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Mariculture Management for Pohnpei State, Federated States of Micronesia

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MARICULTURE MANAGEMENT FOR POHNPEI STATE, FEDERATED STATES OF MICRONESIA

BY

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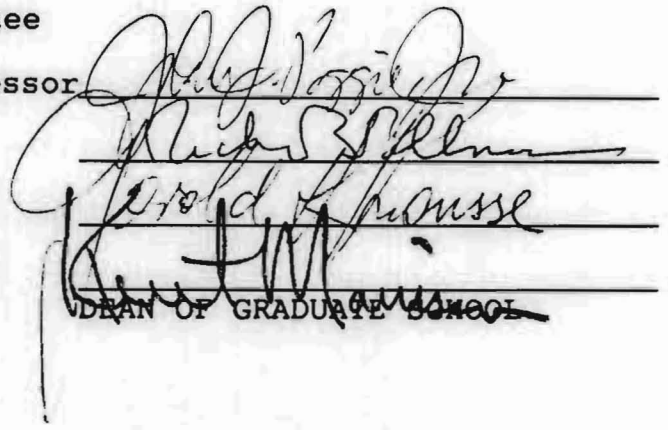

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ABSTRACT

The Marine Resources Division of Pohnpei State, Federated States of Micronesia is currently engaged in development activities that include the establishment of family scale mariculture projects for community members of remote villages and outer islands. The goal of this undertaking is to supplement subsistence and income generation ventures for community members through the wise use and exploitation of the marine environment. These aims may be jeopardized unless a management plan is devised that reflects the customary marine resource practices as embraced by islanders from each community. The intent of this thesis project is to devise a mariculture management model that could assist marine resource managers minimize and avoid marine resource user conflicts that may become manifested with the introduction of family mariculture projects. A ten week field investigation was conducted on three different study sites to obtain qualitative and quantitative data that would aid in the development of an appropriate mariculture management model. Research results disclose various marine resource user rights and practices that are consistent with mariculture management parameters and could significantly reduce user conflicts for each community.

ACKNOWLEDGEMENTS

I wish to extend my sincere thanks to the following people for the professional courtesy, assistance and friendship which I have been the recipient of throughout my thesis investigation. I would like to recognize Flinn Curren, Aquaculture Consultant, for his outstanding work at the Marine Resources Division, Pohnpei State, and his assistance and friendship which ultimately aided in the development of my thesis question and field work investigation. Tashiro Ludwig, Chief of Marine Resources Division, for his assistance and friendship which opened doors and created opportunities during the field work investigation and previous work. Kit Dahl, Sea Grant Extension Agent, for his thoughtful comments and previous investigation that greatly aided in the direction of this thesis. Gerry Heslinga, Micronesian Mariculture Demonstration Center, The Republic of Palau, for his inspirational work and incite into giant clam cultivation and management in Micronesia. Mike Gawel and Dick Croft, FSM Marine Resources Division, for their incite into conducting field work investigations for each study site.

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MARICULTURE MANAGEMENT FOR POHNPEI STATE

CHAPTER ONE

INTRODUCTION

The thrust of this paper is to view the possibilities for mariculture development as they exist for three communities of Pohnpei State, Federated States of Micronesia (FSM). Contradictions that exist between cultural marine resource management styles and the government's open access approach to marine resource management risks the security and continued maintenance of mariculture projects for this area. A mariculture development overview for this area will be accompanied by theoretical arguments for the incorporation of customary marine tenure practices as an approach to mariculture management for several communities of Pohnpei State. Field work observations and statistical analysis will illustrate the findings of this study.

I spent the last seven years in Micronesia and was associated with several development and research entities that include the United States Peace Corps, the University of Guam Marine Laboratory, the Guam Aquaculture Development and Training Center, the Center for Tropical and Sub-tropical Aquaculture; and I also carried out a 10 week field data collection trip sponsored by the University of Rhode Island and the University of Hawai'i Sea Grant programs, of which the qualitative and quantitative data from this field work serve

as the basis for this thesis.

Thesis Investigation

Principal objectives of this paper include an examination of the customary marine tenure and government marine resource management practices that exist in three communities of Pohnpei State (Nukuoro atoll, Pingelap atoll and Pehleng village). I will describe patterns of customary lagoon boundary claims, fishing limitations and access rights as directed by the authority structure for a given community. Specific objectives of the field survey are to discern community values and attitudes toward Perceived Authority Over Marine Natural Resources; Confidence in Government Legal Methods and Customary Marine Tenure Practices to Conserve Marine Natural Resources; and Confidence in Government Legal Methods and Customary Marine Tenure Practices to Protect Individual Family Mariculture Projects for each site visited within the time constraints of this pilot study.

The intent of this investigation is to ascertain whether communities that employ degrees of customary marine tenure practices, to conserve Marine Natural Resources (MNR), could provide a more effective overall cultural milieu for the protection of individual family mariculture projects from poaching, than communities that rely exclusively on government legal methods to achieve this aim. It is hypothesized that community members will rely more on customary or informal

management schemes to provide protection for family mariculture projects as compared to current government strategies.

Methodology

A ten week investigation was conducted in three study sites (i.e., Nukuoro Atoll, Pingelap Atoll and Pehleng Village) to discern community perceptions toward marine resource management that may apply to family style mariculture projects. This investigation involved interviewing 24 participants from Nukuoro; 30 participants Pingelap; and 30 participants from Pehleng. I was assisted by one or more interpreters per study site to mediate questions and answers between the investigator and respondents. Interpreters were selected on the basis of their command of the English language, standing in the community and experience with marine management issues. Mr. Toshiro Ludwig, Chief of Pohnpei State Marine Resources Division, was instrumental in identifying reliable interpreters for each study site.

I traveled to and from each study site via field trip ship, plane and by walking. Prior to my arrival, community leaders were contacted and informed to the nature of my visit and arrival date. Upon reaching each study site, community leaders were contacted and an informal meeting ensued, providing leaders with an opportunity to further question the purpose and method of the investigation. These meetings also afforded

me an opportunity to explore the nature of marine resource management from the perspective of the island's leadership. The opportunity to meet with traditional and secular leaders greatly facilitated and expedited the information gathering process in each study site.

Community members were interviewed on an opportunistic basis, with willing subjects participating in the oral investigation. The sample in this study is not a random one. Readers should be cautioned that generalizations about the "hypothetical universe" (Thomas 1976:444) of samples for this pilot study can only be made with this in mind. However, because of the limitations of time and resources, it was the best method available for use in this setting as a systematic assessment of community perceptions. Community members who took part in this survey included traditional and secular leaders, fishmasters, fisherwomen and fishermen. Subjects were asked to respond to several topics that included marine resource and mariculture management, fishing techniques and fishing lore. Interviewees responded to questions that ranged from open-ended, qualitative interpretations to specific answers designed to quantify and gauge collective positions regarding resource management issues.

Respondents provided information regarding three management topics: (1) perceived authority over marine natural resources, (2) confidence in government methods and customary methods to

conserve marine resources, and (3) confidence in government methods and customary methods to protect individual family mariculture projects. Relative sizes of responses for the three management topics in each community will be related as percentages. A Chi-Square 3 by 2 Contingency Analysis Test will be used to test the significance of community preferences for management schemes regarding the conservation of marine natural resources and security for individual family mariculture projects. Conclusions drawn from the Chi-Square Test will be used to determine whether the general thesis hypotheses are plausible or not.

Descriptive Statistics

The first topic (table 2 and figure 2), perceived authority over marine natural resources, contained six categories that are the Government, Nahnmwarki, Traditional Clan, Community, Fishermen, and Fishmasters. Figure two illustrates and compares cumulative responses per each study site.

The second topic (table 3 and figure 3), confidence to conserve marine natural resources, contained two groups that are Government and Customary Marine Tenure. For this topic, respondents were asked to rate their confidence in government legal methods and customary marine tenure practices to conserve marine natural resources. The scale offered respondents an opportunity to select the most appropriate term that best described their confidence in both conservation

management schemes. Respondents chose one of five responses, on a scale of one to five, that included ratings of (1) Complete Confidence, (2) Strong Confidence, (3) Moderate Confidence, (4) Weak Confidence, and (5) No Confidence, to express their views toward each management scheme. Results of interviewees' responses for ratings 3, 4 and 5 were omitted to facilitate data reporting. Percentages appearing in table 3 and figure 3 are responses of Complete Confidence and Strong Confidence ratings that have been combined into one category.

The third topic (table 4 and figure 4), confidence to protect individual family mariculture projects, contain two groups that are Government and Customary Marine Tenure. For this topic, respondents were asked to rate their confidence in government legal methods and customary marine tenure practices to provide security for family mariculture projects. Analogous to the previous scale, respondents were offered a choice from one of five ratings that best described their confidence in both security management schemes for prospective family mariculture projects. Again, reported percentages are combined responses of ratings 1 and 2, of which responses from ratings 3, 4 and 5 have been omitted. Figure 4 compares responses for this topic from each study site.

Chi-Square 3 by 2 Contingency Analysis Test

The chi-square test for two independent variables is designed to test whether the collected responses, nominal sample data, is random or not. Chi-square tests for differences between two groups and is contingent upon the relative frequency of cases or responses according to the rating system. Data are cast into a 3 by 2 contingency table with three rows and two columns. In this investigation, rows represent the three classes of ratings (Favor, Indifferent and Opposed), and columns represent two groups (Government and Customary Marine Tenure) that are being tested. To simplify calculations, positive responses (1) Complete and (2) Strong, have been combined into one rating, (1) Favor. Moderate or neutral responses have been combined into a second rating, (2) Indifferent. Negative responses, (4) Weak and (5) No Confidence, have been arranged into one rating, (3) Opposed.

After data has been cast into a contingency table, the chi-square calculation is performed. The chi-square 3 by 2 contingency analysis test formula[1] is expressed as:

$$X^2 = \text{sum sum } \frac{(n - E)^2}{E}$$

$$E = \frac{(R)\ (C)}{N}$$

The degree of freedom (df) is expressed as:

$$df = (r - 1)(c - 1)$$

After a test statistic has been derived using this formula, the resultant figure is equated with a table statistic. The table statistic, located in a table of Critical Values of the Chi-Square Distribution, is determined by evaluating the significance level (i.e., alpha level) and the degrees of freedom. The table statistic is the value where both variables intersect. The significance level for this series of tests will be alpha = .05. Five percent of the entire area under the sampling distribution curve will constitute the region of rejection. This means that research hypotheses have a possibility of being confirmed by chance alone and accepted, 5 in 100 times, or less.

Respondents were asked to provide an efficiency rating for each management strategy, government legal methods and customary marine tenure practices, for two topics: Conservation of Marine Natural Resources and Security Management for Individual Family Mariculture Projects. Management strategies were rated for each topic under a three point rating scale: (1) Favor, (2) Indifferent, (3) Opposed. The chi-square tests will be conducted in order to ascertain if community preferences toward one or the other management scheme is statistically significant. This process will ultimately be used to reject or accept the null and research hypotheses for each topic.

CHAPTER TWO

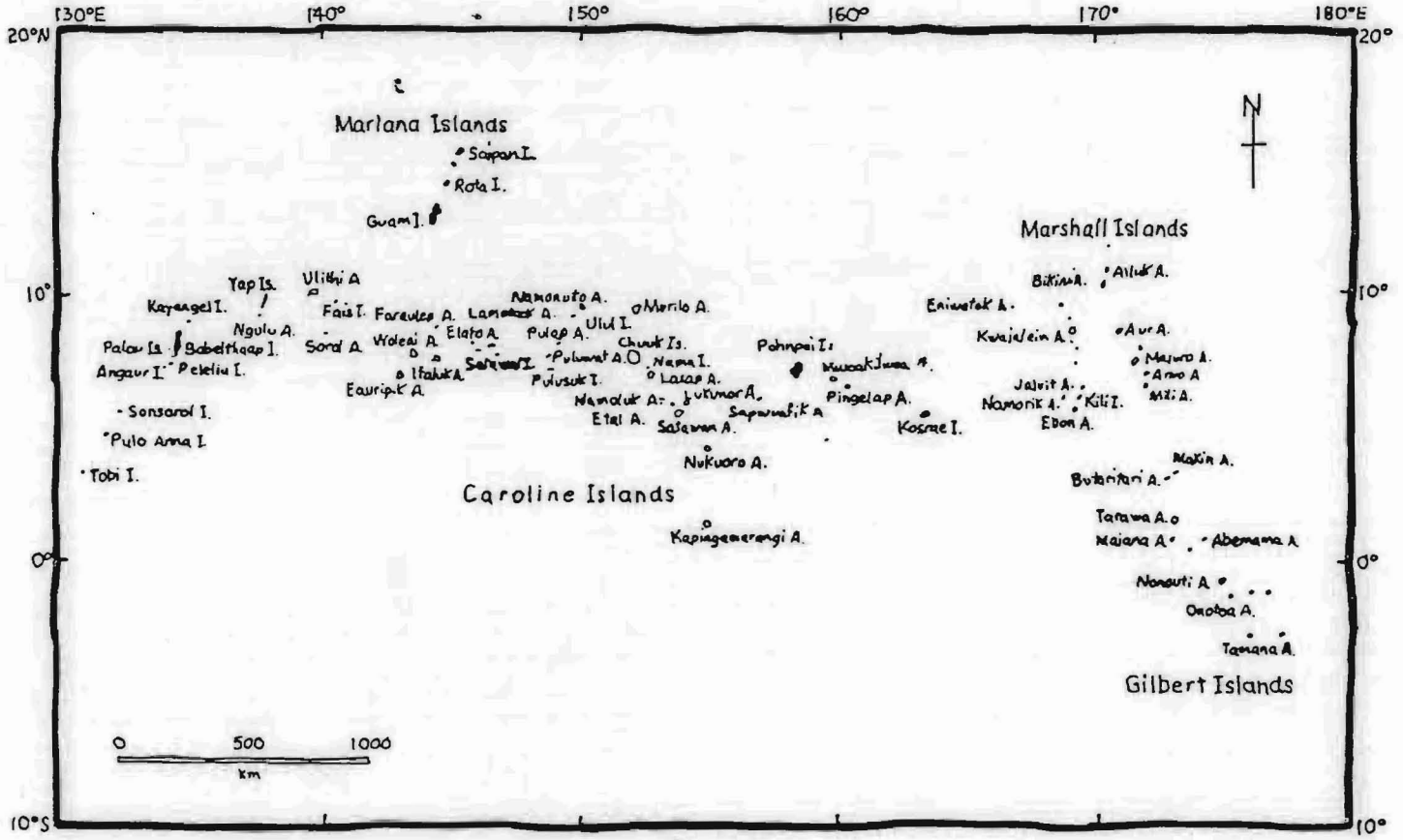
POHNPEI ENVIRONMENT and CULTURE

Pohnpei is a basalt high island located in the western central Pacific (Map 1 & 2), 6° 54′ North latitude, 158° 14′ East longitude, at the eastern end of the Caroline Islands. Prolific vegetation abounds throughout the interior of the island while an extensive mangrove forest thrives in the semi-saline environment where island meets lagoon. Lush valleys and steep mountains, which rise up to over 2,300 feet, receive several hundred inches of rain each year. The land area of Pohnpei is about 129 square miles; while the lagoon area inside the barrier reef is about 70 square miles. Pohnpeian climate is characterized as breezy with moderate precipitation during the trade wind season, December to June, with increasing frequencies of rain and higher humidity for the rest of the year. Annual rainfall for the lowland areas of Pohnpei average approximately 192 inches (487cm) and 400 inches (1016cm) for the interior highlands. This part of the western central Pacific is the center of origin for severe tropical storms and typhoons.

Haun (1984:110-240) proposes a sequence for subsistence food production development that begins as early as 500 B.C.. Pohnpei was visited throughout the 19th century by whalers,

missionaries and traders. Hezel (1984:16-363) tracks the administration and economic development and ventures of four different foreign governments that include Spain, Germany, Japan and the United States.

Pohnpei was formally administered by Spain from 1886 to 1898. Spain's goals "...to Christianize the people and make them loyal subjects..." were supplanted when defeat during the Spanish-American War spelled the end of Spanish presence in Micronesia (Hezel 1984:16). Germany purchased the Caroline Islands from Spain in 1899, established a lucrative copra and phosphate industry, and introduced "...Conditional Fee Simple Titles to lands (e.g., private land ownership) that had formerly 'belonged' to the high chiefs" (Castro 1984:185). Actouka and Ice analyze the influence which foreign administrations had on land ownership and how it is evident in in contemporary Pohnpei (1981:12). German administration of the islands ended in 1914 when Japan seized the islands and organized a substantial private entrepreneurial presence that traded in sugar, copra, phosphate, agricultural and fisheries products. The Japanese Land Register furthered the evolution of foreign land tenure intervention by recognizing inheritance to females; allowing for Japanese nationals and companies to buy and retain titles to land; and recognized persons other than the Nahnmwarki as approving authorities to sales and conveyances of titles (Castro 1984:187).



MAP OF MICRONESIA

LEGEND

IS. = ISLANDS

I. = ISLAND

A. = ATOLL

MAP ONE

The final foreign administration of Micronesia began in 1945, after World War II, which culminated in an agreement between the United Nations and the United States in 1947. This arrangement was born due to strategic interests of the United States in the region and would eventually produce the Trust Territory of the Pacific Islands. The trusteeship was terminated in 1986 and the Federated States of Micronesia, which is composed of the four states of Pohnpei, Chuuk, Yap and Kosrae, continues political and economic ties with the United States under the Compact of Free Association (Schwalbenberg 1984:63). Land conflict resolution was neglected under this administration until mounting pressure from the Congress of Micronesia resulted in the establishment of the Ponape Land Commission in 1971. Since its establishment, the commission has progressed towards determining rights of land parcels under a private ownership regime.

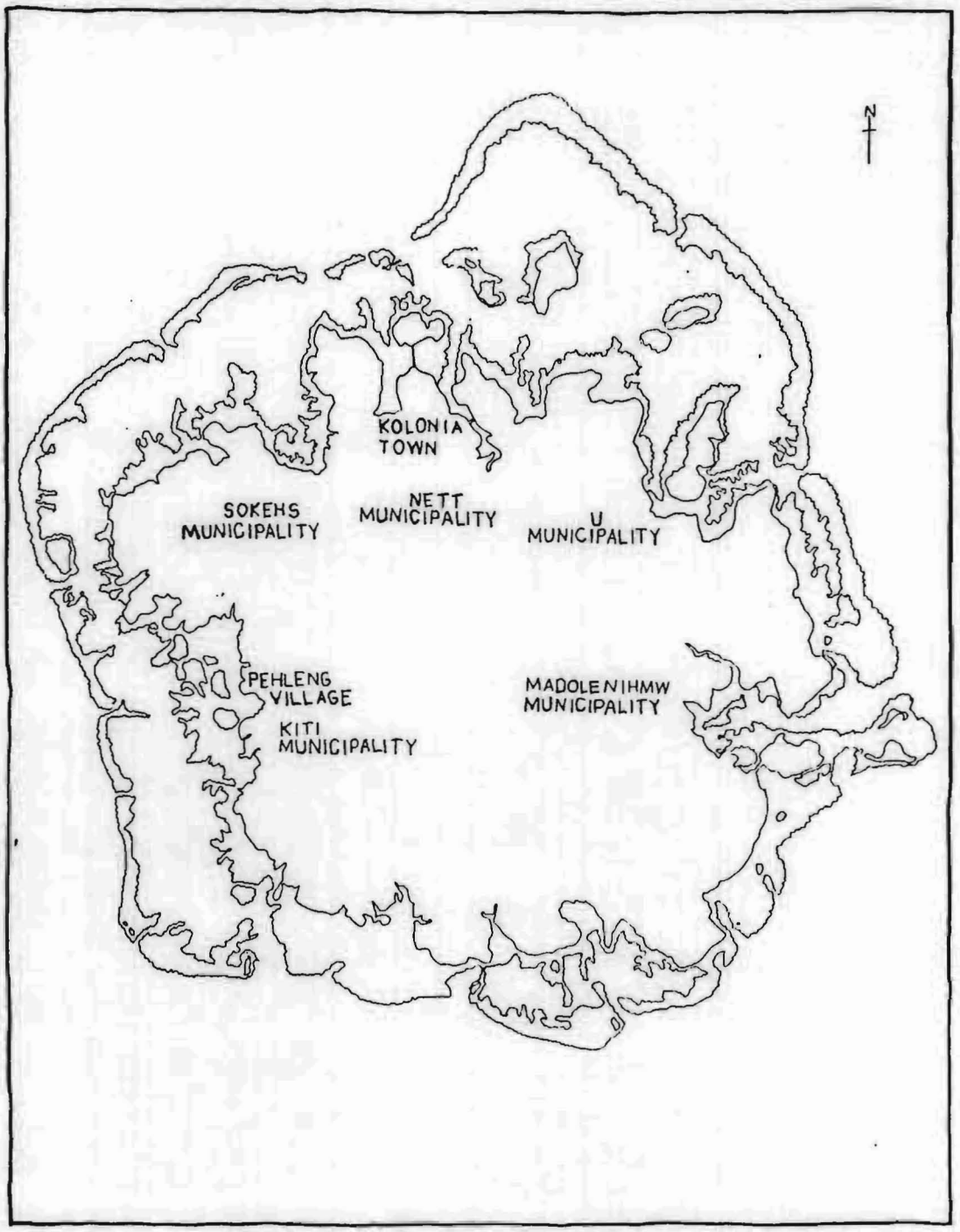
The island of Pohnpei is divided into several political municipalities or wehi that include: Net, Uh, Sokehs, Madolenihmw, Kiti and the main population center, the town of Kolonia. There are approximately 32,000 residents of Pohnpei State with about 21 percent of them living in or near Kolonia. The paramount chief of each wehi are called Nahnmwarki, assisted by the second highest chief called the Nahnken. Within each wehi are divisions or Kousapw traditionally

managed by the Soumesenkousapw under the direction of the Nahnmwarki (Fischer 1958:122). Contemporary nontraditional leaders of each municipality include the Chief Magistrate and councilmen who are voted into municipal office by popular election. A governor, lieutenant governor and legislature are also voted into office under a popular election, and conduct government affairs of Pohnpei State for Pohnpei Island, Pingelap Atoll, Mwoakilloa Atoll, Sapwuahfik Atoll, Nukuoro Atoll, Kapingamarangi Atoll, Pakin Atoll, Oroluk Atoll and Ant Atoll. Palikir village, Kiti municipality is the capital seat for the FSM national government.

Pehleng Village

Pehleng is a small village located on the southwestern side of Pohnpei in Kiti municipality. The population is about 500. The village is about 10 miles from the town of Kolonia and can be reached by vehicle, an occasional taxi, small power boat, outrigger or hitchhiking. Since the completion of the island's circumferential road, access to Kolonia has been made easier for once remote communities. One state government goal is to provide each village with electricity; Pehleng has had electricity for about one year.

Pehleng is considered a typical fishing village, but fishing is not the exclusive source of food or income. Villagers spend as much time on their farms as they spend fishing. Pohnpeians grow yams, breadfruit, taro, sweet



POHNPEI ISLAND

US HYDROGRAPHIC CHART
#6030

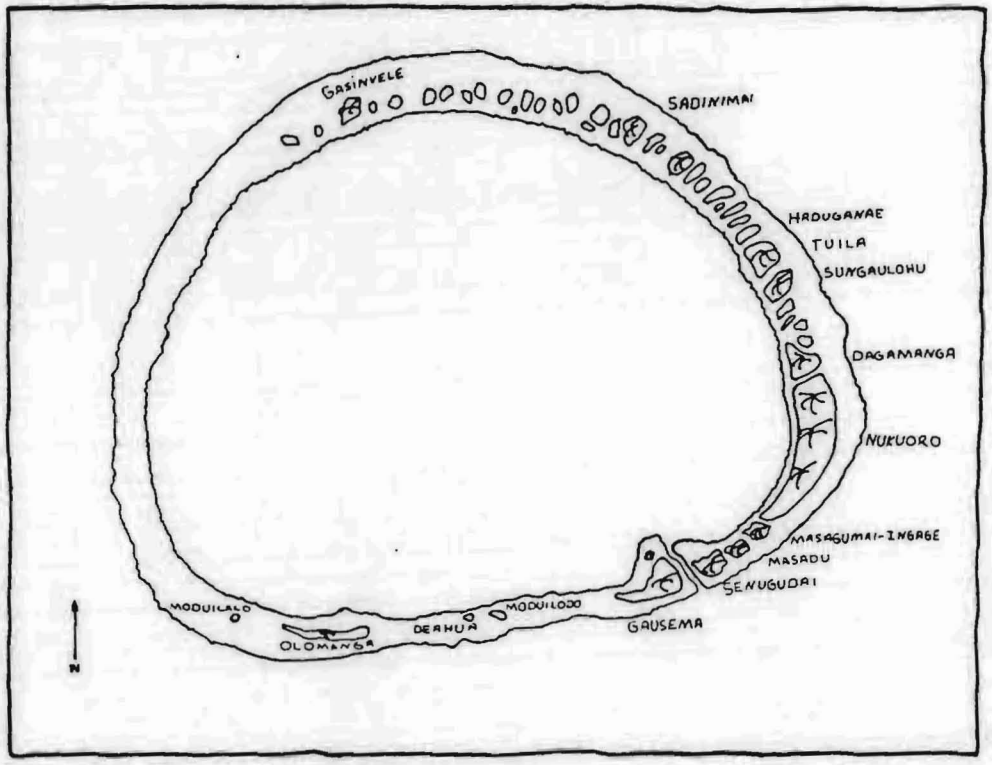
LEGEND
NATURAL SCALE = 1:103,557
ONE NAUTICAL MILE =

potatoes, bananas, mangoes, papayas, citrus, apples and avocados. Sources of protein obtained through domestication or hunting include mountain fowl, deer, pigs, dogs, cows, carabao, goats, sheep, chicken and ducks. Pehleng has its fair share of government workers that enables most extended families to live a modest life style. Pehlengese can purchase rice, canned meat, fish and vegetables conveniently from local "mom and pop" stores; instead of once every few months when the state sponsored field trip ship visits most outer atolls.

Nukuoro Atoll

Nukuoro Atoll (Map 3) is southwest of Pohnpei by 250 miles, 5°50′ North latitude, 155°56′ East longitude. This is the second most remote atoll in the state, except Kapingamarangi atoll, from Pohnpei Island. The atoll is "...oval shaped, about 4 by 5 miles and has one deep narrow passage on the south side" (Nugent 1946:756). The uncommonly deep lagoon, over 50 fathoms to the lagoon floor, is home for a variety of common reef fish, marine mammals and occasional pelagic fish (e.g., tuna) that chase bait fish into the protected recesses of the lagoon. The combined land area of 45 small islets is about 3/5 of a square mile.

The first European to visit Nukuoro is Captain Don Juan Batista Monteverde of the Spanish frigate 'La Pala' in 1808 (Eilers 1934:1). Davidson mentions that Nukuorans may have



NUKUORO ATOLL

SCALE = 1:50,000

(CARROLL: 1966)

LEGEND

= ISLET

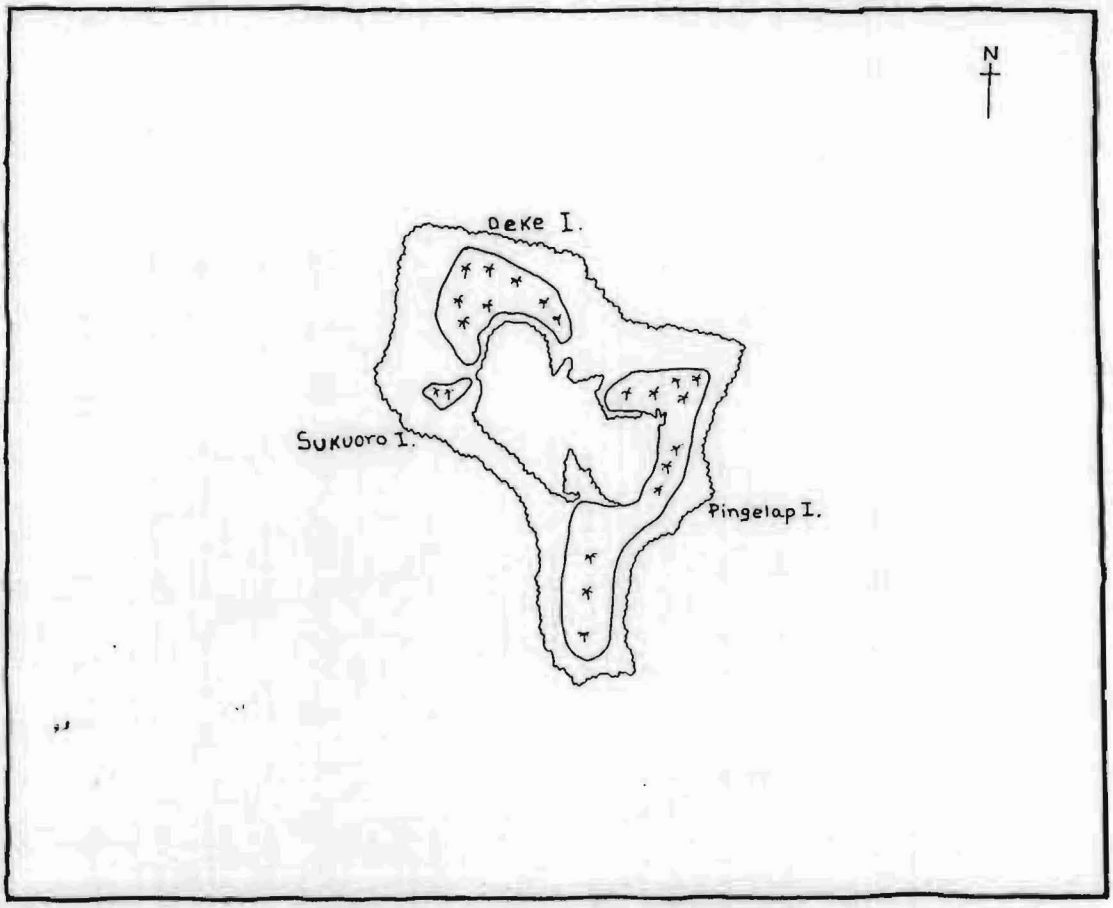
ONE MILE

come from the Samoa or Ellice Group and are known as the northernmost of the Polynesian (1968:51). For contemporary Nukuoro, most of the 400+ inhabitants reside on the largest islet of Nukuoro. Islanders subsist on agricultural crops such as taro, breadfruit and coconuts that are grown on the other, easily accessible islets. Sources of protein are derived from domesticated pigs, fishing and harvesting shellfish in the lagoon.

Traditional leaders have been largely displaced by local religious leaders and the government. The church is a central meeting place for both religious and secular activities. The Nukuoro Municipal Office is led by the chief magistrate and councilmen who conduct government activities, elections and coordinate shipping activities with the state government sponsored field trip ship (Micro Glory). An elementary grade school services the island's children for grades 1-8.

Pingelap Atoll

Pingelap Atoll (Map 4) is about 140 miles south east of Pohnpei Island, 6°12′ North latitude, 160°53′ East longitude. The diminutive lagoon (about 25 fathoms), roughly one by one half mile, lacks a natural channel, but is flooded at high tide. Reef fish and sharks inhabit the lagoon though not in any significant abundance as compared to observed populations beyond the fringing reef. The lagoon is surrounded by three



PINGELAP ATOLL

JAPANESE SKETCH
SURVEY 1920

LEGEND
NATURAL SCALE = 1:50,000
ONE NAUTICAL MILE =
0 1
= ISLET

islets, Pingelap, Sukuoro and Deke, that have a combined land area of less than 1 square mile.

About 850 people live on Pingelap, the largest islet, and reserve the other two islets for growing vegetables and fruits. Fishing and farming are among the primary forms of food gathering activities that are undertaken by everyone. The municipal government and elementary school are the largest employers on Pingelap. The paramount chief, the Nahnmwarki, and traditional system has been documented by Hurd (1977:37). The Congregational Church serves as the focal point of Pingelapese religious and social activities.

Irregular voyages by the state sponsored field trip ship carry cargo and passengers between Pingelap and Pohnpei. Pingelap's runway can accommodate light planes that are used by missionary pilots to provide regular passenger service and emergency medical evacuations for the atoll's community.

Outer islanders probably best understand the finite marine and terrestrial resources available to them and the precarious life their forefathers led, of which they continue. Outer islanders must contend with several deprivations and hazards that high islanders do not encounter, these include saltwater intrusion on taro patches; typhoons and severe storms that can destroy scarce agricultural resources; sparse land areas to provide enough dwellings for the island's inhabitants and fruits, vegetables, and domesticated animals for subsistence

purposes. For this reason, outer islanders depend more on their lagoons, reefs and sea for daily protein requirements.

Because of this reliance upon one primary food source, complex fisheries regulations and customary marine tenure practices evolved over hundreds of years to ensure that marine resources were conserved for sustained use. It is to this end that mariculture projects have been investigated to serve as a source of food and income to which they can be efficiently managed under contemporary customary marine tenure practices. The remains of these regulations and practices will be examined by reviewing contemporary literature and discerning contemporary perspectives toward marine resource use by the people who inhabit these remote areas.

Summary

High islanders have an abundance of resources, both natural and imported, that they can rely upon to support a burgeoning population. On the other hand, outer islanders have had fewer natural resources and less access to imported goods to sustain themselves. The impact of several foreign administrations seriously eroded the traditional authority and land tenure systems by which islanders governed themselves and managed land and sea resources. Contemporary efforts can now be made to identify customary marine user practices that may be appropriate for mariculture management purposes in several outer islands and remote villages of Pohnpei State.

CHAPTER THREE

DEVELOPMENT OVERVIEW

Pacific Island governments have come under increasing pressure to ascertain methods for the provision of food and employment for a burgeoning Pan-Pacific population. One agent for change has been identified by the national government as the introduction of mariculture projects to remote villages and outer islands for subsistence use and income generation purposes. Mariculture could be employed as an economic tool to diversify local economies and reduce the present reliance upon foreign food stuffs. Of the many species of fish and shellfish that pose as viable options for this undertaking, giant clams (f. TRIDACNIDAE) have been selected by Pohnpei State for cultivation by individual mariculture farmers. Economic research toward the development of giant clams make evident that "...the integration of clam farming into traditional social and economic structures would probably tend to maximize employment of family groups" (Tisdell 1989:86). Unfortunately, this objective may be in jeopardy on Pohnpei due to inconsistencies between community values and attitudes toward marine resources and the state government's open access policy[1] toward marine resource management.

The Pohnpeian government's policies and laws presently

mimic the open access approach to marine resource use and management as practiced in the United States[2]. These laws have been adopted by Pohnpei from the former United Nations Trust Territory of the Pacific Islands code that was administered by the United States after World War II. "Americanization of fishing set the indigenous sea tenure systems on a collision course with antithetical principles of open-access, common-property fishing in the European tradition" (Cordell 1984:310).

Incipient levels of user conflicts are manifested in response to the government's assertion of authority and management style over marine resources. The present management scheme does little to address incongruities between private mariculture farmers and near shore fishermen (e.g., spear and net fishermen) who pose a threat to mariculture sites. Consequently, the discrepancy between policy and practice results in a liability to the security of mariculture sites and risks poaching of species designated for ocean based growout areas.

An analysis of customary marine tenure practices for three Pohnpeian communities, Nukuoro Atoll, Pingelap Atoll and Pehleng Village, could help provide the information needed to design a culturally appropriate management framework for mariculture projects. Embodying community practices into state

government marine resource policy would help resource managers avoid cultural disputes and minimize marine resource user conflicts to ameliorate the implementation and sustainability of future mariculture endeavors. This process ultimately translates into a more sustainable and dependable supply of protein in the daily diets of islanders and a more pragmatic use of marine resources for the direct benefit of community members.

Perspectives in Mariculture Development

Resource managers are now recognizing the positive aspects of promoting local protein sources and the methods to which the cultivation of marine organisms by individual and family sea farmers can be achieved. Various degrees of malnutrition and escalating frequencies of diabetes, heart disease and high blood pressure (i.e., diseases of modernization) have permeated the societies of most Pacific Island nations. In the Federated States of Micronesia, Lewis and Levy (1980) report an infant mortality rate of 45 per 1000, as compared to a Pan-Pacific average of 41; and an average life expectancy of residents to be 58 years as compared to a Pan-Pacific average of 62 years. Many contemporary health problems that indicate an increase in heart disease and high blood pressure and cholesterol in the FSM can be attributed, at least in part, to the growing preference for canned and processed meats over local fresh fish.

Malnutrition is a common phenomena throughout contemporary Micronesia. Fathers, brothers, uncles and even mothers are becoming more gainfully employed in the government and to a lesser degree, local business. Some families for the first time must learn to live on a fixed income. Entering a market economy has not been accomplished without acute problems for the family unit who are now limited by time and financial resources to acquire food stuffs, either at the market or by farming and fishing.

Employed family members no longer have the time to dedicate to subsistence activities, but must rely on more of their income to provide a substantial portion of their weekly food requirements. Large families (e.g., 6 siblings) are prevalent throughout Pohnpei State and place pressures on heads of families to provide for these numbers under this system. Inflated food prices, sometimes three and four hundred percent higher as compared to prices in Hawai'i and the U.S. mainland, impede a families' ability to maintain a balanced and healthy diet for all members. As a result, family members, especially young children, may not receive sufficient quantities of the important food groups on a daily basis.

To combat the diseases of modernization, the cultivation of marine animals for local consumption would provide important nutrient requirements without the high fat intake that is

associated with processed meats, commonly found on the shelves of most grocery stores. Cultivated marine animals are sources of lysine, sulphur amino acids, vitamin A and D, iodine and minerals such as iron, calcium and phosphorus. "Fish is high in polyunsaturated fatty acids (especially omega-3) that can be important in lowering blood cholesterol levels" (Kent 1987:29). Public health officials have reiterated the importance of including fresh, local marine products in daily diets to combat escalating health problems that are currently manifested in the Pohnpeian society. From this perspective, family style mariculture projects could be viewed as a step in the direction toward ensuring that local sources of fresh protein are in abundance to meet each family member's daily nutrient requirements.

The "gardening process" of raising giant clams is not a new idea to the people of the Pacific. Giant clams are inhabitants of the reefs of the Indian and Pacific Oceans and have formed a significant part of the everyday diets of the peoples of Oceania for thousands of years (Munro 1983:3). Traditionally, islanders have gathered juvenile specimens on the fringing reef and transplanted them onto tranquil and protected reef plots to be grown out to larger sizes. Harvesting would be conducted when fish catches were insufficient or during severe storm events when open ocean fishing was impossible (Davis 1984:236; Akimichi 1986:16; Baines 1985:47). In actuality,

contemporary efforts to encourage family style mariculture projects should be viewed more as a process for the revitalization of endemic species and previous practices, than as the introduction of new species and ideas. Gerald Heslinga best related the idea of giant clam cultivation by families in terms of an underwater taro patch.

> As families visit their farms on a weekly basis, cleaning and harvesting agricultural products such as taro, bananas, and sugarcane; also, they could provide low maintenance requirements to the clam gardens and harvest on a need basis. This is consistent with already established patterns of subsistence use gardening (pers.com.1989).

Giant clam cultivation endeavors have been primarily viewed by resource developers as an alternative protein source that could supplement nutritional needs of islanders with the potential to reduce dependence upon imported foreign canned meats. The possibility of economic exploitation of this resource, though not without certain constraints for sale on the local market and as an export, deserves attention.

Economic Considerations

World wide emphasis has been placed on expanding cultured aquatic organism yields such that, "...by the end of the century aquaculture could account for 20-25 percent by weight of the total world fisheries production" (FAO 1989:1). Present production of cultured organisms in the Pacific region is about 22,000 tons (INFOFISH 1989:37) with unrecorded regional efforts for subsistence use. More recently, fisheries products have gained increased importance as a source of foreign

exchange (Bailey 1987:170). Primary constraints for the development of mariculture in Micronesia as a growth industry has been identified as start up costs and the logistical outlays involved with product export (Figure 1).

The primary thrust and pursuit of mariculture development is to set the standard for the hatchery and sea farmer, alike, to operate as a private profit making enterprise. A 1984 purchase of 1000 Tridacna derasa juveniles (84mm) for US $1.10 each (Heslinga 1989:317) was the going rate for clam seed with little change in price since then. "Seed production could be a government function, but the level of subsidy should be explicit" (Dahl 1991). Hatcheries must serve as economic growth models to mariculturists by embodying fundamental principles of a market economy into their organizational structure. Ultimately, hatcheries must become self sufficient by reducing their overall dependence upon government subsidies and relying on the "supply and demand" idea of which business establishments exist. Hatcheries must incorporate entrepreneurial qualities, as well as technological advances, as a part of the facility's primary directives. Adopting these qualities into facility production can have a trickle down effect and instill income generation values into the sea farming community.

Likewise, giant clam farmers must approach mariculture as a business that is primarily geared towards income generation. A well managed growout site has the potential for delivering a subsistence use crop as well, but the farmer must operate within the realms of the market economy. In so doing, a genuine step toward integrating mariculture into the local economy as a viable source of income and a subsistence protein supplement could be established.

In addition to seed acquisition costs, the giant clam farmer's immediate investments will include low technical supplies and labor. Low technical supplies will consist of mesh cages, buckets, knives and other miscellaneous tools. Labor will be an investment of time and energy by the farmer and his/her family, but giant clam gardening will not be considered a labor intensive proposition. Family members will likely provide primary assistance to the farmer during planting, maintenance and harvest stages as well as security for the reef plot.

LEGEND

I. Financial and labor costs that the Giant Clam Farmer will incur include the following variables.
- Clam seed
- Supplies and labor
- Transporation
- Business expenditures

II. Benefits include:
- Subsistence use
- Traditional feasts
- Income generation

ECONOMIC VARIABLES

Table I.

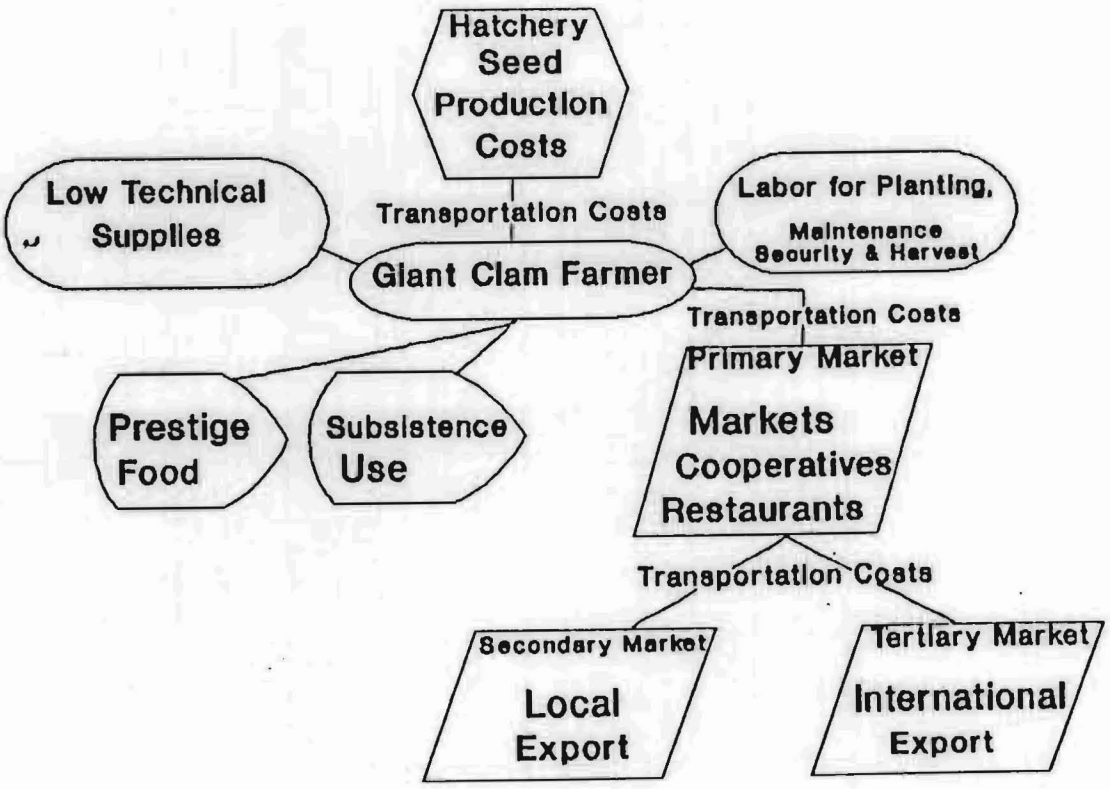


Figure 1. Economic Variables

The farmer must decide upon the amount of clam stock to be apportioned for subsistence use and income generation. Best estimates for subsistence use consumption can be determined by accounting for the size of a farmer's family and number of prestige events he/she attends in one year. Abundant supplies of clams are sure to be presented at prestige events, such as funerals and traditional gatherings, due to local preferences for clam meat. Although subsistence foods may be consumed at feasts, they do not count in prestige competition (Bascom 1970:92). It should be noted, however, that resources dedicated towards subsistence and prestige events should be gleaned from that portion of the crop that is not associated with basic operating costs.

Farmers will need to calculate the percentage of their stock to be sold on the primary or local market. The farmer will need to sell enough of his stock in order to cover purchasing costs, maintenance expenses and costs incurred to bring the product to market. Selling the soft tissue/muscle of giant clams to primary markets will include local fish and agricultural markets, cooperatives, restaurants and sakau bars that are located in the main population center of Kolonia, Pohnpei Island. Total expenditures to bring giant clams to market will be less for farmers from remote villages of Pohnpei island as compared to farmers from outer islands due to factors that include commitment in time, shipment and

personal travel expenses. Yet, it is the outer islander who may find giant clam farming most appealing because of the lack of other resources for income generation within the boundaries of these small coral atolls. Resource planners must conduct a cost benefit (market) analysis to discern the relative investments and profits that clam farmers can expect to realize should they undertake a venture to sell clam meat and shells on the Kolonia market.

Secondary markets will be located in the geographical region of Micronesia, such as Guam or Saipan. Nelson (1989:25) reports that Guam imports US $7 million in fish and seafood to provide for its local and military population and burgeoning tourism industry. Farmers interested in developing a giant clam meat export to Guam and Saipan to take advantage of this demand will incur a substantial financial commitment to transport a quality product (e.g., shells, meat, or adductor muscle) to these destinations. Although it is likely that mariculturists will raise their clam crop individually (Pollnac 1978:26), they are more apt to export clam meat and shells cooperatively with other farmers to take advantage of bulk handling rates (Nelson 1989:11). A market research analysis of the cost to undertake this endeavor would be valuable information for potential mariculturists.

High value products for trade, such as the adductor muscle, could be dried and exported internationally to tertiary

markets in Asia with an "...estimated annual demand for some 3,000 tons (live weight)" (Heslinga 1989:316). "Dry marketable weights for two, three and four year old giant clams are approximately .25 grams, 4 grams and 8 grams and represent approximately 30 percent of the total live weight" (Heslinga 1989:315). Munro (1983:4) mentions that dried adductor muscle in Hong Kong is sold for $120.00/kg. Japanese and Hawai'ian markets for this product should be explored as well.

Potential aid for start up production to farmers may come as loans from Pohnpei State Department of Resource and Development and the FSM National Government. State and national governments should look to international banks, organizations and developed nations that have vested interests in the area such as Japan, the United States, and Australia for foreign aid and mariculture development assistance. It is incumbent upon government leaders to set forth progressive and responsible guidelines for the assistance of mariculturists to initiate sea farming endeavors within the market economy approach.

Irresponsible financial guidance and credit will simply perpetuate dependence upon a government subsidized economy and nullify the prospects for the establishment of a market oriented endeavor. Ruddle (1989:74) argues that endeavors based on the wise use and exploitation of local marine resources must be coupled with the integration of traditional

and modern production. The immediate task for planners is to identify the most appropriate avenue in which mariculture development can be consummated within a bonifide market system.

Biological Review of the Giant Clam (f. TRIDACNIDAE)

Prospects for growing giant clams for reef enhancement and consumption have been in the makings for several years throughout Micronesia. The primary facility for research and seed production in the region, which employs a land based spawning and ocean based nursery growout process, is the Micronesian Mariculture Demonstration Center at Malakall in the Republic of Palau. Other hatcheries in Micronesia that have shown interest in producing seed production capabilities include Langar Island, Pohnpei State; The Republic of the Marshall Islands; the Guam Aquaculture Development and Training Center, Guam; and Kosrae State, FSM.

"The members of the Tridacnidae are among the most important constituents of the fauna of coral reefs in the Indo-Pacific regions" (Yonge 1936:39). "The family is geologically young, having existed from Eocene to Recent times, and evidently having arisen from some cardiid-like ancestor in the Eocene" (Rosewater 1965:347). "Giant clams are protandric functional hermaphrodites" (Wada 1952:23). Unicellular dinoflagellates, zooxanthellae (Symbiodinium microadriaticum), play an important role in the nutrition of

tridacnids. "These algal symbionts function as internal solar collectors, converting sunlight, carbon dioxide, and dissolved nutrients into carbon-based photosynthates, some of which are released directly into the bloodstream of the host" (Heslinga & Fitt 1987:332). Though there are seven different species of giant clam,[3] of which only three species, Tridacna gigas, Tridacna derasa, and Hippopus hippopus, have been identified as feasible for mass cultivation purposes.

Anatomical and ecological attributes of T. gigas, T. derasa and H. hippopus exhibit characteristics that are favorable for mariculture purposes. "Tridacna gigas (Linnaeus, 1758) the Giant Clam is the largest extant bivalve and may attain weights of over 200kg, of which 55-65kg is living tissue" (Heslinga 1989:295). The shell may reach lengths in excess of 1370mm. "Tridacna derasa (Roding, 1819), the Southern Clam, is the second largest tridacnid, reaching about 500mm in shell length" (Heslinga 1989:295). "Hippopus hippopus (Linnaeus, 1758), the Strawberry Clam, reaches approximately 400 mm in length" (Heslinga 1989:295 & Rosewater 1982:3). Heslinga and Fitt suggest that postlarval growth in Tridacna gigas and Tridacna derasa is swift, with yearly growth rates averaging between 5-10 cm (1987:333). Munro and Heslinga (1983:127) report growth rates for cultured Hippopus hippopus to reach 1.93cm in 5 months. "Such rapid growth, where length increased

by 5 to 8cm per year, or by 50cm or more in from 6 to 9 years, probably gives the giant clam the distinction of being the fastest growing of bivalves" (Bonham 1965:301). "Specimens that measure 140 centimeters are of great age, and may possibly live for 200 years" (Summerhays 1979:25).

Scientists have endeavored to culture tridacnids since Stephenson's (1934:261) attempts in Australia, with subsequent efforts made by Rosewater (1965:348) in the Marshall Islands and Wada (1954:273) in Palau. Labarbera (1975:69) successfully triggered a spawning reaction in Tridacna maxima and Tridacna squamosa by employing stripped eggs. Beckvar (1981:22) succeeded in stimulating Tridacna gigas, Tridacna derasa and Tridacna squamosa to spawn in Palau by employing macerated gonads (fresh & frozen) and hydrogen peroxide. Braley (1985:323) induced spawning in six species (Tridacna gigas, Tridacna derasa, Tridacna maxima, Tridacna crocea, Tridacna squamosa, Hippopus hippopus) of tridacnids with various dosages of serotonin solution.

After spawning has transpired, giant clams are grown out in land based raceways that use filtered seawater systems. Juvenile clams are placed in ocean nursery trays at a size of 30-40mm, some 8-9 months post-fertilization, and remain there until they reach a size of 100-120mm at 2 years post-fertilization (Heslinga 1989:312). Weekly maintenance concerns include redistributing clams that have become densely

populated; cleaning trays that show signs of algal turf buildup; and the liquidation of predators[4]. Heslinga notes that at about 2.5 years post fertilization, the juvenile clams can be removed from from the ocean nursery and transplanted without shelter on the reef substrate (1989:313). Heslinga and Watson suggest that clams can attain shell lengths in excess of 200-250mm over the next 2 to 3 years, at which time survival is high (e.g. 90 percent) and maintenance is not neccessary (1985:534).

Summary

Increasing pressure to feed and provide employment for a growing population has prompted FSM government planners to review options for exploiting local marine resources. Family style mariculture projects appeal to the public health sector as an easily accessible form of nutrious food. Locally cultivated marine animals can serve as an alternative source of food to imported canned meats. Expanding an already established undertaking (e.g., giant clam gardening) would help facilitate family food gathering efforts while Pohnpeians confront the ongoing transition process from a subsistence economy to a market economy.

CHAPTER NOTES

(1) Barch, Ryther and McLarney (1972:3) write:

> Aquaculture is akin to terrestrial agriculture in that it cannot economically be carried out just anywhere. A site for aquaculture must present certain natural amenities, particularly an ample supply of water of suitable temperature, salinity, and fertility. It is also necessary that the culturist exercises control through ownership, lease, or other means of secure holding; this consideration is problematical for marine and brackish water aquaculture in many parts of the world, including much of the United States, where the traditional view is that the sea, its shores, and its resources are common property, available to all. Where this attitude prevails, aquaculture is effectively thwarted.

(2) Review Pohnpei State Law: S.L. No.2L-106-81. The Marine Resources Conservation Act of 1981 empowers the Director of the Department of Resources and Development in consultation with the State Fisheries Officer to declare rules, regulations and enforcement procedures to manage marine resources within the jurisdiction of Pohnpei State. Access to several species are regulated under an open and closed harvest season according to this Act. Reference to Pohnpei State Law: S.L. No.1L-155-87 and Secretarial Order No. 2969 as promulgated by the Secretary of the Interior of the United States of America on December 26, 1974 demonstrates the extent to which the Pohnpeian government adopted Trust Territory guidelines for the administration of Public Lands.

(3) Giant Clam classification:

Phylum:	Mollusca
Class:	Bivalvia
Subclass:	Heterodonta
Order:	Veneroida
Superfamily:	Cardiacea
Family:	TRIDACNIDAE
Genus species:	Tridacna gigas
	Tridacna derasa
	Tridacna squamosa
	Tridacna maxima
	Tridacna crocea
	Hippopus hippopus
	Hippopus porcellanus

(4) Heslinga (1989:302) writes:

> Predators identified so far include hermit crabs (Dardanus), various molluscivorous fishes (Monotaxis, Balistoides, Rhinecanthus), carnivorous snails (Chicoreus, Cymatium), octopus and man.

CHAPTER FOUR

CUSTOMARY MAINTENANCE OF INDIVIDUAL FAMILY STYLE MARICULTURE PROJECTS

There are several reasons fisheries management has been at a relative disadvantage compared to terrestrial resource management. "In the case of the forest, the landowner controlled the number of trees per acre of land, the time of planting, and the time of harvest, thus effectively controlling the forest throughout its life cycle" (Randall 1987:319). Foresters and agricultural farmers in general have the advantage of knowing where, when and how much to plant; and most importantly, they have the advantage of determining the quantity of their crop to harvest when market prices are in their favor.

Fishermen, on the other hand, are harvesters, not planters; they have no control over fish stocks, where, how or when they recruit, feed or migrate. Fishermen must rely on their equipment, boat, crew, skill and luck to bring home their catch. Fishermen do not enjoy the same security of knowing how large their catch will be, how much of an investment each trip will be to meet desired quotas nor can they guarantee that the harvest will coincide with favorable market conditions. It is at this point that I would like to distinguish the mariculturist from the fisherman and view him from the

perspective as an ocean or sea farmer.

The sea farmer is subject to many of the same conditions that his terrestrial counterpart experiences, plus the additional burden of farming in a marine environment. At the hatchery or land based phase, the mariculturist can control environmental conditions (e.g., temperature, salinity, water flow) for spawning and juvenile maturation purposes. After seedlings have been planted on the reef, farmers can control population densities and disease with occasional culling of the stock; influence growth rates with periodical cleaning; and ensure lower mortality rates by liquidating obvious predators. Mariculture is efficient because it does not take many people to conduct weekly maintenance requirements; and it is a low technology based form of employment. Harvests can be coordinated when the animals are in their best condition; when the processing facility is ready to handle them; and when optimal market conditions present themselves for the farmer's maximum benefit. However, for the mariculturist to consummate these objectives, he/she needs the authority to effect this blueprint for development.

Shellfish stocks in Micronesia, and throughout the world for that matter, have dwindled in recent years due to several factors that include over-harvesting, disease, pollution and destruction of habitat. Conservation efforts to stem this loss do not appear to be rooted in biological or economic reasons

(though they are very much influential by this process), but are grounded in cultural and political ideology. Gordon (1954:134) writes "...the plight of fishermen and the inefficiency of fisheries production stems from the common-property nature of the resources of the sea is further corroborated by the fact that one finds similar patterns of exploitation and similar problems in other cases of open resources." "Excess effort has come to be recognized as the major and most intractable problem in marine fishery resources management" (Keen 1983:197). Fishermen do not have the incentive to restrict their harvests due to their inability to regulate the catches of other fishermen, which inevitably leads to the 'tragedy of the commons.' Keen furthers this argument by listing consequences of excess effort that are associated with the open access form of marine resource management:

> (1) The incentive to take the best first.(2) The incentive to continue exploitation as long as the user's opportunity costs are met even though the resource is greatly reduced in productivity.(3) The incentive to continue to increase investment in exploitation even after the maximum (Optimal) sustainable yield is exceeded if the demand forces the value of the resource upward.(4) A lack of incentive to invest in productivity of the resource even though to do so would, in terms of total productivity, provide a handsome return on the investment (1983:198).

The open access approach is synonymous with resource depletion and offers few incentives for the efficient utilization and protection of marine resources to which they may be maintained for the next generation. Overcapitalization (e.g., too many fishermen and gear and not enough fish) in the

fishing industry is an associated phenomena with open access fishing. It may even result in growth overfishing (e.g., catching fish before they reach their optimum development) or reproductive overfishing (e.g., catching too many fish so that a population can't reproduce enough to sustain its optimum level)"...if the degree of fishing intensity at which the fishery as a whole becomes unprofitable approximates the level of intensity necessary to prevent a fish stock from reaching maximum weight in a given age class" (Cordell 1978:2).

The alternative choice to propagating an open access management system, would be the examination of a resource ownership strategy for mariculturists to manage shellfish growout sites. Gordon states that "...property rights in some form predominate by far, and, most important, their existence may be easily explained in terms of the necessity for orderly exploitation and conservation of the resource" (1954:134). Tisdell advances this thought by suggesting that the cultivation of marine organisms can best be accomplished under the establishment of property rights system (1989:82). Private property rights for sea farmers, in some cases, could be the instrument in which excessive resource exploitation may be controlled while providing for a viable milieu in which

families could cultivate marine animals. Though this theory may have real application for some societies, traditional marine tenure does not necessarily guarantee the wise use and conservation of a resource and should be scrutinized before being incorporated into the management strategy (Polunin 1984:267).

Resource ownership strategies for managing mariculture endeavors by private residents may appeal as an avenue in which the relative health of the habitat and security for the growout site from poaching could be maintained. Resource ownership would place the farmer directly in charge of the habitat in which cultured sea organisms mature and where he/she would control the product's security, harvest, and sale. In turn, this would invite the farmer to preserve the habitat to ensure that an equitable balance between environment and man's presence is maintained.

In Micronesia, areas designated for mariculture projects need to be protected from ecologically devastating practices. These practices include dynamiting reefs for fish; pouring bleach into streams with the intent to kill fish and marine invertebrates and subsequently, all other marine flora and fauna in its path; uncontrolled reef and shore dredging

practices that release large quantities of silt into the water and choke coral reefs; and destructive seawalls that divert silt and sand to undesired locations when the wall is ultimately undermined due to wave action. These practices are detrimental to both the natural habitat and mariculture growout sites and would find an adamant opponent to their continued practice in the form of the sea farmer. Mariculturists, under a resource ownership regime, augment habitat productivity, which is contrary to open access fishing.

Security for mariculture growout sites fits well in the resource ownership strategy and is as important to the success of a mariculture project as safeguarding habitat productivity. The sea farmer has the incentive to provide security for the growout site to meet desired goals of harvesting shellfish. To meet these aims, the farmer must have the authority to provide adequate security for growout site from poaching. Factors that are involved with maintaining a secure growout site include community awareness of the farmer's intent to undertake mariculture projects; acceptable location and boundaries within the community in which the growout site will be established; and community acceptance of the method to which

security will be rendered.

It is important to keep in mind that the introduction of mariculture projects could potentially bring additional food and wealth resources to a community. If marine resource managers can engender community interest and acceptance of this form of resource exploitation, there may be greater approval for its introduction and support for its continued existence, under the umbrella of a local management strategy. This could be done by gaining the trust of numerous farmers to implement small gardens at the initial stage of development, instead of a few farmers with large gardens. Disparity is keenly observed among small communities and it could prove disadvantageous (e.g., promote poaching) to approach mariculture development and management strategies without concensus and participation from the entire community.

Avoiding user conflicts between multiple users is an important consideration in locating a growout site and the area or acreage that it will ultimately encompass. The sea farmer must be careful to avoid areas that are frequently visited by fishermen and other users. It is equally important to locate the site where it is biologically advantageous[1] and

not in areas that are susceptible to severe storms, typhoons and predators. The sea farmer must balance social preconditions with biological requirements to guarantee successful returns.

Finally, the methods to which protection is provided for a growout site by the farmer is an important consideration that must meet with community consensus. Operating outside the social configuration of a community could invite reprisals (Acheson 1981:281) on the sea farmer or his/her growout site. Traditionally,"...the most widespread single marine conservation measure employed in Oceania, and the most important, was reef and lagoon tenure" (Johannes 1978a:350).

Reef and lagoon tenure is a site specific form of resource ownership that could be employed by community members as a mariculture management strategy to preserve habitat integrity and security. The following section will define customary marine tenure and its importance as a contemporary form of marine conservation.

Customary Marine Tenure

What is Customary Marine Tenure? A broad definition of customary marine tenure may include elements of investigations that several researchers on this subject have elucidated. Sudo defines customary marine tenure as a system by which individuals and/or community members use sea space; and define and regulate its utilization in order to prevent the over-exploitation of marine resources found within a designated sea area (1984:203). Johannes postulates that an important component in defining marine tenure is the ability of the claiming individual(s) to prevent non-members from participating in resource harvest without authorization (1981:64). McGoodwin makes note that successful marine resource management strategies may stem from situations in which established customs effect an enduring management system that benefits community members (1984:45). The importance of these comments brings forth four points that are fundamental to understanding customary marine tenure.

First, utilization of a sea, reef, or lagoon area by an individual or group implies specific boundaries that are well defined and collectively recognized by other individuals or groups. Levieil and Orlove provide evidence that sea

territories can be boundaries that are delimited by the shore; lateral lines perpendicular from the shore; and offshore features (1990:367). Shore boundaries are delimited by the contour of the shoreline. Lateral and offshore boundaries may be delimited by the physical environment, such as reef morphology (Nietschmann 1989:72), or man made features (Fischer 1958:126).

Second, there are incentives for those in control of an area to guard against the over-exploitation and depletion of a resource. Johannes best qualified this when he wrote:

> Where fishing rights exist it is clearly to the advantage of those who control them to fish in moderation, for this ensures the future productivity of their fishing grounds. In the absence of such controls, it would be to the advantage of a fisherman to catch all he could and to use destructive methods in doing so if they simplified the task. If he didn't, someone else would. Moderation would be pointless and the resource would therefore dwindle (1977:122).

Though, this view is not universally accepted (cf. Poggie and Pollnac 1991), it seems to be a hypothesis worthy of testing in policy decisions and scientific social research.

Third, access to sea areas or resources (e.g., certain species) is controlled and sanctioned accordingly by the authority structure of a community. Access for non-community

members to a particular area or specie could be attained after consent is gained from those who authorized its exploitation. Dahl (1988:42) speculates that the defense of marine areas or resources from outside intervention and depletion can be explained by vested group interests and group consensus to maintain the resource(s). Thus, is born a socially regulated form of security for marine resources within a community.

Fourth, custom is a set of contemporary social practices embodied within the structure of a community. Custom is the social fabric that bonds a community to operate collectively within approved guidelines for the exploitation of marine resources which are subject to continuous interpretation and change by community members. "As behavior changes, custom changes, as custom is the pattern of behavior" (Crocombe 1989:23). "Customary marine tenure can be seen as ideas and rules that influence social behavior relationships regarding the sea and its use" (Hviding 1989:9). Ideas and rules are in a state of flux; a dynamic situation in which community behavior towards the regulation of marine resources is predicated on current events which shape that behavior.

"The most important fact to remember about customary tenure today is that it has very little in common with customary tenure a hundred years or more ago" (Crocombe 1989:21). The evolution of marine tenure is modified by a variety of factors that include changes in community politics, ease in migration, commercialization, population growth, land tenure patterns and increasing frequencies of contact with foreign governments.

Customary marine tenure may be classified as primary and secondary according to the type of customary practice that is being exercised. Primary customary marine tenure can apply to communities that perpetuate marine tenure systems that exist under the traditional authority structure. Johannes (1978a:350) has noted that in Oceania, fishing rights and resource exploitation were usually regulated by families, clans or chiefs. "Restrictions on fishing have been achieved by the use of closed seasons, closed areas, size restrictions, gear restrictions and the most important of all fisheries management strategies, restricted entry" (Johannes 1982:259). For Pohnpei, the Nahnmwarki was the central figure who asserted authority over marine resource use rights.

Secondary customary marine tenure practices are contemporary arrangements as prescribed by community members that result in collective agreement towards the use, access and exploitation of marine resources. Secondary practices operate outside the traditional authority structure that has either become devitalized or totally abandoned and replaced with an introduced governing system. Likewise, informal marine resource user arrangements exist beyond the sphere of a formal governing authority. These arrangements are very much akin to the informal property rights system which Bowles and Bowles (1989:229) have described to be employed by certain lobstermen groups of Maine (1989:229). These informal arrangements exist exclusively between marine resource users and will be refined later in the text of this thesis.

Customary Marine Tenure as a Mechanism to Conserve Marine Resources

Marine resource managers are primarily concerned with the preservation of habitat productivity and growout site security for the development of family style mariculture projects. Valencia and Vanderzwaag indicate that appropriate elements of customary practices may be consistent with strategies to conserve a diminishing nearshore fish stock (1989:128).

Designing a local marine resource management scheme that incorporates customary practices may prove more feasible for a developing Pacific island, than the western open access approach to management.

First, Micronesian governments have fewer resources, than developed nations, to dedicate toward science research that pertain to marine resource management. The biology, ecology, population dynamics and catch data of an enormous variety of tropical fish, as compared to temperate regions, is somewhat unknown. At best, fisheries management, as demonstrated by the regional council system in the United States, is an imprecise method for conserving marine resources and should not serve as a model for developing Pacific countries. Though attributes of this system have been incorporated into contemporary fisheries management during the Trust Territory administration of Micronesia, managers should redirect their efforts towards resource management by looking inward and solving intrinsic predicaments with local solutions. "When the knowledge of both groups (systems) is combined, our understanding of natural resources and their management is far better than if the knowledge of only one of these groups is used" (Johannes & Hviding 1987:3).

Secondly, Klee maintains that contemporary resource managers could take advantage of master fishermen and their accumulated knowledge of local marine flora and fauna (1980:255). Master fishermen could serve as community based advisors with regards to the marine habitat, its use, and regulation. Not only are they keenly aware of the optimal circumstances for fishing, but they are regarded with high esteem by other fishermen. Though the traditional title of master fishermen waned with the demise of the traditional authority structure of a community, remote communities and outer islands may retain an informal master fishermen among their ranks who has filled the spot of the previous traditional holder. These men and women should be identified and included as part of the complete resource management strategy for a community.

Third, related to this is the wealth of local knowledge regarding fishery conditions which can provide assistance in information gathering and enforcement functions (Cycon 1986:12). Participation by community members in the management of marine resources would contribute to the idea that the management design is appropriate, purposeful and benefits eveyone. Johannes indicates that local involvement in the

management design and activity would better insure community participation in the project and user conflict arbitration at the community level (1989:29).

Fourth, Hviding reports that in Marovo, "...an increasing number of marine resources are being exploited for cash purposes, and this leads to reformulation, diversification and stronger enforcement of marine tenure" (1988:79). This hypothesis stipulates that an escalation in economic growth will be accompanied by an increasing resilience in sea boundaries. Customary practices that have evolved to preserve subsistence practices may be reinforced and strengthened with the introduction of a marine cash crop, such as giant clam farming. The net result of Hviding's presumption is that this phenomena may effect the identification of an individual with a particular stretch of reef or lagoon, who will manage the cultivation of a mariculture project, and the reduction of the chances for user conflict (1988:98).

A window of opportunity exists for researchers to identify and describe primary and secondary customary marine tenure practices that may exist in communities that continue to rely on marine resources as their main source of protein. Consequently, marine tenure practices could be augmented and

given greater legitimacy by being acknowledged and incorporated into state marine resource conservation policy and mariculture management strategies.

Giving Credence to Customary Marine Tenure Practices under Marine Resource Management Policy

Primary and secondary forms of customary marine tenure could become valid marine resource management practices through the establishment of flexible government policy measures. Such measures should consider the diversified customary practices of each community by integrating basic components from each tenure system into government project management strategies. Hviding (1989: p.28) points out that, "...rather than aiming to codify the customary marine tenure system of an area, the aim should be to identify the basic local patterns, values and axioms of the tenure system and use these as the basis for negotiations on how any development should be carried out." Policy measures should be flexible in nature, and allow for dynamic changes within the customary system to evolve.

The pitfalls of not incorporating local values and practices into government policy, when initiating marine resource development endeavors, include compromising the

successful implementation, security and continued maintenance of the project and promulgating dependence upon the government to supply these needs. By reducing the role that community members play in the actualization of a specific goal, the government creates a void that must be filled by its own employees and neglect the importance of community participation. Johannes (1977:124) writes "...such legislation would therefore increase the government's regulatory responsibilities and place serious additional burdens on already understaffed and underfunded fisheries departments."

This problem seems manifested in the Kingdom of Tonga's recent attempts to implement giant clam mariculture projects on one island while granting leases and operating under an open access resource management framework. Fairbairn reports that:

> "...the clam circle on Nei'afu appears to have failed and future prospects are uncertain. The main reason for lack of success was said to be a failure to control poaching. This weakness, in turn, reflects a lack of adequate policing of the project and support from the local community" (1990:12).

Fairbairn (1990:13) determines that important components to resolving the poaching issue involves greater community association with the project, along with advocating

established shares and control in its undertaking.

Community participation in the management of family mariculture projects will be important to head off increasing competition over finite marine resources. Competition for reef/lagoon space by sea farmers and traditional fishermen will be the principal source of contention between resource users. Traditional and subsistence coastal resource rights and uses must be integrated with national coastal resource priorities at the planning stage before implementation is initiated (Hothus 1990:11; Ruddle 1988:183).

Of equal importance to the stability of a mariculture site is the maintenance of each particular specie that is being grown out. Heslinga and Fitt note that tridacnids will remain susceptable to predation by a variety of marine carnivores throughout their juvenile life (1987:183). This observation makes a strong statement for the timely and consistent maintenance of mariculture sites of which predator eradication is an important duty. Relying on government employees, locked into regular government working hours, to provide maintenance and security requirements for mariculture sites is a serious liability that could very well jeopardize a project. Fishermen and farmers are best qualified to meet these obligations as

they consistently attend their reefs and farms daily.

If a government's ultimate goal is to decentralize economic activity to stimulate growth in outlying communities via mariculture projects, appropriate legislation will be necessary to guarantee the rights of access to those who are directly involved with the implementation, maintenance, protection and harvest of targeted mariculture species. The manager must view policy as an incorporation of contemporary, community based values and attitudes regarding the authority structure embraced by a community to manage marine resources, its use and conservation. Only from this perspective can the manager deploy an accurate strategy that will have a "goodness of fit" for a particular community within the guidelines that are approved by that community and compatible with national development priorities.

Summary

Resource ownership, a fundamental principle of customary marine tenure, is consistent with mariculture management strategies for the security of growout sites and preservation of habitat integrity. Customary marine tenure is the accumulation of collectively recognized user rights which limit access to marine resources and sustain such resources for subsistence exploitation. Contemporary, "site specific" social behavior determines the appropriate use of marine resources within a community. Customary marine tenure can be classified as either primary or secondary practices. Marine resource managers will find it cost efficient to employ already established community based marine conservation practices, than non-domestic strategies. Government planners must design management policy to be flexible enough to withstand the test of time, while preserving a sea farmer's authority to effectively maintain his/her growout site.

CHAPTER NOTES

(1) Conditions for giant clam growout sites.
a. Giant clams should be placed in areas that receive a good flushing on a daily basis and not located in stagnant waters. A good rule to remember in locating growout sites is to look for established coral growth which will indicate if the area is healthy for zooxanthellae to flourish.
b. Protection from severe storms. Clams can be placed in areas where the coral reef provides natural protection from high energy waves.
c. Clams should be placed in depths of 1-2 meters. The clams should not be exposed at low tide nor should they be placed in deep waters, otherwise vitality and growth rates will be adversely affected.

CHAPTER FIVE

CUSTOMARY MARINE TENURE, FISHING TECHNIQUES and LORE FOR NUKUORO, PINGELAP AND PEHLENG

This section will describe the marine resource user rights and arrangements that are presently practiced in the communities of Nukuoro, Pingelap and Pehleng. The method for obtaining information concerning these practices was based on interviews with traditional and government leaders, fishmasters, fishermen and fisherwomen from each community.

NUKUORO

Customary Marine Tenure

Several informal marine resource user arrangements that exist between the community members of Nukuoro include dai mada hale, hada gima, hada ba, and mamunoa[1]. These arrangements are current practices among community members to delimit ownership of "sea space" by families and fishermen. The informal nature of this system is based upon mutual respect for one another's right to delimit sea space and define its use within the acceptable sphere of contemporarily

shared attitudes and values towards the utilization of marine resources. Since these informal arrangements are regulated by community members, and not through traditional means of authority, they can be considered secondary customary marine tenure practices.

Dai mada hale is a well established system in which families claim ownership over marine resources found within the sea space immediately in front of their beach front property. Claims over sea space are delimited by the contour of the beach and extreme lateral boundaries of the families' property, adjacent to neighboring boundaries. Lateral lines extend out from the beach to a point where the slope of the lagoon drops off and denotes the extent or limit of the families' sea space. Fish and shell fish within this area belong to the family. Non-family members must obtain permission to harvest marine resources within a dai mada hale from the entitled family.

Hada gima or "place for clams" are areas in which families grow giant clams for subsistence purposes. Shellfish are collected in the lagoon or outside the reef and deposited within the boundaries of a particular families' dai mada hale. Rocks and shells are placed in a circular fashion around the

collection to distinguish one hada gima from another and can range from two to six feet in diameter. Several hada gimas may exist in one families' dai mada hale. Each hada gima may be owned by individual family members or shared with relatives who do not own a dai mada hale.

One respondent reported that some clams within the hada gimas could last for several years before being harvested. Observations from three hada gimas revealed 26 Hippopus hippopus with an average length of 137mm; and 2 Tridacna squamosa, of which one measured 243mm.

Hada ba are similar to hada gimas, with one distinction in that they contain oysters, not giant clams. Hada ba are not as common as hada gima with only one hada ba observed in a study area equivalent to four dai mada hale. This hada ba proved to be home for several oysters that included 6 Pinctada magaritifera and 3 Pinctada fucata.

Mamunoa is a marker system for individual fishermen to delimit sea space in the lagoon. Baeao, the marker, is a floating coconut husk that is anchored on the shoulder of the lagoon or reef. The baeao is a notice for other fishermen to keep a distance of about 30 feet from the floating coconut husk and restricts them from fishing within the immediate

proximity of this area. Fishermen often establish mamunoa sites near coral outcroppings called manuea. Manuea are geomorphological anomalies[2] scattered throughout the perimeter of the lagoon and serve as natural "fish aggregation devices" for small and large reef and pelagic fish that enter the lagoon.

Dehagaluulunga means "a place where fishermen feed the fish." Chumming is commonly practiced by Nukuoran fishermen to attract fish to a fisherman's mamunoa. Dugidelodo means "bottom fishing in the lagoon" and is the most common fishing style associated with mamunoa. Presently, there are just ten fishermen (which range in age from approximately 45 years and older) who continue to actively employ mamunoa as a technique to delimit sea space for fishing.

The survival of delimiting claims with floats is questionable. Older fishermen who continue to employ this practice believe their sites are being raided by younger fishermen. They speculate that young people intrude upon a fisherman's mamunoa and utilize several fishing methods to catch fish within an established sea space that include net fishing (duuli), spear fishing (velo velo) or bottom fishing

(dugidelodo). Most fishermen consider it counter productive to expend their efforts to attract fish to their mamunoa when it will be exploited by others. Consequently, few fishermen are still engaged in this fishing practice.

Fishing Techniques and Lore

In aboriginal times, tautai was the traditional title given to the fishmaster by the ruling clan, De Gau Langedi. The title of tautai is also documented for two south Pacific Polynesian islands that include Tuvalu (Zann 1985:68) and Tokelau (Hooper 1985:21). For contemporary Nukuoro, the term is loosely used with reference to the very best fishermen on the atoll. Three men on Nukuoro who hold this informal title, bestowed on them by their peers, are Daniel Mahora, Reverend Martin Naoah and Vice Otto. Some responsibilities of the fishmaster include teaching fishing techniques to younger fishermen; locating when and where important fish stocks can be found; leading small and large groups of men on fishing excursions; and serving as prominent members and leader(s) of the fishing committee.

Under the traditional title system, the tautai could set limits on the length of line fishermen used for bottom fishing. Fishermen not abiding by this rule were subject to

having their lines cut by the tautai. Maximum lengths of 50 fathoms were maintained to prevent fishermen from depleting a stock or forcing it into deeper water. To this day, fishermen continue to maintain specific lengths of line while bottom fishing outside the reef and regulate this practice among themselves.

Fishermen have formed a fishing committee to coordinate group fishing events called gai nga dahi and to conduct community fishing matters. An individual can join the committee when he has demonstrated his prowess as a competent fisherman, comparable to those on the committee. Gai nga dahi is a fishing event that occurs during times when bottom fishing (dugidelodo), trolling (alohagi), and flying fish (bokousave) season are at their peak. The fishing committee, usually led by one or more tautai, organize fishing gear, outriggers and men for the occasion. Upon completion of the expedition, fishermen are greeted with a feast prepared by the women of the community. The catch is cooperatively divided up for community members by the tautai and elder fishermen.

Large group fishing, gai nga dahi, is an opportunistic event. Factors which influence its commencement include favorable weather conditions; easy access to fish stocks; and

a predictably large catch which may denote the zenith of the seasons harvest. Presently, gai nga dahi may be organized by the fishing committee once, twice or even three times in one year. Generally, Nukuoran fishermen limit the size of daily fishing to small groups, pairs or unaccompanied trips.

Fishing matters include establishing and enforcing rules for the community. Some of the methods that the committee encourage fishermen to employ in their style of fishing include the following practices. (a) Always "feed the fish in an area" with small bait fish or small octopus before one begins fishing. (b) Inform your neighbor where you are building a hada gima or a hada ba and it will not be pillaged. (c) Fishermen and fisherwomen hunting for octopus are not allowed to break or destroy the coral "house" in which octopus reside. Instead, the approved practice is to push a black sea cucumber into the entrance of the octopus's den and then squeeze it until a sticky white substance[3], which the creature emits, fills the hole. This substance will entangle the octopus and enable fishermen to safely extract it from its lair without damage to the habitat. (d) Fishing for flying fish is conducted at night. Fishermen must exit the channel

entrance (mateaua) by 100 yards before they can illuminate their torches (llama), lanterns or lights. Custom and courtesy dictate that boats must not overtake each other during the course of the evening, but must follow one another in a single file. Usually, a tautai or older fisherman is present on the lead boat. Finally, those community members that break established fishing rules will simply be prohibited from fishing by the fishing committee. The length of the suspension will vary according to the severity of the offensive action.

Fishing seasons have been defined for trolling (alohagi), bottom fishing for tuna (haangoda dagua), and catching flying fish (bokousave). Alohagi is conducted during the months of September though December. Haangoda dagua takes place during the summer months from March to September. Bokousave is undertaken during the months of January through March. Though every month of the year is met with a particular fishing method, fishermen's catches vary from poor to good during the waxing and waning of each fishing season.

Fisherwomen generally practice three types of fishing, refered to as dagi, ogo alili and sisi ngudu ahua. Dagi is line fishing that takes place in the lagoon. Women bait hooks and fish from the dock, outriggers or in reef channels to

catch small reef fish. Ogo alili is a form of reef gleaning. Women walk along exposed reefs at low tide and collect crabs (alili) or other creatures such as small fish trapped in tidal pools and shellfish. Sisi ngudu ahua means pole and line fishing, and is conducted at high tide in the channels between the many islets of the atoll or near the surf zone at the edge of the reef. Women will undertake sisi ngudu ahua to supplement the men's daily catch when fishing is very poor.

PINGELAP

Customary marine tenure practices, in Pingelap are severely weakened in their contemporary form due to acculturation of the traditional title system (Damas 1982:17). Only fragments of this system still persist under the authority of the present Nahnmwarki (Mr. Yukiwo Solomon) or traditional king of Pingelap. The Nahnmwarki's authority does not extend to exuding power over sections of reef or marine resources, but is directed toward asserting jurisdiction over several fishing techniques. Fishing activities[4] on Pingelap can be considered as an example of a primary customary marine tenure system.

Customary Marine Tenure

Spear fishing or sepis is one of several conditions when

the Nahnmwarki's authority to regulate fishing activities can be actualized. Seasons are open or closed for several reasons which are contingent upon the Nahnmwarki's authorization. Generally, spear fishing season is closed when small bait fish, ikonet, sepos or sekeriak enter the lagoon across the reef flat area from sikieuieu to doweilok[5] at high tide. Bait fish are eventually followed by larger reef fish and pelagics which prey upon the smaller schools. Bottom fishing in the lagoon or just outside the fringing reef, apiap mesenpeteu, replaces spear fishing to ensure that fishermen will selectively harvest larger fish that feed upon the bait fish. Fishermen feel that spear fishing will scare off bait fish and result in the larger targeted species to retreat from the lagoon and fringing reef. This rational apparently extends the period in which large fish inhabit fishing grounds and enhances a fisherman's chance of catching them.

The Nahnmwarki may close the spear fishing season to conserve reef fish if he feels reef fish stocks are scarce. An alternating three month period may be initiated by the Nahnmwarki who will close and then open spear fishing as a conservation strategy. This measure is designed to allow reef

fish stocks an opportunity to grow and reproduce during the closed season. This practice is also intended to attract larger fish to feed upon the abundant reef fish stock and replenish accessible fishing grounds.

The Nahnmwarki may open a spear fishing season for fishermen to augment catches which will be contributed toward several special holidays that include mwuongomwong, songomwuar and Easter week. Mwuongomwong is a traditional holiday that marks the beginning of breadfruit season. Songomwuar, another traditional holiday, indicates when breadfruit, which is preserved in the ground and called furo, may be unearthed and eaten. This holiday, which is supplemented with fish, takes place during the time of year when breadfruit trees do not bear fruit.

Taringpwong refers to trolling for tuna and other pelagics and is conducted from just before dawn to late afternoon. Kasoasoa means to "take away the right"; and the Nahnmwarki takes the right away from fishermen to go trolling at night which prevents them from "scaring" fish away from the atoll. This strategy will allow pelagic fish to feed around the atoll at night, undisturbed, and enable fishermen to have an easier

time of locating and harvesting fish the following day.

Molehs is a period when fishing activities around the atoll cease in order to accommodate a particular bait fish, bokuta, to become established around the fringing reef and lagoon. Fishermen wait in anticipation (e.g., as much as two or three weeks) for larger predatory fish to arrive in substantial numbers, attracted to the atoll by the bokuta, before fishing begins. The Penik, a traditional worker for the Nahnmwarki, relays the Nahnmwarki's command to open the season for fishermen to commence fishing activities for the larger species and subsequently the bait fish.

Another conservation effort is an island-wide ban on harvesting small cowry shells[6]. This order has been issued by the Nahnmwarki due to the rapid depopulation of cowerie shells on the atoll and applies to all residents and visitors. The Nahnmwarki contends that the shells have been over harvested by residents for making handicraft that are sold in Kolonia to tourists or exported. The ban on taking shells will remain in effect until the Nahnmwarki feels the shell population has recovered from its present state of decline.

Fishing Techniques and Lore

Pinegelapese fishermen have several informal arrangements or secondary CMT's that are incorporated into daily fishing practices, as well. Deleia, which refers to throwing hand nets, is frequently used by fishermen to catch a variety of reef fish which inhabit the intertidal zone. Fishermen, when using deleia, will release apiel or goat fish (Mullidae) and kolau (Acanthuris triastigus) that measure four inches and smaller in length. One siahk or customary law, requires that men under the age of 18 are not permitted to troll or bottom fish for tuna beyond the fringing reef. Fishermen will refrain from catching several types of fish that they believe to be poisonous (e.g., ciguaterra toxin) that include wot (Puffer fish: Tetraodontidae), mesol (Angel fish: Pomacentridae), and kopulik (Black Grouper: Serranidae).

Women are restricted, by custom, from participating in most fishing activities except for several techniques that include pang, wesrap and rik pwun. Pang is pole and line fishing and is undertaken at the edge of the lagoon, in reef channels or near the surf zone on the reef at low tide to catch small reef fish. Wesrap refers to catching eels, rap and selongalong (Gymnothorax sp.), under rocks. Gleaning the reef for octopus,

small reef fish or shellfish (Tridacna maxima), is called rik pwun.

Other fishing techniques employed by the fishermen of Pingelap include kahlek, selong, ilarik and uhk. Kahlek is undertaken to catch flying fish, at night, during the winter months of January through March. Fishermen will exit the lagoon via a channel in single file and form a se or semi-circle, parallel to the contour of the fringing reef. Using the reef as a barrier, fishermen will light torches to attract flying fish to their positions and trap the fish, which fling themselves toward the light, with nets.

Selong is a style of bottom fishing for tuna which is conducted at a distance from the atoll. Fishermen will position themselves several hundred yards from the atoll and drift in their outriggers while bottom fishing. Lures are lowered by handlines to depths between ten to thirty fathoms. The development of fishing at a distance from the atoll may be indicative of a cold water current(s) which may attract the tuna to these fishing grounds.

Ilarik is a method of trolling for a variety of pelagic fish of which the most prized catches include Skipjack tuna, Wahoo, Yellow fin tuna, and Mahi Mahi. Men will circle the

island in fiberglass motorboats or motor powered outriggers while dragging long hand held lines and lures in their wake. Fishermen typically start daily trolling trips before dawn and may continue until well into the afternoon, which is determined by a fisherman's deftness to fill daily catch expectations. If a fisherman has had a good day, he may decide to preserve and salt a portion of the catch for later meals for his family; to sell excess salted fish at the Kolonia market; or give pieces of salted fish to friends and family living on Pohnpei island.

Uhk is the name of a gill net used by fishermen to snare reef fish. The gill net is placed into position on top of the reef and between rocks or in channels while the tide commences to rise. Fish become entangled in the web of the net and perish. Fishermen return to the net after the tide has begun to recede to collect their catch and reset their nets. Uhk may also be modified and used to entrap flying fish during kahlek season.

Some of the local fishing lore which circulates among community members on Pingelap includes, pwong mas, kemelis, soused, aisekala, seweth keren sed, sewepel, and pelenihm mwesa. Pwong mas, "first dark night", is a special occasion

during kahlek season when fishermen will contribute their flying fish catch to the Nahnmwarki. The "first dark night" is the first night during kahlek season in which there is no moon for an hour and a half after sunset. At this time, fishermen make ready their outriggers and take up positions in line (se) to catch the fish. Upon their return, fishermen will donate their yield to the Nahnmwarki who will, in return, present them with a traditional feast to commemorate the occasion. A unique food that is prepared by the Nahnmwarki for this affair and presented to fishermen is called kemelis. Kemelis is a mixture of coconut meat with one or several other ingredients that include rice, breadfruit, bananas, or taro. Prior to the feast, the Nahnmwarki will lead the community in prayer on the fishermen's behalf for a safe and prosperous season. Since kahlek season lasts for three months, pwong mas is conducted on the "first dark night" of each month with the ceremonial food exchange repeated for each night.

Soused is an informal title accorded to fishermen considered to be very experienced. To qualify as a soused, fishermen must be adept at every style of fishing and have accomplished an important criteria called aisekela. A fisherman can attain the feat of aisekela when he has caught

ten tuna while bottom fishing from an outrigger in a single day. Fishermen present their catch to the Penik who will, in turn, pass it on to the Nahnmwarki. The Nahnmwarki will then make this feat known to community members and distribute the catch among the atoll's inhabitants.

Pelenihm mwesa denotes when a fisherman must refrain from net fishing (uhk). The fisherman is expected to cease from fishing activities either during the period when his wife gives birth or during menstruation. This belief, held firmly among the community of fishermen, applies especially during kahlek and bokuta season for fear that a "tainted" fisherman will scare these important stocks away from the atoll. The term seweth keren sed, literally means "not qualified to touch the sea" and obligates the fishermen to refrain from fishing for several days during this period. Another belief is that a Pingelapese fisherman must sleep by himself in another part of the house and abstain from intimate relations with a woman the night before he goes fishing. This belief is called sewepel and is best associated with a group net fishing style called ukesik.

PEHLENG

Pehleng village, Kiti Municipality, once considered a remote village is now easily accessible from the main population center of Kolonia. Pelheng, as with other villages and communities of Pohnpei, has undergone great cultural change since the foreign powers first made their presence on the island, early on in the 19th century. With the introduction of new religions (Nakayama 1987:363), land distribution strategies (Castro 1984:184) and governments, much traditional acculturation has taken place. Johannes (1978b) determined that the traditional Nahnmwarki system, and customary methods that governed the access and use of marine resources per village, have been severely eroded. However, the importance of the data gathered from this site reflects contemporary marine resource management strategies in which fishermen and women operate.

Marine Resource Management

The Pohnpei State Marine Resources Division (MRD) is cited by respondents as the principal authority over marine resources and fishing grounds. Use and access to marine resources is described as "open" by fishermen with several

limitations as prescribed by MRD. Such restrictions include the designation of a Trochus shell sanctuary and season, and the protection of several regulated fish species.

Trochus shells or sumwumw, are regulated under the Marine Resources Conservation Act of 1981, enacted by the Pohnpei State Legislature. The Director of the Department of Resources and Development, in conjunction with the State Fisheries Officer (e.g., Chief of Marine Resources Division), is charged with the responsibilities of specifying areas for Trochus conservation sanctuaries; maintaining a conservation officer program designed to monitor the sanctuaries during open and closed harvest seasons; and supervising the distribution of marketing licenses to Trochus harvesters.

The harvest season is an annual event and usually lasts for several days with hundreds of fishermen participating. The Chief of Marine Resources, Toshiro Ludwig (1990), speculates that some fishermen harvest the Trochus shell during the closed season (illegally), but participate in the state government monitored harvest in order to sell their shells on the market (legally). The only measure of prevention that MRD can employ to guard against poaching Trochus shells is for its conservation officers, which vacillates between two and three

men, to catch the poachers in the act. This is an imperfect system which is vulnerable to the poacher who is willing to risk undertaking illegal activity in order to gain the benefits of a large Trochus shell harvest.

Fishermen have identified several species that are regulated by the Marine Resources Division that include wei (Green Turtle), kamaik (Humphead Parrot fish: Bolbometopon muricatum) and mwanger (Grouper: Serranidae). Fishermen collectively believe that wei are not authorized for catch unless they have a minimum shell length of two feet. Kamaik are presently the subject of a year round ban on harvesting this specie. Mwanger are open to fishermen for most of the year, except for the months of March and April.

Fishing Techniques and Lore

Fishing techniques which interviewees reported as currently used by fishermen in the mangrove forest, intertidal zone and lagoon areas include uhk, uhk en saip, kasik, duhsuwmuhmw and duh. Uhk, gill net, is set on the floor of the mangrove forest or on the reef flat of the intertidal zone at low tide by fishermen. Large reef fish and occasionally pelagic fish infiltrate the network of mangrove trees and roots, as the tide rises, in search of juvenile fish who seek refuge in this

habitat. Uhk are designed to capture larger reef fish while allowing the smaller bait fish to pass through the net, unscathed. Fishermen will collect their nets, along with their catch, after the high tide has fallen.

Fishermen may sometimes leave their nets on the reef or in the mangrove forest overnight, but admit that this practice may result in the theft of the net. As such, a wise fisherman will always hide his net and not divulge this hiding place to others. Hiding an uhk from other fishermen is easily accomplished in the mangrove forest due to the extensive network of channels and trees. However, uhk is susceptible to theft by other fishermen if left unattended on the exposed reef. Fishermen are especially concerned about fishermen from other villages stealing their nets, but can do nothing under the present management scheme other than keep the net within continuous visual contact.

Uhk en saip, throw net, is conducted at low tide on the reef in the intertidal zone. Fishermen will walk along the reef with net in hand, stalking a variety of small reef fish[7] which include kioak (Rabbit fish: Siganus doliatus), epil (Goat fish: Upeneus arge), and eki (Milk fish: Chanos chanos).

When a fisherman has converged upon a school of fish, he will cast the net in an arcing fashion at the center of the school. The weighted, circular net will envelope and trap the fish until the fishermen can retrieve his net. The catch will be killed and secured in a plastic bag or on a stringer that the fishermen carries on his person.

Kasik, bottom fishing, involves fishing from an outrigger in the lagoon and targets larger fish such as mwanger and ikiepw (Snapper: Lethrinus kallopterus). Duhsuwmuhmw, diving for Trochus shells, is usually conducted on the barrier reef or patch reefs scattered throughout the lagoon. Duh, spearfishing, conducted during the day and night, is one of the most favored techniques among fishermen that targets the highest variety and volume of reef fish. Gear used for this technique includes a mask, fins, snorkel, spear and if diving at night, an underwater flashlight.

Customary fishing related activities still practiced in Pehleng village include katepeik, laidkapw, oulaid, kapas and sounmeterek[8]. Katepeik and laidkapw are feasts conducted to celebrate the purchase or construction of new canoes (katepeik) and fishing gear (laidkapw). When fishermen build

or purchase new outriggers/ fiberglass boats or receive new fishing gear, they are expected to participate in an annual food exchange ceremony with their respective Nahnmwarki. The Soumesenkousapw, a traditional leader under the Nahnmwarki, directs the group of fishermen to go fishing while a land-group (oulaid) prepare food as part of the exchange. When fishermen have returned from the sea they will present their catch to the Soumesenkousapw, who will present the catch to the Nahnwmarki. Upon receiving the catch, the Nahnmwarki will distribute the fish to the oulaid group and in return, present kapas or food prepared by the oulaid group to the Soumesenkousapw. The Soumesenkousapw will then distribute kapas to the fishermen.

Sounmeterek is a traditional funeral tribute to the deceased. On the third day of a funeral procession, a member of the family goes fishing. Upon his return, a portion (e.g., usually one fish) of the catch is placed on the grave site as a sign of farewell. The remaining portion of the catch is given to the family of the deceased.

Summary

Evidence that primary and secondary customary marine tenure systems exist in the communities of Pingelap and Nukuoro are reported as contemporary means to manage various marine activities. Pehlengese continue to fish for subsistence purposes, though they continue to do so under the government managed open access regime and have largely discarded customary fishing practices. Understanding the realities of the fishing practices that exist in each community will now lend credence and serve as a foundation for the formulation of localized management strategies.

CHAPTER NOTES

(1) Hudson Mahora and Apolis Johnny served as my Nukuoran interpreters. They assisted me with conducting interviews and verified Nukuoran word spelling and definitions. Mr. Toshiro Ludwig, Chief of Pohnpei State Marine Resources, assisted with the confirmation of terms and observations. Consult Vern Carrol (1966) Ph.D dissertation.

(2) Geomorphological anomalies are pinnacles, possibly basalt, submerged just below the surface that rise up from the floor of the lagoon. The pinnacles are pillars that have been encrusted in coral growth over long periods of time and attract a variety of marine organisms.

(3) This substance is called "the tubules of Cuvier". Holothuria emit sticky white tubules from the anal region as a defensive measure which acts as an adhesive to entangle predators.

(4) Sorhim Isaac, Ensner Rizana and Person Samson served as my Pingelapese interpreters. They assisted me with conducting interviews and verified Pingelapese word spelling and definitions. Mr. Ahser Edwards, Assistant Professor of the Community College of Micronesia (Kolonia, Pohnpei), assisted with the confirmation of terms and observations.

(5) This area of reef is located between the airport (West, South West corner of Pingelap Islet) and Sukuoru Islet.

(6) Cowry shells: Interviewees have identified the money cowry (Cypraea moneta) as the specie currently prohibited from harvest.

(7) Names of Pohnpeian fish were verified through conversations with local fishermen, my interpreter (Hickerson Heinrick), and Goodwin (1983: p.207) and Myers (1989).

(8) Traditional marine feasts were verified with the assistance of Pehleng's Soumesenkousapw, Mr. Elliot David and Shimizu (1982: p.202).

CHAPTER SIX

DATA ANALYSIS

This section presents empirical evidence on the appropriateness of incorporating customary marine resource practices into Pohnpei State Government strategies for family mariculture project management. Responses to questions concerning an attempt to measure perceptions of authority over marine resources; contemporary marine resource conservation schemes; and preferences toward family mariculture security strategies are presented. Discerning community perceptions regarding these subjects reinforce previous theoretical arguments toward employing customary marine resource practices as the best possible strategy to manage family mariculture projects.

STATISTICAL ANALYSIS AND RESULTS

An interview schedule (Appendix B) was employed in each community in order to understand community member perceptions of authority, conservation and protection of marine natural resources and mariculture growout sites. The first topic queried fishermen regarding who they perceived as the primary authority over marine natural resources found within the lagoon, on top of the reef flat and open ocean for their

community. The second topic concerned the degree of confidence which respondents had for government legal methods and customary marine tenure practices to conserve marine natural resources. The third topic dealt with the degree of confidence respondents had for government legal methods and customary marine tenure practices to protect individual family mariculture projects in their community.

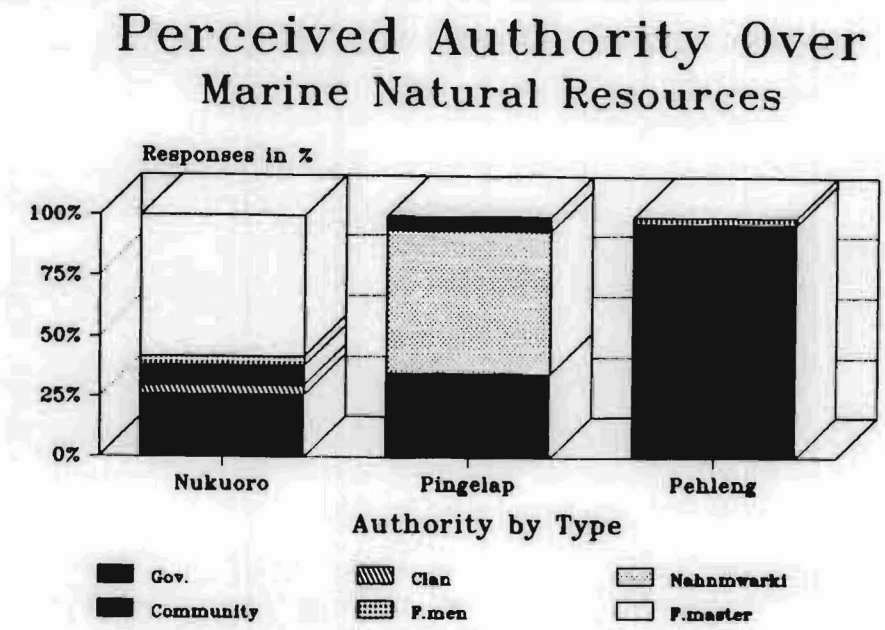
PERCEIVED AUTHORITY OVER MARINE NATURAL RESOURCES

Interviewee' responses are reported as percentages in table two and illustrated in figure two. For **Nukuoro**, 26% of the respondents perceived the municipal and state government to assert authority over marine resources; 4% feel the traditional clan still control authority; 8% believe the community was in charge; 4% consider fishermen control resources; and 58%, the majority, regard the Tautai or fishmaster in charge of marine natural resources. On **Pingelap**, 35% believe the government asserts authority; 59%, the majority, consider the Nahnmwarki to claim authority; and 6% feel the community has rights over marine resources. For **Pehleng**, 97%, the majority, consider the government to command authority; while only 3% feel fishermen have authority over marine natural resources.

Perceived Authority Over Marine Natural Resources

	Nukuoro	Pingelap	Pehleng
Government:	26%	35%	97%
Nahnmwarki:	-	59%	-
Traditional Clan:	4%	-	-
Community:	8%	6%	-
Fishermen:	4%	-	-
Fishmaster:	58%	-	3%

Table 2



MNR in Lagoon, Reef & Open Ocean

Figure 2.

CONFIDENCE TO CONSERVE MNR

Respondents were asked to rate the degree of confidence that they had in the government and customary marine tenure practices to conserve marine resources in their community. Here, we are reporting (table 3) and illustrating (figure 3) positive responses for both government and customary practices. For Nukuoro, 13% feel strong or complete confidence in the governments' ability to conserve; while 96% feel strong or complete confidence in customary marine tenure practices. In Pingelap, 43% believe in the governments' capacity to conserve; while 84%, the majority, consider customary practices, specifically the Nahnmwarki, to play a significant role in conserving marine resources. In Pehleng, 37% respondents have confidence in the government's ability to conserve; while only 7% have strong or complete confidence in customary practices to conserve marine natural resources.

	Confidence to Conserve MNR		
	Nukuoro	Pingelap	Pehleng
Government: Strong or Complete Confidence to Conserve MNR.....	13%	43%	37%
CMT: Strong or Complete Confidence to Conserve MNR.....	96%	84%	7%

Table 3

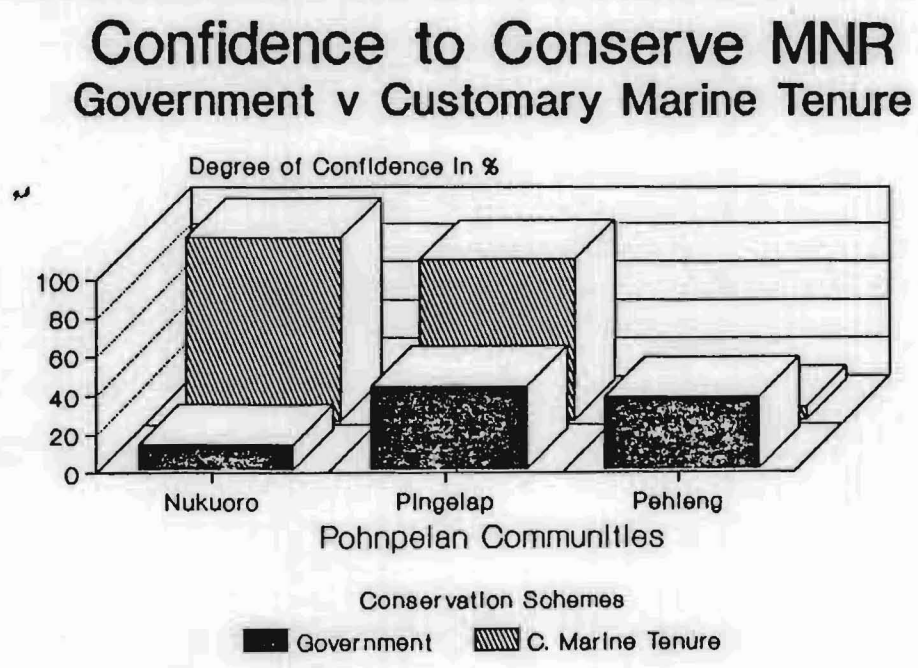


Figure 3.

CONFIDENCE TO PROTECT IFMP'S

Interviewees were asked to rate the degree of confidence that they would have in government legal methods and in customary marine tenure practices to provide sufficient protection for potential family mariculture projects against poaching. Again, we are comparing (table 4) and illustrating (figure 4) positive responses for both government and customary practices. For Nukuoro, 100% of the respondents consider customary practices, such as dai mada hale, as the most appropriate management scheme for IFMP's. In Pingelap, 47% feel the government or local municipal police force could provide protection; while 40% feel customary practices, in the form of agreements as arranged by the Nahnmwarki between community members, could provide protection. Finally, in Pehleng, 20% feel that the government could provide sufficient protection; while 60% feel customary practices (ie. arrangements between community members) and a line of sight feature from the families home to the proposed site could help to ensure the projects' protection.

Confidence to Protect
Individual Family Mariculture Projects

	Nukuoro	Pingelap	Pehleng
Government: Strong or Complete Confidence to Protect IFMP's.....	0%	47%	20%
CMT: Strong or Complete Confidence to Protect IFMP's.....	100%	40%	60%

Table 4

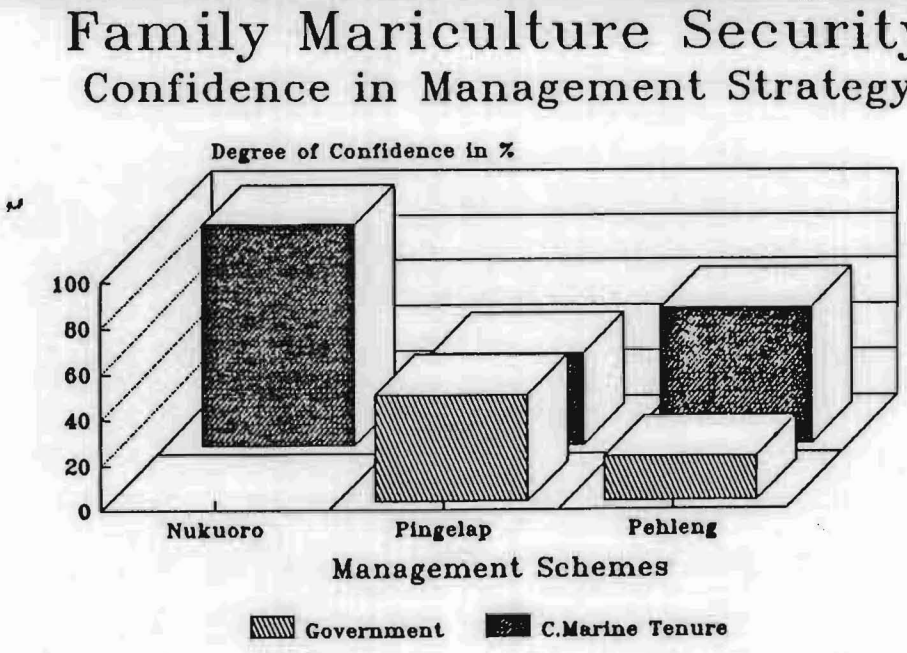


Figure 4.

Chi-square 3 by 2 Contingency Analysis Test Results

Topic One: Confidence to Conserve Marine Natural Resources

Hypothesis: It is hypothesized that outer islanders from Nukuoro and Pingelap as compared to Pohnpeians from Pehleng, will demonstrate a higher confidence in customary marine tenure practices than government methods as a mechanism to conserve marine natural resources.

Test 1. Conservation of Marine Natural Resources

Null Hypothesis (H_o): It is hypothesized that there is no difference in confidence, among community members from three study sites, between government and customary marine tenure methods to provide conservation management for marine natural resources.

Research Hypothesis (H_R): It is hypothesized that there is a difference in confidence, among community members from three study sites, between government and customary marine tenure methods to provide conservation management for marine natural resources.

Sample Size: 77

Significance Level: Alpha = .05

Confidence to Conserve Marine Natural Resources	Government	Customary Marine Tenure		Total
Nukuoro	3	23		26
Pingelap	13	25		38
Pehleng	11	2		13
Total	27	50	=	77

FAVORABLE RESPONSES REPORTED

Table 5.

Test Statistic: $X^2 = 28$

Degrees of Freedom: 2

Table Statistic: 5.99

Decision: Since the Test Statistic (28) is greater than (>) the Table Statistic (5.99) at a Significance Level of .05 with 2 Degrees of Freedom, the test can be considered statistically significant. In this case, the Null Hypothesis (H_o) will be rejected and the Research Hypothesis (H_R) will be accepted.

Conclusion: The chi-square test suggests that there is a difference in confidence among community members from the three study sites regarding the choice between government and customary methods to conserve marine natural resources.

Reading table 4 clearly depicts outer islanders, community members from Nukuoro and Pingelap, as responding more favorably toward employing customary methods for conservation purposes as compared to Pehlengese.

Topic Two: Confidence to Provide Security for Family Mariculture Projects

Hypothesis: It is hypothesized that community members from each study site will demonstrate a higher confidence in customary marine tenure practices, as compared to government methods, for management strategies that provide security for family mariculture sites.

Null Hypothesis (H_o): It is hypothesized that there is no difference in confidence, among community members from the three study sites, between government and customary marine tenure methods to provide security management to family mariculture projects.

Research Hypothesis (H_R): It is hypothesized that there is a difference in confidence, among community members from the three study sites, between government and customary marine tenure methods to provide security management to family

mariculture projects.

Confidence to Protect Family Mariculture Projects

	Government	Customary Marine Tenure	Total
Nukuoro	0	24	24
Pingelap	14	12	26
Pehleng	6	18	24
Total	20	54	= 74

FAVORABLE RESPONSES REPORTED

Table 6.

Sample Size: 74

Significance Level: Alpha = .05

Test Statistic: $X^2 = 18$

Degrees of Freedom: 2

Table Statistic: 5.99

Decision: Since the Test Statistic (18) is greater than (>) the Table Statistic (5.99) at a Significance Level of .05 with 2 Degrees of Freedom, the test can be considered statistically significant. In this case, the Null Hypothesis (H_o) will be rejected in favor of the Research Hypothesis (H_R).

Conclusion: Results from this test illustrate a higher degree of confidence among community members from each study site to employ customary marine tenure practices, than government methods, to provide adequate security management for family mariculture projects.

CHAPTER NOTES

(1) Test formulas used for statistical analysis can be found in Siegel (1988:111-122).

CHAPTER SEVEN

DISCUSSION

Qualitative and quantitative data presented in the body of this thesis suggest certain strategies which may be integrated into family mariculture projects via government and community management entities. Instruments of the government that can play a primary role in sculpting future marine resource and mariculture management policies include the Marine Resources Division, municipal governments and the Pohnpei State Legislature. Community based figures that could be included in the overall development of marine resource and mariculture management strategies include traditional leaders, fishmasters, fisherwomen and fishermen, as appropriate per community. The primary vehicle in which much of this change can be initiated is the state agency, Marine Resources Division.

The Pohnpei State Marine Resources Division is best suited to facilitate the incorporation of customary practices into family mariculture management; whereas, legitimacy for customary practices can be realized within the legal structure of Pohnpei State. The Marine Resources Division can play a

principal role in extending the jurisdiction of marine activities to local management. The following recommendations will suggest avenues by which this aim may be achieved. (1) Identify customary marine resource practices in each village and atoll community within Pohnpei State jurisdiction. (2) Seek a level of support from within the municipal government of a given community toward the implementation and maintenance of family mariculture projects that is consistent with Marine Resource Development conservation and mariculture management goals. (3) Gain political support from state legislators and draft legislation that lends legitimacy to customary marine resource practices for which marine resources and family mariculture projects will be safeguarded. (4) Community based leaders and persons that have been identified as key components of customary marine resource practices should be included in the process of planning, implementing and supporting family mariculture projects.

Municipal governments also could play an important role in facilitating the integration of customary marine resource practices into management schemes for several reasons. Since most municipal government workers are fishermen, they will have a sense of the customary practices currently maintained

by the local population. From this perspective, municipal ordinances can be developed by municipal officers with the help of local traditional leaders, fishermen and fisherwomen to give more validity to contemporary marine resource practices. Municipal governments may serve as the intermediary between the local population and the state government. Marine Resource Division planners and extension agents should work cooperatively with the municipal government to gain greater local participation during the management design and implementation phases. The extent to which customary practices are included in mariculture management schemes may, in fact, depend upon the pivotal role played out by the local municipal office, especially in the case of remote and outer island communities.

Traditional and informal figures of authority in a community that relate to customary marine resource practices should be recognized by government planners and included in the design of local management strategies. Lending legitimacy to traditional and informal leaders will reinforce customary practices and marine resource conflict resolution by endorsing and including local attitudes and values in government decision making. Embracing local customs into marine policy is

a process that must be accomplished with direct dialogue and participation among concerned parties that include the Marine Resources Division, municipal governments, traditional and informal leaders, as well as, fisherwomen and fishermen.

State legislators can play a significant role in the process to ensure that local customary practices are recognized as bonafide marine resource management tools which can be used by planners to effect an appropriate mariculture scheme for a particular community. Flexible and durable legislation should be grounded in the precepts of Pohnpeian law to secure customary and informal user rights regarding the collective and appropriate use of marine resources. These practices and arrangements should reflect the most appropriate strategy in which community members intend to maintain local marine natural resources and provide security for family mariculture projects. Finally, legislative action should generally depict the role in which community members, traditional leaders, municipal governments and the Marine Resources Division interact to bring about the assimilation of these methods into management strategies and policy.

Management Strategies per Study Site

Survey results suggest specific actions for the implementation and maintenance of individual family mariculture projects for Nukuoro, Pingelap and Pehleng.

In Nukuoro, dai mada hale is a well respected customary practice for the ownership of marine resources by families. Resource managers can take advantage of this practice by incorporating this idea into mariculture management. Managers should approach and seek out assistance from the Nukuoran Municipal Office, fishmasters and the general community for advice in implementing and maintaining family mariculture projects.

For Pingelap, clearly the Nahnmwarki should play a role in developing user access arrangements with community members and the municipal government. Leadership from traditional and government entities, along with community input, should provide a viable management scheme suitable for the maintenance and protection of family projects.

Implementing mariculture projects in Pehleng could prove to be the greatest challenge in providing proper protection against poaching. Families who embark upon establishing mariculture growout sites should do so cooperatively with

other families and neighbors. Periodic visits to mariculture sites could be shared by families or neighbors under a collaborative commitment to provide the necessary maintenance and protection for growout areas. The Soumesenkousapw and the Municipal Government Office should support and encourage the creation and development of informal arrangements among community members in which they can pursue the cultivation of marine organisms. Cooperative informal arrangements may subsequently lead to the implementation of a lease system in which sea farmers could jointly rent sections of reef for mariculture ventures.

Zoning

The Marine Resources Division could accommodate both customary and government lease management strategies for each community under a State geographic zoning plan. This process would involve identifying contemporary marine resource uses, harvest practices and rights that exist in each community of Pohnpei State. An assessment of community member perspectives should also include the appropriate means to which security for family mariculture projects can be provided.

Each community could then be zoned according to the management strategy that best fits their situation. For instance, Pingelap could be zoned as a primary customary site; Nukuoro could be zoned as a secondary customary site; and Pehleng could be zoned as a government sponsored lease site. Community strategies would be collectively portrayed in a portfolio that represents the mariculture management schemes for the entire state. Resource planners could then approach the implementation of family mariculture projects with an understanding of each communitie's needs and preferences toward mariculture management.

Marine resource management zoning is a more complex form of management as compared to the open access form of management that is presently espoused by the Pohnpeian government. Resources would need to be dedicated toward understanding the culturally diverse communities of Pohnpei State. However, recognizing the diversity in cultural patterns that exist in each community, as they relate to marine resources, would ultimately provide for a strong local management strategy in which family mariculture projects could be implemented and maintained. In the end, decentralizing authority over family mariculture projects in favor of local management would prove

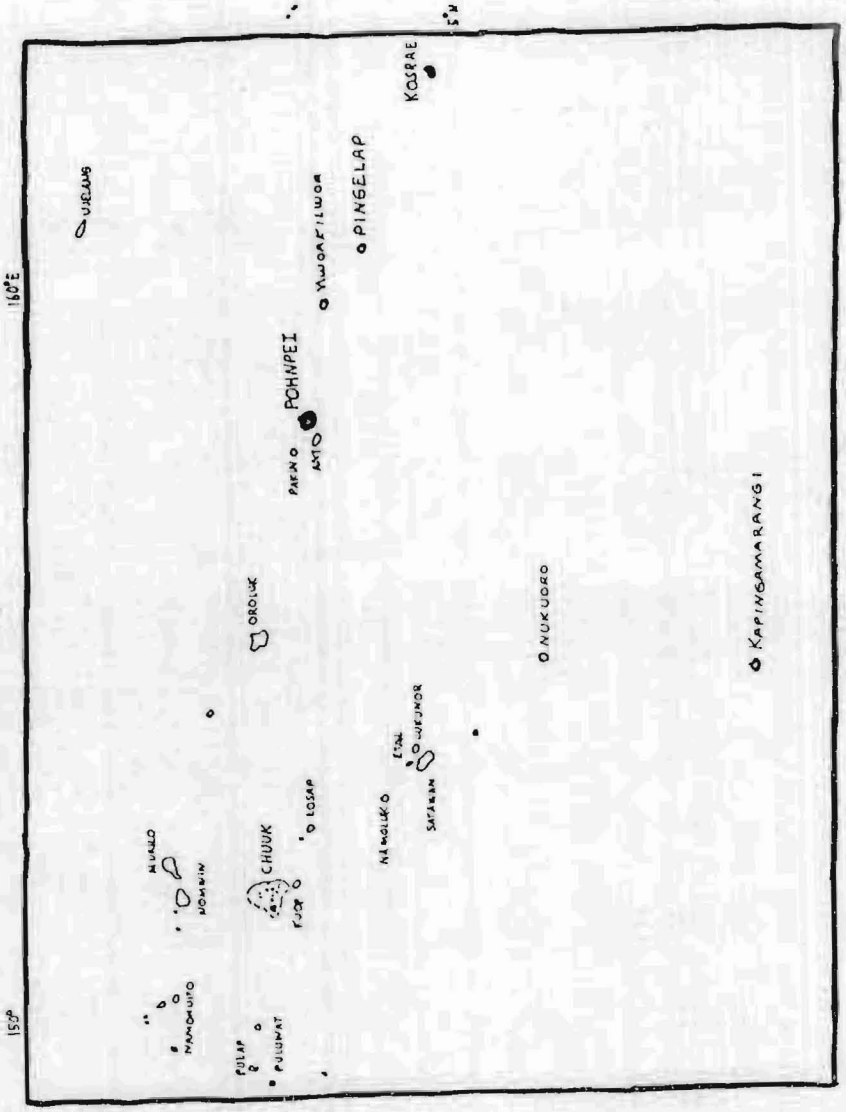
to be a more effective and cost efficient management method, given the current limitations of Pohnpei State government resources.

Conclusion

This pilot study has uncovered various patterns of perceptions about the regulation of marine resources for three Pohnpeian communities. It is hoped that the methodology, preliminary observations, and recommendations will assist the Pohnpei State Government in its efforts to develop an appropriate management model for the implementation of mariculture projects in remote communities of Pohnpei. Further research on customary marine resource practices of these and other Pohnpeian communities, which are targeted for mariculture projects, should be investigated.

On a grander scale, other Pacific island nations which intend to embody mariculture into national strategies as an economic tool toward development should explore the utility of incorporating customary marine resource practices into their management plans and policies.

APPENDIX A



EASTERN CAROLINE ISLANDS

APPENDIX B

Survey

(1). Who has authority or control over the islands reefs, lagoon and marine Natural Resources?

(2).A. Are there any areas of the reef or lagoon tha can be closed at anytime of the year? When, Where and Why?

B. Who has the authority to close a section of reef or lagoon?

C. How long can these reef/lagoon sections remain off limits?

(3).A. Is it tabu/ restricted to catch a certain type of fish?

B. If so, by:
1. specie
2. season
3. size
4. area of lagoon or reef

C. Who authorizes this tabu or restriction system?

(4). Do fishermen or women set limits on the amount of fish that they will catch?

(5).A. Are there any tabus/ restrictions on the type of gear a fishermen uses?

B. What are these restrictions, if any?

(6).A. During communal/large group fishing excursions, who leads the group?

B. Who usually distributes the fish? To who? How much?

(7).A. Do fishermen have complete access to fish anywhere inside the reef:

B. Who authorizes this system?

(8). How often do you go fishing?

(9). List in priority the fishing techniques that you use most often?

(10). What do you consider to be your principle catch?

(11).A. To what degree do you believe the local and/or state government is able to monitor the harvest of Marine Natural Resources (fish or shellfish) that may be protected under government conservation laws?
1. 100% Degree of Confidence (Complete agreement with statement).
2. 75% Degree of Confidence (Strong agreement with statement).
3. 50% Degree of Confidence (Indifferent)
4. 25% Degree of Confidence (Weak agreement with statement).
5. 0 Degree of Confidence (No confidence with statement).

B. To what degree do you believe that Marine Natural Resources are protected under customary marine tenure practices or informal arrangements which exist between community members?

1. 2. 3. 4. 5.

(12).A. If a mariculture project is established on the reef in front of several families beach front homes, which would be best ensure the implementation and security of the project?

Government Legal Methods or Informal or Customary Arrangements

B. To what degree could informal or customary arrangements protect mariculture sanctuaries?

1. 2. 3. 4. 5.

C. To what degree could Government Legal Methods protect mariculture sanctuaries?

1. 2. 3. 4. 5.

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