



UNIVERSITY
OF HAWAII
HILO

**A Study of the Effects of the West Hawaii Regional
Fishery Management Area on the Aquarium Fishery**

Project Leader

Brian Zgliczynski

Advisors

Dr. P. Haberstroh, Assistant Professor
University of Hawaii, Hilo

Dr. M. Parsons, Assistant Professor
University of Hawaii, Hilo

Dr. L. Hallacher, Associate Professor
University of Hawaii, Hilo

Final Manuscript
May 1, 2000

Abstract

This study was focused on the aquarium collectors in the Western Region of Hawaii in an attempt to document their sources of work satisfaction and the concerns they had related to the implementation of the West Hawaii Regional Fishery Management Area (WHRFMA). Most previous studies focused on the effects on the coral reef habitat when Marine Reserves are implemented or expanded. Closing areas to fishing can cause long-term cultural, social and economic effects on the persons who make a living from this activity.

The purpose of this research was to study three aspects of fish collection affected by the Marine Reserve expansion: 1) species caught including type, size, number and mortality rates during collection; 2) fishing behavior and fisherman satisfaction including a study of distance traveled, time spent collecting, date of collection, methods of collection, cost and profits of the collection activity and general satisfaction with the collection effort; and 3) effects of habitat including the location of the collecting activity, presence of other collectors or recreational vehicles and divers and weather and sea conditions.

A Collector Satisfaction and Concerns Survey was sent to 19 collectors from West Hawaii. This survey allowed the researcher to summarize the issues relating to the implementation of the Fish Replenishment Areas and the "culture" of the west Hawaii aquarium collector industry. Although a total of 103 fish species are collected in West Hawaii, this group focuses its collection efforts on 11 species. Two monitoring techniques, often used in observing the fishing industry, were designed in this study. The Modified Roving Creel Survey requires the researcher to come out with individual collectors to get quantitative data on the catch and to learn about problems or changes in procedures required by the new law. This method is to be utilized in the next phase of the study. The Modified Angler's Diary was a daily logbook, which was sent out to 6 individual collectors who were willing to participate in this aspect of the study. The initial diary served as a pilot survey, allowing the collectors to give comments and suggestions on the format of the Angler's Diary. Implications for effective management of Marine Reserve Areas that also supports the aquarium collection industry are also discussed.

Introduction

The aquarium fish industry has increased in popularity and is of worldwide importance (Andrews 1990). The aquarium fishery is reported to be the world's largest fishery (Whithead *et al.* 1986). The global trade of ornamentals is estimated to involve 350 million fish annually with a value of \$963 million (Young 1997). The fish collected for the trade are obtained from a wide variety of tropical seas including Hawaii and Florida (Lubbock & Polunin, 1996). Most of the fish collected from the U.S. are obtained from Hawaiian reefs, which possess high quality fish and rare endemics that are high in value (Tissot & Hallacher, 1999).

Aquarium fish collection is a lucrative business in Hawaii because of the increasing popularity of the household marine aquarium (van Poollen & Obara, 1984). Cultivating marine ornamentals has not been found to be cost-effective due to many reef species having complex larval stages, each requiring unique feed. While research on mariculture is still developing, 99% of the marine species used in aquariums originate from coral reef populations (Young 1997). Hawaii contains 85% of the coral reef habitat in the United States, housing 5,000 known species of marine plants and animals (Tissot & Hallacher, 1999).

The collection of reef fishes on a large scale has ecological effects that are both direct, resulting from the selective removal of particular organisms, and indirect, due to the disruption of coral reef habitat (Lubbock & Polunin, 1996). In 1973, the state of Hawaii began to require monthly aquarium catch reports from collectors (Katekaru 1978). Today these reports are issued by the Division of Aquatic Resources (DAR) and are termed C-6 Aquarium Fish Catch Reports (See Appendix A) (Miyasaka 1997) The first yearly summary reported 90,000 fishes collected, with a reported total value of \$50,000 (Katekaru 1978). The last published yearly summary was in 1995, reporting 422,823 fish collected with an estimated value of \$844,843 (Miyasaka 1997). The 1995 report listed 103 fish species collected but 90% of the harvest consisted of eleven species (See

Appendix B) (Tissot & Hallacher, 1999). Aquarium species are predominantly collected from the West Coast of the island of Hawaii. That increase of collection activities in the Kona and Milolii areas of Hawaii added to the long-standing concerns over the impact of this activity on the coral reef community.

Recent analysis by DAR indicates that the values presented in the previously published summaries was underestimated (DAR, unpublished data). At present, 59.5% of the monthly catch reports are not being filed, resulting in inaccurate and underestimated catch data (DAR, unpublished data). Therefore the value of the industry is likely to be substantially higher than previously reported.

Unfortunately, the last comprehensive study of Hawaii's aquarium fishery was in 1984 (van Poolen & Obara, 1984). Van Poolen and Obara (1984) estimated that there were 49 collectors involved in the aquarium industry statewide. They also concluded that the percentage of fish collected from the island of Hawaii would increase with the availability of direct flights to the mainland U.S. from the Keahole-Kona International Airport in West Hawaii. Today, the Division of Aquatic Resources (DAR) has issued 54 collecting permits for the island of Hawaii alone (DAR, unpublished data). Each of these collection operations is varied in size and scope of operation. Some aquarium collectors make the fishery their livelihood, while others utilize it as a part-time business. There is a need for the State of Hawaii to have an updated study describing the entire scope of the fishery in order to gain a better understanding of the fishery. It is particularly important to coordinate this data collection with the implementation of the Fish Replenishment Areas (FRAs) because the impact of the increased regulation to the collection industry isn't known. This study aims to take the first steps in designing and piloting the data collection methods needed to provide a comprehensive description of the fishery and the collection industry.

Studies have been conducted at various locations around the world to assess the impacts of both commercial and recreational fishing (Amesbury, Sherwood & Davis, 1991). Most studies of commercial fishermen have focused on fishes caught for consumption rather than on aquarium collectors. The coral reef fishes collected for use in the aquarium trade is small in comparison to the productivity of the habitats and the amount of fish utilized for table consumption (Andrews 1990). However the intensive and selective collection techniques used in the trade are of particular concern (Andrews 1990). Marine Protected Areas (MPA's) have been utilized in several locations as tool to manage coastal fisheries (Bohnsack 1998). When MPA's are established, research and government agencies collect data to evaluate the effects on the reef community. In the State of Hawaii, the West Hawaii Regional Fishery Management Area (WHFMA) was established in ACT 306 and is currently in effect. The WHRFMA is intended to manage fish resources in West Hawaii by restricting aquarium collection in FRAs. These FRAs have been implemented and make up 32.5% of the 150-mile West Hawaii coastline (Shown in Appendix C) (Tissot & Hallacher 1999). Presently, there is the West Hawaii Aquarium Project (WHAP) which is an on-going study set up to examine the biological parameters of the reefs of West Hawaii (DAR, unpublished data). The study's main objective is to determine the effectiveness of the WHRFMA by comparing the FRA's with the non-protected areas. My study complements the WHAP by looking at the fishery from a sociological standpoint and serves as a baseline study, providing feedback to fisheries managers about the effectiveness of the WHRFMA. The past studies conducted looked only at the impacts of fish collection to fish populations but no study has focused on the number of collectors and the impacts, if any, that are associated with FRA implementation.

Scientific research and monitoring of anglers and their catches is not an unfamiliar approach to studying coastal fisheries. Surveys on anglers and their catches are among the most useful

professional tools available to managers of fisheries (Kendall 1991). All fishery agencies conduct creel and angler studies (Kendall 1991). Many of these studies are focused on the recreational fishing industry rather than near shore commercial fisheries. Researchers collect biological and harvest data on the species and also data to provide insights about the anglers themselves - their needs and the socioeconomic context of the fishing activity. Creel studies are the most often used technique. A creel study is measure of the amount of fishing taking place in time and space. It may gather concomitant information on fishing and is often times used as a research or management tool, providing information used to monitor the well-being of some fish populations, to aid in management or preservation, or to promote more desirable exploitation (Hayne 1991). The utilization of either roving studies, where a clerk travels through a fishery to interview anglers in the act of fishing (Robson 1991), or access point studies, where anglers are surveyed at the end of their fishing activity (Hayne 1991), is determined by the type of fishing area to be studied. Another technique utilized to collect angler data is a fishing diary where the angler records daily catch information including species type and number, location of catch and angler method and satisfaction data (Anderson & Thompson, 1991). Each of these studies has been conducted at locations around the globe. In tropical island settings, creel studies have been less popular because of logistic difficulties and the problems presented by variety of fishing methods and diversity of species (Amesbury *et al.*1991). These two methods will be utilized, with possible modifications, as the basis for collecting fishery data on the west Hawaii aquarium fishery.

Although studies have been conducted on Hawaii's commercial fishery, they have not included an in-depth study of Hawaii's aquarium industry in recent years. The latest study conducted to look at Hawaii's marine aquarium industry was in 1984 (van Poolen & Obara, 1984). Closing areas to fishing can cause long-term cultural, social and economic effects particularly in heavily exploited areas (Bohnsack 1997).

Goals and Objectives

The purpose of this research is to study three aspects of fish collection affected by the Marine Reserve expansion:

- The social component of the fishery. This will focus on the collectors' perceptions of the implementation of the FRAs and the effectiveness of the WHRFMA. It will also ascertain how the FRAs will change the behavior of the collectors;
- Catch analysis and qualitative view of the fishery. It will include: fishing behavior including a study of distance traveled, size of operation, number of participants, location of collection, time spent collecting, date and time of collection, methods of collection, gear type, depth and length of dives, sea state and weather conditions, cost and profits of the collection activity and general satisfaction with the collection effort; and
- Biological scope of the fishery. This will focus on: quantifying the catch and effort, determining the species harvest, including type, length-frequency size, selectivity of size of individual species caught, and mortality rates during collection and transport.

A delay in the actual implementation of the FRAs until January 2000 with actual physical boundaries set in March 2000 led to a modification in the study's goals. Data collection could not start until February and the preliminary phase of the study would run February-April of 2000.

Subsequently the modified goals of the study were:

- Design the three data collection instruments to be used in a comprehensive study of the fishery and aquarium industry;
- Distribution of the Satisfaction and Concerns inventory to the 19 publicly identified aquarium collectors and summarization of their issues during the first months of the implementation of the FRAs. Contact with collectors would also include phone and in-person interviews to obtain data and to develop a description of the "culture" of the west Hawaii aquarium collector industry; and
- Piloting of the Angler's Diary to collect information for possible modification for use with a larger sample of aquarium collectors.

- Development of one or more proposals for funding and support for the next phases of the project. Attempts would be made to secure official funding and support from the State of Hawaii so that the researcher could gain access to state records. This would aid in the further identification of the population of permit holding aquarium collectors and to access the C-6 Aquarium Fish Catch Reports for comparison to Angler Diary data.

MATERIAL AND METHODS

For a West Hawaii coastline of 120km, 35.2 percent of the coastline has been designated as Fish Replenishment Areas. There is a basic lack of information on any aspect of the fishery, and the details of the fishery are not well known. This information is crucial if the fishery is to be managed successfully. The long-term goal of this study is describing the entire scope of the fishery in order to gain a better understanding of the fishery. Meeting the modified objectives of the study was accomplished by designing and using a combination of survey methods: 1) A general satisfaction and concerns survey of collector demographics and concerns related to implementation of the FRAs; 2) a modified roving creel survey ; and 3) a modified angler's diary.

Population

The data would be collected from the population of permit-holding aquarium collectors on the island of Hawaii. Hawaii's DAR has issued 54 collecting permits for the island of Hawaii (DAR, unpublished data). Since the identities of the 54 collectors in West Hawaii isn't public information, (Miyasaka 1999) another approach had to be taken in order to identify aquarium collectors. A personal contact was made at the Marine Ornamentals 99' conference held at the Hilton Waikoloa Village November 16-19, 1999. The personal contact identified 19 collectors and supplied their phone numbers and addresses. Surprisingly, there is little unity, if any, among the collectors and there is no identified organization of collectors from West Hawaii. Since collecting is a lucrative business, many involved are competitive and not willing to share information publicly.

It was assumed that the population would therefore be hesitant about sharing information with a researcher and that there might be fear of how any data would be used.

Instrument Development

Meeting the objectives of the study was accomplished by designing a combination of data collection methods: 1) A general satisfaction and concerns survey of collector demographics and concerns related to implementation of the FRAs; 2) a roving creel survey; and 3) a modified angler's diary.

The Satisfaction and Concerns Survey

This survey method was used to help establish communication between the aquarium collectors and the researcher, thus enabling the researcher to gain feedback on the collectors' feelings relating to the effectiveness of the FRAs through time. The initial Satisfaction and Concerns Survey (Shown in Appendix D) was also focused on collecting demographic data of the collection industry, which had been neglected for quite some time. The questions used in the initial survey were developed by gathering input from fellow researchers in the field of environmental sciences.

Once the questionnaires were finalized a packet was sent out to the 19 identified collectors. Each packet contained a Satisfaction and Concerns Survey, a self-addressed stamped envelope, a cover letter describing the study, a self-addressed stamped postcard questionnaire (Shown in Appendix E), and a \$5 gift certificate from Blockbuster Video as a token of appreciation for participation in the survey. The surveys were to be mailed to me anonymously, protecting the collectors from being associated with individual questionnaires. The postcard questionnaire was used to find out if individual collectors would be willing to participate in other aspects of the study. Follow-up phone calls were made to answer questions and to ensure that the surveys were being completed properly. Some data collection had to be collected over the phone when it became

apparent that some subjects were not comfortable with sending written surveys back, but would talk about their concerns over the phone.

The Modified Angler's Diary

In order to study the daily activities of the fish collectors, a survey method known as the Angler's Diary (Shown in Appendix F) was used. The diary format used was very similar to the C-6 Aquarium Catch Report issued by the DAR. Since each commercial collector is required to file a monthly report using the C-6 Aquarium Fish Catch Report, (Clark & Gulko, 1999) the Modified Angler's Diary should have been easy to complete. A new version of the C-6 Report's map was included with the Diary. The C-6 Report include a map which divided the 120km coastline into 3 large sections (Miyasaka 1997). The map included with the Angler's Diary divided the 120km coastline into 6 sections with respect to the FRAs in order to get a better representation of the collecting locations. The goals of this survey was to collect data pertaining to species harvest and fishing behavior including: distance traveled, number of collectors, location of collection, time spent collecting, date and time of collection, methods of collection, gear type, depth and length of dives, sea state and weather conditions. The Angler's diary was printed out on waterproof never-tear paper, which allowed the participants to fill the survey out while collecting. The Angler's diary was sent out to 6 collectors who were willing to participate in this aspect of the study. The initial diary served as a pilot survey, allowing the collectors to give comments and suggestions on the format of the Angler's Diary.

The Modified Roving Creel Survey

The utilization of either roving studies, where a clerk travels through a fishery to interview anglers in the act of fishing, (Robson 1991) or access point studies, where anglers are surveyed at the end of their fishing activity, (Hayne 1991) is determined by the type of fishing area to be

studied. Collection is conducted on the leeward side (west side) of the island which is dominated by rich coral reef communities that are found near a wave base between 15 and 27m depth (Grigg 1997). The collectors utilize all of the public boat ramps along the coast and while out on the ocean are like most people who fish and prefer to keep their location of collection to themselves. This survey method is to be utilized in the next phase of the study once trust has been built up with collectors who will allow the researcher to observe the collection process.

Tissot and Hallacher (1999) found that the C-6 Aquarium Fish Catch Report was not compared to actual catches, resulting in there being no quality assurance that the reports are accurate. The Modified Roving Creel Survey (Shown in Appendix G) designed for this study would help to ensure quality assurance and accuracy of the data from the Angler's Diary. This survey is similar in format to the C-6 Aquarium Fish Catch Report. The survey allows the researcher to observe the collection processes first hand, thus allocating for a wide array of data to be deduced. Observations of: location of collection, depth of collection, methods of collection, and physical environmental conditions could be made. The survey also allows the researcher to verify catch statistics. The data collected from this survey method should be statistically similar to the data from the Angler's diary. While in the field the researcher also collects length-frequency data and data pertaining to the selectivity of size of individual species caught. This time also allows the researcher to gain feedback on the WHRFMA.

Proposal Development

During this study three proposals were written in order to gain support and funding. Initially, a grant proposal was submitted to the University of Hawaii, Hilo's Marine Option Program (Shown in Appendix H). The University's required budget format was followed and the budget was submitted along with the research proposal in January 2000. In order to conduct the study in the future, further funding was required. Two separate grant proposals were submitted to The

University of Hawaii Sea Grant College Program. One of the submitted proposals was submitted for a grant, which would provide support from March 2001 – March 2003 (Shown in Appendix I). The second proposal was submitted to provide temporary funding until other sources of funding could be determined (Shown in Appendix J).

Results

Population of Aquarium Collectors

The demographics of the industry were defined from the surveys sent out and through personal communication with the 19 identified collectors. The results of the demographic questions are shown in (Table 1). The collectors were also asked where the collection of aquarium fishes fit with their financial situation. All of the collectors that were spoken to listed aquarium collection as their sole source of income. In conducting the demographic survey, the range of collectors involved in the fishery was also determined. The collectors involved in the fishery can be described in four different ways: 1) Business contractor; 2) Independently contracted; 3) Independently operated business; and 4) Group operated business. One of the collectors operates by contracting independent collectors to collect his fish. He owns the boats and equipment used in the collection process. Currently he has six independent collectors working for him while he heads up the marketing and shipment of the fish. The six independent collectors under his supervision each possess a collection permit, but remain anonymous by law at this time. Two of the collectors from west Hawaii are independently running their business. They collect and sell their fish independently. The final and most common method of operation in West Hawaii is the group operated business. Sixteen of the collectors interviewed operate in this fashion, and make up 9 private collection businesses.

Table 1. Results of the demographics of the Aquarium Fishery of West Hawaii. (n = 19)

Question Asked	Range of Answer	Average Value
Number of years in the business	1-30	8
Number of years as a collector	1-30	8
Number of employees	1-6	2
Number of days per week are spent collecting	2-5	3
Average number of dives done per outing	3-4	3
Average depth of dive (feet seawater)	35-150	55

Satisfaction and Concerns Data

The analysis of the collectors' satisfaction and concerns was obtained from the mailed surveys and through personal communication. The results of the survey are listed in Table 2.

Additional concerns involved with the implementation of the FRAs were also obtained from 14 of the collectors and are listed in Table 3 and Table 4.

Table 2. The results from the Satisfaction and Concerns Survey (n = 19)

Questions Asked	Range of Answers submitted and the number of collectors who answered the question	
Satisfaction with the business	Collecting is an excellent business opportunity	10
Satisfaction with the income	I am extremely satisfied with the income	17
	I am satisfied with the income from the business	2
Expenses incurred collection	Costs are increasing	19
The FRAs will	Have no effect on my collection business	4
	Have serious effect on my collection business	15
I believe the FRAs will (mark all that apply)	Increase my time collecting	15
	Increase the distance traveled to collection site	15
	Decrease the number of fish collected	8
	Increase my cost of collection	12

Table 3. Additional concerns given by the collectors pertaining to the implementation of the FRAs

Concerns related to the implementation of the FRAs
The areas were not picked for the fisheries good.
The areas were not picked scientifically and were picked by a task force with other reasons.
Poor science was used to pick areas.
The FRAs were based on politics and not on resource management.
No long term plan and no enforcement to get rid of bad collectors.
Travel and expenses are going to increase greatly.
Not enough area to fish and collection will be more competitive.
Travel is going to increase and ultimately increasing fish prices.
Dive operations shouldn't be allowed to dive in the FRAs.

Table 4. Additional concerns given by the collectors pertaining to the implementation of the FRAs

Comments on how the collection business could be made more successful.

Better communication between the state and the fishery.

Better communication between collectors.

A management plan based on resource management.

Better regulation of new collectors.

More boat ramps built down south to allow for shorter travel time on the water.

Pilot of the Angler's Diary

Six packets of information were sent out, but only one was sent back at this present time.

The others are still being completed. Although only one survey was sent back, the comments received from the survey were extremely helpful. The collectors of West Hawaii utilize barrier nets as their primary method to collect fish. A barrier net is a net typically 6-10m long and 1-2m in drop. The mesh size of the net is very small, typically 12-18mm in diameter to prevent the fish from getting caught by their gills. The collectors set the net out either in a horseshoe or a direct wall. The divers involved in collection swim towards the net causing the fish to get trapped between the net and the collectors. This is the typical strategy of most of the collectors but it was found that at certain times, collectors dive at the same time but each individually focuses collection on selected species. The comments received in the pilot survey suggested that the diary be modified to account for when collectors worked individually, and for when the dives were at different depths throughout the dive (multi-level).

Creel Survey

Due to time constraints this method could not be utilized in the initial stage of the study.

Contact has been made with collectors who are willing to allow the researcher to accompany them in the act of collecting. I did however find that some collectors were fishing heavily in the FRAs

prior to the physical boundary markers being put up by March 2000 (DAR unpublished data). The WHAP project also found information to support this by finding that declines in fish abundance were significant in FRAs and impact areas prior to FRA implementation (Tissot & Hallacher, unpublished data).

Proposal Writing

Three grant proposals were submitted with the purpose of receiving funding and support. The grant proposal sent to the University of Hawaii, Hilo's Marine Option Program was approved, with the University providing some of the requested supplies and funding of \$100. Two proposals were submitted to the University of Hawaii Sea Grant College Program. The proposal submitted to the University of Hawaii Sea Grant College Program for funding for the term March 2001 – March 2003 is still under review. The second grant proposal submitted to Sea Grant has been approved and will provide \$10,000 in future support of the study.

Discussion

This project has been difficult to conduct due to the lack of support from the State of Hawaii and the fact the topic of aquarium fish collection is contentious and emotional. The WHRFMA was just approved and the FRAs were closed to aquarium collection on January 2000 with the physical boundaries completed in March 2000 (DAR unpublished data). Since the closures have just recently been instituted, the concurrent study of the effects of the FRAs to the aquarium fishery is in its infancy.

The State of Hawaii's Department of Land and Natural Resources (DLNR) will not release the C-6 Aquarium Fish Catch Reports because of Section 189-3, Hawaii Revised Statutes (Miyasaka personal communication 1999). Although the reports are supposed to be summarized on fiscal year intervals, they are not due to manpower shortages (Miyasaka personal communication 1999). This makes comparing past data with current and future data impossible. Another problem

faced in the study of the fishery was that due to state law, the identities of the aquarium collectors could not be released to a public researcher. This makes defining the population of fish collectors from West Hawaii a difficult task. A possible solution to this is that by receiving support from the University of Hawaii Sea Grant College Program, the identities of the 54 collectors might be made available in the near future.

Conducting the written and personal surveys assessed the general feeling among collectors. Many of the collectors felt that the data collected and implementation of the FRAs had been done hastily with no attention paid to their needs or concerns. Of the 19 collectors interviewed, collection of aquarium fishes is their sole source of income. Since this is the case, the collectors are tied into the topic with strong emotions. Many feel that the general public and research conducted is aimed at putting them out of business. As a result, they are hesitant to talk with a researcher and not willing to participate in any studies. This being the case, much time was committed to building up trust between the researcher and the collectors and demonstrating a true interest in their concerns about managing the fishery effectively.

This initial part of the study helped produce a better picture of the 19 identified collectors. I was able to determine the four general collection styles with the group-operated business being the most popular. These group-operated businesses have an owner or manager who has employees that work under his supervision. All the fish are collected, marketed, and shipped by the individual business. I also found that the collectors that had been in the business the longest had the most interest in participating in the study. Because of their experience, these long-time collectors provided valuable information about how the industry could be monitored more effectively. Some common suggestions among these collectors were shown in Table 4. Establishing better communication between the industry and the state and ultimately leading to an improvement in the data collection. Another common feeling among the collectors was that the dive tour boats

shouldn't be allowed to use the FRAs because they were having an impact on the reefs. Some initial studies have conducted on the dive industry. The studies found that the dive tour boats were not having a significant impact of the coral reef habitat so further studies were discontinued (DAR unpublished data).

One of the survey methods utilized in this project was the Angler's Diary (Shown in Appendix F). The pilot survey was mailed out to six collectors. Although only one survey was returned at this time, valuable information was gained on how the survey technique could be improved. One suggestion was that the survey needed to be modified to meet the requirements needed by the different collectors. Therefore separate surveys will be developed to meet the needs of the collectors.

Since this study is unique, the information and data collection methods can be shared with other fisheries manager from different locations around the world. These countries could use the information to help regulate and manage the aquarium collectors in their local regions.

References

- Amesbury, S.A., T. Sherwood, G. Davis. (1991) Monitoring a Tropical Island Fishery. *Creel and Angler Surveys in Fisheries Management* (eds. Guthrie, D., J.M. Hoenig, M. Holliday, C.M. Jones, M.J. Mills, S.A. Moberly, K.H. Pollock, & D.R. Talhelm), pp. 84-87. American Fisheries Society Symposium, 12.
- Anderson, L.E. & P.C. Thompson. (1991) Development and Implementation of the Angler Diary Monitoring Program for Great Bear Lake, Northwest Territories. *Creel and Angler Surveys in Fisheries Management* (eds. Guthrie, D., J.M. Hoenig, M. Holliday, C.M. Jones, M.J. Mills, S.A. Moberly, K.H. Pollock & D.R. Talhelm), pp. 457-475. American Fisheries Society Symposium, 12.
- Andrews, C. (1990) The ornamental fish trade and fish conservation. *Journal of Fish Biology*, 37, 53-39.
- Bohnsack, J.A. June (1998) Application of marine reserves to reef fisheries management. *Australian Journal of Ecology* 23(3), 298-304.
- Bohnsack, J.A. (1997) Consensus Development and the Use of Marine Reserves in the Florida Keys, USA. *Proceedings of the 8th International Coral Reef Symposium*, 2, 1927-1930.
- Clark, A. M. & D. Gulko. (1999) Hawai'i's State of the Reefs Report, 1998. *Department of Land and Natural Resources, Honolulu, HI*, 41.
- Grigg, R. W. (1997) Hawaii's coral reefs: status and health in 1997, the International Year of the Reef. *Status of Coral reefs in the Pacific*. (eds. R. W. Grigg & C. Birkeland), 59-72. University of Hawaii Sea Grant College Program. Honolulu, HI.
- Hayne, D.W. (1991) The Access Point Creel Survey: Procedures and Comparison with the Roving Clerk Creel Survey. *Creel and Angler Surveys in Fisheries Management* (eds. Guthrie, D., J.M. Hoenig, M. Holliday, C.M. Jones, M.J. Mills, S.A. Moberly, K.H. Pollock, & D.R. Talhelm), pp. 123-138. American Fisheries Society Symposium, 12.
- Katekaru, A. (1978). Regulations of tropical fish collecting. *Hawaii Sea Grant College Program, Working papers*, 34, 35-42.
- Kendall, R.L. (1991). Preface and Acknowledgments. *Creel and Angler Surveys in Fisheries Management*. (eds. Guthrie, D., J.M. Hoenig, M. Holliday, C.M. Jones, M.J. Mills, S.A. Moberly, K.H. Pollock, & D.R. Talhelm), pp. Xi. American Fisheries Society Symposium, 12.
- Lubbock, H.R. & N.V.C. Polunin. (1996) Effects of fishing effort and catch rate upon the structure and biomass of Fijian reef fish communities. *Journal of Applied Ecology*, 22, 400-412.
- Miyasaka, A. (1997). Status Report, Aquarium fish collections, Fiscal Year 1994-95. Division of Aquatic Resources, Department of Land and Natural Resources, State of Hawaii. Honolulu, Hawaii, pp. 1-10.

Robson, D.S. (1991). The Roving Creel Survey. *Creel and Angler Surveys in Fisheries Management* (eds. Guthrie, D., J.M. Hoenig, M. Holliday, C.M. Jones, M.J. Mills, S.A. Moberly, K.H. Pollock, & D.R. Talhelm), pp.19-24. American Fisheries Society Symposium, 12.

Tissot, B. N. & L. E. Hallacher. (1999) Impacts of aquarium collectors on reef fishes in Kona, Hawai'i. Division of Aquatic Resources, Honolulu, HI. Technical Report. (submitted to *Ecological Applications*).

Van Poolen, H.W. & A.M. Obara. (1984). Hawaii's Marine Aquarium Fish Industry Profile. Studies on Marine Economics No. 3. University of Hawaii Sea Grant College Program. Ocean Resources Office Contribution No. 14, State of Hawaii, Department of Planning and Economic Development.

Whithead, M., Gilmore, J., Eager, E., McGinnity, P., Craok, W. & Macleod P. (1986) *Aquarium Fishes and Their Collection in the Great Barrier Reef Region*, Technical Memorandum, Scrips Institution of Oceanography, University of California, San Diego. 1-34.

Young, L.G.L. (1997). Sustainability issues in the trade for wild and cultured aquarium species. *Marketing and Shipping Live Aquatic Products*, pp. 145-151. '96, Seattle, Washington, 13-15 October, 1996. Northeastern Regional Agricultural Engineering Service Cooperative Extension, Ithaca, New York.

Appendix A

C-6 Aquarium Fish Catch Report

**Division of Aquatic Resources
Department of Land and Natural Resources
State of Hawaii**

C-6

AQUARIUM FISH CATCH REPORT

DATE MAILED	DATE MAILED
July _____	January _____
August _____	February _____
September _____	March _____
October _____	April _____
November _____	May _____
December _____	June _____

**INSTRUCTIONS FOR FILLING OUT THE
AQUARIUM FISH CATCH REPORT**

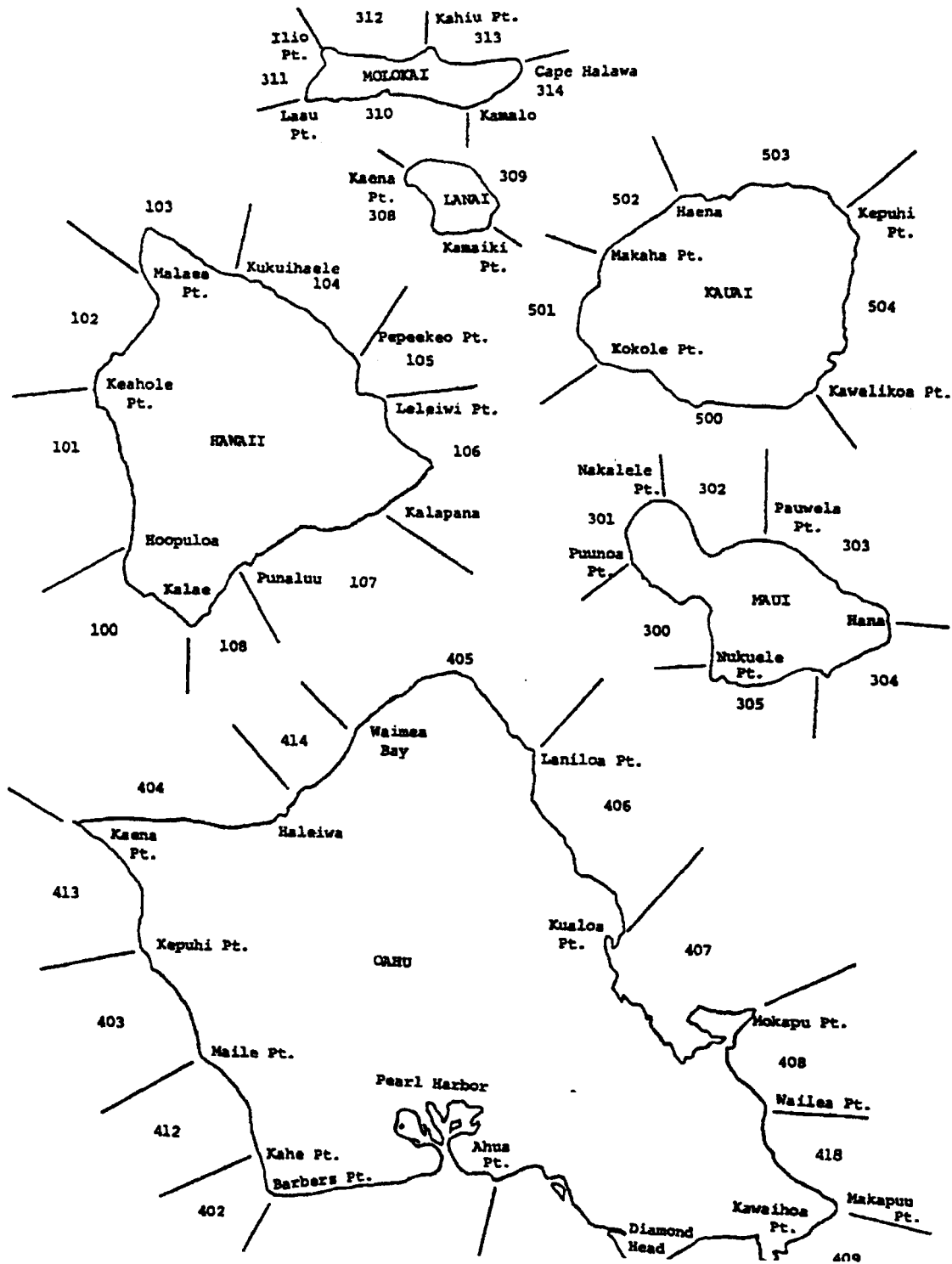
- 1) SUBMITTED REPORTS WILL BE RETURNED IF NOT FULLY OR CORRECTLY COMPLETED.
- 2) You are required to submit a report monthly, no later than ten (10) days following the end of the month. Please return completed forms in the self-addressed envelopes provided.
- 3) If you do not catch any fish, write "NO FISHING" on the report form and mail it in. You still need to submit reports for months you did not fish.
- 4) Fill out one form for each zone fished. Do not combine zones.
- 5) The buyer is the name of the person or company that bought your fish.
- 6) Check either export or local, depending on if you sold your catch aboard or locally. If you sold your catch abroad, write where exported. Identify the state if sold on the mainland.
- 7) If you catch fish that are not listed on the report form, write them in the spaces provided. A complete listing of species is included in this booklet.
- 8) For each species, the number caught does not have to equal the number sold. If some fish die or are not sold, then the number caught would be more than the number sold.
- 8) In the "Value" column, put the total value received for that species. Do not put the price per individual animal.
- 9) A booklet entitled "Hawaii Fishing Regulations" contains a complete listing of the regulated species, areas, and prohibited fishing methods. You may obtain a copy from your local office of the Division of Aquatic Resources. In addition to these, your permit lists more prohibited species.

Note: The Division of Aquatic Resources uses the information you provide to monitor fish populations and the status of the aquarium fish industry. This enables the State to better manage and conserve its resources and ultimately benefit you, the fisherman. These reports are kept strictly confidential.

AREAS WHERE AQUARIUM FISH COLLECTING IS RESTRICTED

OAHU	Ala Wai Canal-Kapiolani Drainage Haleiwa Harbor Hanauma Bay Coconut Island, Kaneohe Bay Heeia-Kea Wharf Kapelama Canal Nuuanu Freshwater Refuge Pokai Bay Pupukea Waikiki-Diamond Head Paiko Lagoon Wildlife Sanctuary	KAUAI	Hanaleulu Bay Kapea Canal Kokee Public Fishing Area Waikaena Canal Wailua Public Fishing Area Waimea Bay Alakai Wilderness Preserve
HAWAII	Kailua Bay Keelakekua Bay Lapakahi Pueko Kawaihae Harbor Hilo Harbor Radio Bay Waialea Public Fishing Area Waialea Bay Waioa River Waialuku River Waimanu Estuarine Sanctuary Kona Coast No Collecting Areas Old Kona Airport	MAUI	Ahihi-Kinau Natural Area Reserve Honolua-Mokuleia Bays Kahului Harbor Molokini Shoal Kanaha Pond Wildlife Sanctuary
		LANAI	Kanale-Hulopoe Bays
		MOLOKAI	Kaunakakai Wharf

Aquarium Fish Catch Report Zone Numbers



AQUARIUM FISH CATCH REPORT
DEPARTMENT OF LAND AND NATURAL RESOURCES

Name _____ Permit No. _____

Zone Fished _____ Date _____ Buyer _____

Total Hours Fished _____ Export ____ Local ____
 (count fishing time only, do not include travel time) (where exported: _____)

SPECIES	COMMON NAME	CODE	CAUGHT	SOLD	VALUE
Acanthurus achilles	Achilles Tang	103			
Ctenochaetus strigosus	Kole	113			
Zebrasoma flavescens	Yellow Tang	115			
Naso lituratus	Clown Tang	118			
Zanclus cornutus	Hoopfish Idol	127			
Pseudochellinus octotaenia	Eight Lined Wrasse	139			
Thalassoma duperrey	Saddle Back Wrasse	148			
Coris gaimard	Clown Wrasse	154			
Anemonea chrysocephalus	Red Tail Wrasse	159			
Halichoeres ornamentalis	Ornate Wrasse	161			
Bascyllus albicella	Aloiloi	180			
Forcipiger flavissimus	Lononose Butterfly	200			
Chaetodon unimaculatus	One Spot Butterfly	210			
Chaetodon multiginctus	Pebbled Butterfly	215			
Chaetodon miliaris	Lemon Butterfly	217			
Chaetodon kleinii	Coral Butterfly	207			
Chaetodon quadrimaculatus	Four Spot Butterfly	214			
Centropyge potteri	Potter's Angel	220			
Canthigaster coronata	Saddle Back Puffer	291			
Canthigaster lactator	White Spotted Puffer	292			
Ostracion munitus	Spotted Boxfish	320			
Swanothorax curvatus	Common Eel	422			
ANTENNARIIDAE	ANGLERFISHES	610			
Anthias thompsoni	Fairy Bass	662			
Sabellastarte sanctiosephei	Feather Duster Worm	921			
Hippolytinae acicula	Cleaner Shrimp	945			
Stenopus hispidus	Coral Banded Shrimp	948			
PAGURIDEA	HERMIT CRABS	934			
ECHINOIDEA	SEA URCHINS	952			
ASTEROIDEA	SEA STARS	956			

Aquarium Fish Name List

- 100 ACANTHURIDAE
 -101 A TRIOSTEGUS (MANINI)
 102 A GUTTATUS (SPOTTED TANG)
 -103 A ACHILLES (ACHILLES TANG)
 -104 A NIGRICANS (GOLD-RIM TANG)
 -105 A LEUCOPAREIUS (MAIKOIKO)
 -106 A NIGROFUSCUS (LAVENDER TANG)
 107 A NIGRORIS (MAIKO)
 108 A THOMPSONI (THOMPSON'S TANG)
 -109 A OLIVACEUS (NA'E NA'E)
 110 A DUSSUMIERI (PALANI)
 111 A XANTHOPTERUS (PUALU)
 112 A BLOCHII (BLUE-BANDED PUALU)
 -113 C STRIGOSUS (KOLE)
 -114 C HAWAIIENSIS (CHEVRON TANG)
 -115 Z FLAVESCENS (YELLOW TANG)
 116 Z VELIFERUM (SAILFIN TANG)
 -117 NASO (UNICORN FISHES)
 -118 M LITURATUS (CLOWN TANG)
 119 M HEXACANTHUS (SIX-SPINED KALA)
 120 M BREVIROSTRIS (LONG BODIED KALA)
 -121 M UNICORNIS (KALA)
 -122 Z CORNUTUS (MOORISH IDOL)
- 130 LABRIDAE (WRASSES)
 131 C INERMIS (KUPUPOU)
 133 B BILLMULATUS (HOG WRASSE)
 134 L PHTHIROPHAGUS (CLEANER WRASSE)
 136 C UNIFASCIATUS (PO'OU)
 137 C BINACULATUS (TWO-SPOT WRASSE)
 138 P EVANIDUS (SCARLET WRASSE)
 139 P OCTOTAENIA (EIGHT-LINED WRASSE)
 140 P TETRATAENIA (FOUR-LINED WRASSE)
 141 HEMIPTERONOTUS SP
 142 H LECLUSEI (SHARP-HEADED WRASSE)
 143 X PAVONINUS (PEACOCK WRASSE)
 144 M TAENIOURUS (DRAGON WRASSE)
 145 M UMBRILATUS (RAZOR WRASSE)
 146 T FUSCUM (AMELA)
 147 T LUTESCENS (YELLOW-BROWN WRASSE)
 148 T DUPERREY (SADDLE-BACK WRASSE)
 149 T PURPUREUM (PURPLE WRASSE)
 150 T BALLIEUI (BALLIEUI'S WRASSE)
 151 G VARIUS (BIRD WR)
 152 C FLAVOVITTATA (HILU)
 153 C VENUSTA (RED-BANDED)
 154 C GAINARD (CLOWN WRASSE)
 155 C BALLIEUI (SAND WRASSE)
 156 L CERASINUS (PENCIL WRASSE)
 157 B BALTEATA (ORANGE-STRIPE WRASSE)
 158 M GEOFFROY (POTTER'S WRASSE)
 159 A CHRYSOCEPHALLUS (RED TAIL WRASSE)
 160 A CUVIER (FLAG WRASSE)
 161 H ORNATISSIMUS (ORNATE WRASSE)
 162 C JORDANI (JORDAN'S WRASSE)
 165 T LUNARE (LYRETAIL WRASSE)
- 169 GOATFISHES
 170 U ARGE (NIGHTMARE MEKE)
 171 M FLAVOLINEATUS (WHITE MEKE)
 172 M VANICOLENSIS (RED MEKE)
 174 P PLEUROSTIGMA (MALU)
 175 P CYCLOSTOMUS (MOANA KEA)
 176 P PORPHYREUS (KUMU)
 177 P MULTIFASCIATUS (MOANA)
 178 P BIFASCIATUS (MUMU)
- 180 D ALBISSELLA (ALO'I LO'I)
 181 A SORDIDUS (KUPIPI)
- 182 A ABDONINALIS (MAMO)
 183 P IMPARIPENNIS (CAT-EYES DANSEL)
 184 P SINDONIS (BLK MAMO)
 185 P JOHNSTONIANUS (BLUE EYE DANSEL)
 186 S FASCIOLATUS (YELLOW-EYE DANSEL)
 187 C VANDERBILTII (BLK-FIN DANSEL)
 188 C OVALIS (BLUE DANSEL)
 189 C LEUCURUS (DARK DANSEL)
 190 C VERATOR (3-SPOT DANSEL)
 191 C MANUI (WHITE-TAIL DANSEL)
 195 DANSELFISHES
- 199 BUTTERFLYFISHES
 -200 F FLAVISSTIMUS (LONG NOSE)
 -201 F LONGIROSTRIS (RARE LONG-NOSE)
 202 H DIPNREUTES (FALSE KIHIKIHI)
 203 H THOMPSONI (THOMPSON'S)
 204 M POLYLEPIS (PYRAMID)
 -205 C FREMBLII (BLUE-LINED BFF)
 206 C RETICULATUS (RETICULATED BFF)
 -207 C KLEINI (CORAL BFF)
 208 C EPHIPIUM (SADDLE-BACK BFF)
 -209 C AURIGA (CROSS-STRIPE BFF)
 -210 C UNIMACULATUS (ONE-SPOT BFF)
 -211 C LUNULA (RACCOON BFF)
 -212 C TRIFASCIATUS (THREE-BANDED BFF)
 -213 C ORNATISSIMUS (ORANGE-STRIPE BFF)
 -214 C QUADRIMACULATUS (FOUR-SPOT BFF)
 -215 C MULTICINCTUS (PEBBLED BFF)
 216 C CITRINELLUS (CITRON BFF)
 -217 C MILIARIS (LEMON BFF)
 218 C TRIFASCIALIS (ACROPORA BFF)
 219 M ARCUATUS (BLK-BANDED ANGEL)
 220 C POTTERI (POTTER'S ANGEL)
 221 C LORICULUS (FLAME ANGEL)
 222 C LINEOLATUS (LINED BFF)
 223 C FISHERI (FISHER'S ANGEL)
 224 C TINKERI (TINKER'S BFF)
 225 G PERSONATUS (MASKED ANGEL)
 230 SCARIDAE (PARROTFISHES)
 240 SLEEPING UNUS
 250 CARANGIDS (JACKS)
 267 L KASHIRA (TAAPE)
 268 A THOMPSONI (FAIRY BASS)
 270 K BIGIBBUS (MUMU)
 280 K SANDVICENSIS (AHOLEHOLE)
- 290 CANTHIGASTERIDAE (SHARP-NOSE)
 291 C CORONATA (SADDLE-BACK PUFFER)
 292 C JACTATOR (WHITE-SPOTTED PUFFER)
 293 C AMBOINENSIS (SPIDER-EYE PUFFER)
 294 C RIVULATA (PU'U OLA'I)
 299 X MENTO (CROSSHATCH MUMU)
 300 X AURIMARGINATUS (BLUE-THROAT MUMU)
 301 R RECTANGULUS (BLK-WEDGE MUMU)
 302 R ACULEATUS (BLK WEDGE MUMU)
 303 M NIGER (BLACK MUMU)
 304 M VIDUA (PINK TAIL MUMU)
 305 S BURSA (GRAY-GREEN MUMU)
- 307 BALISTIDAE (TRIGGERFISHES)
 311 A SCRIPTUS (BROOM-TAIL FILE)
 312 P SPILOSONA (FILEFISH)
 313 C DUMERILI (ORANGE-FIN FILE)
 314 C SANDWICHIENSIS (SI FILE)
- 320 O MELEAGRIS (BOXFISH)
 321 O WHITLEYI (WHITLEY'S BOX)
 322 L FORNASINI (COMFISH)

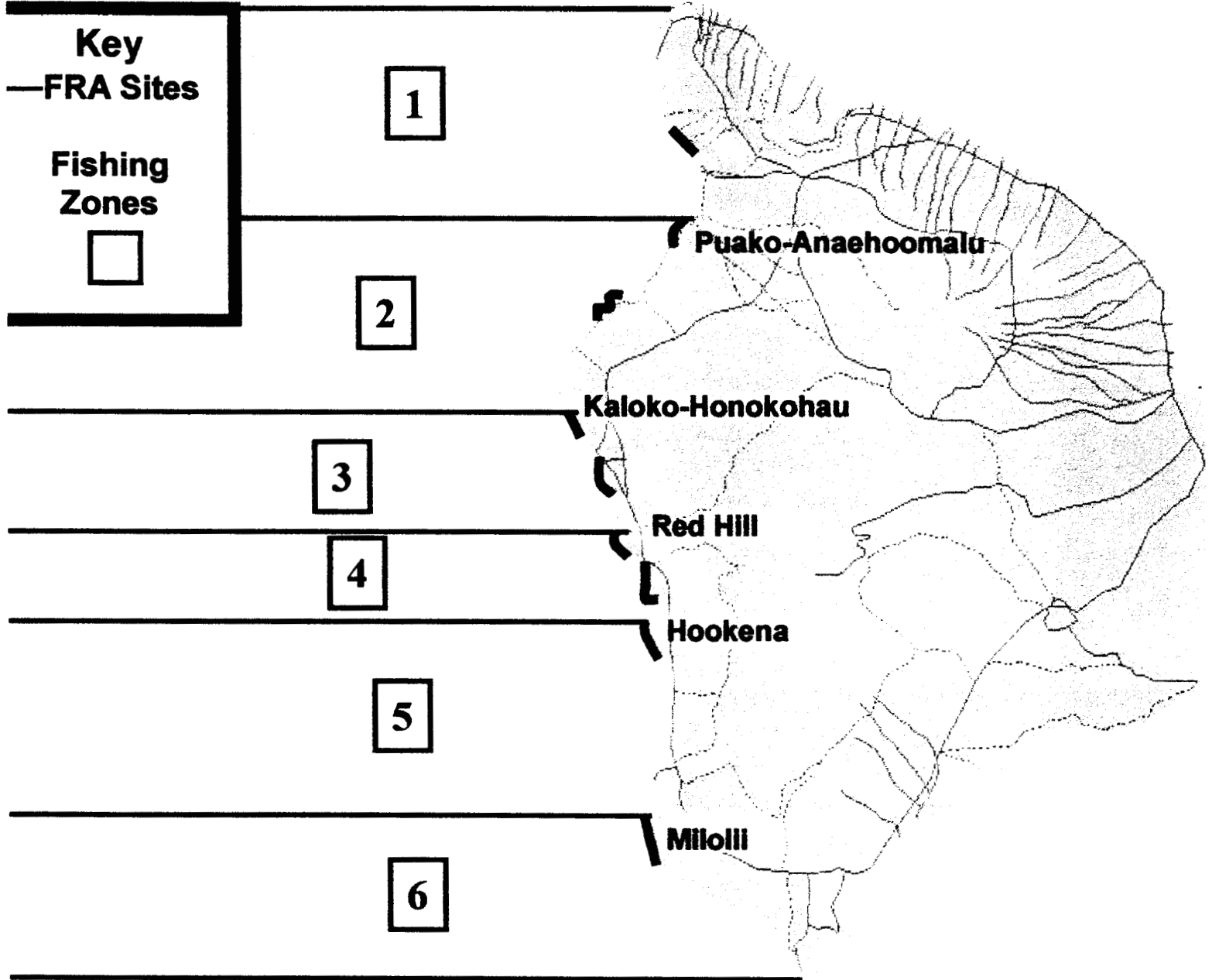
Appendix B

A list of the top 11 collected species of aquarium fish in Hawaii

Scientific Name	Common Name
<i>Acanthurus achilles</i>	Achilles Tang
<i>Centropyge potteri</i>	Potter's Angelfish
<i>Chaetodon lunula</i>	Raccoon Butterflyfish
<i>Chaetodon multicinctus</i>	Pebbled Butterflyfish
<i>Chaetodon ornatissimus</i>	Ornate Butterflyfish
<i>Chaetodon quadrimaculatus</i>	Fourspot Butterflyfish
<i>Ctenochaetus strigosus</i>	Gold-Ring Surgeonfish
<i>Forcipiger flavissimus</i>	Longnose Butterflyfish
<i>Naso lituratus</i>	Orangespine Unicornfish
<i>Zanclus cornutus</i>	Moorish Idol
<i>Zebrasoma flavescens</i>	Yellow Tang

Appendix C

West Hawaii Fish Replenishment Area Sites



Appendix D

Satisfaction and Concerns Survey Data Sheet

Demographic

How many years have you been in the business? _____

How many years have you been a collector? _____

Presently, how many employees (regular, temporary, or contract) work with you? _____

Number of days per week your business goes out collecting? _____

On average, how many dives per outing are done? _____

What is the average depth of each collection dive? _____

Is marine aquarium collection (Please circle one)? _____

1. Sole source of income
 2. Part-time source of income
 3. Occasional source of income
 4. Seasonal source of income
 5. Other (Please explain) _____
-

Satisfaction

Satisfaction with the business

1. Collecting is an excellent business opportunity
 2. Collecting is an mediocre way to make a living
 3. I would do something other than collecting if the opportunity was available
 4. Other (Please explain) _____
-

Satisfaction with the income provided by marine aquarium collection

1. I am extremely satisfied with the amount of income I make from the business
 2. I am satisfied with the income from the business
 3. I am dissatisfied with the income made from the business
 4. Other (Please explain) _____
-

Expenses incurred from the business

1. Costs are increasing
 2. Costs have stayed about the same
 3. Costs are going down
 4. Other (Please explain) _____
-

Feeling on the implementation of the Fishery Replenishment Areas (FRAs)

The implementation of the Fish Replenishment Areas will:

1. Have no effect on my collection business
 2. Have little effect on my collection business
 3. Have some effect on my collection business
 4. Have serious effect on my collection business
 5. Other (Please explain) _____
-

I believe the Fish Replenishment Areas will (Circle all that apply)

1. Increase my time collecting
2. Increase the distance traveled to collection site
3. Decrease the number of fish collected
4. Increase my costs of collection
5. Other (Please explain) _____

What are your concerns related to the implementation of the Fish Replenishment Areas?

What would be helpful to make your collection business more successful?

Other comments or suggestions:

Appendix E

Self-addressed Stamped Postcard Questionnaire

Company Name: _____

Please mark all that apply

- I have sent my Satisfaction and Concerns Survey as requested.
- I would be willing to have a researcher come out on a collection trip.
- I would be willing to complete the Angler's diary to help this project.
- I would like to meet with the researcher to discuss this project.
- I would like to attend an aquarium collectors' meeting to discuss this project in further detail.
- I would like a copy of the completed data summary.

Appendix F & G

Angler's Diary & Roving Creel Survey Data Sheet

Name:	Zone(s) Fished (See Zone Numbering Map)
Company:	
Number of Collectors:	
Date:	

Time in Route	Leave Port	Arrive Dive 1	Leave Dive 1	Arrive Dive 2	Leave Dive 2	Arrive Dive 3	Leave Dive 3	Arrive Dive 4	Leave Dive 4	Arrive Port

Collection Time (Dive Time)	Dive 1	Dive 2	Dive 3	Dive 4

Weather Conditions:

- 1 Clear and Sunny
- 2 Partly Cloudy
- 3 Cloudy
- 4 Raining

Weather Conditions (Select from List)	Dive 1	Dive 2	Dive 3	Dive 4

Water Conditions:

- 1 Calm & Glassy
- 2 Slight Chop and Small Swell
- 3 Medium Swell
- 4 Large Swell

Weather Conditions (Select from List)	Dive 1	Dive 2	Dive 3	Dive 4

Visibility:

- 1 10 feet
- 2 15feet
- 3 20 feet
- 4 >25 feet

Visibility (Select from List)	Dive 1	Dive 2	Dive 3	Dive 4

Depth of Dive:

- 1 30 feet
- 2 30 – 40 feet
- 3 40 – 50 feet
- 4 >50 feet

Depth of Dive (Select from List)	Dive 1	Dive 2	Dive 3	Dive 4

Collection Methods Used:

- 1 Hand Net
- 2 Barrier Net
- 3 Trap
- 4 Tickle Stick
- 5 Other (Please Describe)

Collection Methods Used (Select all that apply)	Dive 1	Dive 2	Dive 3	Dive 4

Species Collected:

(Tally number of fish collected in appropriate column)

Species	Common Name	Number Collected			
		Dive 1	Dive 2	Dive 3	Dive 4
Acanthuridae	Sugeonfishes				
<i>Acanthurus achilles</i>	Achilles Tang				
<i>Zebrasoma flavescens</i>	Yellow Tang				
<i>Zebrasoma veliferum</i>	Sailfin Tang				
<i>Ctenochaetus strigosus</i>	Kole Tang				
<i>Ctenochaetus hawaiiensis</i>	Chevron Tang				
<i>Naso lituratus</i>	Naso Tang				
<i>Naso unicornis</i>	Unicorn Tang				
<i>Acanthurus olivaceus</i>	Orangeband Tang				
<i>Acanthurus triostegus</i>	Convict Tang				
<i>Acanthurus nigrofuscus</i>	Lavender Tang				
<i>Acanthurus nigricans</i>	Goldrim Tang				
Zanclidae	Moorish Idols				
<i>Zanclus cornutus</i>	Moorish Idol				
Chaetodontidae	Butterflyfishes				
<i>Chaetodon auriga</i>	Threadfin Butterfly				
<i>Chaetodon fremblii</i>	Bluestripe Butterfly				
<i>Chaetodon lunula</i>	Raccoon Butterfly				
<i>Caetodon multinctus</i>	Pebbled Butterfly				
<i>Chaetodon miliaris</i>	Milletseed				
<i>Chaetodon ornatissimus</i>	Ornate Butterfly				
<i>Chaetodon quadrimaculatus</i>	Fourspot Butterfly				

<i>Chaetodon unimaculatus</i>	Teardrop Butterfly				
<i>Chaetodon trifasciatus</i>	Oval Butterfly				
<i>Chaetodon kleinii</i>	Bluehead Butterfly				
<i>Chaetodon tinkeri</i>	Tinker's Butterfly				
<i>Chaetodon reticulatus</i>	Reticulated Butterfly				
<i>Forcipiger flavissimus</i>	Long Nose Butterfly				
<i>Forcipiger longirostris</i>	Rare Long Nose				
Pomacanthidae	Angelfishes				
<i>Centropyge potteri</i>	Potter's Angel				
<i>Centropyge loriculus</i>	Flame Angel				
Labridae	Wrasses				
<i>Thalassoma duperrey</i>	Saddle Back				
<i>Pseudocheilinus octotaenia</i>	Eight-lined Wrasse				
<i>Pseudocheilinus tetrataenia</i>	Fourline Wrasse				
<i>Coris gaimard</i>	Clown Wrasse				
<i>Halichoeres ornatissimus</i>	Ornate Wrasse				
<i>Anampses chrysocephalus</i>	Psychedelic Wrasse				
<i>Bodianus bilinulatus</i>	Hawaiian Hogfish				
<i>Gomphosus varius</i>	Bird Wrasse				
<i>Labroides phthirophagus</i>	Cleaner Wrasse				
<i>Novaculichthys taeniourus</i>	Rockmover Wrasse				
Pomacentridae	Damselfishes				
<i>Dascyllus albisella</i>	Domino Damsel				
<i>Chromis Hanui</i>	Chocolate Dip				
<i>Chromis vanderbilti</i>	Blackfin Chromis				
<i>Chromis agilis</i>	Agile Chromis				
<i>P. imparipennis</i>	Bright-eye Damsel				
Tetradontidae	Pufferfishes				
<i>Arothron hispidus</i>	Stripebelly Puffer				
<i>Arothron meleagris</i>	Spotted Puffer				
<i>Canthigaster jactator</i>	Whitespotted Toby				
<i>Canthigaster coronata</i>	Crowned Toby				
Ostraciidae	Boxfishes				
<i>Lactoria forasini</i>	Thornback Cowfish				
<i>Ostracion meleagris</i>	Spotted Boxfish				
Muraenidae	Moray Eels				
<i>Echidna nebulosa</i>	Snowflake Moray				
<i>Gymnomuraena zebra</i>	Zebra Moray				
<i>Gymnothorax eurostus</i>	Stout Moray				
Balistidae	Triggerfishes				
<i>Sufflamen bursa</i>	Bursa Trigger				
<i>R. rectangulus</i>	Picasso Trigger				
<i>R. aculeatus</i>	Lagoon Trigger				
<i>Melichthys vidua</i>	Pinktail Trigger				
<i>Melichthys niger</i>	Niger Trigger				

Cirrhitidae	Hawkfishes				
<i>Cirrhitus pinnulatus</i>	Stocky Hawkfish				
<i>Oxycirrhites typus</i>	Longnose Hawkfish				
<i>Paracirrhites forsteri</i>	Blackside Hawkfish				
<i>Paracirrhites arcatus</i>	Arc-Eye Hawkfish				
Antennariidae	Frogfishes				
Serranidae	Anthias				
<i>Anthias thompsoni</i>	Fairy Bass				
Lutjanidae	Snappers				
<i>Lutjanus kasmira</i>	Bluestripe Snapper				
<i>Lutjanus fulvus</i>	Blacktail Snapper				
Holocentridae	Squirrelfishes				
Holocentridae	Soldierfishes				
Monacanthidae	Filefishes				
<i>Pervagor spilosoma</i>	Fantail Filefish				
Mullidae	Goatfishes				
<i>Mulloidichthys flavolineatus</i>	White Goatfish				
<i>Parupneus cyclostomus</i>	Blue Goatfish				
<i>Parupeneus multifasciatus</i>	Manybar Goatfish				
Microdesmidae	Dartfishes				
<i>Nemateleotris magnifica</i>	Fire Dartfish				
Scaridae	Parrotfishes				
Other Species Collected					

Comments or Unusual Occurrences:

Appendix H

University of Hawaii Marine Option Program Budget Proposal

Project Title: A Study of the Effects of the West Hawaii Regional Fisheries Management Area on the Aquarium Fishery	Date: January 12, 2000
Project Leader: Brian Zgliczynski University of Hawaii, Hilo	
Advisors Dr. Paul Haberstroh University of Hawaii, Hilo Dr. Mike Parsons University of Hawaii, Hilo	Project Duration: January 2000- May 2000

In kind I'm providing:

- Vehicle (Travel to Kona)
- Garmin GPS 48
- Humminbird Marine Radio

Expendable Supplies And Equipment			
1. Waterproof Paper	8 boxes @ \$40./box	\$ 320.00	
2. Mechanical Pencils	5 packs @ \$ 2.50/ pack	\$ 12.50	
3. Notebooks	10 notebooks @ \$ 4.00/ notebook	\$ 40.00	
4. Manila Envelopes	1 box @ \$ 10.00/ box	\$ 10.00	
5. Classification Folder	1 folder @ \$15.00/ folder	\$ 10.00	
6. Postage and Photo Copy Expenses		\$ 35.00	
7. Miscellaneous Expenses		\$ 20.00	\$ 447.50
Travel Stipend			
1. Travel from Hilo to Kona during project (210 miles round trip)			\$ 200.00
		Total	\$ 647.50

Appendix I

Pre-Proposal Submitted to the Sea Grant College Program

UNIVERSITY OF HAWAII SEA GRANT COLLEGE PROGRAM

Principal Investigator: Paul R. Haberstroh

Department, School or College: Marine Science Department, U.Hawaii, Hilo

Mailing Address (building/room no.): Natural Sciences Division,
200 W. Kawili St., U.H. Hilo, Hilo, HI. 96720

Telephone No.: 808-974-7677

E-mail: haberstr@hawaii.edu

Fax No.: 808-974-7693

Title of Project: A Study of the Effects of the West Hawaii Regional Fishery Management Area to the Aquarium Fishery

Research Field of Proposed Study: West Hawaii

Project Period:

Sea Grant Funds Requested: 1st Year: \$ 29,577 2nd Year: \$ 26,879

Match Funds Provided: 1st Year: \$ 24,260 2nd Year: \$ 24,260

A. Rationale

Aquarium fish collection is a lucrative business in Hawaii because of the increasing popularity of the household marine aquarium (van Poollen and Obara, 1984). Cultivating marine ornamental fish has not been found to be cost-effective, so 99% of the marine species used in aquariums originate from coral reef populations (Young 1997). Hawaii possesses 85% of the coral reef habitat in the United States, harboring 5000 known species of marine animals and plants (Tissot and Hallacher, 1999).

The State of Hawaii began in 1973 to require monthly aquarium catch reports from collectors (Katekaru 1978). The first yearly summary was reported to be 90,000 fish collected, with an estimated value of \$50,000 (Katekaru 1978). The last published yearly summary was in 1995, reporting 422,823 fish collected with an estimated value of \$844,843 (Miyasaka 1997). The 1995 report listed 103 fish species collected, but 90% of the harvest consisted of 11 species (Tissot and Hallacher, 1999). Most of the aquarium species are collected from the West Coast of the island of Hawaii. That increase in collection activities in the Kona and Milolii areas of Hawaii has added to the long standing concerns over the impact of these activities on the coral reef community. Indeed, it has long been established that the very health of coral reef is linked synergistically to the activities of these populations (Meyer and Schulz 1985).

Recent Analysis by DAR indicates that the values presented in the previously published summaries was underestimated (DAR, unpublished data). At present, 59.5% of the monthly catch reports aren't being filed, resulting in inaccurate and underestimated catch data (DAR, unpublished data). Therefore the value of the industry is substantially higher than previously reported.

Unfortunately, the last comprehensive study of Hawaii's aquarium fishery was in 1984 (van Poollen and Obara 1984). Van Poollen and Obara (1984) reported that there were 49 collectors statewide. Today, the Division of Aquatic Resources (DAR) has issued 54 collecting permits for the island of Hawaii alone (DAR, unpublished data). Each of these collection operations is varied in size and scope of operation. Some collectors make the fishery their full-time livelihood, while others utilize it more as part-time enterprise. This proposed study would focus on the entire scope of the fishery in order to gain a better understanding of the fishery. The operations and total number of collectors will be determined from data supplied by the Marine Aquarium Council, an organization of representatives from the aquarium collection industry.

Marine Protected Areas (MPA's) have been utilized in several locations to assess and manage coastal fisheries (Amesbury et al. 1991; Bohnsack 1998). In the State of Hawaii, the West Hawaii Regional Fishery Management Area (WHFMA) was established in act 306 and is currently in effect. The WHRFMA is intended to manage fish resources in West Hawaii by restricting aquarium collection in Fish Replenishment Areas (FRA's). These FRA's have been implemented and make up 32.5% of the West Hawaii coast (Tissot

and Hallacher 1999). Presently, there is the West Hawaii Aquarium Project (WHAP) which is an on-going study set up to examine the biological parameters of the reefs of West Hawaii. The study's main objective is to determine the effectiveness of the WHRFMA by comparing the FRA's with the non protected areas. The proposed study will compliment the WHAP by looking at the fishery from a sociological standpoint. The study will use three established survey methods to determine of the impact of the FRAs on the aquarium fishery and to establish methods to properly manage and create a sustainable aquarium fishery in West Hawaii.

B. Goals and Objectives

The purpose of this research is to study three aspects of fish collection affected by the Marine Reserve expansion:

- Catch analysis and qualitative view of the fishery. It will include: fishing behavior including a study of distance traveled, size of operation, number of participants, location of collection, time spent collecting, date and time of collection, methods of collection, gear type, depth and length of dives, sea state and weather conditions, cost and profits of the collection activity and general satisfaction with the collection effort;
- Biological scope of the fishery. This will focus on: quantifying the catch and effort, determining the species harvest, including type, length-frequency size, selectivity of size of individual species caught, and mortality rates during collection and transport; and
- The social component of the fishery. This will focus on the collectors' perceptions of the implementation of the FRA's and the effectiveness of the WHRFMA. It will also ascertain how the FRA's will change the behavior of the collectors.

C. Methods

Thirty-two and a half percent of the West Hawaii coastline has been set-aside as Fish Replenishment Areas. This study will encompass the entire range of collectors and describe the fishery as a whole. It will focus on catch, fish collectors, and the collection methods used. A combination of survey methods will be used:

- General satisfaction and concerns survey of collector demographics and concerns related to implementation of the FRA's. These survey, which will be mailed out periodically. The initial satisfaction and concerns surveys are under-way;
- A modified Angler's Diary, which is a daily logbook that individual collectors record pertinent data during collection. The researcher will be using a modified version of the monthly catch report form, which the collectors are already familiar with. The survey will gather qualitative and quantitative data relating to the actual act of fish collection; and
- A modified Roving Creel Survey, where the researcher goes out into the field with the collectors to gather quantitative data. The researcher will use the same form used in the modified angler's diary. This survey method will also allow the researcher to gain feedback from the collectors' relating to the implementation of the FRA's.

D. Expected Outcomes

The expected outcomes of this study are to:

- Be able to characterize the aquarium fishery as a whole by determining fishing behavior including a study of distance traveled, size of operation, number of participants, location of collection, time spent collecting, date and time of collection, methods of collection, gear type, depth and length of dives, sea state and weather conditions, cost and profits of the collection activity and general satisfaction with the collection effort;
- Gain a basic fully developed understanding of the biological parameters of the fishery by quantifying the catch and effort, determining the species harvest, including type, length-frequency size, selectivity of size of individual species caught, and mortality rates during collection and transport;

- Serve as a baseline study. Since the WHRFMA has a 5-year review plan, this study will serve as a baseline study for future studies. The study proposed would compliment the WHAP, and together the studies will provide feedback to fishery managers about the effectiveness of the FRA's in the future; and
- Establish communication between the aquarium industry and the community and ultimately lead to an improvement in data collection. The topic of aquarium fish collection has been the subject of heated debate for decades with many people having estranged emotions. This study will hope to establish dialogue between the community and the collectors and eliminate the conflict between the two groups. It will also gain feedback from the collectors pertaining to the effectiveness of the FRA's through time.

E. Literature Cited

- Amesbury, S.A., T. Sherwood and G. Davis (1991) Monitoring a tropical island fishery. *In: Creel and angler surveys in fisheries management*. Guthrie, D. and others (eds.). *Am.Fish. Soc. Symp.* 12: 84-87.
- Anderson, L.E. and P.C. Thompson (1991) Development and implementation of the angler diary monitoring program for Great Bear Lake, Northwest Territories. *In: Creel and angler surveys in fisheries management*. Guthrie, D. and others (eds.). *Am.Fish. Soc. Symp.* 12:457-475.
- Bohnsack, J.A. (1998) Application of marine reserves to reef fisheries management. *Australian Journal of Ecology* 23(3): 298-304.
- Department of Land and Natural Resources, Division of Aquatic Resources, State of Hawaii. (1985) *Hawaii Fisheries Plan 1990-1995*.
- Hayne, D.W. (1991) The access point creel survey: procedures and comparison with the roving clerk creel survey. *In: Creel and angler surveys in fisheries management*. Guthrie, D. and others (eds.). *Am.Fish. Soc. Symp.* 12: 123-138.
- Katekaru, A. (1978) Regulations of tropical fish collecting. *Hawaii Sea Grant College Program, Working paper* 34: 35-42.
- Kendall, R.L. (1991) Preface and acknowledgements. *In: Creel and angler surveys in fisheries management*. Guthrie, D. and others (eds.). *Am.Fish. Soc. Symp.* 12: xi.
- Meyer, J.L. and E.T. Schulz (1985) Tissue and growth rate of coral associated with schooling fish. *Limnol. Oceanogr.* 30(1): 157-166.
- Miyasaka, A. (1997) Status report, aquarium collections, fiscal year 1994-1995. Division of Aquatic Resources, Department of Land and Natural Resources, State of Hawaii, Honolulu, Hawaii, 10p.
- Robson, D.S. (1991) The roving creel study. *In: Creel and angler surveys in fisheries management*. Guthrie, D. and others (eds.). *American Fisheries Society Symposium* 12:19-24.
- Tissot, B.N. and L.E. Hallacher (1999) Impacts of aquarium collectors on coral reef fishes in Kona, Hawaii. Submitted to *Ecological Applications*.
- Van Poolen, H.W. and A.M. Obara (1984) Hawaii's marine aquarium fish industry profile. *Studies on marine economics* No. 3. University of Hawaii Sea Grant College Program. Ocean Resources Office Contribution No. 14, State of Hawaii, Department of Planning and Economic Development.
- Young, L.G.L. (1997) Sustainability issues in the trade for wild and cultured aquarium species. *In: Marketing and shipping live aquatic products*. Northeastern Regional Agricultural Engineering Service Cooperative Extension, Ithaca, New York: 145-151.

Appendix J

Proposed Budget Submitted to the Sea Grant College Program

NOAA FORM 90-4 U.S. DEPARTMENT OF COMMERCE
SEA GRANT BUDGET

Grantee: UNIVERSITY OF HAWAII Grant/Proj.No:
Project Title: A Study of the Effects of the Implementation of the West Hawaii Regional Fishery Management Area to the
Aquarium Fishery Project Status:
Principal Investigator: Paul R. Haberstroh Duration: 3/01/01-2/28/02

A. SALARIES AND WAGES	MAN MOS.	SEA GRANT FUNDS	GRANTEE SHARE*
1. SENIOR PERSONNEL			
a. (Co)Principal Investigator:	1.00	\$0	\$ 4444
b. Associates (Faculty/staff):			
Brian Tissot, (W.S.U.),	1.00	\$0	\$ 5000
William Walsh (D.A.R., D.N.L.R.)	1.00	\$0	\$ 3000
Sub Total:	3.00	\$0	\$ 12444
2. OTHER PERSONNEL			
a. Professionals:		\$0	\$0
b. Research associates (1/2 time, \$11.97/hour)	6.00	\$ 11,491	\$0
c. Research asst. grad. students:		\$0	\$0
d. Prof. school students:		\$0	\$0
e. Pre-Bac. student(s):		\$0	\$0
f. Secretarial-clerical:		\$0	\$ 500
g. Technical-shop:		\$0	\$0
h. Misc.:		\$0	\$0
Total Salaries and Wages:		\$ 11491	\$ 12944
B. FRINGE BENEFITS (When charged as direct cost):		\$ 184	\$ 4660
Total Salaries (A and B):		\$ 11875	\$ 17604
C. PERMANENT EQUIPMENT:		\$ 2000	\$0
D. EXPENDABLE SUPPLIES AND EQUIPMENT:		\$ 3500	\$0
E. TRAVEL			
1. Domestic U.S.		\$ 3750	\$0
2. International		\$0	\$0
Total Travel:		\$ 3750	\$0
F. PUBLICATION AND DOCUMENTATION COSTS:		\$0	\$250
G. OTHER COSTS:			
1. Analytical Services; Recharge		\$0	\$0
2. Communications; Photocopying		\$0	\$250
3. Computer Costs		\$0	\$0
4. Equipment Maintenance/Use		\$0	\$0
5. Shiptime; Submersible Dive Packages		\$0	\$0
6. Publication Costs		\$0	\$0
7. Others: Housing and Food		\$ 1000	\$0
8. Stipends		\$0	\$0
9. (no O/H)		\$0	\$0
10. (no O/H)		\$0	\$0
Total Other Costs:		\$0	\$250
TOTAL DIRECT COSTS (A through G):		\$ 21925	\$ 18104
INDIRECT COST (On campus 34.9% of MTDC)		\$ 7652	\$ 6156
INDIRECT COST (Off campus)		\$0	\$0
Total Indirect Cost:		\$ 7652	\$ 6156
TOTAL COSTS:		\$29577	\$24260
ROUNDED TO:			

*Matching funds equal to one-half of the federal funds requested are required by the granting agency, NOAA. If match will be provided by sources other than your department, please note the funding agency at the bottom of each budget page.

West Hawaii Aquarium Fisheries Project: Zgliczynski: Page 39

NOAA FORM 90-4 U.S. DEPARTMENT OF COMMERCE
 SEA GRANT BUDGET

Grantee: UNIVERSITY OF HAWAII Grant/Proj.No:
 Project Title: A Study of the Effects of the Implementation of the West Hawaii Regional Fishery Management Area to the
 Aquarium Fishery Project Status:
 Principal Investigator: Paul R. Haberstroh Duration: 3/01/02-2/28/03

A. SALARIES AND WAGES	MAN MOS.	SEA GRANT FUNDS	GRANTEE SHARE*
1. SENIOR PERSONNEL			
a. (Co)Principal Investigator:	1.00	\$0	\$ 4444
b. Associates (Faculty/staff):			
Brian Tissot, (W.S.U.),	1.00	\$0	\$ 5000
William Walsh (D.A.R., D.N.L.R.)	1.00	\$0	\$ 3000
Sub Total:	3.00	\$0	\$ 12444
2. OTHER PERSONNEL			
a. Professionals:		\$0	\$0
b. Research associates (1/2 time, \$11.97/hour)	6.00	\$ 11,491	\$0
c. Research asst. grad. students:		\$0	\$0
d. Prof. school students:		\$0	\$0
e. Pre-Bac. student(s):		\$0	\$0
f. Secretarial-clerical:		\$0	\$ 500
g. Technical-shop:		\$0	\$0
h. Misc.:		\$0	\$0
Total Salaries and Wages:		\$ 11491	\$ 12944
B. FRINGE BENEFITS (When charged as direct cost):		\$ 184	\$ 4660
Total Salaries (A and B):		\$ 11675	\$ 17604
C. PERMANENT EQUIPMENT:		\$0	\$0
D. EXPENDABLE SUPPLIES AND EQUIPMENT:		\$ 3500	\$0
E. TRAVEL			
1. Domestic U.S.		\$ 3750	\$0
2. International		\$0	\$0
Total Travel:		\$ 3750	\$0
F. PUBLICATION AND DOCUMENTATION COSTS:		\$0	\$250
G. OTHER COSTS:			
1. Analytical Services; Recharge		\$0	\$0
2. Communications; Photocopying		\$0	\$250
3. Computer Costs		\$0	\$0
4. Equipment Maintenance/Use		\$0	\$0
5. Shiptime; Submersible Dive Packages		\$0	\$0
6. Publication Costs		\$0	\$0
7. Others: Housing and Food		\$ 1000	\$0
8. Stipends		\$0	\$0
9. (no O/H)		\$0	\$0
10. (no O/H)		\$0	\$0
Total Other Costs:		\$0	\$250
TOTAL DIRECT COSTS (A through G):		\$ 19925	\$ 18104
INDIRECT COST (On campus 34.9% of MTDC)		\$ 6954	\$ 6156
INDIRECT COST (Off campus)		\$0	\$0
Total Indirect Cost:		\$ 6954	\$ 6156
TOTAL COSTS:		\$26879	\$24280
ROUNDED TO:			

*Matching funds equal to one-half of the federal funds requested are required by the granting agency, NOAA. If match will be provided by sources other than your department, please note the funding agency at the bottom of each budget page.