GOOD MANAGEMENT PRACTICES FOR SUSTAINABLE SHRIMP PRODUCTION IN COASTAL HABITATS

Project Findings and Recommendations for a Phase II Work Program



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The Conservation of Critical Coastal Ecosystems in Mexico program is part of the Coastal Resources Management Project II, a partnership between the United States Agency for International Development and the Coastal Resources Center at the University of Rhode Island The project aims to conserve critical coastal resources in Mexico by building capacity of NGOs, Universities, communities and other key public and private stakeholders to promote an integrated approach to participatory coastal management and enhanced decision-making.

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Purpose

This document outlines the results and recommendations of the planning initiative supported by the David and Lucille Packard Foundation, which was intended to develop strategies for sustainable development and management of shrimp mariculture in Sinaloa, Mexico. This effort was one of several initiatives that contribute to the integrated management plan for Bahía Santa María with applications to Sinaloa and other similar coastal lagoons and wetland systems in Pacific Mexico. Relevant findings from similar initiatives are also described and their application to the Mexico case is explicitly detailed. Finally, recommendations and a detailed plan of action are outlined in order to make progress in supporting and managing sustainable shrimp culture development as a major force shaping the future of the Mexican coast and its communities. This project was undertaken by Coastal Resources Center at the University of Rhode Island (CRC-URI) in collaboration with the Conservation International/Mexico (CIMEX), University of Hawaii at Hilo (UHH), Ecocostas, and the Sinaloa Institute for Aquaculture (ISA *Instituto Sinaloense de Acuacultura*). A broad group of persons from industry, government and institutions in Sinaloa participated in workshops and contributed to the findings and recommendations.

Background

Aquaculture is becoming increasingly important on a global scale as wild fisheries are depleted and the demand for seafood product grows. The latest Food and Agriculture Organization fisheries assessment (FAO, 2000) estimates that 80% of the world fisheries are either fully or over-exploited. Demand for seafood has recently increased sharply in the developed world as health-conscious, wealthy consumers look for low-fat protein sources, while developing countries desperately seek ways to generate employment and foreign exchange. The U.S. alone currently imports 731 million pounds annually of the 815,000 tons of shrimp produced globally (Rosenberry, 2000). These trends are expected to continue with aquaculture supplying an increasingly larger percentage of the world's food supply and to a large extent, replacing wild fisheries.

Shrimp production in Latin America plays an important role in local economies as well as in the economy of the U.S. which is the principal market for this production. Population growth in the Western Hemisphere is concentrated in coastal areas, where land is often marginal for traditional agriculture. Shrimp culture represents a good opportunity to utilize marginal or isolated coastal areas with access to brackish or seawater. Shrimp culture makes important contributions to food security as a cash crop, employment and generation of foreign exchange. In some countries,

such as Mexico and Columbia, shrimp culture may be one of the few high-value crops that can compete with drug production.

Although shrimp culture has great potential to render multiple benefits to coastal populations in Latin America, care must also be taken to ensure that its development is planned and integrated with other uses in order to minimize potential impacts. Of particular concern in the case of Sinaloa is the Bahía Santa María, an area of high biodiversity and economic potential as a site for fisheries, aquaculture and eco-tourism. In Sinaloa, approximately 28,000 hectares of shrimp ponds have been constructed and operated at least for one harvest. 7,000 of these hectares have been constructed in Bahia Santa Maria. At present three-quarters of Mexico's shrimp farms in production are located in Sinaloa (19,000 hectares) and over a quarter of these (4,800 hectares) are found in Bahía Santa María—a high concentration in an area of significant environmental importance. For this reason, one of the five priority management issues identified through the current bay management initiative is to "improve fisheries productivity and promote low impact aquaculture." The overall vision for the future assumes that such economic activities can be developed in a compatible manner with the environment to achieve an appropriate balance of both conservation and development.

In 1999, a multi-institutional effort was initiated in Bahía Santa María, involving broad group of stakeholders including three levels of government, industry, universities, and non-government organizations. The overall objective of the Bay Management Program is to carry out participatory, community management strategies that will preserve the different coastal environments of Santa Maria Bay. This means protecting the flora and fauna of the region, in particular endangered species. It also means promoting sustainable practices for current Bay uses and pursuing promising alternative productive activities. Specific program objectives include:

- Expand local capability to conserve critical zones in the Bay.
- Promote low impact resource uses to reduce the pressure on overexploited or critical resources.
- Incorporate environmentally friendly management practices with ongoing economic activities.
- Promote the sustainable development of the Bay.

Bahía Santa María Issues

While we use Bahía Santa María as a pilot site for understanding both the issues and the potential for applying good management practices, we feel that the issues and solutions will be applicable to the rest of Sinaloa. Mangrove wetlands and tidal flats are critical to the health of the Bay. There are two main regions of mangrove forests in Bahía Santa María, one in the south and the other in the north. Between 1973 and 1986, the overall mangrove forest grew from 32,455 hectares to 37,908 has. By 1992, the total area covered by mangrove forests declined to 33,940 hectares.

At the same time mangrove area began to decline, shrimp pond area increased. Shrimp pond area in Bahía Santa María has expanded to its present area of 4,800 hectares in just 10 years, 1987-

1997. Continued rapid shrimp industry growth is expected in Bahía Santa María, and Sinaloa in general. Conservative projections predict that this area will double in the next 5 years, and triple in the next 15 years.

A number of serious biophysical and environmental changes have occurred in Bahía Santa María and similar areas in Sinaloa due to the pressure from a number of economic activities including fishing, agriculture, urbanization and aquaculture. Shrimp aquaculture is known to have caused environmental and social problems in other regions, and given the projected expansion, a precautionary strategy of prevention is necessary. Shrimp aquaculture is not the only activity which impacts the Bay; urbanization, fisheries, intensive agriculture, tourism and other activities are also impacting these sensitive areas. However, given recent advances with aquaculture management and policy in other Latin American countries, shrimp farming is viewed as a manageable activity and hence, management of this activity serves as a model for other resource management issues in the area. Good management practices are essential tools towards this end.

Most of the shrimp farms in Bahía Santa María are located near mangroves and tidal flats. This is an inheritance of the initial Ecuadorian shrimp practices adopted in Sinaloa by the first shrimp farms in the area in the 1980's. Tidal flats that served as sinks for fresh water runoff and coastal flood areas during common meteorological events (e.g. hurricanes and summer storms) are now occupied by shrimp farms, which obstruct runoff and increase the potential for coastal damages from natural hazards.

The large water requirements of shrimp farms may also tend to disturb the overall hydrodynamic patterns of small estuaries, provoking erosion/sedimentation processes sometimes in detriment to the health of the Bay. The impact of shrimp ponds on hydrodynamic patterns may be a cause for a decline in the area of the Bay that has fallen from 151,314 hectares in 1973 to 145,022 hectares in 1992.

Finally, it has been suggested that the water pumping operations capture large quantities of small fish and invertebrate fry's, including shrimp post larvae, and disrupt the fragile nursing grounds of these species, some of which are commercially important to the region.

Pond siting, construction and management practices in Bahía Santa María vary greatly. Some ponds and canals are poorly sited and have caused environmental problems. There is no clear consensus as to the best practices for the different species that are cultivated, nor for the level of production intensity. Both technical and financial capacities are low; this leads to poor practices that reduce socioeconomic benefits and can cause environmental impacts.

The Bay is losing area, depth, mangroves, commercially important fisheries, and fresh water runoff. Some of these are a result of natural processes and part is provoked and enhanced by human activities. There are great regional and governmental expectations for developing a sustainable aquaculture industry in the area. Efforts should be taken for promoting the adoption of better shrimp practices by current and new projects. Better practices need to be identified and promoted that are environmentally friendly and will promote the growth and consolidation of the shrimp farming industry without provoking detrimental impacts to the environment.

Major Findings and Results from Planning Phase

Coastal Mexico is entering a critical period of development as critical habitat areas are built out and conflict by the various resources users begins to build. Shrimp mariculture has been targeted for growth in Sinaloa. Government officials state that more then 100,000 hectares are feasible for shrimp farming activities in Sinaloa. Among the emerging lessons learned from the Planning phase of this work is that while shrimp culture is rife with a number of problems related to its development and management, capacity and interest among the stakeholders is adequate to meet these challenges given the opportunity and resources. Additionally, development of tools and strategies to manage aquaculture growth is viewed as a unique opportunity to catalyze stakeholder action around a common area of interest as the first in a series of management actions contributing to the integrated management of coastal areas in Mexico.

Among the major findings and results are:

1. Institutional capacity and collaboration require strengthening in selected areas

A relatively high level of technical capacity exists within industry and the government institutions which exceeds that found in Central America where the Coastal Resources Center at the University of Rhode Island (CRC-URI) has previously worked with good management practices. The difficulty in dealing with development issues appears to be due to the lack of coordination and communication between the key institutions. Thus, one of the first steps was to form an inter-institutional working group to analyze the issues and develop preliminary strategies. Formalization of an inter-institutional body occurred during this period with the formation of the Sinaloa Institute for Aquaculture (ISA). An additional weakness is the lack of capacity within the social sector involved in shrimp farming. Given that the social sector is financially and technically weak and governmental services are inadequate, this sector, which stands to potentially benefit the most from shrimp farming, is lagging behind private farms.

2. Identification of key issues

The working group and other stakeholders met during five work sessions to identify key issues related to industry development and management. Foremost among the issues identified was lack of current technical information and technical support available to the industry with the dual consequences of poor management and inadvertent environmental impacts. Evidence of this is seen in the uncontrollable epidemics that have swept the industry, abandoned and unstocked ponds, siting ponds in inappropriate sites, resource user conflicts and economic exploitation of shrimp farmers from the social sector. Mechanisms to deliver technical services to the industry and links between producers and resource managers were also lacking. There are also major gaps in the data base and the skills array available to the industry. Economic and environmental data are particularly lacking. Additionally, the social sector which is viewed as one of the primary stakeholder groups suffers from a lack of social organization, technical skills and entrepreneurial ability that hinders its ability to manage shrimp farming in an economically and environmentally sustainable fashion. It is projected that without assistance, the social sector may disappear from the shrimp farming scene.

3. Gaps in policy and land use planning

While Mexico is more advanced than many countries in having a sound policy and regulatory framework, key elements are either missing or are ineffective due to lack of application and enforcement. One key element is the disconnect between policy for land and coastal water management. Corruption continues to be a severe problem and this is exacerbated by the lack of coordinated action and transparency between the various institutional players and industry. Even weaker are efforts at regional land use planning and zoning that could be effective in siting shrimp farms in appropriate areas, protecting sensitive areas and avoiding conflicts between resource users.

4. Shared vision and preliminary action strategies

The planning initiative provided many opportunities for the various stakeholders to work together on a regular basis to express their vision for the future and potential of the industry, and to come to a consensus as to strategies to resolve common problems. These issues and strategies are described below.

The vision is stated as follows:

- *More efficient aquaculture production, developed within the sustainable capacity of the coastal ecosystem, managed through aquaculture parks, with open participation from all sectors, organized as one association with an entrepreneurial vision.*

- *Development of government programs that include regulation, assistance to the aquaculture sector, basic infrastructure (roads, energy), financing, property rights and land tenure*

- *Research Centers that enhance the industry's quality and financial stability through certification of inputs, biosecurity, increased genetic capacity of the brood stock, environmental monitoring, and technology development and exchange*

Other Experiences with Good Management Practices

The CRC-URI has worked over the last 5 years in Central America, Tanzania and Indonesia to develop tools and strategies to improve the feasibility and sustainability of mariculture, within a framework of integrated coastal management (ICM) initiatives. In Central America, the CRC-URI built on the long-term effort of Auburn University and its partners under the Pond Dynamic/Aquaculture Collaborative Research Support Program (PD/A CRSP) supported by US Agency for International Development (USAID) which tested good management practices, conducted environmental monitoring of the ecosystem and shrimp farms and worked towards adoption of a Code of Practice. The CRC worked with Auburn and the Honduran Association of Aquaculture Producers (ANDAH) to take the next steps of developing a set of good management practices and assess industry compliance with these. The same partners continued work in conjunction with new partners, including University of Hawaii at Hilo (UHH) and Ecocostas in Nicaragua under the Hurricane Mitch Recovery efforts to provide training and technical support to promote implementation of the GMPs in Honduras and Nicaragua.

These experiences have demonstrated that the challenges, whether environmental, social or economic, can be addressed through application of integrated coastal management tools and

faithful adherence to a collaborative process that builds inter-institutional and multidisciplinary capacity. Critical phases and actions in this process include:

- Identify critical issues associate with shrimp farming
- Develop recommendations and practices to address these issues
- Test practices and subsequent refinement
- Support implementation of tested GMPs by stakeholders
- Build inter-institutional capacity and coordination through facilitated interactions of working groups centered around management actions
- Provide training for technical assistance providers to enhance their ability to support industry
- Work towards a permanent program of collaborative research and extension to support industry and environmental goals
- Enhance the capacity of industry to develop skills in pond, environmental and business management to optimize use of natural resources
- Provide continual monitoring and assessment of the effectiveness of GMPs with feedback to stakeholders

These experiences from Central America provide a sound basis as well as practical tools and strategies to address the challenges faces by the Mexican shrimp industry.

Objectives and Expected Outcomes

Based on past work and the analysis of the Sinaloa situation, the following objectives and expected outcomes have been identified as priorities by the stakeholders and project managers during the planning initiative.

- Strengthen institutional capacity and coordination to support development of an environmentally and economically sound shrimp industry based on optimal use of natural resources

- Develop management strategies for shrimp farming that directly contributes to improved management of the Bahía Santa María and other critical wetland areas in Sinaloa

- Provide training and technology transfer to promote changes in practices by institutions and producers that contribute to improved industry management in a wide array of inter-related topics

- Conduct applied research and testing to develop a data base for management decision making at the ecosystem and farm level. This will include economic, environmental and technical aspects in a multidisciplinary approach to integrated management

- Design and implement monitoring systems and outcome assessment on a permanent basis to evaluate the effectiveness of management actions which incorporate feedback mechanisms for stakeholders.

Strategies and Activities to Promote Good Management Practices

Shrimp culture has been an important productive activity for many coastal communities located in marginal areas where agricultural production is problematic and where fisheries are reaching or exceeding sustainable limits. Shrimp production has provided numerous benefits for producers of all scales. For small and medium producers, shrimp culture provides a cash crop that sustains families with income that is used to buy the necessities of life. In the case of large farms, shrimp production for export provides valuable foreign exchange and employment in areas where employment opportunities are limited. In the latter case, many of these jobs are occupied by women who find work in processing plants, which often offer the only source of employment available to women.

Shrimp farming in the Americas and Asia has traditionally relied upon expansion and intensification as strategies to increase production. Both of these strategies may produce environmental, economic and social impacts. Geographic expansion of shrimp farms may lead to construction of farms in fragile coastal habitats such as mangrove or wetlands. Not only does this result in loss of habitat, but future production is affected since these areas have characteristics such as acid-sulfate soils, which condemn the shrimp farmer to permanent problems with water quality leading to poor production.

Intensification as a strategy to increase production can also led to disastrous results unless farmers are equipped with good management skills and institutions have the capacity to manage industry. During the last 15 years, a series of viral diseases has repeatedly swept the global shrimp industry, resulting in losses of hundreds of millions of dollars and abandonment of shrimp farms. The gravity of these diseases is believed to be partly due to poor management methods, which produce poor environmental conditions exacerbating the effects of epidemics and increasing economic loss. The same inadequate management methods contribute to poor effluent quality, poor construction methods, and poor site selection. The lack of institutional capacity to enforce regulations that prevent introduction and spread of disease is also at fault. Thus, the presence and rapid spread of introduced disease is an indicator akin to “a canary in a coal mine” of management weakness at multiple levels.

In order for intensification to be effective as a strategy to increase production in a sustainable fashion, several pre-conditions must exist: 1) the farmer must possess sufficient knowledge and have adequate management skills; 2) measures to prevent introduction of disease must be put into place (biosecurity); and 3) measures to manage effluents and other possible environmental impacts must exist. These preconditions depend on the availability of information on pond dynamics and their relationship with ecosystems dynamics.

As limits to growth and expansion are reached in coastal areas, making the best possible use of natural resources is increasingly important. Recognizing the limits to increasing production either through expansion or intensification is part of this. Increasingly, optimization of production is the strategy of choice rather than simply attempting to increasing the volume or area of production. Optimization is defined as making the most efficient use of the natural

resources used to support shrimp production and lowering risks. The limits of optimization as set by the boundaries imposed the need to prevent environmental impacts and conflicts with other natural resource uses.

Optimization of production within environmentally imposed limits depends on understanding the nature of pond ecosystems, the relationship with the wider ecosystem and increasing the capacity of pond managers to apply this knowledge to their systems.

Characteristics of Good Management Practices and their Application

Good Management Practices as defined in past work, are those practices which:

- Increase the efficiency of production though better use of resources to increase production within limits imposed by the carrying capacity of the ecosystem;
- lower risks (to the producer and to the ecosystem); and
- minimize environmental impacts.

Shrimp farming is an activity, which combines ecosystems management (pond and surrounding ecosystems) and business management. Effective use of GMPs requires increasing the capacity of shrimp farmers in a wide range of fields. As shown in figure 1, production depends upon four elements: natural resources; capital; labor; and management.

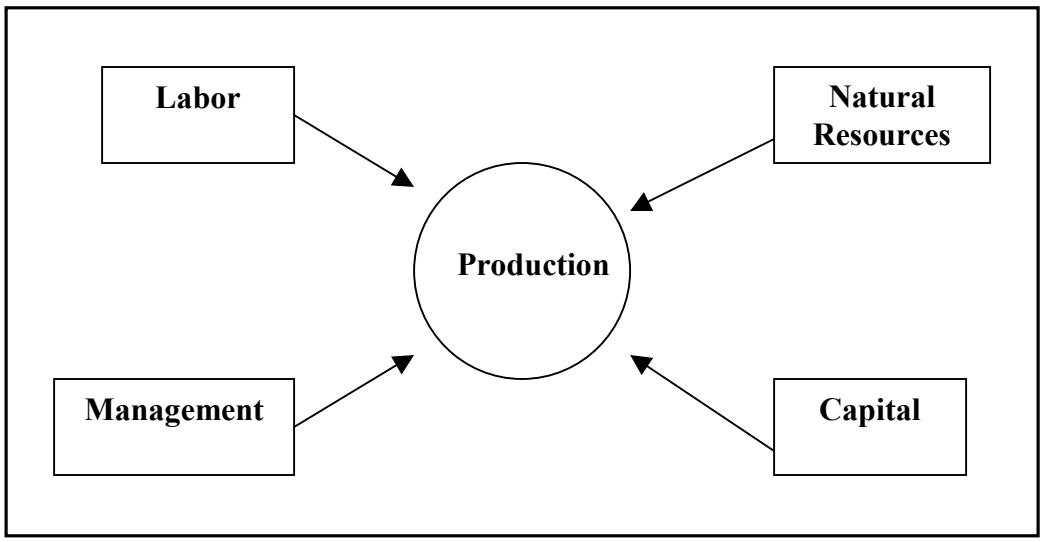


Figure 1 Elements to production and focus areas for building a sustainable shrimp industry

GMPs for shrimp production have previously focused on improving capacity to make the best use of the natural resources upon which shrimp farming depends and strengthening management skills of the producers. The proposed work for Sinaloa will focus on the optimization of the use of natural resources and management. To some extent, issues of capital and labor will also be

addressed through the proposed economic analysis and strengthening of business skills in the social sector.

This work proposes to develop and implement GMPs for the Mexican shrimp farming industry to optimize production within environmentally imposed limits. This entails the following steps:

1) Transfer GMPs from other shrimp farming areas and adapt for implementation within the conditions of the Mexican industry. These GMPs cover a wide range of natural resources use within shrimp farming.

2) Expand current GMPs to include management topics and provide basic business management tools in order to support more effective implementation of GMPs for natural resources use.

3) Provide training to stakeholders in GMPs and support extension efforts designed to promote implementation on farms.

4) Develop monitoring programs and feed back systems to evaluate the effectiveness of GMP application and work towards increased effectiveness over time.

Proposed Activities

The following activities are proposed for a three-year project in Sinaloa. While some of the activities should be implemented at a broad scale, it is suggested that specific field and training activities initially be focused in two or three pilot regions, one being Bahía Santa María. This will allow the industry to have critical mass within certain regions to implement and evaluate the program. It will also allow for the participation of various sectors (ejido, cooperatives, private farms) within the pilot sites. With the training of trainers and the participation of regional institutions, this can then be extended to the other regions of the state.

1. Transfer and Adapt Existing Good Management Practices

Central America experience provides a good foundation for transfer and adaption of Good management practices for shrimp farming, specifically the GMPs developed during the PD/A CRSP project and the North American Free Trade Agreement projects supported in part by USAID. During the on-going US Department of Agriculture project, an operations manual for implementation of GMPs was developed along with simplified extension materials. Extension agents and producers were trained in GMP concepts and application and implementation is currently underway to promote adoption and implementation of GMPs among small and medium shrimp farmers in two countries.

The GMPs, operations manual, training curriculum and materials, and extension materials provide an important source of information and experience in the area of GMPs. This material will be reviewed and adapted for use in Mexico by the proposed Interinstitutional Working Group during the first year of the project, in preparation for training courses and extension work in years 2 and 3. Currently, GMPs exist for the following topics:

- Water and soil quality management
- Site selection and pond construction
- Feeding and Fertilization
- Closed and recirculating systems
- Postlarvae handling and stocking
- Harvesting
- Food quality and safety
- Financial administration and business management
- Environmental aspects of aquaculture

During initial phases of the project a field survey will be conducted to confirm existing practices and prioritize GMPs for extension, training and monitoring activities. The adapted and expanded GMPs will provide the conceptual basis for extension activities designed to provide assistance to shrimp farmers, with emphasis on the social sector and small private farmers, to enable them to implement environmentally-friendly methods of shrimp farming. Developing a strong cooperative extension capacity among the private and public sectors is the primary strategy by which GMPs can be implemented (see below).

2. Expansion of Good Management Practices to Other Critical Topics

To date, GMPs and training materials exist for a wide range of topics related to pond management, farm siting and construction, biosecurity, product quality and financial administration. Based on experiences in Central America, certain topics have been identified as requiring more emphasis in order to fully implement GMPs adequately on farms. Most of the developed GMPs focus on pond management and the use of inputs such as feed and fertilizer. However good pond management is, the ability to use inputs and produce efficiently depends on the operators' ability to command a wide range of other GMPs in addition to a supportive regulatory and planning framework. This work proposes to develop new areas of GMPs as a means of further increasing production capacity. The relevance of these topics is discussed below.

a. Biosecurity and Disease Management

Biosecurity is the ability to prevent losses to disease through exclusion of pathogens and their carriers. The Mexican industry has been heavily damaged by the recent waves of devastating viral diseases. This was one of the priority issues that the Sinaloa industry felt needed to be addressed through good management practices. The project contracted with Drs Donald Lightner and Carlos Pantoja of the University of Arizona to participate in a workshop with the industry as a first step towards employing GMPs for biosecurity. Their paper*, Bioseguridad y El Cultivo de Camarones*, is provided as an attachment to this report.

It is believed that these diseases are transferred between regions through the importation of hatchery broodstock, postlarvae and shrimp products. Once new pathogens are imported to an area, infection of wild stock appears to be inevitable, eliminating future possibilities of using uncontaminated wild stock to culture. Misguided, partial attempts to establish biosecurity in Mexico have led to a situation where approximately 30% of the farms are out of operation due to restrictions of importing postlarvae. This ban is unconditional and does not take into account that imported Specific Pathogen Free (SPF) postlarvae, as certified by qualified laboratories,

could be a safe means of stocking farms. This ban has heavily impacted the cooperatives and ejidos, which cannot afford to purchase larvae at the inflated prices now commanded by hatcheries who hold a monopoly on postlarvae supplies. Hatcheries are currently charging $7.50 US /1000 postlarvae. This prices is highly inflated as compared to prices elsewhere in Latin America ($2.50-$3.00 US/1000 postlarvae). Hatchery production is insufficient to supply the entire industry, and since other possible sources of postlarvae have been eliminated due to manipulation by interested parties, producers have no choice but to buy overpriced hatchery larvae or go out of production.

However, hatcheries continue to import broodstock from other regions and while these hatcheries claim to implement methods to assure production of SPF larvae, lack of certified, standardized laboratories which can conduct supervised inspection of imported broodstock makes any assurance of safety spurious. This puts the Mexican shrimp industry in a highly precarious position where farms do not have access to safe stock at reasonable prices. Aside from the economic loss born by the social sector, continued importation of question broodstock will eventually lead to introduction of the new strains of viral disease now appearing in other regions. Once introduced into the hatcheries which are now the sole source of postlarvae, rapid dissemination of diseased postlarvae throughout the entire industry is guaranteed. An additional element of danger is added since the inflated price of postlarvae is spurring the beginnings of a boom in hatchery construction. Since there is no system to assure that hatcheries practice safe methods and are biosecure, a rash of new, inexperienced hatchery operators will only increase the probability of new disease introduction.

Prevention of future epidemics on farms and prevention of the introduction of new diseases into the wild populations is critical. Rapid action needs to be taken to work towards a biosecure situation where the industry is not completely vulnerable to random introduction of disease by inexperienced or careless operators who operate without public scrutiny or government control. This issue is particularly critical if the social sector is to continue producing shrimp.

A completely biosecure system of postlarvae supply would be one in which hatcheries ceased importation of broodstock through domestication and certification of disease free (SPF) or disease-resistant (SPR) shrimp. Use of wild postlarvae, which cannot be guaranteed to be disease free would also be curtailed. This entails the ability of hatchery operates to repeatedly breed new generations of broodstock shrimp in quarantined and closely monitored systems and supply adequate numbers of postlarvae to the industry. Biosecurity also entails the ability of the government to supervise this activity by constant monitoring of the disease free status of the hatchery shrimp using independent laboratories. These laboratories must have trained personnel, adequate equipment, use modern and standardized diagnostic methods and operate in a transparent manner to serve the public good.

Development of a sustainable shrimp industry requires working towards such a scenario, but achieving this ideal situation is not immediately possible due to lack of qualified laboratories, wide-spread lack of understanding of the basic principles of shrimp pathology and biosecurity, and lack of public sector capacity to oversee safe postlarvae production in hatcheries.

This work proposes to take intermediate steps to alleviate the scarcity of postlarvae while working towards a completely biosecure system for the industry. Given that hatchery supply will be inadequate for some time, use of wild postlarvae is required. While wild postlarvae cannot be guaranteed to be disease free, the probability of obtaining safer larvae sources can be achieved through the following intermediate steps:

1) Provide training to personnel of postlarvae collection centers in field diagnosis of disease and short term quarantine systems. Laboratory capacity to support these centers will be required.
2) Conduct a rapid assessment of wild postlarvae populations to determine if imported diseases are indeed present in wild populations, and if so, does this vary by region. If imported diseases are detected in some populations, this information can be used to determine which populations may be more likely to provide safe sources of postlarva.
3) Train farmers and extension agents in methods of disease management, part of which includes good management practices that help prevent stressful pond conditions which exacerbate the tendency towards disease outbreaks. Good pond management and disease management are critical preconditions to a successful industry, since even if SPF hatchery produced shrimp are used, these may be infected once introduced to farm areas.
4) Work with government institutions to develop requirements for government inspection and certification for all imported broodstock.
5) Develop capacity of university and research center laboratories to aid the sector in the detection, diagnosis and reporting of diseased animals.

This work will also assist farmers in routine disease management. As in all livestock and agricultural operations, disease is always present, but economic loss can be largely prevented when farmers understand the characteristics of diseases and their transmission, have access to diagnostic services and have the support of extension agents trained in good disease management. Additionally, this effort will have positive benefits for the environment. Farmers who come to understand the good management practices reduce the probability of disease will be motivated to implement GMPs and consequently prevent environmental impacts. Preventing the introduction of new diseases through hatcheries will prevent infecting wild stock with new diseases and the environmental impacts caused by farm failures will be avoided.

b. Social Organization and Business Management for Cooperatives and Ejidos

The ability of cooperatives and ejidos to function as small businesses is a critical issue identified by the issue identification conducted by Ecocostas. Decision-making is often disassociated from technical competency within the organizational structure of these entities. Regardless of the degree of technical competency of the organization, GMPs cannot be effectively implemented unless:

- Technically skilled personnel are empowered to be agents of change within an organization;
- both management and labor are trained in basic business management skills; and
- the expected outcome of the organization is to produce profits and re-invest to build a long-term functioning business entity.

These issues are complex and inter-related, but previous experiences with cooperatives in Sonora, Mexico have demonstrated that success can be achieved through long-term training and technical support; organizational restructuring to improve management and decision-making and business planning to achieve long-term profitability and reinvestment.

This activity will involve providing support to one or two cooperatives or ejido organizations (they have several cooperatives or ejidos as members) in a pilot effort to support development of appropriate institutional organizational structure and management capability. The Interinstitutional Working Group and working group, consisting of an economist, cooperative business specialist, finance specialist, and management and technical personnel from the participating cooperative or ejido will provide support to this effort. Experiences and results will be closely monitored and documented so that other groups may benefit.

c. Food Quality and Commercialization

The work in Central America revealed that a significant barrier to efficient and environmental sound use of natural resources occurs at the end of the productive system. Even when shrimp are successfully brought to harvestable size, significant economic losses and impacts may occur during harvest and post-harvest processing. There are also important links to environmental and human health. Traditional methods of shrimp harvest as practiced by an unsophisticated producer may result in the discharge of effluents heavily loaded with organic nutrients and sediments. The same method results in a large percentage of the harvested shrimp being of poor quality. Post-harvest handling methods results in further downgrading of the shrimp. ANDAH estimates that the 300 small and medium shrimp producers in Honduras lose $4 million annual due to reductions in quality during and after harvest. Of particular note are losses that may occur due to shrimp being contaminated with salmonella or *E. coli* as a result of the lack of good hygiene or public sanitation. The U.S. Food and Drug Administration (FDA) has a zero tolerance for salmonella in shrimp and European standards are similarly strict. Many producers have trouble complying with export standards meaning that their shrimp must be sold on the local market. This results in economic loss and is a potential threat to local public health.

Processing plants are often owned by shrimp companies or ejidos. Further economic loss may result at the packing and shipping stages due to contamination with filth, inappropriate use of chemical treatments, microbiological contamination within the plant or losses during preservation and shipping. These losses are often passes along by the plant to the producers.

In order for shrimp culture to be truly sustainable and to contribute to food security, these types of losses must be prevented. Human health, locally and internationally, must also be protected. GMPs for on-the-farm and processing plants already exists and are incorporated into the HACCP (Hazard Analysis at Critical Control Points) system that is rapidly becoming the international standard for the food industry. For this component of the project, critical issues for food safety and handling will be identified within the Sinaloa industry, and training developed to address these issues.

3. Training and Extension to support Implementation of GMPs

a. Training and Extension

Once the GMPs and training materials are modified and adapted to Mexico industry conditions, training and technical assistance to support implementation of GMP will developed through training of trainers (TOT) events and inter-institutional extension for producers.

The Interinstitutional Working Group and selected sub-groups of experts will work with international specialists to design and deliver the TOT courses. This is the most efficient use of resources and training personnel already engaged in providing assistance to producers and are expected to have a multiplicative effect. Training participants will be carefully selected based on individual and institutional commitment to replicating the training through the extension initiative.

The key to success in replicating training and providing support to successfully implement GMPs on a long-term basis is development of inter-institutional capacity in extension, based on the Land Grant or Sea Grant model (Figure 2) of collaborative extension in the U.S. Capacity for extension is currently limited in Mexico, with extension being conducted in a fragmented manner by a few universities and government institutions with limited resources. Building upon the inter-institutional capacity represented by the Interinstitutional Working Group, it is proposed that formal arrangements and strategies be developed during Phase I to create a long-term capacity for collaborative extension.

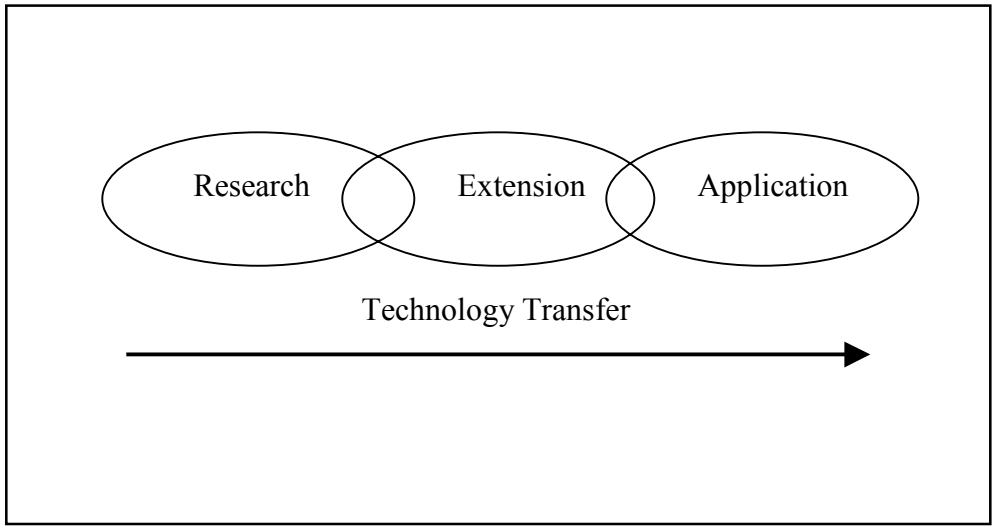


Figure 2 Technology transfer through cooperative research and extension

As training proceeds, the trainers, international specialists and training participants will begin to operate as extension teams under the inter-institutional agreements to being providing support directly to producers. This will continue and be expanded in the latter stages of Phase II and III.

b. Demonstration of GMPs

An important part of the training is demonstration of the utility of employing good management practices. Also critical is the need to conduct applied research in the implementation of GMPs under local conditions, given that environmental conditions are highly variable between regions. A small demonstration project will be supported at a local university and research center consisting of a modest demonstration hatchery and a series of small ponds at a nearby farm. These facilities will allow training participants and farmers to practice new methods during training events, provide facilities for researchers to conduct limited applied research into carefully chosen GMP topics, and provide concrete illustration of the benefits or potential obstacles of implementing GMPs. The small hatchery facility is a key part of improving the capacity within the industry to manage disease and work towards biosecure systems. As there are no documented biosecure hatcheries or farms in the industry in Sinaloa, this will be an unique opportunity to demonstrate basic techniques and methods required to implement these changes. The small demonstration system should eventually become self-financing through sales of shrimp and postlarvae, much as has been done at the demonstration farm of the Universidad Centroamericana in Nicaragua.

4. Monitoring Systems, Outcome Assessment and Feed Back Mechanisms

Because development and implementation of GMPs is relatively new, GMPs must constantly be revisited and revised as scientific and empirical experience accumulates. The results of implementing GMPs must be monitored and assessed systematically in order to do this. This requires establishing monitoring systems and assuring that the technical capability exist to develop monitoring frameworks, collect data, conduct analysis, interpret data and apply results to management decision-making.

This work proposes to establish three monitoring and feed-back systems to support the implementation of GMPs: 1) water quality monitoring; 2) pathology and biosecurity monitoring; and 3) financial analysis and tracking of economic impacts. These efforts will be linked with existing monitoring systems where feasible and appropriate.

a. Water Quality Monitoring

This work proposes to build upon the newly established monitoring program in Bahía Santa María and strengthen current efforts in this direction as a model effort to be adopted in other shrimp farming areas in the future. This will include monitoring the Bay and it's tributaries and inlets, as well as shrimp ponds and their effluent plumes. The purpose is to collect baseline data and to assess the effects of GMPs as they are implemented. A key part of this will be to provide training to monitoring personnel, assure that analytical capability exists in laboratories and that results can be applied to management of shrimp farms and the Bay. Components of this work include training of personnel, standardization of existing laboratories, establishment of voluntary monitoring by shrimp farms, and a collective effort to interpret and share data among concerned stakeholders.

b. Pathology Monitoring

As the regional industry strives towards improved disease monitoring and biosecurity systems, the capability of private and public sector laboratories must be strengthened. Diagnostic ability

depends on the farmer understanding basic diagnostic techniques that can be conducted at the farm and knowing when and how to send samples to a qualified laboratory. Additionally, laboratories must employ up-to-date, standardized diagnostic techniques. This also entails systems of quality assurance/quality control that allow laboratories to produce reliable and similar results. In the case of Mexico, this is of particular importance given the political aspects of biosecurity; in order for rational, public debate on the merits of biosecurity measure to proceed, it is necessary that the results of the laboratories participating in this effort be verifiable and reliable. This component will have three components: 1) training farmers in farm level diagnostics; 2) training laboratory personnel in diagnostic techniques; 3) standardizing and certifying laboratories; and 4) incorporating laboratories into the extension methods and management decision-making.

c. Economic Effects of GMPs

GMPs are a two-edged sword from the perspective of economics. While designed to provide economic benefits to the producer through optimization of production and lowering of risks, GMPs may require funding to implement. In most cases, the cost/benefits of some of the GMPs with the most potential to yield environmental benefits are unknown. Preliminary work in this area has been conducted by Dr. Carole Engle (University of Arkansas, Pine Bluff). Working with 10 years of data from the Honduran industry, Dr. Engle has developed a model that allows analysis of the cost/benefits of a select set of practices. This model is also useful in that it allows a producer to examine a large number of management scenarios a priori to estimate the expected financial and production results of changing a particular practice. Training in this model, which has an easily used EXCEL spread sheet user interface was given to extension agents in Honduras and Nicaragua and is now being employed by them to assist farmer in financial planning. It is proposed that this work be extended to Mexico and be used as a monitoring tool to allow extensionists and producers to predict and assess the results of changing practices. This work would include: 1) data collection; 2) application of the model; 3) training in the use of the model; and 4) routine testing and use of the model as GMP implementation is carried out throughout the life of the project.

d. Outcome Assessment

Outcome mapping and systems dynamics techniques will be applied to the initiatives to enhance project strategies which define outcome goals and track desired changes in behaviour and practices of the industry. The results will be used to inform resource managers and stakeholders as to means of improving effectiveness of their efforts.

5. Zoning and Regional Land Use Planning

Currently, the state of Sinaloa is undergoing various zoning activities, however, primarily on the landward side of mean high water. In addition, the entire Gulf of California is in the process of the Ordenamiento Marino, or the Marine Zoning at a regional scale. In general, Mexico has made several advances to decentralize the management of the coastal zone, to the state and municipal authorities. The Sinaloa Institute of Aquaculture has promoted the idea of zoning the tidal flats, and organizing the mariculture industry into microzones, as both a management tool and a development tool. In this way the shrimp farms can be zoned in a manner consistent with

the environmental and economic carrying capacity of the specific microzone or lagoon (8 in total in Sinaloa), with oversight by local authorities (as opposed to only federal government oversight) who obtain the federal concession. Addtionally, this would provide opportunities to develop locally managed shrimp parks, where common infrastructure can be built and maintained for the social sector and cooperatives involved in mariculture. This concept has been implemented in Sonora, and provides an alternative for improving the social sector participation in the industry. Similar plans have been made in Sinaloa, however, have not been implemented to date.

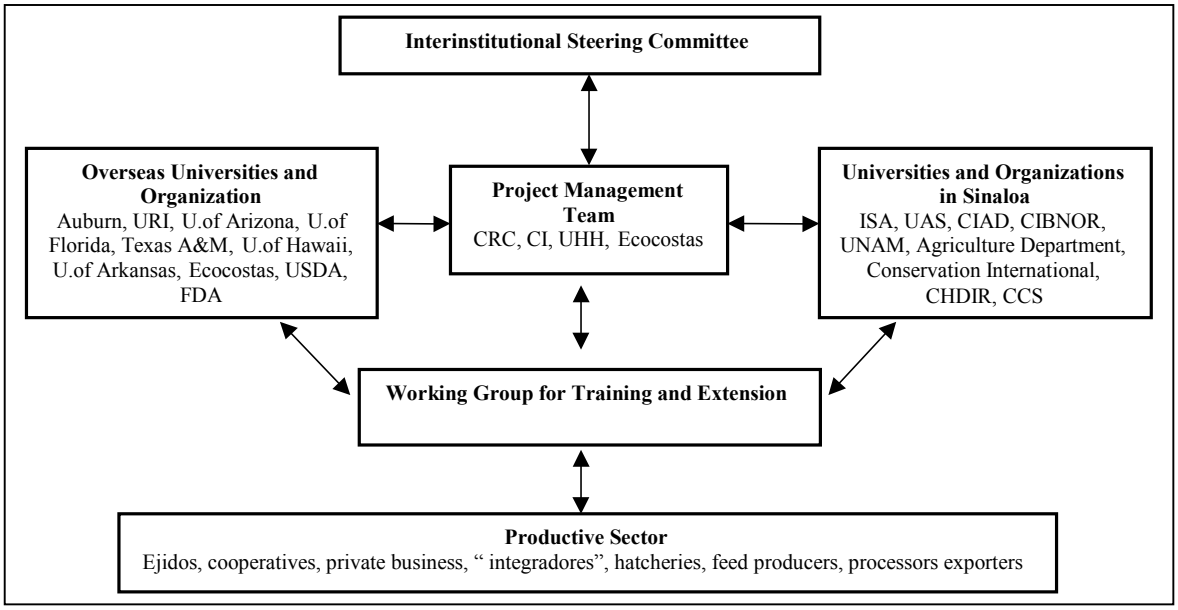
The work proposed includes: 1) linking efforts with the state and industry on zoning; 2) incorporation of good management practices in zoning and environmental review frameworks; 3) case study evaluation of the Sonora shrimp park programs and the Sinaloa proposals to advance development of social sector management tools within some of the microzones; and 4) capacity building of government and social sector stakeholders to improve implementation of zoning, land use and governance tools.

Project Implementation

As seen in figure 3, the project encompasses a number of partnerships and alliances, each with a specific set of tasks:

1) Development of a network between universities and federal agencies in Mexico and the United States (i.e. Land Grant Universities, FDA, USDA, ISA, UAS, etc.). These entities will provide technical capacity and external experiences to the local management landscape.
2) Development of a network of technical assistance providers within Mexico (CIAD, UAS, CIBNOR, etc.). This network will be primarily responsible for the execution of the applied research, training and extension activities with support from the overseas universities and organizations and will work collaboratively with producers.
3) Creation of an inter-institutional working group for oversight and execution of training and extension activities. This group will lead the network of technical assistance providers and act as technical leads for the various tasks.
4) Inter-institutional and international steering committee for project oversight and execution of policy and planning activities. This group will take the political leadership and provide high-level institutional support to the on-the-ground activities. Policy, regulation and zoning issues will be the primary considerations of this group.
5) Project management team consisting of Conservation International, CRC/URI, Ecocostas and the University of Hawaii will coordinate activities, oversee linkages between efforts and implementers and provide the primary resource management capability.

Figure 3. Project Organization



Funding for Work Program Implementation

Based on our experience in Central America, and our efforts to date in Sinaloa, it is felt that this program would require 2.5 years to complete, at a total funding of $500,000. This effort could be divided into 3 additional phases. It is felt that a *bridging period* from September 2001 until the spring 2002 would allow to secure long term funding while implementing necessary activities and maintaining local enthusiasm to advance GMPS as a key strategy. As seen in the attached illustrative budget, it is estimated that these bridging activities will require $60,000 in funding. The Coastal Resources Center has set aside $15,000 to support this effort as part of the FY2002 program activities, and is contingent upon USAID approval in September 2001. The following schedule outlines projected phases:

Planning Phase
Completed June 2000 – July 2001

Months 1 – 6 (Bridging Period, project scale up)
Project start up
Field verification of practices
Adaption of best practices to local conditions
Revised GMP operations manual
Institutional commitment to Code of Practice
Case Study and study tour of Sonora shrimp farms

Months 7 – 24 (Implementation)
Selection of training candidates
Training of Trainers
Modify training curricula and development of GMP in new areas

Training and extension program to 2 pilot regions
Establish and operate demonstration facilities
Establish and implement monitoring and feedback for WQ and disease
Modeling of Economic Impacts of GMPs
Contribute to zoning and legal frameworks

Months 25-30 (Implementation and evaluation for follow up)

Evaluation of GMPs
Identify mechanisms to extend pilot to other regions
Implement statewide workshop on results
Identify followup mechanisms

Potential for Leveraged Funding and Collaboration

During the planning phase, the team was in contact with several potential partners who expressed interest in promoting good management practices in shrimp mariculture. Now that the proposed work program is completed, the project team will be contacting them to determine their interest in collaboration and funding for the next phase of the project. These institutions include:

- Global Aquaculture Alliance
- US Agency for International Development Global Development Alliance
- Commission for Economic Cooperation
- US Department of Agriculture
- World Bank
- Sinaloa Institute of Aquaculture
- CONACYT in Mexico
- *Cámara Nacional de la Industria Pesquera*
- Municipal and state match
- Private sector industry match in Sinaloa

Full project proposals will be developed during the fall and early winter of 2001 with the aim of receiving funding for initiating training and extension in the spring/summer of 2002.

References

FAO (2000). State of the World Fisheries. Rome, Italy.

Rosenberry, R. (2000). Shrimp Farming News International. San Diego, CA.

Acronyms

ANDAH	Honduran Association of Aquaculture Producers
CIMEX	Conservation International/Mexico
CRC-URI	Coastal Resources Center of the University of Rhode Island
CCS	*Centro de Ciencias de Sinaloa* (Sinaloa's Science Center)
CIAD	*Centro de Investigación en Alimentación y Desarrollo* (Food and Development Research Center)
CIBNOR	*Centro de Investigaciones Biológicas del Noroeste* (Northwest Biological Research Center)
FAO	Food and Agriculture Organization
FDA	The U.S. Food and Drug Administration
GMP	Good Management Practices
HACCP	Hazard Analysis at Critical Control Points
ICM	Integrated Coastal Management
ISA	*Instituto Sinaloense de Acuacultura* (Sinaloa Institute for Aquaculture)
PD/A CRSP	Pond Dynamic/Aquaculture Collaborative Research Support Program
TOT	Training of trainers
UAS	Autonomous University of Sinaloa
UHH	University of Hawaii at Hilo
UNAM	*Universidad Nacional Autónoma de México* (Mexico's National Autonomous University)
USAID	US Agency for International Development