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Export Feasibility Study of a Pohnpein Marine Venture

A dissertation submitted by

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ABSTRACT

US subsidized funds have been the primary source of revenue for the FSM for decades as the nation never developed a market economy. This funding is being withdrawn and the nation must develop a self-supporting economic base. The export of marine ornamentals has been identified as a potentially profit-generating industry, and this dissertation examines the economic feasibility and the environmental and cultural impact of harvesting and exporting Pohnpein fish. Economic evaluation is derived by applying a Cost Effective Analysis. There are seven constraints associated with this analysis: environmental, financial, distributional, management, transportation, cultural, infrastructure. This analytical framework addresses the three research objectives of this study: a cost estimation of the venture, identification of a profitable mix of fish, and the effect the monopoly structure of the FSM transport industry has on export viability. It was determined that a product mix of 21 species of fish could generate a positive revenue stream. It is unknown, however, how many firms the industry could support as quantitative data on the fish stock of Pohnpein waters has not been published. Analysis of environmental and cultural constraints revealed multiple intangible costs and consequences of the export. It could not be determined if the monetary contribution to Pohnpein society would be enough to offset these negative repercussions as such alterations could not be reversed or replaced. The negative intangibles of the export impact so heavily on the NPV that viability is reduced to 0. As a result, economic justification of the export is not present as overall outcome of the export to society could not be fully calculated.

CERTIFICATION OF DISSERTATION

I certify that the ideas, experimental work, results, analyses, software and conclusions reported in this dissertation are entirely my own effort, except where otherwise acknowledged. I also certify that the work is original and has not been previously submitted for any other award, except where otherwise acknowledged.

Vivian Grace Viar — August 6, 2008

Signature of Candidate — Date

ENDORSEMENT

…… ……

Signature of Principal Supervisor — Date

…… ……

Signature of Associate Supervisor — Date

DEDICATION

This thesis is dedicated to:

Karl
- - - my love - - -

and
to

Mac
- - - my life - - -

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I would like to acknowledge Karl, with gratitude and love, for his unending emotional and financial support throughout the duration of researching and writing this dissertation.

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INTRODUCTION

1.1 The Federated States of Micronesia

The Federated States of Micronesia (FSM) is an island chain consisting of 607 small islands and atolls situated in the Tropical Pacific Ocean. Aggregate surface land of 702 square kilometres is spread across 2,641,800 square kilometres of ocean area. Pohnpei is the capital island of the FSM. Kosrae, Chuuk, and Yap are the three other primary islands of the chain. The total FSM population is approximately 118,100, with Pohnpei having a population of approximately 30,000 native Micronesians and 5,000 foreign expatriates. FSM average population growth is 2,126 persons per year and urban population centers average 33,422 persons. The average literacy rate is 93.9%, however only 50% of the population has a high school education. The infant/child mortality rate is 52 per 1,000 live births, and life expectancy is 67 years. (World Bank Group, 2001).

While traditional subsistence gathering, fishing and communal sharing are fundamental to the island culture, Western theology and materialism are gaining acceptance. As a consequence, the cultural and historical structure of the islands is beginning to erode. The islands have limited access to global trade routes, with Continental Airlines providing a limited and prohibitively expensive air service. One international shipping line delivers supplies, food, and mail every six to eight weeks. Utility and telecommunication infrastructure provides service to a relatively small percentage of the population.

Based on the World Bank indicators, derived from a combination of statistical values associated with industrial progress, wealth and income, imports and exports, the FSM islands are classified as a developing or emerging nation (World Bank 1998 and 2001). Specifically, the FSM Gross National Product is US$249,700,000 with a per capita Gross National Product of US$2,110. The Gross Domestic Product is slightly less at US$228,200,000 with a per capita Gross Domestic Product of US$1,810. The subsistence economy is estimated to be valued at one quarter of the Gross Domestic Product. The Gross Domestic Product growth rate and inflation are rising at nearly the same rate, that is, 3 % and 2.9% respectively. Conversely, money growth is declining by 1% per year (Johnson and Dahl, 1995; World Bank, 2001). Private sector capital formation is less than 10%, making it one of the lowest capital formation rates among the world's market economies (Asian Development Bank, 1996).

The FSM's economy is subsidized at around 95% through the 1986 United States Compact of Free Association. The non-subsidized portion of revenue is generated through the sale of FSM fishing rights to Japan. In 1995, public sector compensation payments provided income for over 60% of the workforce (Osman, 1998). The government of the FSM spends the majority of US funds on current expenditures rather than on capital investments. This pattern, although indicative of a consumption-based culture, is a fundamental source of progressive economic decline (Brigham and

Gapenski, 1997; Onkvisit and Shaw, 1997). Foreign subsidies have tended to erode any incentive for the nation to increase efficiency or establish competitive markets for goods and services (Asian Development Bank, 1996; Mansfield, 1999). Contributing to this inefficient state are bureaucracy and political favoritism, which has successfully discouraged expatriate investment.

The primary goal of the Compact with the United States has been to transform the communal economy of FSM into a market economy. This has not been achieved. The imminent cessation of the flow of US dollars into the nation and the anticipated loss of the majority of personal incomes has prompted national leaders to assess what opportunities and resources are available that could be utilized for economic development.

The overwhelming majority of the nation's natural resources are marine-based; that is, 2.6 million square kilometres of ocean as compared with 702 square kilometres of land mass. Given the extent of the nation's marine-based natural resources, the Pohnpein government has identified the aquarium industry, generally, and, specifically, the export of marine ornamentals as a potential profit-generating industry.

1.2 The Aquarium Industry

The aquarium industry is composed of two distinct categories of aquatic animals: freshwater and marine. There are around 1,800 species of freshwater aquarium fish and invertebrates (FishBase, 2001). This is compared with the 12,000 identified species of marine finfish, of which 900 to 1,200 species are traded in the ornamental industry. Tropical oceans and coral reefs are favored locales for collection of marine ornamentals. It is commonplace to use the terms 'tropical fish' and 'marine ornamentals' interchangeably as almost 100% of marine aquarium fish are tropical species. Marine invertebrates comprise a small but growing sector of the trade (Marine Aquarium Council, 1998; FishBase, 2001).

There are two means of producing ornamentals. These are aquaculture and wild harvest. Aquaculture is the cultivation and rearing of aquatic animals in a controlled, often man-made or enhanced environment. An estimated 95% of freshwater aquarium species are produced via the aquaculture method, whereas the percentage of aquaculture marine ornamentals is estimated at less than 1% (Dawes, 1999). Given this low percentage, it is assumed, within the industry, that the term 'marine ornamentals' refers to wild-harvest fish. Wild-harvest or wild-catch production is the capture and removal of creatures from their natural habitat. Nets, fishing lines, chemicals, and various hand methods are used to gather the fish.

Eighty-five percent of the marine ornamentals for trade, worldwide, are supplied by the Philippines and Indonesia, and 7% to 10% are harvested from Fiji, the Pacific Islands, and Sri Lanka. The balance is collected primarily from the Caribbean, Hawai'i, and Florida, with a fraction originating in Australia, Brazil, the Indian Ocean, East Africa,

and the Red Sea (Marine Aquarium Council, 1998; Ornamental Aquatic Trade Association, 2001).

Supply potential is high for Micronesian waters. Hundreds of small fish, which are classified as ornamentals, inhabit Pohnpein lagoons and reefs (FishBase, 2001). A list of the ornamental species inhabiting the waters of FSM is provided in Appendix 1.

Demand for marine ornamentals is concentrated in the United States at around 60 percent of the international trade. Western Europe and Japan consume a majority of the remaining 40 percent with Taiwan and Australia purchasing the balance. The hobby is expanding to other parts of the world, thereby establishing the potential for a rise in future demand (Marine Aquarium Council, 1998; National Oceanic and Atmospheric Administration, 2001).

Aquarium keeping is the second fastest growing hobby in the United States and Western Europe. Approximately 60 to 100 tonnes or 10 to 15 million aquarium fish are caught and exported annually to meet demand (Marine Aquarium Council, 1998). The Food and Agriculture Organization of the United Nations (1999) estimates that since 1985 the international trade for aquatic ornamentals has been increasing at an annual rate of 14 percent. Predictions of future growth rates range from 10 percent to 30 percent annually. Currently, the marine sector is expanding more rapidly than its freshwater counterpart due to an increase in awareness and interest in coral reefs and their tropical inhabitants (Food and Agriculture Organization of the United Nations, 1999; King, 1999).

The global aquarium industry is estimated to be worth US$4.5 billion to US$7 billion. Fish account for roughly a quarter of this value with the remaining 75 percent being comprised of aquarium support hardware, equipment, and supplies. The marine sector of the industry is valued at US$900 million to US$1.4 billion (University of Maryland, 1997; Marine Aquarium Council, 1998; University of Florida, 2001).

Marine ornamental fish are one of the highest value-added sustainable ocean products harvested. It is estimated that up to 98 percent of the value-added component for the ornamentals' market occurs after the original sale of the animal. That is, after the collector sells the specimen to an exporter (Baquero, 1999 and 2001).

1.3 Objectives of the Study

The primary aim of this study is to undertake a cost-effectiveness analysis to determine viability of the export of Pohnpein marine ornamentals.

The specific research objectives of the study are to:

1) identify a mix of economically viable fish and estimate the profit associated with the specific mix of fish;
2) estimate the costs associated with the export of Pohnpein marine ornamentals;

3) determine the effect that the monopoly structure of the transport industry has on export viability.

1.4 Outline of the Study

The study is structured as follows:

Chapter 2 *Business Growth Potential and the Cultivation of Marine Products in the Tropical Pacific Islands*. In this chapter, regional issues and constraints to economic growth are explored. To assess potential viability of the industry in the FSM, marine projects that have been undertaken in other areas of the Tropical Pacific, are analyzed having regard to their success or failure. A Political/Legal Economic Sociocultural Technological (*PEST*) Analysis for the FSM is also presented.

Chapter 3 *A Cost-Effectiveness Analysis of a Pohnpein Marine Ornamental Export Industry.* In this chapter, the elements of the cost-effectiveness analysis for this study are examined; specifically constraints, economic evaluation, scope and objective of the analysis, cost identification and identification of outputs and outcomes (benefits). Each element is detailed and presented and incorporates location-specific attributes of the FSM.

Chapter 4 *Interpretation and Results.* The tangible elements of the cost-effectiveness analysis are presented in this chapter. A sample of Pohnpein marine ornamentals and the value of the associated constraints and costs of production are listed. Summary tables of revenue and costs provide relevant information on which to base an assessment of industry viability. The results of the three research objectives of this study are presented in this section and the question of viability in establishing an export industry is answered.

Chapter 5 *Summary*. A summary of this study is proffered in this final chapter. Background and information on the FSM, and an overview of Tropical Pacific marine products are reviewed. Examination of industry viability via the application of a cost-effectiveness analysis and the valuation of the constraints, costs, outcomes and benefits is summarized.

CHAPTER 2
BUSINESS GROWTH POTENTIAL AND THE CULTIVATION OF MARINE PRODUCTS IN THE TROPICAL PACIFIC ISLANDS

2.1 Introduction

The numerous islands and atolls in the Tropical Pacific Ocean have historically depended upon the ocean for survival. The isolation and the extremely limited landmass of the islands in this region required native populations to depend, to a large extent, on marine resources for nourishment. Through the centuries, generations of islanders honed their sea navigation and fishing skills in order to support and continue their indigenous ways and culture.

The 19th century brought change to the region as telecommunications, international shipping lanes, and air traffic began to incorporate the Tropical Pacific islands into the rest of the world. Western ways were introduced into island cultures, the most influential being the introduction of a monetary system. As foreign presence grew, imports began to flow into the islands. Conversely, the subsistence-based local economy did not generate exports. However, first world nations quickly identified a highly prized and valuable resource that the islands did possess; that is, their strategic location. In this connection, Spain, Japan, Germany, and the United States of America have all occupied, controlled, or subsidized a majority of the islands during the last century and a half. The FSM was granted US territory status in 1951. The reason for this status upgrade was that, in return for substantial rent payments, the US would have exclusive access to the area's waterways.

In 1986, this status was terminated in favour of a Compact of Free Association. This compact agreement provided in excess of three billion dollars in subsidy revenue to the nation from 1951 to 2001. The ultimate goal of the compact was to provide basic support while the nation developed an independent stance through education and modernization, moving from a consumption to a production based economy (Johnson and Dahl, 1995). This goal of economic expansion or development of private firms and productive institutions is reflective of what Siggel (2005, p.3) terms as a "new emphasis in development economics".

The independence and growth, envisaged by the Compact, did not progress according to the original concept. While the standard of living did increase, the national economy created few productive resources. In 2001, the compact expired. The monetary flow is currently on a decelerating schedule and will stop within the next decade. After decades of debate over economic change, it is now time for the FSM to make some decisions. The realization that "economic development is a process of achieving sustained and sustainable growth in per capita income, accompanied by diversification of production, reduction of poverty, and expansion of economic opportunities for all citizens" (Lynn, 2003, p.16) is requiring political leaders to review export options for industry development.

Subsistence survival and communal sharing in the FSM do not operate according to western economic theory. Traditional education does not include the disciplines of accounting and economics (Chung, 1997). A subsidized government does not abide by fundamental economic practices (Morisset and Neso, 2002). For example, maximizing output, minimizing costs, and encouraging competition. While the FSM is attempting to create a free economy, it is doing so before it truly understands what a free economy is and what basic structural requirements will be needed. With a lack of any conceptual framework and with attention being focused on the end results, it is unlikely that a competitive export sector will emerge in the short to medium term (Lalkaka and Bishop, 1996).

Concepts such as resource allocation and scarcity, opportunity-valued labor, and management tools of input, output, and cost optimization are not part of the Micronesian frame of reference (Hezel, 1992; Dobbin and Hezel, 1998). They have not been taught through education, experience, or exposure, the premises upon which open economies operate. Although this lack of understanding can be attributed to the nation's history of subsistence, invasion, and subsidization, it does not negate the fact that knowledge of economic principles, and the ability to apply this knowledge in a practical manner, is paramount to the initial stages of creating a market economy (Asian Development Bank, 1996; World Bank Report, 1999).

This chapter is organized as follows:

Section 2.2 *Regional Business Climate and Constraints*

In this section, four issues are explored:

- Planning. A lack of adequate business planning of marine export product is prevalent in the region.
- Transportation. Complete dependence on air transportation from remote locations is expensive, and the shipping of live animals is difficult.
- Government. Involvement in private industry inhibits sector growth.
- Socio-Economic Constraints. Socio-economic factors affect island industries.

Section 2.3 *Marine Projects in the Tropical Pacific*

In this section, literature is reviewed on the export of giant clams, coral, seaweed, and Trochus; export projects that have had varying degrees of success. Factors effecting success of these export ventures, such as overly optimistic production plans, are identified.

Section 2.4 *Political/Legal Economic Sociocultural Technological (PEST) Analysis*

Discussed in this section are the current trends and conditions affecting the marine ornamental trade. Specifically, the environmental protection concerns and global trade implications, supplier versus consumer economies, environmental awareness and response and issues pertaining to the humane treatment of animals, and technological advances.

Section 2.5 *Summary*

The business climate and constraints of the region are summarized in this section. Literature on marine project previously attempted in the Tropical Pacific region and a PEST analysis pertaining to the current trends and conditions of the trade are also summarized.

2.2 Regional Business Climate and Constraints

2.2.1 Planning

Studies and business plans by different governments and world aid organizations have been written, yet the country continues to fall further behind in developing sources of revenue (World Bank, 1999). Practical application and hands-on instruction, normally not included in broad plans, are the reason that such plans have not been successful. This lack of working economic and business planning in Tropical Pacific island industries is noted repeatedly in the literature. For example, see Hezel, 1992, Osman, 1998, and World Bank Report, 2002.

A particular aspect of business planning in this region has been seriously overlooked. That is, the element of environmental assessment and the integral part the environment and natural resources plays in the majority of Tropical Pacific products (Hilson, 2003). Environmentalism and the protection and sustainability of our planet are increasingly strong business considerations that are endorsed by global agencies. The mandatory environmental regulations of most developed countries have not trickled down to the smaller, remote areas of the world, however, acknowledgement and recognition of these vital issues are paramount (Schmandt and Ward, 2000; Hilson, 2003).

Subsistence economies, such as the FSM, do not have a ready frame of reference to western monetary and economic principles, nor to the process and costs of production and market delivery. Knowledge of western-oriented operations and an understanding of planning strategy that includes the basics of a business from the ground up and that is relevant to the island's remote location and scarce resources are needed for Pohnpeins to effectively operate a business and economy (Micronesian Entrepreneur Development Center, 1995; Cheshire, 2003). While several projects have been tried, namely the production of seaweed, Trochus, giant clams, pearls, sponges, oyster spat, coral, and Bench de Mere, they have all met with limited success. Any success that has been achieved would seem to be due to having sound and island-applicable business planning

throughout the entire business/production cycle (Morisset and Neso, 2002). One reason for the failed operations is unrealistic revenue generation expectations. National governments have consistently over-projected returns from commercial development of products. In this connection, Smith (1992, p.10) states that:

> …to date there has been minimal success. With the exception of irregular Trochus harvesting, where transplanting has been undertaken since the Japanese administration, there have been no commercial successes.... A review of the FSM aquaculture sector found that the prospects for commercial activities have been exaggerated, and that the evidence suggests that the sector will not be a significant revenue earner for FSM.

2.2.2 Transportation

Dependence on air transport to the global marketplace is a fact of the Tropical Pacific island region as very few ocean shipping lanes service the islands. Entire industries will be halted if disruption in air service occurs. Given the geographical logistics of all the Pacific islands and their limited accessibility to commercial carriers, the issue of transportation is a principal business consideration. As Foscarini and Prakash of the Ministry of Primary Industries for Fiji in 1990 (p.1) noted, one product of the region, Eucheuma seaweed, shows potential namely because of the low shipping cost associated with the product. In their terms, this is "the most important factor for sustainable development of export-oriented fisheries industry in the Pacific." (Foscarini and Prakash, 1990, p.1)

This is contrasted to the international air transportation costs, which are recognized as a primary constraint to export industries in the islands (Asian Development Bank, 1996; Baquero, 1999; World Bank, 2002). Continental Airlines monopolizes the air routes in the FSM island region, and the limited capacity of the islands' airport runways dictate the size of aircraft that can land. At present, export industries are almost completely dependent on air transportation routes for their products. The World Bank (2002, p.4) has indicated, in a report on the Pacific Islands that:

> …the remoteness and isolation of many small states…particularly in the Pacific, has significant economic and administrative implications…. Transportation costs tend to be high, resulting from the distance of these countries from principal export markets…. Small economies also pay higher transportation costs because of the relatively small volume of cargo, small cargo units, and the need for bulk breaking, particularly if freight carriers and airlines attempt to exploit monopoly positions. High international transport costs serve to increase the cost of exports, thereby reducing their competitiveness and reducing export returns. Similarly, the costs of imports are increased, resulting in consumer welfare losses.

A critical aspect in the success of exporting live animals is ensuring that they arrive to the buyer alive. The extreme points of origin for Pacific tropical ornamentals dictate a transport duration range of 64 hours to in excess of 72 hours from farm site to arrival at primary markets. According to Cole, Tamaru, Bailey, Brown, and Ako (1999, p.3) …"when you consider total transport time, perhaps the most important aspect of shipping fish lies with the airline itself…". Marine Aquarium Council certification standards state

"that livestock transported in closed receptacles must be packed to survive at least 150% of the anticipated transport time" (Marine Aquarium Council, 1999, p.23). Therefore, familiarity with airline schedules and freight handling procedures is required for successful shipment.

Determining the optimal shipping parameters with regards to weight, container shape and type, quantity and type of fish per unit, density of oxygen, etcetera, will increase unit output for the producer. Optimizing parameters will also help deflect transport costs for the buyer by eliminating the shipping of extra water in large containers. The fish are confined to sealed plastic containers that are charged with oxygen. Unhealthy or fatal hazards such as oxygen-depletion, carbon dioxide poisoning, water chemical imbalance, or water leakage can occur at any point during the journey (Leung, Shang Wanitprapha, and Tian, 1994; Bruckner, 2001). The shipper must identify the balance of transportation conditions that will be the most cost-effective yet not inflict unnecessary risk on the specimens (Herwig, 1979; Cole et al, 1999).

Shipping charges are an important cost factor in the industry due to the lack of competition. The size of these charges is frequently not realized by foreign business planners or project aid donors as most global air transportation is competitive (Banister and Berechman, 2000). However, in the case of FSM, competitive equilibrium does not exist because there is only a single carrier, and there is not a substitute available for the monopolistic firm's product or service. Pricing exploitation may occur in these circumstances (Vickers, 2001; Banister, 2002). While price does not have to equal marginal revenue because the product is highly inelastic, market power of this nature inhibits the 'invisible hand' from intervening in price control mechanisms and allows the supplier to set its prices (Tomek and Robinson, 1995; Stonecash, Gans, King, and Mankiw, 1999).

The geography of the Tropical Pacific islands provides little incentive for airline firms to service the area. The islands are remote, generate little demand for cargo and passengers, and have limited runway and airport capacities (Campbell, Menz, and Waugh, 1989; Micronesian Entrepreneur Development Center, 1995). The cost of the craft and the fuel outweighs the generated revenue (Jasper, 2001). Therefore, with the exception of one or two carriers, airline firms historically have not competed for Tropical Pacific air routes. Micronesia is serviced by a single carrier.

The FSM government has directly and indirectly discouraged and prevented competitive airlines from entering its transportation market. Former FSM President, J. Hegleglam, explained this lack of entry during an address in 2002 to the effect that "Continental Airlines promised many benefits to the government in the form of complimentary tickets, price breaks, and special deals if the carrier was guaranteed to be the only airline allowed to fly in the FSM" (Hegleglam, 2002). While the country has been petitioned over the years by a few airline companies, access has consistently been denied by the government and, as a result, a monopoly now exists. This has disallowed protection from the "undue exercise of monopoly power" (Tomek and Robinson, 1995, p. 89). The nation's island

structure and geographic isolation in the Pacific Ocean eliminates the possibility of substitute forms of speedy transportation, thus rendering the service inelastic.
Given the nature of some products, airfreight is the only option many businesses have to transport their product to market. With a limited number of flights and a minimum amount of cargo space commanding premium prices, this cost is quite prohibitive and has a detrimental impact on the nation's ability to enter the world export market.

2.2.3 Government

Excess government interference in the private sector of the FSM appears to be a serious constraint to the growth of export industries. Developing nations are particularly susceptible as the government sector can control up to 90% of a country's monetary supply. Studies funded by independent institutions have found that government interference in the FSM and, indeed, the general Oceania area is substantial. Four commonalities on this issue are noted as follows:

1) Bureaucratic framework. Morisset and Neso (2002) describe the regulations and requirements for private entrepreneurs as complex, expensive, and irregular. The study found that administrative barriers vary across the islands and between government branches and tend to be higher in the lesser-developed nations. Such inconsistency in the bureaucratic process makes it difficult to estimate costs and time required, as noted in a research draft on planning for the promotion and development of indigenous enterprises in the FSM (Micronesian Entrepreneur Development Center, 1995). The draft recognizes the importance of consistent administration and states on page 18 that:

   > …policies and regulations, which affect the overall business environment, are the most important tools available to the government in the promotion of…enterprises. It is perhaps far more important than any direct assistance or service that may be provided… since the business environment affects the entire population …

2) Equal application of the rules. Island governments are fraught with nepotistic favoritism, bribery, black market practices, and fund embezzlement. Dobbin and Hezel (1998) elaborates on this prevalence by noting that the perpetrators or recipients of governmental favoritism are frequently the same people who are responsible for policing such behavior. Businesspersons not willing to participate in these activities or are unaware of this governmental sub-culture are biased against (Murphy, 1980).

3) Government takeover. Research by Hezel, Edwin, Petteys, and Chang (1997) note that island governments have the wherewithal to *adopt* a private industry and adapt it into a public enterprise. Repeatedly this has been the case when private production of a product has been profitable. For example, Ponape pepper was once considered a gourmet specialty item and commanded a high price in an international niche market. High profit margins attracted government involvement and, within a short time, the entire industry was under governmental control. Profits disappeared as the pepper quality decreased due to substandard

management and quality control, and the project was closed. Today, a single private firm processes and exports Ponape pepper on a limited scale.

4) Governmental decision discontinuity. "Government investment decisions must start with certain choices: (a) what broad sectors or industries are important, (b) within those sectors, what specific projects are crucial, and (c) what techniques make sense…" (Lynn, 2003, p.73). The Pohnpein government is not making the necessary sequential logistical decisions required of a successful export venture. That is, they are planning a production industry of an export product before an affordable transport conduit is available, and they are basing the export on the harvest of live animals before populations and sustainable harvest limits have been established.

2.2.4 Socio-Economic Constraints

Socio-economic factors are frequently the primary constraints to Micronesian ventures. In a report by Australian Planning and Training Associates (APTA) PTY LTD (1990), seven primary constraints exist in the islands of Oceania. They are summarized here.

1) Availability of a skilled workforce. There is a steady outflow of available skilled labour from FSM. This is a factor that is indicative of other developing nations (Hilson, 2003). Jammal (1998) reports the skills required for basic understanding of production operations and business management are not common in the local population. Knowledge of international markets, marketing, and capital financing is also low. The World Bank (2002) observes the steady outflow of available skilled labor is continuous and detrimental to the formation and retention of a skilled workforce.

2) Land tenure. The land tenure and ownership is complex and non-uniform throughout the islands. Ashby's (1999) research indicates each island has land conventions regarding foreign ownership, patriarchal/matriarchal passage, lagoon/reef access, and leasing allowances. For example, until 1910, the five traditional leaders of Pohnpei Island (Nahnmwarki) owned all of the land and the sea immediately adjacent to the land. The people in the Nahnmwarki's clan asked permission to farm and fish the land and sea and presented the leader with a harvest tithing in thanks. Private ownership introduced in 1910 allowed individual Pohnpeins to own land.

   Today, Pohnpeins still own all the land and sea; foreigners and Micronesians from other islands are not entitled to land ownership of the island. Johnson and Dahl (1995) in conjunction with the Bank of Hawai'i, found that although leasing to foreigners is permitted for a maximum period of 25 years, this period is often not long enough to warrant long-term investment and discourages foreign capital investment. In addition, the leasing process is quite complicated and obtained lease agreements are frequently revoked or violated with little or no recourse by the lessee (Hezel, 1992; Hezel et al, 1997).

3) Culture. Island tradition based on subsistence living is deeply ingrained in the population. Fishing, farming, and bartering have sustained the islands for millennia and the cultures and traditions that have emerged are rich and unique (Lynn, 2003). Gathering just enough to sustain one's family is a natural form of conservation and it allows plenty of time to cultivate social relationships, "which are regarded as the most important value in island life." (Dobbin and Hezel, 1998, p.11)

Johnson and Dahl (1995) describe the FSM as a communal economy based on the concept of extended family, where the individual's economic productivity, regardless of amount or value, belongs to the family. The altruistic nature of this sharing or spreading the 'wealth' is a concept that is part of the nation's identity. Such communal and familial obligation is at odds with the values of western capitalism and materialism (Chung, 1997).

4) Cost of inputs. One hundred percent of all technical and mechanical inputs and supplies must be imported. The lack of experienced mechanics and replacement parts further increase cost budgets. The charges are high for utilities, as are air transportation and export expenses. World Bank (1996 and 2001) indicators report that transport costs are at least 20% higher for Pacific island countries than other developing nations.

5) Funding. Bureaucratic rules and regulations depress foreign investment. Adding to this inefficiency is a mode of government operation that is not only rampant with nepotism, fraud, and embezzlement, but spends most of its money on current expenditures (Khalafalla and Webb, 2001). World aid and finance organizations make loans for productive, economic purposes and they generally do not finance government operations and consumption activities. Private investors seeking external funding for investment run into usury interest rates, as the risk of investing in FSM under the current government is high (Asian Development Bank, 1996).

6) Planning. A constraint to Micronesian industry is a poor to non-existent practical planning process. The Micronesian frame of reference does not include feasibility studies, international market awareness or understanding, accounting concepts, or monetary costs. Projects have historically been proposed by public officers or elected representatives of the subsidized government, not by entrepreneurs, scientists, or economists (Thomas, Dailami, Dhareshwar, Kaufmann, Kishor, Lopez, and Wang, 2000). Such projects typically do not benefit the general population, but rather government-connected individuals. Business plans must be tailor-made to fit an exact geographical location (Asian Development Bank, 2003). Feasibility of a business plan on one island does not necessarily extend to other islands. Acceptance and support by the community must also be factored into any plan (Campbell et al, 1989; Chung, 1997).

7) Infrastructure. The isolation of the islands in the Tropical Pacific contributes to infrastructure issues. Technology, hardware, and skilled personnel are imported at premium prices that are passed on to the consumer. Operating a western facility within the bounds of local specifications produces inconsistent and irregular products and services (World Bank, 1996 and 2002). Frequent electrical disruptions for extended periods and periodic contamination of the water supply compounds the existing problems associated with the island's infrastructure. As noted by Johnson and Dalh (1995, p.4), "until there is a concerted effort to build the necessary infrastructure, the nation cannot be a participatory player in the economic surge of its neighboring islands of Guam and Palau."

2.3 Marine Projects in the Tropical Pacific

"Marine resources are the most significant natural assets of the Yap State." (MRMD, 1994, p.5) This claim pertains to all Tropical Pacific islands because land resources are minimal compared to their marine resources. Familiarity with the sea and dependence on seafood are an integral part of island cultures. Therefore, extending this resource for commercial use should be intuitive. However, the leap from subsistence to commercial export is not easily attained (Baker, 1994). As indicated below, the harvest and production of several products have been attempted, with various levels of success.

2.3.1 Giant Clams (*Tridacna*)

Research has been conducted on the production and export of giant clams (*Tridacna)* in the Tropical Pacific island area, with Tisdell (1990 and 1992), in particular, providing insight into export potential for these bivalves. His focus is on Fiji, a main supplier of giant clams. Cultured clams are reared in land-based aquaculture sites, and then are transferred to wire cages in the ocean for completion of the growth phase. This type of aquaculture is "one of the few self-sustaining production activities available." (Tisdell, 1992, p. 12) This sustainability is a paramount issue because commercial exploitation of the clams has historically depleted wild clam stock.

In 1988, Fijian clam meat exports reached 38,493 kg prompting the Fijian Government to impose a 10-year export ban on the meat. Clams harvested for domestic or subsistence consumption were not affected (Tisdell, 1992). Tonga Island, while possessing the natural characteristics of *Tridacna* habitat, is an extremely limited exporter of the clams. A naturally abundant supply of the species is not available. Anecdotal evidence suggests that sporadic, heavy, short-term exploitation of the species has depleted clam stock in the area (McKoy, 1980).

There are three main end markets for giant clam products: Meat for human consumption, live specimens for saltwater aquariums, and giant clam shells. The meat is sub-divided into three separate products. These are adductor muscle, remaining flesh and mantle, and sashimi (Shang, Tisdell, and Leung, 1991; Leung et al, 1994). Specimens designated as marine ornamentals are of the highest quality, which is evident in the royal blue or green mantel of the clam. Clamshells are sold for decorative purposes or processed for

construction and manufacturing material (Ellis, 2000). Export of *Tridacna* products is the most justifiable goal of the industry as domestic demand is limited.

There are two government maintained giant clam productions facilities in Micronesia; one on Kosrae and the other on Lenger Island in the Pohnpein lagoon. These producers sell their ornamental giant clams at approximately one-quarter of the wholesale list price. Capital, opportunity, and administrative costs for the Micronesian facilities average 55% of the selling price. The wholesaler and retailer pay packing and shipping costs.

2.3.2 Coral

The trade of coral and the condition of coral reefs are two issues discussed in the literature on marine products. Coral is wild harvested or culture grown in open tropical waters. Unfortunately, coral reef habitat is declining. The World Resources Institute in the 1998 report 'Reefs at Risk' estimate that 58% of the world's reefs are currently being threatened by human activities (Bruckner, 2001). 1998 saw the most severe and extensive coral bleaching episode in modern history with the mortality fallout affecting 70-80% of all shallow-water coral specimens in the Indo-Pacific region (Bryant, Burke, McManus, and Spalding, 1998; Wilkinson, 1998). Destructive gathering has killed many reefs beyond the point of no return. Fallout from a killed coral reef is felt throughout the ecosystem, decreasing the output potential of plants and animals in the area (Marine Aquarium Council, 1998; Green and Shirley, 1999).

The halt of destructive collection and the education of sustainable production methods are united goals among oceanic conservation organizations. Global enforcement regulatory measures have been implemented and are slowly halting the destruction. Raised awareness and the willingness to pay for conservation are evident as consumers 'demand' coral from regulated countries or licensed dealers (Convention on International Trade in Endangered Species, 2001).

Live coral is marketed exclusively to the aquarium trade in developed nations. Since the product is harvested from equatorial waters, the transport distance and cost to market is a major consideration. Producers of soft coral receive approximately one quarter of the wholesale list price. Capital, opportunity, and administrative costs for a coral farming operation in Palau average 32% of the selling price. The buyers, wholesalers and retailers, pay for the packing and shipping portions of the chain, thus adding considerable value. The specimen continues to inflate in value until it is sold at eight times the producers' selling price. For example, a 3-4 inch Sun Polyp exports for US$2.00 and retails for US$16.00 (Sharon and Ellis, 1999; Jeff's Exotic Fish, 2002).

Ornamental species of hard and soft coral are abundant within the shallow reef waters of the FSM islands. Although a number of species demanded by the aquarium trade are available here, the majority of them are banned or restricted from export according to Convention on International Trade in Endangered Species (CITIES) and other regulatory agencies (Heslinga, 1995). There is not a domestic market for ornamental coral.

The accessibility of coral makes it easy to gather. On Pohnpei, coral dredging operations are continuous as the material is a cheap substitute for imported construction material for road surfacing and cement mix. Another use is personal; healthy coral is gathered, dried, and ground into lime. Lime is a key ingredient in betel nut chewing, the national equivalent to smoking or chewing tobacco. It is estimated that 100% of Micronesians living in the islands continually chew betel nut. A betel nut is split open, sprinkled with lime, wrapped in a pepper leaf, and chewed and sucked on for hours.

2.3.3 Seaweed

Eucheuma seaweed is used in the food processing industry in the form of carrageenan or seaweed flour. The carrageenan is extracted from the plant and can be found in ice cream, yogurt, canned food, and sauces to name a few. The chemical form of carrageenan is also used to manufacture water-based paints, toothpaste, shampoo, and beer. The pharmaceutical industry utilizes the seaweed's properties in many drug compounds. Although the uses are plentiful, the quantity of buyers is extremely small.

The cultivation of Eucheuma seaweed farms has had some success in the Fijian islands. This is because of the low technology required for production, the limited farming skills needed, the prime sea-growing space readily available, and the fact that the product may be exported on ships as Fiji is on several international shipping lanes. The industry has received funding and information from the Food and Agriculture Organization of the United Nations. This support provided for the publication of *The Handbook on Eucheuma Seaweed Cultivation in Fiji*, a detailed field document that provides step-by-step instructions on why and how to start and operate a farm. It also lists selling and marketing strategies specifically for Fiji. The export of the product has been steady enough over the past two decades to establish a reputation of quality. The industry is periodically disrupted when a buyer pulls out or changes, or when import restrictions on the product are created or adjusted (Foscarini and Prakash, 1990).

2.3.4 Trochus *(Trochus Niloticus)*

Trochus shells are large, thick turban-shaped shells with an edible fleshy mantel. Trochus meat has been harvested for subsistence purposes for centuries. The shell has historically been carved and fashioned for cookery, tools, and ceremonial adornment. Current uses for Trochus shell include buttons, jewelry, inlay material, and souvenirs. The meat is prized on the gourmet sushi market (Smith, 1992).

Trochus habitat occurs on tropical reefs, preferably on the ocean side where wave action is high. They live .6 to 6 meters under the water and are gathered by hand. Reproduction age is around two years old and fertilization occurs externally. The fertilized eggs become planktonic larvae and the succeeding rate of growth is strongly determined environmental conditions. Harvest is appropriate after a minimum basal diameter of 76 mm is reached (Heslinga, Orak, and Ngiremengiar, 1984; Bour, 1990).

Trochus harvest within the FSM islands during the first part of the 19th century averaged 23.8 tonnes per year. By 1923, the fishery had been depleted and harvest restrictions were applied. Commercial harvest started again around 1950 and great amounts were secured for export, with annual harvest averages of 208.6 and 163.3 tonnes from Chuuk and Pohnpei, respectively (McGowan, 1958; Izumi 1987). Significant declines in the post-harvest stock of the 1960's indicated severe over-fishing had occurred, and commercial harvest restrictions were again imposed for two decades. Yap and Pohnpei resumed harvest during the 80's and early 90's. The peak harvest for the FSM occurred in 1986 at 357.5 metric tonnes. During the interim, the value of Trochus had increased substantially and the highest annual revenue netted was during 1986 at US$138,500 for Chuuk, 1988 at US$506,400 for Pohnpei, and US$142,540 for Yap. (Smith, 1992)

Poor Trochus harvest management within the FSM is believed to be the cause of the fisheries continuous decline. Kosrae, Chuuk, and Pohnpei have government-defined sanctuary areas where harvest is not allowed, but Yap cannot define sanctuary areas because the nature of traditional ownership of the reefs prohibits it. The sanctuary boundaries were marked with piles of rocks and mangrove stakes; these were quickly washed away, damaged, or naturally reconfigured. This led to the establishment of larger and self-defined sanctuaries by officials. In 1988, the largest Pohnpein sanctuary was abandoned because of the lack of adequate manpower for necessary patrols. Subsequent transplant efforts to a more secure environment were undertaken. Three thousand shells were being successfully reared in an on-land tank hatchery when a typhoon hit the facility and killed 95% of the shells by destroying the tanks. (Micronesian Maritime Authority, 1990; Pohnpei Marine Resources Division, 1991).

Currently, the harvest season is two days per year on the FSM islands where harvest still occurs. The quantities gathered are for domestic use only and no Trochus is exported from the FSM. Subsistence gathering continues but on an extremely limited scale as stocks are very low.

2.3.5 Micronesian Studies on Marine Production and Exports

Several studies on the potential of production and export of the Micronesian aquatics indicate economic feasibility is low. Shepard and Clark (1984, p.91) observed that, although numerous aquatic production projects started with potential ..."long-term costs of production have been underestimated and economic failure and suspension of operations…have resulted". This negative opinion is shared by Murphy (1980) in a publication on fishery development problems in Oceania. He considers most ideas and proposals for aquaculture overly optimistic and believes that the majority of the money being invested will lead to nothing but disappointment and waste.

According to the World Bank (1996) and confirmed by Ascher (1997), the potential of capitalizing on a rich abundance of natural resources is frustrated by ineffectual management practices and the involvement of government. In the FSM, the lack of a coastal or in-shore fisheries management plan contributes to the stagnant growth of marine industries. Another aspect of the absence of regulations is any development of

intertidal fisheries, given the ready access to this area of the reef, can be easily over-exploited and habitat can be destroyed (Baker, 1994). It is argued, however, that sound and sustainable harvesting practices cannot be forced by laws and restrictions, rather they will be achieved through raising the awareness of traditional leaders who, in turn will educate the people and monitor their compliance (Virdin, 1999). This awareness is critical to finding the right balance between development and environment as without adequate environment protection, developmental progress will be thwarted or eventually halted (Thomas et al, 2000).

Another contributing factor is the tradition of communal sharing and an inability to separate business and family. For example, family members have access to any part of the business assets. As noted by the Micronesian Entrepreneur Development Center (1995), a prevalent cause of business failure is directly related to not realizing or factoring in one's family obligations. Saying no or refusing to oblige or cooperate with a request from a family member or high clan member is not acceptable.

Similarly, Uwate and Kunatuba (1983) express strong pessimism for economic viability of the Pacific island marine industry attempts. To this extent, Uwate and Kunatuba reviewed a number of South Pacific Islands Fisheries Development Agency's initiatives, production facilities, and research sites located in New Caledonia, Fiji, and Palau. Of all the projects studied, successful technical feasibility and commercial viability of the generated products was not demonstrated in a single case.

Pessimism of marine exports continues with Campbell et al (1989, p.169) recounting cynicism for aquatic ventures in the islands in a paper presented in Tasmania:

> The reality is, however, that the benefits of potential projects have rarely been sufficient to make them commercially viable. It is overly optimistic to hope that, at the present stage of development, the success of aquaculture in Southeast Asia can be repeated in the Pacific. Indeed, the South Pacific region is the antithesis of Southeast Asia. Unlike Asia, the islands of the Pacific have low populations, are unable to find large markets, have poor transport and communication facilities, are not in a position to trade significantly on an inter-island basis, and they lack the required infrastructure and refrigeration facilities. Most importantly, the cultural and social characteristics of the islanders, and their traditional background, have not proved conducive to aquaculture development in general.

2.4 Political/Legal Economic Sociocultural Technological (*PEST*) Analysis

The Political/Legal Economic Sociocultural Technological (*PEST*) analysis is used to examine the current trends and concerns of the marine ornamental trade environment. Past events and future possibilities are also touched upon (Rugman and Hodgetts, 1995; Johnson and Scholes, 1999).

2.4.1 *P*EST: Political/Legal

There are two main political/legal factors that have an impact on the global industry for marine ornamentals. These are environmental protection concerns, and global trade implications. Environmental influences and macro environmental conditions directly impact upon organizations within an industry. Therefore, awareness and understanding of such environmental factors are paramount to organizational success. Influences pertaining to the harvest and sale of marine ornamentals are particularly important since the product is alive and perishable.

In terms of environmental protection concerns, given the nature of the collection methods of these live animals, it is vitally important to the sustainability of the species and their natural habitats that environmental protection measures are in place and adhered to. Unfortunately, the growing environmental awareness and proactive stance that developed nations have taken in this area are slow at being adopted in the developing sectors of the Tropics. Collectors of marine fish are usually one step away from poverty and they are rewarded for the quantity of fish they catch (ABC 1999; Boruchowitz, 2001). Consequently, excessive habitat disruption or reef destruction is of secondary concern. Structured resource renewal and sustainable habitat management are advanced western practices and rarely play into the collection ways of native fisherpersons (Marine Aquarium Council, 1998; Baquero, 1999 and 2001).

The global trade implications of harvesting the live product from one location and exporting it into a foreign environment can be considerable. Almost 100% of marine ornamentals are harvested from tropical waters (National Oceanic and Atmospheric Administration, 2001). Demand, however, is concentrated in the northern hemisphere. Transporting animals out of their indigenous surroundings into foreign regions has potentially serious repercussions. Exotic or alien species, defined as introduced from abroad and not native, are capable of carrying disease and contaminates to native animals and environments. The release of tropical fish into foreign bodies of water has, on occasion, devastated native populations and adversely altered local ecosystems (Ornamental Aquatic Trade Association, 2001). In reaction to this threat, several lawsuits filed in the US courts pertaining to imported animals include a clause to ban the trade of live marine organisms (Sadvoy, 1999; National Oceanic and Atmospheric Administration, 2001).

Another protective measure to ensure continued native biological balance has been taken in Western Europe. An import risk analysis process has been initiated, with the main focus being examination of the effectiveness of current quarantine practices (Fossa, 1997; Ornamental Aquatic Trade Association, 2001).

2.4.2 P*E*ST: Economic

Opposite economic conditions exist between the suppliers and consumers of the industry. In terms of supply, approximately 95% of marine aquatics are harvested from tropical nations that are classified as under-developed or developing. These countries have

economies ranked by the World Bank as low to lower-middle income (World Bank, 2001). Laborers in Indonesia and some of the Pacific islands earn less than US$755 annually, or approximately US$3 per day. The Philippines, Fiji, Sri Lanka, and the remaining Pacific islands pay annual wages ranging from US$756 to US$2,995, or US$3 to US$12 per day. Fish collectors are paid by piecework, as they are generally not qualified to earn a set wage. On average, compensation per fish is equivalent to a few US pennies (Baquero, 1999; University of Florida, 2001). This low cost of labor is one of the competitive advantages such locations possess.

Conversely, consumer economies that import marine ornamentals are classified as developed with high-income levels. American marine aquarium hobbyists spend on average US$1 billion a year for tropical fish and on aquarium supplies. Similar expenditures occur in Europe and marginally lesser amounts in Japan (Marine Aquarium Council, 1998; Adams, Larkin, Degner, and Milon, 1999; Environmental Media Services, 2001). Ready access to a wide selection of marine fish and support supplies is characteristic of all the nations that import this product.

2.4.3 PEST: Sociocultural

Two sociocultural influences are emerging as influential factors in the marine ornamental trade. These are environmental awareness and response, and issues pertaining to the humane treatment of animals.

Awareness and knowledge about coral reef ecosystems are on the rise. The destruction of the reefs due to the collection methods of marine ornamental harvesters is a major concern. Irreversible damage to the skeletal structure and plant environment of reefs and the spread of lethal contaminants are common as fisherpersons attempt to capitalize on the rising demand for their product (Marine Aquarium Council, 1998; Food and Agriculture Organization of the United Nations, 1999; International Center for Living Aquatic Resources Management, 2001).

In response to the growing need to protect the world's tropical reefs from demand consumerism, the production option of aquaculture for marine ornamentals is being revisited. Although this is the natural alternative to wild-caught fish, as of 1999 there were only five marine aquaculture farms around the world, collectively contributing less than 1% to the total tropical fish supply. The practice of marine aquaculture has not had the success rate of freshwater aquaculture ventures for several reasons:

1) cultivation of the fish has yet to be proven economically viable on a long-term basis;
2) the quality and color of the fish are frequently inferior to their wild-caught counterparts;
3) disease control and other biological concerns, prevalent in marine hatchery fish, are in the research or immediate post-research stages. Progress in this field of study is required if industry sustainability is to be achieved. This fact has been

recognized and research funds and investment into start-up farms are increasing (Tropical Marine Centre, 1998; King, 1999; Fisheries Western Australia, 2000).

Attitudes and practices in the humane treatment of animals vary around the world for different reasons. Economic conditions of developing nations contribute significantly to the way tropical fish are collected and handled. For example, in order to increase product quantity, sodium cyanide poisoning is sprayed on the reef and into surrounding areas to stun the fish and make collection a simple matter of scooping up handfuls of inert fish. Although the ingested poison dissipates and the fish subsequently revive, side effects stay with the fish indefinitely. The fish are held for processing in rusty, leaky tin buckets that are sitting in the direct sunlight for extended periods of time because other containers are not available or not affordable. To the western perception, such husbandry is inhumane, however, to the fisherperson, it is the most economically feasible way to catch large quantities of fish quickly and hold them at a minimum cost (Marine Aquarium Council, 1998; ABC, 1999; Baquero, 1999 and 2001; Boruchowitz, 2001; International Center for Living Aquatic Resources Management, 2001).

Private firms operating within the import and retail segments of the industry are beginning to invest in the direct education of suppliers. In actions similar to vertical integration, sound harvesting methods, environmental awareness, and fish welfare skills are being taught and supplemented with the provision of quality supplies. The realization is that the industry's longevity and profitability are positively correlated to these actions (Marine Aquarium Council, 1998).

2.4.4 PES*T*: Technological

Aquatic technological advances over the previous decade have contributed to the rapidly expanding hobby of aquaria (Boruchowitz, 2001). The current trend in marine tanks is the simulation of a coral reef environment. These aquariums require an extensive amount of hardware and apparatus; at a minimum, an artificial light source, a water heater, bio-filters, an aeration/gas exchange system, and a 250-1000 liter tank is required. Competition is increasing as aquarium distributors take advantage of new technology and rising customer demand. This, in turn, lowers the equilibrium price, allowing more purchases to be made. Purchases of aquarium paraphernalia are not singular in nature, thus, the proliferation of the industry is supportive within itself.

2.5 Summary

The Compact that has been supporting the FSM has ended, and the islands are attempting to establish a market economy. The export of marine products is an industry option given the island's access to marine resources.

Before the industry can be successful, several regional constraints need to be addressed. Business plans must have a practical application, and must include realistic cost and revenue information. Recognizing that transportation of the product is a critical part of a foreign production industry and that dependence on a single air carrier is expensive is

important. Government interference in the private sector is high. Excessive bureaucracy discourages entrepreneurial investment. Island and population characteristics and the lack of a skilled workforce, land and culture issues, and business and infrastructure concerns affect economic progress. These constraints have manifested in past production efforts of giant clams, coral, seaweed, and Trochus.

Current trends and concerns in the marine ornamental trade environment will influence the progress of a FSM ornamental industry. Aquarium technology is increasing and the demand for fish is growing. However, environmental concern of coral reef habitat and fish collection methods is also progressing.

CHAPTER 3
A COST-EFFECTIVENESS ANALYSIS OF A POHNPEIN MARINE ORNAMENTAL EXPORT INDUSTRY

3.1 Introduction

As discussed in previous chapters, the Compact of Free Association between the United States and the FSM officially ended in 2001. However, negotiations have taken place to extend the deadline by which the nation will be required to become economically self-sufficient. Potential industries are being considered by the government, and several have been identified as being economically viable. Therefore, the objective of this chapter is to develop a model that assesses the viability of establishing an export-oriented industry supplying marine ornamental fish to the US market from Pohnpei, FSM. In this dissertation, the approach taken to measuring viability is cost-effectiveness analysis.

This chapter is organized as follows:

Section 3.2 *Economic Evaluation*

In this section, economic efficiency of the potential marine ornamentals' export industry is derived by applying a cost-effectiveness analysis. Section 3.3 *Scope and Objective of the Analysis*. This study is concerned with analyzing the viability of the export with the primary aim of developing a cost-effectiveness model. There are seven constraints associated with this assessment approach.

Section 3.4 *Cost Identification*

Listed in this section are six cost categories necessary for the CEA of Pohnpein ornamentals. Capital, labor, opportunity, transportation, environmental, and miscellaneous input costs are identified and valued.

Section 3.5 *Output and Outcomes (Benefits) Identification*

In this section, the benefits that will be generated by the project are identified and discussed. They are revenue, resale value of the capital equipment, saved costs, productivity savings, and non-quantifiable outcomes.

Section 3.6 *Summary*

Summarized in this section is the justification for using CEA and the subsequent building of its framework of constraints, costs, and outcomes.

3.2 Economic Evaluation

Economic analysis is defined by the Asian Development Bank (2003, pp.1-2) as:

> ...attempts to assess the overall impact of a project on improving the economic welfare of the citizens of the country concerned. It assesses a project in the context of the national economy..[and]..includes all members of society, and measures the project's positive and negative impacts in terms of willingness to pay for units of increased consumption, and to accept compensation for foregone units of consumption…

As previously noted, the analytical framework, upon which the current model is based, is a cost-effectiveness analysis. For the purposes of this study, a cost-effectiveness framework will enable the systematic recording and comparison of the costs of inputs with the outputs and outcomes of establishing an export-oriented business, supplying marine ornamental fish. It will allow for the determination of the economic efficiency of the industry initiative and, as a consequence, lead to more informed decisions on resource allocation between different industry initiatives and policy options.

As Dhiri and Brand (1999, p. 8) note, "economic evaluation enables a number of key questions to be answered:

- What was the true cost of an initiative, practice or policy?
- Did the outcome(s) achieved justify the investment of resources?
- Was this the most efficient way of realizing the desired outcome(s) or could the same outcome(s) have been achieved at a lower cost through an alternative course of action?
- How should additional resources be spent?"

In the case of the FSM, these questions would seem particularly pertinent given the current conditions attached to the US Compact of Free Association. However, it should also be noted that while economic evaluation provides a useful tool for assessing the use of scarce resources and comparing the costs and benefits of different initiatives, practices and policies, it does not necessarily provide the final answer as to whether or not a policy option or initiative should be pursued. There are likely to be a range of reasons for allocating resources in a particular way, which fall outside the scope of the analysis (Dhiri and Brand, 1999).

3.2.1 Cost-Effectiveness Analysis (CEA)

As previously indicated, the evaluative technique used to determine the efficient allocation of resources in the current study is cost-effectiveness analysis. The underlying objective of cost-effectiveness analysis is to assist or provide guidance to decision-makers on the efficient allocation of resources in areas where private markets cannot or do not achieve allocative efficiency. Cost-effectiveness analysis assesses alternative projects in terms of their relative contribution towards a specific objective. In other words, a non-monetary criterion of effectiveness is predetermined and alternatives are then compared in terms of either their cost per unit effectiveness or of units of effectiveness per dollar. As Dhiri and Brand (1999, p.13) point out "CEA compares

alternative cost streams to produce broadly similar outputs or outcomes. The least-cost alternative to produce the defined outcome (or set of outcomes) is the most desirable option. This is, however, subject to wider outcomes that cannot be incorporated into the analysis, being taken into account".

3.3 Scope and Objective of the Analysis

The first step in developing a cost-effectiveness model of Pohnpein ornamentals is to define the scope and objective of the analysis and to outline the constraints associated with meeting the objective to be addressed by the export business initiative.

As previously indicated, this study is concerned with analyzing the viability of supplying Pohnpein marine ornamentals to the US market. In this connection, Pohnpein ornamentals refer to ocean-harvested ornamental reef fish. The objective of this study is to develop an economic cost-effectiveness model to determine viability of the export of Pohnpein ornamentals.

As stated in chapter 1, the specific research objectives of the study are to:

1) identify a mix of economically viable fish and estimate the profit associated with the specific mix of fish;
2) estimate the costs associated with the export of Pohnpein marine ornamentals;
3) determine the effect that the monopoly structure of the transport industry has on export viability.

3.3.1 Constraints

There are a number of likely constraints associated with determining the viability of the proposed industry. For ease of reference, these constraints have been placed into seven categories as follows:

1) Environmental Constraints
2) Financial Constraints
3) Distributional Constraints
4) Management Constraints
5) Transportation Constraint
6) Cultural Constraints
7) Infrastructure Constraints

3.3.1.1 Environmental Constraints

As previously indicated in chapters 1 and 2, the FSM is largely a subsistence economy. To this extent, reef fish play a fundamental role in the island's food supply. Disruption of this resource because of export initiatives is likely to result as the displacement of fishermen from the subsistence labor force and the disturbance and relocation of the food fish will impact Pohnpei's food supply.

Damage to the reef's ecosystem inflicted by harvesters will affect the intertidal zone, the mangroves, and the shoreline of the island. The extent of the impact is unknown; however, degradation always produces negative repercussions. Intertidal and mangrove harvesting of crustaceans will decline if habitat erodes. Coral polyp displacement or breakage will erode the integrity of the reef itself, and Pohnpei Island is a coral reef atoll.

The land tenure and ownership is complex and non-uniform throughout the islands. Ashby's (1999) research indicates each island has land conventions regarding foreign ownership, patriarchal/matriarchal passage, lagoon/reef access, and leasing allowances. For example, until 1910, the five traditional leaders (Nahnmwarki) of Ponape Island owned all of the land and the sea immediately adjacent to the land. The people in the Nahnmwarki's clan asked permission to farm and fish the land and sea and presented the traditional leader with a harvest tithing in thanks. Private ownership introduced in 1910 allowed individual Ponapeins to own land. Today, Pohnpeins still own all the land and sea; foreigners and Micronesians from other islands are not entitled to land ownership of the island. Harvest tithing is still offered out of respect to the five Nahnmwarki families even though all land is privately owned. Johnson and Dahl (1995) in conjunction with the Bank of Hawai'i, found that although leasing to foreigners is permitted for a maximum period of 25 years, this period is often not long enough to warrant long-term investment and discourages foreign capital investment. In addition, the leasing process is quite complicated and obtained lease agreements are frequently revoked or violated with little or no recourse by the lessee (Hezel, 1992; Hezel et al, 1997).

3.3.1.2 Financial Constraints

For a nation completely reliant on subsidization, financial constraints are a relatively new concept. The industry is not going to be subsidized by the US government, but be privately financed. There are only two lending institutions on Pohnpei. Both banks have strict guidelines for borrowing, and require a substantial amount of local collateral for all loans. Frequently, the only collateral available on-island is family land, owned collectively among many persons, and agreement to pledge the land for collateral is not forthcoming.

Bureaucratic rules and regulations depress foreign investment. Adding to this inefficiency is a mode of government operation that is not only rampant with nepotism, fraud, and embezzlement, but spends most of its money on current expenditures (Khalafalla and Webb, 2001).

World aid and financial organizations make loans for productive, economic purposes and they generally do not finance government operations and consumption activities. Private investors seeking external funding for investment run into usury interest rates, as the risk of investing in FSM under the current government is high (Asian Development Bank, 1996). The Compact's intention is for Micronesians to become self-sufficient and not rely on foreign aid. Therefore, acceptance of foreign assistance or aid is not acceptable.

3.3.1.3 Distributional Constraints

Cultural dictates complicate the distribution of the monetary benefits derived from harvesting since the reef is publicly owned. A portion of all sea bounty or its monetary equivalent must be offered to the Nahnmwarki, the traditional clan leader of the land and sea bordering the reef area. If an offering is not made, the public reefs will become culturally 'inaccessible'.

If Pohnpei develops a successful industry, jealousy and rivalry from the other three island states is possible. Other Micronesians residing on Pohnpei will want to become involved with the export in order to send money to their islands. In addition, as Pohnpein economic success grows and the need for subsidization is eliminated, the remaining funds of the Compact, until its final termination, are likely to be directed towards Yap, Chuuk, or Kosrae, essentially penalizing Pohnpei for successful economic growth.

3.3.1.4 Management Constraints

Good management of any operation is essential for success. Regional constraints contribute to the difficulty of managing a Pohnpein-based firm. As in other developing nations, there is a steady outflow of available skilled labour from FSM (Hilson, 2003). Jammal (1998) reports the skills required for basic understanding of production operations and business management are not common in the local population. Knowledge of international markets, marketing, and capital financing is also low. The World Bank (2002) observes the steady outflow of the available skilled labor is continuous and detrimental to the formation and retention of a skilled workforce.

Management personnel with the skills to operate a production firm are not available on-island. Off-island recruitment is expensive and a lengthy process. Too often, when a candidate is hired from abroad and relocates to Micronesia, they cannot acclimate and return home. If the candidate does stay, they find working within the confines of a developing nation extremely frustrating and this contributes to a low retention rate of qualified foreign workers.

Governmental regulation dictates that all businesses in Pohnpei be owned by a Pohnpein. Foreign-managed firms that are owned by local citizens tend to run into the pervasive problem of profits being readily siphoned off into the local family purse. Re-investment rarely occurs as management of the finances is controlled by the Pohnpein and indirectly, their family. This is the sole reason why many businesses have failed.

Poor to non-existent practical planning processes hinder management effectiveness. The Micronesian frame of reference does not include feasibility studies, international market awareness or understanding, accounting concepts, or costs. Projects have historically been proposed by public officers or elected representatives of the subsidized government, not by entrepreneurs, scientists, or economists (Thomas et al, 2000). Such projects typically do not benefit the general population, but rather government-connected individuals. Business plans must be tailor-made to fit an exact geographical location

(Asian Development Bank, 2003). Feasibility of a business plan on one island does not necessarily extend to other islands. Acceptance and support by the community must also be factored into any plan (Campbell et al, 1997).

3.3.1.5 Transportation Constraint: Airline Structure External of the FSM

Product transportation is a key element of success for any production project. The airline firms that supply transport services to the US ornamental trade may collectively be considered an oligopoly (Onkvisit and Shaw, 1997). They are relatively few in number, the cost of entering the airline industry is very high, product differentiation is low, prices are similar, and a direct substitute does not exist. The oligopoly criterion effectively prevents start-up airlines from entering the market specifically to service diverse locations. A lack of competition in the FSM allows for a different market structure, namely a monopoly, which is controlled by Continental Airlines. The prices for Continental's services must be accepted if air cargo is to be exported from the island. Product substitution for tropical marine ornamentals is high with the majority of supply originating from the Philippines. Shipping costs from the Philippines are lower than those from the FSM. Therefore, buyers can purchase the product cheaper given that shipping costs are lower.

3.3.1.6 Cultural Constraints

Culture plays an integral part in who the Pohnpein people are, and island tradition based on subsistence living is deeply ingrained in the population. Fishing, farming, and bartering have sustained the islands for millennia and the cultures and traditions that have emerged are rich and unique (Lynn, 2003). Gathering just enough to sustain one's family is a natural form of conservation and it allows plenty of time to cultivate social relationships, "which are regarded as the most important value in island life." (Dobbin and Hezel, 1998, p.11)

Johnson and Dahl (1995) describes the FSM as a communal economy based on the concept of extended family, where the individual's economic productivity, regardless of amount or value, belongs to the family. The altruistic nature of this sharing or spreading the 'wealth' is a concept that is part of the nation's identity. Such communal and familial obligation is at odds with the values of western capitalism and individual materialism (Chung, 1997).

3.3.1.7 Infrastructure Constraints

The isolation of the islands in the Tropical Pacific contributes to infrastructure issues. Technology, hardware, and skilled personnel are imported at premium prices that are passed on to the consumer. Operating a western facility within the bounds of local specifications produces inconsistent and irregular products and services (World Bank, 1996 and 2002). Frequent electrical disruptions for extended periods and periodic contamination of the water supply compounds the existing problems associated with the island's infrastructure. As noted by the Johnson and Dalh (1995, p.4), "until there is a

concerted effort to build the necessary infrastructure, the nation cannot be a participatory player in the economic surge of its neighboring islands of Guam and Palau".

3.4 Cost Identification

Cost variables are defined by Dhiri and Brand (1999, p.2) as "any human, physical, and financial resources that are necessary to undertake a project." In this study, there are six cost categories for the production of Pohnpein ornamentals. These are:

1) Capital Costs
2) Labor Costs
3) Opportunity Costs
4) Transportation Costs
5) Environmental Costs
6) Miscellaneous Input Costs

3.4.1 Capital Costs

Capital assets are necessary for the start of any business. The fixed assets required for this production firm are an automobile, a boat and engine, and general office equipment. While these assets may be acquired on-island, with the exception of office equipment, they are likely to be second-hand. However, this may result in a lower initial cost, given that any item ordered from off-island will attract a surcharge of at least 25%.

There is no new automobile dealership on the island. However, used Japanese and American automobiles are sold by local enterprises and through private sale. Similarly, boats are often imported from Chuuk, bought through private sales, or are ordered from off-island. In the latter case, boats are required to be shipped to Pohnpei and this results in an additional expense. Boat engines may be purchased on Pohnpei, but the selection is limited to two brands and a few sizes. Typically, engine prices are 30% to 50% higher than US mainland prices.

Office equipment, on average, costs 50% more than it would in the US. High-tech or specialty items must be ordered off-island. Production equipment of various aquatic hoses and pumps, a generator, and two oxygen regulators are required to house and pack the fish for shipment and are typically available only off-island.

The average cost of capital is 8%. Depreciation is straight-line over five years due to the used condition of most of the assets; however it is not included in this analysis as it is an accounting expense.

3.4.2 Labor Costs

Unskilled, local labor is utilized for the harvest and capture of the ornamentals and is readily available. It is important to realize that any unskilled labor employed will likely subtract from the subsistence labor pool. Management of the plant and holding site

requires skilled, typically educated and foreign, employees. Recruitment off-island for management personnel is characteristic, however, the normal amount of applications received is very low.

3.4.3 Opportunity Costs

Opportunity costs are the costs of using facilities or land that are already in use for some other project. Available rental space is rare and always priced at a premium given the small amount of developed and available land on the island. Shoreline land that is appropriate for holding tanks is at a minimum. Water-adjacent land will have to be leased from private clans and there will be inconvenient stipulations, such as unlimited access for the clan across the land to the water and boat mooring rights for the family.

3.4.4 Transportation Costs

Continental Micronesia, a commercial passenger airline, is the sole transport option for this export product. Transporting the animals via an ocean-going vessel is not an option at this time since such cargo vessels currently do not service the islands.

The transportation costs of moving live aquatics from Micronesia to the US market are prohibitive. Transportation expenses are not directly paid by the local producer; they are a cost absorbed by the buyer. However, the amount of the shipping expense directly impacts the net price paid for the product. The indirect transference of shipping costs to the producer is fundamental to the question of export viability. Monopolistic control of the air conduits by Continental Micronesia exacerbates this element of the cost equation.

Live aquatics must be air shipped via two specific cargo classes; wet cargo and must-confirm. Wet cargo rates are charged per 1000 kilograms. Must-confirm indicates that freight in this category cannot be bumped and is guaranteed to fly. Must-confirm status requires a premium charge that is dependent on the length of the journey. From Pohnpei to Guam, the wet cargo, must-confirm cost per 1000 kg is US$2,080, and to Hawai’i, the charge is US$7,380.

Pohnpei’s international airport consists of one small open-air terminal. The single lane runway is 1.83 kilometres long. The largest aircraft it can accommodate is a Boeing 737-800. Pilots are required to be able to undertake precision landings and take-offs. An over or under shot of the smallest degree will literally land or dump the plane into the ocean and, in turn, lead to the runway being inaccessible. This will effectively close the island’s only air conduit.

One flight per day arrives and departs Pohnpei. On Monday, Wednesday, and Friday the plane originates in Guam and is destined for Hawai'i. Tuesday, Thursday, Saturday, and Sunday the plane turns around and transverses back over the same route. This flight is aptly known as the ‘island hopper’. On departure from Guam, the stops it makes en route to Hawai'i are Chuuk, Pohnpei, Kosrae, Majuro, Kwajalein, and Johnston. Cargo space is at a premium, as mail, medical supplies, other export products, and, of course, luggage

for the onboard passengers is restricted to 44 cubic meters. Commercial shipments are frequently off-loaded to await later flights if the need for emergency shipping of items arises; for example, a dead body being shipped off-island, Christmas mail, medicine to curb an epidemic, typhoon relief and so on.

3.4.5 Environmental Costs

The environmental costs associated with this export are critical given that the supply is alive and an integral part of an ecosystem. The type of fish supplied must mirror demand as closely as possible, but at the same time maintain stock sustainability. Harvesting all types of fish and selling those with lesser levels of demand at reduced rates is not an optimal situation. This will only serve to deplete the overall reef population. Conversely, harvesting large quantities of fish in high demand will quickly draw supply down to unsustainable levels. Therefore, optimal production combinations will require a rotation or seasonal product mix of high demand species. Such a rotation among the species will conform to the superimposed harvest limitations required to maintain reproduction and overall sustainability.

Fish populations inhabiting the Pohnpein reef zone have not been established. Scientific data pertaining to the reefs and intertidal zone around Pohnpei does not include fish population dynamics. However, the general benchmark of sustainability accepted within the scientific community is that a species population has the ability to sustain itself at a 10% removal rate per year. For hermaphroditic species, removal may be slightly higher.

Reef preservation has significant cultural value as the ties between the islanders and the sea go back millennia. Aquatic-related ceremonies and recreational activities are interwoven with the people's identity and religion.

3.4.6 Miscellaneous Input Costs

Additional costs for supplies and services not captured thus far are categorized as miscellaneous input costs. Automobile insurance is not a legal requirement, but it is highly recommended. Fishing implements such as nets, snorkels and masks, and buckets are available continuously in the retail outlets. Packing supplies required for transportation of the live export must be acquired off-island. Other supplies such as toner or printer cartridges may or may not be available as island-bound cargo is frequently bumped or delayed without notice. An additional complication to receiving supplies from a cargo ship is the fact that the vessel arrives once every six to eight weeks.

Bureaucratic licenses and miscellaneous business requirements are frustrating and difficult to obtain for foreigners, and the local owner is usually not knowledgeable or apt in paperwork requirements. The FSM government is not an organized or consistent entity, and discrimination against foreigners or favoritism of certain clans contributes to lengthy and inefficient red tape.

Utility services provided by the public utility corporation are often unreliable. Electrical

surges are frequent and power outages occur on a regular basis. This less than optimal service is due to the state of equipment, a lack of local repair knowledge and expertise, and the fact that all supplies must be purchased off-island. For businesses that depend on consistent power, a gas generator is mandatory.

Water and sewer service is also of inconsistent quality. The many pigpens and local 'toilets' on Pohnpei frequently leak raw sewage into the underground water pipes, thus contaminating the water supply. Businesses that rely on a clean source of fresh water must have a filtration system in place. Businesses located on the shoreline and which are dependent on clean saltwater for their operations must be aware of any sewage drainpipes on or near their property. Evidence of draining sewage may invalidate saltwater-reliant operations at that location.

Telephone prices are established rates determined by the FSM government. Telecom Pohnpei has a website that lists basic and international telephone rates, as well as Internet charges. Off-island calls are prohibitively expensive, as the island is not linked to a fibre-optic cable network. Basic internet is available at the much more reasonable rates of US$19.95 per month. This charge includes 10 hours of internet access, with each additional hour costing US$1.95. Email is the most utilized communication method to and from the island.

3.5 Output and Outcomes (Benefits) Identification

The intended benefit of establishing the export industry is to initiate a private industry that will generate revenue and economic activity, thus lending to the support of the island's livelihood. In support of this goal, the following benefits will be generated by the project:

1) Revenue
2) Resale Value of the Capital Equipment
3) Saved Costs
4) Productivity Savings
5) Non-Quantifiable Outcomes

3.5.1 Revenue

Selling the fish to the US market will generate revenue for the export. Disposable income supports the retail market for the fish. The latest trend in aquariums is artificial reef habitats. Since tropical fish are the type of ornamentals necessary for these habitats, the retail price for the fish is relatively high compared to fresh water fish. Indirect revenue from the export will flow into the Pohnpein retail market as on-island supplies and equipment for the industry are continuously purchased.

3.5.2 Resale Value of the Capital Equipment

The resale value of the capital equipment will be low to non-existent. There are four reasons for this:

1) Most equipment purchased will be second-hand. Additional use will further decrease its value.
2) There is not a market for twice-used equipment.
3) New assets acquired may have a low resale value. The climate conditions of high humidity and heat cause electrical equipment to degrade quickly, and a lack of proper maintenance devalues boat and automobile engines.
4) Another contributing factor to the devaluation of assets is the poor quality of inputs or external conditions. Specific examples of this include; for engines and motors, watered down or dirty diesel and gas corrode and hinder functionality and longevity; for electrical equipment, frequent power surges and disruptions and power outages reek havoc on electrical circuits; and for automobiles, bad roads, heavy loads, and continuous use of the vehicle for personal or clan use shorten the automobile's lifespan considerably.

It is common practice on the island to simply leave used assets for the owner of the land. This courtesy is assumed when a foreign managed firm enters into a business arrangement and a lease agreement with a local Pohnpein.

3.5.3 Saved Cost

When the Compact subsidies end, the only means of support for the nation will have to be self-generated. If an economy is not established, the population may be fed with subsistence bounty. As the pool of money decreases, expenditures on the tangible and intangible that increase the quality of like, such as medical care, utilities, fuel, transportation, and education will cease.

3.5.4 Productivity Savings

Currently, there are no direct expenditures that will be saved as a result of the project. Indirectly, however providing a livelihood from employment will lessen the public assistance costs and lessen the burden on the subsistence sector.

A contractual agreement between the US and the FSM for the Micronesian islands to eventually become a self-sustaining nation was one of the binding factors of the Compact. Project development in an attempt to fulfill the contract obligation will save the nation from being in violation of the Compact.

3.5.5 Non-Quantifiable Outcomes

The most important non-quantifiable outcome of the industry is the acquisition of business knowledge and awareness. The Pohnpeins must learn how to operate

efficiently in a business/economic arena if their island and nation is to survive and progress into the global economy as an independent country. Learning how to maintain and protect their natural resources while exploiting those resources for economic gain is also of benefit to the Pohnpeins.. The symbiotic relationship between the people, the land, and the sea is part of the nation's identity and cannot be lost.

3.6 Summary

The cost-effectiveness analysis developed to assess the viability of establishing an export-oriented industry of aquarium fish from the FSM addresses the research objectives of this study. That is, to estimate the costs associated with the export of Pohnpein ornamentals, identify a mix of economically viable fish and estimate the profit associated with the specific mix of fish, and determine the effect that the monopoly structure of the transport industry has on export viability.

The analytical framework consists of seven constraints; environmental, financial, distributional, management, transportation, cultural, and infrastructure. Six cost categories also contribute to the framework; capital, labor, opportunity, transportation, environmental, and other inputs. Five outputs and outcomes are identified; revenue, resale value of the capital equipment, saved costs, productivity savings, and non-quantifiable outcomes.

CHAPTER 4
INTERPRETATION AND RESULTS

4.1 Introduction

In this chapter, the results of the cost-effectiveness analysis developed in chapter 3 are examined. The costs previously identified are quantified and valued in order to calculate the output and outcomes of the production process. Viability of establishing the export industry can then be determined.

This chapter is organized as follows:

Section 4.2 *Sample*

In this section, a sample of 21 Pohnpein ornamentals is identified. Specie sustainability and population parameters are examined and their importance to the export venture is explained.

Section 4.3 *Value of Costs*

In this section, the monetary value of business initiation and production expenses is estimated.

Section 4.4 *Outcomes and Benefits*

In this section, the expected outcomes and benefits of the export industry are quantified. Revenues and expenses are estimated in a net income statement that can be used in determining financial viability.

Section 4.5 *Results*

The three research objectives of this paper are addressed in this section. The findings support the primary goal of this paper, namely is economic viability present in a Pohnpein marine ornamental export project.

Section 4.6 *Summary*

In this section, the results of the cost-effectiveness analysis are summarized.

4.2 Sample

Four hundred and eighty two species of fish that can be classified as tropical ornamentals inhabit Pohnpein waters. The common and scientific names of the fish are listed in Appendix 1. Aquarium store retailers, on average, carry 25 to 50 species of marine fish for sale. Vibrant coloring and unique physical characteristics are the features customers

demand from tropical ornamentals. Fish with these attributes are the types of fish that are most traded.

The sample for this thesis was established by matching potential supply to known demand. This is a version of backward linkage. Surveys, as outlined in Appendix 3, were emailed to 80 US aquarium stores that advertise on the Internet. The 80 stores were selected because they were located on the West Coast and in Hawai'i, the most likely locations to import Pohnpein ornamentals. Of the original 80 sent, 39 were rejected as invalid address or unable to deliver. Forty one surveys were received by retailers, of which 16 responded with completed questionnaires. Therefore, the response rate was 20%, which is statistically representative (Neuman, 2000).

The survey asked retailers to list their ten most demanded fish and ten lesser-demanded fish. However, all of the respondents listed their 10 most demanded fish and stated they do not purchase fish that are in less demand. The responses provided enough of an overlap so that 21 demanded fish were identified. Therefore, the breadth and scope of this study limits the sample to twenty-one fish. The sample species identified are as shown in Table 4.1:

Table 4.1
Sample of 21 Pohnpein Ornamental Species

Common Name	Scientific Name
Anemonefish Clark's	*Amphiprion clarkii*
Anemonefish pink	*Amphiprion perideraion*
Anemonefish tomato	*Amphiprion frenatus*
Angel bicolor	*Centropyge bicolor*
Angel flame	*Centropyge loriculus*
Blenny bicolor	*Ecsenius bicolor*
Butterfly longnose	*Forcipiger longirostris*
Butterfly saddled	*Chaetodon ephippium*
Butterfly teardrop	*Cheatodon unimaculatus*
Butterfly vagabond	*Chaetodon vagabundus*
Damsel lemon	*Pomacentrus moluccensis*
Goby Rainford's	*Amblygobius rainfordi*
Surgeonfish palette	*Paracanthurus hepatus*
Tang achiles	*Acanthurus achilles*
Tang convict	*Acanthurus triostegus*
Tang sailfin	*Zebrasoma scopas*
Tang yellow	*Zebrasoma flavescens*
Trigger clown	*Balistoides conspicillum*
Trigger huma Picasso	*Rhinecanthus aculeatus*
Wrasse six line	*Pseudocheilinus hexataenia*
Wrasse yellowtail	*Anampses meleagrides*

Note: Some species requested on the surveys required their Micronesian equivalent to be identified as the types were specific to the Philippines (Tepoot and Tepoot, 1996; Myers, 1999).

4.2.1 Specie Sustainability

Specie sustainability requirements for marine animals are an ongoing research goal of scientists around the globe. Hence, precise sustainability levels for marine ornamentals are not available at this time. "A general benchmark of sustainability accepted within the scientific community is at a 10% removal rate per year, whereby a species population has the ability to sustain itself. For hermaphroditic species, the removal rate may be slightly higher." (Brookins, 2005).

Population parameters of the sample fish in this study have not been scientifically catalogued; only their habitat presence in Pohnpein waters has been officially recorded. Field research is required to identify the true quantity status of the fish. However, this is beyond the scope of this paper. Table 4.2 provides figures of population estimations if the 10% removal rate is applied. The estimations are for specific shipping quantities at two packing densities of 84 kg per month. Two packing densities are necessary because certain characteristics of different species require more packing space.

Table 4.2
Population Estimations

Common Name	Shipped per Year	Packing Density 84 kg	Population Estimations
Anemonefish Clark's	2,500	208	25,000
Anemonefish pink	2,500	208	25,000
Anemonefish tomato	2,500	208	25,000
Angel bicolor	420	35	4,200
Angel flame	420	35	4,200
Blenny bicolor	2,500	208	25,000
Butterfly longnose	420	35	4,200
Butterfly saddled	420	35	4,200
Butterfly teardrop	420	35	4,200
Butterfly vagabond	420	35	4,200
Damsel lemon	2,500	208	25,000
Goby Rainford's	2,500	208	25,000
Surgeonfish palette	420	35	4,200
Tang achiles	2,500	208	25,000
Tang convict	2,500	208	25,000
Tang sailfin	2,500	208	25,000
Tang yellow	2,500	208	25,000
Trigger clown	2,500	208	25,000
Trigger huma picasso	420	35	4,200
Wrasse six line	2,500	208	25,000
Wrasse yellowtail	2,500	208	25,000

4.2.2 Environmental Costs of Harvest

Harvesting small fish that hide in crevices can be quite destructive to the environment. A multitude of damaging harvest techniques is used to gather marine aquarium fish, such as underwater demolition to stun the fish, cyanide poisoning to drug the fish, and breaking coral polyps that house the fish. It is not foreseen that the Marine Aquarium Council (MAC) certification standards for damage-free harvesting methodology will be adopted in the FSM in the near future (Marine Aquarium Council, 1999). Such destruction to the reefs and atoll cannot be assigned a monetary value as the impact is so far-reaching. Destruction can be limited to inconsequential levels through extensive training in harvesting techniques and via monitoring, but this level of training and control will raise the cost of labor significantly, perhaps to the point of negating any return from the export.

The Nahnmwarkis must ultimately decide if allowing the expenditure of the island's natural resources, renewable and non-renewable, is worth economic progress. The post-Compact FSM government, in conjunction with traditional leadership, is attempting to balance tangible and intangible cultural preservation with economic progress and growth that operates within a monetary system. Whether this attempt is possible remains to be seen. At this point in time, long-term questions as to the value of the reefs and traditional ways of living have not been answered. Consequently, there are no guidelines or limitations pertaining to harvesting the reef for monetary purposes.

4.3 Value of Costs

The cost categories required for the export of Pohnpein ornamentals were identified in chapter 3. In this section, each item in the categories is valued in US dollars during a timeframe covering the three year period 2003 through 2005, inclusive. In addition, as noted in chapter 3, there are seven constraints that directly or indirectly affect the values of the costs, and these effects are reflected in the prices, were applicable.

4.3.1 Capital Costs

The fixed assets required for this production firm are an automobile, a boat and engine, and general office equipment. Each asset is assigned a value in this section.

4.3.1.1 Automobile

Via private sale, a used truck sufficient for transporting equipment and fish can be obtained for approximately US$15,000. The purchased truck must have a trailer hitch and be sturdy enough to haul the trailer and boat.

4.3.1.2 Boat and Engine

A sea-worthy boat of 20 to 25 feet may be purchased on island for US$5,000. This is the most affordable option as off-island purchases are considerably higher. An engine large enough to power this size of boat costs US$4,500. A boat trailer costs US$1,500.

4.3.1.3 General Office Equipment

Office equipment necessary to open the firm is minimal. A fax machine for US$200, a computer for US$2,000, and a printer and scanner for US$500 may be purchased new on-island.

4.3.1.4 Production Equipment

Since the fish must be packed for transport onsite, the firm needs to acquire various aquatic hoses and pumps, a generator, and two oxygen regulators off-island. The costs respectively are US$1,000, US$2,000, and US$1,000 and include the 25% surcharge.

4.3.1.5 Summary of Capital Costs

Table 4.3 summarizes the estimated capital costs for the production firm.

Table 4.3
Estimated Capital Costs

Asset	Value (US$)
Automobile	15,000
Boat	5,000
Engine	4,500
Trailer	1,500
Fax Machine	200
Computer	2,000
Printer & Scanner	500
Hoses & Pumps	1,000
Generator	2,000
Oxygen Regulator (2)	1,000
Total Fixed Asset Investment	**$32,700**

4.3.2 Labor Costs

The export firm requires skilled management to run operations and unskilled labor to harvest the fish. Employment taxes are paid on both classes of workers.

4.3.2.1 Skilled Management

Management with the skill-set needed to operate an efficient firm is typically not found on-island. Recruitment off-island is lengthy and expensive. A standard contract is for two years and includes a housing allowance and relocation benefits for the applicant and their family.

Surveys (Appendix 2) were emailed to the four main Pohnpein employers of foreign and skilled labor. All surveys were answered and the results were tallied and averaged.

Compensation per year is US$17,500, monthly housing allowance is US$600, and relocation benefits for a family of three total US$10,000.

4.3.2.2 Unskilled Labor

Locals provide the unskilled labor and are paid an hourly minimum wage. The minimum wage has been consistent for seven years at US$1.35 per hour. An employee is compensated US$54 for a forty-hour week of harvesting.

4.3.2.3 Employment Taxes

The taxes assessed by the FSM government are Social Security (SS) and Income Tax. The social security rate is 6% on the first US$5,000 earned per quarter, amounts earned over US$5,000 per quarter are not SS taxed. The income tax rate is 6% on the first US$10,000 earned, and amounts over US$10,000 are taxed at a rate of 10%.

Foreign employees are usually exempt from paying income tax to their country of citizenship. For example, the US exempts the first US$90,000 of foreign-earned income from all US taxes. However, local taxes must be paid by all employees and the employer.

The social security and income tax rates have remained constant since 2000. However, the ceiling for annual gross earnings and gross earnings per quarter was raised in 2003. Additional increases are not foreseen in the near future. A tax rebate of US$60 is issued to all employed Pohnpeins once a year.

4.3.2.4 Summary of Labor Costs

Table 4.4 summarizes the estimated labor costs over one year. Personnel assumptions are one foreign manager and two harvesters. The relocation benefits for management are pro-rated for the two-year contract.

Table 4.4
Estimated Labor Costs

	Monthly (US$)	Annually (US$)
Management (1)		
Salary	1,458	17,500
Benefits*	1,017	12,200
SS Tax	262	1,050
Income Tax**	113	1,350
Unskilled Laborers (2)		
Wage	432	5,184
SS Tax	52	622
Income Tax	52	622
Total Labor Costs	**$3,386**	**$38,528**

*benefits annual formula: ((5000/12) +600)*12
**income tax annual formula: (10000*.06) + (7500*.1)

4.3.3 Opportunity Costs

Rental facilities of a building and land on the shoreline are required. Continuous access to fresh saltwater for the holding tanks and a boat mooring are not available inland. Given the inherent limitation of land on the island, such a rental spot will only be obtained via local contacts as all pieces of land are owned according to the family or clan of the specific area. This constraint is an important consideration, indeed fundamental to new businesses as foreign management without local contacts exacerbates the condition. If a site is located and rented, extenuating clauses in the lease can be expected, such as access through the property to the shoreline and sharing of the mooring structure by the clan. Office space should be located in the close proximity of the production yard in order to monitor and protect the fish being held.

Surveys were used to gather information on the rental charges for buildings and land. The four main landlords on the island were emailed surveys, as indicated in Appendix 4. All surveys were returned and the rates were tallied and averaged. Building space rents for approximately US$1.50 per square foot and land rents for US$1.00 per square foot. The opportunity cost for facilities of 300 square feet of building and 600 square feet of land is US$1,050 per month.

4.3.4 Transportation Costs

Transportation charges are not paid by the export firm. They are absorbed by the buyer of the ornamentals. However, they are a cost factor of production and relevant to this model. The live nature of the fish and their extreme perishability requires the product to be shipped as wet cargo, must-confirm rates, as previously explained in chapter 3. This class of shipment is treated as ‘fragile’ since it contains liquid and cannot be off-loaded from the plane en route for any reason. The charge per kilogram is US$7 from Pohnpei to Hawai’i. The average size of a shipping container holds 7 liters of water and fish and costs US$49.

4.3.5 Environmental Costs

The environmental costs of harvesting ornamental fish primarily impacts subsistence fishing and is two-fold: It will decrease the quantity of able-bodied fishermen available to gather food for the clan by employing them for wages, and the activity of harvesting ornamentals from the reef and inter-tidal zones will inevitably push the schools of food fish further off-shore, thus compounding the difficulty and expense of subsistence fishing.

The decrease of subsistence fishing for the clan is not offset by the amount of wages earned. A fisherman gathers enough fish to feed his family; this quantity ranges from 8 to 15 pounds of fish per day. The market value of this food fish is US$10.40 to US$19.50 @ US$1.30 per pound; net wages earned per day is US$9.52 (1.35 less taxes * 8 hours).

Relocation of food fish to the deeper waters will complicate subsistence fishing for the entire island. Spear fishing is often preformed by standing on the reef and spearing fish in shallow water. Line fishing is done in the same locations. Fishing boat excursions to deeper water will require the added expense of more gasoline, better boat engines, and a sea-worthy boat.

4.3.6 Miscellaneous Input Costs

Automobile Insurance. Automobile insurance is not required by FSM law. However, it is required by the bank if borrowed funds are used to purchase the vehicle. Full, comprehensive coverage is available starting at US$900 a year.

Fishing Gear. General fishing implements needed to gather the fish and hold them for packing are nets, catching gear, buckets, and coolers. These items are purchased on-island for an annual charge of US$1,500 or US$125 per month.

Office Supplies. General office supplies are purchased from local retailers. Approximately US$200 a month is budgeted for miscellaneous supplies. Printer cartridges and toner for the machines are occasionally not available as the cargo ship arrives once in every six to eight weeks. Therefore, extra quantities of these items should be kept on hand.

Fees. A Foreign Investors Permit (FIP) is the main licensing requirement. The fee for the FIP is US$250 and it must be renewed annually. The surplus US$350 is to cover filing fees, surcharges, and other bureaucratic expenses that are charged to foreign-managed firms.

Utilities. Utility rates are set by the government and the quality of the services fluctuates. For a basic telephone line, three hours of international line time, and 35 hours of Internet and email time, the monthly charge will be US$356. The water and sewer rate is US$10 a month. Electricity usage of 3,000 kwh is US$510.

Fuel. Fuel prices are set by Mobil Inc., the only supplier to the island. Occasionally, there is no fuel available so a small stockpile is necessary. The contingency supply is also necessary during power outages as the gas pumps run on electricity. Gasoline averages US$3.25 per gallon and 40 gallons is approximately the monthly use. Diesel is US$3.00 a gallon and, approximately, 40 gallons a month will be required.

Packing Supplies. Packing supplies needed for transporting the fish are oxygen, Florida Styrofoam packing boxes (42.5 cm x 42.5 cm x 25 cm, volume of seven liters of water including fish), and pleated plastic bags. The respective charges estimated for a month of production are US$150 for one cylinder of oxygen, US$336 for 84 boxes, and US$30 for 84 bags. The prices for the boxes and bags include the 25% shipping surcharge as these supplies are not available on Pohnpei.

4.3.6.1 Summary of Miscellaneous Input Costs

Table 4.5 summarizes the estimated miscellaneous input costs required for this production process.

Table 4.5
Estimated Miscellaneous Input Costs

Expenses	Monthly (US$)	Annually (US$)
Automobile Insurance	75	900
Gasoline	130	1,560
Diesel	120	1,440
Office Supplies	200	2,400
Telephone & Internet	356	4,272
Water & Sewer	10	120
Electricity	510	6,120
Packing Supplies	516	6,192
Fishing Implements	125	1,500
Fees	50	600
Total Estimated Miscellaneous Input Costs	**$2,092**	**$25,104**

4.3.7 Summary of Costs

All of the cost estimates identified for the production of Pohnpein ornamentals are summarized in Table 4.6.

Table 4.6
Estimated Cost Summary

Costs	Monthly (US$)	Annually (US$)	Initial Investment (US$)
Capital Costs			32,700
Labor Costs	3,386	38,528	
Opportunity Costs	1,050	12,600	
Miscellaneous Input Costs	2,092	25,104	
Total Estimated Costs	**$6,528**	**$76,232**	**$32,700**
Transportation Costs*	4,116	49,392	

*Transportation costs are based on a monthly shipment of 84 boxes of 7 kg per box. This cost is not included in the firm's cost summary because the buyer pays for shipping.

4.4 Outcomes and Benefits

The intended benefit of establishing the export is to initiate a private industry that will generate revenue and economic activity. At this point in the study, the costs of production have been valued and itemized and now the outcomes and benefits may be quantified.

4.4.1 Revenue

Revenue generated is from the sale of Pohnpein ornamentals to US buyers. The buying price for the ornamentals is on average 1/5 of the retail price. Retail values for the sample of fish in this study were obtained online from four websites advertising the fish for sale. The prices were averaged and multiplied by 1/5. The annual estimated quantities of fish produced listed in Table 4.2 are multiplied by the price received to determine revenue generated. Table 4.7 lists the estimated price of each fish and the estimated revenue received on specific quantities produced.

Table 4.7
Estimated Price, Production Quantity, and Revenue

Common Name	Scientific Name	Price (US$)	Production Quantity	Revenue (US$)
Anemonefish Clark's	*Amphiprion clarkii*	3.00	2,500	7,500
Anemonefish pink	*Amphiprion perideraion*	2.50	2,500	6,250
Anemonefish tomato	*Amphiprion frenatus*	2.40	2,500	6,000
Angel bicolor	*Centropyge bicolor*	4.93	420	2,069
Angel flame	*Centropyge loriculus*	8.40	420	3,528
Blenny bicolor	*Ecsenius bicolor*	3.15	2,500	7,875
Butterfly longnose	*Forcipiger longirostris*	5.45	420	2,289
Butterfly saddled	*Chaetodon ephippium*	4.50	420	1,890
Butterfly teardrop	*Cheatodon unimaculatus*	4.50	420	1,890
Butterfly vagabond	*Chaetodon vagabundus*	4.20	420	1,764
Damsel lemon	*Pomacentrus moluccensis*	0.90	2,500	2,250
Goby Rainford's	*Amblygobius rainfordi*	3.90	2,500	9,750
Surgeonfish palette	*Paracanthurus hepatus*	7.05	420	2,961
Tang achiles	*Acanthurus Achilles*	10.50	2,500	26,250
Tang convict	*Acanthurus triostegus*	4.75	2,500	11,875
Tang sailfin	*Zebrasoma scopes*	6.70	2,500	16,750
Tang yellow	*Zebrasoma flavescens*	5.45	2,500	13,625
Trigger clown	*Balistoides conspicillum*	15.25	2,500	38,125
Trigger huma picasso	*Rhinecanthus aculeatus*	5.73	420	2,405
Wrasse six line	*Pseudocheilinus hexataenia*	3.60	2,500	9,000
Wrasse yellowtail	*Anampses meleagrides*	3.54	2,500	8,844
Total Production			**35,860**	
Total Revenue				**$182,889**

As previously indicated, the production capacity of 35,860 fish is based on estimated population quantities. Actual population parameters have not been established for Pohnpein ornamental species.

4.4.1.1 Net Income

The estimated annual net income for this export is summarized in Table 4.8. The revenue and expense figures in this table are from Tables 4.3, 4.6 and 4.7.

Table 4.8
Estimated Annual Net Income

	Value (US$)	Totals (US$)
Revenue		
Sale of Fish	182,889	**182,889**
Expenses		
Labor	38,528	
Rent	12,600	
Miscellaneous Inputs	25,104	
Depreciation	6,540	
Total Expenses		**82,772**
Estimated Annual Net Income		**$100,117**

Financial viability for the industry is present based on these revenue and cost estimations. However, the number of firms the industry can support is unknown given the lack of hard data pertaining to fish populations.

4.4.2 Resale Value of the Capital Equipment

Resale values on capital equipment apply to the automobile, boat, engine, trailer, and generator. The resale value of capital equipment, as indicated in Table 4.9, is based on the assumptions of straight-line depreciation, a lifespan of 5 years, and zero salvage value. The absence of a salvage value was justified in section 3.5.2. To reiterate, the second-hand nature of most capital equipment, climate conditions of the Tropics, and the poor quality of inputs and maintenance contribute to the assets accelerated rate of devaluation, and it is customary to leave used assets for the owner of the leased land.

Table 4.9
Resale Value of Capital Equipment

	Value (US$)				
Year	**1**	**2**	**3**	**4**	**5**
Automobile	15,000	12,000	9,000	6,000	3,000
Boat	5,000	4,000	3,000	2,000	1,000
Engine	4,500	3,600	2,700	1,800	900
Trailer	1,500	1,200	900	600	300
Generator	2,000	1,600	1,200	800	400

Non-capital assets such as office equipment, hoses and pumps, and oxygen regulators will also have minimal to zero resale value because of the same reasons listed above.

4.4.3 Intangible Benefit

The intangible benefit of initiating this export is indirect, yet fundamentally important. The nation will be in compliance with the Compact if a new industry is initiated. If Pohnpein industries are not started, the nation will be in violation of the Compact

agreement between the United States. The exact penalty and the nature of the penalty of Compact violation are not known. However, any punitive measures applied to the FSM will be detrimental and affect economic growth and progress.

4.4.4 Productivity Savings

There are no current productivity savings as the industry has not yet been established. Future productivity savings will be identified through the trial and error of running a business or industry. Australian Planning and Training Associates PTY LTD (1990) found that savings related to harvest and production techniques emerge as the learning curve accelerates over time.

4.4.5 Non-Quantifiable Outcomes

If a FSM economy does not emerge through the creation of industries, the nation will not be able to support itself. Moreover, with the eventual cessation of US subsidizes, the situation will be dire. The population must learn how to operate a business and manage resources. Such knowledge can only be gained through experience.

4.5 Results

The primary aim of this study is to determine if the export of tropical aquarium fish from Pohnpei, Federated States of Micronesia to the US market is an economically viable industry. To this end, the principal objective of this study was to develop an economic cost-effectiveness model upon which viability can be assessed. Three research objectives were identified and answered in order to satisfy this goal. The objectives, as stated in chapter 1, are:

1) identify a mix of economically viable fish and estimate the profit associated with the specific mix of fish;
2) estimate the costs associated with the export of Pohnpein marine ornamentals;
3) determine the effect that the monopoly structure of the transport industry has on export viability.

Each objective has been achieved and the results are presented in this section. The question pertaining to the economic viability of starting an export industry is also answered here.

4.5.1 Identify a Mix of Economically Viable Fish and Estimate the Profit Associated with the Specific Mix of Fish

As previously indicated, the mix of species demanded by consumers was obtained directly from tropical ornamental retailers and is as listed in Table 4.1. While current population levels of these fish in Pohnpein waters are not known at this time, as outlined in section 4.2.1, an estimate of the population for each variety of fish has been provided.

For the purposes of this dissertation, 10% of this estimated population has been considered as representative of the number of fish a firm will harvest and ship.

Production decisions regarding the quantity of each type of fish harvested and sold, in large part, conform with the underlying assumption of profit maximization. However, it should also be noted that this assumption is constrained by ensuring that the levels of harvesting do not rise above sustainable levels of harvesting and, at the same time, do not attract retaliation from current market participants. In general terms, it is noted that in order to effectively fulfill the objective of profit maximization, both marginal costs and marginal revenues should be calculated. However, due mainly to the broad estimation of fish stocks, marginal calculations have not been undertaken. For the purposes of this study, total revenues and total costs have been utilized to provide a broad indication of potential profits accruing to producers. It is, however, recognized that, given finite fish stocks, marginal costs would be likely to rise as output increases and, as a result, the profit levels indicated here, may well be overly optimistic.

The price for each species was obtained directly from the retailers. Since the producer does not pay the transportation expense for the animals, the buyer calculates this expense into the price they are willing to pay for the product. The average buying price is 1/5 of the retail value. Table 4.7 identifies the price per specific type of fish and Table 4.10 provides the revenue, costs, and profit estimates for the specific production quantities of the species.

Table 4.10
Estimated Revenue, Costs, and Profit

Common Name	Scientific Name	Production Quantity	Revenue (US$)	Costs (US$)	Profit (US$)
Anemonefish Clark's	*Amphiprion clarkii*	2,500	7,500	5,770	1,730
Anemonefish pink	*Amphiprion perideraion*	2,500	6,250	5,770	480
Anemonefish tomato	*Amphiprion frenatus*	2,500	6,000	5,770	230
Angel bicolor	*Centropyge bicolor*	420	2,069	969	1,099
Angel flame	*Centropyge loriculus*	420	3,528	969	2,559
Blenny bicolor	*Ecsenius bicolor*	2,500	7,875	5,770	2,105
Butterfly longnose	*Forcipiger longirostris*	420	2,289	969	1,320
Butterfly saddled	*Chaetodon ephippium*	420	1,890	969	921
Butterfly teardrop	*Cheatodon unimaculatus*	420	1,890	969	921
Butterfly vagabond	*Chaetodon vagabundus*	420	1,764	969	795
Damsel lemon	*Pomacentrus moluccensis*	2,500	2,250	5,770	-3,520
Goby Rainford's	*Amblygobius rainfordi*	2,500	9,750	5,770	3,980
Surgeonfish palette	*Paracanthurus hepatus*	420	2,961	969	1,992
Tang achiles	*Acanthurus achilles*	2,500	26,250	5,770	20,480
Tang convict	*Acanthurus triostegus*	2,500	11,875	5,770	6,105
Tang sailfin	*Zebrasoma scopas*	2,500	16,750	5,770	10,980
Tang yellow	*Zebrasoma flavescens*	2,500	13,625	5,770	7,855
Trigger clown	*Balistoides conspicillum*	2,500	38,125	5,770	32,355
Trigger huma picasso	*Rhinecanthus aculeatus*	420	2,405	969	1,436
Wrasse six line	*Pseudocheilinus hexataenia*	2,500	9,000	5,770	3,230
Wrasse yellowtail	*Anampses meleagrides*	2,500	8,844	5,770	3,074
Estimation Totals		**35,860**	**$182,889**	**$82,772**	**$100,117**

Note: Estimation totals for costs and profit are adjusted by $8 due to a rounding differential.

Based on the revenue and costs associated with the fish damsel lemon *Pomacentrus moluccensis,* it is not profitable to produce this species. Deleting damsel lemons from the production line would increase net profit by US$3,520. However, for the purpose of this analysis, damsel lemon fish are not excluded from the sample.

4.5.2 Estimate the Costs Associated with the Export of Pohnpein Marine Ornamentals

4.5.2.1 Monetary Costs

The monetary cost estimates of exporting Pohnpein fish to the US market are calculated in Section 4.3. Each cost category, with the exception of transportation and environmental costs, is a required expense paid for by the producer of the fish. Table 4.6 summarizes the estimated financial costs.

The indirect cost of transferring subsistence labor to the economic sector can be estimated. A loss of US$.88 to US$9.98 will result if a laborer earning US$9.52 per day must purchase fish for food at the market versus catching it.

The financial lending market on Pohnpei is limited to two institutions. Loan collateral must be on-island and the guidelines for borrowing and repayment are strict and rigidly enforced. The cost of capital is not competitive given the limited market.

4.5.2.2 Non-Monetary and Constraint Costs of the Industry

The main non-monetary costs are environmental in nature. Secondary categories are management, culture, and infrastructure.

1) Environmental Costs: Destruction to the reef and lagoon from harvesting the ornamentals will occur. Intertidal and mangrove habitat will be altered and coral polyp displacement or breakage will erode the integrity of Pohnpei atoll. An increase in reef activity will drive food fish further off-shore and this will complicate and increase the social and human expense of subsistence gathering. Application of international harvesting and industry guidelines pertaining to good husbandry and habitat conservation methodology is predicted not to be forthcoming to a FSM production industry.

   The absence of quantified population parameters of Pohnpein species is fundamental in the consideration of establishing the export. Projecting harvest quantities and profit expectations on unknown supply quantities is risky and should be carefully evaluated prior to investing in a production firm. If production commences and populations are unknowingly drawn down to precipitously low levels, specie sustainability will not occur. The elimination of a species in a symbiotic environment such as a coral reef ecosystem is drastic and will alter the very fiber of the system.

   Land tenure and ownership is controlled by Pohnpeins. Foreigners cannot own land on the island. Leases are granted for a maximum of 25 years. Obtained leases are tenuous in that they can be revoked, adjusted, or violated by the landlord at any time with few, if any, legal repercussions. Capital investment into a firm that does not have clear and legally-binding lease rights may not be an optimal investment scenario.

2) Management Costs: The steady outflow of available skilled labor from Pohnpei requires qualified management to be recruited from off-island. This process is lengthy, expensive, and inherent with risk. Governmental regulations state that all foreign investors and/or management must be in partnership with a local who owns a majority of the business. This combination of business philosophies (western, capitalistic, individual and subsidized, subsistence, communal) leads to minimal re-investment into the business and a consistent flow of business funds to the Pohnpein family and clan members.

3) Cultural Costs: Exploiting the reef's resources for private commercial gain will disrupt the ceremonial and cultural ties the Pohnpeins have had with the sea and land for millennia. The traditional leaders of Pohnpei wield a considerable

amount of power when it comes to the preservation of history and culture. If the decision to cease harvest of a reef section is made by a Nahnmwarki, then production will stop regardless of lease agreements or any established and legal business understandings. If harvesting the reef for economic gain is allowed, it will have unknown cultural repercussions and an uncertain impact on the historical way of life on Pohnpei.

Culture dictates the distribution of sea bounty or its monetary equivalent. A portion of all harvest is due to the Nahnmwarki. Likewise, any request from a family or high clan member for money must be honored.

4) Infrastructure Costs: The infrastructure on Pohnpei is substandard. Utility services do not extend to the entire island. Maintenance to the public systems is poorly applied due to the high cost of imported equipment and qualified personnel. Frequent electrical and water outages create additional stress on structural components and are disruptive to customers and businesses.

4.5.3 The Effect the Transportation Monopoly Structure has on Viability

Transportation access and cost for exporting products from the Tropical Pacific to market are primary business considerations. Transporting the live product from the Tropical Pacific region to the US is expensive. Continental Airlines has a monopoly on the air service to the FSM islands. If the airline service is disrupted for any reason, there is not an alternative shipping method. The industry is entirely dependent on the reliable and continuous service of Continental and on the condition of the Pohnpei airport and runway. Any disruption in air service or any closure of the airport will immediately stop revenue generation for the industry given the perishability of the product. The possibility of additional airlines entering the market is remote; the FSM government receives various incentives in return for guaranteeing the continuance of the monopoly.

The transportation costs are not paid by the producer, but rather by the buyer of the product. However, these expenses are indirectly passed on to the producer in the form of reduced prices paid for the fish. Table 4.6 lists the transportation charges for a monthly shipment of 84 boxes of 7 kg per box at US$4,116 or US$49,392 annually. This is the cost for transporting the fish from Pohnpei to Honolulu. Table 4.11 shows the impact the indirect cost transference has on estimated revenue and profit.

Table 4.11
Transportation Charges in Relation to Estimated Annual Revenue and Profit

Estimated Revenue	182,889
Transportation Charges	49,392
Gross Revenue	**232,281**
Transportation Charges of $49,392 are 21.3% of Gross Revenue	
Estimated Profit	100,117
Transportation Charges	49,392
Gross Profit	**149,509**
Transportation Charges of $49,392 are 33% of Gross Profit	

The lack of competitive options to ship the fish to market decreases gross revenue and profit by 21.3% and 33% respectively. The size of these percentages reflects the monetary impact of operating within the confines of a monopolistic transportation structure. Shipping expenses cannot be eliminated altogether, but they can be reduced considerably given competitive market conditions.

4.6 Assessment of Economic Viability of the Industry

As previously stated, economic evaluation of a project or proposed industry "…attempts to assess the overall impact of a project on improving the economic welfare of the citizens of the country concerned." (Asian Development Bank, 2003, pp.1-2) The positive and negative impacts of the project on the members of society are evaluated. According to Dhiri and Brand (1999, p.8) answering four key questions will effectively assess economic viability of a project. Analysis and data presented thus far are used to answer the specific questions:

1) What was the true cost of an initiative, practice or policy?

There are three financial costs to the initiative.

a. The capital investment into a single export firm is US$32,700.
b. The annual production cost of producing 35,860 ornamental fish is US$82,772.
c. A cost is incurred when a subsistence laborer is transferred to the economic sector. The laborer is unable to catch fish for food while he/she is employed. The daily earned wage is US$.88 to US$9.98 less than the purchase value of the food fish they would otherwise catch.

There are five non-monetary costs directly tied to the initiative.

a. Destruction of the reef and coral habitat from harvesting the fish will occur. Subsequent erosion of the intertidal and mangrove ecosystems will threaten the integrity of Pohnpei atoll.
b. Increased activity in the reef zone will drive food fish schools further off-shore. This will complicate subsistence gathering of sea sustenance.

c. Depleting ornamental fish stocks before population bases are known can lead to the elimination of entire species. Sustainability levels must be maintained to ensure specie continuity, as well as habitat integrity. Scientific data pertaining to Pohnpein fish populations is not known at this time.

d. Foreign investors into this export must be in partnership with a local Pohnpein and is entitled to own only a minority of the business. Management for the production initiative must be recruited from off-island. The communal and sharing nature of Pohnpein culture dictates that any request for money or assets from the business by granted. This lack of fiscal and business control is a serious cost consideration for foreigners.

e. Cultural ties between Pohnpeins and the sea go back millennia. Harvesting the reef for personal economic gain and damaging the intertidal habitat in the process may not be acceptable to traditional leaders. Traditional and culturally related decisions carry a lot of power, and if the Nahnmwarki decide to stop reef harvest, it will stop. Legal recourse would not be forthcoming as the local ownership of the firm will honor the traditional authorities. If production proceeds unimpeded, the cultural repercussions and the impact on the historical way of life and tradition is unknown.

To summarize, the annual financial cost of the initiative is approximately US$115,472 per export firm and approximately US$229 to US$2,595 per displaced subsistence laborer in the additional cost for food. The intangible costs of altering the reef's ecosystem and the intertidal zones, the disruption of current food fish schools, the depletion of stock levels of which population parameters are unknown, the lack of majority control over the business and its assets, and the adverse impact a production operation may have on Pohnpein culture and the historical way of life on the island cannot be quantified. Regardless of their non-quantifiable nature, the individual and collective value of these five costs is great. The environmental and cultural alterations they represent cannot be reversed or replaced.

2) Did the outcome(s) achieved justify the investment of resources?

The monetary investment of US$32,700 into a production firm will generate an estimated net annual pr fit of US$100,117 per firm. This is a significant return for a firm in a developing nation and financial justification for project initiation is present. The Net Present Value (NPV) of four scenarios is calculated in Table 4.12. In each case, a positive NPV is present. This indicates that, based on financial data, pursuing the industry is viable. However, the best scenario of fifteen firms at an 8% discount rate will contribute approximately only 4.02% to the current GNP of US$249,700,000 and approximately 4.4% to the current GDP of US$228,200,000.

Table 4.12
Net Present Value (US$) of the Proposed Industry

Discount Rate	8%	10%	12%	14%
One Firm	639,093	582,475	532,983	489,521
Five Firms	3,326,266	3,043,178	2,795,716	2,578,409
Ten Firms	6,685,232	6,119,056	5,624,133.79	5,189,518
Fifteen Firms	10,044,198	9,194,934	8,452,550	7,800,627

assumptions: each firm generates US$100,117 of annual cash flow
capital investment is US$32,700
there are 10 years of cash flow (or life span is 10 years)

The size of the industry and the quantity of firms that can be supported by the supply of Pohnpein ornamentals is unknown, as was previously discussed. The required specie population estimations for one, five, ten, and fifteen firms are listed in Table 4.13.

Table 4.13
Population Estimations of Four Industry Scenarios

	Required Population Estimations			
Common Name	**One Firm**	**Five Firms**	**Ten Firms**	**Fifteen Firms**
Anemonefish Clark's	25,000	125,000	250,000	375,000
Anemonefish pink	25,000	125,000	250,000	375,000
Anemonefish tomato	25,000	125,000	250,000	375,000
Angel bicolor	4,200	21,000	42,000	63,000
Angel flame	4,200	21,000	42,000	63,000
Blenny bicolor	25,000	125,000	250,000	375,000
Butterfly longnose	4,200	21,000	42,000	63,000
Butterfly saddled	4,200	21,000	42,000	63,000
Butterfly teardrop	4,200	21,000	42,000	63,000
Butterfly vagabond	4,200	21,000	42,000	63,000
Damsel lemon	25,000	125,000	250,000	375,000
Goby Rainford's	25,000	125,000	250,000	375,000
Surgeonfish palette	4,200	21,000	42,000	63,000
Tang achiles	25,000	125,000	250,000	375,000
Tang convict	25,000	125,000	250,000	375,000
Tang sailfin	25,000	125,000	250,000	375,000
Tang yellow	25,000	125,000	250,000	375,000
Trigger clown	25,000	125,000	250,000	375,000
Trigger huma picasso	4,200	21,000	42,000	63,000
Wrasse six line	25,000	125,000	250,000	375,000
Wrasse yellowtail	25,000	125,000	250,000	375,000

The purpose of initiating this industry is to fulfill the nation's goal of becoming self-sufficient through private economic growth and expansion. The impetus behind this economic autonomy is the nation's compliance with the Compact of Free Association. An industry of fifteen firms will contribute less than 5% to the economic expansion initiative (calculated as a percentage of current GNP and GDP). However, estimating the

contribution of this scenario or any other one should be considered premature until the required population estimations in Table 4.13 can be scientifically established, and the size of the industry and its real monetary contribution to the welfare of Pohnpein citizens can be determined. It is also unknown if a contribution of US$10,044,198 (NPV) to Pohnpein society will be enough to offset the environmental and cultural impacts of the project as monetary assessment of these impacts have not been made.

A positive NPV indicates industry viability and identifies the "positive…impacts of the project on the members of society…." (Dhiri and Brand, 1999, p.8) However, the intangible "…negative impacts of the project on members of society" (Dhiri and Brand 1999, p.8), should also be taken into account. In this connection, it is likely that these negative impacts may substantially affect the NPV. However, as previously stated, the monetary cost for environmental alteration and the loss of Pohnpein culture cannot be calculated.

3) Was this the most efficient way of realizing the desired outcome(s) or could the same outcome(s) have been achieved at a lower cost through an alternative course of action?

This proposed initiative is not the most efficient way to reach the desired outcome of economic self-sufficiency. The FSM officials have identified industry potential of exporting aquarium fish based on cursory information such as retail price of the ornamentals, the present of the fish in Pohnpein waters, and cheap local labor costs. An in-depth financial analysis would have revealed the costs of production, real revenue projections, and the detrimental financial impact of operating within and relying on a monopolistic air transport structure. The risk factor associated with operating in the confines of a narrow transportation sector is very high as any disruption or adjustment with the sector will immediately impact the export industry. The issue of harvesting live animals before scientific data pertaining to population quantities is available would have come to light and signaled that perhaps industry initiation is premature. A subsequent economic analysis would have revealed the negative environmental and cultural implications of the export and the lack of an overall contribution to society.

An alternative course of action that would have resulted in a lower cost in terms of spent resources establishing the industry would have been to research prior export ventures in the Tropical Pacific region and analyze the causes of success or failure. Application of the knowledge to the constraints of FSM would have indicated a course of action or non-action. Realization that western ways of exploiting natural resources for economic gain conflict with the rich and traditional culture of the Pohnpein people would have revealed the negative impact of the initiative.

4) How should additional resources be spent?

If the export industry is to be established, additional resources should be spent on supply quantification and environmentally-sound harvesting techniques. It is fundamental to the success of this industry to establish population parameters of the species to be harvested

and to ensure harvesting methodology is as non-invasive and habitat-friendly as possible. The evidence that short-term feasibility of exporting fish is positive should not overshadow the long-term uncertainty of supply sustainability and environmental degradation. Resources should also be spent on determining if the irretrievable loss of certain aspects of Pohnpein culture is worth the temporary economic gain of harvesting ornamentals.

In summary, a cost-effectiveness analysis was used to structure and quantify and qualify the information in order to reach a logical economic assessment of industry viability. In this context, the preceding cost assessment to determine if the export of tropical aquarium fish is an economically viable industry revealed that a positive NPV was present. However, further analysis that incorporated the impact of intangible costs reduced this value to 0, and it is concluded that economic viability is not present at this time.

4.7 Limitations of this Study

There are three primary limitations of this study: 1) The scope of the CEA is based on one firm, producing 21 types of fish. 2) Specie population numbers are not available; therefore all analysis pertaining to production quantities and required supply levels is estimates only. 3) The value of Pohnpein culture is intangible. Any change or disruption to the culture may or may not affect its value. The cultural value expressed in this paper may or may not be considered subjective.

Further research is mandatory if this export initiative is to begin and succeed. Specifically, the three areas that need to be examined and/or quantified are specie population bases of Pohnpein marine ornamental fish, the environmental costs and repercussions of harvesting the fish, and the value of Pohnpein culture in relation to the need for economic development.

4.8 Summary

A sample of 21 Pohnpein ornamentals is presented, and a sub-section pertaining to species sustainability points out the importance of established population parameters. The CEA cost elements discussed in chapter 3 are costed and listed. The cost categories of capital, labor, opportunity, transportation, environmental, and miscellaneous inputs are valued; the annual total sum of operating costs is estimated at US$82,772. Revenue and net income based on a specific production capacity are estimated at US$182,889 and US$100,117 respectively.

The three research objectives of this paper are answered, namely, a mix of economical fish is identified and the estimated profit of the mix is itemized, an estimation of the monetary and non-monetary costs associated with the export is listed, and the negative effect the transportation monopoly structure has on financial viability is presented. The goal of this thesis is to determine if economic viability of the industry is present. The answer to this question is no, economic viability is not present. This conclusion is based on the premise that even though a positive NPV of an industry could be generated, the

significant cost of intangible project-generated consequences may reduce viability. This assessment provides a basis for the judgment that the economic welfare of the Pohnpein citizens will not be improved, to any great extent, by the initiation of this industry.

CHAPTER 5
SUMMARY

The Federated States of Micronesia (FSM) is an island chain situated in the Tropical Pacific Ocean. Aggregate land surface of the islands is 702 square kilometres and is spread across 2,641,800 square kilometres of ocean area. Pohnpei, a coral reef atoll, is the capital island of the FSM. FSM population is approximately 118,100, with Pohnpei having a population of approximately 30,000 native Micronesians and 5,000 foreign expatriates.

Subsistence gathering, fishing and communal sharing are the traditional way of life on Pohnpei. However, Western theology and materialism are gaining acceptance as the FSM interacts with the rest of the world. As a consequence, the cultural and historical structure of the islands is beginning to erode. The islands are connected to global air trade routes through the services of Continental Airlines. Continental controls a monopoly on air service to and from the islands. A single international ocean freight shipping line delivers cargo, supplies, food, and mail every six to eight weeks to the four main FSM islands. Utility and telecommunication infrastructure provides service to a relatively small percentage of the population.

World Bank Group classifies the FSM as a developing or emerging nation. The subsistence economy is valued at approximately US$57,050,000 or one quarter of the Gross Domestic Product. The Gross Domestic Product growth rate and inflation are increasing at about the same rate, that is, 3% and 2.9% respectively. Money growth, however, is declining by 1% per year. FSM private sector capital formation is one of the lowest capital formation rates in the world; it is on average less than 10%.

The FSM's economy is subsidized by a compact with the US. The 1986 United States Compact of Free Association supports about 95% of the economy through subsidized payments. In addition, public sector compensation payments provide income for over 60% of the workforce. The majority of US funds flowing into the nation is spent on current expenditures rather than on capital investments. This spending pattern is a primary reason for the nation's progressive economic decline. The continuous flow of 'free' money has eroded any incentive for the nation to increase efficiency or establish competitive markets for goods and services. The main goal of the Compact was to transform the communal economy of FSM into a market economy. This has not been achieved.

The Compact expired in 2001. The subsidized funds are on a decelerating schedule. When the flow of US dollars into the nation stops, the majority of personal incomes will also cease. This scenario has prompted national leaders to assess what opportunities and resources are available that could be utilized for economic development. Given that most of the nation's natural resources are marine-based, the aquarium industry, generally, and, specifically, the export of marine ornamentals has been identified as a potential profit-generating industry.

The progress envisaged by the Compact did not occur. While the standard of living did increase, the national economy created few productive resources. After decades of debate over economic change, it is now time for the FSM to make some decisions and the political leaders are reviewing export options for industry development. Four region-specific constraints need to be factored into the decision making process; the historical lack of acute business planning, the nation's dependence on a single air transportation carrier, government, and socio-economic factors of the islands.

Various studies and business plans pertaining to the FSM have been written, yet the country continues to fall further behind in economic development. A lack of practical application and hands-on instruction has been missing in the broad plans and this exclusion is the reason such plans have not been successful. Another important aspect missing from different studies is the element of environmental assessment and the integral part the environment and natural resources plays in the majority of Tropical Pacific products. Environmental issues such as the protection and sustainability of our planet are increasingly strong business considerations for foreign investors.

Complete dependence on air transportation for moving a product to any international market is an expensive constraint of the islands. Ready access to markets and transport conduits facilitates economic expansion. Unfortunately, the geography of the Oceania region precludes quick and competitively priced transport options for island-based production and export firms.

Developing nations are particularly susceptible to local governmental interference. Four obstructive modes of governmental operations are an irregular and complex bureaucratic framework, the unequal application of rules and regulations, the wherewithal for government to take over a private industry, and decision discontinuity in investment choices and implementation.

Socio-economic factors weigh heavy in the success or failure of Tropical Pacific ventures. Seven factors have been noted to occur with regularity within the FSM islands: 1) The retention and availability of a skilled workforce is problematic for local firms, 2) land tenure issues are tenuous and non-uniform and the fact that foreigners cannot own land on Pohnpei complicates capital investment into land and fixed assets, 3) the subsistence nature of the local economy facilitates the altruistic, communal culture that prevails on Pohnpei, 4) the cost of all technical and mechanical inputs is high because everything must be imported, 5) funding sources for investment into a project are slim due to the inherent high business risk developing countries usually have, 6) planning is not a standard business activity for the average local entrepreneur, and 7) infrastructure integrity issues exacerbates the business operations and costs.

Marine resources are the most significant natural assets of the islands and familiarity with the sea and dependence on seafood are an integral part of island cultures. Extending this resource for commercial use to generate an economic return should be intuitive, and,

indeed the harvest and production of several products have been attempted. However, few projects have been successful.

The production and export of giant clams (*Tridacna*) have been attempted in several island nations. The bivalves are sold on different markets; the seafood market as meat for human consumption, the aquarium market as live specimens for saltwater tanks, and the manufacturing market as the giant clam shells are used for decorative purposes or processed for construction and manufacturing material. The commercial harvest of clams from the open ocean has historically depleted the wild clam stock. Today, Tonga is a limited exporter of the clams. Micronesia has two giant clam production facilities but both farms are government maintained and the output is extremely limited.

Live coral is harvested and sold to the aquarium trade. Coral is wild harvested or culture grown in open tropical waters. Unfortunately, coral reef habitat is declining around the world. It is estimated that 58% of the world's reefs are currently being threatened by human activities. Global climate conditions are also contributing the decline of healthy coral reefs; 1998 saw the most severe and extensive coral bleaching episode in modern history with the mortality fallout affecting 70-80% of all shallow-water coral specimens in the Indo-Pacific region.

Ornamental species of hard and soft coral are abundant within the shallow reef waters of the FSM islands. Although a number of species demanded by the aquarium trade are available here, the majority of them are banned or restricted from export according to CITIES and other regulatory agencies. The accessibility of coral makes it easy to gather. On Pohnpei, coral dredging operations are continuous as the material is a cheap substitute for imported construction material for road surfacing and cement mix. Destructive gathering has killed many Pohnpein reefs beyond the point of no return. Fallout from a killed coral reef is felt throughout the ecosystem, decreasing the output potential of plants and animals in the area. Currently, no coral is exported from the Tropical Pacific region.

Eucheuma seaweed is harvested for use in the food processing industry in the form of carrageenan. Eucheuma seaweed farms have had some success in the Fijian islands. The success is due to the low technology and limited farming skill requirements, the availability of prime sea-growing space, and the fact that the product may be exported on ships and Fiji is on several international shipping lanes. The production of seaweed has not been attempted in the FSM.

Trochus *(Trochus Niloticus)* is sold on the seafood market, as well as to the manufacturing industry. Trochus are large, thick turban-shaped shells with an edible fleshy mantel and have been harvested for subsistence purposes for centuries. The shell has historically been carved and fashioned for cookery, tools, and ceremonial adornment. Current uses for Trochus shell include buttons, jewelry, inlay material, and souvenirs. The meat is prized on the gourmet sushi market.

In 1970's, significant declines in stocks indicated severe over-fishing had occurred, and commercial harvest restrictions were imposed for two decades. Limited harvesting has

resumed and continues today. Currently, the harvest season is two days per year on the FSM islands where harvest still occurs. The quantities gathered are for domestic use only and no Trochus is exported from the FSM.

Several studies on the potential of production and export of Micronesian aquatics indicate economic feasibility is low. Research has shown that although numerous aquatic production projects start with potential, the long-term costs of production are underestimated and the result is economic failure and suspension of operations. The potential of capitalizing on a rich abundance of natural resources has been thwarted by ineffectual management practices and the involvement of government. In the FSM, the lack of a coastal or in-shore fisheries management plan contributes to the stagnant growth of marine industries. Another aspect of the absence of regulations is any development of intertidal fisheries, given the ready access to this area of the reef, can be easily over-exploited and habitat can be destroyed.

Contributing to the low success rate of Micronesian marine export projects is the tradition of communal sharing and an inability to separate business and family; family members have access to any part of the business assets. Saying no or refusing to oblige or cooperate with a request from a family member or high clan member is not acceptable. This altruistic sense of communal sharing is a prevalent cause of business failure.

To understand how a Pohnpein export venture may or may not fit into the global marine ornamental trade, a Political/Legal Economic Sociocultural Technological (*PEST*) analysis is used to examine the current trends and concerns of the trade industry. The two main political/legal factors that have an impact on the global industry for marine ornamentals are environmental protection concerns, and global trade implications. Environmental protection concerns are important considerations given the excessive habitat disruption and reef destruction that result from harvesting small aquarium fish. Unfortunately, the growing environmental awareness and proactive stance that developed nations have taken in this area are slow at being adopted in the developing sectors of the Tropics.

Global trade implications of harvesting the live product from one location and exporting it into a foreign environment can be considerable. Almost 100% percent of marine ornamentals are harvested from tropical waters. Demand, however, is concentrated in the northern hemisphere. Exotic or alien species, defined as introduced from abroad and not native, are capable of carrying disease and contaminates to native animals and environments.

Opposite economic conditions exist between the suppliers and consumers of the industry. In terms of supply, approximately 95% of marine aquatics are harvested from tropical nations that are classified as under-developed or developing. Laborers in these nations earn from US$3 to US$12 per day. Fish collectors are paid by piecework, as they are generally not qualified to earn a set wage. On average, compensation per fish is equivalent to a few US pennies. Conversely, consumer economies that import marine ornamentals are classified as developed with high-income levels.

Two sociocultural influences are emerging as influential factors in the marine ornamental trade: Environmental awareness and response, and issues pertaining to the humane treatment of animals. Awareness and knowledge about coral reef ecosystems are on the rise. The destruction of the reefs due to the collection methods of marine ornamental harvesters is a major concern. Irreversible damage to the skeletal structure and plant environment of reefs and the spread of lethal contaminants are common as fisherpersons attempt to capitalize on the rising demand for their product.

Attitudes and practices in the humane treatment of animals vary around the world. Economic conditions of developing nations contribute significantly to the way tropical fish are collected and handled. For example, in order to increase product quantity, sodium cyanide poisoning is sprayed on the reef and into surrounding areas to stun the fish and make collection a simple matter of scooping up handfuls of inert fish. Although the ingested poison dissipates and the fish subsequently revive, side effects stay with the fish indefinitely. To the western perception, such husbandry is inhumane, however, to the fisherperson, it is the most economically feasible way to catch large quantities of fish quickly.

Aquatic technological advances over the previous decade have contributed to the rapidly expanding hobby of aquaria. Technological improvement of all the basic aquarium apparatuses has provided this impetus. The current trend in marine tanks is the simulation of a coral reef environment. These aquariums require an extensive amount of hardware and apparatus.

The objective of this study is to develop an economic cost-effectiveness model to determine viability of the export of Pohnpein ornamentals. Economic analysis attempts to assess the overall impact of a project on improving the economic welfare the nation's citizenry. It measures the project's positive and negative impact on the country. For the purposes of this study, a cost-effectiveness framework will enable the systematic recording and comparison of the costs of inputs with the outputs and outcomes of establishing an export-oriented business, supplying marine ornamental fish.

Four key questions will be answered in the process: 1) What was the true cost of an initiative, practice or policy? 2) Did the outcome(s) achieved justify the investment of resources? 3) Was this the most efficient way of realizing the desired outcome(s) or could the same outcome(s) have been achieved at a lower cost through an alternative course of action? and 4) How should additional resources be spent?

The underlying objective of cost-effectiveness analysis is to assist or provide guidance to decision-makers on the efficient allocation of resources in areas where private markets cannot or do not achieve allocative efficiency. There are seven categories of non-monetary constraints: Environmental, Financial, Distributional, Management, Transportation, Cultural, and Infrastructure. There are six cost categories: Capital, labor, opportunity, transportation, environmental, and miscellaneous input costs. There are five

outcomes and benefits: Revenue and net income, resale value of the capital equipment, saved costs, productivity savings, and intangible benefits and non-quantifiable outcomes.

For the purpose of this paper, the CEA is assessing a production firm that employees three people and annually produces 35,860 fish. The sample of fish consists of 21 Pohnpein marine ornamental species that inhabit FSM waters. The constraint and cost categories of this scenario are explained and/or valued in order to calculate the outcomes and benefits of the production process.

Environmental constraints are paramount to this export proposal. The FSM is largely a subsistence economy and to this extent, reef fish play a fundamental role in the island's food supply. Disruption of this resource because of export initiatives is likely to result as the displacement of fishermen from the subsistence labor force and the disturbance and relocation of the food fish will impact Pohnpei's food supply. Damage to the reef's ecosystem inflicted by harvesters will affect the intertidal zone, the mangroves, and the shoreline of the island. Intertidal and mangrove harvesting of crustaceans will decline if habitat erodes. Coral polyp displacement or breakage will erode the integrity of the reef itself, and Pohnpei Island is a coral reef atoll.

Another environmental consideration is the fact that land tenure and ownership is complex and non-uniform throughout the islands. Pohnpeins own all the land and sea adjacent to their land; foreigners and Micronesians from other islands are not entitled to land ownership of the island. Leasing of land and sea is allowed, however the maximum lease term allowed is 25 years. In addition, the leasing process is quite complicated and obtained lease agreements are frequently revoked or violated with little or no recourse by the lessee.

For a nation completely reliant on subsidization, financial constraints are a relatively new concept. There are only two lending institutions on Pohnpei and both bank have strict guidelines for borrowing, and require a substantial amount of local collateral for all loans. Frequently, the only collateral available on-island is family land, owned collectively among many persons, and agreement to pledge the land for collateral is not forthcoming. Private investors seeking external funding for investment run into usury interest rates, as the risk of investing in FSM under the current government is high.

Distributional constraints are directly tied to cultural dictates. A portion of all sea bounty or its monetary equivalent must be offered to the Nahnmwarki, the traditional clan leader. If an offering is not made, the public reefs will become culturally 'inaccessible'. Although the sea directly adjacent to the land is privately owned, the reefs are publicly owned and reaping private reward from harvesting them is not culturally done.

Management constraints are a serious issue in establishing a production firm on the island. The skills required for basic understanding of production operations and business management is not common in the local population. Management personnel with the skills to operate a production firm are not available on-island. Off-island recruitment is expensive and a lengthy process. Governmental regulation dictates that all businesses in

Pohnpei be owned by a Pohnpein. Foreign-managed firms that are owned by local citizens tend to run into the pervasive problem of profits being readily siphoned off into the local family purse. Re-investment rarely occurs as management of the finances is controlled by the Pohnpein and indirectly, their family.

Transportation constraints inhibit most production ventures in the FSM as product transportation is a key element of export success. Continental Airlines controls a monopoly on the air services to the Micronesian islands. Product substitution for tropical marine ornamentals is high with the majority of supply originating from the Philippines. Shipping costs from the Philippines are lower than those from the FSM. Therefore, buyers can purchase the product cheaper given that shipping costs are lower.

Culture plays an integral part in who the Pohnpein people are, and island tradition based on subsistence living is deeply ingrained in the population. The FSM as a communal economy based on the concept of extended family, where the individual's economic productivity, regardless of amount or value, belongs to the family. The altruistic nature of this sharing or spreading the wealth is a concept that is part of the nation's identity. Such communal and familial obligation is at odds with the values of western capitalism and individual materialism. Culture mandates that family and clan have access to all business assets.

Infrastructure constraints are compounded by the isolation of the islands in the Tropical Pacific Ocean. Technology, hardware, and skilled personnel are imported at premium prices. Operating a western facility within the bounds of local specifications produces inconsistent and irregular products and services. It is agreed that until there is a concerted effort to build the necessary infrastructure, the nation is not going to be a participatory player in the economic surge of its neighboring islands.

A fundamental constraint that does not fall into a specific category is the issue of specie sustainability. Specie sustainability requirements for marine animals are an ongoing research goal of scientists around the globe. Hence, precise sustainability levels for marine ornamentals are not available at this time. A general benchmark of sustainability accepted within the scientific community is at a 10% removal rate per year, whereby a species population has the ability to sustain itself. Population parameters of the sample fish in this study have not been scientifically catalogued; only their habitat presence in Pohnpein waters has been officially recorded. Field research is required to identify the true quantity status of the fish. Starting a fish export industry before actual supply levels of the fish are known is risky. If harvest commences before sustainability quantities are established, the possibility of eliminating a species is real.

The initial capital asset investment to begin production is valued at US$32,700. Labor costs equal US$38,528. Opportunity costs total US$12,600. Miscellaneous input costs tally to US$25,104

Transportation charges are not paid by the export firm. They are absorbed by the buyer of the ornamentals. However, they are a cost factor of production and relevant to this

model. Transportation costs equal approximately 21.3% of gross revenue or 33% of gross profit and are indirectly passed on to the producer in the form of lower prices paid for the exported fish. The monopoly structure of the transport conduit to and from Pohnpei eliminates the possibility of lowering these transportation costs.

The environmental costs of harvesting ornamental fish primarily impacts subsistence fishing and is two-fold: It will decrease the quantity of able-bodied fishermen available to gather food for the clan by employing them for wages, and the activity of harvesting ornamentals from the reef and inter-tidal zones will inevitably push the schools of food fish further off-shore, thus compounding the difficulty and expense of subsistence fishing.

The decrease of subsistence fishing for the clan is not offset by the amount of wages earned. A fisherman gathers enough fish to feed his family; this quantity ranges from 8 to 15 pounds of fish per day. The market value of this food fish is US$10.40 to US$19.50 @ US$1.30 per pound; net wages earned per day is US$9.52 (1.35 less taxes * 8 hours).

The intended benefit of establishing the export is to initiate a private industry that will generate revenue and economic activity. The costs of production have been valued and itemized. The outcomes and benefits may now be quantified, specifically revenue, net income, resale value of the capital equipment, and productivity savings. Intangible benefits and non-quantifiable outcomes are addressed.

Revenue generated on the sale of 35,860 fish totals US$182,889. Net Income is US$100,117. Resale value of the capital equipment after five years of service is US$5,600. Productivity savings are currently zero as the industry has not yet been established. Future productivity savings will be identified through the trial and error of running a business or industry.

The intangible benefit of initiating this export is indirect, yet important. The nation will be in compliance with the Compact is a new industry is initiated. If Pohnpein industries are not started, the nation will be in violation of the Compact agreement between the United States. The exact penalty and the nature of the penalty of Compact violation are not known.

The economic viability of the industry is now assessed. The data of this study will be the context of the answers to four questions: 1) What was the true cost of an initiative, practice or policy? There are three financial costs to the initiative: a) The capital investment into a single export firm is US$32,700. b) The annual production cost of producing 35,860 ornamental fish is US$82,772. c) A cost is incurred when a subsistence laborer is transferred to the economic sector. The laborer is unable to catch fish for food while he/she is employed. The daily earned wage is US$.88 to US$9.98 less than the purchase value of the food fish they would otherwise catch.

There are five non-monetary costs directly tied to the initiative: a) Destruction of the reef and coral habitat from harvesting the fish will occur. Subsequent erosion of the intertidal and mangrove ecosystems will threaten the integrity of Pohnpei atoll. b) Increased activity in the reef zone will drive food fish schools further off-shore. This will complicate subsistence gathering of sea sustenance. c) Depleting ornamental fish stocks before population bases are known can lead to the elimination of entire species. Sustainability levels must be maintained to ensure specie continuity, as well as habitat integrity. d) Foreign investors into this export must be in partnership with a local Pohnpein and are entitled to own only a minority of the business. The communal and sharing nature of Pohnpein culture dictates that any request for money or assets from the business by family or clan be granted. e) Cultural ties between Pohnpeins and the sea go back millennia. Harvesting the reef for personal economic gain and damaging the intertidal habitat in the process may not be acceptable to traditional leaders. Traditional and culturally related decisions carry a lot of power, and if the Nahnmwarki decides to stop reef harvest, it will stop. Legal recourse would not be forthcoming as the local ownership of the firm will honor the traditional authorities. If production proceeds unimpeded, the cultural repercussions and the impact on the historical way of life and tradition is unknown.

To summarize, the annual financial cost of the initiative is approximately US$115,472 per export firm and approximately US$229 to US$2,595 per displaced subsistence laborer in the additional cost for food. The intangible costs of altering the reef's ecosystem and the intertidal zones, the disruption of current food fish schools, the depletion of stock levels of which population parameters are unknown, the lack of majority control over the business and its assets, and the adverse impact a production operation may have on Pohnpein culture and the historical way of life on the island cannot be quantified. Regardless of their non-quantifiable nature, the individual and collective value of these five costs is great. The environmental and cultural alterations they represent cannot be reversed or replaced.

2) Did the outcome(s) achieved justify the investment of resources? The positive impact of investment into the project is that a capital outlay of US$32,700 into a production firm will generate an estimated net annual profit of US$100,117 for that firm. The Net Present Value (NPV) of the project is positive. This indicates that, based on financial data, pursuing the industry is viable.

The negative impacts of the investment are intangible and impact so heavily on the NPV that viability is reduced to 0. As previously stated, the monetary cost for environmental alteration and the loss of Pohnpein culture cannot be calculated. Therefore, economic justification of the investment of resources into the proposed initiative is not present as the overall outcome of the project to society cannot be fully calculated.

3) Was this the most efficient way of realizing the desired outcome(s) or could the same outcome(s) have been achieved at a lower cost through an alternative course of action? This proposed initiative was not the most efficient way to reach the desired outcome of economic self-sufficiency. An in-depth financial analysis would have revealed the costs

of production, real revenue projections, and the detrimental financial impact of operating within and relying on a monopolistic air transport structure. The risk factor associated with operating in the confines of a narrow transportation sector is very high as any disruption or adjustment with the sector will immediately impact the export industry. The issue of harvesting live animals before scientific data pertaining to population quantities is available would have come to light and signaled that perhaps industry initiation is premature. A subsequent economic analysis would have revealed the negative environmental and cultural implications of the export and the lack of an overall contribution to society.

4) How should additional resources be spent? If the export industry is to be established, additional resources should be spent on supply quantification and environmentally-sound harvesting techniques. It is fundamental to the success of this industry to establish population parameters of the species to be harvested and to ensure harvesting methodology is as non-invasive and habitat-friendly as possible. The evidence that short-term feasibility of exporting fish is positive should not overshadow the long-term uncertainty of supply sustainability and environmental degradation. Resources should also be spent on determining if the irretrievable loss of certain aspects of Pohnpein culture is worth the temporary economic gain of harvesting ornamentals.

In conclusion, a cost-effectiveness analysis was used to structure and quantify and qualify the information in order to reach a logical economic assessment of industry viability. In this context, the preceding cost assessment to determine if the export of tropical aquarium fish is an economically viable industry revealed that a positive NPV was present. Further analysis that incorporated the impact of intangible costs reduced this value to 0 and it is concluded that economic viability is not present at this time.

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APPENDIX 1
ORNAMENTAL SPECIES OF THE FSM

Species of Ornamental Fish Inhabiting Waters of the FSM

Scientific Name	**Common Name**
Abalistes stellaris	Starry triggerfish
Abudefduf sordidus	Black-spot sergeant
Abudefduf vaigiensis	Indo-Pacific sergeant
Acanthurus achilles	Achilles tang
Acanthurus bariene	Roundspot surgeonfish
Acanthurus blochii	Ringtail surgeonfish
Acanthurus chronixis	Chronixis surgeonfish
Acanthurus dussumieri	Eye-stripe surgeonfish
Acanthurus guttatus	Whitespotted surgeonfish
Acanthurus leucopareius	Whitebar surgeonfish
Acanthurus lineatus	Striped surgeonfish
Acanthurus maculiceps	White-freckled surgeonfish
Acanthurus mata	Elongate surgeonfish
Acanthurus nigricans	Whitecheek surgeonfish
Acanthurus nigricauda	Epaulette surgeonfish
Acanthurus nigrofuscus	Dusky surgeonfish
Acanthurus nigroris	Bluelined surgeonfish
Acanthurus olivaceus	Orangeband surgeonfish
Acanthurus pyroferus	Mimic surgeonfish
Acanthurus thompsoni	Thompson's surgeonfish
Acanthurus triostegus	Convict tang
Acanthurus xanthopterus	Yellowfin surgeonfish
Aeoliscus strigatus	Shrimpfish
Alectis ciliaris	Threadfin pompano
Aluterus scriptus	Scribbled filefish
Amblycirrhitus bimacula	Two-spotted hawkfish
Amblyeleotris guttata	Spotted prawn-goby
Amblyeleotris periophthalma	Periophthalma prawn-goby
Amblyeleotris steinitzi	Steinitz' prawn-goby
Amblyglyphidodon aureus	Golden damsel
Amblyglyphidodon curacao	Staghorn damselfish
Amblyglyphidodon leucogaster	White-belly damsel
Amblygobius decussatus	Crosshatch goby
Amblygobius hectori	Hector's goby
Amblygobius nocturnus	Nocturn goby
Amblygobius phalaena	Brown-barred goby
Amblygobius rainfordi	Rainford's goby
Amblygobius sphynx	Sphynx goby
Amphiprion chrysopterus	Orange-fin anemonefish
Amphiprion clarkii	Clark's anemonefish
Amphiprion frenatus	Tomato anemonefish
Amphiprion melanopus	Dusky anemonefish
Amphiprion perideraion	Pink anemonefish
Amphiprion sandaracinos	Orange anemonefish
Anampses caeruleopunctatus	Blue-spotted wrasse
Anampses geographicus	Geographic wrasse
Anampses meleagrides	Yellowtail wrasse
Anampses twistii	Yellowbreasted wrasse
Anomalops katoptron	Two-fin flashlightfish
Antennarius coccineus	Freckled frogfish
Apogon compressus	Ochre-striped cardinalfish
Apogon gilberti	Gilbert's cardinalfish
Apogon kallopterus	Iridescent cardinalfish
Apogon leptacanthus	Threadifn cardinalfish
Apogon taeniopterus	Bandfin cardinalfish
Apolemichthys trimaculatus	Three-spot angelfish
Apolemichthys xanthopunctatus	Golden spotted angelfish
Aprion virescens	Green jobfish
Arothron hispidus	White-spotted puffer
Arothron meleagris	Guineafowl puffer
Aspidontus dussumieri	Lance blenny

Aspidontus taeniatus taeniatus	Cleaner mimic
Asterropteryx semipunctatus	Starry goby
Atrosalarias fuscus holomelas	Coral blenny
Aulostomus chinensis	Chinese trumpetfish
Balistapus undulatus	Orangestriped triggerfish
Balistoides conspicillum	Clown triggerfish
Blenniella chrysospilos	Red-spotted blenny
Blenniella gibbifrons	Hump-headed blenny
Bodianus anthioides	Lyretail hogfish
Bodianus axillaris	Axilspot hogfish
Bodianus mesothorax	Splitlevel hogfish
Bolbometopon muricatum	Humphead parrotfish
Bothus mancus	Peacock flounder
Bryaninops natans	Redeye goby
Bryaninops yongei	Whip coral goby
Butis amboinensis	Olive flathead-gudgeon
Calotomus carolinus	Stareye parrotfish
Calotomus spinidens	Spinytooth parrotfish
Cantherhines dumerili	Barred filefish
Canthigaster amboinensis	Spider-eye puffer
Canthigaster coronata	Crowned puffer
Canthigaster janthinoptera	Honeycomb toby
Canthigaster solandri	Spotted sharpnose
Canthigaster valentini	Valentinni's sharpnose puffer
Caracanthus maculatus	Spotted coral croucher
Centropyge bicolor	Bicolor angelfish
Centropyge bispinosus	Two-spined angelfish
Centropyge colini	Colin's angelfish
Centropyge flavissimus	Lemonpeel angelfish
Centropyge heraldi	Yellow angelfish
Centropyge loriculus	Flame angelfish
Centropyge multicolor	Multicolor angelfish
Centropyge nox	Midnight angelfish
Centropyge tibicen	Keyhole angelfish
Centropyge vrolikii	Pearlscale angelfish
Cephalopholis argus	Peacock grouper
Cephalopholis boenak	Chocolate hind
Cephalopholis miniata	Coral hind
Cephalopholis urodeta	Flagtail grouper
Cetoscarus bicolor	Bicolor parrotfish
Chaetodon auriga	Threadfin butterflyfish
Chaetodon baronessa	Eastern triangle butterflyfish
Chaetodon bennetti	Bennett's butterflyfish
Chaetodon burgessi	Burgess' butterflyfish
Chaetodon citrinellus	Speckled butterflyfish
Chaetodon ephippium	Saddled butterflyfish
Chaetodon kleinii	Klein's butterflyfish
Chaetodon lineolatus	Lined butterflyfish
Chaetodon lunula	Racoon butterflyfish
Chaetodon melannotus	Black-backed butterflyfish
Chaetodon mertensii	Merten's butterflyfish
Chaetodon meyeri	Meyer's butterflyfish
Chaetodon ornatissimus	Ornate butterflyfish
Chaetodon punctatofasciatus	Spot banded butterflyfish
Chaetodon quadrimaculatus	Fourspot butterflyfish
Chaetodon rafflesii	Latticed butterflyfish
Chaetodon reticulatus	Reticulated butterflyfish
Chaetodon semeion	Dotted butterflyfish
Chaetodon speculum	Ovalspot butterflyfish
Chaetodon trifascialis	Chevroned butterflyfish
Chaetodon trifasciatus	Redfin butterflyfish
Chaetodon ulietensis	Pacific double-saddle butterflyfish
Chaetodon unimaculatus	Teardrop butterflyfish
Chaetodon vagabundus	Vagabond butterflyfish
Channomuraena vittata	Long-jawed moray
Cheilinus chlorourus	Floral wrasse
Cheilinus fasciatus	Red-banded wrasse
Cheilinus trilobatus	Tripletail wrasse
Cheilinus undulatus	Humphead wrasse
Cheilio inermis	Cigar wrasse

Chlorurus bleekeri	Bleeker's parrotfish
Chlorurus frontalis	Tan-faced parrotfish
Chlorurus gibbus	Gibbus parrotfish
Chlorurus japanensis	Pale bullethead parrotfish
Chlorurus pyrrhurus	Redtail parrotfish
Chlorurus sordidus	Bullethead parrotfish
Choerodon anchorago	Yellow-cheek tuskfish
Choerodon fasciatus	Harlequin tuskfish
Chromis agilis	Bronze reef chromis
Chromis amboinensis	Ambon chromis
Chromis atripectoralis	Black-axil chromis
Chromis elerae	Twin-spot chromis
Chromis margaritifer	Bicolor chromis
Chromis ternatensis	Ternate chromis
Chromis vanderbilti	Vanderbilt's chromis
Chromis viridis	Blue-green chromis
Chromis xanthura	Black chromis
Chrysiptera biocellata	Two-spot demoisele
Chrysiptera caeruleolineata	Blue-line demoiselle
Chrysiptera cyanea	Blue devil
Chrysiptera leucopoma	Surge demoiselle
Chrysiptera oxycephala	Bluespot demoiselle
Chrysiptera unimaculata	One-spot demoiselle
Cirrhilabrus cyanopleura	Blueside wrasse
Cirrhitichthys aprinus	Threadfin hawkfish
Cirrhitichthys falco	Falco hawkfish
Cirrhitichthys oxycephalus	Pixy hawkfish
Cirrhitus pinnulatus	Stocky hawkfish
Cirripectes castaneus	Chestnut blenny
Cirripectes stigmaticus	Redstreaked blenny
Cirripectes variolosus	Red-speckled blenny
Conger cinereus	Moustache conger
Coris aygula	Clown coris
Coris batuensis	Batu coris
Coryphopterus neophytus	Sand goby
Coryphopterus signipinnis	(Not Available)
Corythoichthys haematopterus	Yellow-streaked pipefish
Cryptocentrus cinctus	Yellow prawn-goby
Cryptocentrus strigilliceps	Target prawn-goby
Ctenochaetus binotatus	Twospot bristletooth
Ctenochaetus Hawai'iensis	Hawai'ian surgeonfish
Ctenochaetus marginatus	Blue-spotted bristletooth
Ctenochaetus striatus	Striped bristletooth
Ctenochaetus strigosus	Goldring surgeonfish
Ctenogobiops aurocingulus	Gold-streaked prawn-goby
Ctenogobiops pomastictus	Gold-specked prawn-goby
Cyprinocirrhites polyactis	Swallowtail hawkfish
Dactyloptena orientalis	Helmet gurnard
Dascyllus aruanus	Humbug dascyllus
Dascyllus melanurus	Black-tail dascyllus
Dascyllus reticulatus	Reticulated dascyllus
Dascyllus trimaculatus	Three-spot dascyllus
Dendrochirus biocellatus	Ocellated lionfish
Dendrochirus zebra	Zebra lionfish
Diodon holocanthus	Porcupinefish (Long-spine)
Diodon hystrix	Porcupinefish (Spot-fin)
Diodon liturosus	Black blotched porcupinefish
Diploprion bifasciatum	Barred soapfish
Doryrhamphus excisus	Bluestripe pipefish
Echeneis naucrates	Sharksucker
Echidna nebulosa	Snowflake moray
Echidna polyzona	Barred moray
Ecsenius bicolor	Bicolor blenny
Ecsenius opsifrontalis	Comical blenny
Ecsenius yaeyamaensis	Yaeyama blenny
Eleotris fusca	Dusky sleeper
Entomacrodus decussatus	Wavyline rockskipper
Entomacrodus striatus	Blackspotted rockskipper
Epibulus insidiator	Slingjaw wrasse
Epinephelus fasciatus	Black-tipped grouper

Epinephelus fuscoguttatus	Brown-marbled grouper
Epinephelus lanceolatus	Giant grouper
Eviota fasciola	Barred pygmy goby
Eviota infulata	Infulata pygmy goby
Eviota pellucida	Pellucida pygmy goby
Exallias brevis	Leopard blenny
Exyrias belissimus	Mud reef-goby
Exyrias puntang	Puntang goby
Fistularia commersonii	Cornetfish smooth flutemouth
Forcipiger flavissimus	Long-nosed butterflyfish
Forcipiger longirostris	Big long-nosed butterflyfish
Gambusia affinis	Mosquitofish
Genicanthus melanospilos	Black-spot angelfish
Glossogobius giuris	Tank goby
Glyptoparus delicatulus	Delicate blenny
Gnathanodon speciosus	Golden trevally
Gobiodon citrinus	Lemon coral goby
Gobiodon rivulatus	Rippled coral goby
Gomphosus varius	Bird wrasse
Grammistes sexlineatus	Sixline soapfish
Gunnellichthys monostigma	Onespot wormfish
Gunnellichthys pleurotaenia	Onestripe wormfish
Gymnomuraena zebra	Zebra moray
Gymnothorax flavimarginatus	Yellow-margined moray
Gymnothorax meleagris	Whitemouth moray
Gymnothorax undulatus	Undulated moray
Halichoeres biocellatus	Two-spotted wrasse
Halichoeres hortulanus	Checkerboard wrasse
Halichoeres margaritaceus	Weedy surge wrasse
Halichoeres marginatus	Dusky wrasse
Halichoeres melasmapomus	Black-ear wrasse
Halichoeres trimaculatus	Three-spot wrasse
Hemiglyphidodon plagiometopon	Lagoon damsel
Hemigymnus fasciatus	Barred thicklip wrasse
Hemigymnus melapterus	Half-and-half wrasse
Hemitaurichthys polylepis	Pyramid butterflyfish
Heniochus acuminatus	Longfin bannerfish
Heniochus chrysostomus	Pennant bannerfish
Heniochus monoceros	Masked bannerfish
Heniochus singularius	Singular bannerfish
Heniochus varius	Humphead bannerfish
Heteropriacanthus cruentatus	Glasseye
Hippocampus histrix	Thorny seahorse
Hippocampus kuda	Yellow seahorse
Histrio histrio	Sargassum fish
Hologymnosus annulatus	Ring wrasse
Hologymnosus doliatus	Longface wrasse
Hoplolatilus starcki	Stark's tilefish
Inimicus didactylus	Spiny devilfish
Istiblennius edentulus	Rippled rockskipper
Istigobius ornatus	Ornate goby
Kyphosus bigibbus	Insular rudderfish
Labrichthys unilineatus	Tubelip wrasse
Labroides bicolor	Bicolor cleaner wrasse
Labroides dimidiatus	Bluestreak cleaner wrasse
Labroides pectoralis	Blackspot cleaner wrasse
Labropsis alleni	Allen's wrasse
Labropsis micronesica	Micronesian wrasse
Labropsis xanthonota	Wedge-tailed wrasse
Lactoria cornuta	Longhorn cowfish
Lactoria diaphana	Spiny cowfish
Lactoria fornasini	Thornback cowfish
Lepidozygus tapeinosoma	Fusilier damsel
Leptoscarus vaigiensis	Seagrass parrotfish
Liza vaigiensis	Yellowtail mullet
Lutjanus decussatus	Checkered snapper
Lutjanus fulvus	Flametail snapper
Lutjanus kasmira	Bluelined snapper
Lutjanus malabaricus	Malabar blood snapper
Macropharyngodon meleagris	Leopard wrasse

Mahidolia mystacina	Flagfin prawn goby
Malacanthus brevirostris	Quakerfish
Malacanthus latovittatus	Striped blanquillo
Meiacanthus anema	Threadless blenny
Meiacanthus atrodorsalis	Yellowtail poison-fang blenny
Meiacanthus grammistes	Striped poison-fang blenny
Melichthys niger	Black triggerfish
Melichthys vidua	Pinktail triggerfish
Microphis brachyurus brachyurus	Short-tailed pipefish
Monodactylus argenteus	Mono
Monotaxis grandoculis	Bigeye emperor
Myrichthys maculosus	Spotted snake eel
Myripristis berndti	Bigscale soldierfish
Myripristis kuntee	Pearly soldierfish
Myripristis murdjan	Red soldierfish
Naso annulatus	Whitemargin unicornfish
Naso brachycentron	Humpback unicornfish
Naso brevirostris	Spotted unicornfish
Naso hexacanthus	Blacktounge unicornfish
Naso lituratus	Orangespine unicornfish
Naso lopezi	Lopez' unicornfish
Naso thynnoides	Singlespine unicornfish
Naso tuberosus	Humpnose unicornfish
Naso unicornis	Bluespine unicornfish
Naso vlamingii	Bignose unicornfish
Nemateleotris decora	Decorated dartfish
Nemateleotris magnifica	Fire dartfish
Neocirrhites armatus	Flame hawkfish
Neomyxus leuciscus	Acute-jawed mullet
Neoniphon sammara	Spotfin squirrelfish
Novaculichthys taeniourus	Rockmover wrasse
Odonus niger	Redtooth triggerfish
Ophiocara porocephala	Northern mud gudgeon
Oplopomus oplopomus	Spinecheek goby
Oreochromis mossambicus	Mozambique tilapia
Ostracion cubicus	Yellow boxfish
Ostracion meleagris	Spotted trunkfish
Oxycheilinus bimaculatus	Twospot wrasse
Oxycheilinus celebicus	Celebes wrasse
Oxycheilinus digrammus	Bandcheek wrasse
Oxycheilinus orientalis	Oriental maori wrasse
Oxycheilinus unifasciatus	Ringtail wrasse
Oxycirrhites typus	Longnose hawkfish
Oxymonacanthus longirostris	Longnose filefish
Oxyurichthys microlepis	Maned goby
Oxyurichthys papuensis	Frogface goby
Paracanthurus hepatus	Palette surgeonfish
Paracentropyge multifasciatus	Barred angelfish
Paracirrhites arcatus	Arc-eye hawkfish
Paracirrhites forsteri	Blackside hawkfish
Paracirrhites xanthus	(Not Available)
Paragobiodon echinocephalus	Redhead goby
Parupeneus barberinoides	Half-and-half goatfish
Parupeneus barberinus	Dash-and-dot goatfish
Parupeneus bifasciatus	Two-barred goatfish
Parupeneus cyclostomus	Yellowsaddle goatfish
Parupeneus multifasciatus	Multibarred goatfish
Parupeneus pleurostigma	Sidespot goatfish
Pastinachus sephen	Fantail stingray
Pempheris oualensis	Copper sweeper
Periophthalmus argentilineatus	Barred mudskipper
Pervagor melanocephalus	Blackheaded filefish
Petroscirtes breviceps	Striped poison-fang blenny mimic
Petroscirtes mitratus	Floral fangblenny
Petroscirtes xestus	Xestus sabretooth blenny
Photoblepharon palpebratus	Small flashlighfish
Plagiotremus rhinorhynchos	Bluestriped fangblenny
Plagiotremus tapeinosoma	Scale-eating fangblenny
Platax orbicularis	Circular spadefish batfish
Platax pinnatus	Pinnate spadefish

Platax teira	Longfin spadefish
Plectorhinchus albovittatus	Two-striped sweetlips
Plectorhinchus chaetodonoides	Harlequin sweetlips
Plectorhinchus gaterinoides	Lined sweetlips
Plectorhinchus lineatus	Lined sweetlips (Yellowbanded)
Plectorhinchus orientalis	Oriental sweetlips
Plectorhinchus picus	Spotted sweetlips
Plectroglyphidodon dickii	Dick's damsel
Plectroglyphidodon imparipennis	Brighteye damsel
Plectroglyphidodon johnstonianus	Johnston damsel
Plectroglyphidodon lacrymatus	Jewel damsel
Plectroglyphidodon leucozonus	White-band damsel
Plectroglyphidodon phoenixensis	Phoenix islands damsel
Plectropomus leopardus	Leopard coralgrouper
Plesiops coeruleolineatus	Red-tipped longfin
Plesiops corallicola	Bluegill longfin
Plotosus lineatus	Striped eel catfish
Polydactylus sexfilis	Sixfinger threadfin
Pomacanthus imperator	Emperor angelfish
Pomacanthus navarchus	Blue-girdled angelfish
Pomacanthus sexstriatus	Six-banded angelfish
Pomacanthus xanthometopon	Blue-face angelfish
Pomacentrus bankanensis	Speckled damsel
Pomacentrus coelestis	Neon damsel
Pomacentrus moluccensis	Lemon damsel
Pomacentrus philippinus	Philippine damsel
Pomacentrus vaiuli	Princess damsel
Premnas biaculeatus	Spinecheek anemonefish
Priacanthus hamrur	Goggle eye
Priolepis cincta	Pacific convict goby
Priolepis semidoliatus	(Not Available)
Pseudanthias bicolor	Bicolor anthias
Pseudanthias dispar	Peach anthias
Pseudanthias randalli	Randall's anthias
Pseudanthias squamipinnis	Scalefin anthias
Pseudobalistes fuscus	Blue triggerfish
Pseudocheilinus evanidus	Striated wrasse
Pseudocheilinus hexataenia	Sixline wrasse
Pseudocheilinus tetrataenia	Fourline wrasse
Pseudochromis cyanotaenia	Blue-barred dottyback
Pseudochromis fuscus	Brown dottyback
Pseudochromis porphyreus	Strawberry dottyback
Pseudodax moluccanus	Chiseltooth wrasse
Pseudoplesiops typus	Ring-eyed dottyback
Ptereleotris evides	Blackfin dartfish
Ptereleotris heteroptera	Spot-tail dartfish
Ptereleotris microlepis	Pearly dartfish
Pterois antennata	Spotfin lionfish
Pterois radiata	Clearfin lionfish
Pterois volitans	Turkeyfish
Pygoplites diacanthus	Regal angelfish
Rhinecanthus aculeatus	Picassofish
Rhinecanthus rectangulus	Wedge picassofish
Rhinecanthus verrucosus	Blackbelly picassofish
Rhinopias frondosa	Weedy scorpionfish
Salarias fasciatus	Jeweled blenny
Sargocentron caudimaculatum	Tailspot squirrelfish
Sargocentron diadema	Crown squirrelfish
Sargocentron punctatissimum	Speckled squirrelfish
Scarus dimidiatus	Turquoise-capped parrotfish
Scarus flavipectoralis	Yellowfin parrotfish
Scarus frenatus	Vermiculate parrotfish
Scarus ghobban	Blue-barred parrotfish
Scarus globiceps	Violet-lined parrotfish
Scarus niger	Swarthy parrotfish
Scarus oviceps	Dark-capped parrotfish
Scarus prasiognathos	Greenthroat parrotfish
Scarus psittacus	Palenose parrotfish
Scarus rubroviolaceus	Redlip parrotfish
Scarus schlegeli	Yellowband parrotfish

Scatophagus argus	Scat
Scolopsis bilineata	Twoline spinecheek
Scolopsis lineatus	Black-and-white spinecheek
Scorpaenodes parvipinnis	Coral scorpionfish
Scorpaenopsis diabolus	Devil scorpionfish
Scuticaria tigrina	Tiger snake moray
Siganus argenteus	Forktail rabbitfish
Siganus corallinus	Coral rabbitfish
Siganus guttatus	Golden rabbitfish
Siganus lineatus	Golden-lined spinefoot
Siganus puellus	Masked rabbitfish
Siganus spinus	Scribbled spinefoot
Siganus vermiculatus	Vermiculated rabbitfish
Siganus vulpinus	Foxface rabbitfish
Sphaeramia nematoptera	Pajama cardinalfish
Stanulus seychellensis	Seychelles blenny
Stethojulis bandanensis	Red-shoulder wrasse
Stethojulis strigiventer	Three-ribbon wrasse
Stethojulis trilineata	Three-blueline wrasse
Sufflamen bursa	Scythe triggerfish
Sufflamen chrysopterus	Halfmoon triggerfish
Sufflamen fraenatus	Bridled triggerfish
Symphorichthys spilurus	Blue-lined sea bream
Synanceia verrucosa	Stonefish
Synchiropus morrisoni	Morrison's dragonet
Synchiropus ocellatus	Ocellated dragonet
Synchiropus splendidus	Mandarinfish
Taenianotus triacanthus	Leaf scorpionfish
Thalassoma amblycephalum	Twotone wrasse
Thalassoma hardwicke	Sixbar wrasse
Thalassoma jansenii	Jansen's wrasse
Thalassoma lunare	Crescent wrasse
Thalassoma lutescens	Surge wrasse (Yellow-brown)
Thalassoma purpureum	Surge wrasse
Thalassoma quinquevittatum	Fivestripe wrasse
Thalassoma trilobatum	Christmas wrasse
Toxotes jaculatrix	Banded archerfish
Upeneus vittatus	Yellowbanded goatfish
Uropterygius concolor	Unicolor snake moray
Uropterygius macrocephalus	Large-headed snake moray
Valenciennea puellaris	Maiden goby
Valenciennea sexguttata	Six-spot goby
Valenciennea strigata	Blue-streak goby
Vanderhorstia ornatissima	Ornate prawn-goby
Variola louti	Lyretail grouper
Wetmorella nigropinnata	Blackspot pigmy wrasse
Xanthichthys auromarginatus	Guilded triggerfish
Xyrichtys aneitensis	Yellowblotch razorfish
Xyrichtys pavo	Indianfish blue razorfish
Zanclus cornutus	Moorish idol
Zebrasoma flavescens	Yellow tang
Zebrasoma scopas	Brushtail tang
Zebrasoma veliferum	Sailfin tang

This list is courtesy of FishBase, located on the Internet site www.fishbase.org. This information was retrieved on 11.16.01.

APPENDIX 2
SKILLED LABOR WAGES QUESTIONNAIRE

Greetings [Name of Employer]
[Title of Employer]
[Institution]

As a postgraduate student of the University of Southern Queensland residing in Micronesia, I am undertaking research on the viability of exporting Pohnpein marine ornamentals.

FSM officials have identified the production and export of marine aquarium fish as a potentially viable export for the nation. The combination of an international demand for tropical ornamentals and the rich reefs of Pohnpei that house an abundant supply of aquarium fish, indicates a promising potential for this industry.

The goal of my research is to provide a production cost analysis of the fish in order to determine if financial feasibility is possible. If such feasibility is real, I will broaden the scope of the analysis and assess economic viability of the export for the island.

To ensure accuracy of my data, I am surveying private and public employers of Pohnpei on actual labor and overhead costs. Below are four business-related questions. I am asking you to email your answers to these questions to me (vgviar@hotmail.com) no later than _____. Please be assured your responses will be treated with strict confidentiality. No names will appear in my data consolidation, and the results will be tallied for an average number rather than reported on an individual basis.

Any queries can be made to me at 011.691.350.4352 or by email. If you wish to consult with my supervisor at University of Southern Queensland to verify this project, you may contact Dr. Adkins via email (adkins.g@bigpond.com). I sincerely appreciate your valuable contribution to this important research endeavor.

Thank you, in advance, for your time and consideration of my request.

Vivian Viar

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Question	1)	What is the average wage you pay a skilled local employee? ('Skilled' meaning having prior knowledge and working expertise of the skills your specific business requires.)
Question	2)	What is the average wage you pay a skilled foreign employee?
	2.a)	What is the average total value of any benefits (housing, relocation costs, etc.) you provide to your foreign employees?
Question	3)	What is the average rental price your organization pays per square foot for a building or land?

APPENDIX 3
10 MOST DEMANDED TROPICAL ORNAMENTAL SPECIES QUESTIONNAIRE

Greetings [Name of Retail Outlet]

As a postgraduate student of the University of Southern Queensland residing in Micronesia, I am undertaking research on the viability of exporting Pohnpein marine ornamentals.

The Federated States of Micronesia officials have identified the production and export of marine aquarium fish as a potentially viable export for the nation. The combination of an international demand for tropical ornamentals and the rich reefs of Pohnpei that house an abundant supply of aquarium fish indicates a promising potential for this industry.

The goal of the research is to provide a production cost analysis of the fish in order to determine if financial feasibility is possible. If such feasibility is real, I will broaden the scope of the analysis and assess economic viability of the export for the island.

To ensure accuracy of the data, I am surveying US commercial aquarium stores that advertise on the Internet. To establish a sample population for the study, I need to identify the top ten species of fish that are in most demand (currently). Below are three product-specific inquires. I am asking you to email your answers to these questions to me (vgviar@hotmail.com) no later than December 23, 2004. Please be assured your responses will be treated with strict confidentiality. No names will appear in the data consolidation, and the results will be tallied for an average number rather than reported on an individual basis.

Any queries can be made to me at 011.691.350.4352 or by email. If you wish to consult with my supervisor at University of Southern Queensland to verify this project, you may contact Dr. Adkins via email (adkins.g@bigpond.com). I sincerely appreciate your valuable contribution to this important research endeavor.

Thank you, in advance, for your time and consideration of my request.

Vivian Viar

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1) Please list your top ten most demanded tropical ornamental species.
2) Please list ten additional species that you purchase for resale on a regular, albeit lesser, basis.
3) Where does the majority of your tropical ornamental supply originate from (i.e., what country or ocean)?

APPENDIX 4
RENTAL PRICES QUESTIONNAIRE

Greetings [Name of Landlord]
[Name of Enterprise]
Kolonia, Pohnpei

As a postgraduate student of the University of Southern Queensland residing in Micronesia, I am undertaking research on the viability of exporting Pohnpein marine ornamentals.

FSM officials have identified the production and export of marine aquarium fish as a potentially viable export for the nation. The combination of an international demand for tropical ornamentals and the rich reefs of Pohnpei that house an abundant supply of aquarium fish, indicates a promising potential for this industry.

The goal of my research is to provide a production cost analysis of the fish in order to determine if financial feasibility is possible. If such feasibility is real, I will broaden the scope of the analysis and assess economic viability of the export for the island.

To ensure accuracy of my data, I am surveying private landlords on Pohnpei to obtain an average rental price for land and buildings. Below are three business-related questions. I am asking you to email your answers to these questions to me (vgviar@hotmail.com) no later than _____. Please be assured your responses will be treated with strict confidentiality. No names will appear in my data consolidation, and the results will be tallied for an average number rather than reported on an individual basis.

Any queries can be made to me at 011.691.350.4352 or by email. If you wish to consult with my supervisor at University of Southern Queensland to verify this project, you may contact Dr. Adkins via email (adkins.g@bigpond.com). I sincerely appreciate your valuable contribution to this important research endeavor.

Thank you, in advance, for your time and consideration of my request.

Vivian Viar

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Question 1) What is the average rental price you charge for an apartment (private dwelling)?

Question 2) What is the average rental price you charge for a commercial building?

Question 3) What is the average rental price per square foot you charge for land?