increased social fishery education. These results are valuable because they suggest which regulations and which user groups might have the highest level of compliance.

In terms of education, media sources reached the most people most frequently, and the media did not favor any user groups over another. Workshops, however, were more highly attended by matai and participants in the community based fishery management program. These findings are important because people who attended workshops were more likely to agree with regulations than those who did not attend a workshop. Social fishery education, on the other hand, was received more by males and people who fish. Interestingly, people between the ages of 31-45 received the least social education and were least likely to attend workshops. The understanding of the distribution of fishery education is important because it assists in planning how to design future fishery education programs and disseminate information efficiently.

We found that there is significant spatial variation in perceptions and opinions about fishery management and education. Furthermore, when sociological factors are combined with data of fishery use and potential, we found that managers could potentially analyze the effectiveness of fishery management decisions at the regional or village level. For example, we discovered that the remote villages of Ofu and Olesega have the highest reef complexity and average to above average per capita effort, but their residents have the lowest mean agreement with DMWR regulations and higher proportions of the populations prefer village level management. Additionally, we learned that of the members of the Community Based Fishery Management Program, Auto and Amaua have lower than average percentage of people who prefer village level management, lower levels of workshop education, and higher agreement with DMWR regulations than Alofau and Fagamalo. Regarding fishing effort, we noticed that villages with greater than average populations display lower than average per capita fishing effort, but many have significantly higher than average total effort. Additionally, land-locked villages, such as Faleniu may impact adjacent villages' fisheries due to additional population pressure. By analyzing multiple fishery influences and visualizing the data with GIS, DMWR can improve its ability to identify areas of management concern.

Use of the Results

Human activities are the source of many coral reef threats and their activities are ultimately affected by any policy implementation. Thus, it is important to incorporate community input and anthropogenic influences into any decision making process. This research provides valuable information regarding socio-economic aspects of nearshore coral reef fisheries management in American Samoa. It highlights current conditions and explains significant influences in fishery use, education, and regulatory perceptions. Moreover, it proposes a spatially explicit model of resource availability, resource use, and sociological concerns. Finally, it presents a conceptual representation of how this information fits into the broader scope of fisheries policy development. By analyzing the sociological component of fisheries in American Samoa, this research provides beneficial decision support for fisheries managers.

The socio-economic information provided enables coral reef managers to integrate stakeholder concerns and interests into the process, and to determine the effects of policy decisions on those stakeholders. Specifically, it identifies the current opinions towards existing regulations and enforcement, characterizes perceptions of regulations among user groups, determines the availability and accessibility of fishery education, explores the importance of spatial variation in management concerns, and demonstrates how this information should be integrated into policy development to allow resource managers to make more informed decisions towards the fisheries.

Before developing solutions, fisheries managers must first comprehend the problem, which in this case, requires a thorough measurement of the use of the fishery. After determining the dependence on the resource, managers must assess the benefits of different management alternatives. Knowledge concerning perceptions of current and proposed regulation strategies present managers with an idea of how much opposition they may receive during implementation and enforcement of regulations. Understanding where different user groups receive fishery education and how it affects their opinions of the resource is vital to developing an effective education program that promotes conservation. Additionally, analyzing information spatially assists managers in identifying regional concerns and targeting specific geographic areas.

This document provides a means of support by informing policy makers of the sociological concerns and makeup of the local residents. While the findings of this report are instructive, they still must be balanced with other available information regarding the coral reef resources in American Samoa. The combination of scientific research with local knowledge is critical in making educated decisions about the best policy for American Samoa. Furthermore, management must take into account effects that extend beyond direct extractive use. In future management decisions, socio-economic data can be combined with knowledge of biophysical aspects of the reef ecosystems in order to create a comprehensive fishery management plan for the territory.

Appendices

Appendix A: Summary Fishing Regulations

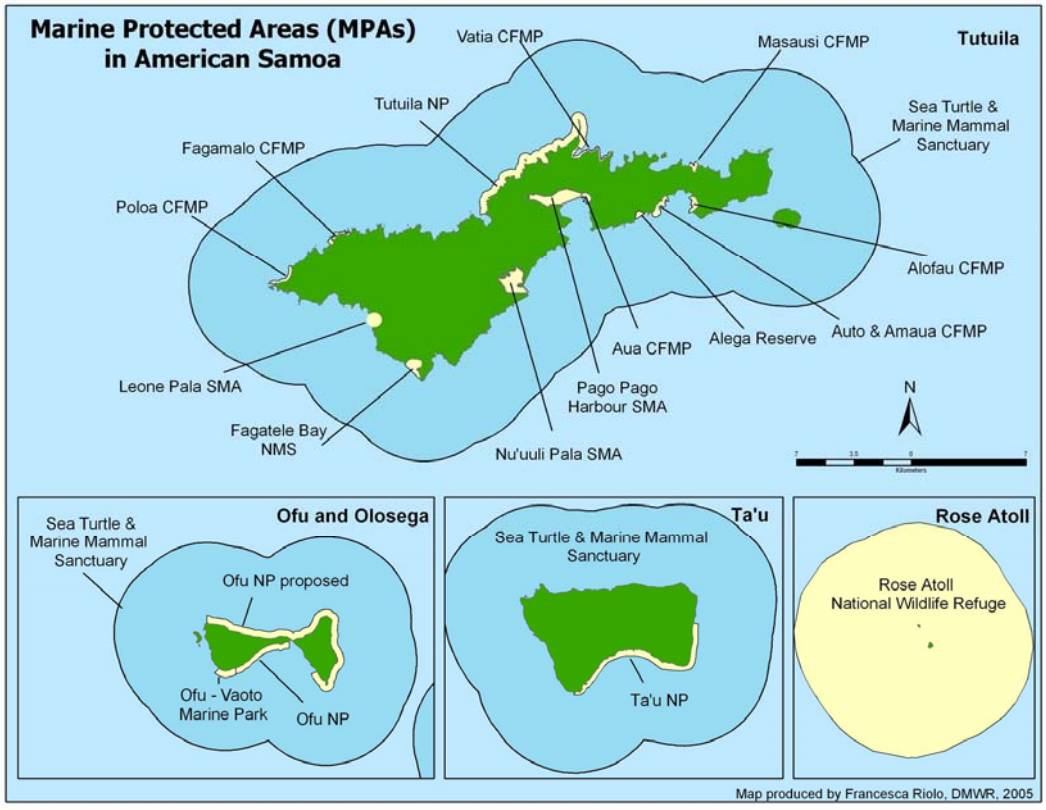
Summary of current near shore fishing regulations in American Samoa (ASCA §24.0902-24.0945)

Type of Regulation		Regulation
Gear Restrictions	**Banned Methods**	Ban on Dynamite and Explosives
		Ban on poisonous substances
		Ban on electrical devices
		Ban on SCUBA-assisted fishing
	Restrictions on Hand nets	Hand net or scoop may not be larger than 3 ft. in diameter
	Restrictions on Cast nets	Cast or throw nets may not have a stretched mesh size of less than .75 inches
	Restrictions on Gill nets	Gill nets may not have a stretched mesh size of less than 1.5 inches
		Gill nets may not have a length of more than 700 ft. (singly or in series)
		Gill nets may not be deployed with 50 feet of another gill net or weir
		Gill nets may not be abandoned or discarded in the water
		Gill nets may not be deployed in a way that violates territorial or Coast Guard regulations or causes a navigation hazard
		Ban on drift gill nets
		Gill nets may not be used below a depth of 60 feet
		Gill nets must be checked every 3 hours and cleared of fish and debris
	Restrictions on Seines	Seines, surround nets, and drag nets may not have a stretched mesh size of less than 1.5 inches, with the exception of traditional nets made from natural materials
	Restrictions on Fish weirs	The use of fish weirs require a permit
	Restrictions on fish and shellfish traps	Fish and shellfish traps may not exceed 6 feet in any linear dimension
		Fish and shellfish traps must be checked and emptied every 24 hours
		The deployment of fish or shellfish traps may not pose a navigation hazard
		Fish and shellfish traps may not be abandoned or discarded in the water

		A permit is required for commercial use of fish and shellfish traps
	Restrictions on habitat destruction	Ban on willful destruction of corals and other fish habitat
Species Specific Restrictions	**Coral**	Coral may not be harvested at a depth less than 60 feet
		Commercial harvest or coral requires a permit
	Giant Clams	Giant Clams must be at least 7 inches across the longest part of the shell to harvest
		Giant Clams that are consumed must have meat still attached until the fishermen is home to facilitate measurement
		Giant Clams that are sold or imported must have meat still attached to facilitate measurement
		Restrictions on giant clam harvesting do not apply to aquaculture clams
	Shells	Commercial harvest of shells requires a permit
	Mangrove Crabs	Egg-bearing Mangrove crabs may not be possessed taken, sold, imported or exported
		Mangrove crabs must be at least 6 inches in length across the longest part of the back to harvest
	Coconut Crabs	Egg-bearing Coconut crabs may not be possessed taken, sold, imported or exported
		Coconut crabs releasing larvae into the water may not be interfered with
		Coconut crabs must be at least 3 inches in length across the longest part of the back to harvest
		Regulations apply to marine and terrestrial areas
	Slipper Lobsters	Egg-bearing Slipper Lobsters may not be possessed taken, sold, imported or exported
		Spears or snagging devices may not be used for catching Slipper Lobsters
	Spiny Lobsters	Egg-bearing Spiny Lobsters may not be possessed taken, sold, imported or exported
		Spiny Lobsters must be at least 3.125 inches from the leading edge of the carapace to the rear edge of the carapace top harvest
		Spiny Lobsters taken, imported, or sold must be whole to facilitate measurement
License	**Commerical Fishing**	Any and all commercial fishing activity requires a license

Appendix B: Map of MPA Locations

Marine Protected Areas in American Samoa (Riolo DMWR 2005)



Appendix C: Federal MPA Characteristics

Characteristics of Federal Marine Protected Areas (MPAs) in American Samoa

MPA	Year Established	Fishing Regulations	Management Agency
Rose Atoll National Wildlife Refuge (RANWR)	1973	No fishing activity allowed; visitation requires a permit	Fish and Wildlife Service (FWS)
Fagatele Bay National Marine Sanctuary (FBNMS)	1986	No fishing activity allowed in Subzone A; no commercial fishing or use of fishing poles, handlines, or trawls in Subzone B	National Marine Santucary Program
National Park of American Samoa	1993	Only tradition fishing methods allowed; no commercial fishing	National Park Service (NPS)

Appendix D: Territorial MPA Characteristics

Characteristics of Territorial Marine Protected Areas (MPAs) in American Samoa (ASCA § 18.0214 and ASCA § 26.0221)

MPA	Year Established	Fishing Regulations	Management Agency
Vaoto Territorial Marine Park	1994	Ban on fishing activity except by residents of the island of Ofu	Department of Marine and Wildlife Resources (DMWR)
Pago Pago Harbour Special Management Area	1980	None; Designation protects habitat from land-based threats like sedimentation and habitat destruction	Department of Commerce Coastal Management Program (ASCMP)
Leone Pala Special Management Area	1990	None; Designation protects habitat from land-based threats like sedimentation and habitat destruction	Department of Commerce Coastal Management Program (ASCMP)
Nu'uuli Pala Special Management Area	1990	None; Designation protects habitat from land-based threats like sedimentation and habitat destruction	Department of Commerce Coastal Management Program (ASCMP)

Appendix E: Community MPA Characteristics

Characteristics of Co-Managed and Self-Managed Marine Protected Areas (MPAs) in American Samoa (CBFMP village Management Plans 2005)

MPA	Year Established	Fishing Regulations	Management Agency
Alofau Community-based Reserve	2001	Fisherman from neighboring villages may not be present in village reef area; violators taken to court and fined	Co-management between village council and DMWR Community Based Fisheries Management Program (CBFMP)
Aua Community-based Reserve	2002	Village fines for violation of territorial regulations; ban on fishing by fisherman fromneighboring villages, punishable by a fine	Co-management between village council and DMWR Community Based Fisheries Management Program (CBFMP)
Auto and Amaua Community-based Reserve	2003	No fishing of any kind	Co-management between village council and DMWR Community Based Fisheries Management Program (CBFMP)
Fagamalo Community-based Reserve	2003	No fishing activity in near shore area or streams; boats in this area are seized and violators are fined, their fish is confiscated and they are required to feed the village; fishing for traditional events requires approval by village council	Co-management between village council and DMWR Community Based Fisheries Management Program (CBFMP)
Masuasi Community-based Reserve	2002	Ban on fishing by fishermen from neighboring villages	Co-management between village council and DMWR Community Based Fisheries Management Program (CBFMP)
Poloa Community-based Reserve	2001	Ban on fishing by fishermen from neighboring villages	Co-management between village council and DMWR Community Based Fisheries Management Program (CBFMP)
Vatia Community-based Reserve	2001	Village fines for violation of territorial regulations; ban on fishing by fisherman fromneighboring villages, punishable by a fine	Co-management between village council and DMWR Community Based Fisheries Management Program (CBFMP)
Alega Reserve	N/A	Ban on fishing by fishermen from neighboring villages	Self-enforced by villagers

Appendix F: Sample Survey

1.

Age	
Gender	

2. I prefer to eat the following type of fish. Circle only **ONE**:

fresh tuna bottom fish fish of the reef No preference No fish Other

If you chose other, please specify_____

3. I prefer to eat the following type of *figota.* Circle only **ONE**:
Lobster Giant Clam Palolo No preference No figota Other

If you chose other, please specify_____

4. How much do you agree with the following statement?
Over the next twenty years, I would rather eat reef fish instead of invertebrates:

Agree Somewhat Agree Neither Agree nor Disagree Somewhat Disagree Disagree

The remainder of the survey refers strictly fish of the reef

5. How many times a month do you do the following?
Catch fish and/or shellfish for my family to eat ____/mo
Glean for fish and/or shellfish for my family to eat ____/mo
Buy fish and/or shellfish for my family to eat ____/mo
Buy fish and/or shellfish to resell to make money ____/mo
Sell fish and/or shellfish to make money ____/mo
Catch fish and/or shellfish for enjoyment ____/mo
Eat fish and/or shellfish for cultural purposes ____/mo

6. How much do you agree with the following statement?
Over the next twenty years, I would prefer to eat farmed reef fish and/or shellfish instead of fish and/or shellfish caught on the reef

Agree Somewhat Agree Neither Agree nor Disagree Somewhat Disagree Disagree

7. How much do you agree with the following statement?
I prefer to eat imported reef fish and/or shellfish instead of fish and/or shellfish caught on the reef of American Samoa?

Agree Somewhat Agree Neither Agree nor Disagree Somewhat Disagree Disagree

8. Over the next twenty years, which **species** of fish and/or shellfish will be most important to you for the following uses? (Write "none" if you do not plan to use fish and/or shellfish for the given use).

Use	Important Species	Of the species listed, which is the most important?
Catch for food		
Buy in market		
Catch for fun		
Ceremonies and traditional events		
Maintaining a healthy ecosystem		

9. In the future how would you like DMWR to formulate the rules for fishing the coral reefs?
According to village According to district According to island Territory wide Other

If you chose other, please specify:_____

10. Out of every 100 days coral reef fishing occurs in American Samoa, how many of those days do you think coral reef fishermen are involved in illegal fishing activity?

11. How important to you are the following future uses of reef fish and shellfish?
Check **ONE** for each use.

Use	Important	Somewhat Important	Neutral	Somewhat Unimportant	Unimportant
To catch for food					
To purchase from markets and restaurants					
To sell to markets and restaurants to make money					
To catch for fun					
To use for traditional and cultural ceremonies					
To catch for the aquarium trade					
To maintain a healthy ecosystem					

12. DMWR wants to manage the reef fisheries. We would like to find out how the community feels about each of the following regulations.

How much do you agree with the following statements? Check **ONE** for each statement.

	Agree	**Somewhat Agree**	**Neutral**	**Somewhat Disagree**	**Disagree**
DMWR should regulate who is allowed to fish (permits, licenses)					
DMWR should regulate what kind of fish and/or shellfish is caught					
DMWR should regulate what is done with the catch after it is caught					
DMWR should regulate when people can fish					
DMWR should regulate where people can fish					
DMWR should regulate how people can fish (gear regulations and boat regulations)					

13.

Use	**Agree**	**Somewhat Agree**	**Neutral**	**Somewhat Disagree**	**Disagree**
DMWR should regulate fishing during fish and/or invertebrate spawning events					
Fishing regulations should be placed on fishing for elders					
Fishing regulations should be placed on individuals younger than eighteen					

14. DMWR wants to find out how the community feels about current regulations and enforcement efforts. Please complete the following sentences by checking the appropriate box. Check only **ONE**.

	Too Strict	**About Right**	**Too Lenient**
Current coral reef fishing regulations are			
Current enforcement of coral reef fishing regulations is			

15. How often have you received education regarding fishing in coral reefs from the following sources?

Education Type	**Most Days**	**Once a week**	**Once a month**	**Once a year**	**Never**
School					
College					
Fishery Workshops					
Television/Radio					
Newspapers					
Pamphlets					
Family					
Other (please specify)					

16. What is your household income range per year?

<$7500 $7500-$14999 $15000-$25000 >$25000

17. How many people live in your household?

18. Do you hold a matai title? If yes, please specify_____

19. Where were you born?

20. What is your citizenship?

Appendix G: Fishing Frequency Regression

The effect of various factors on a respondent's fishing frequency was analyzed using a nominal logistic regression and an α value of 0.10. Results of this regression show that the variables of Age, Gender, Curfew, CBFM Participation, Coastline, and Citizenship were statistically significant. The R^2 value for the model equaled 0.11.

Total Fishing Frequency (subsistence and recreation combined)- Whole Model

Table 1: Significance of Hypothesized Variables in Explaining Fishing Frequency

Variable	Type of Variable	Probablity>Chi Squared
Age	Nominal	0.1158
Gender	Nominal	0.0012
Matai	Nominal	0.8367
Curfew	Nominal	0.0004
CBFM Participation	Nominal	0.0003
School Education	Continuous	0.2838
Media Education	Continuous	0.4039
Social Education	Continuous	0.6777
Workshop Education	Nominal	0.2896
Habitat Complexity	Continuous	0.7182
Coastline	Continuous	0.0526
Population Density	Continuous	0.5981
Citizenship	Nominal	0.0288
Income	Ordinal	0.8598

Total Fishing Frequency (subsistence and recreation combined)- Final Model

Table 2: Parameter Estimates for Final Model of Factors Affecting the Frequency of Fishing

Variable	Estimate	Probability >Chi Squared
Intercept	0.06133088	0.8373
Age[A]	-0.2018115	0.3185
Age[B]	-0.7316773	0.0011
Age[C]	0.49385122	0.0236
Gender[Female]	0.31099562	0.0112
Curfew[No]	0.28042923	0.1450
Curfew[Yes]	0.33389167	0.0522
CBFM Participation[0]	0.07576776	0.7306
Coastline	-0.0000608	0.1992
Citizenship[0]	0.35508089	0.0625
Intercept	-0.1225143	0.6993

Variable	Estimate	Probability >Chi Squared
Age[A]	-0.5280804	0.0255
Age[B]	-0.1106515	0.6044
Age[C]	0.5850785	0.0115
Gender[Female]	-0.4161254	0.0022
Curfew[No]	0.11778012	0.5807
Curfew[Yes]	-0.5581812	0.0053
CBFM Participation[0]	-0.7314486	0.0005
Coastline	0.0000707	0.0644
Citizenship[0]	-0.1049679	0.6563

Estimates for log odds of 0/Below Average, Above Average/Below Average

The effect of various factors on a respondent's subsistence fishing frequency was analyzed using a nominal logistic regression and an α value of 0.10. Results of this regression show that the variables of Age, Gender, Curfew, Citizenship, and Coastline were statistically significant. The R^2 value for the model equaled 0.15.

Subsistence Fishing-Whole Model

Table 3: Significance of Hypothesized Variables in Explaining Frequency of Subsistence Fishing

Variable	Type of Variable	Probability>Chi Squared
Age	Nominal	0.1660
Gender	Nominal	0.0000
Matai	Nominal	0.3901
Curfew	Nominal	0.0007
CBFM Participation	Nominal	0.4927
School Education	Continuous	0.5656
Media Education	Continuous	0.8671
Social Education	Continuous	0.8418
Workshop Education	Nominal	0.9702
Habitat Complexity	Continuous	0.0757
Coastline	Continuous	0.0282
Population Density	Continuous	0.9471
Citizenship	Nominal	0.0509
Income	Ordinal	0.8715

Subsistence Fishing-Final Model

Table 4: Parameter Estimates for Final Model of Factors Affecting Subsistence Fishing

Variable	Parameter Estimate	Probability>Chi Squared
Intercept	1.14188169	<.0001
Age[A]	0.00071754	0.9973
Age[B]	-0.4641745	0.0388
Age[C]	0.31863292	0.1785
Gender[Female]	0.45035631	0.0005
Curfew[No]	0.25179765	0.2279
Curfew[Yes]	0.00400197	0.9816
Coastline	-0.0001192	0.0110
Citizenship[0]	0.35293756	0.0969
Intercept	-0.0481393	0.8766
Age[A]	-0.44981	0.0707
Age[B]	0.10799993	0.6330
Age[C]	0.3616139	0.1547
Gender[Female]	-0.4423426	0.0027
Curfew[No]	-0.0266283	0.9075
Curfew[Yes]	-0.5218973	0.0054
Coastline	0.00002397	0.5577
Citizenship[0]	-0.1639686	0.5265

Parameter estimates for log odds of 0/Below Average, Above Average/Below Average

The effect of various factors on a respondent's fishing frequency was analyzed using a nominal logistic regression and an α value of 0.10. Results of this regression show that the variables of Curfew, CBFM Participation, Coastline, Social Education, and Population Density were statistically significant. The R^2 value for the model equaled 0.10

Recreational Fishing-Whole Model

Table 5: Significance of Hypothesized Variables in Explaining Frequency of Recreational Fishing

Variable	Type of Variable	Probability> Chi Squared
Age	Nominal	0.1492
Gender	Nominal	0.6799
Matai	Nominal	0.1065
Curfew	Nominal	0.4711
CBFM Participation	Nominal	0.0038
School Education	Continuous	0.0475

Variable	Type of Variable	Probability> Chi Squared
Media Education	Continuous	0.5818
Social Education	Continuous	0.3195
Workshop Education	Nominal	0.1877
Habitat Complexity	Continuous	0.5617
Coastline	Continuous	0.2963
Population Density	Continuous	0.0538
Citizenship	Nominal	0.0487
Income	Ordinal	0.9896

Recreational Fishing-Final Model

Table 6: Parameter Estimates for Final Model of Factors Affecting Recreational Fishing

Variable	Parameter Estimate	Probability>Chi Squared
Intercept	0.54691858	0.0569
Curfew[No]	0.06407676	0.7474
Curfew[Yes]	0.28238029	0.1189
CBFM Participation[0]	0.44102144	0.0476
Social Education	0.00034072	0.7191
Coastline	-0.0000658	0.1394
Population Density	-11.611066	0.8692
Intercept	-0.4355486	0.1725
Curfew[No]	-0.3934154	0.1219
Curfew[Yes]	0.28303461	0.1839
CBFM Participation[0]	-0.1913102	0.3956
Social Education	0.00245276	0.0189
Coastline	0.00005535	0.1969
Population Density	128.692649	0.1116

For log odds of 0/Below Average, Above Average/Below Average

Appendix H: Regulation Regressions

Part 1: Overall Agreement

The effect of various factors on a respondent's overall agreement with the regulation types (the sum of all the regulations with which the respondent agreed) was analyzed with an ordinary least squares test and an α value of 0.10. Results of this regression show that the variables of Social Education, Workshop Education, Age, Citizenship, Curfew, Fishing Frequency, and Perceptions of Illegal Fishing were statistically significant. The R^2 value for the model equaled 0.15

Table 1: Significance of Hypothesized Variables Explaining Agreement with Regulations

Variable	Type of Variable	Prob > F
Media Education	Continuous	0.2428
Social Education	Continuous	<.0001
Workshop Education	Nominal	0.0510
Age	Nominal	0.0368
CBFM	Nominal	0.9264
Samoan	Nominal	0.0798
Matai title	Nominal	0.8499
Curfew	Nominal	0.0073
Perception of Illegal Fishing	Nominal	0.0044
Fishing Frequency	Nominal	0.0029
Gender	Nominal	0.3572

Table 2: Parameter Estimates for Final Model of Factors Affecting the Agreement with Regulations

Variable	Parameter Estimate	Prob>|t|
Intercept	5.6224312	<.0001
Social Education	-0.003374	<.0001
No Workshop Attendance	-0.202678	0.0667
Age[A]	-0.538105	0.0037
Age[B]	0.155336	0.4081
Age[C]	0.1222577	0.5163
Non-Samoan	-0.305558	0.0775
No Curfew	0.0873955	0.5991
Enforced Curfew	0.4088131	0.0043
Perception of Illegal Fishing	-0.316085	0.0039
Non-Fisher	0.428502	0.0059
Above Average Fisher	-0.5214	0.0012

By eliminating the insignificant variables, the final model becomes:

$$\textit{Overall Agreement with Regulations} = \alpha_0 + \alpha_1*(\textit{Fishing}) + \alpha_2*(\textit{Social}) + \alpha_3*(\textit{Workshop}) + \alpha_4*(\textit{Curfew}) + \alpha_5*(\textit{Age}) + \alpha_6*(\textit{Citizenship}) + \alpha_7*(\textit{Illegal Fishing}) + \varepsilon_i$$

Part 2: Specific Regulations

Nominal logistic regressions were also run for each specific question regarding agreement levels with different regulations. Variables with P values less than or equal to 0.10 for each of these 8 regressions have been determined as significant factors in influencing the opinions towards these regulations (Table 3).

Table 3: Significant Variables for Regulation Agreement Regressions

Variable	Media Education	Social Education	Workshop Education	Age	Participation in CBFM	Citizenship	Matai Title	Curfew	Perception of Illegal Fishing	Fishing Frequency	Gender
Overall Agreement		X	X	X		X		X	X	X	
Regulation of Who		X						X	X	X	
Regulate What is Caught		X		X	X			X	X	X	
Regulate What is Done w/ Catch		X	X						X	X	
Regulate When			X					X		X	
Regulate Where		X				X		X	X	X	
Regulate How	X	X	X	X					X	X	
Regulate During Spawning		X				X		X			
Regulate Minors		X				X					

"DMWR should regulate who fishes"

The effect of various factors on a respondent's agreement with this regulation was analyzed using a nominal logistic regression and an α value of 0.10. Results of this regression show that the variables of Social Education, Curfew, Fishing Frequency, and Perceptions of Illegal Fishing were statistically significant. The R^2 value for the final model equaled 0.07.

Table 4: Significance of Hypothesized Variables in Explaining Agreement with Regulation Type

Variable	Type of Variable	Prob>ChiSq
Media Education	Continuous	0.9011
Social Education	Continuous	0.8991
Workshop Education	Nominal	0.0009
Age	Nominal	0.3034
CBFM	Nominal	0.9558
Samoan	Nominal	0.7822
Matai title	Nominal	0.6991
Curfew	Nominal	0.5946
Perception of Illegal Fishing	Nominal	0.0340
Fishing Frequency	Nominal	0.0190
Gender	Nominal	0.0899

Table 5: Parameter Estimates for Final Model of Factors Affecting the Agreement with Regulation Type

Variable	Estimate	Prob>ChiSq
Intercept	-0.9402503	<.0001
Social Education	0.00257458	0.0015
No Curfew	0.05495943	0.7460
Enforced Curfew	-0.4006212	0.0068
Perception of Illegal Fishing	0.28812706	0.0105
Non-Fisher	-0.1722711	0.2864
Above Average Fisher	0.36038129	0.0251

Parameter estimates for log odds of disagreeing with regulation type

By eliminating the insignificant variables, the final model becomes:

$$\textit{(Agreement with regulation type)} = a_0 + a_1 * \textit{(Social Education)} + a_2 * (\textit{Curfew}) + a_3 * (\textit{Illegal Fishing}) + a_3 * (\textit{Fishing}) + \varepsilon_i$$

"DMWR should regulate what is caught"

The effect of various factors on a respondent's agreement with this regulation was analyzed using a nominal logistic regression and an α value of 0.10. Results of this regression show that the

variables of Social Education, Age, CBFM, Curfew, Fishing Frequency, and Perceptions of Illegal Fishing were statistically significant. The R^2 value for the final model equaled 0.10.

Table 6: Significance of Hypothesized Variables in Explaining Agreement with Regulation Type

Variable	Type of Variable	Prob>ChiSq
Media Education	Continuous	0.2715
Social Education	Continuous	0.0233
Workshop Education	Nominal	0.9972
Age	Nominal	0.0103
CBFM	Nominal	0.0422
Samoan	Nominal	0.5748
Matai title	Nominal	0.5013
Curfew	Nominal	0.0073
Perception of Illegal Fishing	Nominal	0.0327
Fishing Frequency	Nominal	0.0781
Gender	Nominal	0.4420

Table 7: Parameter Estimates for Final Model of Factors Affecting the Agreement with Regulation Type

Variable	Parameter Estimate	Prob>ChiSq
Intercept	-1.3429762	<.0001
Social Education	0.00210924	0.0277
Age[A]	0.74343234	0.0006
Age[B]	-0.3246365	0.1842
Age[C]	-0.3848259	0.1223
CBFM[FALSE]	-0.4294474	0.0497
No Curfew	-0.1375315	0.5237
Enforced Curfew	-0.4735142	0.0220
Perception of Illegal Fishing	0.32428118	0.0165
Non-Fisher	-0.4547159	0.0331
Above Average Fisher	0.30123958	0.1258

Parameter estimates for log odds of disagreeing with regulation type

By eliminating the insignificant variables, the final model becomes:

$$\textit{(Agreement with regulation type)} = a_0 + a_1*\textit{(Social Education)} + a_2*(\textit{Age}) + a_3*(\textit{CBFM}) + a_3*(\textit{Curfew}) + a_4*(\textit{Illegal Fishing}) + a_5*(\textit{Fishing Frequency}) + \varepsilon_i$$

"DMWR should regulate what is done with catch"

The effect of various factors on a respondent's agreement with this regulation was analyzed using a nominal logistic regression and an α value of 0.10. Results of this regression show that the variables of Social Education, Workshop Education, Fishing Frequency, and Perceptions of Illegal Fishing were statistically significant. The R^2 value for the final model equaled 0.06.

Table 8: Significance of Hypothesized Variables in Explaining Agreement with Regulation Type

Variable	Type of Variable	Prob>ChiSq
Media Education	Continuous	0.3525
Social Education	Continuous	0.0035
Workshop Education	Nominal	0.1851
Age	Nominal	0.2237
CBFM	Nominal	0.4995
Samoan	Nominal	0.9841
Matai title	Nominal	0.8824
Curfew	Nominal	0.2398
Perception of Illegal Fishing	Nominal	0.0364
Fishing Frequency	Nominal	0.0054
Gender	Nominal	0.8527

Table 9: Parameter Estimates for Final Model of Factors Affecting the Agreement with Regulation Type

Variable	Parameter Estimate	Prob>ChiSq
Intercept	-1.2305121	<.0001
Social Education	0.00241981	0.0038
No Workshop Attendance	0.21146267	0.0803
0 Perception of Illegal Fishing	0.26738046	0.0208
Non-Fisher	-0.3519114	0.0373
Above Average Fisher	0.49593472	0.0022

Parameter estimates for log odds of disagreeing with regulation type

By eliminating the insignificant variables, the final model becomes:

$$\textit{(Agreement with regulation type)} = a_0 + a_1 * \textit{(Social Education)} + a_2 * (\textit{Age}) + a_3 * (\textit{CBFM}) + a_3 * (\textit{Curfew}) + a_4 * (\textit{Illegal Fishing}) + a_5 * (\textit{Fishing Frequency}) + \varepsilon_i$$

"DMWR should regulate when people can fish"

The effect of various factors on a respondent's agreement with this regulation was analyzed using a nominal logistic regression and an α value of 0.10. Results of this regression show that the variables of Workshop Education, Curfew, and Fishing Frequency were statistically significant. The R^2 value for the final model equaled 0.05.

Table 10: Significance of Hypothesized Variables in Explaining Agreement with Regulation Type

Variable	Type of Variable	Prob>ChiSq
Media Education	Continuous	0.5180
Social Education	Continuous	0.1920
Workshop Education	Nominal	0.0149
Age	Nominal	0.5566
CBFM	Nominal	0.9052
Samoan	Nominal	0.2005
Matai title	Nominal	0.4327
Curfew	Nominal	0.0514
Perception of Illegal Fishing	Nominal	0.1613
Fishing Frequency	Nominal	0.0169
Gender	Nominal	0.1262

Table 11: Parameter Estimates for Final Model of Factors Affecting the Agreement with Regulation Type

Variable	Parameter Estimate	Prob>ChiSq
Intercept	-0.556859	<.0001
No Workshop Attendance	0.27157816	0.0167
No Curfew	0.06426958	0.6940
Enforced Curfew	-0.4145117	0.0038
Non-Fisher	-0.4144197	0.0087
Above Average Fisher	0.31927776	0.0424

Parameter estimates for log odds of disagreeing with regulation type

By eliminating the insignificant variables, the final model becomes:

(Agreement with regulation type) $= a_0 + a_1 *(Workshop) + a_2 *(Curfew) + a_3 *(Fishing) + \varepsilon_i$

"DMWR should regulate where people can fish"

The effect of various factors on a respondent's agreement with this regulation was analyzed using a nominal logistic regression and an α value of 0.10. Results of this regression show that the variables of Social Education, Citizenship, Curfew, Perceptions of Illegal Fishing, and Fishing Frequency were statistically significant. The R^2 value for the final model equaled 0.10.

Table 12: Significance of Hypothesized Variables in Explaining Agreement with Regulation Type

Variable	Type of Variable	Prob>ChiSq
Media Education	Continuous	0.2150
Social Education	Continuous	0.0053
Workshop Education	Nominal	0.1262
Age	Nominal	0.1539
CBFM	Nominal	0.5300
Samoan	Nominal	0.0464
Matai title	Nominal	0.1308
Curfew	Nominal	0.0507
Perception of Illegal Fishing	Nominal	0.0074
Fishing Frequency	Nominal	0.0065
Gender	Nominal	0.1853

Table 13: Parameter Estimates for Final Model of Factors Affecting the Agreement with Regulation Type

Variable	Parameter Estimate	Prob>ChiSq
Intercept	-1.1887547	<.0001
Social Education	0.00223255	0.0150
Non-Samoan	0.33234774	0.0856
No Curfew	0.00609604	0.9746
Enforced Curfew	-0.5042282	0.0034
0 Perception of Illegal Fishing	0.33342925	0.0084
Non-Fisher	-0.5355196	0.0082
Above Average Fisher	0.43983986	0.0166

Parameter estimates for log odds of disagreeing with regulation type

By eliminating the insignificant variables, the final model becomes:

(Agreement with regulation type) = a_0 + a_1**(Social)*+ a_2*(*Citizenship*) + a_3*(*Curfew*) + a_4*(*Illegal Fishing*) + a_4*(*Fishing*)+ ε_i

"DMWR should regulate how people fish"

The effect of various factors on a respondent's agreement with this regulation was analyzed using a nominal logistic regression and an α value of 0.10. Results of this regression show that the variables of Media Education, Social Education, Workshop Education, Age, Perceptions of Illegal Fishing, and Fishing Frequency were statistically significant. The R^2 value for the final model equaled 0.10.

Table 14: Significance of Hypothesized Variables in Explaining Agreement with Regulation Type

Variable	Type of Variable	Prob>ChiSq
Media Education	Continuous	0.0175
Social Education	Continuous	0.0035
Workshop Education	Nominal	0.0447
Age	Nominal	0.0748
CBFM	Nominal	0.6092
Samoan	Nominal	0.4750
Matai title	Nominal	0.6214
Curfew	Nominal	0.1302
Perception of Illegal Fishing	Nominal	0.0129
Fishing Frequency	Nominal	0.0399
Gender	Nominal	0.6180

Table 15: Parameter Estimates for Final Model of Factors Affecting the Agreement with Regulation Type

Variable	Parameter Estimate	Prob>ChiSq
Intercept	-1.9820988	<.0001
Media Education	0.00112444	0.0132
Social Education	0.00268027	0.0030
No Workshop Attendance	0.29366421	0.0294
Age[A]	0.50498797	0.0141
Age[B]	0.09240324	0.6656

Variable	Parameter Estimate	Prob>ChiSq
Age[C]	-0.2069499	0.3547
0 Perception of Illegal Fishing	0.35519223	0.0047
Non-Fisher	-0.4960379	0.0102
Above Average Fisher	0.49811201	0.0051

Parameter estimates for log odds of disagreeing with regulation type

By eliminating the insignificant variables, the final model becomes:

(Agreement with regulation type) = a_0 + a_1**(Media)* + a_2**(Social)*+ a_3*(*Workshop*) + a_4*(*Age*) + a_4*(*Illegal Fishing*) + a_5*(*Fishing*)+ ε_i

"DMWR should regulate during spawning events"

The effect of various factors on a respondent's agreement with this regulation was analyzed using a nominal logistic regression and an α value of 0.10. Results of this regression show that the variables of Social Education, Citizenship, and Curfew were statistically significant. The R^2 value for the final model equaled 0.03.

Table 16: Significance of Hypothesized Variables in Explaining Agreement with Regulation Type

Variable	Type of Variable	Prob>ChiSq
Media Education	Continuous	0.2489
Social Education	Continuous	0.0639
Workshop Education	Nominal	0.2134
Age	Nominal	0.3890
CBFM	Nominal	0.9455
Samoan	Nominal	0.1216
Matai title	Nominal	0.8440
Curfew	Nominal	0.0679
Perception of Illegal Fishing	Nominal	0.1187
Fishing Frequency	Nominal	0.4177
Gender	Nominal	0.1338

Table 17: Parameter Estimates for Final Model of Factors Affecting the Agreement with Regulation Type

Variable	Parameter Estimate	Prob>ChiSq
Intercept	-1.0952107	<.0001
Social Education	0.00152662	0.0801
Non-Samoan	0.32514436	0.0711
No Curfew	-0.0870376	0.6373
Enforced Curfew	-0.3617181	0.0262

Parameter estimates for log odds of disagreeing with regulation type

By eliminating the insignificant variables, the final model becomes:

$$(Agreement\ with\ regulation\ type) = a_0 + a_1*(Social) + a_2*(Citizenship) + a_3*(Curfew) + \varepsilon_i$$

"Minors should be regulated"

The effect of various factors on a respondent's agreement with this regulation was analyzed using a nominal logistic regression and an α value of 0.10. Results of this regression show that the variables of Social Education and Citizenship were statistically significant. The R^2 value for the final model equaled 0.04.

Table 18: Significance of Hypothesized Variables in Explaining Agreement with Regulation Type

Variable	Type of Variable	Prob>ChiSq
Media Education	Continuous	0.9816
Social Education	Continuous	0.0000
Workshop Education	Nominal	0.6040
Age	Nominal	0.8045
CBFM	Nominal	0.7256
Samoan	Nominal	0.0832
Matai title	Nominal	0.8097
Curfew	Nominal	0.8166
Perception of Illegal Fishing	Nominal	0.2310
Fishing Frequency	Nominal	0.3237
Gender	Nominal	0.6864

Table 19: Parameter Estimates for Final Model of Factors Affecting the Agreement with Regulation Type

Variable	Parameter Estimate	Prob>ChiSq
Intercept	-0.7078296	0.0002
Social Education	0.00332951	<.0001

Variable	Parameter Estimate	Prob>ChiSq
Non-Samoan	0.30033203	0.0740

Parameter estimates for log odds of disagreeing with regulation type

By eliminating the insignificant variables, the final model is as follows:

$$(Agreement\ with\ regulation\ type) = a_0 + a_1 * (Social) + a_2 * (Citizenship) + \varepsilon_i$$

Appendix I: Education Regression

The effect of various factors on a respondent's fishery education from social sources was analyzed using an ordinary least squares regression and an α value of 0.10. Results of this regression show that the variables of Age, Gender, and Curfew were statistically significant. The R^2 value for the model equaled 0.05.

Social Education-Whole Model

Table 1: Significance of Hypothesized Variables in Explaining Fishery Education from Social Sources

Variable	Type of Variable	Probability > F
Age	Nominal	0.1155
Gender	Nominal	0.2132
Fishing Frequency	Nominal	0.3444
Gleaner	Nominal	0.4021
Matai	Nominal	0.4086
Curfew	Nominal	0.0965
CBFM Participation	Nominal	0.3451

Social Education-Final Model

Table 2: Parameter Estimates for Final Model of Factors Explaining Fishery Education from Social Sources

Variable	Parameter Estimate	Probability>|t|
Intercept	121.99808	<.0001
Age[A]	0.3809838	0.9734
Age[B]	27.725543	0.0160
Age[C]	-14.58491	0.2081
Gender[Female]	-13.00024	0.0491
Curfew[No]	-3.646818	0.7193
Curfew[Yes]	-19.39337	0.0282

The effect of various factors on a respondent's fishery education from media sources was analyzed using an ordinary least squares regression and an α value of 0.10. Results of this regression show that no variables were statistically significant. The R^2 value for the model equaled 0.02.

Media Education-Whole Model

Table 3: Significance of Hypothesized Variables in Explaining Fishery Education from Media Sources

Variable	Type of Variable	Probability > F
Age	Nominal	0.2980
Gender	Nominal	0.5220
Fishing Frequency	Nominal	0.4594
Gleaner	Nominal	0.8909
Matai	Nominal	0.4389
Curfew	Nominal	0.8841
CBFM Participation	Nominal	0.2918

The effect of various factors on a respondent's education from fishery workshops was analyzed using nominal logistic regression and an α value of 0.10. Results of this regression show that Age, Matai Status, and CBFM Participation were statistically significant. The R^2 value for the model equaled 0.08.

Fishery Workshop Education-Whole Model

Table 4: Significance of Hypothesized Variables in Explaining Fishery Education from Workshops

Variable	Type of Variable	Probability >Chi Squared
Age	Nominal	0.1261
Gender	Nominal	0.3701
Fishing Frequency	Nominal	0.4148
Gleaner	Nominal	0.3561
Matai	Nominal	0.0000
Curfew	Nominal	0.3060
CBFM Participation	Nominal	0.0743

Fishery Workshop Education-Final Model

Table 5: Parameter Estimates for Final Model of Factors Explaining Fishery Education from Workshops

Variable	Parameter Estimate	Probability> Chi Squared
Intercept	-0.2028415	0.2743
Age[A]	-0.1212406	0.5119
Age[B]	-0.4023092	0.0267
Age[C]	0.44414381	0.0227
Matai[No]	0.72789257	<.0001
CBFM Participation[0]	0.34768076	0.0301

*For log odds of 0/1

Literature Cited

Adams, T. J. H. and P. J. Dalzell (1995). "Management of Pacific Island Inshore Fisheries" Integrated Coastal Fisheries Management Project (3rd Australasian Fisheries Managers Conference).

Alder, N. (1994). Have six years of public education changed attitudes and awareness? Proceedings of the seventh international coral reef symposium, Guam, University of Guam Press.

Arlinghaus, R. and T. Mehner (2003). "Management preferences of urban anglers: Habitat rehabilitation versus other options." Fisheries 28(6): 10-17.

Bindon, J. R., A. Knight, et al. (1997). "Social context and psychosocial influences on blood pressure among American Samoans." American Journal of Physical Anthropology 103(1): 7-18.

Bunce, L., Townsley, P., Pomeroy, R., Pollnac, R. (2000). Socioeconomic Manual for Coral Reef Management, Australian Institute of Marine Science.

Burger, J., W. J. Stephens, Jr., et al. (1999). "Factors in Exposure Assessment: Ethnic and Socioeconomic Differences in Fishing and Consumption of Fish Caught along the Savannah River." Risk Analysis 19(3): 427-438.

Caley, M. J. and D. Schluter (1997). "The relationship between local and regional diversity." Ecology 78(1): 70-80.

Census (2000). Population and Housing Profile: 2000 Census of Population and Housing. U.S. Department of Commerce.

Chapman, M. D. (1987). "Women's fishing in Oceania." Human Ecology 15(3): 267-288.

Coutures, E. (2003). "The shoreline fishery of American Samoa, analysis of 1-year data and implementation of a new sampling protocol." Department of Marine and Wildlife Resources Report Series(102).

CRAG, (2004). American Samoa- Three Year Local Action Strategies 2004-2007.

Craig, P., C. Birkeland, et al. (2001). "High temperatures tolerated by a diverse assemblage of shallow-water corals in American Samoa." Coral Reefs 20: 185-189.

Craig, P., G. DiDonato, et al. (2004). Status of Coral Reefs in American Samoa.

Craig, P., L. Peau, et al. (2000). "Impacts of Rapid Population Growth in American Samoa: A Call for Action."

CRTF, C. R. T. F.-. (2000). The National Action Plan to Conserve Coral Reefs.

Dalzell, P. J., T.J. H. Adams & N.V.C. Polunin (1996). "Coastal Fisheries in the Pacific Islands." Oceanography and Marine Biology: an Annual Review 34: 395-531.

DOI (1999). A Report on the State of the Islands, U.S. Department of Interior-Office of Insular Affairs.

Fiske, S. J. (1992). "Socio-cultural aspects of establishing marine protected areas." Ocean & Coastal Management 18: 25-46.

Fitzgerald, M., H. and A. Howard (1990). "Aspects of Social Organization in Three Samoan Communities." Pacific Studies 14(1): 31-54.

Green, A. (2002). Status of coral reefs on the main volcanic islands of American Samoa: a resurvey on long-term monitoring sites. Pago Pago, American Samoa, Department of Marine and Wildlife Resources.

Houk, P., G. DiDonato, et al. (2005). "Assessing the Effects of Non-Point Source Pollution on American Samoa's Coral Reef Communities." Environmental Monitoring and Assessment 107: 11-27.

Johannes, R. E. (1978). "Traditional Marine Conservation Methods in Oceania and their demise." Annual Review of Ecology and Systematics 9: 349-364.

Lambeth, L., B. Hanchard, et al. (2001). "An Overview of the Involvement of Women in Fisheries Activities in Oceania."

Lemay, M. and L. Hale (1989). Coastal resources management:A guide to public education programs and materials. West Hartford, Connecticut., Kumarian Press.

McClanahan, T. R. (1994). "Kenyan coral reef lagoon fish: effects of fishing, substrate, and sea urchins." Coral Reefs 13: 231-241.

McCook, L. J. (1999). "Macroalgae, nutrients, and phase shifts on coral reefs: scientific issues and management consequences for the Great Barrier Reef." Coral Reefs 18: 357-367.

McDade, T. W. and C. M. Worthman (2004). "Socialization Ambiguity in Samoan Adolescents: A Model for Human Development and Stress in the Context of Culture Change." Journal of Research on Adolescence 14(1): 49-72.

Mundy, C. (1996). "A Quantitative Survey of the Corals of American Samoa."

Oram, R. (2005). Draft: American Samoa's Marine Protected Areas Program: a plan for meeting the territory's 20% no-take management goal.

Osman, W. M. (1997). American Samoa Economic Report, Bank of Hawaii.

Passfield, K., L.Blee, A. Solofa., A.Mulipola (2001). The Enhanced Capacity of the Samoa Fisheries Division to Facilitate Management of Commerical and Subsistence Fisheries. F. D. Samoa Fisheries Project, Government of Samoa.

Pauly, D. (1995). "Anecdotes and the shifting baseline syndrome fisheries." Trends in Ecology and Evolution 10(10).

Pomeroy, R. S. (1995). "Community-based and co-management institutions for sustainable coastal fisheries management in Southeast Asia." Ocean and Coastal Management 27(3): 143-162.

Ponwith, B. J. (1992). "The Pala Lagoon Subsistence Fishery."

Rhoads, B. L., D. Wilson, et al. (1999). "Interaction Between Scientists and Nonscientists in Community-Based Watershed Management:Emergence of the Concept of Stream Naturalization." Concept Emergence in Watershed Management.

Sauafea, F. S. and F. Curren (2000). Survey on Village Reef Fishing Problems in American Samoa, Department of Marine and Wildlife Resources.

Severance, C. and F. R. (1989). "Justification and design of limited entry alternatives for offshore fisheries of American Samoa, and an examination of preferential fishing rights for native people of American Samoa within a limited entry context."

Sheppard, C. (1995). "The shifting baseline syndrome." Marine Pollution Bulletin 30: 766-767.

Skelton, P. A., L. J. Bell, et al. (2000). "The Status of Coral Reefs and Marine Resources of Samoa."

Spurgeon, J., T. Roxburgh, et al. (2004). Economic Valuation of Coral Reefs and Adjacent Habitats in American Samoa.

Tuitele, C. (2005). Personal communication.

Vaitautolu, S. (2005). Personal communication.

Veitayaki, J. (1996). "Fisheries resource-use culture and its implications in Fiji." Culture and sustainable development in the Pacific: 116-130.

Wass, R. (1984). "An Annotated Checklist of the Fishes of Samoa."

Whittingham, E., J. Campell, et al. (2003). Poverty and Reefs: A Global Overview. Exeter, UK, Intergovernmental Oceanographic Commision of UNESCO.

Wilkinson, C. E. (2004). Status of Coral Reefs of the World:2004 Vol. 1&2, Australian Institute of Marine Science.

WPFMC (1999). The Value of the Fisheries in the Western Pacific Fishery Management Council's Area.

Zann, L. P. (1999). "A new (old) approach to inshore resources management in Samoa." Ocean & Coastal Management 42: 569-590.

Zeller, D., S. Booth, et al. (2005). "Reconstruction of coral reef fisheries catches in American Samoa, 1950-2002." Coral Reefs 24(3).