1. Development of Biosecure Operational Protocols for Warm-Water Marine Hatchery Operations in Hawaii and the Pacific Region

Problem statement: With the growth of marine finfish aquaculture as a significant sector for seafood production in the U.S., there is a critical need to improve the biosecurity of hatchery operations, whether targeting fingerling production for on-shore or open ocean growout. The control of pathogen entry and proliferation has become an essential aspect of any intensive animal production unit and is one of the most difficult challenges facing the emerging finfish culture industry worldwide. Indeed, the Hawaii industry is already facing hatchery disease challenges that affect both the reliability and overall output of emerging hatchery operations. The "aquatic" nature of aquaculture operations and frequent import of broodstock, eggs and live feeds offer a multitude of opportunities for pathogen entry into intensive hatchery operations. Once imported, pathogens can easily proliferate within systems leading to chronic disease issues, sometimes leading to a complete collapse in production, or more intermittent outbreaks affecting output reliability. These problems are magnified in the warm-water environment of hatchery operations in Hawaii and throughout the Pacific where farms are likely to encounter a number of new pathogens and must deal with much higher rates of pathogen proliferation. Therefore, this project is designed to examine the key vectors for pathogen entry and develop practical methods to limit pathogen entry, movement, and proliferation in the hatchery environment.

Strategic areas and FY 2008 Priority addressed: Offshore aquaculture, health management, Pacific Island Development

Proposed objectives:

Year One:

1) Develop and test water treatment systems to ensure biosecure water supply to the marine warm-water hatchery.
2) Develop practical disinfection protocols for egg introduction into the larval rearing systems.

Year Two:

3) Develop practical methods to minimize bacterial levels in live feeds (microalgae, copepods, rotifers, and Artemia) inputs to the larval rearing system.
4) Write a manual for operation and maintenance of a biosecure marine finfish hatchery operation.

Approach:

Objective No. 1: Develop and test water treatment systems to ensure biosecure water supply to the marine warm-water hatchery. Preliminary work at both our research and production hatcheries is showing that the operation and maintenance of hatchery water treatment systems is much more complex than expected. System components such as sand and cartridge filters, essential for mechanical removal of particulates including many pathogens, also act as incubators that routinely pulse bacteria into the larval rearing environment. Further filter and system sterilization protocols can actually aggravate the situation. Therefore efforts under this objective will focus on examining the working effectiveness of each component of flow-through and recirculating water treatment systems. It will also develop methods to best manage the

associated microflora and limit introduction of pathogenic organisms into the pre- and early-feeding environment of the larvae. Studies will examine the effectiveness and maintenance procedures of sand/glass filters, rotating drum filters, bead filters, cartridge filters, UV sterilizers and ozonation units in efforts to optimize the biosecurity of water entering the larval rearing system.

Objective No. 2: Develop practical disinfection protocols for egg introduction into the larval rearing systems. Although the introduction of eggs obtained from broodstock holding systems is clearly a requirement for hatchery operations, it provides opportunity for both vertical and horizontal transmission of pathogens into the larval rearing environment. Research under this objective will examine egg hatching rates and control of introduced microflora under a range of practical egg disinfection protocols in efforts to prevent pathogen entry. Methods to be examined include rinsing, UV sterilization, ozonation, and chemical disinfection methods.

Objective No. 3: Develop practical methods to minimize bacterial levels in live feeds (microalgae, copepods, rotifers, and Artemia) inputs to the larval rearing system. The microflora associated with live feed organisms used to support the early feeding larvae have clearly been shown to harbor a number of pathogenic organisms. In addition, preliminary studies have shown that the live feed associated microflora quickly come to dominate the microenvironment of larval rearing systems. Therefore efforts under this objective will focus on opportunities for live feeds processing prior to introduction into the larval rearing system, in an effort to develop more biosecure procedures for maintaining live feeds in the larval tank systems. Efforts will initially focus on characterizing the microflora in key live feed cultures, and work to developing practical methods to minimize co-introduction of possible pathogens into the larval system. Procedures to be examined include the development of rinsing procedures and testing of potential disinfectant treatments including UV sterilization, ozonation and chemical treatments.

Objective No. 4: Write a manual for operation and maintenance of a biosecure marine finfish hatchery operation. The final component of this project will be the development and distribution of an operational manual based on the findings of this research for operation and maintenance of biosecure marine finfish hatchery operations. The manual will include sections on broodstock quarantine, hatchery water treatment, egg and live feeds disinfection. The manual will be presented at an industry workshop where the authors will present their findings and discuss future research needs.

Estimated Budget:	**Yr1**	**Yr2**
Salaries & Benefits:	$48,900	$51,345
Equipment & Supplies:	$12,400	$9,800
Other Costs:	$9,291	$9,756
TOTAL BUDGET:	**$70,591**	**$70,901**

2. Developing the Capacity to Address Aquaculture Biosecurity Issues for the State and Pacific Region

Problem Statement

One restraint to the continued expansion and diversification of Hawaii and Pacific aquaculture industries that was identified at the Hawaii Aquaculture Industry Stakeholder Summit held in 2005 was and remains "insufficient disease diagnostics/ability/capacity in the State". As indicated under the Health Management strategic area and priority in the current Center for Tropical and Subtropical Aquaculture request for pre-proposals, there is a "lack of concerted effort toward health management, diagnostics and research" for aquaculture activities in the Pacific. The proposed project seeks to address these challenges in both a targeted and strategic manner utilizing the already established collaborative partnership between the Aquaculture Extension Project of the University of Hawaii Sea Grant College Program and the Disease Management Program of the Aquaculture Development Program.

Proposed Objectives

Year 1

- Develop "State of the Art " diagnostic testing using Polymerase Chain Reaction (PCR) technology with routine bacterial identification methods for Francisella/RLO or more commonly known as the rickettsia-like organism in tilapia.
- Using developed methods confirm the presence or absence of RLO in tilapia populations in the wild and production facilities statewide.
- Establish what healthy background levels are for various types of tilapia farms within the state
- Expand capacity to obtain samples from wild populations and production facilities from other Pacific Island farms (Guam, Philippines, American Samoa, Micronesia) for comparison.
- Develop information base on Francisella/RLO available for tropical environments.
- Determine and field test methods of prevention.
- Summarize results in a minimum of one manuscript to be submitted for publication in a peer reviewed journal.
- Conduct extension and outreach using classical methods (e.g., technical handout, newsletter article, informational workshop with the Hawaii Aquaculture Association).

Year 2

- Establish "State of the Art " methods of detecting one or more of the following: Spring Viremia of Carp (SVC), Koi Herpes Virus (KHV) or Viral Hemorrhagic Septicemia (VHS)
- Determine and field test methods of prevention
- Develop Specific Pathogen Free (SPF) certification process as established by Office International des Epizooties (OIE) & United States Department of Agriculture Animal Plant Health Inspection Service (USDA APHIS) for one or more of the following: KHV, SVC and VHS for Hawaii producers
- Produce an up to date fact sheet on the pathology and epidemiology for one or more of the following: KHV, SVC or VHS.

- Conduct extension and outreach using classical methods (e.g., technical handout, newsletter article, informational workshops with the Honolulu Aquarium Society and Hawaii Carp and Goldfish Association).
- Conduct stakeholder workshop to determine focus of project work group on emerging pathogen(s) of concern.

Approach

If the project working group is solicited to submit a full proposal a stakeholder workshop will be held prior to the submission of the full proposal to provide a general overview of the proposed work and obtaining substantial stakeholder input and buy-in into the activities and process of implementing the proposed project. This is necessary because of the complexity of the issues and regulatory mandates (e.g., O.I.E. listed) that come with some of the potential pathogens being targeted. The proposed project will utilize the already established collaborative partnership between the University of Hawaii Sea Grant College Program's (UHSGP) Aquaculture Extension and Outreach Project and the State Department of Agriculture Aquaculture Development Program's (ADP) Disease Management Program to achieve the objectives of the proposed project. The administration of the project objectives will be shared. This alliance allows each institution's material and intellectual capital to be focused on addressing key issues within the state and region as they arise. ADP will be contributing both manpower in the form of salary and fringe benefits of [key personnel] and facilities at Anuenue Fisheries Research Center and Halawa stations. The only recipients of salary support from the project will be towards the PI and [one other person]. UHSCP will have the facilities at the Windward Community College Aquaculture Complex as a contribution in kind to the project. A major activity will be upgrading ADP's disease management program's capacity to include PCR technology that would compliment the services already available. With the upgrading of capacity several specific disease challenges will be addressed over the course of the proposed project.

Duration

The initial proposed project is to last for two years and targets specific disease management challenges. However, with the acquisition of the equipment, expertise and experience to conduct analyses at the molecular level which will also be combined with the already available diagnostic services of the ADP's Disease Management Program the project work group will be strategically positioned to address a host of challenges in a cost-effective manner.

Estimated Budget

Year 1 = $100,000 Year 2 = $90,000

3. Assessment of Frozen Shrimp Import Risk on Hawaii's Shrimp Production

PROBLEM STATMENT

The viability of Hawaii shrimp aquaculture, especially the SPF (specific pathogen free) shrimp broodstock industry, largely depends on maintaining the status of disease-free production. The SPF label enables Hawaii's shrimp producers to market to Asian countries that desire SPF products or those that are limited to importing SPF products. The imports of contaminated frozen commodity shrimp (from the U.S. mainland and foreign countries) into Hawaii however have posed significant risk on maintaining the disease-free production status. Isolated occurrences of Infectious Hypodermal and Hematopoietic Necrosis Virus (IHHNV) and White Spot Syndrome Virus (WSSV) outbreaks have been reported on Oahu and Kauai, putting Hawaii's shrimp aquaculture industry in imminent danger. The recent WSSV outbreak on Kauai caused an estimated $1 to $2-million in lost revenue for the single facility. The prevalence of viral disease in the local shrimp production also significantly taints Hawaii's SPF shrimp product image. There is no doubt that contaminated frozen commodity shrimp which have been found in the local marketplace has posed a considerable threat to Hawaii's shrimp aquaculture livelihood and SPF marketability.

In order for Hawaii's SPF shrimp farming industry to expand and capture the lucrative international market, it is paramount to devise strategies to maintain the SPF status--at least in some portion of the State if a statewide-SPF status is not feasible. Regional pathogen-free status is one potential avenue. However, the benefits of alternative biosecurity strategies must be considered in light of their costs.

A preliminary analytical model for assessing the impacts of various biosecurity strategies on WSSV-import risk through imported frozen commodity shrimp to Hawaii's shrimp aquaculture has been developed by Kam (2006)[1], using the Bayesian decision network (BDN) approach. This model is more exploratory and descriptive, and needs refinement to include some important aspects of risk management to enhance its usability and relevancy. Important omissions include possible differences in response from various shrimp farmers, retailers, and consumers under alternative biosecurity strategies, the interactions among these stakeholders, and the effects of spatial allocation of shrimp farms.

The proposed research therefore addresses the second priority, "Health Management", identified by CTSA for FY2008. It facilitates the management of a problem of industry importance and helps to ensure the long-term biosecurity of a sustainable aquaculture in Hawaii.

OBJECTIVES

The purpose of the proposed research is to develop a risk management model for the evaluation of alternative biosecurity strategies on shrimp WSSV-import risk in Hawaii, using a combined BDN and agent-based modeling (ABM) approach. Specific objectives of this research include:

1) To update market and consumption information for the parameterization of the model.
2) To reconstruct the preliminary BDN model for WSSV-import risk using the ABM approach.
3) To include the possible responses of various stakeholders (food shrimp producers, shrimp broodstock producers, national chain retailers, local chain retailers, independent retailers, etc) and their interactions toward WSSV-import risk and alternative biosecurity regulations into the risk management model.

[1] Kam, Lotus E.Y.W. 2006. A Bayesian Decision Network Model for Analyzing Biosecurity Risk. Ph.D. Dissertation, University of Hawaii at Manoa, 214pp.

4) To explicitly include the effect of spatial proximity on the interaction and behavior of shrimp retailers and farmers into the risk management model.
5) To include the welfare statuses of stakeholders other than shrimp producers in Hawaii (primarily the local consumers) in the assessment of alternative biosecurity strategies.
6) To conduct a risk analysis of WSSV-import risk for the island of Oahu and compares the costs and benefits of alternative biosecurity strategies, using the BDN-ABM-enhanced model. Evaluation of alternative SPF zoning recommendations include a national movement restriction, biosurveillance, and SPF zoning on statewide frozen commodity shrimp (FCS) retail and shrimp aquaculture industries.

APPROACH

Bayesian Decision Network (BDN): Impacts of alternative biosecurity strategies on WSSV-import risk for Hawaii's shrimp aquaculture will be evaluated under the Bayesian decision network (BDN) framework.

Agent-based Modeling (ABM): ABM is an innovative modeling technique specifically designed for capturing the interactive and spatial behaviors of many heterogeneous stakeholders. The generic average retail unit and shrimp farm in the preliminary BDN model will be extended to incorporate individual characteristics and possible differences in their responses to alternative biosecurity strategies. The ABM extension will also explicitly consider the effects of spatial proximity on the interaction and behavior of retailers and farmers.

Risk Analysis: The WSSV-import risk assessment will consist of a release assessment (the likelihood of imported commodity shrimp being infected with a pathogen), an exposure assessment (the likelihood of farms exposure to the pathogens introduced by imported frozen commodity shrimp), a consequence assessment (the relationship between the level of exposure to the pathogen hazard and the potential consequences due to different possible pathway of exposure), and a risk characterization (the current disease threat to individual farms, the industry, and state under current import practices).

Welfare Analysis: In the BDN-ABM-enhanced model, the consequences of alternative biosecurity strategies will be evaluated in a broad context in terms of consumer surplus and producer surplus other than farm profit and direct cost.

DURATION

This is a two-year project with the first year devoted to objectives 1 to 4, the second year to objectives 5 and 6.

ESTIMATED BUDGET

	Year 1	Year 2
Salary	$18,824	$20,330
Equipment	$5,000	$0
Travel	$3,000	$6,000
Materials and Supplies	$7,000	$8,000
Total	$33,824	$34,330