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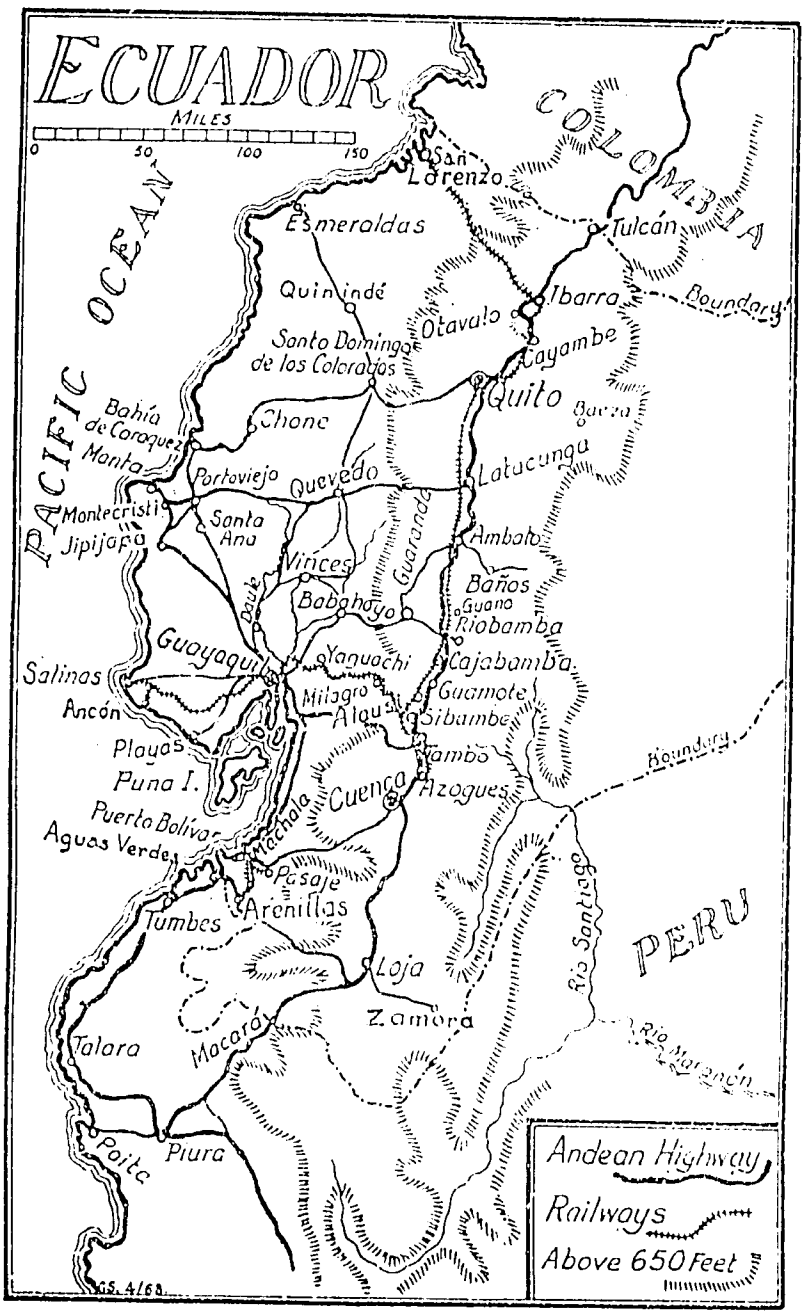
THE SOCIAL ECONOMY OF SHRIMP MARICULTURE IN ECUADOR



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THE SOCIAL ECONOMY OF SHRIMP MARICULTURE IN ECUADOR

Edward LiPuma
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Introduction[1]

In the last ten years, the Ecuadorean shrimp industry has surged in economic importance. Currently, the shrimp industry ranks second only to oil in revenues, and constitutes a critical source of foreign exchange and employment. There is a headlong rush into mariculture; from Esmeraldas south through Bahia to the Peruvian frontier, entrepreneurs are converting mangroves, salt flats, farm lands, and grazing pastures into shrimp ponds even before they obtain government permits. This accelerated growth of shrimp mariculture is totally reshaping the coastal zone of Ecuador.

Several biological analyses of the shrimp industry and its relationship to coastal ecology have appeared in the past three years. Snedaker et. al (1983) has undertaken a study of shrimp pond siting; Barniol (n.d.) has given a profile of the industry, Cun and Marin (1982) have produced a study of species composition of shrimp catches; Weidner (1985) investigated the postlarvae situation in Ecuador and development of hatcheries; and Mock (1981) has estimated the production function. However, the absence of social and economic data has mitigated the value of these studies for formulating a coherent and integrated coastal policy. Our goal here is (1) to provide an initial account of the social economy of the shrimp industry and (2) to lay the foundation for more comprehensive analyses. This will complement existing biological studies, strengthening the management of the shrimp resources in Ecuador.

Shrimp Industry Profile

The social geography of Ecuador is divided into three main regions: coastal lowlands, Andean highlands, and Amazon. Basic differences in ethnic composition, social organization, economic activity, settlement pattern, and world view characterize the various regions. Where prior to the 1970's, coffee, cacao, and bananas dominated production, today's economy centers around oil and shrimp. The worldwide overproduction of bananas and coffee have added to Ecuador's agricultural problems and heightened its dependence on oil and shrimp as exports.

The coastal zone of Ecuador concentrates the wealth of the nation, affording opportunities for developing the interlocking ecological, social, and economic structures. The flow of water connects areas as diverse as offshore oil drilling, shrimp pond

production, rural agriculture, water management, and harvesting of mangrove products. The most critical coastal resource sector is shrimp pond and mangrove management. It illustrates the need to address how coastal resource management issues embrace past, present, and future concerns. Compelling reasons for Ecuador's focus on mariculture include its socio-economic importance, the realization that shrimp and mangroves must be treated as renewable resources rather than disposable commodities, and a desire to resolve growing user-group conflicts.

Ecuador has two modes of commercial shrimp production: trawl fishing and mariculture. These two modes of production are very distinct in terms of lifestyles, management, capital inputs, and social organization. Trawl fishing dates back to the 1940's and is entrenched in the local social economy. Nonetheless, over the past ten years, mariculture has rapidly superceded trawl fishing in terms of landings and dollar value. In 1965, the Ecuadorean industry produced some 5,000 metric tons of shrimp, mainly as a result of trawling. Twenty years later in 1985, production has soared to 35,000 tons annually through the development of shrimp ponds. Where in 1970 there were no more than 300 hectares under cultivation, today shrimp ponds cover approximately 75,000 hectares (see the study by Snedaker et.al 1983). Rapid increases in the harvesting of wild shrimp and the culturing of pond species are powered by strong profit margins and firmness of prices. World market prices for shrimp have remained relatively constant even as supply has increased. This provides economic incentive for accelerating production and seeking economies of scale. For the most part, pond operators have achieved these goals extensively, by placing new lands under cultivation.

From the vantage of fisheries, the Ecuadorean coast divides into four zones: north to south they are Esmeraldas, Monto-Palmar, Playas, and Gulf. The trawler fleet is composed mainly of artisanal boats, between 15 and 30 meters in length and 20 to 60 tons. Larger, more powerful artisanal boats typically refrigerate their catch, and have fishing trips ranging from 15 to 30 days. The smaller, less powerful vessels use ice to conserve the shrimp, and mostly do day trips. About 95% of the shrimp trawlers are built locally from mangrove wood. This employs artisanal laborers in and around the main ports and is one of the many tributaries for redistributing trawler revenues. These boatyards build about 20 vessels a year, although the number appears to have slipped in recent years. They also absorb some of the excess work force in cities like Manta and Guayaquil, important for reinforcing the local economy and furthering political calm in cites undergoing explosive growth (e.g. Guayaquil).

Maturation Cycles and Modes of Production

Almost all the shrimp harvested in Ecuador are members of a relatively primitive family. The shrimp shed their eggs into the open sea where they hatch and develop through nauplius, protozoeal and zoeal stages (McPadden 1984). Responding to local currents, salinity and temperature, the freeswimming larve become bottom-dwelling postlarvae. The postlarvae infiltrate estuaries where they begin to develop into juveniles. Over 90,000 semilleros (fishermen who capture semilla) capture postlarvae for stocking mariculture ponds.[2]

After 3 to 5 months in natural nursery areas, the grown juveniles migrate out into nearshore waters where they are caught by artisanal fishermen using tangle and gill nets (Ibid.). Adult shrimp eventually head to the open sea where they complete the spawning cycle. The trawl fleet intercepts the shrimp during this journey. Trawl-caught shrimp are generally larger than those produced by mariculture (i.e. U16/21 versus U26/31).[3]

In terms of the maturation cycle, trawl fishermen, small-scale fishermen including semilleros, and mariculturalists are interdependent. Natural and induced mortalities in any one stage of the shrimp's life will influence harvests at the next stage. Substantial reduction of postlarvae in a given year class, for example, will decrease the total catch and catch per unit effort of the trawl fleet. By the same token, the clearing of mangroves for the construction of new fish ponds may have reached the point of diminishing returns. Additional inputs of land, labor, and machinery into mariculture have not resulted in greater total harvests. The construction of new ponds not only demands more postlarvae but eliminates the mangroves which serve as their nursery. However, local beliefs concerning conservation and ecology debate this and claim there is no exact correlation between mangrove cutting and semilla production.

The production of both shrimp and seed illustrate the nature of this problem. Although the area of cultivation has increased by approximately 60% since 1982, exports of shrimp have advanced much more slowly. Using a combination of official and unofficial figures we estimate that Ecuador exported 19,000 metric tons in 1982, and 23,000 tons in 1984. Though there has been an explosive growth in postlarvae fishing effort--the number of semilleros more than doubling in the past five years--the total number of postlarvae captured has barely increased. Semilleros will catch approximately 12 billion semilla in 1985, approximately the same amount they caught in 1981. Of these 12 billion, only about 6 billion are Penaeus vannamei, the preferred species that survive best in the depth, temperatures, and salinity offered by ponds built in Ecuador. There is little doubt that the industry, reaching a plateau in postlarvae supplies, is now experiencing the beginnings of a shakeout. Many pond owners will go bankrupt during July through November of 1985 when the annual scarcity will be even more severe than in previous years.

Another crucial link between mariculture and the trawl fisheries is in the development of fish hatcheries. Only one of the existing hatcheries has closed the maturation cycle for the preferred species, P. vannamei, enabling the male and female shrimp to breed captivity. The rest depend on the trawl fleet to bring in gravid females, ripe with fertilized eggs, to release them in the laboratory. Accordingly, companies, such as Empacadora Nacional, which have both mariculture ponds and trawl boats, use gravid females to produce P. vannamei hatchery seed.

Although trawling, mariculture, and small-scale fishing including semilleros, are all ecologically interconnected, their social and economic bases are distinct. Deep-sea fishermen seldom possess the interest, expertise, or capital to become mariculturalists, an enterprise which is more akin to farming than fishing. We found that 1% of the trawl fishermen who had gone into mariculture and no mariculturalists who were planning to trawl shrimp. Only the large, integrated fishing companies crossed over into the pond sector by adding a new and separate division, complete with its own personnel, management, and financing.

Business Perspectives and the Growth of Mariculture

Ecuadorean entrepreneurs have a business perspective which stresses three factors. First, the investment opportunity must have a short time horizon. Business plans frequently only extend out five to seven years, the expectation being that initial capital costs will be fully paid up after two years. This necessitates that the investment area have extremely high profit margins (i.e. above 40%). Second, businessmen seek investments having low start-up costs. This entices Ecuadoreans since banks' lending policies call for 125% collateral, and because local investors equate higher capital costs with greater risk. Finally, Ecuadorean businessmen strive to minimize operating costs, even if this results in lower production. The minimization of capital and operating costs is their basic form of management (minimal input management).

Mariculture has taken off in Ecuador because the nature of shrimp cultivation coincides with this business philosophy. The mangrove lands where shrimp ponds are built are royalty-free government concessions. Ponds can be located below the high water mark so that tides exchange water naturally, bringing food and oxygen. Here, shrimp can be stocked at low densities so that no artificial feed is required. Initially, ponds could be stocked for less than $US 15 per hectare using this system. Labor costs for such highly extensive ponds are relatively modest (i.e. less than 10% of direct operating costs). The government subsidizes fuel for transportation and whatever water-pumping is necessary, bringing fuel costs to about 1/5 of the world market price even after the price hike in January 1985.

These factors make for an ideal investment that can produce a high return on low initial investment in less than five years. Thus, most successful businessmen and government officials on the coast hold interests in shrimp farm production.[4] And, those not yet involved are looking to enter the industry. It is the congruence between the characteristics of shrimp production and the local business philosophy that attracts investors to the sector. This implies that shifting to more intensive production --one development option--will require not only more technology, capital, and skilled labor, but basic revisions in the Ecuadorean view of what business is about.

The Structure of Production

Shrimp mariculture begins with the capture of postlarvae by semilleros (or more recently on a limited scale, hatchery production). Without a regular and fluid supply of semilla there is no shrimp industry. In the past five years, however, seed production has fluctuated widely, not only from season to season but from year to year. In 1982 and 1983, the "El Nino effect" increased semilla production. Torrential rains swelled the estuaries with fresh water, causing a reduction in predators and a favorable environment for postlarvae development. The inflated supply of quality seed brought reasonable prices and stimulated the construction of new ponds, many by first-time operators. Government permits to establish shrimp ponds jumped 25% each of those years. In 1984, climatic conditions returned to normal and seed production fell back to 1981 levels. Currently, the increased number of ponds have insufficient semilla to stock them, causing widespread concern that a seed crisis is looming.

The seed shortage has led to higher prices and occasional hijackings. An active commerce in Peruvian seed has also developed, traders shipping it from Aguas Verdes (in northern Peru) to El Oro and Guayas where ponds are most dense. The law prohibiting seed imports had to be repealed in April 1984.[5]

Because of the great number of competing buyers and sellers, supply and demand structure seed prices. Approximately 90,000 workers obtain income from gathering semilla (including full and part-time workers). Semilleros intensify their efforts during the bi-monthly "aguaje" or spring tide. The most rewarding fishing takes place during a 3 to 4 hour period when the larvae must struggle against the outgoing tide to swim up into the mangroves. Each semillero gathers from 20 to 50,000 postlarvae on one tide. These quantities are generally too small, and the semilleros too widely distributed, for them to sell directly to shrimp ponds. Seed brokers, occasionally semilleros who have raised enough money to invest in a motorboat or car, purchase the catch of others (normally 20 to 30 semilleros), pooling the seed for resale to shrimp ponds. Some pond owners prefer to buy directly from individual semilleros to guarantee lower mortality through their own proper handling: seed in comfortable densities being

transferred to oxygenated holding tanks for transport back to the farm.

Lots of seed are sold by large, blue, plastic container (tacho). The benchmark price is set at a certain number of sucres per 1000 postlarvae. Semilleros adjust the price of seed not by increasing cost, but by lowering real quantity. Hence, "1000 seed" may be as little as 350 postlarvae, effectively tripling the cost. To test the density of postlarvae, many buyers run a liter of water from the tacho holding the seed through a screen, multiplying times the liters contained in the tacho.

Although only P. vannamei is desired, semilleros harvest seed indiscrimately, including in a tacho whatever species are netted. Therefore, a key factor in determining seed price, besides quantity, is species composition. The greater the percentage of P. vannamei, the more valuable the tacho of shrimp. An important ingredient for the success of any pond is a skilled seed buyer. He must be able to examine a bucket of semilla to ascertain the approximate density and percentage of P. vannamei. This determines the price or whether it is worth purchasing at all. In spite of the costly errors that can ensue from examining seed by eye, only a handful of buyers use microscopes and statistical procedures. Magnifying glasses and screens are the common level of technology employed, and many use the naked eye.

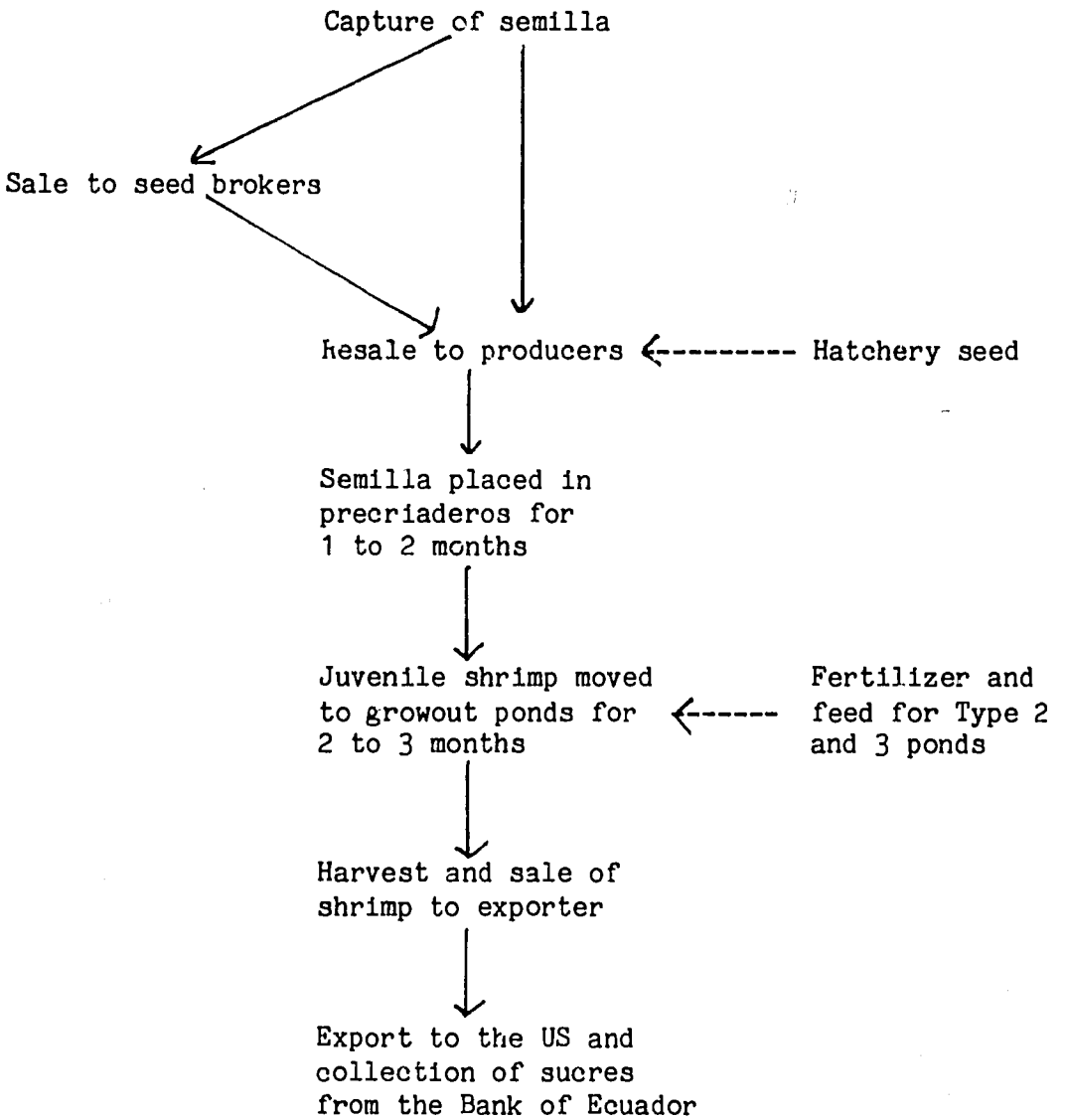
The stage of the shrimp is equally significant to ascertaining value. Postlarvae allowed to mature for a month or so--becoming juveniles of 2-3 grams--bring the best price because mortality to maturation as well as the growout period have been reduced. Moreover, it is easier to accurately count and identify juveniles, assuring the purchase of P. vannamei and only P. vannamei. Depending on region and season, juveniles fetch from 0.8 to 2.5 sucres each. On average, juveniles cost four times more than seed. This has motivated semilleros in Bahia, where both semilla and juveniles are in greater supply hence cheaper, to maintain their own hand-dug, tidal, nursery ponds to increase their earnings.

In March 1985, the beachhead price --that paid to semilleros--was 85 to 100 sucres per 350 seed of mixed species. Almost invariably seed lots include P. stylirostris and other less desirable shrimp species. Beachhead prices rise 100 to 200 sucres per lot during July through November when seed is seasonally scarce. Middlemen mark-up beachhead prices anywhere from 100 to 150%. Seed prices also vary geographically, being lowest in Manabi (Bahia area) and highest around the Guayaquil estuary where pond densities are greatest. Most published reports on semilla prices fail to take these factors into account, resulting in widely varying and sometimes grossly inaccurate figures.

The connection between the pond owner and the semilleros is a combination of social and economic factors. Business is based on personal, face-to-face interaction where economic calculation commingles with social concerns. This social relationship does not influence price as much as access to a reliable seed supply or purchaser. Successful buyers, be they brokers or the pond owners and managers, win semilleros' loyalty and trust by offering a fair price (thus saving the semillero the trouble of finding another buyer). Some buyers establish a personal relationship with the semilleros, advancing a token payment not based on the amount of semilla they commission to be caught, and of course paying immediately in cash when the semilla are procured. Semilleros, having been burned by outside buyers who never paid (i.e. Guayas buyers going to Bahia on a one shot deal), state that price and fairness determine customers. Given the value placed on establishing these social relationships, it is sometimes difficult for newcomers to buy seed, especially when it is scarce.

The postlarvae are placed in precriaderos, nursery ponds (usually between 1 and 2 hectares), for a month until they become juveniles weighing 2-3 grams. They are then removed to larger grow-out ponds ranging from 5 to 50 hectares. In the grow-out ponds, shrimp feed on algae, phytoplankton and zooplankton. Although these bloom naturally, more intensive ponds add fertilizer to stimulate production. Some ponds add both fertilizer and artificial feed (a compound of vitamins, binder, and protein). After about 3 months growth, shrimp are harvested and then trucked or taken by outboard or small plane to an exporter. Ecuador is fortunate in having sufficient infrastructure to accomodate the transport of iced shrimp in the tropics, unlike neighboring Colombia. The exporter's packing plant women remove the heads, classify the shrimp by size, and the producer gets paid accordingly. Exporters differ significantly in terms of what percentage of the animal they consider tail (e.g. 68% versus 65%), affecting the tail size classification which is based on units per pound, and thus producer's pay. Figure 1 illustrates the production process.

FIG. 1. Production Process for Shrimp Mariculture



Start-up Processes and Costs

To begin a shrimp pond operation usually entails obtaining a government land concession, a bank loan to finance construction, one partner able to visit the site weekly, and a pond manager familiar with shrimp mariculture.

The government concession is necessary to build a shrimp pond in the mangroves or salt flats. According to Ecuadorean law, all land lying below the highest tide line belongs to the government, under the jurisdiction of the Navy. Prospective users may obtain a ten year concession to build a shrimp pond by getting approval from the Navy, Ministries of Agriculture and Natural Resources, plus the commissions of Land Reform and Rural Development. Owners disagree on the desirability of ten year concessions, many preferring a guarantee for thirty years or to buy outright, neither of which is legal at the moment.

Obtaining a concession is a costly and time-consuming process. Actual cost and time depend on the applicant's social position or rank. The ordinary businessman receives approval in anywhere from one to three years, depending on intensity of office rounds and personal connections. Six months of daily office visits in Guayaquil can land a "free" permit, but few can afford this time investment. Besides diligence and persistence, the key to quick approval can be a series of unofficial payments given to members of the various government agencies. These payments vary depending on the size of the concession sought and the applicant's negotiating skill. Total unofficial payments (i.e. cash, gifts, and services) of $US 10,000 are by no means unusual for a 100 hectare concession.

For government officials seeking a concession, the process is quicker and less costly. This is especially true for ranking members of the military and Ministries of Agriculture and Natural Resources, almost all of whom are shrimp pond owners. They frequently receive concessions in just a few months without unofficial payments. In reality, officials in charge of granting concessions operate on a pro quid pro basis, except that the currency is political leverage instead of cash. Savings on unofficial payments are important to the ultimate success of a venture because they permit a producer to maintain a stronger cash position during the critical period prior to the initial harvest.

Acquiring a loan to construct a shrimp pond is not an easy task. Ecuadorean banks require borrowers to secure their loans up to 125%. Collateral requirements are also strict, houses or land being demanded in most cases. The easiest way to receive a loan is to have a good friend or relative who is a bank official (e.g. loan officer), and to offer them money or a share in the pond in exchange for loan approvals. Because of these banking practices, many start-up operations are self-financed. Indeed, the ideal combination for launching a shrimp pond is to have a partner who is a government official, banker, navy officer, or businessman who knows an agricultural export industry. These partnerships confer other advantages such as access to earthmoving equipment, foreign

aid programs, and subsidized agricultural loans. Not surprisingly, then, government officials who oversee shrimp mariculture are also investors; and personal networks have formed linking the aforementioned groups.

Construction costs for a shrimp pond run between US $6,000 and $10,000 per hectare. The three most important costs include the purchase or rental of earthmoving equipment to excavate canals and ponds (plus hiring the driver), the purchase of water pumps, and the building of worker housing and work stations. Many entrepreneurs fail at the construction stage because they cannot project costs accurately or maintain proper production schedules. In Guayas and Manabi there are occasional testimonies to builders who ran out of funds: three-walled ponds which are as good as no pond at all.

Land Use and Shrimp Mariculture

Shrimp mariculture in Ecuador utilizes three types of land: mangroves, salt flats, and agricultural land. The advantage of mangroves and salt flats are that they are free. The government issues the ten year concessions on the basis of applications submitted to an inter-agency review board. The authorized use of mangroves and salt flats have climbed from 5,725 hectares annually in 1980 to more than 17,000 in 1984. In many cases, producers build their pond long before they have obtained the permit. One consequence is that government statistics on pond area lag behind real pond area by about two years. Total area converted to production is currently around 75,000 hectares (including an unknown number of non-producing ponds).

Mangroves also have the advantage that tides exchange water naturally, reducing capital and operating costs. The principal disincentives are: (1) the farm is located in a swampy area where transportation is difficult; (2) mangrove bark and ooze of decomposing mangrove leaves release high acidity harmful to shrimp; and (3) construction costs are highest because trees must be felled and muck moved. For these reasons, some owners prefer to locate their ponds in the barren, acid-free salt flats, lying slightly upland, whose clays are more easily shaped into ponds. Producers perceive two major problems with salt flats: (1) water salinity is hard to control; and (2) the land does not furnish nutrient support for the growth of algae, phyto and zooplankton upon which shrimp feed.

Owners also construct ponds in agricultural land, although the law technically prohibits this. There is a movement to take land dedicated to cattle and short-cycle crops, such as rice, and turn it into shrimp farms. Agricultural land above the flood line avoids the problems of dikes washing away. Construction costs are moderate and, more importantly, it permits efficient access to direct transportation and more controlled water management, the most critical factor for maintaining a sound and stable environment. Owners also believe that farm land yields a richer

natural green growth, thus reducing feed costs. The main disadvantage is that salt water must be pumped the longest distance upland. The cost effectiveness of pumping depends heavily on below-market fuel prices.

Owners hold diverse opinions on which land type is most productive. The common wisdom, other factors notwithstanding, is that farm land contains the richest nutrients, followed by acidic mangroves, and then barren salt flats. From a biological perspective, it is unlikely that one type of land is truly richer than another, for pond excavation always removes the land's topsoil (Enrique Lahmann and Melvin Brown, n.d.). Pond owners vary in their knowledge of, access to, and willingness to apply such ecological information. Individuals see benefits in each type of land, mostly basing decisions on a mixture of experience and folk ecology.

For both historical and economic reasons, shrimp ponds are currently distributed about 70% in mangroves, 15% in salt flats, and 15% in agricultural land, although this is likely to change. There is a shift to farm land. The conversion of farm land is increasing for three reasons: (1) good mangrove sites, government concessions that cost no money, are becoming harder to obtain; (2) many new companies, particularly foreign-controlled firms, believe that farm land provides the best conditions for intensive, mechanized production requiring efficient transportation; and (3) the government technically always retains title to both mangroves and salt flats. Hence, ponds built in either area cannot serve as collateral to secure a bank loan, preventing producers from using one pond to finance construction or improvement of another. In 1984, representatives from Guayaquil introduced a bill to allow shrimp producers to buy the government land. However, an unlikely coallition of conservationists and naval administrators (afraid of losing control) defeated the bill.

Different Types of Pond Operations

There are three basic types of pond production in Ecuador: (Type 1) highly extensive ponds which add as few human inputs as possible; (Type 2) moderately extensive ponds which seek to increase output by combining natural and artificial factors; (Type 3) semi-intensive ponds which gear production to the regulation and control of artificial inputs. About 35% of existing ponds are Type 1, 55% Type 2, and 10% Type 3. Looking to the future, there are plans, particularly by foreign-based corporations, to develop a fourth type, intensive hatchery-oriented operations.

The first method of pond production was the highly extensive system begun in the late 1960's, mainly in El Oro province by men from the local banana industry. Such ponds utilize low stocking densities (20,000 semilla per hectare) and natural water exchange. They are invariably sited on concession land and are constructed on cleared mangrove areas. Most of these ponds use little if any artificial feed or fertilizer, relying instead on natural growth.

Producers practice minimal input management, meaning that their main objective is to complete the production cycle at the lowest possible cost. Under these Type 1 systems, particularly in El Oro province, the older the operation the larger the total pond area. Land rather than other inputs is the avenue of expansion. Competition, therefore, is for land and seed, not for improved technology or access to capital. The majority of Type 1 ponds produce from 400 to 600 lbs. per hectare. With few exceptions, they are owned and operated by individuals rather than companies--what Ecuadoreans term "natural" as opposed to corporate ownership.

Where the oldest ponds are generally highly extensive, later ones have tended to be more capital intensive and aim for greater productivity. These moderately extensive, or Type 2, ponds predominate in Guayas, especially in the Guayaquil estuary region. They use medium stocking densities between 40,000 and 60,000 seed per hectare. Pumps cycle the salt water on a continuous basis and most producers add some feed and fertilizer. The majority of Type 2 ponds produce 600 to 900 lbs. per hectare, though this probably overstates total average yields because ponds are sometimes decimated by poor biological control (e.g. overfertilization) resulting in no harvest. These moderately extensive ponds are operated by Ecuadorean businessmen, many of whom have diverted capital from the primary business into shrimp. In many cases, they are agribusinessmen transposing their management techniques and financial vision to mariculture.

A common scenario is for a successful businessman, for instance in construction, to gather several associates, such as a relation in government and a local banker, and invest in a shrimp pond. Since life on the shrimp pond is difficult, the pond being located in a rural area far from amenities of city life, the investors hire an administrator to oversee the purchase of semilla and the seeding and harvesting of the pond. This manager will likely possess little biological training or the know-how to make critical managerial decisions. One of the partners usually invests time in lieu of some capital. He is in daily radio contact with the administrator. He visits the shrimp farm perhaps twice a week, arranging supply needs from the city where he lives. Many owners are reluctant to pay the live-in administrator/manager a salary and bonuses commensurate with his role in the pond's success. Indeed, a main characteristic of moderatelyextensive ponds is absentee ownership coupled with semi-professional management. The result is that intuitive judgments govern pond feeding and fertilization.

In both highly extensive and moderately extensive systems, each farm owner adopts its own management system for labor, security, and biology. Pond managers think of themselves as "friends" of the owner, not in the sense of school chums or socializing together, but from the same town and known to the owner for honest work. Managers are recruited because the owner has confidence in their honesty. The guiding perception among owners is that loyalty (including honesty and faithfulness) makes

a good manager, outweighing even biological expertise or managerial skills. A pond owner generally develops a biological strategy in concert with his manager, being present for seeding and harvesting in order to participate in the important decision-making. Because the manager resides on the farm, he makes the daily decisions, such as purchasing semilla and altering water oxygen levels and salinity.

Managers receive a salary and bonuses for good harvests. More sophisticated ponds set a constantly updated harvest goal based on seeding and survival rates, then pay a bonus if at least 95% of the goal is met. The most advanced bonus system takes this one step further by awarding profitability of production, accounting all costs. To be able to do this requires exact knowledge of water management, monitoring costs for feed, fertilizers, pumping and labor. Only the one most advanced shrimp company rewards employees on this basis. This bonus system is at the core of their management training, teaching people the exact value of each shrimp via water management. Overall, the majority of moderately extensive and highly extensive pond owners are less capable of determining costs and predicting yields, so they pay a bonus if the harvest is respectable, over 700 lbs. per hectare, regardless of direct operating costs (i.e. many ponds award 1 sucre/lb. to the manager and 5 sucre/lb. divided among all the workers).

In recent years, there has been a growth in semi-intensive ponds under professional management. Type 3 ponds are carefully designed by architects and consturcted by engineers to facilitate labor-efficient, capital-intensive water management. They have stocking densities between 60,000 and 90,000 per hectare, making feed and fertilizer critical to success. All Type 3 ponds hire professional biologists who supervise transportation of seed, transfer of juveniles into growout ponds, daily water quality measurements, feeding schedules, fertilization, and ultimately timing of the harvest. It is usual on semi-intensive farms for the biologist to instruct the administrator, telling him what work to assign the laborers. The most highly developed scheme actually trains the biologist to be the manager, calculating and forecasting the cost per shrimp--in the words of one company's president, seeing each shrimp as "a bundle of sucres to be nurtured." The general opinion is that it is essential to hire a foreign-trained or foreign biologist because they will have advanced training and a more business-like attitude towards planning and efficiency. Type 3 ponds can produce between 1500 and 2500 lbs. per hectare.

The dominant trend since the late 1970s has been the entrance of foreign enterprises into Ecuador's shrimp industry, predominantly US but also European (e.g. French) and Japanese. Business financed and managed by US corporations now control about 50% of the exporting business, 60% of the market in feed and fertilizer, many of the semi-intensive ponds, and two of the most productive hatcheries in [illegible]ing the only one to master the maturation cycle of P. van[illegible].[6]

The success of these [illegible]anaged companies stems from several

factors. First, US companies are accustomed to operating on razor thin profit margins. Therefore, the high profit margins normal in Ecuador provide an ample opportunity to penetrate the market. Second, US companies have access to powerful US capital markets--providing better money at lower interest rates. Third, American companies have access to and hire top-flight biologists, construction engineers, and executive personnel. Finally, they are vertically and horizontally integrated. They control all phases of production and marketing, from the maturation of semilla to feed production to export and sales in the US. In all likelihood, the market power of US-based companies will continue to grow, as will their interest in the Ecuadorean shrimp industry.

The official government position is that foreign investment in shrimp is nil, or minimal because, legally, foreign investment is limited to 49% ownership. In reality, there are numerous ways foreigners circumvent this restriction. The head of one US company has an Ecuadorean wife who is 51% owner of the firm. Another company pays an Ecuadorean to be its public image while the real owners and managers remain almost totally invisible. In fact, few local businessmen in the shrimp industry recognize the names of the most powerful foreign leaders. mistaking their companies for Ecuadorean firms with limited foreign control.

One of the positive effects of foreign competition is that it is forcing Ecuadorean firms to become more efficient. However, it is improbable that local companies can transform swiftly enough to prevent foreign firms from locking up what will ultimately be the most lucrative sectors of shrimp mariculture: production of hatchery seed and feed (see **Hatcheries**).

Agriculture and the Shrimp Industry

Many shrimp pond owners were or still are involved in agribusiness. In El Oro, shrimp pond owners got started with capital and expertise gleened from the banana industry, just as they were in cattle and poultry in Manabi, and agricultural exports in Guayas. Mariculture is an extension and development of agriculture, not of the shrimp trawl fishery. The result is that the concepts and principles of agribusiness appear in shrimp farming.

The first shrimp ponds in Ecuador entered production around 1970, along the banks of the Arenilla River in El Oro. They were begun by men involved in the banana industry of Machala, still the banana capital of Ecuador. Gradually, as shrimp farming demonstrated its profitability, these men diverted more and more capital from agriculture to mariculture. Owning a banana plantation conferred several advantages on the potential shrimp farmer. For one, the plantation could be used as collateral in securing bank loans. And, those already in agribusiness were well versed in the nature of earning foreign exchange through export and differential exchange rates. Between 1970 and 1984, hundreds of millions of dollars poured out of agriculture into shrimp

mariculture. This outflow of capital has contributed to the recent slump in Ecuadorean agriculture. An important question for future study is the impact of mariculture on the structure and productivity of agriculture, including the move from the Ministry of Natural Resources (where shrimp was overshadowed by oil) to the Ministry of Agriculture.

Today, the income generated by shrimp farming exceeds livestock or bananas. One result has been a shift in the work force as managers and laborers, seeking higher wages, have turned to mariculture. Many Sierra men who had come down to the coast for seasonal plantation employment, have been switching to year-round jobs in shrimp. And, as the expanding shrimp industry has needed more workers and has continued to pay up to triple the wages of agricultural labor, migration from the Andes has increased.

In years past, owning a hacienda or ranch were symbols of social status. Now, the shrimp pond is too, being both a potentially potent source of income and index that the owner is a progressive, forward-thinking individual. Nevertheless, social status is still based upon the amount of hectares a man farms, rather than his productivity. This is partly a carry-over from the epoch of hacienda-based agriculture when land was synonymous with wealth. Furthermore, as in agriculture, men who are successful on the strength of their own individual ideas attain greater social status. Thus, each pond owner is motivated to implement his personal concepts for production. He experiments on an ad hoc basis, concocting his own water management or feeding programs (e.g. horse meat, bananas). Some owners level all the mangroves and dig open canals in the vicinity of their ponds on the grounds that this allows their semilleros to collect P. vannamei instead of other species. Their ecological theory is that the penetration of maximum sunlight promotes greater algae growth and hotter temperatures where only P. vannamei can remain alive. Such management relies on a personal rather than scientific sense of how ecosystems operate. In the same vein, owners are reluctant to follow outside advice, especially with respect to management.

The overwhelming result is that Ecuador's shrimp industry has myriad management practices and no common biological guidelines. However, as the semi-intensive farms demonstrate great yields, others are asking to purchase their feed. In a classic move by the biggest US producers who started selling feed on demand, they will consciously try to increase their share of the feed market from 34%, by publishing a complete manual on shrimp rearing that could set the first standards for the industry. Unlike most Ecuadorean concerns, the sale of their shrimp rearing technology in return for higher profits in feed sales is completely non-threatening to the owners' identity and a sense of power (only hatchery methods and feed ingredients are proprietary).

Operating Costs for a Pond

Shrimp pond operating costs vary enormously depending on the production regime. Direct costs differ sharply in terms of total dollar inputs, ranging from highly extensive ponds in which costs seldom exceed several hundred dollars per hectare (annually) to semi-intensive ponds which spend thousands of dollars per hectare. Ponds vary in terms of the composition of costs--some ponds use fertilizer while others do not; some ponds exchange water indiscriminately while others test water quality and pump only when the water quality indicators signal the need. The structure of these costs is also variable, in most cases riding on the management decisions taken by the pond's administrator. For some ponds, feed and fertilizer are principal costs, consuming 30% of the operating budget. For others, feed and fertilizer are minor factors (less than 8%). Great diversity in the sophistication, objectives, and regimes of pond management give rise to sharp variation.

For most ponds, the purchase of postlarvae is their highest operating cost. However, highly extensive ponds located in the mangroves may recruit their own seed naturally when the tides exchange water. This is possible because highly extensive ponds demand low stocking densities and are often situated below the tide line in mangroves, which are sources of seed. This is particularly true in El Oro, where some highly extensive ponds take in more than enough seed for their own needs, selling the surplus as an additional source of revenue. In semi-intensive ponds, expenditures for feed and fertilizer may exceed those for seed although stocking densities are greater. In Manabi province where postlarvae is less expensive, this is often the case.

Table 2 presents an analysis of operating costs, based on a number of examples from each pond type. The purpose of the table is not to furnish precise cost averages (which is well beyond the scope of the pilot study), but to show the relationship between costs under different production regimes. Recall that the three categories of ponds are: highly extensive (stocking densities between 20-40,000 postlarvae per hectare), moderately extensive (stocking densities between 40-60,000), and semi-intensive (stocking densities between 60-90,000).

Table 1

Operating Costs for Shrimp Ponds Per Hectare Per Harvest

Item	Highly Extensive	Moderately Extensive	Semi-Intensive
Postlarvae	$166	$415	$664
Feed & Fertilizer	0	$100	$770
Labor	$100	$220	$290
Security	$30	$45	$45
Fuel	$70	$110	$110
Other	$10	$50	$70
TOTALS	$376	$940	$1949

The three pond types vary markedly in the size of their harvests. Highly extensive ponds obtain on average 400 lbs. per hectare; moderately extensive ponds 700 lbs. per hectare; and semi-intensive ponds 2000 lbs. per hectare. Observe that the spread between operating costs and harvest yields is 3:1 for both the highly extensive and the semi-intensive ponds. However, it is only 2:1 for moderately extensive ponds. For example, the operating costs of a semi-intensive pond are $.98 per lb. compared with $1.34 for moderately extensive ponds. These differences become more significant when we remember that capital costs are primarly a function of size rather than production regime. And as might be expected, it is the extensive farms which are currently under the most pressure and are most likely to fail. Meanwhile, both sophisticated management of semi-intensive systems and minimum input management of highly extensive ponds are more successful than moderately extensive ponds, though for totally distinct reasons.

Hatcheries Development and New Shrimp Species

Everyone in Ecuador's shrimp industry is concerned with the sporadic shortages in semilla. Semilla is unanimously considered the number one problem today. Blame is laid on poor handling techniques of postlarvae, growth in pond area, and unknown ecological shifts in the environment. Few, however, cite the destruction of mangroves.

The general consensus is that farms over 300 hectares will need hatchery seed in the future to survive. Some owners want to start their own hatcheries, or labs, now. It is the main topic of conversation among shrimp producers and is the most prestigious venture in the industry. Most recognize that the technology and capital outlay is beyond them, so they hope the government will step in to provide soft loans and research support. The pond

owners associations are lobbying for government aid to hatchery development. Some want the state to go as far as restocking the estuaries themselves.

One Guayas businessman has proposed forming an owners corporation for joint investment in a hatchery, without waiting for government aid. He wants owners, pooling technology and capital, to enter the hatchery field as an investment, breaking out of their individualist mode. He knows that the time to recruit shareholders will occur during the seasonal shortages coming July through November when farms desparately seek semilla. Meanwhile, many owners are operating on a short-term horizon, uninterested in such investments as long as they can import seed from Bahia or find local sources.

Few are currently stocking their ponds with hatchery seed although everyone considers the possibilities. In part, this is because hatchery seed has a notorious reputation, survival rates below 30% being commonly quoted. One reason for hatchery seed not faring well in ponds, developing a reputation for weakness, is that few people know how to transfer the seed from hatchery to pond. By moving the semilla without acclimatizing it to salinity and temperature changes causes shock and high mortality.

Pro-hatchery arguments that their seed is of uniform age, health, size, and quality hence produces better are still unaccepted. Observing success will generate believing. For instance, Empacadora Nacional has stocked ponds with hatchery seed from gravid females and gotten over 2000 lb. per hectare, an enviable return which should stimulate demand for their lab seed, convincing owners to shift over from wild semilla.

Overall, the limited supply of lab seed has curtailed owners' experience of it and affected their willingness to try it. Supply is low because technology and capital necessary for producing P. vannamei seed on a commercial scale are beyond the scope of most individuals and their companies. Ten hatcheries are attempting seed production, but they are still forced to use gravid females captured in the wild. Only one lab, belonging to the largest shrimp concern in Ecuador, has perfected the maturation cycle that allows it to produce commercially, selling 35 million semilla a year after stocking its own ponds. They have been scientifically successful because of huge inputs of American, and initially French, technology. Moreover, their professional management system and disciplined approach creates an atmosphere for motivated success. The hatchery field is not a place for owners to invent individual schemes and try out personal methods, as is common practice for managing shrimp farms.

Shrimp hatcheries require scientific experimentation and advanced biologists brought in to work on the problem. Ecuadorean companies who wish to participate have to be able to pay competitive salaries (between $40-80,000 depending on experience) and provide good facilities to attract the best minds. Ecuador's imported biologists are part of the relatively new mariculture field, and as such are a relatively young and mobile group, in demand throughout the various countries interested in increasing

their share in world mariculture production.[8] Globally, maturation cycle technology is being perfected. For Ecuador, new species are being investigated and evolved to: find disease-resistant strains, break dangerous dependence on monoculture, and raise bigger types to take advantage of price differentials.

Besides offering biologists competitive facilities and financial incentives, companies interested in developing labs in Ecuador have to deal with Ecuadorean import regulations. Because it takes weeks to obtain the proper permits for importing the necessary chemicals, those who are interested in laboratory research are forced to import illicitly. Artemia shrimp (brine shrimp)--a foodsource crucial for cultivation in hatcheries--was forbidden until early 1985. Even Artemia's new legal status does not solve problems import problems in order to facilitate hatchery development. It has to be smuggled along with the chemicals by using the appropriate unofficial payments because waiting endlessly for permits would halt research. Permitting procedures need to be reformed to allow rapid entry of research materials.

In Ecuador, only the largest shrimp concern that is starting to sell its lab's P. vannamei is launching a program to develop new species. Because P. stylirostris produces three times over P. vannamei and breeds easily in hatcheries, they are searching for a disease-resistant strain. They are also investigating possibilities for P. monodon (tiger shrimp) from Asia which grow to twice the size of P. vannamei within 110 days on the same 2/1 feed ratio.

It is predictable that foreign firms are leading the way in new species development because these species require more capital input to rear than P. vannamei. For instance, P. stylirostris needs: deeper ponds for cooler temperatures which are more costly to construct; higher salinity locations which rule out some farms; higher protein feed which is more costly; and pond bottoms to be sterilized inbetween harvests since P. stylirostris spends more time in the bottom. These factors, which all call for intensified capital inputs, have discouraged Ecuadorean owners whose philosophy favors natural systems including the species that grows naturally with little management--P. vannamei.

Handling of Seed Stock

Interrelated with supporting the development of hatcheries and research into improved strains of shrimp for Ecuador, is the basic need to eliminate ecological waste surrounding the handling and rearing of wild stocks. As long as pond expansion and mishandling of semilla continue, seasonal shortages run the risk of becoming year-round, sending seedless owners out of production or into the marketplace desparate for hatchery production which may not have reached sufficient commercial scales to satisfy demand.

Recall that of the approximately 12 billion semilla captured annually in the wild, only half are P. vannamei, the species which

Ecuadorean ponds are prepared to rear. And of these 6 billion P. vannamei, only 1 billion 2 million ever reach the export stage. Calling this "a shrimp killing business," one farmer pressed not only for hatchery programs to reduce pressure on the wild population, but for training seminars to educate semilleros and managers in seed handling techniques. In every aspect of semilla, whether wild or lab, handling must be improved to cut down on waste due to shock and death. Training should include transportation and transfer methods in temperature maintenance, oxygenation, acclimatization to new environments, and stocking densities.

Exports and Exchange Rates

In the past three years, independent buyers with transport have smuggled an increasing amount of shrimp out of Ecuador, while exporters have under-invoiced and not declared a similar amount of shrimp sent directly to the US. This makes it difficult to assess the growth of industry or the revenues it generates with any precision, or to create a national data-based management program. It is clear that both forms of illicit exportation have become institutionalized-- meaning that they are widely and easily available.

Capitalizing on the favorable differential between the floating and official rates of exchange and Peruvian export incentives, smugglers can offer the strongest shrimp prices, selling in Peru for re-export to the United States. Ecuadorean exporters gain the added benefit of avoiding a 1% tax on exports. We estimate that approximately 20% of the Ecuadorean shrimp exports leave through these channels. This will likely increase in 1985.

The primary incentive to smuggle is the differential between floating and official exchange rates. The floating rate against the dollar is about 120 sucres while the official rate is 95 (in March 1985). For example, a sale of shrimp worth $US 1000 would convert to 120,000 sucres under the floating rate and 95,000 with the official rate. This amounts to a 25% tax on earnings, levied through the exchange rate mechanism.

It is well known that when the spread between the floating and official rates exceeds 6%, a blackmarket will arise. There is simply sufficient profit margin to make illicit buying and selling of currency, shrimp, and most other export products, worthwhile. A government can successfully skim about 5% on the exchange rate and still deny the blackmarket enough profit and liquidity to function effectively. Clearly, the Ecuadorean rate of exchange violates this principle, tempting the inevitable.

Peurvian export incentives further stimulate the stream of contraband. Indeed, motorboats scour the coast from Esmeraldas to El Oro looking for shrimp to resell in Peru. Peru adds a 36% incentive onto exports over and above the floating rate. Thus, a gap of 70% arises between the Ecuadorean official rate and the

Peruvian export rate. In March 1985, the Ecuadorean rate was 95 sucres per dollar and the Peruvian rate was 167 sucres per dollar. Sale of 1000 pounds of shrimp that would yield 95,000 sucres through the Banco Central, earn 167,000 sucres through Peruvian exporters. Accordingly, there are at least four large exporters in Tumbez, the Peruvian town situated just across the border from El Oro .

A glance at Peru's shrimp production gives some idea of the intensity of smuggling. There are about 900 hectares of Peruvian shrimp farms in the vicinity of Tumbez, which is a continuation of the Gulf of Guayaquil. This area could produce about 1 million lbs. of shrimp per year, making the conservative assumption that Peruvian farms produce the same amount per hectare as Ecuadorean farms. However, Tumbez exported some 14 million lbs. of shrimp to the US in 1984. Presumably, 13 million lbs. of shrimp were Ecuadorean.

In addition to Peruvian sales, there are of course the unreported sales direct to the US which probably amount to another 20 million lbs. (c.f. Spurrier 1984). Such illicit exports occur through undeclared and under-declared sales. It is common practice to understate the size category hence the price at which shrimp is sold to the US. Thus, Ecuadorean statistics for exports FOB are usually US $1/lb. lower than those registered by US Customs. The declared price for shrimp exports is typically 20% to 30% lower than real prices.

Companies which under-invoice, sell to Peruvian exporters, or otherwise circumvent the rules obtain a competitive advantage over those companies which comply with regulations. Over time, this progressively induces more and more companies to act illicitly--especially as the Peruvian route or under-invoicing become more institutionally visible and efficient. They are already common knowledge.

Smuggling and under-invoicing are economically important because they are linked to the export of capital. The usual procedure is to repatriate the income from declared sales and channel the rest into a Miami bank account. A desire to avoid detection by Ecuadorean authorities and to take advantage of the safety and high marginal return on dollar-denominated investments motivates this outflow of capital. Capital flight is probably in the neighborhood of US $75 million. This represents a serious problem because it extracts investment capital of which Ecuador is sorely in need.

In 1984, by taking into account under-reporting of both prices and sales, Ecuador exported approximately 23,000 metric tons of shrimp worth about US $225 million. These represents a decline from 1983, when Ecuador exported approximately 27,000 metric tons of shrimp worth about US $290 million. The estimates of both production and income are greater than government figures, but are below some of the more liberal estimates (e.g. $400 million in annual sales). For purposes of comparison we have included government figures for the last three years.

Table 2 Reported Exports of Shrimp (1982-1984)

Year	Metric Tons	US $ FOB
1982	16,962	129,726,000
1983	23,428	183,626,000
1984	19,437	149,580,000

Source: Direccion General de Pesca.

The illicit exportation of shrimp is oiled by a well-defined unofficial payment schedule. Custom officials assess exporters one half of their expected gain from unreported export. That is, they charge exporters about 13% of the value of the under-declared or undeclared sale, this being 1/2 of the 25% surcharge levied via the differential exchange rates. The result is that the exporter and custom officials split the extra income generated by avoiding the official exchange channels.

In Guayaquil and at the Peruvian frontier, unofficial payments represent a significant component of government officials' earnings. Thus, there is widespread reluctance to tamper with the system, close the gap in exchange rates, or provide law enforcement. In one case, the Subsecretaria de Pesca tried to halt several out-of-line shipments, only to be thwarted by Port and Customs authorities. To help combat the problem of illict exports, the present government has hired a Swiss firm to monitor shrimp exports. The shrimp industry has vigorously decried the hiring of these foreign observers, claiming that it unfairly impugns the character of Ecuadorean businessmen. Rhetoric notwithstanding, there are only four Swiss observer units who, according to government and business alike, are not nearly enough to check the flow of exports.

Relationships Among Producers

Each of the three major producing provinces--El Oro, Guayas, and Manabi--has at least one producers association and sometimes two. These organizations are essentially lobbying groups who inveigh against taxes, fuel hikes and more restrictive legislation; argue for government financing of hatchery develpment; and write articles in local newspapers to build the image of the industry. They meet when there is a common problem, like the rise in subsidized fuel prices. Otherwise they meet infrequently--once a year--and such meetings seldom draw the majority of owners. Many of the major producers, especially those who run more intensive operations, are not members or do not

participate. They see the associations' internal factionalism and powerlessness.

In recent years, producers associations have splintered. The division is between those who have finished leveling mangroves and established ponds, and those who are in the process of establishing ponds and desire to continue cutting. Those with established ponds believe that by militating for strict laws protecting mangroves they can limit competition, most critically for seed. At a 1983 Symposium on Mangroves organized by FAO, the head of one of Manabi's producers associations, a group of established owners responsible for cutting over 2,000 hectares of mangroves, pleaded for vigilant law enforcement regulating mangrove use.

Interprovince trade in semilla is the another point of competition among producers. Here, what is at stake are the relations between producers from different regions. Although semilleros and middlemen in Manabi are satisfied selling seed to Guayas producers who come with cash, the Manabi producers interpret this as unfair demand on seed that is rightfully theirs. During times of plentiful semilla, Manabi owners do not object to these sales, but when seed is short all around, feelings of prioity surface. To halt shipments out of Manabi during times of scarcity, some owners have had trucks transporting seed enroute to Guayas overturned. When supplies are available, however, a few enterprising Manabi owners have actually taken advantage of seed price differentials between provinces and become intermediaries selling to Guayas where stocking demand is greatest due to density of ponds.[9]

Labor and Community Relations

Shrimp farm labor, on a whole, enjoys higher wages than agriculture at both administrative and unskilled levels. The hours are long and irregular because the primary activities, harvesting and seeding, are geared to ecological cycles and the perishable nature of shrimp. Compensation for hard work varies from farm to farm as does compliance with labor laws regarding overtime and minimum wages. The minimum wage of 8,500 sucres/ month applies only to workers classified as permanent. Owners see Ecuador's stringent labor laws and unions as the bain of business, and few farms tolerate unionizing workers. Overall, producers believe that shrimp ponds have fewer labor problems than plantations because they employ far fewer workers. The largest shrimp operations require only 70 men, while ponds under 50 hectares can employ less than a dozen, bringing in temporary "shovel hands" for construction and harvest help.

Owners achieve a relatively stable, non-transient workforce by offering amenities such as TV, good showers and clean sheets, supplementing these with harvest bonuses and good pay compared to plantations. Few farms furnish facilities for families. Instead, men can take leave on an average of every 15 days to visit home,

or each weekend if they work near home which is far less common. Workers cite family separation as the most trying part of shrimp farm labor.

Pond owners commonly recruit through their administrators and workers who spread the word that so many men are needed. This recruiting system asks men to call in friends and relations, having the effect of providing companionship and easing loneliness on isolated farms away from home. Administrators also tend to seek men from their home region, feeling more comfortable with a familiar personality type. Some owners also recruit the best temporary workers, slowly building up a strong, reliable labor force.

In terms of recruiting workers from the Sierra and coastal plantations, the consensus among owners, management and labor alike is that Sierra men are hardest working and humble. Coastal people say they find the stoic Sierra demeanor difficult to interpret and thus control. Therefore, some owners and management prefer to hire the reputedly lazier, more jovial coastal men whose visible emotions are purportedly safer to manage.

Owners have different theories on the best composition for a workforce: sierra or coastal; a local man or one far from home. Their main consideration is the likelihood of collusion with local people, leading to theft. Because only 1% of owners live by their ponds, they must rely on administrators and workers to monitor theft. Fear of theft runs so high that many administrators and visiting owners carry pistols and rifles. Sometimes they fire blindly into the shadows of the mangroves to scare any lurking thieves. They place armed guards on boats and trucks making shrimp deliveries. Owners associations culminated their discussions of the theft problem in 1984, the solution being that now most farms have hired guards.

A reliable security system has become a manditory expense on shrimp farms. Because of escalating armed robberies of shrimp either at the ponds themselves or on the waterways and roads to market, owners have been forced to direct capital to security, a non-productive expenditure. Currently, 12% to 16% of the farm workforce are guards.

Most farms over 300 hectares hire at least 9 men to do nothing but guard, while the smaller farms rely on 2 or 3, hoping that generating good social relations with people living in the vicinity will keep them from being targets. The most jaded owners hire a temporary guard force at one third higher pay than the regular workers, changing these men every six months to avoid familiarity hence complicity with neighbors. A few of the wealthiest owners have asked faithful, family employees to set up their households around the parameters of the farm in order to keep watch in return for continued largess, work and shrimp to eat. Some military owners hire ex-commandos who make particularly avid guards. If anything, their enthusiasm has to be restrained in declaring war on thieves and mining the surrounding mangroves where local people regularly fish and hunt. The only guarding method that owners unanimously agree upon is the necessity of

dogs.[10]

Guards and dogs patrol nightly, protecting ponds in particular where the shrimp have reached saleable size (U36 and up). Vulnerable points in guarding a pond full of harvest-size shrimp are the exitdoors where water can flow in or out. Robbers, by opening these flood gates (usually just a set of horizontal boards) can let the pond rush out into a weir, rapidly collecting shrimp. Two or three robbers with cast nets can also easily capture 300 lbs. of shrimp in a night's work. At 100 sucres/lb. on the blackmarket, this is equivalent to a month's wages, so extremely tempting that men continue to steal despite the added risk of death.

Since there is no contol over the blackmarket, the temptation to steal shrimp is exacerbated. Restaurants and exporters are only too happy to purchase shrimp at one third their value. Both groups feel they know who are illegitimate sellers because they accept the first low price without bargaining, and often claim to have caught stolen shrimp at sea, despite their clear color marking them as pond-grown. Exporters generally do not care if the shrimp are stolen since they need no official records for the government on who sold the shrimp and in what amounts. Pond owners are caught in a double-bind because they want to continue disguising true production figures, hence they are not pressuring government to require stricter shrimp transaction record-keeping despite the fact that this would make it tougher to sell stolen shrimp.

Economic Uncertainty

There are two basic types of uncertainty which influence shrimp mariculture. The first type centers on how variations in economic or environmental factors complicate management. The second type centers on uncertainty concerning demand. Demand is significant because, through price, it determines the income of mariculture operations and the incentive for new entrepreneurs to enter the sector.

The price of Ecuadorean shrimp is inversely proportional to the quantity of shrimp harvested by the US and Mexican Gulf fleets. Thus, a 20% increase in the Gulf harvest for 1985 has resulted in a 20% decline in the price for Ecuadorean shrimp. However, this basically affects the small and medium size shrimp (U26/35) which are the sizes recently caught in the Gulf now glutting the market. As a consequence, there has been a signficant price jump of more than a dollar per pound between the U26/30's and the U21/25's. More generally, the rise of mariculture worldwide is likely to increase the supply of medium sized shrimp, leading to permanently lower prices for these size categories. This makes it imperative for Ecuadorean producers to target their production on larger shrimp species for the future.

Monoculture is another source of uncertainty and danger in the Ecuadorean shrimp industry. The concentration on a single species--*P. vannamei*--means that a single disease could have a

devastating effect on the whole business. Such monoculture tends to favor a short-term perspective. A few business leaders are becoming aware of the advantages of species diversification in order to reduce risks. As discussed under **Hatcheries**, the US-led firms are especially anxious to move into new, disease-resistant strains of P. stylirostris and P. monodon, which also gain price advantages by growing to larger size categories on the same food ratio as P. vannamei.

Another important uncertainty in shrimp mariculture is the availability of postlarval shrimp. Most ponds are stocked with postlarvae harvested from nearshore waters. Beginning in 1984, there were severe problems in obtaining an adequate and constant supply of postlarvae. This uncertainty is affecting investment decisions and encouraging the continuation of an extensive pond system. The shortage of postlarvae is prompting pond managers and owners to try to further reduce operating costs, even at the expense of higher production and future profits. For example, the absence of postlarvae is motivating some owners to postpone excavating the silt which has accumulated in the bottom of their ponds. The build-up of silt makes it more difficult to control water temperature and salinity.

There are two sources of uncertainty from the standpoint of demand. First, the consumption of shrimp in the United States is sensitive to changes in income. And because shrimp pass through restaurant channels, recessions--by reducing restaurant dining, travel, etc.--depress shrimp prices. This means that there will be high income elasticities for shrimp. Sound management of the shrimp industry would accordingly seek to anticipate downturns in demand (and upturns in supply) and to take appropriate measures. Second, there is uncertainty associated with the price of shrimp substitutes because Americans and Japanese feel that lobster, crab, shrimp, and scallops are substitutable.

A final and important cause of uncertainty is the lack of a uniform shrimp management system. Because the shrimp industry is still relatively new in Ecuador (recall that El Oro's oldest farms are ten to fifteen years old, but that the general spread began around 1977), legislation has not caught up with the industry. This has created a business attitude towards management to "profit quickly before laws catch up and prevent it." Moreover, national policies of the Ministries change with each administration, introducing large measures of institutional uncertainty (e.g. concerning fuel subsidies and exchange rates). Furthermore, owners do not see government agencies as regulatory agencies, but rather as groups of self-interested businessmen who pursue their own ends through government channels. Overall, government action is perceived as being as uncertain as the individuals who fill the bureaucratic posts.

Social Economy and the National Good

The socially governed use of natural resources for economic

ends is a central field of enquiry for social economy. Resource scarcity is a socio-economic rather than a physical phenomena--the recycling of used materials, technological progress, and new discoveries have combined to contradict predictions of resource limitations. Hence, the major issues are: (1) how will technological progress augment the supply of essential inputs (e.g. development of hatchery seed and new species), and (2) under what conditions will management adopt new production strategies (e.g. extensive versus intensive farming and capital intensive water management). These issues depend on factors as diverse as the social system within which the shrimp producers operate, government policy on fuel subsidies and exchange rates, the local business perspective and business philosophy, and the economics of shrimp production.

These issues are significant because the Ecuadorean shrimp industry has relied on extensive production which maximizes the utilization of natural resources and minimizes capital outlays. Any assessment of the national value of the shrimp industry must thus weigh the economic return of the shrimp ponds against the social and economic return of a productive mangrove ecosystem in terms of food, forest products, income distribution, encouragement of entrepreneurship, coastal stabilization, capital reinvestment, the liquidity of local markets, etc.. This means that a balanced analysis must contrast the systemic values derived from using all of the nodes of an ecosystem with the concentrated value derived from exploiting one node. This is critical because the systemic values--such as anchoring the rural population--are often social, qualitative, and of general benefit. When production exploits a single node of the ecosystem to produce an export, values can be expressed visibly and quantitatively in the dollars generated by a specific industry. Thus, the optimal utilization of coastal resources for sustained economic development entails the analysis and balancing of systemic and non-systemic values. Simple as the point may seem, failure to commission research that leads to well-balanced assessments has inspired development projects which harm the social economy.

One of the questions raised but not answered by this pilot report is the economic value of mangroves to local residents. Tucked along the banks of the Guayaquil estuary, and in the other mangroves of El Oro and Manabi, are dispersed settlements. Clutches of 3 to 4 houses are grouped in a clearing on high ground. Many semilleros fish and hunt inside the mangroves when the tides are not right for semilla to supplement their seed income and to obtain valued sources of food. They work the mangroves more intensively from July to November when the postlarvae are not plentiful. Though several uses of mangrove wood are known, the extent of its economic contribution is not. Local inhabitants use mangrove to construct the hulls of fishing boats and for house posts. They recognize that mangrove wood is virtually indestructible in an environment where most things decay rapidly. Besides boats, mangrove is used for the making of fishing weirs and circular shelters to attract fish. Inside the mangroves,

local inhabitants capture most of their direct sources of protein: several types of crabs and finfish as well as oysters, birds, and mammals. Mangrove wood is burned to make charcoal to sell for additional income. The bark is also sold in Guayquil for its content of tannic acid.

Another question in need of future investigation is the role of shrimp as a local food source and the impact of shrimp farming on local diet. Shrimp were common fare on the coast prior to the first ponds 15 years ago. Shrimp sold as daily protein for 1 or 2 sucres/lb., while chicken was the choice food for celebrations. Today, what shrimp not exported are on restaurant menus and retail for 300 sucres/lb., not within reach of most coastal villagers. Coastal people now mostly harvest shrimp as semilla to sell to ponds and end up with more cash than before. Meanwhile, many of the Manabi chicken ranchers have added shrimp farming to their business repertoire.

Conclusions and Recommendations

The objective of this initial report has been to determine the primary socio-economic structures and problems of Ecuadorean shrimp mariculture. It has worked towards the development of a methodology, or set of problems, for analyzing coastal zone management. Throughout we have shown the importance of examining the structure of the social economy, producer's concepts of business and management, and how the political system influences business decisions and export strategies.

Given limitations of time and resources, this pilot study seeks to frame and articulate the relevant issues. It strives for accuracy rather than depth. By highlighting the major problems and suggesting several recommendations, it hopes to open the way for a more comprehensive analysis.

In the absence of major changes, shrimp mariculture is in its final phase of explosive growth. There are serious problems on the horizon. These problems will surface in the later part of 1985 when the seed shortage intensifies, forcing some producers to fail. Such failures will, in turn, induce banks to tighten lending policies to shrimp producers. No doubt, both expansion and the shift towards more intensive production will slow until the availability of hatchery seed resolves the competition for semilla. A question critical to the long term viability of the shrimp industry is how and how well producers will respond to fluctuations in the investment climate. Such information would be important in helping the government and development agencies select the proper policies, programs, and incentives.

The short time horizon of most producers disinclines them to practice even modest conservation. The guiding attitude is that profits must be taken as quickly as possible because economic or political circumstances may change. Thus, producers treat the environment as a disposable commodity rather than as a renewable resource. For the same reason, very few employers try to develop a

permanent, dependable labor force. Their attitude is expressed in the distrust, theft, union-busting, and the general opposition between workers and management.

Should hatchery seed become plentiful at a reasonable price and fuel remain subsidized for pumping water, the industry will expand by leveling more mangroves and converting farm land into shrimp farms. Unless there are economic and political changes, the availibility of seed will encourage small and medium-sized producers to continue with the established practice of building farms in the mangroves. Over the next decade, this will likely reduce the existing mangroves by half. For now, a social and biological, media-publized study should be carried out to either confirm or disprove whether the destruction of mangroves is connected to declining catches of semilla.

Hatchery seed will also stimulate the trend towards the utilization of agricultural land. It has a reputation for being a nutrient-rich, flood-free area which allows access to both bank financing and easy transportation. We have already suggested that the flow of capital from agribusiness into mariculture is responsible for some of agriculture's recent woes. A critical investigation should determine how much capital, personnel, and business interest is being redirected to mariculture, and what long-range impact this transfer will have on domestic food production.

The two areas which will grow most rapidly in the years to come are the production of feed and hatchery seed. These areas offer excellent opportunities for Ecuadorean business. A major step should be the development of high-quality shrimp feed that capitalizes on local products. For example, shrimp feed could utilize locally available but currently wasted proteins, such as cattle blood. Vitamins and binders are currently imported. Feed binder (the most critical element of good feed) could also be produced in-country with limited technological development. In addition, feed could be exported to other countries (e.g. Colombia and Brazil) which are just beginning to enter the shrimp business.

Only since the rapid expansion in shrimp pond area and the corresponding seed shortages of 1984, have owners clamored for hatchery development. Although many still think laboratory seed is weaker, hatcheries are unanimously considered the solution to the semilla problem. The direction of hatchery development will generate major structural changes. It will eliminate dependence on semilleros, no doubt decreasing employment and income levels for a group which has recently prospered. If the laboratory search for new species is successful it will end the danger of monoculture and enable the introduction of more profitable species (i.e. disease-resistant species that grow faster and larger). Finally, hatchery development is likely to place greater industry control in the hands of foreign companies, since they have the science, technology, and capital to develop and control the hatchery seed market.

The shortage of semilla is changing peoples' views of how the government should be involved in the industry and how the

industry, itself, should evolve. The producers see themselves as facing a dilemma and are divided on the issue of government involvement. On one hand, they are reluctant to encourage the government to enter their industry; on the other, they do not see how they could develop hatcheries without government aid of some kind. Government support could take several forms: tax incentives, soft loans, government-sponsored technical research, government-owned hatcheries (the least popular idea), and reform of import permitting procedures. The form, amount, and timing of this aid will determine who pioneers and who profits from laboratories. For example, if government offers low-interest loans for hatchery development, it is likely that medium-sized companies will have a change to participate. Each of the government's options has different socio-economic implications, making it critical to have information on the effect of each alternative.

No matter who develops the hatcheries, it is clear that progress will occur more rapidly if the government reforms its import permitting procedures. For hatchery development to take place, scientists must be able to import the necessary chemicals and equipment. An important step might be to lift the legal and bureaucratic roadblocks to those specific imports critical to hatchery research.

There are three other pragmatic ways the government could help assure the stable, long-term growth of the shrimp industry. First, a tax could be levied against the amount of land held under concession rather than the pounds of shrimp exported. This tax would encourage intensive farming by rewarding intensification and penalizing extensive ponds. This would reduce the need to destroy mangroves. The current policy of granting royalty-free concessions stimulates extensive farming and thus the leveling of mangroves. By putting a price on land, the tax would also inhibit producers from seeking larger concessions than needed. This would allow market forces (such as managerial ability) to have more control over land distribution. It is important to limit concession areas (1) because some producers destroy mangroves just to simplify the capture of semilla in open canals, and (2) because concession areas sometimes become off-limits to nearby villages who need them for hunting, fishing, and gathering mangrove wood and bark. A land tax would avoid the disadvantage of the current 1% export tax which is to penalize productivity. Furthermore, land area taxes are usually easier and less costly to administer.

Second, the government could eliminate or reduce existing exchange rate differentials. This would undermine blackmarket operations by removing the main incentive for smuggling to Peru and under-invoicing exports to the US. Bringing exchange rates into line would encourage the repatriation of capital. This is important for financing the future growth of mariculture without withdrawing capital from other sectors. Another benefit is that the government would find it easier to gather accurate statistics and hence better assess industry growth and revenue generation. Moreover, without a blackmarket there would be no need to make unofficial payments, payments which have had a corrosive effect on

government agencies and which undermine their credibility to the industry. One of the side effects of smuggling is that once trade routes become institutionalized, they acquire new functions and create new problems. The flow of illegal shrimp to Peru is stimulating the counterflow of drugs through Ecuador.

Third, the advent of government and foreign aid training courses and seminars would provide and encourage open access to technical information. A problem is that scientific institutes, industry associations, and government agencies in Ecuador do not share information. Nonetheless, publishing industry guidelines on shrimp pond construction, water management, fertilizing, and feeding would augment overall national production. It is likely that foreign companies will begin to openly publish information to further their own objectives (e.g. publishing shrimp rearing guidelines to increase their market share in feed). Total productivity gains would result if the myraid individualistic and ideosyncratic management systems gave way to scientific ones..

Another area where training would prove effective is in the conservation of semilla. High mortality rates are a feature of current collection and transportation practices. Semilleros and pond managers alike could be trained to handle seed efficiently, and taught basic biology to explain pond management needs such as oxygen levels (e.g. that shrimp breathe through gills underwater which is not self-obvious).

With the move towards hatcheries, there has been an influx of biological expertise and a growing sense among produers that technological sophistication is necessary. This is beginning to stimulate other areas of shrimp farm technology and to promote a deeper appreciation of the role and application of science. The still common view of many small and medium scale producers sees technology as a foreign yet wonderous power which will increase productivity and profits instantaneously and without additional contributions of capital, management planning, or skilled labor. A vital question for further study is how this understanding of techno- logy guides farm management today, and how it will influence the acceptance and use of new technologies tomorrow.

It is clear that the social and economic problems common to the management of Ecuador's coastal zone and its resources will not be resolved through the passage of new laws or amendments of existing ones, though this is where both government and industry usually concentrate their efforts. Shrimp producers comply with existing laws only when and where they dovetail with their own interests. This is because laws are both unenforceable and lack an essential credibility. Those who carry out the laws are also directly or indirectly involved in shrimp production. Hence, the law prohibiting the reduction of mangroves has not slowed their destruction but only distorted government statistics on the type of land placed in production. The enactment of a law or a set of regulations (e.g. for sanitation) only gives the impression that something concrete is being done.

But much more important is to (1) tailor coastal resource policies to the structure and limitations of the social economy;

(2) create the proper mix of economic incentives to motivate compliance; (3) obtain a sound data base to better orient decision-making; (4) create training programs to improve the handling of seed, water management, and similiar skills; (5) use the public media to develop a national conservation ethos towards renewable resources; (6) streamline the bureaucratic process and seek to minimize the conflicts of interest; and (7) enact only those coastal zone management laws which are enforceable and will be enforced.

As a final note, it is worth restating that the Ecuadorean shrimp industry has tremendous potential to generate employment, foreign exchange, and technological development. It has, however, matured to the point where future growth depends on the creation of a coastal zone management policy and its coordination with a coherent economic development policy.

There are several ways USAID could help Ecuador to attain these goals. Besides arranging developing training courses on wild and hatchery semilla handling, it could commission a social and economic analysis so that policy-makers and industry groups work from a sound data base. This base could be used to help establish management and ecological guidelines for intensifying production, the future for a healthy Ecuadorean shrimp industry.

Footnotes

1. We wish to thank AID grant DPE-5542-G-SS-4022-00 titled Shrimp Pond Siting and Management Alternatives in Mangrove Ecosystems in Ecuador for its support made available through the Principle Investigator Dr. Samuel C. Snedaker. Dr. Snedaker and and his co-workers Dr. Joshua Dickinson, Enrique Lahmann, and Melvin Brown, shared their thoughts and companionship in the field which enhanced this pilot study.

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2. The term postlarvae will be used synonymously with semilla and seed.

3. The shrimp industry uses size categories based on Units per pound. Thus, U26/31 can be read 26 to 31 shrimp per pound, indicating their size range.

4. Ecuadorean investors feel the need to oversee production, only buying a shrimp farm if they themselves or a partner can be on site at least once a week. Therefore, Sierra money has not flooded into the coastal shrimp industry despite stories of vast profits to be made. Sierra investors have only joined the "shrimp rush" in limited cases where one of the partners could move down to the coast to be physically in charge.

5. In addition, there is a brisk seed traffic from Manabi and Esmeraldas.

6. The estimate of level of US participation is based on our research and an elaboration of the Subsecretary of Fisheries' data on company holdings.

7. Moreover, most owners are constantly altering and reshaping their water management practices so that even on a single farm, variation is high from one pond to the next and during the course of the year. This affects methodology, in that interviewing an owner on his current management system does not give a fair idea over time at that farm, let alone on other farms owned by the same man. Management changes from farm to farm, pond to pond, and over time, even given the identical ownership.

8. Approximately 15% of the world shrimp market is supplied by mariculture, and this share is predicted to grow as more Third World countries in Africa and Latin America enter the industry.

9. The sale of juveniles to Guayas is another variation. Bahia producers, using their local relationships with semillero villagers who rear juveniles in holding ponds, guarantee the quantities needed for stocking. In one case, the Guayas owner paid 10 million sucres up front to a Bahia producer to amass 10 million juveniles for trucking to Guayas. Even after paying commission, the price per juvenile was 1.5 sucres, 25% below the going rate of 2 sucres per juvenile in Guayas.

   Such business dealings bond owners into reciprocal relations and become important to methodology when investigating the Ecuador shrimp industry. Provinces are integrated and cannot be separated or seen as isolated units for the sake of simplifying a study.

10. One owner is putting in a pack of great danes for their intimidation factor. Danes are rare dogs in Ecuador, but their gentle nature during the day, plus short-hair adaptability to the tropics makes them ideal guards.

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