TRANS-BOUNDARY AQUATIC ANIMAL PATHOGEN TRANSFER AND THE DEVELOPMENT OF HARMONIZED STANDARDS ON AQUACULTURE HEALTH MANAGEMENT (FWG/03/2000)

REPORT OF THE JOINT APEC/FAO/NACA/SEMARNAP WORKSHOP

Puerto Vallarta, Jalisco, Mexico.

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1 Executive Summary

This document provides the report of the joint APEC/FAO/NACA/SEMARNAP expert workshop on "Trans-boundary aquatic animal pathogen transfer and the development of harmonized standards on aquaculture health management (FWG 03/2000)," held at Puerto Vallarta, Jalisco, Mexico on the 24-28 July 2000. The workshop, attended by 49 government representatives and experts from 17 APEC economies, FAO and NACA member countries, intended to: (a) ***review existing knowledge on impacts*** of trans-boundary aquatic animal pathogen movement and establishment; (b) review ***management strategies*** to control impacts of aquatic animal diseases, with an emphasis on measures taken at the ***state-level*** and among the ***private sector;*** (c) identify and ***evaluate current and potential future management interventions*** at the national, regional and international levels, with special reference to ongoing Asia-Pacific and international programs and potential cooperative mechanisms; (d) review the existing knowledge on the ***standardization, validation and harmonization of diagnostic techniques*** for fish and shellfish diseases; and (e) develop a ***program of follow-up actions*** for standardization of aquaculture health management measures. The impetus to the workshop was the growing concern over the impacts of trans-boundary spread of aquatic animal pathogens, including their impacts on aquaculture industries in the Americas and the Asia-Pacific Region.

During the five-day workshop, the participants shared knowledge on the impacts of, and management strategies for, aquatic animal diseases. Although, the emphasis of the discussions was on shrimp viral diseases and control of their negative impacts on shrimp aquaculture, the participants recognized the management measures discussed have broader application throughout Asia and the Americas in aquatic animal disease control. At the end of the workshop, the participants adopted a comprehensive "***Puerto Vallarta Plan of Action***" incorporating a wide range of recommendations for short, medium and long-term action to control the spread of serious aquatic animal pathogens. The ***Plan of Action*** strongly emphasizes the importance of effective cooperation between states, between states and private sectors, and within and between regions to harmonize aquatic animal health management measures and promote responsible trans-boundary movement of aquatic animals, ultimately contributing to improvements in the trade of aquatic animals and products and social and economic development through aquaculture. The recommendations emphasize an important role for APEC in capacity building and support to harmonization of aquatic animal health standards between member economies in the Asia-Pacific Region; the need for FAO, along with OIE, to promote broader international cooperation in aquatic animal health management; and a role for NACA in supporting further development of aquatic animal health capacity building within the Asia-Pacific Region.

The ***Plan of Action*** recognizes that serious aquatic animal diseases are not constrained by national boundaries, and that a mechanism for regional cooperation in the Americas is urgently needed to prevent the rapid spread of diseases. Such regional cooperation should address issues of technical development and harmonized approaches to aquatic animal health, as well as strategies for establishing regional mechanisms for presenting a coordinated view to relevant international and regional bodies such as OIE and FAO. The goal of this cooperation is to facilitate international trade in aquatic animals and further the sustainable development of aquaculture.

2 Background to the project and workshop

Aquatic animals are often intentionally moved (introduced and transferred) for various purposes, and the trans-boundary movement of species of living aquatic animals, primarily finfish, molluscs and crustaceans, is well recognized as facilitating the introduction of serious infectious diseases into new areas.

With the growth of the aquaculture sector, the international movement of aquatic species has escalated over the last two decades, and there is strong evidence suggesting that such movements have been responsible for the recent outbreaks of exotic aquatic animal diseases that have caused substantial economic losses to the aquaculture sector in many parts of the world. Although the direct impacts of pathogen transfers, such as mortalities in aquaculture farms, are often apparent, their indirect impacts and the effects of exotic pathogens on aquatic ecosystems and biodiversity, the socio-economic conditions of rural communities, and the potential implications for long-term international trade are hardly understood.

In Asia, such concerns led to a regional cooperative program – being undertaken by the Food and Agriculture Organization of the United Nations (FAO), Network of Aquaculture Centres in the Asia-Pacific (NACA) and the Office International des Épizooties (OIE) - to explore ways to control the spread of serious pathogens. This cooperation led to 21 governments adopting an Asia regional agreement on aquatic animal quarantine and health certification in Beijing, China, during June 2000[1].

Recently, concern has arisen in some countries on the eastern side of the Pacific, especially in Mexico and the United States, due to reports of the presence of the exotic white spot syndrome virus (WSSV) in shrimp aquaculture in Central America, and the risk of dissemination of this, and other aquatic animal pathogens, throughout the Americas. It was thus considered appropriate and timely to review the current status of knowledge, with the view to better understand the potential negative impacts of such trans-boundary pathogen transfers, and to make considerations for future actions. It was also recognized that the discussions within Americas could be greatly facilitated through cooperation with the ongoing Asia regional activities of NACA, and through linkages with the global programs of FAO.

In this regard, the Project "Joint APEC/FAO/NACA Ad Hoc Expert Consultation on Trans-boundary Aquatic Animal Pathogen Transfer and the Development of Harmonized Standards on Aquaculture Health Management (FWG 03/2000)", was proposed by the Asia Pacific Economic Cooperation (APEC) Fisheries Working Group in May 1999 and subsequently approved by the APEC Secretariat.

Since 1996, NACA, FAO and a number of organizations (e.g. OIE; Australian Centre for International Agriculture Research (ACIAR); Department of Agriculture, Fisheries and Forestry Australia (AFFA); Department for International Development of the United Kingdom (DFID); Aquatic Animal Health Research Institute of Thailand (AAHRI) and others) have been cooperating in the development and implementation of an Asia regional strategy for the responsible trans-boundary movement of live aquatic animals. The regional strategy is now embodied in a major program on aquatic animal health management and implemented in early 1998 with the participation of 21 countries in the Asia-Pacific and the cooperation of various regional organizations, including APEC. Under this program, several in-economy/country level training activities, workshops and regional thematic reviews were organized and implemented on different subject areas of aquatic animal health management, including, among others, standardization of diagnostic techniques for aquatic animal diseases and pathogens, health and socio-economic impact assessments, and management strategies for major shrimp diseases.

Under this regional program and as part of an on-going project on shrimp aquaculture management being implemented by NACA with support from various organizations such as FAO, the World Bank (WB) and the World Wildlife Fund (WWF), a thematic review workshop on "Management Strategies

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[1] FAO/NACA. The Asia Regional Technical Guidelines on Health Management for the Responsible Movement of Live Aquatic Animals and The Beijing Consensus and Implementation Strategy. *FAO Fisheries Technical Paper* No. 402. Rome, FAO. 2000. 53p.

for Major Diseases in Shrimp Aquaculture" was convened in Cebu City, Philippines on 28-30 November, 1999, subsequently referred to in this document as the **'Cebu Workshop'**. The workshop drew together shrimp disease experts in Asia and some countries in Central and South America who presented national reviews concerning the main shrimp viral diseases, their impacts and management strategies, and specialist synthesis reviews on trans-boundary movement of live aquatic animals. The Cebu Workshop successfully compiled the most comprehensive information and up-to-date analysis of shrimp health management strategies available to-date, providing an important document for discussion during the Puerto Vallarta workshop. The main recommendations from the Cebu Workshop are in Annex 10 of this report.

Building on the knowledge gained during the Cebu Workshop, an expert workshop on Trans-Boundary Aquatic Animal Pathogen Transfer and the Development of Harmonized Standards on Aquaculture Health Management (FWG 03/2000) was held jointly by APEC, FAO, and NACA and hosted by the Government of Mexico (SEMARNAP) at Puerto Vallarta, Jalisco, Mexico, on 24-28 July 2000. This report presents the activities and findings of this meeting, together with recommendations for follow-up actions – to national, regional and international organizations and bodies - to confront the economically serious problems being caused by the trans-boundary spread of aquatic animal pathogens.

3 Summary Workshop Report

3.1 Workshop background

The joint APEC/FAO/NACA/SEMARNAP expert workshop on "Trans-boundary aquatic animal pathogen transfer and the development of harmonized standards on aquaculture health management (FWG 03/2000)" was held at Puerto Vallarta, Jalisco, Mexico on the 24-28 July 2000.

49 government representatives and experts attended the workshop from 17 APEC economies and FAO member countries. The workshop program is given in Annex 1 and the list of participants provided as Annex 2.

3.2 Objectives

The objectives of the expert workshop were:

1. To ***review existing knowledge on impacts*** of trans-boundary aquatic animal pathogen movement and their establishment. Different pathways of pathogen transfer and the impact on aquaculture, rural livelihoods, trade, aquatic biodiversity, and other potential sectors were evaluated.

2. To review ***management strategies*** to control impacts of aquatic animal diseases, with an emphasis on measures taken at ***government level*** and among the ***private sector***, including farmers, hatcheries, feed manufacturers and others, Special reference was given to the white spot syndrome virus (WSSV) and Taura syndrome virus (TSV) problems, as such diseases have contributed to significant economic losses within aquaculture industries in Asia and the Americas.

3. To identify and ***evaluate current and potential future management interventions*** at national, regional and international levels, with special reference to ongoing Asia-Pacific and international programs and potential cooperative mechanisms.

4. To review the existing knowledge on the ***standardization, validation and harmonization of diagnostic techniques*** for fish and shellfish diseases (with special reference to shrimp viral diseases), and making compatible, national and international standards and regulations.

5. To develop a ***program of action*** in order to make compatible the different standards for aquaculture health management, in particular those for shrimp.

3.3 Methodology

The workshop was carried out over five days with the participation of representatives and experts from member economies and countries of APEC, FAO and NACA, in particular from Central and South America. The following APEC economies and FAO/NACA countries participated in the workshop: Australia, Canada, Belize, Colombia, Costa Rica, Cuba, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Panama, Peru, Thailand, United Kingdom, United States of America and Venezuela. The broad participation of economies/countries from Central and South America was essential because of the widespread impact of shrimp diseases among the countries of this region.

The following provides a summary of the major workshop sessions and findings of the workshop. Further details are provided in subsequent sections and Annexes.

3.4 Session I: Opening ceremony

Master of Ceremonies: Mr Gabriel Martinez

Lic Francisco Mayorga, Secretario de Desarrollo Agropecuario del Gobierno del Estado de Jalisco.
Lic. Mayorga welcomed all the delegates and thanked the organizers for choosing Mexico for the workshop. He wished the meeting success and an enjoyable time for the participants in Puerto Vallarta.

Mr Stetson Tinkham, Lead Shepherd, APEC Fisheries Working Group
The Lead Shepherd of the APEC FWG remarked that this is an important meeting because it brings together the very spirit that leaders envisioned at APEC. He emphasized that this spirit has been broadened to the global level at the FAO and another level at the region, through NACA, which includes non-APEC members. He congratulated Mexico for taking the leadership in this project, and he hoped that the meeting would assist in finding solutions to some of the problems being faced with respect to aquatic animal diseases. The APEC FWG mandate is provided as Annex 3.

Dr Rohana Subasinghe, FAO
Dr Subasinghe informed the participants that the problem the meeting will address is an important one, and that this workshop is a pioneering venture bringing together experts from within and outside the Americas. He noted that FAO, with NACA, is pleased to be part of this activity, and he stressed that this is the beginning of a process and that FAO will continue to support activities pertaining to controlling trans-boundary aquatic animal diseases.

Mr Hassanai Kongkeo, NACA Coordinator
The NACA Coordinator welcomed the delegates on behalf of NACA. He informed the meeting of the recently developed Asia Regional Technical Guidelines on Health Management for Responsible Movement of Live Aquatic Animals, which he hoped, would be of interest to the participants from the Americas. He thanked the organizers and expressed the desire and commitment of the NACA organization to foster cooperation across the Pacific with APEC member economies and other countries in the Americas.

Dr Porfirio Alvarez Torres, Director General de Investigacion en Acuacultura, SEMARNAP
Dr Torres welcomed all delegates and indicated that Mexico is very pleased that this meeting is being held here, because it will give Mexico the opportunity to immediately lay the groundwork for improved aquaculture productivity and resource conservation. He reiterated that this workshop is the first of a series of activities that will hopefully be undertaken to address the issues pertaining to trans-boundary diseases, biodiversity concerns and others. He emphasized that the meeting was in line with the recommendations of the recently concluded Conference on Aquaculture in the New Millennium, and that SEMARNAP is very interested to participate in supporting implementation of these recommendations. He also expressed the hope that the meeting would lead to further cooperation between Asia and the Americas.

Biol. Carlos Ramirez Martinez, Director General de Acuacultura, SEMARNAP
Dr Martinez expressed his gratitude to NACA. FAO and APEC and welcomed the international and Mexican delegates to Puerto Vallarta. He emphasized that the meeting is an opportunity for raising awareness and should provide a basis for developing measures for detection and control of aquatic animal diseases. He described some of the activities in Mexico in disease control involving cooperation between industry, scientists and the government. He reiterated the desire of the Mexican government that this meeting should be remembered not only technically, but also for the spirit of regional cooperation.

Lic Carlos Camacho Gaos, Subsecretario de Pesca, SEMARNAP
Dr Gaos welcomed the delegates on behalf of the Mexican government. He indicated that instead of talking about the importance of this meeting, he wished to talk about the importance of one of the objectives, which is to bring the recommendations of this meeting not only to APEC and NACA, but also to the FAO Committee on Fisheries (COFI). The objective is one of harmonization, standardization,

and moving forward to a common objective – and that if this can be achieved, this is a further step forward in the responsible development of aquaculture. He was pleased to see the participation of other Latin American countries, and thanked APEC, FAO and NACA for their support. He was also very pleased to see industry participation, where in the past, there were only government representatives and researchers.

3.5 Session II - Overview and objectives

Chairperson: Dr Rohana Subasinghe. Rapporteur: Dr Christina Chavez Sanchez

This session provided an overview of the objectives and expected outputs from the workshop, background on relevant ongoing regional and international programs, and other information pertinent to the workshop deliberations. The following presentations were made. Section 6 of the report provides further information.

- ***Objectives and expected outcomes from the Expert Consultation - FWG 03/2000 Project Overseer – Dr Ana Montero.*** The paper introduced the overall objectives of the workshop, and the expected outcomes.

- ***An overview of FAO/NACA activities and regional, inter-regional, and international cooperation in trans-boundary aquatic animal disease control – Dr Rohana Subasinghe (FAO) and Dr Melba Reantaso (NACA).*** The presentation discussed the recent and ongoing regional activities and cooperation in aquatic animal health management in Asia, and the activities planned to support regional cooperation within the Americas.

- ***Review of existing knowledge on the social, economic and biological impacts of trans-boundary aquatic animal pathogen movement and their establishment - Dr J. Richard Arthur (Project consultant, Canada).*** The presentation highlighted the current knowledge on impacts of trans-boundary aquatic animal pathogens and their establishment. The emphasis was on current knowledge in Asia, and broadly covered shrimp, fish and molluscs. The report prepared by Dr Arthur and colleagues, which was the basis of this presentation, is provided in full in Section 9.

- ***Trans-boundary aquatic animal movement: compliance to international treaties and conventions: Organization International des Epizooties. The World Organization for Animal Health (OIE) – Dr Barry Hill (OIE Fish Disease Commission and CEFAS, UK).*** The presentation covered the work of OIE and its Fish Disease Commission, the Sanitary and Phyto-sanitary (SPS) agreement and the World Trade Organization (WTO), and other issues concerning international standards for aquatic animal health in relation to trade. The importance of standardized diagnostic techniques and health certification for responsible movement of live aquatic animals was emphasized.

- ***Trans-boundary aquatic animal movement: Responsible use of introduced species: FAO and the Convention on Biological Diversity (CBD) - Dr Devin Bartley (FAO).*** The presentation looked at introduced species and their benefits to world fisheries production. The potential negative impacts were also noted, and the importance of development and implementation of appropriate protocols was discussed. The FAO Code of Conduct for Responsible Fisheries and the Convention on Biological Diversity and their relevance to responsible movement of live aquatic animals were presented.

- ***Cebu Workshop on Shrimp Health Management Strategies: the main conclusions and recommendations – Dr Michael Phillips (NACA) and Dr Rohana Subasinghe (FAO).*** The presentation provided a brief overview of the Cebu Workshop, held in November 1999, and the major conclusions and recommendations. It was explained that the Cebu Workshop findings provide a basis for further discussion and development during the present expert workshop in Puerto Vallarta. The main findings and conclusions of the Cebu Workshop are noted in Section 9.

3.5.1 Discussion points

The following issues were raised during discussions following this session.

- The impacts of aquatic animal pathogens and disease on aquatic biodiversity. Examples were provided, such as oyster diseases and crayfish plague in Europe. However, it was recognized that there is a lack of understanding and knowledge on the biodiversity implications of aquatic animal diseases. There is a need to improve the knowledge base on such issues.
- The need for more effective cooperation between the fisheries authorities and the veterinary authorities, particularly in the reporting of aquatic animal diseases to OIE.

3.6 Session III – Presentations by APEC economies and selected FAO member countries in the Americas and Asia-Pacific region

Chairperson: Dr Porfirio Alvarez Torres. Rapporteur: Dr Victoria Alday de Graindorge

The experts from each participating economy/country made presentations on the aquatic animal health situation within the respective economy/country. Presentations from were made in the following order: Cuba, Ecuador, Honduras, Colombia, Panama, El Salvador, Belize, Costa Rica, Peru, Guatemala, Venezuela, Mexico, USA and Thailand. The economy/country papers are provided in Section 7.

Each presentation broadly covered the current knowledge on impacts of trans-boundary pathogen movement, with special emphasis on viruses in shrimp aquaculture; management strategies for controlling impacts of important aquatic animal diseases; legislation, regulations and policy issues for the prevention, diagnosis and control of aquatic animal diseases; identification of potential intervention strategies at national, regional and international levels; and recommended actions to deal with identified problems, including harmonization of standards for aquaculture health management, in particular for shrimp culture.

3.6.1 Discussion points

The following issues were raised during the discussions following the presentations.

- The differences in distribution of WSSV and other shrimp viruses in the Americas, and need for a better understanding of this distribution.
- Regulations requiring certification of live, frozen and processed crustaceans had been introduced in some countries in the Americas, but approaches were not well harmonized.
- The need for introducing risk analysis as the basis for restrictions being applied to movement.
- The existing movement of fry and post-larvae between countries in the region and the need to harmonize health certification procedures.
- The need for a program to standardize diagnostic techniques between the different laboratories and to facilitate exchange of information on aquatic animal health management measures.

The economy/country presentations were followed by a presentation on the ***Asia Regional Technical Guidelines on Health Management for Responsible Movement of Live Aquatic Animals by Dr Melba Bondad-Reantaso and Dr Rohana Subasinghe.*** The presentation outlined the history and process involved in formulating the Asia regional guidelines, and the different components of the technical guidelines. The importance of cooperation among countries in development of the guidelines and in the implementation of effective aquatic animal health strategies, at both the national and regional levels, was emphasized. The summary of this presentation is also provided in Section 7.

3.7 Session IV – Potential national, regional, and inter-regional interventions, strategies and cooperation

Chairperson: Mr Stetson Tinkham. Rapporteur: Dr Melba Reantaso

Private sector management and technological requirements for shrimp disease control (covering both the 'industrial' and small-scale livelihood sector) – Mr Daniel Fegan (Project consultant, Thailand). The paper reviewed the current management practices used for control of shrimp diseases, and provided a series of recommendations for further development of strategies for effective management of shrimp viruses. The full paper is provided in Section 8.

3.7.1 Discussion points

The discussion that followed focussed on the following issues:

- Reliable diagnostic tools are essential to support effective farm management decisions for disease control.
- The public health and environmental concerns that exist concerning the use of chemicals for control of shrimp and fish diseases and the importance of proper regulations, and implementation/enforcement of regulations designed to control chemical use.
- The importance of screening of the health status of shrimp post-larvae before stocking in ponds.

Policy, legal and institutional requirements for trans-boundary aquatic animal disease control and management – Dr Richard Arthur (Project consultant, Canada), Dr Rohana Subasinghe (FAO) and Dr Melba Reantaso (NACA). This paper reviewed the policy, legal and institutional requirements for responsible movement of live aquatic animals. Based on experiences within Asian countries, the importance of developing a national strategy encompassing all relevant issues was emphasized. The full paper is provided in Section 8.

3.7.2 Discussion points

The discussion that followed the presentation emphasized the following issues:

- The importance of self-regulation within the aquaculture industry, and effective government-industry cooperation.
- The need for better information on pathogen distribution before going into zoning.
- The need for better understanding of viruses, biodiversity implications and impacts on wild stocks.

Trans-boundary aquatic animal movement: compliance to international treaties and conventions (part 2): WTO – Dr Alejandro Thiermann (USDA/APHIS, USA). The paper gave an overview of the SPS agreement and the WTO, and the significance of animal health in international trade.

3.7.3 Discussion points

After the presentation, participants raised the following issues.

- That there had been a growing number of trade disputes involving aquatic animals. Such problems were best avoided through more effective cooperation and dialogue among relevant parties.
- Assistance should be provided to developing countries to implement international standards for aquatic animal health.
- The importance of scientific information to defend actions which may affect trade.
- The need for aquaculture, a relatively new industry, to develop effective standards and guidelines.
- The obligation on the importing economy/country to manage risk where these options exist.

Following the interest in this subject, Dr Thiermann gave an additional question and answer session on WTO, the SPS agreement and other related international trade issues to the participants in a special evening session.

An overview of shrimp viral diseases – Dr Victoria Alday de Graindorge (CENAIM, Ecuador) The presentation provided an overview of the major shrimp viral diseases, within Asia and the Americas, and current information on the distribution of these diseases. Regarding the diagnosis of aquatic animal diseases, the next few years would see more emphasis on molecular diagnosis. There was also a need for better understanding of the shrimp response to pathogens, and of the pathogens themselves.

Regional and international activities and future requirements for standardization and harmonization of diagnostic techniques for aquatic animal disease identification and control – Dr Peter Walker (CSIRO, Australia) The presentation emphasized the importance of effective diagnostic procedures as a tool in shrimp health management, and the importance of standardization, validation and harmonization of these procedures.

Trans-boundary movement of aquatic animals: applying risk assessment for reducing transfer of pathogens– Dr Alejandro Thiermann (USDA/APHIS, USA). This presentation described the technique of risk assessment and the application of this methodology to making decisions on the movement of aquatic animals.

Zoning for aquatic animal disease control – Dr Barry Hill (CEFAS, UK). The concept of zoning was described and some examples provided on how zoning could form part of an aquatic animal health management program. As the concept was quite new in the Americas, further discussions and possible pilot projects/activities should be initiated.

Regional and inter-regional cooperation requirements for aquatic animal disease control, with emphasis on opportunities for inter-regional cooperation in the Americas and APEC/Asia-Pacific Region – Dr Michael Phillips (NACA) and Dr Rohana Subasinghe (FAO). The paper emphasized the importance of regional and international cooperation in disease control and responsible trans-boundary movement of aquatic animals. A number of potential opportunities were provided, based on the discussions during the Cebu Workshop, and other recent activities within Asia.

3.7.4 Discussion points

- Regarding the unofficially noted report of yellowhead virus in Ecuador, Dr Peter Walker made a statement. He clarified that while there had been some unusual histopathologies observed in a shrimp sample, more extensive tests have subsequently indicated that yellowhead is not present in Ecuador. The reason for the unusual pathology has not been established, but there is no evidence at present of yellowhead in Ecuador.
- The Ecuadorian representative also reiterated that the official government position is that there is no yellowhead disease of shrimp in Ecuador. The Ecuadorian government had communications with Mexico regarding this issue.
- As there was limited time for further discussions during the last four presentations, the participants were invited to consider the issues and suggestions raised during the subsequent working group sessions.

3.8 Session V – Working group discussions

Following the plenary sessions, three working groups were convened to evaluate current and potential future management interventions at the national, regional and international levels, to review the existing knowledge on the validation and harmonization of diagnostic techniques, and to develop a program of action to address the identified needs. The three working groups covered the following topics:

Working Group 1: Disease diagnostics, pathogen screening and certification procedures and protocols

Chairperson : Peter Walker, Australia
Rapporteurs : Victoria Alday de Graindorge, Ecuador; Maria Cristina Chavez Sanchez, Mexico
Working Group members: Adela Prieto, Cuba; Luciano Grobet, Mexico; Victor Manuel Arriaga Haro, Mexico; Leobardo Montoya Rodriguez, Mexico; Marco Linne Unzueta Bustamante, Mexico; Cesar Ortega Santana, Mexico; Leon Armando Alvidrez, Mexico; Jorge Llanos Urbina, Peru; Melba B. Reantaso, NACA; Jeffrey M.Lotz, USA

<u>Working Group 2:</u> Policies, legislation and regulatory frameworks relevant to movement of aquatic animals and animal pathogens.

Chairperson : Barry Hill, United Kingdom
Rapporteurs : Richard Arthur, Canada; Luis Contreras, Mexico
Working Group members: Beverly Wade, Belize; Consuelo Vazquez Diaz, Colombia; Ricardo Gutierrez Vargas, Costa Rica; Franklin Ormaza Gonzalez, Ecuador; Maria Vargas De Marino, El Salvador; Gaudencio Ortiz Navarro, Mexico; Margarita Hernandez Martinez, Mexico; Valente Velazquez Ordoñez, Mexico; Luis Contreras Flores, Mexico; Reynaldo Morales Rodriguez, Panama; Victor Nishio, Peru; Michael Phillips, NACA; Stetson Tinkham, USA; Alex Thiermann, USA; Rohana P. Subasinghe, FAO

<u>Working Group 3:</u> State- and Private-Sector participation in reducing the risk of trans-boundary movement of aquatic animal pathogens.

Chairperson : Hector Corrales, Honduras
Rapporteurs : Daniel Fegan, Thailand; Devin Bartley, FAO
Working Group members: Leonardo S. Maridueña, Ecuador; Jorge Luis Morales, Guatemala; Lorenzo M. Juarez, Honduras; Gabriel Martinez Gonzalez, Mexico; Ana Roque, Mexico; Porfirio Alvarez Torres, Mexico; Pablo Del Monte Luna, Mexico; Josefina Audelo Del Valle, Mexico; Ana Bertha Montero Rocha, Mexico; Pornlerd Chanratchakool, Thailand; Hassanai Kongkeo, NACA; Rodolfo Cadenas, Venezuela

The detailed terms of reference for the working groups and the members of each group are provided in Annex 4.

3.9 Session VI – Presentation of working group findings

Chairperson: Dr Michael Phillips
Rapporteurs: Dr Rohana Subasinghe and Dr Melba Bondad Reantaso

During this plenary session, each working group presented its findings for further discussion and feedback from the workshop participants. Based on the discussions during this session, the working groups prepared their final reports. The final reports were incorporated into the "Plan of Action," which is given in Section 4 which follows.

It was agreed that this plan would be called "The Puerto Vallarta Plan of Action."

3.10 Session VII – Presentation and adoption of the workshop report in plenary

Chairperson: Dr Carlos Ramirez Martinez
Rapporteur: Dr Melba Bondad Reantaso

During this session, the workshop report and Plan of Action was introduced by Dr Porfirio Alvarez Torres, Director General de Investigacion en Acuacultura of SEMARNAP, and adopted by the participants.

The Puerto Vallarta Plan of Action as adopted by the workshop participants is given below.

4 The Puerto Vallarta Plan of Action

4.1 Preamble

The expert workshop on "Trans-boundary aquatic animal pathogen transfer and the development of harmonized standards on aquaculture health management (FWG 03/2000)" was held at Puerto Vallarta, Jalisco, Mexico, 24-28 July 2000. 49 experts attended the workshop, which was organized jointly by the Asia-Pacific Economic Cooperation (APEC), FAO, NACA and SEMARNAP, from 17 APEC economies and FAO and NACA member countries.

The workshop participants reviewed existing knowledge on impacts of trans-boundary aquatic animal pathogen movement and their establishment and management strategies to control impacts of aquatic animal diseases, including measures taken at the state and private sector levels. The current and potential future management interventions at national, regional and international levels were evaluated. Special attention was also given to the standardization, validation and harmonization of diagnostic techniques for fish and shellfish diseases (with special reference to shrimp viral pathogens), and the requirements for compatible, national and international standards, procedures and regulations.

The workshop noted with concern that the increasing disease emergence linked to live aquatic animal movements. The associated economic losses, impact on rural livelihoods and national efforts in poverty alleviation and food security, have become highly significant and emphasize the importance of implementation of effective aquatic animal health management strategies and programs. New trade agreements and obligations generated by the World Trade Organization (WTO) further reinforce the necessity for effective aquatic animal health management measures and harmonization of these measures.

The workshop was of the consensus that investments in aquatic animal health management were required and that such investments were a necessary means to facilitate trade in aquaculture products, and the social and economic development trough responsible development of aquaculture.

Based on these considerations and the discussions during the workshop, the following issues require to be addressed through a coordinated and cooperative program of action.

4.2 Disease diagnostics, pathogen screening and certification procedures and protocols

4.2.1 Validity/effectiveness of diagnostic procedures currently in use

Economy/ Country	Current level of capability			PCR activity	
	Government	University	Private	Screening	Certification
Belize	I				
Brazil		(III)	(III)		
Colombia		II	II	Y	Y
Costa Rica	I	I	I	Y	N
Cuba	III				
Ecuador	II	III	III	Y	Y
El Salvador					
Guatemala					
Mexico	II	III	III	Y	Y
Honduras	I	X	III		
Nicaragua		(II)			
Panama			II	Y	Y
Peru		(III)			
USA	III	III	III	Y	Y
Venezuela	(II)	(II)			

Level I: *Gross observation (field).*
Level II: *Histopathology, parasitology, microbiology.*
Level III: *Virology, immunology, electron microscopy, PCR.*

- There are differing levels of capability in different countries. Capabilities in some countries are very basic. In many cases, the private sector has been active in adopting higher level capabilities, particularly PCR for screening and certification of postlarval quality. PCR screening capability is sometimes available but may be conducted in laboratories outside of the economy/country.

- Techniques for histopathology are mostly standardized for fish, shrimp and molluscs. Lightner's manual is the reference standard for shrimp. Some modifications and improvements are in use. A regular regional newsletter would assist communication of improved protocols.

- At least 3 different PCR methods are presently in use. There is some evidence of WSSV strain variation in Mexico which appears to be affecting the specificity of PCR tests but this requires confirmation. There are also concerns that PCR is unreliable because of lack of appropriate training and that different tests are being required for export certification, causing unnecessary expense to exporters.

- There is a need to discuss regional standardization/harmonization of PCR tests, particularly for certification of postlarvae for export or stocking. A regional workshop to discuss, standardization/harmonization of PCR test methods would be very useful.

- Effective health management cannot be achieved by diagnostics alone. To be effective, diagnostic capabilities must be linked with other aspects of aquatic animal health management.

- The role of stress as a trigger of disease, the effect of multiple concurrent infections and the sensitivity of PCR screening at early PL stages are considered to be important issues and should be the subject of further research.

- In Mexico, a shrimp postlarval certification procedure has been developed and is showing early signs of success. The procedure involves sampling in ethanol, Davidson's fixative and RNA friendly fixative. Triplicate samples of each type are collected and sent to the hatchery, the government and the testing laboratory. In the event of a disease outbreak, the samples are checked by the government to determine if the PL certification was accurate.

4.2.2 Domestication

- Health screened broodstock produced from closed cycle breeding programs are a more reliable source of high quality postlarvae than captured broodstock or postlarvae.

- The availability of domesticated broodstock is relatively limited and is primarily from a small number of commercial closed cycle breeding programs. In Mexico 96-97 % of post-larvae are obtained from imported, domesticated broodstock. In most countries, few or no domesticated broodstock are available. A number of institutions have commenced R&D into closed cycle breeding programs for *P. vannamei*[2], *P. stylirostris* and *P. schmidii*. More widespread use of postlarvae from domesticated broodstock would assist efforts to manage disease provided there is good hatchery health management.

4.2.3 Regional capacity building

- In general, there is insufficient regional expertise and capacity in aquatic animal health and diagnostic technology. There are also significant differences in capacity across different countries the region.

- There is a need to develop training programs, and the methods used in Asia could serve as a model.

- The recommendations of the Expert consultation on DNA-based technologies in the Asian region are also relevant to Latin America and should be implemented.

- Careful selection of appropriate people will be important in achieving a successful training outcome. Training should be an ongoing process of personal development rather than single training workshops. People selected for training should have sufficient technical background and should be in technical/supervisory rather than administrative positions. Such people should be networked with other trained experts in the region and linked with international experts. They should be regarded as national resources for the promulgation of expertise and technology.

- There is also a lack of infrastructure and equipment in many Latin American countries. Training of personnel will be of little value if the infrastructure and equipment is unavailable. As disease is a global issue, it will be important to identify mechanisms for aquatic animal health infrastructure development in developing countries.

- There is also concern that many farmers do not understand PCR technology or principles of health management. There is a need for training of farm technical staff and for education of farmers in the strengths and limitations of diagnostic techniques such as PCR.

- Most of the expertise required for effective aquaculture health management is in developed countries but the industry is based in developing countries. As a result there is a lack of local expertise and also a lack of published literature and reference material in Spanish.

4.2.4 Disease surveillance, reporting and zoning

- In many cases the lines of reporting of diagnostic tests are not appropriate for OIE purposes. Many aquatic animal health professionals are in Fisheries Departments rather than Agriculture Departments and many fish pathologists are not veterinarians. As a result, the reporting processes in most countries results in inadequate or inaccurate information.

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[2] The genus *Penaeus* is used in this report, rather than the recently proposed *Litopenaeus.*

- There is also a lack of suitable techniques and trained personnel for effective implementation of disease surveillance. It is also seen to be very expensive and beyond the resources of many developing countries.

4.2.5 Standardization, harmonization and inter-calibration of diagnostic techniques

- There is general concern about a lack of reproducibility of diagnostic/detection results using PCR technology. Some labs require more than one technique to obtain reliable diagnosis and cannot rely on PCR alone, even for screening purposes. In some labs PCR results for PL certification are unreliable.

- There is an urgent need for training in PCR technology which should include methodologies for sample collection, storage and extraction as well as test protocols. There is also a need for training in PCR laboratory design to avoid problems of false positive results due to contamination.

- In order to achieve better reproducibility between laboratories, there is a need to set up routine lab intercalibration as an ongoing process. Accreditation of laboratories and personnel should be developed to obtain better reliability of PCR results.

- There should be cooperation between private laboratories and government laboratories where possible. In some countries, private laboratories are not employing PCR for screening and in these cases government laboratories should set up the technique.

4.2.6 Regional and inter-regional cooperation

- Asia and Latin America utilize different shrimp farming systems. In Latin America there is expertise in domestication but large-scale farming systems present difficulties for management of water quality and the control of disease carriers. In Asia, domesticated stocks are not used but the farming systems are more amenable to disease control and prevention. Communication and information exchange between the regions could be of mutual benefit in adapting the farming practices to combat WSSV.

- It was recognized that the absence of a professional society for aquatic animal health in Latin America was limiting effective communication and that there was a need for a society similar to the Asian Fish Health Section (FHS). Communication would be assisted by linkages between professional societies.

- It was also recognized the development of aquaculture in Latin America would be assisted greatly by the establishment of a NACA-like organization in this region. This should be an urgent priority for international cooperation and assistance.

4.2.7 Recommendations

The following recommendations are given, short to long-term, and divided into high (H), medium (M) and low (L) priority.

Harmonization and calibration of diagnostic/detection tests

Short-term

- Conduct a workshop to develop an agreed strategy for regional harmonization and inter-calibration of diagnostic tests (H).
- Identify aquatic animal health professionals in each economy/country for intensive training in key technologies (e.g. PCR) through structured workshops and post-graduate education. (H)
- Establish a network of designated Regional Resource Centres and National Resource Centres as repositories of high level expertise in aquatic animal health. (H)
- Conduct a survey to determine aquatic animal health expertise and capacity in the region. (H)

- Conduct regional and national training courses for aquatic animal health practitioners in the following areas: (H)
  - application and interpretation of histopathological methods;
  - PCR technology;
  - epidemiology;
  - aquatic animal health management; and
  - research extension.
- Prepare training manuals and assemble and translate existing reference documents and other literature in Spanish for distribution to health professionals throughout the region. Training manuals are required in the following areas: (H) (Ongoing)
  - Histopathology
  - DNA-based diagnostics
  - Epidemiology
  - Health management extension manuals

Medium-term
- Implement key technologies and standardized/harmonized protocols in National Resource Centres coordinated by Regional Resource Centres. (H)
- Implement key technologies in each economy/country in satellite laboratories coordinated by National Resource Centres. (M)
- Conduct a regional workshop on disease surveillance, reporting and zoning to review disease-reporting mechanisms, identify appropriate linkages with OIE delegates, and establish regional mechanisms. (H)
- Conduct national training workshops in disease contingency planning and surveillance. (H)
- Identify mechanisms for aquatic animal health infrastructure development throughout the region. (H)

Regional communication and networking
Short-term
- Establish a NACA-like inter-government organization to assist development of aquaculture in Latin America. (H)
- Establish a regional aquatic animal health network to assist communication, capacity building and standardization/harmonization of diagnostic procedures. (H)

Medium-term
- Publish a regional newsletter in Spanish and English to assist communication between aquatic animal health specialists. (M)
- Establish a regional society for aquatic animal health professionals with linkages to similar societies in other regions (AFS/FHS-Asia, JSPF, EAFP, and FHS/AFS-America). The society should conduct regular regional scientific meetings (M)
- Establish a technical exchange program between countries in the Asia-Pacific region (M)

Research and development/technology transfer
Short-term
- Develop cooperative research projects to investigate:
  - Stress and other disease triggers (M)
  - The effect of multiple infections on shrimp health (M)
  - The sensitivity of PCR screening of shrimp at very early post-larval stages. (H)
  - Rapid laboratory-based and farm-level diagnostic tests (H)
  - Mechanical carriers. (M)

Medium-term
- Conduct inter-regional research projects on topics of common interest (e.g. Identification and comparison of pathogens in different regions). (M)

- Conduct a regional workshop should to discuss domestication issues for *P. vannamei*, *P. stylirostris* and *P. schmitti* and identify collaborations and linkages between institutions and industry the will facilitate the more extensive use of closed breeding cycle technology. (M)

4.3 Policies, legislation and regulatory frameworks relevant to movement of aquatic animals and animal pathogens.

4.3.1 Current situation

There is a requirement to better understand the existing legislation in the Americas, and international trade agreements before being able to make recommendations related to regional needs. To accomplish this, the group summarized key features relative to national policy and legislation and then identified areas of broad regional concern. These are given below:

- The majority of Latin American countries possess basic animal health legislation of different level of hierarchy (acts, laws, rules, decrees, agreements, resolutions, etc.)

- In almost all countries, specific regulations also exist, covering aquaculture-related activities, although these differ among countries.

- In most countries, there is no clear distinction between terrestrial animal and aquatic animal health legislation. In most cases where specific regulations for aquaculture exist, their enforcement is applied mostly as an emergency procedure to deal with a specific problem, and not as the result of an established program for surveillance and monitoring of the health status of cultured organisms.

- Several countries have specific legislation to regulate the import and export of live aquatic organisms and their products for use in aquaculture, for human consumption, or other purposes. Generally, these laws and regulations are in conformity with the rules of the OIE and WTO-SPS.

- In the majority of Latin American countries, legislation to regulate the internal movement of aquatic animals and the associated risks is non-existent, and quarantine, surveillance and monitoring, and appropriate research programs and focus are lacking or insufficient.

- Most countries in the region lack an effective aquatic animal health program, or effective systems for communication with authorities and organizations responsible for national and international animal health.

- The lack of regional communication on aquatic animal health matters and lack of harmonized approaches to aquatic animal health is of particular concern, and a potential restriction on trade, and should be addressed through a coordinated regional approach.

- There is insufficient financial capacity and infrastructure, and a lack of well trained personnel to formulate and enforce appropriate legislation to meet the current needs of most Latin American countries. The lack of investment in aquatic animal health management is of particular concern, given the growing importance of aquaculture in national economies and trade, and the devastating social and economic impact which uncontrolled aquatic animal outbreaks have had in Americas and Asia.

4.3.2 Recommendations

The following recommendations are made with regard to national legislation and policy, capacity building and national and regional cooperation:

National legislation and policy

- National policy and legislation dealing with aquaculture should take into account the concerns for the environment, aquatic health, public health and food safety.

- To comply with WTO-SPS obligations, governments must implement import/export decisions based on international standards or using science-based Import Risk Analysis (IRA).

- National legislation should be in place to control the use of chemotherapeutants and other substances of concern (antibiotics, pesticides, etc.) used in aquaculture, to avoid indiscriminate use that could lead to human health or environmental risks.

- Governments should review the effectiveness of national legislation for aquatic animal health management, ensuring full consultation between all agencies and stakeholders with responsibility in the field to identify and correct any deficiencies and/or conflicts.

- Governments need to establish effective national strategies for aquatic animal health management that should include those aspects as outlined in the FAO/NACA Asia Regional Technical Guidelines on Health Management for the Responsible Movement of Live Aquatic Animals[3].

Capacity building

- Capacity building should be addressed in all critical areas as identified in national strategies.

- There is a special need for capacity building in risk analysis, procedures for monitoring and disease surveillance, standardization and validation of diagnostics methods, extension services, and contingency planning for emergency disease situations.

Coordination

- Governments should ensure effective coordination between relevant stakeholders, including national authorities, industry, private sector, environmental groups, and academia.

- National and regional coordination should encourage the participation of the private sector to ensure sustainable aquaculture that protects the industry while safeguarding the integrity and processes of natural resources and ecosystems.

- National and regional coordination should encourage the dissemination and implementation of the relevant provisions of the Code of Conduct for Responsible Fisheries and the Jakarta Mandate on Biological Diversity.

- National and regional coordination should aim at improving communication between national authorities dealing with terrestrial animal health, aquaculture and aquatic animal health, and the OIE. For this to be effective, it will be necessary to clarify responsibilities for aquatic animal health issues among domestic agencies.

- Recognizing that serious aquatic animal diseases are not constrained by national boundaries, regional cooperation is needed to prevent the rapid spread of diseases. Such regional cooperation should address issues of technical development and harmonized approaches to aquatic animal health, as well as strategies for establishing regional mechanisms for presenting a coordinated view to relevant international and regional bodies such as OIE and FAO. The goal of this cooperation is to facilitate international trade in aquatic animals and sustainable development of aquaculture.

- There is a need for a mechanism for periodic regional meetings on technical aspects and legislation to facilitate dialogue and mutual support in aquatic animal health policy and legislation.

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[3] FAO/NACA. The Asia Regional Technical Guidelines on Health Management for the Responsible Movement of Live Aquatic Animals and The Beijing Consensus and Implementation Strategy. *FAO Fisheries Technical Paper* No. 402. Rome, FAO. 2000. 53p.

4.4 State- and Private-Sector participation in reducing the risk of trans-boundary movement of aquatic animal pathogens

4.4.1 Introduction

The discussions were limited to some extent by the lack of a wide representation of the private sector. Within the group only 2 representatives of producers associations were present, from Ecuador and Honduras, having been asked by their respective governments to attend. Given the importance of the issues at stake, it was recommended that an opportunity should be made for the other national producers associations in the region to meet and discuss how state and private sector co-operation in the field of live aquatic animal trade, an important activity in the shrimp sector in particular, could be improved. The earliest opportunity for this will be at the forthcoming conference on Aquaculture in Latin America, in Panama in October 2000.

4.4.2 Need for cooperation

The trans-boundary movement of aquatic animals, particularly shrimp, has become a major issue concerning governments and the private sector in the Americas. The demand on the part of the private sector to allow import and export of live shrimp between countries has highlighted the need for governments to establish procedures and regulations to allow this without causing unacceptable risk of pathogen transfer. This will require considerable private sector-government co-operation within and between countries.

Successful co-operation depends on both partners receiving more benefits than costs from their participation. The advantages and disadvantages of state and private sector participation in general were discussed and are listed below.

Advantages

- Provides a forum for private sector participation in development of legislation and can reduce the need for mandatory legislation
- Provides a point of communication between government and private sector
- Facilitates transfer of information and education
- Increases understanding between sectors
- Can assist in the promotion of aquaculture
- Can provide marketing benefits
- Helps in the registration and monitoring of farms, producers etc.
- Assists government to prioritize funding for aquaculture related activities (e.g. R&D, support of the industry etc.)
- Helps in negotiations with financial institutions supporting industry and government activities and the development of risk-amelioration activities
- Provides access to additional funding sources and resources through multilateral and bilateral aid (expertise etc)

Disadvantages

- Loss of autonomy
- Implies or involves increased responsibilities and obligations (financial, restriction, time etc.) on the participating bodies
- May involve issues of disclosure, confidentiality and competition, constraining the open flow of information.
- Changes in participating organizations circumstances risks introducing a lack of continuity and changes in parties willingness to co-operate
- Could be unduly influenced as a result of power imbalances. Governments may have more power in discussions or negotiations due to legislative power. Internal power imbalances in participating organizations may also interfere with communications
- Can increase business costs to the private sector

4.4.3 Private sector organization

At a national level, co-operation between the state and the private sector is considerably enhanced when there is a strong producers association capable of representing the private sector. It is in the governments best interests to find ways to promote the formation of producers associations to improve dialogue and communication. Where several associations exist in a economy/country covering different sectors of the aquaculture industry (species-based associations, producers, suppliers, exporters associations) they should be encouraged to work together in areas of common interest.

There are some constraints in achieving representation combining the interests of different sectors in a single group. Experience has shown that it can difficult to reconcile the diverse interests of large and small-scale producers, for example. However, these constraints need to be overcome if an effective co-operation between the public and private sectors is to be achieved. Even in some well-organized producers groups, consensus on all issues can be difficult to achieve making it difficult for governments to balanced views and where politically influential interest groups exist, these may have more influence with the government than the formal producers organizations.

The relative size and importance of aquaculture sector in relation to fisheries at government level was mentioned. In several countries private sector fisheries organizations are a powerful political lobby and are well represented in government circles. Where there are differing priorities in the fisheries and aquaculture industries, this can be a considerable constraint to establishing aquaculture on the political agenda.

Several countries do, however, have large national producers associations that represent the private sector in meetings with the government. In two cases at least (as highlighted during the working group discussions), Ecuador and Honduras, the government and the producers associations regularly meet and collaborate on issues related to aquaculture. The Camara Nacional de Aquacultura in Ecuador, for example, has played a major role in proposing legislation and assisting the government in developing a regulatory framework for aquaculture as well as assisting the government through self-regulation of the industry. In both Honduras and Ecuador the government frequently consults with the producers associations and has asked the producers associations, on occasion, to represent the government in international and regional fora.

There is an organization in Latin America for private producers (ALAQUA – Asociacion Latinoamericano de Aquacultura). In addition, there are frequent opportunities for them to meet and interact through attendance at technical conferences. The Latin American chapter of the World Aquaculture Society as well as the national organizations themselves, hold regular meetings and seminars open to interested parties from throughout the region.

Some examples of public and private sector co-operation at a national level

There have been several examples, some good, some bad, of public and private sector co-operation in aquaculture. The Fundacion de Investigacion de Recursos Bio Aquaticos (Foundation for Research of Aquatic Biological Resources) (FIRBA) in Ecuador was established to conduct a jointly funded research program with 60:40 private: government funding. This worked well for two years until a change in government led to a lack of political willingness to continue support. This led to the eventual closure of the foundation and loss of the investments made, resulting in a reluctance on the part of the private sector to become involved in a similar organization. However, the Camara Nacional de Aquacultura provides support to the Centro Nacional de Investigaciones Marinos (CENAIM) in its funding requests to funding agencies within and outside the country.

In Honduras, an agricultural pathology laboratory established by the Organismo Internacional Regional de Sanidad Agropecuaria (OIRSA), is owned by the national Department of Agriculture but with operational funding from the Aquaculture producers association ANDAH (Asociacion Nacional de Acuicultores de Honduras). The laboratory provides services to the aquaculture producers and both sectors are represented on the board of directors. ANDAH has also worked on several joint projects with the government such as a monitoring program for water quality in the Gulf of Fonseca. This started in 1993 with the University of Auburn, using USAID funding. When the USAID funding ended in 1998, ANDAH and the government of Honduras took over the funding to maintain the program and database on the water quality of the Gulf of Fonseca on a weekly basis to monitor the impact of aquaculture funded through a levy on the producers based on area under cultivation. This has helped the government to establish mandatory regulations on stocking density, fertilizer use and other factors having an impact on water quality, leading towards establishing best management practices for shrimp aquaculture.

In Mexico, the government and the private sector have collaborated on research funding support since 1996 through the provision of matching funding. To date, approximately US$ 700,000 has been invested in research through this scheme. In 1997, eight projects were funded, increasing to 20 in 1998 covering genetics, physiology, health and disease. Each district has a committee to discuss needs, identify factors and then propose projects. A scientific committee, including the private sector, evaluates project proposals and provides the money to the research institutes. The government and private sector hatcheries have also collaborated on a domestication project in government research centers in Mexico and producers often pay maintenance for, and support activities of, government staff in the field to complement the governments support of laboratories providing services to the producers.

In Guatemala, where there are very good relations between the government and the private sector, the exporters federation and the government have worked together to conduct various studies including monitoring, availability and handling of wild postlarvae.

In Thailand there are several examples of successful public-private sector co-operation to address specific issues or opportunities. When yellowhead virus first occurred in 1993, a task force was established to direct and co-ordinate efforts aimed at investigating and controlling the outbreak. Activities were jointly identified and allocated, many funded jointly by the private sector. Recently, the Thai Department of Fisheries has started to work through private extension networks belonging to suppliers to the aquaculture industry. This provides significant benefits to both by giving the Department of Fisheries access to additional extension resources and the extension agents access to reliable sources of technical information. The Thai National Center for Genetic Engineering and Biotechnology (BIOTEC) is also involved as a joint venture partner with a number of private sector companies in the Shrimp Culture Research and Development Co. Ltd., which is involved in the development of domesticated stocks of shrimp for use in a breeding program.

Regional inter-governmental organizations

The existing inter-governmental organizations in the region were discussed. Several regional inter-governmental organizations concerned with aquaculture, fisheries or animal health, covering combinations of countries in the Americas, exist or have existed. Several of these are either no longer functioning or have limited capacity to play a significant role in the type of co-operative efforts envisioned. The involvement of a large number of countries, and particularly the United States and Canada, was thought to offer substantial benefits over a larger number of smaller organizations.

There was considerable interest in the organization of NACA, how it functioned and whether it could be a model for a similar organization in the Americas. Although this may be a useful exercise, some caution needs to be exercised. COPESCAL, a Latin American mechanism, for co-operation on aquaculture development was established in 1980s. It currently continues to operate in a limited manner as an FAO Regional Body. It was also pointed out that NACA’s progress has not been easy or fast. NACA has taken around 20 years to develop to its current stage, 10 years as a project under UNDP/FAO, then funded by member governments. This was made easier by the fact that aquaculture is a very important sector in many Asian economies and countries although it is increasingly important in many Latin American countries as a source of employment and foreign exchange.

The Central American countries (Mexico to Panama) are members of the Organismo Internacional Regional de Sanidad Agropecuaria (OIRSA). OIRSA is linked to OIE and was originally involved in terrestrial animal diseases. They have already prepared a document detailing economy/country positions (prepared jointly by the government and industry association in each economy/country) on the movement of aquatic animals with a list of aquatic animal products and pathogens of concern that has been accepted by the member governments. Recent laws proposed in Honduras were based on recommendations of the report.

The Inter-American Institute for Co-operation in Agriculture (IICA) is a regional organization covering all of Latin America based in Costa Rica. It has a wider membership than OIRSA, but no effective aquaculture component, as the member governments have not requested this. (Ministers of Agriculture of each economy/country represent the member governments).

4.4.4 Some issues for public and private sector co-operation in Latin America

The implementation of a process of public and private sector co-operation raises some important issues. The issues discussed, although not exhaustive, give some indication of some of the general and technical concerns that should be addressed.

The following general issues were identified:

- ***Commitment to the process.*** Both the public and private sector needs to have, and maintain, a commitment to the process. This requires that both parties are aware of the need for, and benefits of, working together and that continuity of effort is maintained. Changes in the organization of private sector groups and changes of government can have an impact on the willingness of either party to continue, or give a high priority to, the process of co-operation. Where more than one government agency has jurisdiction over the process, efforts should be made to establish a common and consistent approach.

- ***Funding.*** Funding is a key element of the co-operative process. Both parties should benefit from the co-operative process and funding mechanisms should reflect this. A collaboration between public and private sectors is likely to be able to benefit from a variety of funding resources and mechanisms such as incentive measures and increased options to access international sources of funds.

- ***Objectives.*** The objectives for the collaboration will depend upon the type and scope of collaboration. Establishment of objectives is fundamental to the process and should be carried out in a participatory and transparent manner.

Technical issues include:

- ***Health Certification.*** Legally, only governments can authorize health certificates for aquatic animal health, particularly where these are to be used as an international certification. However, the private sector should be involved in development of methods and standards for health certification. This could be done through a commission including representation of the private sector established specifically for this purpose. The government can do certification of laboratories capable of conducting independent verification of diagnosis and inspection results. These laboratories may be either government, university or 3rd party including private sector laboratories with government quality control. Resources to support these activities would have to be identified.

- ***Inspection of 3rd Party Facilities.*** There has been an interest for government bodies to inspect, approve and accredit 3rd party facilities for import of live aquatic animals, sometimes in other countries. This requires co-ordination with the responsible government agency in the economy/country of export. This may require a government to government request for inspection although it may be initiated by a private sector request.

- ***Confidence in certificates between governments.*** There has been concern expressed about differences in capability of agencies within a economy/country to adequately conduct examinations of aquatic animal health and issue meaningful certificates. This will require collaboration between governments and the private sector to establish adequate capacity and agree realistic and achievable standards for certification.

4.4.5 Actions and recommendations

Based on the discussions, a plan of action was developed to promote the development of increased public and private sector co-operation both regionally and inter-regionally. It was emphasized that this effort would benefit from the assistance and co-operation of APEC, FAO and NACA where it was felt to be appropriate.

A commitment was made that the private sector and interested regional and government agencies would try to meet at the 4th Latin American Aquaculture Congress and Exhibition to be held in Panama from 25-28 October 2000 to discuss how to develop a regional effort to increase government and private sector collaboration. The representatives of Honduras and Panama agreed to work together to invite key people and set up an opportunity during the meeting to discuss this issue.

4.4.6 Development of a system for the safe trans-boundary movement of aquatic animals

Short term recommendations

- Build awareness and document the impact and implications (social, economic, markets, future industry development) of the lack of a mechanism for safe aquatic animal movement in each economy/country and within the region
- Establish ongoing dialogue with OIE national delegates in each economy/country
- Review the role and involvement of the private sector in establishing the existing health certification procedures in each economy/country.
- Assess existing capability in the private and public sectors and identify capacity building needs
- Review available epidemiological information and scientific data to assist in developing health certification needs and an epidemiologist (should do risk assessments). Request FAO to provide assistance through the partnership program. Private sector funding may also be obtained for this purpose.
- Bring together stakeholders for training in the procedures of the WTO, SPS and OIE. This should include producers associations, government staff with responsibility for aquaculture and the OIE national delegates to improve understanding of rights and obligations under the OIE.

Medium term recommendations

- Public and private sector co-operation on a project to develop plans to facilitate the safe movement of live shrimp within the Americas region.
- Co-operate to develop contingency plans for major diseases of concern in the region.
- Prepare an action plan to develop national and regional reporting systems, identifying needs and constraints (could be carried out as part of the epidemiology study – point 5 - above). Request assistance from OIE in improving reporting of aquatic animal diseases in the Americas to OIE.
- Identify training needs and specialists for conducting risk assessments.

Long-term recommendations

- Establish and implement a harmonized regional certification system
- Establish a regional training program in aquatic animal health issues including safe trans-boundary movement, risk assessment and contingency planning for public and private sector
- Conduct risk assessment for the various pathogens of concern as part of a risk management program.
- Establish one or more regional reference laboratories for aquatic animal health responsible for standardization and validation of diagnostics.
- Establishment of one or more regional organizations for the Americas to improve government-private sector participation

Short-term actions

- Establish a dialogue between the producers associations at the earliest opportunity to discuss ideas for co-operation and identify strategies available. The Aquaculture meeting in Panama (October

2000) would be a good opportunity for the national producers associations and interested agencies to meet and discuss their strategy and interests in this co-operation.
- Establish objectives for regional and inter-regional co-operation.
- Make contact with the Inter-American Institute for Co-operation in Agriculture (IICA), OIRSA and other regional organizations to discuss co-operation and involvement in the program
- Obtain information on NACA and other regional groups on possible organization formats for an Inter-American regional aquaculture organization

Medium-term actions
- Identify what kind of regional organization(s) are suitable: separate private sector and government organizations with formal contacts or one single private sector: government organization.
- Begin regional co-operation between public and private sector on individual projects.
- Identify and approach sources of technical support and funding for the organizations and co-operative projects.

Long-term actions
- Establish the regional organization(s) identified earlier. Initiate routine meetings and dialogue.
- Establish regular inter-regional exchanges with other regional organizations for information exchange, technology transfer and south-south co-operation.
- Increase the profile of aquaculture in existing inter-governmental organizations in the Americas

4.5 General recommendations for implementation of the Puerto Vallarta Plan of Action

The workshop recognizes that States, in collaboration with the private sector, have primary responsibilities for implementation of the Plan of Action, and accordingly requests the States to give a priority to integrating above recommendations within national development plans.

Recognizing the crucial importance of implementation of the Action Plan, in terms of promoting development of responsible aquaculture, facilitating trade and promotion of conservation, management and sustainable utilization of natural resources, the participants also requested that further support be provided through regional and international co-operation.

The workshop recognized there are some coordinated efforts by international agencies, such as the Consortium on Shrimp Aquaculture and Environment by the World Bank (WB), NACA, FAO, World Wildlife Fund (WWF). This consortium project led to the successful conclusion of the Thematic Review on Management Strategies for Major Diseases in Shrimp Aquaculture, and the information and recommendations derived at the Cebu Workshop became the major background material for the Puerto Vallarta workshop.

The workshop therefore requested FAO to help coordinate follow-up activities, as agreed by the participants, in close consultation with the APEC-FWG, NACA, relevant government authorities, and other concerned regional and international development agencies and organizations.

Recognizing the importance of the recommendations from the meeting in realizing the APEC objectives for trade liberalization and sustainable development in APEC economies, the workshop requested that APEC supports the implementation of the Plan of Action. The workshop recommended that suitable projects be developed by the APEC economies for presentation at the next APEC Fisheries Working Group meeting.

Since the issue of trans-boundary movement of aquatic animal pathogens is a regional concern, which extends beyond APEC economies of the region, the workshop requested FAO and other concerned regional and international agencies to join hands with the APEC in developing and implementing cooperative projects addressing the identified issues.

The workshop participants noted the potential for further mutually beneficial cooperation between the Americas and Asia in aquatic animal health management, and requested that APEC, FAO and NACA seek to further expand such cooperative activities.

The workshop reiterated support for the proposed Regional FAO TCP Project on Shrimp Health Management in the Americas which should be fully implemented and would provide a mechanism to support the Americas in implementation of some of the above recommendations.

It was also suggested to initiate informal discussions in association with FAO/COFI meeting in March 2001 (e.g. provide an executive summary of this meeting, hold informal meeting with regional government representatives) with a view to exploring the opportunities and mechanisms for establishment of an effective mechanism for regional cooperation within the Americas.

The Workshop recognized the importance of raising the profile of aquatic animal health management within relevant international fora and more effective international cooperation among concerned agencies such as FAO, OIE, WTO, WB, etc. The Workshop recommended that aquatic animal health issues be included in the full FAO/COFI meeting agenda in 2001.

The workshop also recognized the lack of aquaculture focus at the FAO Regional Office for Latin America and the Caribbean (FAO/RLAC) and recommended that a technical post for a Regional Aquaculture Officer be established.

Similarly, the workshop also recommended that aquatic animals health concerns and management measures be more vigorously promoted in the Latin America Regional Office of the OIE and APEC-FWG.

Likewise, the workshop also recommended that aquatic animal concerns may also be promoted through other relevant organizations, such as the Convention on Biological Diversity.

Cooperation with other Latin American organizations involved in animal health, and other related interests, such as OIRSA, should also be established and promoted.

5 Closing Ceremony

Following the adoption of the workshop report and ***Puerto Vallarta Plan of Action*** the representatives of the Mexican government, APEC, FAO and NACA thanked the participants for their contribution to a successful workshop, and wished the participants a safe journey home. All speeches emphasized the importance of follow up to the recommendations of the workshop, and the need to continue to strengthen regional and inter-regional cooperation in the control of aquatic animal diseases.

6 Technical Presentations

This section provides the detailed presentations made during technical resource person presentations.

6.1 Objectives and expected outcomes from the Expert Consultation

Presentation by Dr Ana Bertha Montero Rocha (SEMARNAP, Mexico)

6.1.1 Objectives of the workshop

1. To ***review existing knowledge on impacts*** of trans-boundary aquatic animal pathogen movement and their establishment. Different pathways of pathogen transfer and the impact on aquaculture, rural livelihood, trade, aquatic biodiversity, and other potential sectors were evaluated.

2. To review ***management strategies*** to control impacts of aquatic animal diseases, with an emphasis on measures taken at ***government level*** and among the ***private sector***, including farmers, hatcheries, feed manufacturers and others, Special reference was given to the White Spot Syndrome Virus (WSSV) and Taura Syndrome Virus (TSV) problems as such diseases have contributed to significant economic losses within aquaculture industries in Asia and the Americas.

3. To identify and ***evaluate current and potential future management interventions*** at national, regional and international levels, with special reference to ongoing Asia-Pacific and international programs and potential cooperative mechanisms.

4. To review the existing knowledge on the ***standardization, validation and harmonization of diagnostic techniques*** for fish and shellfish diseases (with special reference to shrimp viral diseases), and making compatible, national and international standards and regulations.

5. To develop a ***program of action*** in order to make compatible the different standards for aquaculture health management, in particular shrimp.

6.1.2 Expected outputs of the workshop

The workshop is expected to compile the current technical knowledge on the subject, the prospects, challenges, considerations, and recommendations to reduce impacts of trans-boundary transfers of aquatic animal pathogens. The specific outcomes include:

- peer-reviewed technical document containing the technical papers presented to the workshop;
- consensus on short-, medium-, and long-term interventions and activities to minimize negative impacts on trans-boundary pathogen transfer;
- an action agenda incorporating the recommendations of the workshop, based on the knowledge gained during the workshop, to address the future regional and inter-regional needs and activities on aquatic animal health management;
- opportunities for managing identified risks in aquatic animal health through co-operation, between relevant APEC economies, other relevant countries in Asia and Americas, and appropriate national, regional and international agencies and organizations, through international and inter-regional co-operation;
- a platform for developing harmonized standards on aquatic animal health; and
- an ***Action Plan*** for achieving the above at national and regional levels.

6.2 An overview of FAO/NACA activities and regional, inter-regional, and international co-operation in trans-boundary aquatic animal disease control

Presentation by Dr Rohana Subasinghe (FAO) and Dr Melba Bondad-Reantaso (NACA)

The presentation highlighted the ongoing program of FAO and NACA in support of aquatic animal health management in the Asian region. The presentation highlighted the background to the program, and current activities, including the recently adopted *Asia Regional Technical Guidelines on Health Management for the Responsible Movement of Live Aquatic Animals and the Beijing Consensus and Implementation Strategy.*

Objectives of the Asia Regional Program

- Overall improvement of health management standards in Asia-Pacific
- National and regional capacity building in aquatic animal health management
- Assistance to regional countries in identifying aquatic animal health management needs
- Providing technical assistance to improve national aquatic animals health management policies and regulatory frameworks
- Assistance for implementation of the provisions given in the Article 9 of the Code of Conduct for Responsible Fisheries (CCRF)

History of the Regional Program

- Several Asian regional meetings on quarantine and health certification held since 1972
- 1991 - ADB/NACA Expert Consultation on Fish Health Management held in Pusan, Korea
- 1995 - FAO/FHS-AFS Expert Consultation on Health Management in Asian Aquaculture
- 1996 - FAO/NACA Regional workshop on health and quarantine guidelines for the responsible movement of aquatic organisms
- 1998 - FAO/NACA Asia Regional Technical Co-operation Project

Foundation of the Regional Program

- NACA/FAO Regional Aquatic Animal Health Management Program laid the foundation for co-operation and collaboration among interested and concerned agencies and organizations at national, regional, and international levels.
- The basis for the success of the Asia Regional Program is the opportunity created for co-operation and collaboration among concerned parties and stakeholders.

Major Regional Activities

- FAO Technical Co-operation Project on Assistance to Safe Trans-boundary Movement of Live Aquatic Animals in Asia. The main funding from FAO, implemented by NACA/FAO
- Additional financial assistance from Japan, Aus-AID, APEC, DFID, NACA
- Technical assistance by FAO, OIE, AAHRI, NACA, AFFA, AQIS, Regional Working Group of Experts, Economy/country Co-ordinators
- 21 developed and developing countries in Asia participated

The achievements of the TCP Project

- Asia regional technical guidelines on health management for the responsible movement of live aquatic animals
- Beijing Consensus and Implementation Strategy
- Manual of procedures for the implementation of the technical guidelines
- Asia Aquatic Animal Health Guide
- National strategies on health management for 20 project countries
- Capacity building and training on related subjects in regional countries

Other Cooperative Asia Regional Activities

- Asia-Pacific Molluscan Health Management Program - FAO/OIE/NACA/DFO-Canada/SEAFDEC-AQD/NIWA-New Zealand/IFREMER-France
- Upgrading national capacities on aquatic animal disease surveillance and reporting - FAO/Aus-AID/APEC/NACA
- Grouper Virus Transmission and Vaccine Development Project - APEC/AAHRI/FHS-AFS/NACA
- Aquatic animal health and socio-economic impact assessments in selected countries in Asia - IDRC/Aus-AID/APEC/DFID/NACA/AAHRI

Other Cooperative Activities

- Asia-Pacific Quarterly Aquatic Animal Disease Reporting System - NACA/OIE/FAO Activity
- Diagnostic CD on Shrimp Diseases
- NACA/FAO/WAS/Biotech Activity
- Aquatic Animal Pathogen and Quarantine Information System - Asia Module - AAPQIS-Asia - FAO/NACA Activity - http://naca.fisheries.ac.th

International and Inter-Regional Activities and Cooperation

- Management Strategies for Major Diseases in Shrimp Aquaculture. Involves a Consortium of donors and agencies - WB/NACA/WWF/FAO
- Involving 14 shrimp producing countries in Asia and Latin America
- Workshop held in Cebu, Philippines in November 1999.
- Report with recommendations provides a major reference for this expert workshop
- Research Needs for Standardisation and Validation of DNA-based Diagnostic Techniques for Aquatic Animal Pathogens. International expert workshop held in Bangkok, Thailand in February 1999. Report with recommendations available also provides a major reference for this expert workshop.
- Scoping workshop on 'Primary Aquatic Animal Health Care in Rural, Small-Scale Aquaculture Development in Asia'. Regional workshop held in September 1999 in Dhaka, Bangladesh, Co-sponsored with DFID and hosted by the Government of Bangladesh. Brought together 48 scientists and development professionals from 12 countries. Report and recommendations provides a further reference.

Proposed Regional Activities

- Proposed FAO Technical Co-operation Project on Shrimp Health Management in Americas. Main funding from FAO. Implemented by CENAIM/ASC-Ecuador/FAO.
- Complementary to other on-going activities such as: WB/NACA/WWF/FAO Consortium Program on Shrimp Aquaculture and the Environment.
- APEC/FAO/NACA Program on aquatic animal health management in Americas. US LAND GRANT UNIVERSITIES AND USDA-CSREES under USDA-FAS/ICD. USAID Hurricane Mitch Reconstruction Project activities involving shrimp farming.

Proposed FAO Technical Co-operation Project on Shrimp Health Management in Americas

- Includes all shrimp producing countries in the region. Main objectives are:
- Interventions for improving post-larval quality
- Farmer capacity building on health management in shrimp ponds.
- Establishment of an Aquatic Animal Pathogen and Quarantine Information System for Americas. This expert workshop can provide inputs to the project objectives and activities as the project is still under formulation stage.
- Many opportunities for future collaboration in trans-boundary aquatic animal disease control

- New approaches to reduce the risk of trans-boundary aquatic animal disease control are being applied in many countries
- Many such approaches could be effectively applied to Latin America.
- This workshop, as a pioneering regional venture, should identify activities and strategies which could be supported and implemented by concerned national, regional, and international agencies and organizations.

6.3 Trans-boundary aquatic animal movement: OIE

Presentation by Dr Barry Hill (OIE Fish Diseases Commission and CEFAS, UK).

The presentation entitled "Transboundary aquatic animal movement :compliance to international treaties and conventions: Organization Internationale des Epizooties. The World Organisation for Animal Health (OIE)", introduced the activities of OIE with respect to aquatic animal disease control and responsible movement of live aquatic animals. Created in 1924, the *Office International des Epizooties* (OIE), is the world organization for animal health. In April 2000, the number of Member Countries totaled 155.

The main objectives of the OIE are:
1. To promote and co-ordinate experimental or other research work concerning the causes or control of contagious diseases of animals for which international collaboration is deemed desirable.
2. To collect and bring to the attention of Governments and their animal health services, all facts and documents of general interest concerning the course of epizootic diseases and the means used to control them.
3. To examine international draft agreements regarding animal disease control regulations and to provide signatory governments with the means of supervising their enforcement.

6.3.1 General approach to animal and aquatic animal health control problems

Among the main objectives of the OIE is the duty to increase general awareness of disease problems associated with trade in live animals and animal products, including aquatic animals, and to promote means for diagnosis, control or prevention. These objectives generate an approach based upon the following: co-ordination of investigations of communicable animal diseases for which international co-operation is essential; collection of information on epizootics and control measures applied by the Member Countries; and an advisory role in preparing international standards or agreements pertaining to animal health. The communication of animal health information to Member Countries occurs through their respective Veterinary/Animal Health Services. However, in some Member Countries, another Authority, rather than the National Veterinary Services, is responsible for aquatic animal health.

6.3.2 The OIE and health problems in aquatic animals

In 1960, the OIE established the Fish Diseases Commission to deal specifically with the increase of fish diseases as aquaculture expanded world-wide. In 1988, the scope of the Fish Diseases Commission was extended to include diseases and pathogens of molluscs and crustaceans.

OIE International Aquatic Animal Health Code: listed pathogens and diseases

Pathogens are included in the *International Aquatic Animal Health Code* according to the following basic considerations: resistance or response to therapy; geographical range; and socio-economic importance, regardless of the host. The list of pathogens considered for inclusion in the *Code* is currently restricted to fish pathogens, bivalve molluscs pathogens and crustacean (prawn) viruses.
The OIE approach to animal health control in aquaculture involves making recommendations to Member Countries to apply the following measures:
- assessment of the health status of aquatic animals in a production site, based upon inspections and standardized sampling procedures followed by laboratory examinations conducted in accordance with the instructions given in the OIE *Diagnostic Manual for Aquatic Animal Diseases*
- re-stocking of open waters and farming facilities with products of a health status higher than, or equal to, that of the area concerned
- eradication of diseases of socio-economic importance whenever possible
- notification by every Member Economy/country of additional requirements, in addition to those provided by the *Aquatic Code*, for the importation of aquatic animals and aquatic animal products.

If the above procedures are used, it becomes possible to define the health status of aquaculture products for specified pathogens, according to the economy/country, zone or production site of origin. The health status of the product can thus be warranted by the issue of a health certificate by the appropriate official stating that the aquaculture products in a defined consignment originate from a economy/country, zone or farm/harvesting site free of the specified pathogens listed in the *Aquatic Code* and possible of other specified diseases. The *Aquatic Code* provides disinfection procedures for eggs, to reduce the risk of viral contamination, and the vertical transmission to progeny from adult asymptomatic carriers, as well as disinfection procedures to be followed in connection with disease outbreaks and fallowing of farm sites.

The OIE control policy is thus based on regulations focused on certain pathogens rather than on their hosts and diseases, leading to verification of acceptable sources of aquaculture products for national and international trade. The origin is considered as either entire countries, zones or protected facilities, demonstrated to be officially free of these pathogens, through the implementation of a national health surveillance scheme that employs sampling and laboratory techniques described in the *Manual*.

Both the *International Aquatic Animal Health Code* and *Diagnostic Manual for Aquatic Animal Diseases* are updated regularly. Member Countries may propose change through their Chief Veterinary Officers who communicate directly with the OIE. The proposed changes are examined by the Fish Diseases Commission and draft recommendations are prepared for consideration by Member Countries at the annual General Session.

New occurrences of diseases in a previously free region must be reported to the OIE in accordance with the reporting requirements of the OIE, for announcement in the weekly *Disease Information* and monthly *Bulletin.*

6.3.3 References

OIE. 1997a. International Aquatic Animal Health Code. 2nd Edition. Office International des Epizooties, Paris, 192 p.

OIE. 1997b. Diagnostic Manual for Aquatic Animal Diseases, 2nd Edition. Office International des Epizooties, Paris, 251 p.

6.4 Trans-boundary aquatic animal movement: Responsible use of introduced species: FAO and the Convention on Biological Diversity (CBD)

Presentation by Dr Devin Bartley (FAO, Rome, Italy)

Introduced species (or alien species and alien genotypes) have become an important topic in the international arena. Introduced aquatic species are a proven method of increasing production and economic benefit from the fishery sector; they also are a proven hazard to native aquatic biological diversity. The international development and academic communities recognized these decades ago and set out to review the problem and create guidelines for the responsible use of introduced species (Table 1).

More recently the broader international community has taken up the subject. The topic of alien species figures prominently in the FAO Code of Conduct for Responsible Fisheries (CCRF) and in the work plans and agendas of the Convention on Biological Diversity (CBD) and its Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA) (Table 2). With such an important topic, it will be important to examine how different international instruments can work in complement with each other and not duplicate efforts or give contradictory messages to Members.

Convention on Biological Diversity (CBD)

The CBD has the most signatories of any piece of international legislation. Recent decisions taken by the CBD's Conference of the Parties further reflects the importance given the issue of alien species and genotypes (Table 3). Implementation of both the CBD and the CCRF will require accurate information on species introductions. The FAO Database on Introductions of Aquatic Species (DIAS) (Bartley and Casal 1998; Garibaldi and Bartley 1997) is one source of such information.

Database on Introductions of Aquatic Species (DIAS)

A review of DIAS revealed that aquaculture is the main reason for the deliberate introduction of aquatic species (Fig 1). This issue is extremely important in the Americas as aquaculture is promoted as a means to improved food and economic security. The group responsible for the introduction was not known in most cases, but where it was known, the government was most often cited as the responsible party (Fig. 2). Fin fish was the group most often introduced (Fig. 3) Although the information in DIAS may be biased in favor of reporting those introductions that succeeded in establishing themselves, 65% of the introductions were reported to have lead to established populations (Fig. 4). The impact of the vast majority of introductions has not been evaluated as to their impact on the natural environment or on the associated human community (Fig. 5). However of those introductions that were evaluated, there were more positive social and economic benefits than negative environmental impact.

Table 1. Some international mechanisms from the fishery development and academic communities to deal with introduced species

Mechanism	Reference
Codes of Practice	Bartley *et al*. 1995; FAO 1995; ICES 1995; Turner 1988
Opinionaire	Turner 1988
Networks and Professional Societies	American Fisheries Society (AFS), International Network of Genetics in Aquaculture (INGA)
Database	Bartley and Casal 1998; Garibaldi and Bartley 1999; Pauly and Froese 2000
Precautionary approach	Bartley 2000; Bartley and Minchin 1997;FAO 1997;

Table 2. Complementary articles on introduced species in the FAO Code of Conduct for Responsible Fisheries and the Convention on Biological Diversity

FAO Code of Conduct for Responsible Fisheries	UN Convention on Biological Diversity
9.2.3 Consult with neighbors on making an introduction	14c Notify neighboring countries when introductions are made
9.2.3 Create information systems	7d Maintain and organize data
9.2.5 Monitor aquatic environment	7b Monitor components of biological diversity
9.3.1 Conserve genetic diversity and ecosystems 9.3.3 Minimize disease transfer	8d Protect ecosystems 8g Manage living modified organisms 14a Environmental impact assessment
9.3.2 Develop codes of practice	8h Manage alien species
7.5 Precautionary approach	Prologue – Precautionary approach

Table 3. Recent decisions taken by the Convention on Biological Diversity in regards to introduced species

In Decision V/8 on Alien Species* the Conference of the Parties requested:
Relevant organizations to submit case studies on alien species and review guiding principles on the use of alien species
The Executive Secretary of the CBD to cooperate with relevant organizations on *inter alia* coordinating work, terminology, and methods for risk assessment
Creation of a review paper that outlines options for future work on alien species, including *inter alia*, further development of guiding principles and the development of an international instrument to govern the use of alien species
*Meeting of the Fifth Conference of the Parties to the Convention on Biological Diversity. 15-26 May, 2000. Nairobi, Kenya.

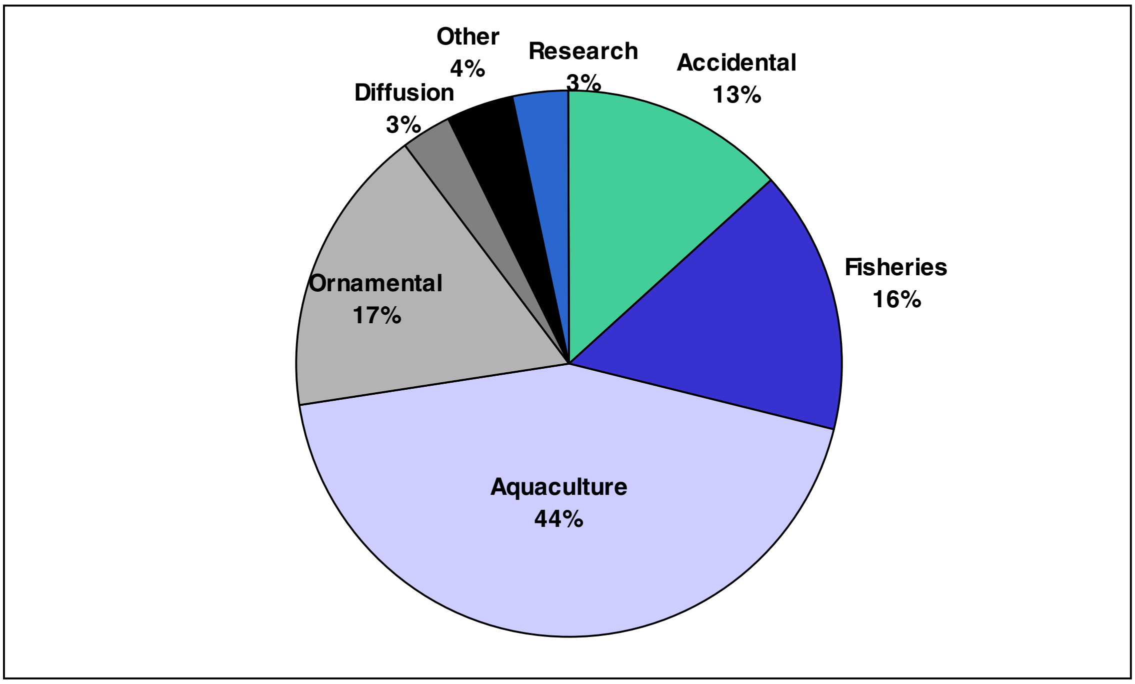

Figure 1. Reasons for introductions of aquatic species into the Americas according to a search of DIAS.

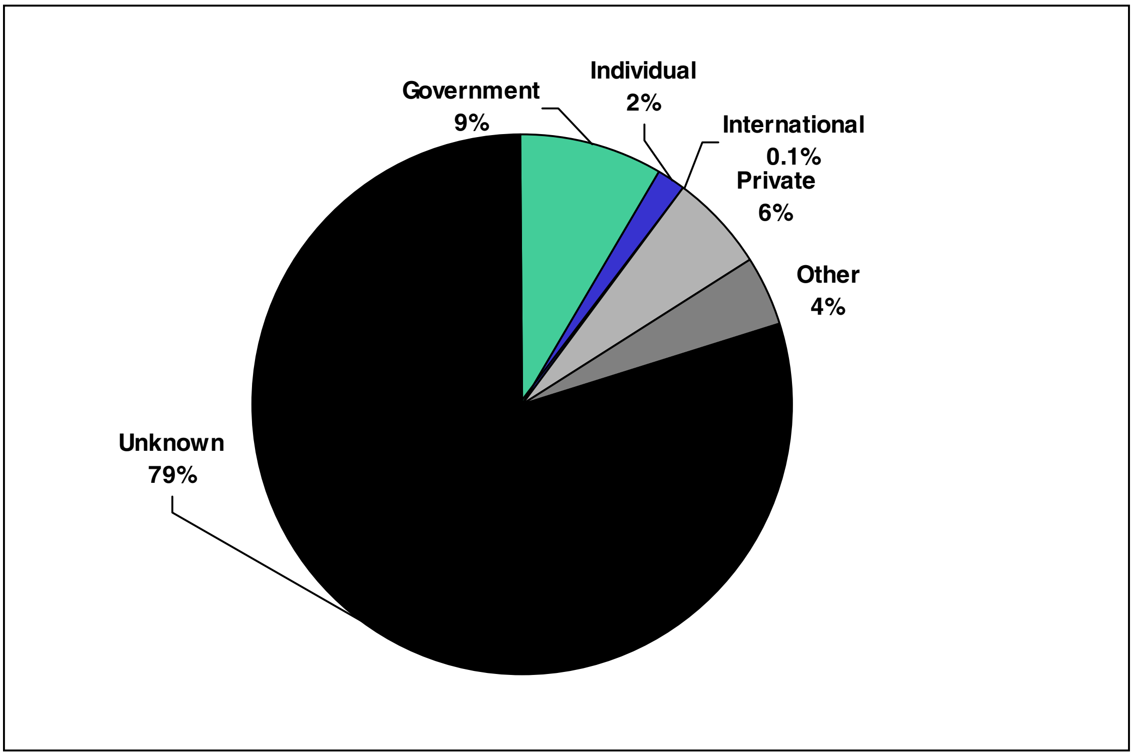

Figure 2. The groups responsible for the introduction of aquatic species into the Americas according to a search of DIAS.

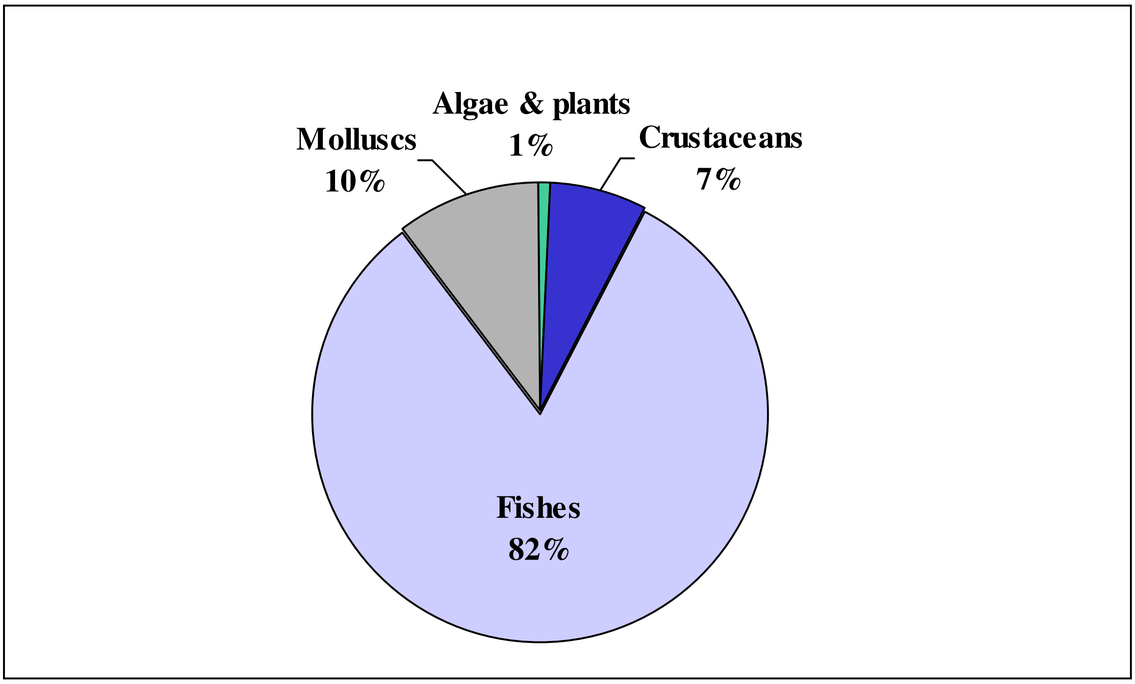

Figure 3. Relative introduction of taxa of aquatic species into the Americas according to a search of DIAS.

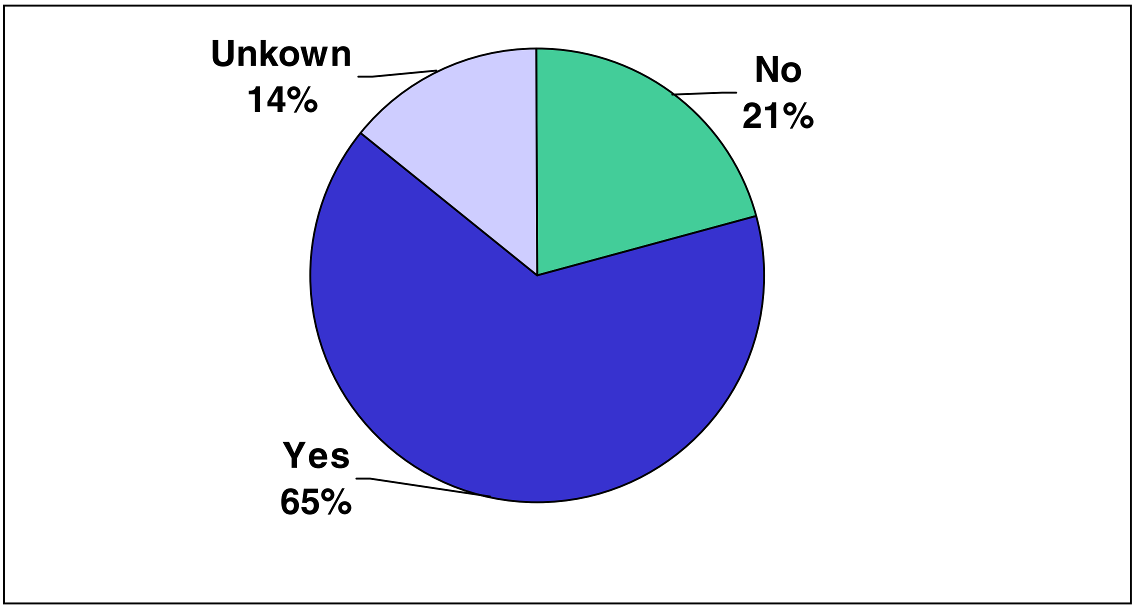

Figure 4. Percentage of introductions that lead to established populations in the Americas according to a search of DIAS.

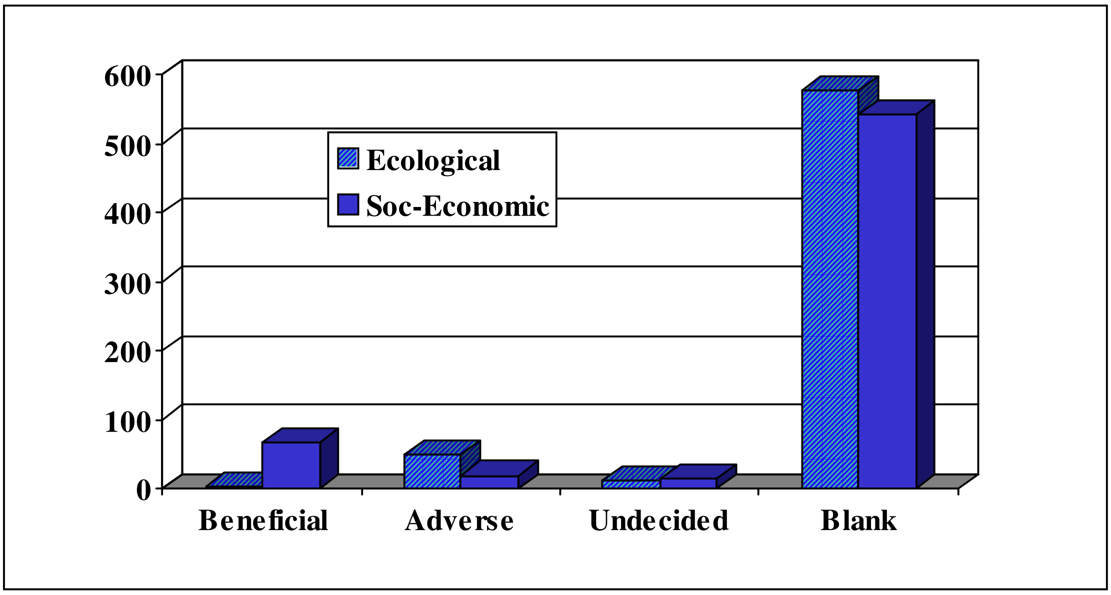

Figure 5. The social and ecological impacts introductions of aquatic species into the Americas according to a search of DIAS.

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6.5 Trans-boundary aquatic animal movement: compliance to international treaties and conventions: WTO

Presentation by Dr Alejandro Thiermann (USDA/APHIS, USA)

Background Paper on Description of the Agreement on the Application of Sanitary and Phytosanitary Measures

Background *The reason for negotiating the agreement and its relationship to other WTO Agreements*	From the beginning of the Uruguay Round negotiations, when many countries proposed the reduction or elimination of quantitative restrictions and other non-tariff barriers to trade in agriculture, it was considered necessary to also ensure that governments not resort to the unjustified use of sanitary or phytosanitary requirements as trade restrictions. It was in this context that a separate, specific Agreement on the Application of Sanitary and Phytosanitary Measures (the "SPS Agreement") was negotiated. The right of governments' to restrict trade when necessary to protect human, animal or plant life or health has always been recognized under the GATT (Article XX(b)) provided that the measures are not applied in a manner which unjustifiably discriminates between countries with the same conditions, or are not applied as a disguised restriction on trade. During the previous round of negotiations, the Tokyo Round, an Agreement on Technical Barriers to Trade (the "Standards Code") was negotiated. Those governments which accepted the Standards Code agreed to apply its notification and other requirements to their technical regulations and standards, including those for human health and safety, animal or plant life or health. The Standards Code was revised during the Uruguay Round and will continue to apply to technical regulations which are not specifically within the scope of the SPS Agreement, including those relating to general food labeling, nutrition, and packaging.
Preamble *Governments' right to protect life or health*	In the *Preamble*, WTO Members reaffirm the right of governments to adopt and enforce measures necessary to protect human, animal or plant life or health. However, they require that such measures not be applied in an arbitrary or discriminatory manner or constitute a disguised restriction on international trade. Because animal and plant health conditions vary widely among countries, sanitary and phytosanitary (SPS) measures are often applied on a bilateral basis. In order to minimize their negative effects on trade, WTO Members agreed to establish a multilateral framework of rules and disciplines for the development and application of SPS measures. WTO Members recognize that developing countries may face special difficulties in complying with the SPS measures of importing countries and agree to assist them.
Article 1 - General Provisions *What are sanitary and phytosanitary measures?*	The SPS Agreement applies to all SPS measures which may affect international trade. Sanitary and phytosanitary measures are defined in Annex I as any measures applied: to protect from human or animal life risks arising from additives, contaminants, toxins or disease-causing organisms in their food; human life plant- or animal-carried diseases (zoonoses); animal or plant life pests, diseases, or disease-causing organisms; a country damage caused by the entry, establishment or spread

	of pests. Sanitary and phytosanitary measures taken to protect the health of fish and wild fauna, as well as of forests and wild flora, are also included in this definition. All types of measures to achieve these purposes are covered by the SPS Agreement, whether these are requirements on final products, processing requirements, inspection, certification, treatment or packaging and labeling requirements directly related to food safety.
Article 2 - Basic Rights and Obligations *The right to restrict trade when necessary to protect health*	The basic right of governments to take SPS measures is subject to the disciplines of the SPS Agreement. SPS measures are to be applied only to the extent necessary to protect life or health; they must be based on scientific principles and not maintained without sufficient scientific evidence. In cases where there is not sufficient scientific evidence, countries can provisionally take SPS measures on the basis of existing relevant information, to be reviewed and revised when more evidence becomes available. SPS measures shall not treat products from various countries differently unless this is because of the specific health conditions (including of animals and plants) of each country, and shall not use SPS measures as disguised trade restrictions.

Articles 3 and 4 - Harmonization and Equivalence *Encouragement to use standards developed by international organizations, right to be more stringent and acceptance of different ways to protect health*	Along with their right to adopt and enforce SPS measures necessary to protect human, animal or plant life or health, governments have the right to establish the level of protection they consider necessary: their own "*appropriate level of sanitary or phytosanitary protection*", often called the *acceptable risk level*. To facilitate trade while ensuring food safety or animal and plant health, countries are encouraged to harmonize their SPS requirements. *"Harmonization"* means that the establishment of national SPS measures should be based on international standards, guidelines and recommendations, where they exist. However, countries may take more stringent sanitary or phytosanitary measures, if they have a scientific justification, or if they can demonstrate that the international standard would not provide what they consider to be the acceptable level of risk. In order to further harmonization, Members are encouraged to actively participate in the relevant international organizations and their subsidiary bodies, with a view to develop and periodically review standards, guidelines and recommendations. One task of a *Committee on Sanitary and Phytosanitary Measures*, established by the SPS Agreement, is to develop a procedure to monitor the process of international harmonization. The level of protection which a country decides to apply can often be achieved by different types of measures. This concept of *equivalence* is recognized by the SPS Agreement. Equivalence implies that the exporting country would have to prove to the importing country that its measure

[4] Three intergovernmental organizations are explicitly recognized by the SPS Agreement: the **Codex Alimentarius Commission**, a subsidiary body of the World Health Organization (WHO) and the Food and Agriculture Organization (FAO); the **International Office of Epizootics (OIE)**; and the **International Plant Protection Convention (IPPC)**, another subsidiary body of the FAO.

The SPS Agreement recognizes as international standards, recommendations and guidelines, those developed for **food safety** (in terms of additives, contaminants, toxins and disease causing organisms) by the Codex Alimentarius Commission; for **animal health** by the OIE; and for **plant protection** by the international and regional organizations operating in the framework of the IPPC.

[5] See note 1.

	achieves the level of protection required by the latter. In other words, that its measure is *equivalent*. For this purpose, the importing country should be allowed to inspect and test the measures of the exporting country.

Article 5 - Assessment of Risk and Determination of the Appropriate Level of Sanitary or Phytosanitary Protection	The SPS Agreement requires that SPS measures should be based as far as appropriate on the analysis and assessment of risks to life or health. This implies that when establishing its SPS measures, an importing country will evaluate the probability of the pest or disease entering the country, spreading and causing damage, and the seriousness of the damage. Damage is measured in both physical and economic terms (such as lost sales due to the pest or disease) or costs of treatment. With regard to food safety, what must be considered is the probability of adverse effects on human or animal health from additives, contaminants, toxins or disease-causing organisms in food, beverages or animal feedstuffs.
	When a country determines what level of SPS protection is acceptable, it should take into account the objective of minimizing negative trade effects. If there are alternative ways to achieve that health protection, the government should use those measures which are less negative to trade. Furthermore, a government's decision on what is an acceptable level of protection should not arbitrarily vary from one situation to another, which could result in discrimination or disguised trade restrictions. In other words, decisions on acceptable risk levels will have to be *consistent*. The SPS Committee is to develop guidelines for the implementation of this requirement, recognizing that there are some food safety risks which consumers voluntarily accept (e.g. from the consumption of alcoholic beverages) which should not be included in guidelines for consistency.
Evaluating the actual risks involved and deciding on the appropriate response	When a government considers that sufficient scientific evidence does not exist to permit a final decision on the safety of a product or process, it can take precautionary measures. Likewise, it can take immediate measures in emergency situations. If a country believes that its exports are restricted by an SPS measure of another country because this measure is not based on an international standard or because such a standard does not exist, it can request the importing country to explain the reasons for its measure.

Article 6 - Pest- or Disease-Free Areas and Areas of Low Pest or Disease Prevalence *Recognizing that health conditions may not correspond to political borders*	The SPS Agreement recognizes the concept of *pest- or disease-free areas*, which are largely determined by geographic and other ecological conditions of an "area" which might be only part of a country, or all or parts of several countries, in which a specific pest or disease does not occur. The practical implication is that an importing country should not deny access to goods from such areas even if the disease prevails elsewhere in the exporting country(ies). Based on certain factors, the exporting country will have the burden to prove the disease-free status that it claims for the region. For this purpose, the exporting country should allow experts from the importing country to test and inspect the area.
Articles 7 and 8 - Transparency and Control, Inspection and Approval Procedures *Making known the actions taken, and ensuring that measures to check compliance do not become trade barriers*	Governments are required to notify other countries of their sanitary and phytosanitary requirements which restrict trade and are not based on international standards, and to set up offices or enquiry points to respond to requests for more information. They must also open to scrutiny how they apply their food safety and animal and plant health regulations. Most countries operate control, inspection and approval procedures to check and ensure the fulfillment of SPS requirements. The SPS Agreement establishes a number of provisions aimed at speeding up the process and avoiding discrimination between procedures applying to domestic and imported products. Some countries have a system for approving the use of additives or for establishing tolerances for contaminants in foods, which prohibits or restricts access to its market because the additive being used or the residue found has not yet been domestically approved and put on a "positive list". In these cases, a country should consider using an international standard as a temporary requirement for imports until it can complete its own approval process. This implies that the importing country will not necessarily ban the entry of a product, whose safety has been considered at an international level, only because it has not yet domestically determined the safety of a specific additive or residue.

[6] See Note 2.

[7] Idem.

Articles 13 and 14 - Implementation *Obligations other than at national levels of government*	Central governments will be responsible for the implementation of the SPS Agreement. They should take the necessary actions to support observance of the SPS Agreement by other levels of government (i.e., provinces, states, departments, etc.), as well as regional government bodies or non-governmental entities.
Articles 9, 10 and 14 - Technical Assistance and Special and Differential Treatment for Developing Countries *Recognizing that developing countries may need help and more time to meet the requirements of the SPS Agreement*	The SPS Agreement calls for technical assistance among Members, in particular to developing countries, to enable them to strengthen their food safety and animal and plant health protection systems. The assistance can take different forms such as advice, training or equipment, or financial assistance, in areas such as processing technologies, research and infrastructure. In addition, the SPS Agreement (Article 10 in particular), recognizes the special needs of developing countries, and in particular of the least developed ones. It allows a certain flexibility for the introduction of new SPS measures and provides for the possibility of time-limited exceptions from some obligations under the SPS Agreement. The final provisions of the SPS Agreement permit least developed countries to delay implementation of the Agreement, with respect to their SPS import requirements, for five years following the entry into force of the WTO Agreement. Other developing countries may delay the application of the SPS Agreement to their import requirements by two years, if the application is prevented by a lack of technical expertise, infrastructure or resources.

Article 11 - Consultations and Dispute settlement *Using WTO procedures to resolve trade disputes*	In the case of a trade dispute regarding SPS measures, countries may use the dispute settlement mechanisms of other appropriate international organizations. Alternatively, they can utilize the WTO's dispute settlement procedures. Under these procedures countries must first try to find a bilateral solution. If they cannot resolve the dispute bilaterally, they can choose to follow any of several dispute settlement procedures, including good offices, conciliation, mediation or arbitration. Alternatively, a government may request that an impartial panel of trade experts be established to hear all sides of the dispute and to make recommendations. These recommendations would be presented for adoption by the Dispute Settlement Body, in which all WTO members are represented. If necessary, the dispute settlement panel can seek advice from a scientific or technical expert or from a group of experts.
Article 12 - Administration *The work of the SPS Committee*	A special WTO committee will be established as a forum for the exchange of information, consultation and negotiation among the WTO member governments on all aspects related to the SPS Agreement. The SPS Committee will review compliance with the Agreement, discuss matters with potential trade impact, and maintain close co-operation with the appropriate technical organizations. The SPS Committee will promote and monitor harmonization, encouraging the use of international standards, guidelines and recommendations. A list of international standards, guidelines and recommendations which have a major trade impact will be established, with countries indicating whether they use these standards as the requirements for imports. If a country does not use the international standard for imports, it should explain the reasons why it does not, especially if it considers that the international norm is not sufficient to provide the level of SPS protection that government has decided is acceptable. The SPS Committee may ask the relevant international organizations to examine the basis of the explanations for non-use. The SPS Committee will review the operation of the SPS Agreement three years after the implementation of the WTO and thereafter as needed and may submit amendment proposals to the WTO Council for Trade in Goods. The SPS Committee will reach its decisions by consensus.

[8]See Note 1.

AGREEMENT ON THE APPLICATION OF SANITARY AND PHYTOSANITARY MEASURES.

Members,

Reaffirming that no Member should be prevented from adopting or enforcing measures necessary to protect human, animal or plant life or health, subject to the requirement that these measures are not applied in a manner which would constitute a means of arbitrary or unjustifiable discrimination between Members where the same conditions prevail or a disguised restriction on international trade;

Desiring to improve the human health, animal health and phytosanitary situation in all Members;

Noting that sanitary and phytosanitary measures are often applied on the basis of bilateral agreements or protocols;

Desiring the establishment of a multilateral framework of rules and disciplines to guide the development, adoption and enforcement of sanitary and phytosanitary measures in order to minimize their negative effects on trade;

Recognizing the important contribution that international standards, guidelines and recommendations can make in this regard;

Desiring to further the use of harmonized sanitary and phytosanitary measures between Members, on the basis of international standards, guidelines and recommendations developed by the relevant international organizations, including the Codex Alimentarius Commission, the International Office of Epizootics, and the relevant international and regional organizations operating within the framework of the International Plant Protection Convention, without requiring Members to change their appropriate level of protection of human, animal or plant life or health;

Recognizing that developing country Members may encounter special difficulties in complying with the sanitary or phytosanitary measures of importing Members, and as a consequence in access to markets, and also in the formulation and application of sanitary or phytosanitary measures in their own territories, and desiring to assist them in their endeavours in this regard;

Desiring therefore to elaborate rules for the application of the provisions of GATT 1994 which relate to the use of sanitary or phytosanitary measures, in particular the provisions of Article XX(b)[9];

Hereby agree as follows:

Article 1

General Provisions

1. This Agreement applies to all sanitary and phytosanitary measures which may, directly or indirectly, affect international trade. Such measures shall be developed and applied in accordance with the provisions of this Agreement.

2. For the purposes of this Agreement, the definitions provided in Annex A shall apply.

3. The annexes are an integral part of this Agreement.

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[9]In this Agreement, reference to Article XX(b) includes also the chapeau of that Article.

4. Nothing in this Agreement shall affect the rights of Members under the Agreement on Technical Barriers to Trade with respect to measures not within the scope of this Agreement.

Article 2

Basic Rights and Obligations

1. Members have the right to take sanitary and phytosanitary measures necessary for the protection of human, animal or plant life or health, provided that such measures are not inconsistent with the provisions of this Agreement.

2. Members shall ensure that any sanitary or phytosanitary measure is applied only to the extent necessary to protect human, animal or plant life or health, is based on scientific principles and is not maintained without sufficient scientific evidence, except as provided for in paragraph 7 of Article 5.

3. Members shall ensure that their sanitary and phytosanitary measures do not arbitrarily or unjustifiably discriminate between Members where identical or similar conditions prevail, including between their own territory and that of other Members. Sanitary and phytosanitary measures shall not be applied in a manner which would constitute a disguised restriction on international trade.

4. Sanitary or phytosanitary measures which conform to the relevant provisions of this Agreement shall be presumed to be in accordance with the obligations of the Members under the provisions of GATT 1994 which relate to the use of sanitary or phytosanitary measures, in particular the provisions of Article XX(b).

Article 3
Harmonization

1. To harmonize sanitary and phytosanitary measures on as wide a basis as possible, Members shall base their sanitary or phytosanitary measures on international standards, guidelines or recommendations, where they exist, except as otherwise provided for in this Agreement, and in particular in paragraph 3.

2. Sanitary or phytosanitary measures which conform to international standards, guidelines or recommendations shall be deemed to be necessary to protect human, animal or plant life or health, and presumed to be consistent with the relevant provisions of this Agreement and of GATT 1994.

3. Members may introduce or maintain sanitary or phytosanitary measures which result in a higher level of sanitary or phytosanitary protection than would be achieved by measures based on the relevant international standards, guidelines or recommendations, if there is a scientific justification, or as a consequence of the level of sanitary or phytosanitary protection a Member determines to be appropriate in accordance with the relevant provisions of paragraphs 1 through 8 of Article 5. Notwithstanding the above, all measures which result in a level of sanitary or phytosanitary protection different from that which would be achieved by measures based on international standards, guidelines or recommendations shall not be inconsistent with any other provision of this Agreement.

4. Members shall play a full part, within the limits of their resources, in the relevant international organizations and their subsidiary bodies, in particular the Codex Alimentarius Commission, the International Office of Epizootics, and the international and regional organizations operating within the framework of the International Plant Protection Convention, to promote within these organizations the development and periodic review of standards, guidelines and recommendations with respect to all aspects of sanitary and phytosanitary measures.

For the purposes of paragraph 3 of Article 3, there is a scientific justification if, on the basis of an examination and evaluation of available scientific information in conformity with the relevant provisions of this Agreement, a Member determines that the relevant international standards, guidelines or recommendations are not sufficient to achieve its appropriate level of sanitary or phytosanitary protection.

5. The Committee on Sanitary and Phytosanitary Measures provided for in paragraphs 1 and 4 of Article 12 (referred to in this Agreement as the "Committee") shall develop a procedure to monitor the process of international harmonization and coordinate efforts in this regard with the relevant international organizations.

Article 4
Equivalence

1. Members shall accept the sanitary or phytosanitary measures of other Members as equivalent, even if these measures differ from their own or from those used by other Members trading in the same product, if the exporting Member objectively demonstrates to the importing Member that its measures achieve the importing Member's appropriate level of sanitary or phytosanitary protection. For this purpose, reasonable access shall be given, upon request, to the importing Member for inspection, testing and other relevant procedures.

2. Members shall, upon request, enter into consultations with the aim of achieving bilateral and multilateral agreements on recognition of the equivalence of specified sanitary or phytosanitary measures.

Article 5

Assessment of Risk and Determination of the Appropriate Level of Sanitary or Phytosanitary Protection

1. Members shall ensure that their sanitary or phytosanitary measures are based on an assessment, as appropriate to the circumstances, of the risks to human, animal or plant life or health, taking into account risk assessment techniques developed by the relevant international organizations.

2. In the assessment of risks, Members shall take into account available scientific evidence; relevant processes and production methods; relevant inspection, sampling and testing methods; prevalence of specific diseases or pests; existence of pest- or disease-free areas; relevant ecological and environmental conditions; and quarantine or other treatment.

3. In assessing the risk to animal or plant life or health and determining the measure to be applied for achieving the appropriate level of sanitary or phytosanitary protection from such risk, Members shall take into account as relevant economic factors: the potential damage in terms of loss of production or sales in the event of the entry, establishment or spread of a pest or disease; the costs of control or eradication in the territory of the importing Member; and the relative cost-effectiveness of alternative approaches to limiting risks.

4. Members should, when determining the appropriate level of sanitary or phytosanitary protection, take into account the objective of minimizing negative trade effects.

5. With the objective of achieving consistency in the application of the concept of appropriate level of sanitary or phytosanitary protection against risks to human life or health, or to animal and plant life or health, each Member shall avoid arbitrary or unjustifiable distinctions in the levels it considers to be appropriate in different situations, if such distinctions result in discrimination or a disguised restriction on international trade. Members shall cooperate in the Committee, in accordance with paragraphs 1, 2 and 3 of Article 12, to develop guidelines to further the practical implementation of this provision. In developing the guidelines, the Committee shall take into account all relevant factors, including the exceptional character of human health risks to which people voluntarily expose themselves.

6. Without prejudice to paragraph 2 of Article 3, when establishing or maintaining sanitary or phytosanitary measures to achieve the appropriate level of sanitary or phytosanitary protection, Members shall ensure that such measures are not more trade-restrictive than required to achieve their

appropriate level of sanitary or phytosanitary protection, taking into account technical and economic feasibility.

7. In cases where relevant scientific evidence is insufficient, a Member may provisionally adopt sanitary or phytosanitary measures on the basis of available pertinent information, including that from the relevant international organizations as well as from sanitary or phytosanitary measures applied by other Members. In such circumstances, Members shall seek to obtain the additional information necessary for a more objective assessment of risk and review the sanitary or phytosanitary measure accordingly within a reasonable period of time.

8. When a Member has reason to believe that a specific sanitary or phytosanitary measure introduced or maintained by another Member is constraining, or has the potential to constrain, its exports and the measure is not based on the relevant international standards, guidelines or recommendations, or such standards, guidelines or recommendations do not exist, an explanation of the reasons for such sanitary or phytosanitary measure may be requested and shall be provided by the Member maintaining the measure.

Article 6
Adaptation to Regional Conditions, Including Pest- or Disease-Free Areas and Areas of Low Pest or Disease Prevalence

1. Members shall ensure that their sanitary or phytosanitary measures are adapted to the sanitary or phytosanitary characteristics of the area - whether all of a country, part of a country, or all or parts of several countries - from which the product originated and to which the product is destined. In assessing the sanitary or phytosanitary characteristics of a region, Members shall take into account, *inter alia*, the level of prevalence of specific diseases or pests, the existence of eradication or control programmes, and appropriate criteria or guidelines which may be developed by the relevant international organizations.

2. Members shall, in particular, recognize the concepts of pest- or disease-free areas and areas of low pest or disease prevalence. Determination of such areas shall be based on factors such as geography, ecosystems, epidemiological surveillance, and the effectiveness of sanitary or phytosanitary controls.

3. Exporting Members claiming that areas within their territories are pest- or disease-free areas or areas of low pest or disease prevalence shall provide the necessary evidence thereof in order to objectively demonstrate to the importing Member that such areas are, and are likely to remain, pest- or disease-free areas or areas of low pest or disease prevalence, respectively. For this purpose, reasonable access shall be given, upon request, to the importing Member for inspection, testing and other relevant procedures.

Article 7
Transparency

Members shall notify changes in their sanitary or phytosanitary measures and shall provide information on their sanitary or phytosanitary measures in accordance with the provisions of Annex B.

Article 8
Control, Inspection and Approval Procedures

Members shall observe the provisions of Annex C in the operation of control, inspection and approval procedures, including national systems for approving the use of additives or for establishing tolerances for contaminants in foods, beverages or feedstuffs, and otherwise ensure that their procedures are not inconsistent with the provisions of this Agreement.

For purposes of paragraph 6 of Article 5, a measure is not more trade-restrictive than required unless there is another measure, reasonably available taking into account technical and economic feasibility, that achieves the appropriate level of sanitary or phytosanitary protection and is significantly less restrictive to trade.

Article 9
Technical Assistance

1. Members agree to facilitate the provision of technical assistance to other Members, especially developing country Members, either bilaterally or through the appropriate international organizations. Such assistance may be, *inter alia*, in the areas of processing technologies, research and infrastructure, including in the establishment of national regulatory bodies, and may take the form of advice, credits, donations and grants, including for the purpose of seeking technical expertise, training and equipment to allow such countries to adjust to, and comply with, sanitary or phytosanitary measures necessary to achieve the appropriate level of sanitary or phytosanitary protection in their export markets.

2. Where substantial investments are required in order for an exporting developing country Member to fulfil the sanitary or phytosanitary requirements of an importing Member, the latter shall consider providing such technical assistance as will permit the developing country Member to maintain and expand its market access opportunities for the product involved.

Article 10
Special and Differential Treatment

1. In the preparation and application of sanitary or phytosanitary measures, Members shall take account of the special needs of developing country Members, and in particular of the least-developed country Members.

2. Where the appropriate level of sanitary or phytosanitary protection allows scope for the phased introduction of new sanitary or phytosanitary measures, longer time-frames for compliance should be accorded on products of interest to developing country Members so as to maintain opportunities for their exports.

3. With a view to ensuring that developing country Members are able to comply with the provisions of this Agreement, the Committee is enabled to grant to such countries, upon request, specified, time-limited exceptions in whole or in part from obligations under this Agreement, taking into account their financial, trade and development needs.

4. Members should encourage and facilitate the active participation of developing country Members in the relevant international organizations.

Article 11
Consultations and Dispute Settlement

1. The provisions of Articles XXII and XXIII of GATT 1994 as elaborated and applied by the Dispute Settlement Understanding shall apply to consultations and the settlement of disputes under this Agreement, except as otherwise specifically provided herein.

2. In a dispute under this Agreement involving scientific or technical issues, a panel should seek advice from experts chosen by the panel in consultation with the parties to the dispute. To this end, the panel may, when it deems it appropriate, establish an advisory technical experts group, or consult the relevant international organizations, at the request of either party to the dispute or on its own initiative.

3. Nothing in this Agreement shall impair the rights of Members under other international agreements, including the right to resort to the good offices or dispute settlement mechanisms of other international organizations or established under any international agreement.

Article 12
Administration

1. A Committee on Sanitary and Phytosanitary Measures is hereby established to provide a regular forum for consultations. It shall carry out the functions necessary to implement the provisions of this Agreement and the furtherance of its objectives, in particular with respect to harmonization. The Committee shall reach its decisions by consensus.

2. The Committee shall encourage and facilitate ad hoc consultations or negotiations among Members on specific sanitary or phytosanitary issues. The Committee shall encourage the use of international standards, guidelines or recommendations by all Members and, in this regard, shall sponsor technical consultation and study with the objective of increasing coordination and integration between international and national systems and approaches for approving the use of food additives or for establishing tolerances for contaminants in foods, beverages or feedstuffs.

3. The Committee shall maintain close contact with the relevant international organizations in the field of sanitary and phytosanitary protection, especially with the Codex Alimentarius Commission, the International Office of Epizootics, and the Secretariat of the International Plant Protection Convention, with the objective of securing the best available scientific and technical advice for the administration of this Agreement and in order to ensure that unnecessary duplication of effort is avoided.

4. The Committee shall develop a procedure to monitor the process of international harmonization and the use of international standards, guidelines or recommendations. For this purpose, the Committee should, in conjunction with the relevant international organizations, establish a list of international standards, guidelines or recommendations relating to sanitary or phytosanitary measures which the Committee determines to have a major trade impact. The list should include an indication by Members of those international standards, guidelines or recommendations which they apply as conditions for import or on the basis of which imported products conforming to these standards can enjoy access to their markets. For those cases in which a Member does not apply an international standard, guideline or recommendation as a condition for import, the Member should provide an indication of the reason therefor, and, in particular, whether it considers that the standard is not stringent enough to provide the appropriate level of sanitary or phytosanitary protection. If a Member revises its position, following its indication of the use of a standard, guideline or recommendation as a condition for import, it should provide an explanation for its change and so inform the Secretariat as well as the relevant international organizations, unless such notification and explanation is given according to the procedures of Annex B.

5. In order to avoid unnecessary duplication, the Committee may decide, as appropriate, to use the information generated by the procedures, particularly for notification, which are in operation in the relevant international organizations.

6. The Committee may, on the basis of an initiative from one of the Members, through appropriate channels invite the relevant international organizations or their subsidiary bodies to examine specific matters with respect to a particular standard, guideline or recommendation, including the basis of explanations for non-use given according to paragraph 4.

7. The Committee shall review the operation and implementation of this Agreement three years after the date of entry into force of the WTO Agreement, and thereafter as the need arises. Where appropriate, the Committee may submit to the Council for Trade in Goods proposals to amend the text of this Agreement having regard, *inter alia*, to the experience gained in its implementation.

Article 13
Implementation

Members are fully responsible under this Agreement for the observance of all obligations set forth herein. Members shall formulate and implement positive measures and mechanisms in support of the observance of the provisions of this Agreement by other than central government bodies. Members shall take such reasonable measures as may be available to them to ensure that non-governmental entities within their territories, as well as regional bodies in which relevant entities within their territories are members, comply with the relevant provisions of this Agreement. In addition, Members shall not take measures which have the effect of, directly or indirectly, requiring or encouraging such regional or non-governmental entities, or local governmental bodies, to act in a manner inconsistent with the provisions of this Agreement. Members shall ensure that they rely on the services of non-governmental entities for implementing sanitary or phytosanitary measures only if these entities comply with the provisions of this Agreement.

Article 14
Final Provisions

The least-developed country Members may delay application of the provisions of this Agreement for a period of five years following the date of entry into force of the WTO Agreement with respect to their sanitary or phytosanitary measures affecting importation or imported products. Other developing country Members may delay application of the provisions of this Agreement, other than paragraph 8 of Article 5 and Article 7, for two years following the date of entry into force of the WTO Agreement with respect to their existing sanitary or phytosanitary measures affecting importation or imported products, where such application is prevented by a lack of technical expertise, technical infrastructure or resources.

ANNEX A

DEFINITIONS

1. *Sanitary or phytosanitary measure* - Any measure applied:

(a) to protect animal or plant life or health within the territory of the Member from risks arising from the entry, establishment or spread of pests, diseases, disease-carrying organisms or disease-causing organisms;

(b) to protect human or animal life or health within the territory of the Member from risks arising from additives, contaminants, toxins or disease-causing organisms in foods, beverages or feedstuffs;

(c) to protect human life or health within the territory of the Member from risks arising from diseases carried by animals, plants or products thereof, or from the entry, establishment or spread of pests; or

(d) to prevent or limit other damage within the territory of the Member from the entry, establishment or spread of pests.

Sanitary or phytosanitary measures include all relevant laws, decrees, regulations, requirements and procedures including, *inter alia*, end product criteria; processes and production methods; testing, inspection, certification and approval procedures; quarantine treatments including relevant requirements associated with the transport of animals or plants, or with the materials necessary for their survival during transport; provisions on relevant statistical methods, sampling procedures and methods of risk assessment; and packaging and labelling requirements directly related to food safety.

2. *Harmonization* - The establishment, recognition and application of common sanitary and phytosanitary measures by different Members.

3. *International standards, guidelines and recommendations*

(a) for food safety, the standards, guidelines and recommendations established by the Codex Alimentarius Commission relating to food additives, veterinary drug and pesticide residues, contaminants, methods of analysis and sampling, and codes and guidelines of hygienic practice;

(b) for animal health and zoonoses, the standards, guidelines and recommendations developed under the auspices of the International Office of Epizootics;

(c) for plant health, the international standards, guidelines and recommendations developed under the auspices of the Secretariat of the International Plant Protection Convention in cooperation with regional organizations operating within the framework of the International Plant Protection Convention; and

(d) for matters not covered by the above organizations, appropriate standards, guidelines and recommendations promulgated by other relevant international organizations open for membership to all Members, as identified by the Committee.

4. *Risk assessment* - The evaluation of the likelihood of entry, establishment or spread of a pest or disease within the territory of an importing Member according to the sanitary or phytosanitary measures which might be applied, and of the associated potential biological and economic consequences; or the evaluation of the potential for adverse effects on human or animal health arising from the presence of additives, contaminants, toxins or disease-causing organisms in food, beverages or feedstuffs.

For the purpose of these definitions, "animal" includes fish and wild fauna; "plant" includes forests and wild flora; "pests" include weeds; and "contaminants" include pesticide and veterinary drug residues and extraneous matter.

5. *Appropriate level of sanitary or phytosanitary protection* - The level of protection deemed appropriate by the Member establishing a sanitary or phytosanitary measure to protect human, animal or plant life or health within its territory.

NOTE: Many Members otherwise refer to this concept as the “acceptable level of risk”.

6. *Pest- or disease-free area* - An area, whether all of a country, part of a country, or all or parts of several countries, as identified by the competent authorities, in which a specific pest or disease does not occur.

NOTE: A pest- or disease-free area may surround, be surrounded by, or be adjacent to an area - whether within part of a country or in a geographic region which includes parts of or all of several countries -in which a specific pest or disease is known to occur but is subject to regional control measures such as the establishment of protection, surveillance and buffer zones which will confine or eradicate the pest or disease in question.

7. *Area of low pest or disease prevalence* - An area, whether all of a country, part of a country, or all or parts of several countries, as identified by the competent authorities, in which a specific pest or disease occurs at low levels and which is subject to effective surveillance, control or eradication measures.

ANNEX B

TRANSPARENCY OF SANITARY AND PHYTOSANITARY REGULATIONS

Publication of regulations

1. Members shall ensure that all sanitary and phytosanitary regulations which have been adopted are published promptly in such a manner as to enable interested Members to become acquainted with them.

2. Except in urgent circumstances, Members shall allow a reasonable interval between the publication of a sanitary or phytosanitary regulation and its entry into force in order to allow time for producers in exporting Members, and particularly in developing country Members, to adapt their products and methods of production to the requirements of the importing Member.

Enquiry points

3. Each Member shall ensure that one enquiry point exists which is responsible for the provision of answers to all reasonable questions from interested Members as well as for the provision of relevant documents regarding:

(a) any sanitary or phytosanitary regulations adopted or proposed within its territory;

(b) any control and inspection procedures, production and quarantine treatment, pesticide tolerance and food additive approval procedures, which are operated within its territory;

(c) risk assessment procedures, factors taken into consideration, as well as the determination of the appropriate level of sanitary or phytosanitary protection;

(d) the membership and participation of the Member, or of relevant bodies within its territory, in international and regional sanitary and phytosanitary organizations and systems, as well as in bilateral and multilateral agreements and arrangements within the scope of this Agreement, and the texts of such agreements and arrangements.

Sanitary and phytosanitary measures such as laws, decrees or ordinances which are applicable generally.

4. Members shall ensure that where copies of documents are requested by interested Members, they are supplied at the same price (if any), apart from the cost of delivery, as to the nationals of the Member concerned.

Notification procedures

5. Whenever an international standard, guideline or recommendation does not exist or the content of a proposed sanitary or phytosanitary regulation is not substantially the same as the content of an international standard, guideline or recommendation, and if the regulation may have a significant effect on trade of other Members, Members shall:

(a) publish a notice at an early stage in such a manner as to enable interested Members to become acquainted with the proposal to introduce a particular regulation;

(b) notify other Members, through the Secretariat, of the products to be covered by the regulation together with a brief indication of the objective and rationale of the proposed regulation. Such notifications shall take place at an early stage, when amendments can still be introduced and comments taken into account;

(c) provide upon request to other Members copies of the proposed regulation and, whenever possible, identify the parts which in substance deviate from international standards, guidelines or recommendations;

(d) without discrimination, allow reasonable time for other Members to make comments in writing, discuss these comments upon request, and take the comments and the results of the discussions into account.

6. However, where urgent problems of health protection arise or threaten to arise for a Member, that Member may omit such of the steps enumerated in paragraph 5 of this Annex as it finds necessary, provided that the Member:

(a) immediately notifies other Members, through the Secretariat, of the particular regulation and the products covered, with a brief indication of the objective and the rationale of the regulation, including the nature of the urgent problem(s);

(b) provides, upon request, copies of the regulation to other Members;

(c) allows other Members to make comments in writing, discusses these comments upon request, and takes the comments and the results of the discussions into account.

7. Notifications to the Secretariat shall be in English, French or Spanish.

8. Developed country Members shall, if requested by other Members, provide copies of the documents or, in case of voluminous documents, summaries of the documents covered by a specific notification in English, French or Spanish.

9. The Secretariat shall promptly circulate copies of the notification to all Members and interested international organizations and draw the attention of developing country Members to any notifications relating to products of particular interest to them.

10. Members shall designate a single central government authority as responsible for the implementation, on the national level, of the provisions concerning notification procedures according to paragraphs 5, 6, 7 and 8 of this Annex.

General reservations

When “nationals” are referred to in this Agreement, the term shall be deemed, in the case of a separate customs territory Member of the WTO, to mean persons, natural or legal, who are domiciled or who have a real and effective industrial or commercial establishment in that customs territory.

11. Nothing in this Agreement shall be construed as requiring:

(a) the provision of particulars or copies of drafts or the publication of texts other than in the language of the Member except as stated in paragraph 8 of this Annex; or

(b) Members to disclose confidential information which would impede enforcement of sanitary or phytosanitary legislation or which would prejudice the legitimate commercial interests of particular enterprises.

ANNEX C

CONTROL, INSPECTION AND APPROVAL PROCEDURES

1. Members shall ensure, with respect to any procedure to check and ensure the fulfilment of sanitary or phytosanitary measures, that:

(a) such procedures are undertaken and completed without undue delay and in no less favourable manner for imported products than for like domestic products;

(b) the standard processing period of each procedure is published or that the anticipated processing period is communicated to the applicant upon request; when receiving an application, the competent body promptly examines the completeness of the documentation and informs the applicant in a precise and complete manner of all deficiencies; the competent body transmits as soon as possible the results of the procedure in a precise and complete manner to the applicant so that corrective action may be taken if necessary; even when the application has deficiencies, the competent body proceeds as far as practicable with the procedure if the applicant so requests; and that upon request, the applicant is informed of the stage of the procedure, with any delay being explained;

(c) information requirements are limited to what is necessary for appropriate control, inspection and approval procedures, including for approval of the use of additives or for the establishment of tolerances for contaminants in food, beverages or feedstuffs;

(d) the confidentiality of information about imported products arising from or supplied in connection with control, inspection and approval is respected in a way no less favourable than for domestic products and in such a manner that legitimate commercial interests are protected;

(e) any requirements for control, inspection and approval of individual specimens of a product are limited to what is reasonable and necessary;

(f) any fees imposed for the procedures on imported products are equitable in relation to any fees charged on like domestic products or products originating in any other Member and should be no higher than the actual cost of the service;

(g) the same criteria should be used in the siting of facilities used in the procedures and the selection of samples of imported products as for domestic products so as to minimize the inconvenience to applicants, importers, exporters or their agents;

(h) whenever specifications of a product are changed subsequent to its control and inspection in light of the applicable regulations, the procedure for the modified product is limited to what is necessary to determine whether adequate confidence exists that the product still meets the regulations concerned; and

(i) a procedure exists to review complaints concerning the operation of such procedures and to take corrective action when a complaint is justified.

Control, inspection and approval procedures include, *inter alia*, procedures for sampling, testing and certification.

Where an importing Member operates a system for the approval of the use of food additives or for the establishment of tolerances for contaminants in food, beverages or feedstuffs which prohibits or restricts access to its domestic markets for products based on the absence of an approval, the importing Member shall consider the use of a relevant international standard as the basis for access until a final determination is made.

2. Where a sanitary or phytosanitary measure specifies control at the level of production, the Member in whose territory the production takes place shall provide the necessary assistance to facilitate such control and the work of the controlling authorities.

3. Nothing in this Agreement shall prevent Members from carrying out reasonable inspection within their own territories.

6.6 An overview of shrimp viral diseases

Presentation by Dr Victoria Alday de Graindorge (Shrimp Diagnostic Unit, Center for Aquaculture Services, Guayaquil, Ecuador)

There are seven different viruses that have relevant impact globally on commercial farming of penaeid shrimp. In the order of greatest to least economic importance, the viruses are : (a) white spot syndrome virus (WSSV), (b) yellow-head virus (YHV), (c) Taura syndrome virus (TSV), (d) infectious hypodermal and haematopoietic necrosis virus (IHHNV), (e) hepatopancreatic parvovirus (HPV), (f) monodon baculovirus (MBV) and (g) baculovirus penaei (BP).

The geographical distribution of these viruses changed during the last few years with an increasing presence in both hemispheres (Table 1). On most occasions, the spread of the virus has been carried out through the uncontrolled movement of live animals.

Table 1. Geographic distribution of the major shrimp viruses

	America	Asia	Australia
WSSV	Present (except for Venezuela, Brazil, Belize, Cuba)	Present	Not described
YHV	USA (1 isolated case)	Thailand	GAV/LOV
TSV	Present	Chinese Taipei-China	Not described
IHHNV	Present	Present	Present
HPV	Present	Present	Present
MBV	Present	Present	Present
BP	Present	Not described	Not described

Histology and polymerase chain reaction (PCR) are the two main techniques used for diagnosis and detection of pathogens. The selection of the technique depends on the purpose of the study. Histology is the adequate method for diagnosis of disease outbreaks as presence and degree of the lesions can be evaluated using this technique. The identification of the causative agent is based on the pathognomonic lesions that it causes. However, histology is not suitable to detect early infections. On the contrary, PCR identifies the presence of a pathogen, but the information on the possible lesions it may be causing is not provided. Due to its high sensitivity, PCR can be used for early detection of infection. PCR has only recently been adopted as a routine technique, till then, diagnosis and detection of pathogens has been done mostly through histology.

6.7 Regional and international activities and future requirements for standardization/harmonization of diagnostic techniques for aquatic animal diseases identification and control

Presentation by Dr Peter Walker (CSIRO, Australia)

Disease is now recognized as one of the primary limiting factors in the ecologically sustainable development of aquaculture. In many developing economies in Asia and Latin America, disease has had a major impact on national production, causing reduced export earnings and loss of income to subsistence level farmers. The impact of disease has been most severe in the shrimp farming sector. In 1996, the World Bank estimated that, in shrimp aquaculture, the direct annual impact of viral disease was in excess of US$ 3,000 million or 40% of global production capacity. During the past 5 years, the impact of disease has not abated. Control measures in Asia have been largely ineffective and production losses in the Americas have increased dramatically through the importation of new disease.

The rapid spread of disease between economies and between regions through trade in live or frozen shrimp is of increasing concern. During the 1990's two of the most damaging pathogens of cultured shrimp have emerged, each apparently from a single site, and rapidly spread in explosively radiating epidemics. White spot syndrome was first reported in 1991, or early 1992, in domesticated *M. japonicus* at a single location in the north-eastern part of the economy of Chinese Taipei (Wang *et al.,* 1996; Chou *et al*., 1995). The virus subsequently spread to mainland China, and was endemic in most of the major shrimp farming regions of Asia by 1996. Isolated cases of white spot syndrome also occurred in the USA from 1995. WSSV has now established as an endemic pathogen throughout most of the shrimp farming regions of the Americas. Taura syndrome first emerged in *Penaeus vannamei* at a single site near the mouth of the Taura River in Ecuador in mid-1992. The virus has subsequently become endemic throughout most of the American industry (Hasson *et al.,* 1999). In March 1999, TSV was also reported in Chinese Taipei, having entered Asia through the importation of covertly infected white shrimp from the Americas (Yu and Song, 2000).

In response to the potential for serious economic consequences of disease importation, there is increasing reliance on trade restrictions to prevent the spread of shrimp pathogens. However, these are often implemented without reference to the internationally agreed procedures and protocols instituted in the Sanitary and Phyto-Sanitary (SPS) Agreement of the World Trade Organization that are intended to promote free trade. A primary impediment to the implementation of appropriate disease surveillance and screening protocols has been the lack of capacity in DNA-based diagnostic procedures. These technically demanding procedures provide the only effective means of screening for shrimp viruses which frequently occur as covert or unapparent infections in healthy shrimp and other crustaceans. There is also a lack standardized/harmonized of DNA-based testing protocols and little inter-calibration of test sensitivity and specificity between laboratories.

In February 1999, FAO/NACA sponsored an Expert Workshop in Bangkok on Research Needs for Standardization and Validation of DNA-Based Diagnostic Techniques for Detection of aquatic Animal Pathogens and Diseases (see FAO Fisheries Technical Paper 395). In addition to programs of underpinning research, the workshop recommended the development of training programs for staff from key laboratories in the region in the application of DNA-based technologies for shrimp pathogens, including sample collection, test protocols and the analysis and interpretation of test results. Training was also recommended in the use of standard histopathological methods for health screening of fish and molluscs, for which DNA-based methods were considered either to be unnecessary, inappropriate or unavailable. The workshop also recommended the development of a laboratory accreditation program in order to achieve standardization/harmonization of sampling methods and test procedures, and the establishment of regional resource laboratories to assist inter-calibration for each of the major pathogens. The WB/NACA/WWF/FAO-sponsored Expert Workshop on Management Strategies for Major Diseases in Shrimp Aquaculture conducted in Cebu City, Philippines in November 1999 identified similar needs in capacity building, harmonization and inter-calibration of diagnostic procedures and for the development national resource centers.

Implementation of harmonized procedures for disease diagnosis and pathogen detection will be assisted by the publication by the OIE in October 2000 of International Aquatic Animal Health Code and Diagnostic Manual for Aquatic Animal Diseases. The Manual will include DNA-based testing protocols for the major viral pathogens of shrimp. An intensive training program in DNA-based diagnostic procedures for shrimp viruses has been developed jointly by CSIRO in Australia and Mahidol University in Thailand, with support from the Australian Centre for International Agricultural Research (ACIAR), the Crawford Fund and the National Centre for Genetic Engineering and Biotechnology (BIOTEC) in Thailand. The training has been implemented successfully for a pilot group of health specialists from 8 Asian countries through courses conducted in Bangkok in 1999 and 2000. A similar course has been conducted for health specialists in Vietnam. Limited inter-calibration exercises for WSSV PCR testing have also been initiated by several groups in Asia and Latin America.

There is a need for a more coordinated approach to the implementation of training for key health specialists in DNA-based detection tests for shrimp pathogens, harmonization/standardization of test protocols, and inter-calibration between laboratories of detection test sensitivity and specificity. This will be assisted by the establishment of regional and inter-regional communication networks of key health specialists and the support from governments and industry for implementation of harmonized protocols and programs of diagnostic laboratory accreditation.

Chou, H.Y. *et al*., 1995. Pathogenicity of a baculovirus infection causing white spot syndrome in cultured penaeid shrimp in Taiwan. Diseases of Aquatic Organisms 23: 165-173.

Hasson K.W. *et al*., 1999. The geographic distribution of Taura syndrome virus (TSV) in the Americas: determination by histopathology and in situ hybridization using TSV-specific cDNA probes. Aquaculture 171: 13-26.

Wang, C.S. *et al*., 1996. Yellow head disease-like virus infection in Kuruma shrimp Penaeus japonicus cultured in Taiwan. Fish Pathology 31: 177-182, 1996.

Yu, C.I. and Y.L. Song, 2000. Outbreaks of Taura Syndrome in Pacific white shrimp *Penaeus vannamei* culture in Taiwan. Fish Pathology 35: 21-24.

6.8 Trans-boundary movement of aquatic animals: applying risk assessment for reducing transfer of pathogens

Presentation by Dr Alejandro Thiermann (USDA/APHIS, USA)

The presentation introduced and discussed the concept of import risk analysis. The movement of live aquatic animals involves a degree of disease risk to the importing country. Import risk analysis (IRA) is the process by which hazards associated with the movement of a particular commodity are identified and options for management of identified risk are assessed. The results of these analyses are communicated to the authorities responsible for approving or rejecting the import. An effective IRA recommends measures which will reduce the identified risk(s)to a level acceptable to the importing authorities.

It is important to note that the methods used in evaluating risk may differ between countries, and approaches taken by an importing country may vary for different commodities. Whatever methods are used, they should be science-based, transparent, and standardized (as far as possible), and the process must include detailed documentation.

The OIE *International Aquatic Animal Health Code* defines import risk analysis as: "...to provide importing countries with an objective and defensible method of assessing the disease risks associated with importation of aquatic animals, aquatic animal products, aquatic animal genetic material, foodstuffs, biological products and pathological material."

The main components of import risk analysis are: hazard identification, risk assessment, risk management and risk communication.

The first stage of an import risk analysis involves identification of any hazards, including all pests and disease agents associated with the commodity, which can be reasonably deemed (i.e., scientifically justified) to be of potential threat to any aquatic animals or component of the importing waters.

This is followed by a risk assessment, where the effect of each hazard under unrestricted importation conditions is evaluated. The risk assessment includes evaluation of the probability of an exotic disease agent becoming established in the importing environment and the consequences of that establishment. Depending on the epidemiological data available for each infectious agent identified, the risk may be estimated qualitatively, semi-quantitatively or quantitatively.

Finally, the management options for the identified risks are considered, and the results are communicated.

Member nations of the World Trade Organization (WTO) have certain rights and obligations under WTO agreements, including the Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement). At present, the SPS Agreement recognizes the standards, guidelines and recommendations developed by the OIE as the international standard for animal health and zoonoses. Under the SPS Agreement, members are encouraged to ensure their health control measures are consistent with international standards. Members may require higher or supplemental levels of protection where these are based on a scientific risk analysis.

6.9 Zoning for aquatic animal disease control

Presentation by Dr Barry Hill (CEFAS, UK)

The presentation provided and outline on the concept of zoning and how the concept may be useful for delineating aquatic animal disease status. As Asia and Latin America have little experience and capacity in zoning for aquatic animal diseases, the information given was based mainly on experience outside of these regions.

The advantages of zoning is that it allows for part of a nation's territory to be identified as free of a particular disease, rather than having to demonstrate that the entire country is free. This is particularly helpful for diseases where eradication is not a feasible option in the foreseeable future, as it permits protection of zones free of the disease by restricting introduction of aquatic animals to those originating from other free zones.

Because most aquatic animal transfers within the Asia and Latin America are from open- or flow-through aquatic environments, it is generally more difficult to establish health status on a farm-by-farm or facility-by-facility basis (as is the case for most terrestrial health management programs). In addition, natural migrations of some species which are moved between areas further broaden the geographic range over which specific disease agents may be distributed. In order to address this, the concept of "zoning" is commonly applied to aquatic environments and species with the goal of: i) facilitating trade between zones of equal health status, and ii) protecting zones determined to be free of specific disease agents from introductions from zones which are positive for these disease agents.

Traditionally, political boundaries have been used to delineate the aquatic animal disease status within a country. Often this has been extended to the country as a whole, even where the diseases of concern have a limited within-country distribution. This has been a common scenario due to administrative ease, rather than a reflection of true health profiles of aquatic animals being moved from one area or country to another.

Ecological, geographical, hydrographical or climatological barriers, rather than political boundaries, form a stronger basis for defining actual disease agent distribution. Since non-political boundaries, by definition, do not necessarily coincide with political boundaries (e.g., multinational river catchment areas, bays or ocean coastlines), this requires multinational or multi-jurisdictional collaboration in order for health management of aquatic animal movements to be effective.

Zoning can be a highly effective tool to restrict the spread of important pathogens and aid in their eradication. Thus, the general principles of zoning should be considered by participating countries and sub-regions when preparing strategies for disease containment and eradication. This may require trans-boundary collaboration.

Implementation of zoning requires a high level of diagnostic, surveillance, monitoring and reporting capability, as well as adequate regulatory control mechanisms. Thus, some countries may not be able to establish zones in the immediate future. Zoning based on a basic diagnostic capability, however, is a valuable first step, while diagnostic capability, national legislation and related infrastructure are developed.

Pilot projects and exchange of information between countries will be necessary to further evaluate the feasibility of zoning within the region.

The nature and maintenance of zones will vary, depending on the particular disease(s) for which they are established. Thus, the size, location and delineation of the zone will depend on the characteristics of the disease, its modes of spread and prevalence in the country(ies) within the zone.

Some diseases will require zonation comprising an entire river catchment from source to sea, or two or more river catchments that are linked to each other. Other cases may permit zonation within part of a river system e.g., river stretches below a physical or ecological barrier could harbor hosts of infected or unknown health status, while upstream of the barrier hosts could be disease-free. The reverse situation is less likely.

Zoning for health status in coastal areas is often difficult due to the complexity of identifying distinct demarcations in contiguous stretches of water.

Where there are zones of equal health status, there is little, if any justification, on disease-risk grounds, for preventing trade in aquatic animals between them. This applies equally to trade between zones which have been demonstrated to be free of particular disease(s), and trade between zones which are positive for the same disease(s).

6.10 Regional and inter-regional cooperation for aquatic animal disease control

Presentation by Dr Michael Phillips (NACA, Bangkok, Thailand) and Dr Rohana Subasinghe (FAO, Rome, Italy)

The presentation discussed regional and inter-regional cooperation in aquatic animal disease control, with emphasis on opportunities for regional and inter-regional co-operation in the Americas and APEC/Asia-Pacific region.

There is a growing international awareness and cooperation in aquatic animal disease control, and there are a number of agencies involved. At global level, FAO has provided support to capacity building, technical assistance, policy and information exchange on aquatic animal health management. OIE is more concerned with aquatic animal information, reporting, and preparation of the International Aquatic Animal Health Code and Manual. Cooperation is becoming particularly essential and cost effective in such a fast growing sector as aquaculture.

In Asia, regional cooperation has been growing for a number of reasons. Aquatic animal disease has become a common regional problem, affecting aquaculture production and livelihoods and trade in aquaculture products. Disease is also a "trans-boundary" issue, and movement of pathogens occurs, domestically and internationally. There are also strong justifications for cooperation in shared watersheds *e.g.* such as the Mekong and Ganges river systems in Asia, shared by several countries. Governments and the private sector to some extent recognize the mutual advantages in sharing solutions to common problems.

Inter-governmental mechanisms exist in Asia to deal with aquatic animal disease problems. The cooperative NACA/FAO/OIE program has developed the Asia regional technical guidelines on "Health management for the responsible movement of live aquatic animals". These guidelines were recently adopted by 21 countries, together with an implementation plan. The implementation plan emphasizes:

- An Asia Advisory Group (formerly the "Regional Working Group") for providing expert advice on aquatic animal health matters to Asian governments.
- National and regional aquatic animal disease reporting systems
- Cooperation in diagnosis of aquatic animal diseases.
- Training and capacity building - including sharing between developed/less developed countries.
- Development of databases to support quarantine decisions and risk analyses - AAPQIS-Asia
- Technical cooperation and exchanges

The program generally provides a platform for regional cooperation in aquatic animal disease control, and is well supported by Asian governments,.

During the Cebu workshop, opportunities for similar cooperation in the Latin America region were also identified. The recommendations identify opportunities for cooperation in:

- Disease reporting, surveillance and contingency planning
- Networking of reference and diagnostic laboratories, to support diagnosis, health certification
- Regional training centers
- Improved communication and information exchange
- Expert exchanges and "Task Force" to deal with serious problems.
- Cooperative research - broodstock development, PL quality etc.

The Cebu workshop also identified opportunities for inter-regional cooperation from Cebu, recognizing the potentially significant mutual benefit from sharing experiences on some common problems, and in the light of considerable and growing trade in aquatic animals between the two regions. These opportunities include:

- Development and linking of databases - AAPQIS-Asia and AAPQIS-Latina
- The applicability of Asia technical guidelines on “responsible movement of live aquatic animals” in Latin America
- Development of Codes of best practice, accreditation and quality assurance, and harmonization of diagnostics
- Research cooperation
- Training and education in common areas where capacity building is required - e.g. import risk analysis, contingency planning, epidemiology
- More effective communication and information exchange
- Networking and Exchange of experts

The challenge is to find the correct and effective mechanism(s) for achieving intra- and inter-regional co-operation. Some mechanisms exist, such as APEC for some economies, and in Asia NACA is an intergovernmental organization catering to the needs of the countries in Asia. There is a need to identify the mechanisms appropriate for the Americas. Sub-regional mechanisms may also be possible. The workshop was invited to discuss these issues, including the need for regional or sub-regional agreements and identify opportunities and mechanisms for effective regional and inter-regional cooperation in aquatic animal health management and disease control.

7 Economy/country papers

This section contains the following economy/country presentations made to the workshop:

APEC member economies
Mexico
Peru
Thailand
USA

FAO member countries
Belize
Cuba
Colombia
Costa Rica
Ecuador
El Salvador
Guatemala
Honduras
Panama
Venezuela

7.1 Mexico

Presentation by Luis Contreras Flores and Ana Bertha Montero Rocha (SEMARNAP, Mexico city, Mexico)

7.1.1 Background

Aquaculture of fish, molluscs, crustaceans, aquatic plants and other aquatic organisms world-wide has contributed to food supply, and generated employment, investment and foreign currency earnings. The activity involves the participation of government, producers and the academic sector.

The chief benefits of aquaculture are food supply for human consumption, as well as ornamental fish for recreation. Food supply is now one of the most demanding issues worldwide, and quality assurance of food products is increasingly essential. Aquaculture has to respond to such concerns. In the same way, the production of ornamental aquatic species, which are important in world trade, must be guaranteed free of important pathogens. Estimates suggest that by 2010 aquaculture could contribute up to 40% of the food supply of aquatic products worldwide, meaning that aquaculture products will become increasingly important in world trade.

Important considerations in the development of aquaculture include the protection of the environment and the sustainable use of natural resources. A legal framework for aquaculture is required to support its sustainable growth. Regulations for aquaculture must cover, among other aspects, site selection for the establishment of farms and means to manage risks of the activity, as well as rules for the manufacture and use of feeds, medicines, hormones and other products used in aquaculture. Such issues are becoming more important, as nowadays public opinion is more demanding of environmental protection. A good crop will be obtained from farms if they have adequate design, a good water supply and above all, good management practice. Aquatic animal health management for the prevention, diagnosis and cure of aquatic animal diseases is an important issue to be considered in the development of aquaculture.

Disease is one of the major problems faced by the aquaculture industry, and many countries have faced major social and economic impacts resulting from uncontrolled outbreaks. Therefore, health management measures need to be carried out at the local, regional, interregional and international levels. The inadvertent introduction of pathogens is one of the factors leading to disease outbreaks which have a negative impact on the development of aquaculture, and the livelihoods of people depending on the sector.

Shrimp farming, in particular, has been affected by disease problems. These have appeared in various regions, and the problems have spread to other parts of the world, probably due the commercial movement of live organisms and dead products. At present, few countries have regulations pertaining to trade in live shrimp, but it is imperative that regulations and policies on such issues are established.

It is also necessary to harmonize and validate the diagnostic techniques for high-risk diseases in cultivated shrimp between laboratories, nationally, regionally and internationally. Diagnostic techniques for shrimp disease have advanced greatly, becoming more specific and sensitive. Any laboratory interested in providing reliable diagnostic services to private or publicly owned shrimp farms must have a process of standardization/harmonization and inter-calibration of equipment. Proper diagnosis is one of the first lines of defense in controlling the spread of serious aquatic animal diseases, and a knowledge of the health status of farmed organisms is essential to making operational decisions at the farm level.

The above considerations are some of the most important issues in aquaculture development from the point of view of aquatic health management. Mexican shrimp farming has, so far, tended to disregard such problems. The objective of this paper is to give a general background on shrimp farming in Mexico, and to present the national strategies agreed jointly between the authorities, farmers, researchers and other stakeholders in order to enhance and protect the activity, as well as to provide for the sustainable development of shrimp aquaculture in the country.

Shrimp farming in Mexico

Shrimp farming in Mexico began in the seventies as an experimental project. In 1977, the first semi-intensive farm was constructed, with an area of 7.5 ha. Growth of shrimp farming started in 1988 with a production of 551 metric tonnes (mt); by 1999 the production was 26,291 mt (Table 1).

Table 1.- Production, number of farms and areas (ha) from 1988 to 1999

Year	**Production (mt)**	**Number of farms**	**Area (ha)**
1989	2,846	124	540*
1990	4,371	132	700*
1991	5,111	201	1,745
1992	8,326	196	4,181
1993	11,846	192	12,511
1994	13,138	212	12,018
1995	15,867	231	14,302
1996	13,315	278	18,188
1997	17,570	285	18,685
1998	23,749	328	20,969
1999	29,120	347	26,291

*Data not accurate.

The average return of production during this period was of 1.28 mt/ha.

In Mexico, the shrimp farming systems, since the beginning, have been extensive, semi-intensive and intensive. Sixty-nine percent of the shrimp farms are semi-intensive, 25% are extensive and the remaining 6% are intensive. The states of Sinaloa, Sonora and Nayarit are the main places where shrimp culture has developed (Table 2).

During this period, shrimp aquaculture has developed in different ways. At the beginning, blue shrimp (*Penaeus stylirostris*) was the species most favored by farmers, however, the presence of infectious hypodermal and hematopoietic necrosis (IHHN), which affects the blue shrimp, caused a severe problem in 1990. Because of this problem, farmers changed to Pacific white shrimp (*Penaeus vannamei*), developing culture technology for this species from the experiences of Ecuador and Panama.

This strategy functioned well until 1995, the year when the Taura syndrome virus (TSV) was first detected. The virus caused a drop in shrimp production of 2,552 mt in 1996. However, shrimp aquaculture recovered the following year, and the production was 17,570 mt (Table 1).

Supply of shrimp postlarvae

An important aspect in the development of shrimp aquaculture in Mexico has been the supply of larvae, which has been obtained from three different sources:

1. captured from natural populations on the Pacific coast, mainly in the Sinaloa, Nayarit and Chiapas states;
2. hatchery production; and
3. importation.

Table 2. Number of shrimp farms, and total area per littoral, state and culture system (Anuario SEMARNAP 1999)

Littoral/State	**Total**		**Extensive**		**Semi-intensive**		**Intensive**	
	Number	**Ha**	**Number**	**Ha**	**Number**	**Ha**	**Number**	**Ha**
National Total	**347**	**26,291**	**87**	**3,214**	**243**	**22,247**	**17**	**830**
Pacific Littoral	**335**	**25,781**	**87**	**3,214**	**235**	**21,911**	**13**	**656**
Baja California	1	25	---	---	1	25	---	---
Baja California Sur	1	9	---	---	---	---	1	9
Sonora	50	6,155	---	---	48	5,918	2	237
Sinaloa	193	17,385	45	2,660	145	14.486	3	239
Nayarit	79	1,937	42	554	33	1,299	4	85
Jalisco	1	20	---	---	1	20	---	---
Colima	5	33	---	---	4	33	1	---
Guerrero	1	2	---	---	1	2	---	---
Chiapas	4	214	---	---	2	128	2	87
Gulf and Caribbean Littoral	**12**	**510**	**---**		**8**	**336**	**4**	**174**
Tamaulipas	8	336	---	---	8	336	---	---
Veracruz	1	2	---	---	---	---	1	2
Tabasco	1	6	---	---	---	---	1	6
Campeche	1	120	---	---	---	---	1	120
Yucatan	1	46	---	---	---	---	1	46

Wild-caught shrimp postlarvae

The capture of postlarvae is carried out by fishermen with the authorization of the Environmental, Natural Resources and Fisheries Secretariat (SEMARNAP), which regulates the activity. The official data for captured postlarvae from wild populations from 1994 to 1999 are given in Table 3.

Table 3. Wild caught shrimp postlarvae (in millions)

1994	**1995**	**1996**	**1997**	**1998**	**1999**
931	4,460	5,924	3,272	1,606	1,344

Table 3 shows an increasing tendency for wild-caught postlarvae during the three years from 1994 to 1997; however, since then, the numbers have decreased steadily. This changing situation was due to the establishment of hatcheries, which have taken pressure off the populations of wild postlarvae. In the same way, regulations on health management of captured postlarvae have been established by SEMARNAP with regard to their transport and acclimatization, helping to better control use of this natural resource.

From 1996, health management guidelines were prepared, including, among others, regulations for hygienic practices for stocking, buildings, tools, equipment for transportation, stocking density, diagnostic sampling and acclimatization. Until 29 September 1999, the procedure for captured postlarvae was to catch them, transport them in containers to the stocking centers where they were acclimatized for two or three days, and feed them with *Artemia* or artificial food. Once shrimp farmers obtained the postlarvae, they transported them to the farm and undertook a second acclimatization period where the temperature and salinity of the water container must be equal to that of the receiving ponds. Subsequently, the acclimatization time was changed by extending it to five days in the Official Mexican Rule (Norma Oficial Mexicana) NOM-003-PESC-2000.

A further factor that contributed to a reduction in the numbers of wild caught postlarvae was the modification to the Fish Laws Rules 1999 (Reglamento de la Ley de Pesca 1999). According to these rules, people authorized to capture postlarvae must present a notice of collection of postlarvae 72 hours after concluding the catch; which is different from the previous rules, where the period for that notice was seven days. Also in force are the guidelines contained in the Mexican Official Rules (Normas Oficiales Mexicanas) NOM-002-PESC-1993, that regulate the exploitation of shrimp species in Mexican waters.

In conjunction with the above changes, the laboratory network system established monitoring programs for the diagnosis of disease in wild populations. This resulted in the discovery of the viral disease IHHN in blue shrimp and white shrimp captured in Nayarit and Sinaloa states on the Pacific coast.

Pathogens identified in wild aquatic crustaceans in Mexico

Pantoja and Lightner in the XXIV Annual Meeting of the Society for Invertebrate Pathology, held in August 1991, presented results on the identification for the first time of IHHNV in *P. stylirostris, P. vannamei* and *P. californiensis* obtained from commercial catches in the Gulf of California facing the Sonora coast (Pantoja and Lightner 1991).

Lightner *et al.* (1990, 1992) considered that the movement of live organisms from one region to another is a common practice in aquaculture, because seed and broodstock are needed. In consequence, pathogens have been transferred to regions where they were previously unknown. One example is the dispersion of IHHNV in Mexico, where it is now established in wild populations of *P. stylirostris,* and possibly also in *P. californiensis* and *P. vannamei* (Pantoja and Lightner 1999).

Hatchery production of postlarvae

In 1999, 17 of 28 registered hatcheries were in operation, and their production was 2,603 million postlarvae and 203 million nauplii These are partial data because most of the hatcheries have not been giving production statistics, or have been very late in supplying this information.

Nowadays, most farmers obtain postlarvae from hatcheries, because of the quality guarantee from the producer, conforming to Mexican Official Regulation NOM-003-PESC-2000.

Importation of postlarvae

Data are available from 1994, the year that Mexican Official Regulation (Norma Oficial Mexicana) NOM-010-PESC-1993 was applied. This established the sanitary requirements for the importation of live aquatic animals for aquaculture. The data are presented in Table 4.

Table 4. Imports of penaeid shrimp postlarvae (1994-1998) (data expressed in millions of postlarvae).

1994	1995	1996	1997	1998
509	107	752	2,141	1,826

Shrimp broodstock supply

Shrimp broodstock supply, like postlarvae, comes from three sources: captured from wild populations, from genetic selection in hatcheries, and from importation. There are few private enterprises which import broodstock to the country, because of the rules imposed by Mexican Official Regulation NOM-010-PESC-1993 and the Emergency Regulations published on March 19, 1999. This regulation establishes certification, initially with the sampling of each imported animal, and afterwards with a representative sample of 150 animals, with pooled samples of 10 organisms for laboratory diagnosis, in addition to the observance of the quarantine period.

Broodstock production

Since the start of laboratory production of postlarvae, some companies have selected postlarvae and have practiced genetically selective combined reproduction in order to have new genetic lines for better quality or resistance to diseases such as IHHNV and TSV. Because this takes place within unregulated private enterprise, we do not know the results of these experiments. There are also molecular genetic projects carried out by the private sector, but at present the results of these too are unknown.

Aquaculture feeds

With regard to feeds for use in shrimp aquaculture, in Mexico these are both produced domestically and imported. There is approximately 60,000 mt of shrimp food production in Mexico by five private companies.

Until now, there have been no regulations on Mexican domestic production, or imported foods; therefore, it has not been possible have an adequate register of artificial food, or other kinds of natural food, such as krill, *Artemia*, squid, and poliquetos, in frozen or microcapsulated form. However since the application of the Emergency Mexican Official Regulation (Norma Oficial de Emergencia) NOM-EM-001-PESC-1999 and its enforcement, feed importation has been regulated. This has resulted in better organization of this activity, with enough data to draw up plans; for example the profile of consumption of *Artemia* for shrimp culture shows that 95% of this product is imported, particularly from the USA.

7.1.2 Aquatic animal health management

In the federal government administration, different programs are being carried out over a term of six years. In the case of the fisheries and aquaculture sector, nearing the end of the term of the present administration, this program was named “Fish and Aquaculture Program 1995-2000.”

This program included aquaculture, which had nine different subprograms, one of them being health management; and the general objective was to regulate the activity from the point of view of health, in order to enhance production and the quality of its products through qualified professional technicians.

In this subprogram, a laboratory network was established through agreements with research institutes and universities which provide diagnostic services to the producers, for example, short courses on up-to-date techniques in prevention, diagnostics, control and certification. Each of these laboratories has a defined geographical area of responsibility.

Guidelines on actions to follow were also established, emphasizing the consolidation and extension of the laboratory network, installing qualified technicians at the farms, and continuing the elaboration of regulations on imported organisms for aquaculture and recreation. Papers on health management and diseases in aquaculture have also been published, and a certification structure for live animals and products used in aquaculture has been set up.

Structural background

The establishment of a health management department began in the federal government in 1977, when the first office of health and nutrition management in aquaculture was created. It was upgraded in 1982 to a department within the Fisheries Secretariat. The growth of the aquaculture sector in Mexico led, in 1990, to the creation of the Control and Health Management Directorate, which is still in existence.

Among the activities carried out by the health management office was the construction and equipping of a diagnostic laboratory at the "Zarco" fish farm, which belongs to the government. Unfortunately, it did not become operational. Afterwards, another diagnostic laboratory was established in Mazatlan, Sinaloa, which became a research investigation center because of the federal government's political commitment to regulating laboratories, rather than operating them.

Thereafter, in 1992, the Aquaculture Directorate created a laboratory network for the prevention, diagnosis and control of aquaculture diseases through an agreement with the Universidad Autónoma de Nuevo León (UANL) in the Biological Science Faculty, now the National Center of Fish and Shellfish Disease Diagnostics.

Laboratory network

Under this agreement, in 1993 six new universities and research institutes were incorporated in the network of laboratories. These are: Centro de Investigaciones Biológicas del Noroeste Unidad La Paz, (CIBNOR) in La Paz, Baja California Sur; Departamento de Investigaciones Científicas y Tecnológicas de la Universidad de Sonora (DICTUS) in Hermosillo, Sonora; Centro de Ciencias de Sinaloa (CCS), in Culiacán, Sinaloa; Facultad de Medicina Veterinaria y Zootecnia de la Universidad Autónoma de Tamaulipas (UAT) in Ciudad Victoria, Tamaulipas; Facultad de Medicina Veterinaria y Zootecnia de la Universidad Autónoma del Estado de México (UAEM) in Toluca, Estado de México, and Universidad Autónoma Metropolitana Unidad Xochimilco (UAM-X) in Distrito Federal. This last functions as the administrative coordinator, and the UANL as the technical coordinator of the laboratory network.

The agreements signed annually between the institutions of the laboratory network and the Aquaculture Directorate establish partial financial support of the UANL, covering some of the activities indicated in the agreements.

Due to the growing demand for these services during the year 2000, the following institutions will be incorporated: Instituto Tecnológico de Sonora in Ciudad Obregón, Sonora; Universidad de Occidente Campus Mochis, in los Mochis, Sinaloa; Centro de Investigación en Alimentación y Desarrollo, A.C. Unidad Mazatlán, in Mazatlán, Sinaloa; and Universidad Autónoma de Chiapas in Tuxtla Gutiérrez, Chiapas. All of these institutions work on shrimp diseases, apart from the Universidad Autónoma del Estado de México and Universidad Autónoma de Chiapas.

Since the establishment of the laboratory network, the number of specialized aquaculture health management professionals has increased, as detailed in Table 5.

Table 5: Number of specialists in the laboratory network

Institution	Number of Specialists	Number of Co-workers
UAM-X		5
UANL	8	11
UAEM	3	
CIBNOR	4	9
DICTUS	1	6
CCS	1	2
UAT	5	5
TOTAL	**22**	**38**

Due to the integration process of the new institutions into the diagnostic laboratory network, we do not have the total number of specialized personnel, but the results of a survey and evaluation carried out by a foreign expert in diagnosis of diseases certified that these laboratories have adequate personnel and equipment to carry out the diagnostic services for the producers.

In the annual signed agreements regulating the operation of this network, each institution must provide an annual report detailing the laboratory tests used and the pathogens identified, training courses given, and contributions to the Bulletin of the National Health Management Program and the Diagnostic Network.

Diagnostic laboratory network and identification of aquatic animal pathogens

The diagnostic laboratory network is operational, and in its first two years work has concentrated on the organization and optimization of the installations. The results obtained during 1999 and 2000 are mainly on high-risk shrimp diseases, due the importance of this activity and the enforcement of laws related to Emergency Mexican Official Regulation 1999.The pathogens identified are presented by prevalence and frequency of appearance in Tables 6 to 10[10].

Table 6. Pathogens identified in cultivated shrimp.

Viruses	Bacteria	Fungi	Parasites
IHHN 93-98			
RDS 94	*Vibrio* spp. 94-98	*Fusarium* spp. 94-97	*Epystylis* spp. 94-97
BP 93-98	*Aeromonas* spp. 94-98	*Lagenidium* spp. 96-98	*Zoothamnium* spp. 94-98
LOVV 93-98	*Pseudomonas* spp. 93.98		*Nematopsis* spp.
STV 95-98	*Rickettsia* spp. 95-98		*Nosema* spp. 95-96
	Leucothrix spp. 96-98		Nematodes 95-96
	Gram-positive *Bacillus* 94-97-98		

Table 7. Pathogens identified in rainbow trout

Viruses	Bacteria	Fungi	Parasites
	Aeromonas spp. 93-98	*Saprolegnia* spp. 93-98	*Trichodina* spp. 93-98
	Pseudomonas spp. 93-98		*Hexamita* spp. 97-98
	Citrobacter spp. 93-98		*Ichthyophthirius* spp. *96-98*
	Enterobacter spp. 93-98		
	Gram-negative *Bacillus* 93		
	Vibrio spp. 94-96		

10 Numbers in the table refer to year of detection.

Table 8. Pathogens identified in tilapia

Viruses	Bacteria	Fungi	Parasites
	Aeromonas spp. 93-98	*Saprolegnia* spp. 93-94	*Myzobdella* spp. 93-98
	Pseudomonas spp. 93-98		*Dactylogyrus* spp. 96-98
	Gram positive *Bacillus* 93-95		*Bothriocephalus* spp. 96
	Enterobacter spp. 93-94		*Argulus* spp. 93-96
	Cytrobacter spp. 93-96		

Table 9. Pathogens identified in catfish

Viruses	Bacteria	Fungi	Parasites
	Aeromonas spp. 93-98		*Alloglossidium* spp. 93-94
	Pseudomonas spp. 94-98		*Corallobothrium* spp. 93-96
	Enterobacter spp. 93-95		*Henneguya* spp. 93-97
	Cytrobacter spp.94-95		*Ergasilus* spp. 94-95
	Micrococcus spp.98		*Myzobdella* spp. 94-95

Table 10. Pathogens identified in carp

Viruses	Bacteria	Fungi	Parasites
	Aeromonas spp. 93-98	*Saprolegnia* spp. 96	*Dactylogyrus* spp. 93-97
	Pseudomonas spp. 94-98		*Lernaea* spp. 94-96
	Cytrobacter spp. 93-98		*Bothriocephalus* spp. 93-98
	Enterobacter spp. 93-98		
	Gram-positive *Bacillus* 93-94		

White spot syndrome virus: government and diagnostic laboratory network actions

In early 1999, information was received about the presence of white spot disease in Central American shrimp farms. Faced with this situation, Mexican producers, knowing the risk posed by the potential introduction of this virus into the country, asked the government to take action in order to prevent this threat. Therefore, the Environmental, Natural Resources and Fisheries Secretariat (SEMARNAP), published the Emergency Mexican Official Regulation NOM-EM-001-PESC-1999, which establishes the ways and means to prevent and control the introduction and spread of white spot syndrome virus (WSSV) and yellowhead virus (YHV). This regulation was prepared with the participation of the authorities, producers and stakeholders involved in shrimp culture.

Scientific papers published in journals underlined the risk of transferring viral diseases through the importation of frozen shrimp and other crustaceans, such as tropical lobsters, that may be infected with the virus. The water used in shrimp reprocessing plants could be a dispersion vehicle to both wild crustacean populations and shrimp farms.

There are also published reports that *Artemia* spp. is a carrier of WSSV and therefore, these products were included in the sanitary inspection in the regulations, in order to avoid introducing this disease to the country through imports.

It was agreed at various meetings between the authorities, producers and other stakeholders to reduce importation of live shrimp to the minimum, in order to reduce the risk of introducing these diseases.

A total of 746 tests were carried out on live and dead shrimp by the Diagnostic Laboratory Network for the detection and diagnosis of WSSV, YHV and IHHNV, among other pathogens.

Between January and May 2000, the Diagnostic Laboratory Network carried out 96 diagnostic services on shrimp viral diseases regulated by the Emergency Mexican Official Regulations published on September 24, 1999.

The data present by the Diagnostic Laboratory Network are preliminary, as the most recent information is still being processed.

The Universidad Autónoma de Nuevo León identified the presence of WSSV in wild populations of the crustacean genus *Callinectes* in the Laguna Madre and the mouth of the Tigre River, located in Tamaulipas State on the Gulf of Mexico, giving a warning about the dispersion of the virus in wild populations.

Results from the network laboratories working on shrimp disease diagnostics during 1999 and 2000 are presented in Tables 11 and 12.

Table 11. Positive diagnosis of WSSV, TSV and IHHNV in Sinaloa State

Laboratory	**WSSV**	**TSV**	**IHHNV**
Centro de Ciencias de Sinaloa	10	14	4
Centro de Investigaciones Biologicas del Noroeste	14	0	0
Universidad Autonoma de Nuevo Leon	3	8	0
Total positive cases	**27**	**22**	**4**

Table 12. Positive diagnosis of WSSV, TSV and IHHNV in Sonora State

Laboratory	**WSSV**	**TSV**	**IHHNV**
Centro de Ciencias de Sinaloa	0	0	0
Centro de Investigaciones Biologicas Noroeste	4	0	0
Universidad Autonoma de Nuevo Leon	0	2	0
Universidad de Sonora	0	0	0
Total positive cases	**4**	**2**	**0**

In Nayarit State, the Universidad Autónoma de Nuevo León found seven positive cases of WSSV from shrimp farms and four positive cases in *Callinectes* spp. living in the supply channels around the farms, giving a total of 36 WSSV-positive cases from shrimp farms and four positive cases from crustaceans in supply channels.

During this period, the Universidad Autónoma de Nuevo León also worked on diagnostics of frozen shrimp imported from several countries. Forty samples were tested, and all were negative for WSSV and YHV.

Using dot-blot and *in situ* hybridization with commercial Diagxotics kits, seven positive cases of white spot were detected in frozen shrimp caught in Mexican waters. It is necessary to confirm these results using the PCR technique and bioassay.

During 1999, the Universidad Autónoma de Tamaulipas carried out diagnostic procedures on 125 samples of frozen imported frozen shrimp, and all of them were negative.

Due to the enforcement of the regulation, *Artemia* importers sent 109 samples of this product for diagnosis to the laboratories (UANL,UAT). Viruses were not detected in any of the samples.

Other activities carried out by the Diagnostic Laboratory Network

Although nowadays the cultivation of shrimp represents the most important aquaculture activity, trout farming in Mexico is growing significantly; therefore the Universidad Autónoma del Estado de México is in charge of the diagnosis of fish diseases, mainly in trout. This university has established a monitoring program in trout farms. By March 2000, infectious pancreatic necrosis virus (IPNV) was identified in an imported batch of eggs from the United States, and also the protozoan genus *Hexamita* was seen.

During the monitoring program, the presence of the bacterium *Edwardsiella tarda,* the causal agent of catfish enteric disease, was detected in catfish farms.

Dissemination of information on health management

In January 1998, the Universidad Autónoma Metropolitana Unidad Xochimilco, administrative coordinator of the Diagnostic Laboratory Network, began the quarterly publication of the "Boletín del Programa Nacional de Sanidad Acuícola y la Red de Diagnóstico" containing information on the prevention, diagnosis and control of diseases in fish, molluscs and crustaceans cultivated in Mexico.

Another means of disseminating this information is through the recently established website of the Universidad Autónoma Metropolitana Unidad Xochimilco, which gives information on the activities of the University in the National Health Management Program.

Training on health management by SEMARNAP and other institutions

The government and other stakeholders involved in shrimp culture have been organizing and promoting courses in health management at all levels, covering the prevention, control and diagnosis of shrimp diseases. Universities, research institutes and international and national experts have been participating in these courses. Since 1999, there have been 10 or 12 courses on shrimp diseases covering aspects from diagnostic techniques to health management in shrimp farms.

Diagnostic techniques used for viral diseases of aquatic crustaceans

Diagnostic techniques are the fundamental tools in monitoring diseases in farms, and are essential for overall management of the sector. The Diagnostic Laboratory Network has been using a wide range of techniques, such as bacteriology, histology, electron microscopy, and molecular biology (dot-blot, *in situ* hybridization (Diagxotics), the polymerase chain reaction (PCR) and the commercial PCR kit developed in Asia, IQ2000, and bioassays). These laboratory techniques, particularly those based on molecular biology, are used all over the world because of their sensitivity, but they have generated some controversial results, and their use has led to some confusion. In order to clarify this situation, in Mexico a process for harmonization and validation of diagnostic techniques, and in particular, the PCR technique, has begun.

Legal framework for aquaculture in Mexico

Environmental regulations

The environmental impacts of aquaculture, including those resulting from the construction of farms, the use of artificial foods and chemicals, the introduction of species, and the movement of species within the country and region, as well as risks from introduction of pathogens to wild populations, create a need for a legal framework for aquaculture development in accordance with the country's particular circumstances and needs.

Such considerations led to the publishing in 1988 of the first environmental law in Mexico that considers the environmental aspects of aquaculture development ("Ley del Equilibrio Ecológico y Protección al Ambiente" 1988). The revision of this law, published in December 1996, specifies that an environmental impact assessment must be carried out before the development of an aquaculture project. The law states that the impact study may be regional or local, and should contain preventative measures for any identified impacts.

In Mexico, the law that regulates the use of water is "Ley General de Aguas Nacionales," published in 1992, and the regulations in 1994, where there are specifications for supply and water discharges from aquatic farms. The instruments of this law are:

1) "Agreement by which ecological criteria on water quality were established, CE-CCA-001/89, published on January 1990." In this agreement, there are specifications on water quality parameters for use in aquaculture, covering transparency, salinity, ammonia content, nitrogen content etc., as well as the maximum permitted concentrations of several contaminants.

2) "Mexican Official Regulation NOM-001-ECOL-1996" established the maximum concentration of contaminants in water discharges. These regulations cover water discharges from aquaculture farms.

Regulations on aquaculture products for human consumption

In Mexico, aquaculture products for human consumption are regulated by three different governmental institutions: Secretaría de Medio Ambiente Recursos Naturales y Pesca SEMARNAP (Environmental, Natural Resources and Fishery Secretariat), through the Comisión Nacional del Agua (National Water Commission), and the Dirección General de Acuacultura (Aquaculture General Directorate), which is in charge of the farming process. Once aquaculture organisms have been harvested, their preservation and quality for human consumption are the responsibility of the Secretaría de Salud (Health Secretariat) through the Dirección General de Calidad Sanitaria de Bienes y Servicios (Sanitary Quality of Consumer Goods and Services General Directorate).

SEMARNAP has a structure for the elaboration of laws, rules, Mexican Official Regulations and other legal instruments for fishery and aquaculture. This is structured in the following way:

The Legislative National Commission (Comisión Nacional de Normalización), which, according to the law, defines the regulatory programs for each government institution, dealing with legal controversies and other affairs. The Legislative National Consultative Committees (Comotés Consultivos Nacionales de Normalización), such as the Responsible Fishery Committee and Subcommittees are where the Mexican official regulations are elaborated and approved. These subcommittees have decision-making representatives, including the authorities, producers, researchers and stakeholders. These regulations are published in the Diario Oficial de la Federación.

The legal decrees which regulate aquaculture are the following:

1) "Fishery Law and its Rules (Ley de Pesca y su Reglamento) published in 1992, revised on 29 September 1999." Some important considerations for aquaculture were written down for the first time in the Law of Fishery Rules (Reglamento de la Ley de Pesca), where aquaculture is treated

separately from the capture fishery. There are defined response times for particular procedures, and specifications on the participation of accredited mediators. These modifications give more clarity and confidence to the users.

2) "The Law of Fishery Rules (Reglamento de la Ley de Pesca)" in force has a chapter on health management with 10 points referring to: the shipping and presentation, depending on the case, of certificates of health for imported live organisms for the export and transport of farmed aquatic species produced in Mexico, for the capture of wild populations, and for the application of quarantine to imported batches; the execution of Mexican official regulations, and the accreditation of mediators.

Mexican regulations on aquatic health management

Mexican Official Regulations on aquatic animal health management are elaborated in the Health Management Subcommittee. Their activities began in 1992, under the regularization programs established then, where the subjects which took priority for legislation were: importation, quarantine, food for aquaculture, risk analysis and control of critical points in aquaculture, substances used in the treatment of diseases in aquaculture, genetics and genetically modified organisms, as well as diagnostic laboratory testing.

From this regulation program, the regulations in force at present are:

1) "Mexican Official Regulation (Norma Oficial Mexicana) NOM-010-PESC-1993," establishes the sanitary requirements for the importation of live organisms at any stage of development, for aquaculture or ornamental purposes, into national territory, published on 16August 1994. The most important issue in this regulation is the inclusion of ornamental species, as well as those for aquaculture, and requiring presentation of health certificates from their point of origin to authorize their importation.

2) "Mexican Official Regulation (Norma Oficial Mexicana) NOM-011-PESC-1993" establishes the application of quarantine in order to prevent the introduction and spread of certifiable and notifiable diseases during the importation of live organisms at any stage of development, for aquaculture or ornamental purposes, in national territory, and was published on the same date as the previous law.

These regulations specify that imported animals must be held in quarantine installations approved by the Aquaculture General Directorate. In this regulation, imported penaeid shrimp are excluded.

The appendices of both regulations list the certifiable and notifiable diseases. White spot syndrome of penaeid shrimp is not included, since it was then not yet identified.

The Health Management Subcommittee also published three projected regulations, but they could not be enforced because the legal process to establish them was not completed in time for publication in a definitive version. These are given below:

1) "Projected Mexican Official Regulation (Proyecto de Norma Oficial Mexicana) NOM-020-PESC-1993" establishes diagnostic tests for the identification of pathogens causing diseases in aquaculture, wild populations and ornamental species in Mexico.

2) "Projected Mexican Official Regulation (Proyecto de Norma Oficial Mexicana) NOM-021-PESC-1994" regulates artificial food, its ingredients and manufacture, and the unconventional food used in aquaculture and the ornamental industry, both imported and domestic, for their commercialization and consumption in the Mexican Republic.

3) "Projected Mexican Official Regulation (Proyecto de Norma Oficial Mexicana) NOM-022-PESC-1994" establishes measures of hygiene and control, as well as the application and assessment of risk analysis and control of critical points in installations and process in aquaculture.

Among the activities planned for the year 2000 is a program of reviewing and updating the Mexican Official Regulation NOM-010-PESC-1993; the elaboration of the Projected Mexican Official Regulation to establish rules on the use of substances for the treatment of diseases in aquaculture; and the revision of NOM-011-PESC-1993.

Emergency regulations issued to protect against white spot syndrome virus and yellowhead virus

Emergency regulations are included in the Mexican legislation, and these are formulated in a different way to Mexican Official Regulations procedures, since the risk of these diseases is an important concern.

In 1999, faced with information on the presence of WSSV in Central American shrimp farms, and knowing the risks posed by these diseases to the Mexican domestic shrimp industry, producers asked the federal government to apply measures in order to prevent the introduction of these diseases to the national territory. Therefore, the NOM-EM-001-PESC-1999 was published in order to establish the regulation. This was elaborated with the participation and agreement of the authorities, producers and stakeholders. Although the legislation in force specified that such a law could be published without consultation with the producers, the authority presented these regulations, and they gave opinions that were considered in the final version. Then on 19 March 1999, the law was published, to be applied for six months, and to be extended by the same period.

From the aquatic health point of view, the most important issues in this regulation are the requirements for the importation of dead aquatic crustaceans and *Artemia.* Also, a buffer zone, or "cordon sanitaire," was established in the states of Campeche, Chiapas, Oaxaca, Tabasco, Quintana Roo and Yucatan, because of their proximity to Central America. The hatcheries located inside this area were required to certify all the spawners, and to certify shrimp at any stage of development for their transportation to the rest of the country. For imports, the 30-day quarantine period for spawners, as set out in NOM-011-PESC-1993, was imposed, and the imported postlarvae must have a certificate specifying that each of the spawners is free of WSSV or YHD.

Cold-water crustaceans were excluded, since there is no scientific evidence of them being carriers of white spot or yellowhead diseases. Crustaceans cooked to a minimum temperature of 70°C for 5 minutes were also excluded, since the viral particles are destroyed under these conditions. In both cases, the presentation of a certificate from the competent authority of the country of origin was required, in which the capture zone of cold-water species must be specified, as well as the temperatures and cooking time of the crustaceans. The appendix containing the specifications for sampling method of dead crustaceans and *Artemia* was also modified.

In the second published emergency regulation, the main consideration was the identification of WSSV in July 1999, but the characteristics of this virus differed from others identified in Central America and Asia; therefore they were still required to be certified free from WSSV and YHD at the point of origin, before importation.

On 24July 1999, in the Federation Official Diary, the second emergency regulation NOM-EM-001-PESC-SEMARNAP-1999 was published. This establishes the measures and requirements for the prevention and control of the introduction and spread of the viral strains of white spot and yellowhead diseases which can put wild and cultivated populations at risk through importation and domestic transportation.

This regulation kept the conceptual frame of that published on 19 March 1999, but had some points not observed in the first one. For example, specific procedures when dead crustaceans go through customs; more precise criteria in the harvesting process and in dispatch to the processing plant when white spot disease is detected; the treatment of water from infected ponds, and obligatory use of the PCR technique as a diagnostic test for the presence VSSV and YHV, with bioassay as confirmatory proof, are specified.

In Appendix 1 of this regulation, the sampling method for dead crustaceans and *Artemia* is specified more accurately, as is the quarantine period for imported spawners. The correct time to end the quarantine period, once the results from the laboratory confirm the disease-free status of the animals for white spot and yellowhead, is also specified.

In order to incorporate other corrections requested of SEMARNAP, an announcement was published on 22 February 2000 which modified and corrected the Emergency Mexican Official Regulation NOM-EM-001-PESC-1999, which establishes the requirements and measures for the prevention and control of the introduction and spread of the viral strains of white spot and yellowhead diseases published on 19 March 1999.In this announcement, there are more customs posts for the entry of dead and live crustaceans for human consumption, and for live crustaceans for aquaculture, all over the country.

As the regulations go out of date so quickly, it was necessary to elaborate a new Emergency Mexican Official Regulation NOM-EM-003-PESC-2000, which establishes the rules for determining the presence of viral diseases in living and dead products and subproducts of crustaceans and *Artemia* for their introduction to, and movement within, the national territory. It was published on 25 April 2000, and will become a Mexican Official Regulation at the end of this year.

The major difference between this regulation and its three predecessors is the inclusion of legislation to regulate the production and transportation of penaeid shrimp at any stage of development in the national territory. Taura syndrome, which has been detected very frequently in shrimp farms by the Diagnostic Laboratory Network, was also covered. The regulation incorporated new specifications for sampling methods for spawners and postlarvae in hatcheries and captured from wild populations, establishing the certification of those three diseases.

Also incorporated in this regulation were the application forms included in the Law of Fisheries rules now in force, where the presentation of these application forms for the importation of live organisms and for quarantine, and certificates of health is required.

Results of application of emergency regulations

In accordance with the above Emergency Regulations, Table 13 presents information gathered about imports of organisms, products and subproducts for shrimp aquaculture from 20 March 1999 to 1 June 2000.

Table 13. Certificates of health for the importation of live organisms, products or sub-products of aquatic crustaceans regulated by the emergency regulation for white spot and yellowhead diseases

Product	**Quantity**	**Certified**
Artemia	220,826 kg	109
Blue shrimp spawners	13,100 pieces	7
White shrimp spawners	15,700 pieces	6
Blue shrimp postlarvae	350,000,000 pieces	4
White shrimp postlarvae	11,200,000 pieces	11
Food	13,289,598 kg	47
Live lobster	402,335 pieces	16
White shrimp nauplii	912,000,000 pieces	5
Frozen crustaceans	738,213 kg	26
Pink shrimp from the Gulf of Mexico	200 pieces	1

Producers organizations and prevention of shrimp disease

Since the alert caused by the identification of WSSV, the government, producers and researchers have carried out various actions in Mexico. The most important among these activities were the meetings between authorities, producers, researchers and stakeholders; a continuous monitoring program for the detection of diseases; the publication of emergency regulations; participation in national and international workshops; short courses; the adoption of an adequate legal framework for health management; and information dissemination through the national health management program and the journal of the Diagnostic Laboratory Network. Never the less, more actions were required to prevent and control the spread of white spot disease.

To address this situation, several meetings were organized between federal, state and municipal governments, producers and stakeholders in order to learn the dimension of the problem in the shrimp farms. These meetings generated data on mortalities and positive diagnoses of white spot disease, and action was taken by producers in order to prevent and control the disease. The probability of infections in neighboring shrimp farms resulting from water discharges, and the application of different methods for the prevention and control of the diseases resulted in the producers organizing and facing up to the problem.

In Sinaloa, Sonora and Nayarit states, which contain the majority of shrimp farms in the country, the shrimp producers decided to organize into regions and microregions depending on their ecological characteristics. This resulted in the following plans: Nayarit is a region with four identified microregions; Sinaloa has three regions, north, central and south; 18 microregions were identified in the north, and the process is ongoing in the central and south; 16 microregions were identified in the State of Sonora.

In each of these microregions, the producers nominate a representative, who, on the one hand, is the spokesman for his co-workers, and on the other, is the interlocutor with other microregions, authorities, diagnostic laboratories and other organizations.

A prime objective sought with this organizational structure is that the shrimp producers who know their farms and those in the neighborhood, in detail, establish hygienic and farm-management programs and a contingency manual which covers, among other aspects, procedures for emergency harvesting, methods of disinfection, monitoring for diagnosis, and the certification of postlarvae and foodstuffs, in order to minimize, as far as possible, the impact of this disease when it appears.

7.1.3 Conclusions

Much more is needed to improve and implement effective health management measures in aquaculture. There is a need to work further towards finding the best management practices and institutional arrangements to minimize the negative impact of current disease problems, and other, as yet unknown, diseases that may appear in the future in shrimp culture and other types of aquaculture.

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7.2 Peru

Presentation by Jorge Llanos Urbina, (Instituto del Mar del Peru, Peru)

7.2.1 Background

The main aquaculture activities in Peru, in order of economic importance, are the culture of shrimp, trout and scallops. Shrimp activity is concentrated in the Tumbes Region, a small area located in the north of Peru with suitable conditions for shrimp culture. The production area is now reduced from the 3200 ha under culture during high production years to only 700 ha at present. Shrimp production was between 1000 to 1500 kg/ha, with two crops per year before the white spot syndrome virus (WSSV) appeared. Survival rates were around 30 to 70%, but decreased to 5-20%.

Trout farms are located along the highlands, mainly in the Junin Region and Titicaca Lake, in the Puno Region. Only one farm produces for export to the European market. Annual trout production is about 1800 mt.

Scallops are cultured at some points along the Peruvian shore, covering 1682 ha of culture area in the Ancash (Samanco), Lima (Pucusana) and Ica (Pisco) regions. Annual production is about 725 mt, which is exported mainly to Europe and the USA.

7.2.2 Aquatic animal health management

At present, there is very little information on the impacts of trans-boundary pathogen movements. For trout, based on histopathological examinations, it appears that eggs imported from Europe and the USA brought with them some viral agents similar to those causing infectious pancreatic necrosis (IPN) and infectious hematopoietic necrosis (IHN). Further analysis is needed to confirm the introduction of these pathogens.

Health facilities in aquaculture centers are basic. Shrimp and trout farms have small laboratories capable of carrying out microbiological examinations. There are no facilities for quarantine or for treatment bioassays in almost any culture center.

There are two laboratories doing aquatic animal disease diagnosis during the last few years. The Laboratory of Microbiology and Aquatic Pathology of the Fisheries Department, Universidad Nacional Federico Villarreal, is doing work on trout diseases, histopathology and microbial disease diagnosis. The Laboratory of Clinical Pathology and Molecular Biology of the Veterinary Department, Universidad Nacional Mayor de San Marcos, is involved in shrimp disease diagnosis using histopathology and molecular diagnostic techniques (i.e., PCR).

Although there is no national diagnostic laboratory, the Peruvian Marine Research Institute (IMARPE) has recently set up a Laboratory of Health Management. This laboratory will develop diagnostic techniques for viral diseases (mainly WSS) using molecular (PCR) and immunological techniques (dot-blot), in addition to the traditional microbiological and histopathological techniques. This laboratory is expected to become the national diagnostics laboratory.

No national training programs on aquatic animal diagnostic techniques are in place. However, IMARPE is planning to train their personnel on molecular techniques for shrimp viral disease diagnosis by sending them to specialized laboratories in Guayaquil and by receiving specialists on health management and fish diseases from Cuba and Korea. IMARPE is also mandated to provide technical support and disseminate scientific results to the aquaculture community.

There is no national action plan for reducing the risk of diseases in aquaculture, even though some epizootics in farmed shrimp (infectious hypodermal and hematopoietic necrosis (IHHN) and Taura syndrome) and trout (*Ichthyophonus* disease) have occurred.

Last year, the government authorities created some regulations in order to avoid the introduction and spread of WSSV. In June 1999, before WSSV was found in Peruvian territory, importation of live shrimp, products derived from them, and any suspected viral carriers from countries with proven presence of the WSSV and yellowhead virus (YHV) were prohibited for 180 days, and the prohibition was later extended for four more months. Despite these regulations, WSSV was introduced and disseminated through almost all the shrimp-producing area, and the authorities decided to lift the prohibition of import. In August 1999, official protocols for certification of imports from countries free from those viral diseases and for monitoring shrimp culture areas were established. However, there is no current regulation on quarantine and certification for fishes.

There is no competent authority specializing in aquatic health management. There are few experts for aquatic animal health certification. In the case of fish disease certification, Dr Enrique C. Mateo, an Emeritus of the Fisheries Department, Universidad Nacional Federico Villarreal, has a United States authorization for viral certification of fish eggs. In the case of shrimp, Dr Armando Hung, a Professor of the Veterinary Department, Universidad Nacional Mayor de San Marcos, was selected to develop a WSSV diagnostic probe for imported shrimp stocks using PCR assay.

7.3 Thailand

Presentation by Dr P. Chanratchakool (Aquatic Animal Health Research Institute, Department of Fisheries, Bangkok, Thailand)

7.3.1 Background

Thailand, the largest shrimp producer in the world since 1991, has faced shrimp disease problems, causing losses from low (chronic) levels to acute, including almost complete crop loss. Production of shrimp in Thailand reached a peak of 250,000 metric tonnes (mt) in 1994. Due to a combination of disease and management-related problems, production started to decline, to 220,000 mt in 1995, 205,000 mt in 1996, and another 30 % decline, to 150,000 mt, in 1997. The major viral pathogens causing this dramatic decline were white spot syndrome virus (WSSV) and yellowhead virus (YHV).

WSSV has proved to be the major cause of mortality in Thai shrimp farming. Many attempts have been made to understand this problem and many recommendations made in order to prevent the disease outbreak. This concerted effort by farmers and supporting institutions has resulted in an increase in production to 210,000 mt in 1998. Improved farm management strategies, as well as better government policy related to shrimp farming, have been partly responsible for this improvement. An important factor in their success has been a good level of co-operation between the private sector and government institutions to develop appropriate techniques and strategies for sustainable shrimp farming.

7.3.2 History of major disease outbreaks

Yellowhead (YHV) was the first viral disease to cause catastrophic and rapid losses in commercial farms in Asia. The disease was first observed in Thailand in 1990. The causative agent was unknown until 1993, when Thai workers isolated viral particles from infected shrimp and experimental infections were conducted to demonstrate their involvement.

Shrimp infected with YHV abruptly stop feeding and gather at the surface and edges of the pond. Within a day, large numbers of dying shrimp are observed at the pond edge, and mortality is almost complete by the 3rd to 5th day. Affected shrimp usually have a light yellow head, and the hepatopancreas has a distinct pale-yellow appearance.

White spot syndrome virus (WSSV) was first reported in Asia in 1992 and 1993 following outbreaks in China and Japan. Some confusion has resulted with the name of the virus, since it was reported in Asia from late 1994 through 1995 under several different names, including hypodermal and haematopoietic necrosis baculovirus, rod-shaped nuclear virus, systemic ectodermal and mesodermal baculovirus (SEMBV), and white spot baculovirus. It is now known that it is not a baculovirus and may, in fact, represent an entirely new group of viruses.

Although the virus was present in Thailand in laboratory-reared *Penaeus monodon* in late 1993, it was not found in farmed shrimp until late 1994, when mass mortalities began to be reported. Infected shrimp usually show distinct white spots on the shell, which may be loose. In many cases, they have a reddish coloration. The white spots are the result of abnormal calcium deposition in the shell. Mortalities are usually high, and cumulative mortality can reach 100% in 3-10 d from the onset of clinical signs. Recently, however, there have been increasing reports of populations of shrimp showing good survival despite being infected by the virus. This has led to considerable speculation on the mechanisms of expression of disease in the shrimp. Thai scientists have proposed that shrimp may be able to "tolerate" viruses if they are exposed to them at a sufficiently early age, and the role of the environment in the development of clinical disease has come increasingly to the fore.

WSSV infects a wide variety of penaeids, as well as many other crustaceans. In recent years, more information has been obtained on its epidemiology. The disease shows a strong seasonality in both prevalence in wild stocks and in the severity of outbreaks. It has also proved to be closely associated with the source and disease status of the postlarvae (PL), with recent studies demonstrating the benefits of screening of PL for the presence of the virus by PCR.

7.3.3 Negative economic and social impacts of disease outbreaks

Direct losses due to YHV in Thailand were estimated at between US$ 30 and 40 million in 1992 and 1993, respectively. Other figures on economic losses include an estimate of US$ 30.6 million from YHV in 1992, and US$ 650 million from all shrimp disease outbreaks in 1994.

Yellowhead was followed by outbreaks of white-spot disease (WSD). Of the two, WSD has proven to be by far the most serious, being estimated to have caused the loss of 70,000 mt of shrimp (around 40% of total production) in 1996. At a rough estimate of $3-5 per kg profit, this represents between US$ 210 and 350 million in lost revenues for Thailand alone.

YHV and WSSV are currently the most serious pathogens threatening the shrimp farming industry in Thailand. Together, these two agents may be responsible for the drop in shrimp production from 250,000 mt in 1994 to 220,000 mt in 1995. At $8 per kg, this represented a shortfall of $240 million. However, this small difference in production is not a true reflection of the full impact of these diseases. At that time, Thai production was rising at 20,000 to 30,000 mt/year, and production for 1996 had been expected to rise. Shrimp disease losses for 1997 reached nearly 50% of total farm output value. Also, these figures do not include losses in related businesses such as in feed production, processing and exporting, ancillary services (repair shops, farm suppliers etc.) and lost income for laborers.

Socio-economics and impacts on small-scale farmers

The reduction by 30 % of total production in 1997 was estimated to be equivalent to US$ 600 million in total, a figure which excludes losses in related businesses such as feed production, processing plants, feed raw material producers and labor. When the same losses are applied to the smallest farms, 30% production loss is equivalent to around US$ 1,000 per pond per crop. As 65% of farmers were reliant on shrimp as the main source of income, it is not surprising to find that disease was reported to have serious impacts on households involved in shrimp aquaculture.

7.3.4 Interventions to disease outbreaks by sector

State Sector interventions

<u>Immediate policy decisions on movement of PL and broodstock</u>

Since 1993, the Department of Fisheries (DOF) has banned the export of live black tiger shrimp regardless of their size. Although this ban was mainly intended to prevent the export of broodstock, it also caused problems for companies exporting live shrimp for consumption. Therefore, the regulation was amended in 1995 to allow the export of juvenile shrimp bigger than 19 gm, excepting broodstock.

To import shrimp into Thailand, there was no quarantine requirement other than the importer requiring permission from the government. However, in April 1999, the DOF banned the importation of live marine shrimp larvae due to the risk of disease transmission.

<u>Introduction of new rules, regulations and legislation</u>

The development of practical health management strategies is a multi-disciplinary activity that requires a high degree of co-operation between farmers and the relevant authorities. The DOF together with the Thai Marine Shrimp Farmers Association, the Thai Frozen Foods Association, the Thai Food Processors Association and the Aquaculture Business Club have signed an agreement for a “Code of Conduct” to govern the operation of the industry. The Code of Conduct is a set of principles and processes that provides a framework to meet the industry’s goal for environmental, social and economic responsibility. The foundation of the Code is the following Mission Statement: *“The marine shrimp farming industry in Thailand is committed to producing high quality, hygienic products in a sustainable manner that provides for environmental, social, and economic benefits to present and future generations.”*

Policy Statements have been formulated that outline actions that the industry will undertake to meet its commitments as set forth in the Mission Statement. These cover a broad range of topics, including: environmental protection, public consultation, regulatory compliance, location, quality and safety, continual improvement, efficiency, research and development, social responsibility, monitoring and auditing, education and training, and international trade. The Code commits the signatories to specific actions, including the development of a series of Operating Guidelines and Procedures Manuals. These actions will aid the industry in carrying out its operations in a manner consistent with the intent of the Code of Conduct. The objective of the Operating Guidelines and Procedures Manuals is to establish a consistent approach to industry operations through establishment of Good Management Practices (GMPs). It is anticipated that implementation of these GMPs will enable the industry to operate in a sustainable manner.

Master Plan for improving the farming environment

The DOF has provided infrastructure improvements for farming development since 1991. Seawater irrigation systems in over-crowded farming areas have been constructed to provide good water, as well as to reduce impacts on the local environment. One site in eastern Thailand and two sites in southern Thailand are currently in operation. In the year 2000, two more sites are planned. Another 48 sites, covering a total production area of 9,150 ha, have been identified and are planned for completion by 2010.

Technical assistance to farmers

In 1992, the government, through the National Science and Technology Development Agency (NSTDA) established a National Yellow-Head Task Force whose main objectives were to identify the causes and management recommendations in order to reduce losses and to identify priority areas for research. The task force consisted of representatives from all stakeholders in the shrimp industry. The task force led to the formation of a Shrimp Biotechnology Program within the National Center for Genetic Engineering and Biotechnology (BIOTEC), to respond to all shrimp-related issues. Many research projects have been conducted with financial and technical support from the division.

Also under the leadership of the NSTDA, a government-industry consortium called the Shrimp Culture Research and Development Company Limited (SCRD) was established in 1996. Its mission is to co-ordinate and support research and development projects that are applicable to both the immediate and long-term needs of the shrimp culture industry. The first priorities are the domestication of shrimp (selective breeding and genetic improvement), shrimp health management, and the development of better and environmentally friendly food management systems. One of the consortium members has successfully domesticated stocks of *P. monodon* and is currently producing an F3 generation of specific pathogen-free (SPF) shrimp screened to exclude major viral pathogens. The company also intends to promote human resource development and technology transfer through training, seminars and workshops, and to develop a shrimp culture research database.

Technical services

With government support, a mobile service unit was set up in 1993 to provide technical assistance directly to farmers on their own farms. Free services, including water quality analysis, disease diagnosis and management recommendations, are provided. Mobile unit services are now available in 21 provinces, covering all shrimp culture areas. Over 15,000 samples per year have been tested. In addition, private companies also provide similar services from local laboratories around the country, including PCR analyses.

Twelve DOF laboratories cover the main farming areas to provide PCR analysis for WSSV, and more than 1,000 samples/month are being analyzed by these laboratories. This type of service is also provided by some academic institutions.

Establishment of the Marine Shrimp Research and Development Institute (MSRDI):

The MSRDI was established in 1997 by the DOF to maintain Thailand's position as the world's largest producer. This agency was made responsible for various academic aspects, especially research and development for shrimp culture and technology transfer to the farmers. The MSRDI is comprised of two research centers, the Marine Shrimp Research and Development Center (MSRDC) of the Andaman Sea at Phuket Province and the MSRDC of the Gulf of Thailand at Songkhla Province. The Andaman Centre is responsible mainly for development of aquaculture technology, including disease management and environmental protection, whereas the Gulf of Thailand center is responsible for genetic improvement, hatchery technology and feed. Both centers are also responsible for technology transfer and training.

Farmer and private sector interventions

Due to the predominance of small-scale farms in Thailand and the rate of development of intensive aquaculture, feed companies and other suppliers have provided a significant source of information to farmers. Shrimp feed companies and other suppliers frequently provide information and technical support as part of their service to customers. As this information is often aimed at increasing sales, this can lead to the widespread recommendation of inappropriate practices, such as overstocking. At the same time, seminars with invited independent experts have been conducted to pass on new information to farmers so that, on balance, the impact of this information transfer has been positive. Most feed companies also provide technical support, including checks on water quality and shrimp health and advice at the farm. A few also offer testing services for shrimp viruses.

Thai farmers have proven to be quite innovative in their approaches to dealing with disease problems. The risks associated with water exchange, which was often reported to result in losses due to WSSV, led to a more widespread adoption of lower water exchange systems, including the use of reservoirs and "closed/recycle" type systems designed to reduce exposure to water-borne viruses and carriers. Water treatment strategies also became more widespread during the yellowhead epidemic, with the use of chlorine both to treat infected ponds to prevent spread of infection and as a means of '"disinfecting" the pond to remove carriers prior to bloom development and stocking of PL. The high cost of chlorine led to a search for cheaper alternatives, and the Charoen Phokphand Company acquired the rights for the sale of trichlorfon, an organophosphate insecticide used in Europe to treat sea lice in salmon, for aquaculture purposes in Asia. This was effectively marketed as a safer, more convenient treatment for elimination of crustacean carriers in ponds prior to stocking.

The use of reservoirs and treatment ponds has resulted in an overall reduction in the production levels of farms using this strategy. Although per pond production has been maintained, the reduction in production area on the farm has reduced the yield per ha total farm area. At the same time, many farmers have reduced stocking densities and levels of intensification in order to reduce their financial exposure. Although this has, in many cases, increased the net profit per unit area, the total income has been reduced.

The discovery that crabs could act as reservoir hosts led to measures designed to eliminate crabs and/or prevent their movement between ponds. Farmers used small fences of cheap netting around the ponds to prevent movement, although this practice has largely ceased as the incidence of WSD has decreased. The use of Synterex® (trichlorfon) to control crustaceans around farms has also continued.

Undoubtedly, a large amount of money has been spent by farmers on all manner of potential cures and treatments for disease, most of which have not been productive. A survey of one group of farmers in southern Thailand revealed that the average amount of money that an individual farmer would spend on potential pond treatments as a trial was 15,000 Baht per crop. For the 1,000 ponds in the survey alone, that represents a total market of 30 million Baht annually. As this survey was undertaken before the onset of major disease losses, the amount farmers would be willing to spend to find a potential solution for disease problems is probably much greater.

Hatchery interventions

For *P. monodon* culture in Asia, it is currently believed that the broodstock and PL used for stocking are a major source of viral infection leading to WSD outbreaks. In Thailand, WSSV is found in captured brooders at very low to up to 100% prevalence, depending upon the location or season of capture. The nature of the viral transfer from brooder to larvae and PL is still under investigation. However, it is likely that most vertical transmission occurs after spawning via egg or larval contact with external viral material in spawning fluids. Since the egg and naupliar membranes are relatively impermeable even to large molecules, they should also be impermeable to viral particles, although this has not yet been proven. By this reasoning, most viral transmission to larvae should occur from the final naupliar stage onwards, after the larvae have a mouth opening. Thus, WSSV prevention strategies are currently based on washing eggs and/or early naupliar stages.

Given the probability of vertical transmission of WSSV, a major focus should be on the development of domesticated broodstock that can be certified as free of WSSV. Such stocks are now commercially available for *Penaeus vannamei* and, on a more limited basis, for *P. monodon.* However most of the industry in Asia still depends on PL derived from wild broodstock. This is due to a lack of acceptance by commercial hatcheries, which still prefer to use wild stocks, partly due to their higher fecundity. In this case, preventive measures against WSSV would best begin with a preliminary screening of brooders to exclude infected individuals from the hatchery. Since brooder infections tend to be very light and since assays must be non-destructive, screening is currently done by molecular genetic techniques including DNA dot-blot and PCR assays performed on extracts of haemolymph or clipped appendages.

A recent study in Thailand has shown that thorough washing of eggs from WSSV-PCR positive brooders greatly reduces the probability of viral transfer. It is now recommended that eggs and/or nauplii completely enveloped by the naupliar membrane be thoroughly washed with clean sea water containing disinfectant (concentration adjusted to suit species and life stage) before transfer to larval rearing tanks. If combined with broodstock screening by PCR, discard of positive brooders and subsequent periodic PCR checks of larvae, the probability of WSSV occurrence in hatchery-produced PL can be made extremely low. Unfortunately, since the demand-supply situation for PL in Thailand depends largely on the season and, as most of the operators are small scale, implementation of such a recommendation is, in many cases, impossible.

Many hatcheries have not adopted these practices. The majority of hatcheries are small-scale, relatively unsophisticated and operated on a seasonal basis. When there are major problems, these hatcheries will close down until more favorable conditions prevail. There has been some difficulty in persuading hatcheries to adopt practices designed, in the end, to protect the interests of the farmer rather than that of the hatchery owner. Farmers have increasingly demanded higher standards of PL production, whether it be overall PL quality or the use of PCR screening techniques to eliminate infected batches. However, at the same time they have been highly resistant to price increases, thereby reducing the incentive to hatcheries to produce higher quality PL. In fact, a widespread practice of demanding guarantees from hatcheries in terms of survival developed which placed a greater burden of credit and risk on the hatchery sector. This has tended to drive hatcheries out of the business due to increased risk and diminishing returns. The ability to extract such concessions from hatchery producers depends, to a large extent, on the demand/supply situation for PL. In recent years, as a result of lower production of PL, demand has sometimes exceeded supply, so that hatcheries have been less willing to make such concessions. In addition, a dual market for PL has developed, with some farmers insisting on PL which have been screened for WSSV and others willing to take unscreened PL despite the risks.

7.3.5 The way forward

Training and education

Training and education of farmers has played a major role in coping with the impacts of disease. Farmers' associations are effective in disseminating information widely, as they provide a forum to reach a large number of farmers with a minimal effort. Government extension services are regarded as useful by most farmers, but budgetary constraints often mean that their coverage and frequency of visits is much lower than the similar extension services provided by suppliers. As a result, the government services are frequently viewed as unbiased but slow and not so advanced as the services provided by private-sector technical support. Transferring information through private-sector sales persons, as well as through government extension officers, is an ideal route. The information provided to these salespeople should be derived from the results of research or activities designed to meet the needs of the industry. With this approach, Thailand has successfully integrated private companies with research institutes to conduct joint research.

Further development of rapid, sensitive diagnostic methods

The arsenal of rapid diagnostic methods available to the farmer and to the small laboratory is currently rather small, although increasing rapidly. This progress needs to continue, since rapid and accurate disease diagnosis is fundamental to appropriate response. This is also the key to preventing viral diseases by allowing the early detection and eradication of infected stocks. For example, current methods of testing for WSSV in PL rely on PCR, which can only be carried out in specialized laboratories. However, the development of a fast, simple, cheap and easy to use diagnostic test would increase the likelihood and willingness of hatcheries and farmers to undertake routine testing as a preventative measure.

Increased application and dissemination of research results

The key to the application of disease research rests with the dissemination of research findings to the farmers who will apply it. Bridging the gap between scientists and farmers is a specialized activity requiring people with a real understanding of the practicalities of farming and a sufficiently good grasp of the scientific benefits of research to be able to effectively develop application of the research findings. This requires not only a good grasp of science and farming, but a clear knowledge of marketing and training techniques to effectively transfer technology.

7.4 The United States of America

by Jeffrey M. Lotz (University of Southern Mississippi, Gulf Coast Research Laboratory, USA)[11]

7.4.1 Marine shrimp consumption and trade

There was a significant increase in the consumption of imported marine shrimp from more than 100 million pounds in the 1980s to more than 600 million pounds in the 1990s. Total imports of seafood for the year 1998 amounted to US$ 8.1 billion; total exports amounted to US$ 2.3 billion; with a total deficit of US$ 5.8 billion. With respect to trade in shrimp, imports amounted to US$ 3.11 billion, while exports had a value of US$ 0.13 billion and thus, there was a trade deficit of US$ 2.98 billion comprising 51% of the total seafood deficit.

7.4.2 U.S. Marine shrimp farming program

The Specific Pathogen Free (SPF) Program started in the late 1980s, and produced an estimated 1.5 million pounds of shrimp, which increased significantly to the 4 million pounds achieved between 1993-1994. Production decreased drastically to less than 3 million pounds in mid-1994 until 1997 with the onset of Taura syndrome virus (TSV) and white spot syndrome virus (WSSV) outbreaks.

There are six institutes involved in the program, namely: (a) the Oceanic Institute, (b) the University of Arizona, (c) Texas A & M University, (d) the Gulf Coast Research Laboratory, (e) Wadell Mariculture Center, and (f) Tuffs University.

Shrimp farming in the United States is characterized by small farms with less than 50 ha and stocking densities of 100,000 to 1,000,000 postlarvae (PL)/ha in open ponds where salinity ranges between 15 to 40 ppt. Inland areas utilize salt water wells with salinities ranging between 0 to 10 ppt, as well as indoor ponds. The survival rate is from about 25% (with TSV) to 80%.

7.4.3 History of WSSV and TSV in the U.S.A.

Table 1 shows the chronology of major shrimp disease outbreaks in the United States.

Table 1. Chronology of major shrimp disease outbreaks

	Hawaii	**Texas**	**South Carolina**
1994	TSV	-	-
1995	-	TSV/WSSV	
1996	-	TSV	TSV
1997	-	TSV*	WSSV
1998	-	TSV*	WSSV
1999	-	TSV*	-
2000	-	?	-

WSSV was also detected among wild populations in three areas in the Gulf of Mexico.

7.4.4 Strategies for disease control in shrimp farming

Strategies for shrimp disease control in the United States have several components. These include (a) production of specific pathogen-free (SPF) and high health seed; (b) eradication measures through drying out of ponds and disinfection protocols; (c) principles of exclusion through quarantine and biosecurity measures in both inland and indoor culture; (d) breeding program; (e) epidemiological

[11] Summary of powerpoint presentation.

studies undertaken in Texas through the US Marine Shrimp Farming Program (USMSFP) and Sea Grant Program under the Department of Commerce; (f) extension work carried out by USMSFP in the states of Hawaii, Texas and South Carolina; (g) education and training conducted by Harbor Branch Oceanographic Institute and Texas A&M and Texas Sea Grant and through the pathology course of the University of Arizona; and (h) graduate education.

7.4.5 Regulatory structures for transport of shrimp within the United States

Three regulatory structures are in place concerning domestic movement of shrimp: (a) state regulations in Hawaii, Texas and South Carolina; (b) federal regulation undertaken by the Department of Interior (Fish and Wildlife) and the Department of Commerce through the National Marine Fisheries Service (NMFS) for protection of natural resources, and the Environmental Protection Agency (EPA) for protection of waters; and (c) the Joint Subcommittee on Aquaculture (JSA).

Current efforts are focused on protection of natural resources, and various programs are being undertaken to achieve this objective. The introduction of pathogens into natural populations of shrimp is a concern, with primary consideration on effluents coming from infected ponds, processing plant wastes and bait shrimp. Risk assessments are being undertaken by JSA through USMSFP and the Global Aquaculture Alliance (GAA) (shrimp processors) through USMSFP.

A number of laboratories are providing disease diagnostic service (e.g., the University of Arizona as the OIE Reference Laboratory, and Texas A&M University) and support for research (e.g., the states of Hawaii and South Carolina, and the University of Southern Mississippi). Certification of diagnostic laboratories and diagnostic tests is being undertaken by the United States Department of Agriculture (USDA] Veterinary Service through the Animal and Plant Health Information System (APHIS). A surveillance program is also in place at both the state and federal levels; through USMSFP in the states of Texas and South Carolina and through the USDA Veterinary Services via the Center for Epidemics and Animal Health at the federal level. Certification for international import/export of shrimp is done by the USDA Veterinary Services through APHIS-certified laboratories.

7.5 Belize

Presentation by Beverly Wade (Belize Fisheries Department, Belize)

7.5.1 Background

Aquaculture is one of the fastest growing industries in Belize, and in 1999 was worth over $46 million (Bze). Investment in aquaculture in Belize has been predominantly in shrimp mariculture, which in turn has been exclusively dedicated to the culture of penaeids. The most widely cultured species has been *Penaeus vannamei.* However, *Penaeus brasiliensis, P. stylirostris and P. schmitti* have been cultured in the past on an experimental basis. The further utilization of these species has been limited due to the lack of information regarding their biology and their physical demands in their natural habitats and therefore, the lack of viable culture techniques. *Penaeus schmitti* is the only native species in Belize.

Freshwater aquaculture in Belize is currently limited to tilapia culture. This is still being carried out on a small scale. Ornamental fish, the Australian freshwater lobster (*Cherax quadricarinatus*) and the red fish (*Sciaenops ocellatus*) were also farmed in Belize on a small scale. However, farming of these species has ceased, mainly due to the lack of markets and increasing global demand for shrimp.

Over the past ten years, the number of shrimp farms has increased from two in 1990 to ten in 2000, and these are currently located in the Belize and Stann Creek districts of Belize. Nine of these farms culture shrimp semi-intensively (500-1000 lbs/acre), with the exception of Belize Aquaculture Limited, which has recently completed a super-intensive closed system R & D project. Belize Aquaculture Limited is now expanding to have 72 acres in production this year (2000) and 320 acres by the year 2001.

In the last ten years, farmed shrimp production has increased from 217,223 lbs in 1990 to approximately 5 million pounds in 1999. Also, the total pond acreage under production has increased from 220 aces in 1990 to 3,100 acres today.

The major constraint for most of the farms in Belize is the availability of disease-free seed and, at present, the majority of the seed is supplied from outside the country. Currently, there are four operational hatcheries in Belize with the capacity to produce 170 million postlarvae (PL) per month.

In 1990, shrimp processing was done in Mexico and Honduras and by the local Fishermen Cooperatives Plants in Belize City. Today, there are four commercial shrimp processing plants in Belize. One plant is undergoing expansion to accommodate a processing of 60,000 lbs of shrimp per day.

7.5.2 Aquatic animal health management

To date, two major pathogens affecting farmed shrimp have been diagnosed in Belize. These are the Taura syndrome virus (TSV) and the infectious hypodermal and hematopoietic necrosis virus (IHHNV). In 1995, the TSV epidemic resulted in high mortalities in stocks of *Penaeus vannamei*. Production for that year was significantly affected.

To counter this epidemic, a disease prevention and control program was established at the affected farms. This program was directed at eradicating TSV and preventing re-infection through contaminants. Ponds were drained completely, flushed, drained again and allowed to dry for two weeks. They were then exposed to UV light (sunlight) and temperatures above 35°C. Treatment with residual free chlorine at concentrations of 10 ppm for 24 to 48 hr and liming with calcium oxide or calcium hydroxide at a rate of 5000kg/ha or 1500kg/ha, respectively (pH >10) then followed.

Strong chlorine solutions were applied to all cement and wooden structures and wherever water or black mud was seen. All life in reservoirs, supply and discharge canals was destroyed with rotenone and chlorine.

Policy and legislation

The current fisheries legislation does not include specific regulations for aquaculture activities. Farms operate under "in house" guidelines developed by the Fisheries Department, and compliance with these guidelines is very much voluntary. All farm operations must conform to the guidelines, which govern mesh size of screens, pond layout, importation of juveniles and broodstock and infrastructure. All broodstock and fingerlings brought into the country for culturing must be accompanied by a phytosanitary certificate. Processing must be conducted in accordance with the quality assurance regulations of the Fisheries Act. Also, the development of aquaculture projects must minimize critical habitat destruction (mangroves etc.) and conform to the environmental guidelines set out by the Department of the Environment and the Fisheries Department. Lastly, an Environmental Impact Assessment is mandatory for most farms under the Environmental Protection Act.

7.5.3 Conclusions

Today the aquaculture industry plays an important role in the economy of Belize. As a result, the Government of Belize is commited to encourage and support future growth and development of this industry. However, the aquaculture industry in Belize faces many challenges, and one of the main challenges is the lack of a formal policy and legislation for aquaculture. This has led to one of the main priorities of the government to be the development of necessary policy and legislation, as well as the other technical support to aid the future development of the industry.

7.6 Colombia

Presentation by Consuelo Vásquez Díaz (National Institute of Fisheries and Aquaculture, Laboratory for Aquatic Pathology)

Colombia has shrimp fisheries and shrimp aquaculture operations on both the Atlantic and the Pacific coasts. There are 10 farms and nine laboratories on the Pacific Coast, and 20 farms and 10 laboratories on the Atlantic Coast. Total production for 1998 was close to 8,227 metric tonnes (mt) and has been increasing steadily.

Currently, several species are cultivated at different levels. These include five species of catfish, two species of *Colossoma*, trout, carp, and red and silver tilapia. Reproduction trials with ornamental species are underway.

The Colombian government, through the National Institute of Fisheries and Aquaculture (Instituto Nacional de Pesca y Acuicultura, or INPA), runs the Laboratory for Aquatic Pathology (LAP), which is responsible for basic and applied research and certification of live aquatic animals (i.e., fish, molluscs and crustaceans) for commercial trade. The laboratory has three experts and has good knowledge of diseases of cultured fish and ornamental fish destined for export.

The holder of an aquaculture operation permit has a responsibility to protect the environment and ensure the health conditions of the cultivated species, especially if the holder intends to introduce eggs or embryonic stages of the species. Quarantine is conducted at the company facilities under LAP technical supervision.

With regard to trans-boundary transfer of pathogens due to movement of live aquatic animals, it is necessary to distinguish two risk groups, as follows:

(a) Live Shrimp: Live animals are risky due to the high commercial trade in nauplii, postlarvae (PL) and broodstock. There is a risk of introducing diseases into laboratories through nauplii and PL. In addition, there is also an increased risk of pathogen spread to other farms through effluent discharge when stocking infected PL into ponds. Movement of broodstock is another important source of pathogens in maturation facilities. In addition, these pathogens could be transferred to other laboratories through the nauplii that have been sold, and then spread to farms by PL, thus continuing the cycle of pathogen transfer.

(b) Frozen Shrimp: Any shrimp product or subproduct from enzootic zones of exotic diseases is considered to represent a potential risk.

The Colombian government works closely with the private sector. The shrimp farmers are organized under an association that conducts research funded partially by the government. An example of this was when Taura syndrome virus (TSV) was detected, the research was expanded to cover other aspects, such as genetics and nutrition. In the case of white spot syndrome virus (WSSV), the government conducted basic research for the detection of the virus, bought PCR equipment and provided workshops on PCR techniques. Currently, the government evaluates any reproduction activities in laboratories to check the quality of the larvae. In such cases, the government provides health certificates for PL through the LAP.

There are two legal instruments to prevent the further dissemination of WSSV. One regulates the commercial trade between the two Colombian coasts. The second regulates crustacean importation by requiring a health certificate from the exporting country. This certificate should include a description of the methodology used to examine the animals. This regulation applies to frozen, fresh, cooked or live animals. Colombia has adopted the format of certification proposed by the Office International des Epizooties (OIE), with some modifications. Currently, the government is developing a National Health Code, which follows the *International Aquatic Animal Health Code* of the OIE as a model.

In terms of training, the LAP develops courses on diseases of aquatic animals at different levels (farmers, workers etc.) annually. In turn, the private sector invited international experts to train their personnel on proper handling and disease diagnostic techniques and/or sent their personnel to other countries for training.

With respect to the trans-boundary transfer of pathogens via the movement of aquatic animals, the following are important considerations:

1) Countries should not import live shrimp from enzootic zones of exotic diseases.

2) Any group of live shrimp imported should have a health certificate. This certificate should include the tests used for pathogens. In an ideal situation, the buyer would send a trained person to participate in the screening procedures/diagnostic tests used for certification by the exporting country.

3) Countries should not import infected shrimp products or subproducts, including those that are frozen raw or frozen cooked.

4) Each country should have a government entity composed of experts responsible to check, accept or reject all live shrimp or frozen shrimp stock that is intended to be imported. This will allow the establishment of a standard protocol to evaluate risk.

5) A network of aquatic animal pathology laboratories should be established under the guidance of the OIE.

6) To support the above-mentioned considerations, a series of conferences and workshops should be conducted to train and update specialists from the different laboratories in order to standardize protocols and procedures.

In closing, the Colombian government is interested to receive training and technical advice on live aquatic animal pathology (fish, molluscs and crustaceans) from organizations such as the FAO.

7.7 Costa Rica

Presentation by Ricardo Gutierrez Vargas (INCOPESCA, Costa Rica)

7.7.1 Background

This presentation contains a summary of the effects of pathogens on shrimp farming in Costa Rica, and the main actions taken in accordance with current regulations. It also includes a plan with specific actions that is currently under revision by the national authorities, farmers and other sectors involved. We consider that this is a good time to try to unify requirements to improve the aquaculture industry.

We express our thanks to the Republic of Mexico, for inviting us to participate in this important consultation.

7.7.2 Aquatic animal health management

Disease outbreaks in shrimp culture

Shrimp farming in Costa Rica utilizes about 1200 ha distributed along the central and south Pacific Coast. In November 1996, Taura syndrome virus (TSV) was detected by a private company based on analyses conducted in the United States. The virus was present in farms along the central Pacific Coast; but after six months the virus spread 100 km to the northeast of the Nicoya Gulf. This virus caused a reduction in survival from 65% to 15%. Other farms located further south were infected by the end of 1998. According to biologist Mr Carlos Lara (Cosechas Marinas Company), two years after TSV was detected in Honduras, this virus was found in Costa Rica.

The El Niño phenomenon during 1997-1998 increased water temperatures to 2-3°C above normal, which affected shrimp farming. This temperature increase resulted in an ecological imbalance, which caused vibriosis in some farms, mainly on the central Pacific Coast. By the end of 1999, the situation was back to normal, with good shrimp growth rates (Carlos Lara, pers. comm.). However, the combined effects of the El Niño and TSV have reduced average productivity from 1100 kg/ha to 400 kg/ha.

As soon as white spot syndrome virus (WSSV) was detected in other countries, a commission disseminated information about the disease and developed preventive measures to try to avoid the introduction and dissemination of this virus in Costa Rica. However, WSSV was detected for the first time in the middle of January 2000. Once WSSV was detected, it spread, with moderate levels of infection, to 200 ha of farms on the Nicoya Gulf. Fortunately, the shrimp cycle was close to the end, and the final harvest was moved forward, moving the next stocking period to June. General prophylactic measures were taken and mass mortalities have not been reported until this date.

The previous month, when WSSV was detected, a farm located on the central Pacific coast experienced mortalities among 10 million (M) postlarvae (PL) imported from Colombia, even though these larvae had health certification. In this case, there is no evidence that the infection was from the country of origin, because of the short incubation period of the disease and the fact that the time when the animals were imported and the outbreak period do not match. Also, part of these imported PL (1.5 M) were sent to another farm where WSSV has not been detected.

To date, yellowhead virus (YHV) has not been detected in the country.

Actions taken

The Animal Health Office, and mainly private industry, after reviewing protocols from other countries (e.g., Thailand and Ecuador) prepared a manual entitled "Health Management Plan for Shrimp Farming" (Plan de manejo sanitario para el cultivo de camarón), which contains biosecurity measures to be applied during the larviculture, grow-out, harvest and processing of shrimp. This manual also includes some recommendations for food processing plants. The document is under revision by interested parties and has not yet been approved by the national authorities, due to disagreement in some important areas.

The Animal Health Office has been developing, in a very strict way, health controls recommended in the manual "Aquatic Zoo-health Norms and Procedures" (Normas y Procedimientos Zoosanitarios Acuícolas) concerning nauplii, PL, juveniles and broodstock, including fresh and frozen shrimp imported into the country. In this manner, INCOPESCA authorizes shrimp imports only when the OIE requirements are fulfilled.

On the other hand, one of the national private industries brought kits for the technical personnel of the Universidad de Costa Rica to conduct PCR tests. Although some test have been conducted, results have not been satisfactory from the technical point of view. Because the cost of these tests is relatively high, the government is sending samples to a laboratory in Arizona, USA, despite the presence of laboratories well known for PCR tests in Panama (e.g., the Smithsonian Laboratory), Colombia and Ecuador.

As mentioned before, there is no specific action plan, however, general information has been disseminated. Also, within Además, the following recommendations have been provided:

- To prohibit imports of nauplii, PL and broodstock from countries with this virus. This measure is not accepted by some farmers and is one of the main obstacles to the final approval of the national plan.

- To prohibit imports of fresh and frozen shrimp from countries with the diseases.

- To require from the exporting countries of nauplii, larvae and broodstock, a health certificate based on the "Manual de Normas y Procedimientos Zoosanitarios."

- Not to stock wild seed.

7.7.3 Conclusions

The Government of Costa Rica and the authorities know the importance of implementing, as soon as possible, an shrimp disease control program at the national level which includes not just health measures already taken, but also measures that prevent and help diagnose diseases in marine products, mainly from shrimp farming. It is important to coordinate with the private sector in developing biosecurity procedures and also to designate an official government authority with responsibilities for implementing these procedures. Also, international cooperation is important, for example, to provide experts for training local personnel at the University of Costa Rica and at the Aquatic Health Office on diagnostic techniques, such as PCR, dot-blot essay and others, and to share their experiences and recommendations on health management programs for important aquatic animal diseases.

7.8 Cuba

Presentation by Adela Prieto, Raquel Silveira and Rafael Tizol (Centro de Investigaciones Pesqueras)

7.8.1 Background

Fisheries and aquaculture development is an important part of the National Food Plan of Cuba. Fish is an important food and protein source for the people and a source of income to the government.

Aquaculture, unknown in Cuba until the 1960s, is becoming an important component of national fish production. This increase is mainly due to freshwater aquaculture. Shrimp culture represents only 2% of national aquaculture production. The national strategy plan for the next five years calls for cultured shrimp production to reach 100,000 metric tonnes (mt) by the year 2005; freshwater cultivated species production to reach 230,000 mt; cultivated marine fish production of15,000 mt; and capture fisheries on the continental shelf to account for 50,000 mt. This means targeting a three-fold increase from the 1999 production, and increasing aquaculture's contribution to 89% of the total national fishery production.

In the case of shrimp culture, a total of 2168 ha was used in 1998. Three operational hatcheries reported production of up to 577 million (M) postlarvae (PL) between 1990 and 1998. The projected growth for the year 2005 is based on the development of new hatcheries to reach a production of 800 M PL per year; construction of larviculture facilities; increase in the number of grow-out ponds; increase in number of feed plants; development of communities; improvement of facilities and management of harvest to increase price.

7.8.2 Aquatic animal health management

The development of freshwater aquaculture in Cuba was based mainly on exotic species with high nutritional value, well-developed culture technique and good adaptation potential to local conditions, since local species do not have these characteristics. Fishes were imported from Europe, Africa and America, and consequently, several pathogens were introduced, mainly ectoparasites and the catfish virus. At this time, there is no information about the health risk of importing exotic species nor are there personnel trained in aquatic animal health management. In 1980, importing regulations were established and a quarantine period, controlled by trained personnel, was conducted to avoid dissemination of aquatic animal pathogens.

Penaeus schmitti, a native species, is used in shrimp farming. Of the two exotic shrimp species introduced to conduct research, *P. stylirostris* was successful, but *P. monodon* did not survive. Shrimp diseases were not introduced with these imports. At present, the only potential risk is due to *Baculovirus penaei*, a virus present at low quantities in natural shrimp populations on the Cuban continental shelf. However, mortalities have not been reported in culture systems, due to health controls conducted on wild broodstock before introduction to hatchery facilities.

The more important diseases in shrimp farming are those caused by nematodes, ectoparasites and *Vibrio* spp. causing luminescent vibriosis. The use of antibiotics is common to prevent disease dissemination and its negative effects on shrimp culture. Antibiotics, most commonly oxytetracycline, are applied during larviculture. Medicated feed is not used.

In the search for new health management techniques that are safe to the environment and the general public, extracts from medicinal plants have been under evaluation during recent years. These have proved to be effective *in vitro* against some pathogens.

Farm-level aquatic animal health management

Considering the importance of disease control for the development of national aquaculture, a general program was developed to control the health conditions of culture stations and hatcheries based on the Operatives Procedures Protocols.

Shrimp farming is expected to be the most rapidly expanding aquaculture industry during the next five years. Intensification will be one of the ways to increase shrimp production, but it will also increase the risk of disease.

Due to the proliferation of bacterial and viral infections and the high economic losses caused by these diseases, it was necessary to summarize in a single document all health management procedures based on prevention by controlling pathogens and carriers. In this manual, shrimp farming is divided into three phases, which include (a) maturation, (b) nursery/larviculture and (c) grow-out; each stage with its own disease problems, and specific and common solutions. The procedures summarized in this manual take into account the different phases, providing an integrated approach to shrimp culture and health management.

The current and potential national epizootic situation and the risk of disease were determined before establishing the above-mentioned systems of health management. Based on these results, a regular program for health management was established. Specific plans were also developed to avoid the entrance of viral diseases (i.e., Taura syndrome virus (TSV) and white spot syndrome virus (WSSV).

Diagnostic procedures

Information published about diagnostic methods has been useful in finding solutions to some problems, however, differences in culture systems, management techniques and climatic conditions necessitate the development of methods for diagnosis, prevention and control specific to each region.

A “Reference Book for the Diagnosis of Diseases of Aquatic Cultivated Species” was prepared following the ISO 9000 Code to standardize the techniques used in the national laboratory network. This book summarizes all the diagnostic techniques used in laboratories as follows:

1) Organization, structure and objectives of the Diagnostic Laboratory
2) Clinical diagnosis
3) Bacteriology laboratory
4) Parasitology laboratory
5) Histopathology laboratory
6) Hematology and serum chemistry laboratory
7) Pharmacology laboratory
8) Health inspection

The Operatives Procedures Protocols is part of the national program. This manual contains standard health procedures for fish and shrimp farms, quarantine procedures to be applied to the importation of live animals to avoid pathogen introductions, and legal considerations.

Another important part of the national program is the basic research conducted at the Reference Laboratory to update the health program. This laboratory has basic facilities and is planning to construct new areas for research in virology and molecular biology. The main research topics are:

- development of efficient techniques based on immunology and molecular biology to diagnose diseases important to aquaculture;
- development of vaccines to control bacterial septicemias; and
- evaluation of natural medicines to control diseases.

As new diagnostic techniques are implemented, specific procedures are established, such as the PCR technique and the rapid histology test for WSSV diagnosis, and the indirect immunofluorescent test to diagnose bacterial diseases of tilapia and ulcerative disease of trout. In this way, diagnostic methods are standardized at the national level.

Government policy and legislation for aquatic animal health

The Ministry of Fish Industry is the government entity responsible for the health management of aquatic organisms. In turn, this ministry delegates this responsibility to the Fish Research Center in accordance to Legal Resolution 068. This center has cooperative agreements with other specialized laboratories, such as the Farming Health Center (Centro de Sanidad Agropecuaria), the Institute of Veterinary Medicine (Instituto de Medicina Veterinaria), and the Genetic Engineering and Biotechnology Center (Centro de Ingeniería Genética y Biotecnología).

The National Aquatic Health Reference Laboratory (NAHRL) has the following objectives:

- to advise the Ministry of Fish Industry,
- to elaborate strategies and health management programs,
- to upgrade capacities, and develop standards and accreditation for national health diagnostics for aquatic organisms,
- to control the use of drugs and therapeutic methods in an effective and safe way,
- to implement biosecurity procedures within the Fish Industry Ministry system, and
- to offer high quality services on aquatic animal health management.

Training on diagnosis of aquatic animal diseases

Specialized training in aquatic animal health is not available within the Cuban educational system. Only some classes on the health of aquatic organisms are offered at the Veterinary Medicine Department and at the Fisheries Institute. However, this class is a core course of the Masters Program on Aquaculture and Veterinary Medicine offered at the Universidad de la Habana and the Veterinary Medicine Department.

The low number of personnel trained in aquatic animal pathology limits the development of an integrated system of aquatic health management at the national level. Therefore, it is important to train personnel to meet the program objectives. The NAHRL offers post-graduate courses, workshops and conferences. The courses are offered twice a year, while the workshops and conferences are organized as the need arises.

The laboratory is planning to develop post-graduate courses at the M.Sc. and Ph.D. levels. Recently, a specialist from the NAHRL was trained in viral diagnosis in Spain and on PCR techniques in Mexico.

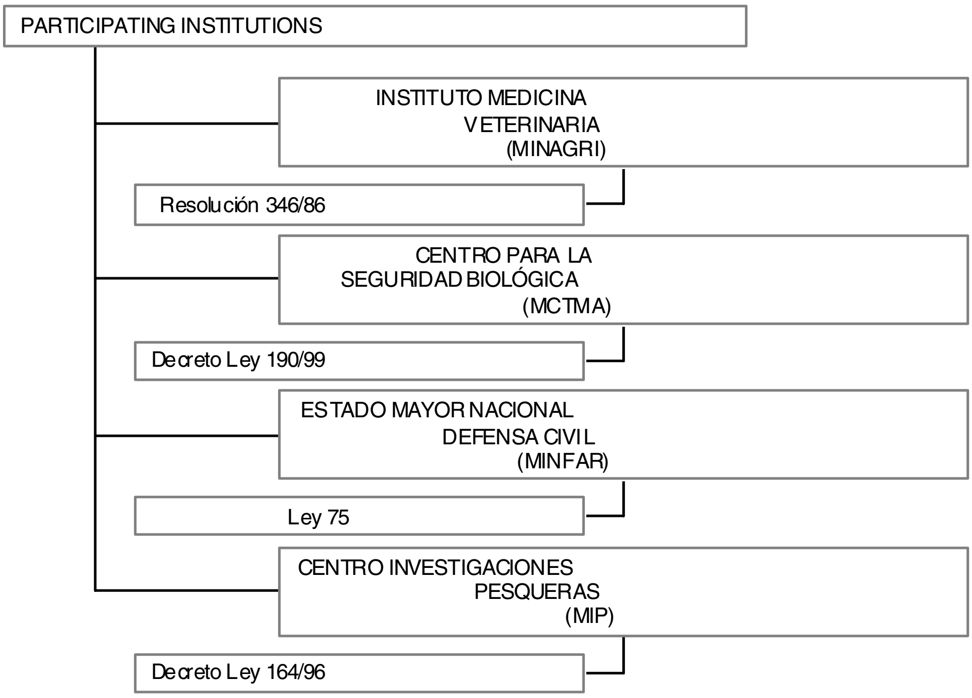
Training on aquatic animal health is also provided to farmers, fishermen and all personnel involved in aquatic animal culture.

A computer database of diseases of aquatic organisms was established for farmers and specialists. This database includes general information about diseases, and diagnosis, prevention and control methods. The users are also able to provide information on new cases observed from their own facilities, as well as information found in published reports.

National Action Plan for aquatic animal health

A general program to avoid introduction of pathogens and to control dissemination of diseases based on prevention by exclusion and control methods is being implemented at the national level. The main objective is to control the spread of pathogens harmful to aquaculture operations.

The legal framework of this National Action Plan, including the facilities is indicated below:



Legend:
MINAGRI - Ministerio de la Agricultura
MCTMA - Ministerio de Ciencia Tecnología y medio Ambiente
MINFAR - Ministerio de las Fuerzas Armadas
MIP - Ministerio de la Industria Pesquera

Important published documents include:

- Preventive Measures Plan for Critical Epizootic Diseases of Aquatic Organisms in the National Territory (Plan de Medidas para Enfermedades Epizooticas Graves de Organismos Acuáticos en el Territorio Nacional);
- Manual of Procedures and Protocols for Disease Diagnoses (Manuales de Procedimientos Operativos de Trabajo para el Diagnóstico de Enfermedades);
- Biosecurity Measures for MIP (Organización para la Seguridad Biológica en el MIP); and
- International Aquatic Animal Health Code, Office International des Epizooties (Código Sanitario Internacional para animales acuáticos de la Oficina Internacional de Epizootias).

National quarantine and certification regulations – regulations on transportation of live aquatic animals and their products

The quarantine procedures are applied based within the above-mentioned legal framework. The NAHRL has the responsibility to issue specific quarantine procedures considering the species to be introduced, obligatory declaration of diseases, health situation in the exporting country, quarantine facility, and any other necessary regulation.

The import permit should be approved by the Fisheries Minister; an Entrance Authorization is solicited from the Frontiers Directions of the Veterinary Medicine Institute; and an Environmental and Importing Permit is solicited from the Biological Security Center and to the Environment Agency.

If a disease of obligatory declaration or an exotic disease is diagnosed during quarantine, the whole stock is incinerated under supervision of national health authorities.

Laboratories and experts for certification of aquatic diseases

The following provides information on the different laboratories in the country and their expertise:

The National Aquatic Health Reference Laboratory (NAHRL) of the Aquaculture Research Center is the national laboratory responsible for the development and implementation of a program on health management; training of farmers and other laboratory personnel on disease diagnosis and diagnostic services; and research on diagnosis, prevention and control of diseases in aquaculture. This laboratory provides authorization to regional veterinary diagnostic laboratories responsible for providing health services to farmers.

Virology Laboratory, National Farming Health Center. This laboratory develops diagnostic techniques for viral diseases of fish.

Regional Diagnostic Laboratory on Veterinary Medicine, Institute of Veterinary Medicine. This laboratory provides diagnostic services to farmers at the national level.

Diagnostic Laboratories in Culture Stations and Regional Fisheries Associations. These private sector diagnostic laboratories in shrimp and fish farms and hatcheries conduct basic disease diagnosis, and extension and field application of research results.

7.8.3 Recommendations

Although it is important to develop an integrated plan immediately, due to limited resources and time, a progressive approach to establishing an effective aquatic health management program is necessary. Recommendations for such a programme, focused mainly on shrimp, are presented below:

Short-term

- To assess the disease situation at the national level.
- To train personnel by country.
- To establish National Action Plans compatible at international and national levels.
- To establish a diagnostic laboratory network at the national level.
- To develop research programs to improve health management of cultured species.
- To establish national reference laboratories for health management.

Medium-term

- To standardize diagnostic techniques for high risk aquatic diseases within all references laboratories
- To establish post-graduate education system to maintain a high standard of professionalism.
- To disseminate regional information at the international level.
- To develop research programs on health management using new techniques.
- To develop control systems safe to the environment.
- To create a regional data base about pathogens.

Long-term

- To centralize production of diagnostic kits for high-risk diseases.
- To establish regional-level standardized agreements to control trade in aquatic species.
- To establish efficient ways to communicate epizootic information within the region.

National and regional strategies and actions to assure sustainability of aquaculture in the Americas

The development of aquaculture does not correspond with either the scientific information available about the cultivated species or the technologies. Based on the experiences of Asia and the Pacific countries, as well as experience in implementation of national programs on aquatic animal health management, it has now become necessary to increase efforts at the regional level.

Cuba is one of the seven major aquaculture-producing countries in Latin America and the Caribbean. Cuba produces 78% of the aquaculture production of the insular Caribbean and has more than 20 years experience in disease management. The following is proposed:

1) To develop a cooperative plan at the scientific and technical levels within the countries of the region.

2) To establish a regional network for health management with the following objectives:
   - to select and standardize effective diagnostic techniques that could be used at the regional level;
   - to improve disease diagnostic and control services for farmers;
   - to train specialists dedicated to develop new aquaculture technologies on genetics, immunology, ecology and pathology; and
   - to establish legal procedures for quarantine and control of dissemination of pathogens caused by transfer of aquatic organisms.

3) To guarantee the economic and ecological sustainability of aquaculture through an effective program on environmental management and disease control.

Acknowledgements

We express our thanks to the Ministry of Fisheries, Repúblic of Cuba for its support and to the Food and Agriculture Organization of the United Nations for the opportunity to participate in this workshop; to SEMARNAP, México for inviting us to participate in this technical consultation; and to all persons involved in the organization of this consultation that will help the aquaculture development of our countries.

7.9 Ecuador

Presentation by Dr Franklin I. Ormaza (National Institute of Fisheries, Ecuador)

7.9.1 Background

Annual shrimp production in Ecuador is estimated at more than 100,000 metric tonnes (mt), with 1998 production valued at some US$ 0.8 billion, representing around 5% of the GDP for 1998. More than 200,000 jobs were created by the industry, utilizing a production area of 160, 000 ha (of which 28% is from mangrove areas), and stocking densities of 80, 000 to 100, 000 postlarvae (PL)/ha.

There are 2.2 cycles per year using extensive to semi-intensive systems. There are more than 300 hatchery laboratories (including a few with maturation systems), with a production of 1200 lb/ha/cycle, harvested at 12 gm per piece, with more than 40% survival.

The following authorities are involved in aquaculture development in Ecuador:

Government sector

- Ministry of Foreign Commerce, Industry and Fisheries
- Under-secretary of Fisheries Resources (the lead agency for fisheries and aquaculture)
- National Director of Fisheries (involved with control)
- National Institute of Fisheries (research and quality control for fishery/aquaculture products)

Private sector

- National Centre of Aquaculture and Marine Research (a foundation established in 1990)
- Aquaculture Service Centre (started operation in 1999)
- National Chamber of Aquaculture
- Private laboratories (e.g., Acuatecnos, Dibsa, etc.)
- Many other private companies with their own laboratories

7.9.2 Aquatic animal health management

A number of shrimp diseases have been diagnosed in Ecuador, namely: (a) gregarines in 1989; (b) sea gull syndrome in 1990; (c) Taura syndrome in 1993; (d) infectious epidermal cuticular necrosis in 1994; (e) intracellular necrosis in 1995; (f) vibriosis (haemocytic enteritis) in 1996 and (g) white spot syndrome virus (WSSV) in 1999.

White spot syndrome virus tragedy

WSSV was first recorded in May-June 1999 in the northern part of Ecuador, before the disease was detected in Central America at the beginning of 1999. The disease had a devastating effect on the shrimp industry, with production dramatically dropping by 60%. Many shrimp farms, packaging plants and hatchery laboratories were closed and thousands became jobless.

Wild shrimp populations were also affected by WSSV. There was a proliferation of the use of PCR techniques by many laboratories, as well as histological and bacterial examination. The problem caused by WSSV has lead to an evaluation of shrimp culture practices with respect to lower density stocking (60,000 PL/ha), use of biosafety procedures, better postlarval selection and genetic improvement studies.

Action and recommendations for dealing with WSSV

Ecuador's official recommendations to deal with the WSSV tragedy are to (a) improve water quality and soil management; (b) improve quality of postlarvae; (c) use better feeds (e.g., immunostimulants); (d) prohibit the importation of shrimp from other countries; and (e) disseminate knowledge (e.g., diagnostic techniques and scientific findings).

In March 1999, a legal restriction on the importation of live shrimp was introduced; while importation of frozen shrimp, allowed under very strict conditions for a few months, has now also been prohibited. Matters concerning aquaculture products (natural or artificial) are under the direct control of the fisheries authorities.

Other control measures include: (a) continuous assessment *in situ* by the National Institute of Fisheries; (b) restrictions on the importation of live and frozen shrimp; (c) provision of resources for research directly to CENAIM; and (d) conduct of workshops, seminars and other forms of information dissemination.

Laboratory capabilities

At the national level, the National Institute of Fisheries (NIF) has capabilities for bacteriology, histology, water and soil quality, fluorescent spectrophotometry, environmental studies and trace metal analysis. Pesticides are rarely determined. Universities are also involved in shrimp disease diagnosis.

Within the private sector, many laboratories are doing the same analyses (e.g., Aquatecnos – histology, water quality, probiotics, chromatography; CENAIM and many other laboratories – PCR analysis).

With respect to quarantine facilities, some facilities are available at NIF, but are not currently operational; small-scale facilities are available at the universities; and so far there are no facilities within the private sector, however, there is a lot of interest to build such facilities.

Current techniques employed for shrimp disease diagnosis include histology (done by almost all private laboratories); PCR methods (only recently introduced in shrimp culture for research and monitoring); and bacteriology. There is no consistent method used for research programs.

Introduction of aquatic animals in Ecuador

Many aquatic exotic species (e.g., tilapia or perch; red claw lobster, *Penaeus monodon* and SPF *P. vannamei*) have been introduced to Ecuador without success. Most of the shrimp diseases (e.g., IHHNV, WSSV and TSV) have been introduced, and there has been a huge impact on wild populations.

In view of this, Ecuador has taken several measures to avoid further introduction of disease. There are laws that restrict the importation of shrimp. There is a request from the private sector to introduce shrimp for genetic studies, however, national authorities think that quarantine systems should be developed first before granting such requests. Private laboratories have recommended the development of a quarantine process, which is now under study by national authorities. Authorities are open to very controlled importation, only under a very strict regime.

7.9.3 Conclusions

The shrimp industry plays an important role in contributing to socio-economic development in Ecuador. The industry has recently been affected by serious bacterial and viral diseases, that have probably been introduced into the country via importation of exotic species.

8.10 El Salvador

Presentation by Maria Vargas de Marino (Centro de Desarrollo Pesquero)

8.10.1 Background

Aquaculture in El Salvador began between 1956 and 1958, using freshwater fish, native fish and Chinese carp. In the 1980s, marine shrimp farming began using infrastructure constructed for salt exploitation in the Bahía de Jiquilisco, Usulután State. Freshwater shrimp culture began at the Aquaculture Station of Izalco with the support of the Agriculture Project of China. Currently, the Mariculture Station “El Zope” has the responsibility to develop shrimp culture research. There is a growing interest to culture shrimp. The most suitable areas for shrimp farming are the Unión Usulután and La Paz states, although these areas have sandy soils and a competitive tourism industry. In the case of freshwater shrimp, there is a total potential production area of 109 ha; however, this activity is limited due to low production of postlarvae (PL).

The general objective of this paper is to present the status of shrimp farming in El Salvador, with the specific objectives of presenting information on current PL production level, shrimp production level, impacts of disease and export/import regulations. The information presented is based on the reports and expert consultation of: (a) David J. Currie, Gopa Consultants; (b) Sr. Jorge Lopez, Consultant; (c) Sra Zobeyda de Toledo, Fisheries and Aquaculture Center (Centro de Desarrollo Pesquero); and (d) the Annual Statistic Report of Fish Production.

Shrimp larval production

There are six laboratories involved in larval production, one government (El Zope, located in Sonsonate) and five private operations (Pescanova (Postlarvae); Pescanova (Maturation); Oceanica; and Marchesini, all located in La Libertad; and Formosa, in La Paz). The government Mariculture Station in El Zope, which produces *Macrobrachium rosenbergii* larvae, and Marchesini, which was only recently constructed, produce larvae for domestic use; while all the other laboratories produce larvae for export.

Postlarval production of *Penaeus vannamei* in El Zope began in 1992 with 2.5 million (M) produced, and production gradually increased to 4 M in 1995, dropped slightly to 3.1 M in 1996, and increased again to 8 M in 1997. In 1998, there was a huge drop to 1.7 M, and an increase again in 1999 and 2000 to about 3.3 and 3.7 M, respectively. PL are used for research, technology development and re-stocking. The demand for PL is low, since wild seed is used for culture. In the year 2000, most of the production was used for restocking mangrove areas, in which case, PL were not available for shrimp farmers.

The land area utilized for shrimp farming using intensive systems is lower than that used for extensive systems. Production can significantly increase if more area is utilized using new culture techniques. The Pacific Coast has more suitable areas for shrimp farming. Bahia de Jiquilisco has 2000 ha for salt production and shrimp farms; while Bahia de la Union has a potential shrimp-farming area of 1000-2000 ha.

The production area managed with more technology is lower than the extensive area, which is managed with low technology. Production could increase significantly if more area was managed following new culture techniques.

El Salvador has 250 km of coast, of which 80 km are mountainous zones between Barra Salada and La Libertad. Based on these characteristics, a consultant (D.J. Currie_ recommended:

1) Shrimp culture projects should range between 20-50 ha
2) Semi-intensive culture should be limited to 100 ha per each 5 km of coast.
3) Shrimp farming effluent discharge should not exceed the carrying capacity of natural systems.
4) Cutting of mangroves should be prohibited.
5) Water uptake and discharge systems should be implemented.

6) A maximum of 2000 ha could be used in bay zones.
7) A water quality control program should be established.

The El Zope Mariculture station is located at 13º32´ LN and 89º¨30´ LW, with a weather typical of tropical savanna. It has two water reservoirs, one for fresh water and another for marine water, both pumped from underground deposits 60 m deep. Its main objectives are to produce freshwater and marine shrimp.

7.9.4 Aquatic animal health management

In 1991, an infection with the protozoan *Zoothamnium* was observed on eggs at the El Zope Mariculture Station. In 2000, *Vorticella* was identified on *Artemia* eggs, and antibiotics were used to control the infection.

In 2000, under the Project "Shrimp Status Assessment in El Salvador" (Monitoreo de Recurso Camarón de El Salvador), samples of larvae, juveniles and adult animals were sent to the AgroBiotechnology Laboratory (Laboratorio Agrobiotek) for disease identification. The results were as follows:

- Taura syndrome virus (TSV) was found in juvenile (total length 4.5-8.5 cm) *P. stylirostris*;
- TSV was not found in adults; only *Zoothamnium* was observed in adults.
- WSSV was not observed.
- TSV was reported by a shrimp farmer in Bahía de Jiquilisco.

During research studies, marine shrimp postlarvae died due to TSV in the Mariculture Station in El Zope. In private hatcheries, PL production has improved recently. Mr J. López (pers. comm.) concluded that TSV was found in wild juveniles. WSSV was not detected in wild populations, but it has been reported by shrimp farmers.

Government policy and legal framework

To export any animal product or sub-product, a health certificate is required; for veterinary or agricultural chemical compounds, a special certificate issued by the Dirección General de Sanidad Vegetal y Animal, (DGSVA), Ministerio de Agricultura y Ganadería, is required. To obtain a health certificate, the CENTREX institution has a representative at the DGSVA. In addition, a certificate from a veterinarian authorized by the Junta de Vigilancia should be included with the export permit.

The following agencies are involved in the export of animals and animal products/subproducts and veterinary and agricultural chemical compounds:

1) Center for Exporting Procedures (CENTREX -Centro de Trámites de Exportación, Banco Central de Reserva de El Salvador), is the institution responsible to facilitate exporting procedures.

2) CENDEPESCA, under the Ministry of Agriculture and Farming (Ministerio de Agricultura y Ganadería), is the institution responsible for fish production development and is the agency that authorizes exportation after fulfillment of requirements.

3) The Ministry of Economy (Ministerio de Economia) has representatives at CENTREX with the responsibility for issuing certificates of origin. These certificates correspond to "Form A" of the General Preferential System and to CBI Forms for the Caribbean Region based on the classification established by the Universal Custom System.

4) Customs (Aduanas de El Salvador), is the government office responsible for evaluation and collection of export and import taxes.

Export data show that most of the exports go to Central America, South America, Mexico and the USA. The USA is the main importer of shrimp fro aquaculture and from capture fisheries. Fisheries and aquaculture production contributes one third of the total national revenue. In 1997, export was higher than import, generating a national revenue of US$ 29.5 M.

Laboratories and institutions

The following provides information on the different laboratories and their capabilities:

1) FUSADES (in El Salvador): organochlorine and organophosphate compound analysis

2) AGROVIOTEK (in Guatemala): analysis to detect IHHNV and WSSV

3) Soluciones Analiticas (in Guatemala): analysis of herbicides and organophosphates

A number of institutions are involved in aquaculture and fisheries. These are: CENDEPESCA (Centro de Desarollo Pesquero), SICA-OSPESCA (Secretaria de Integracion Centroamericana Oficina Sectorial de Peca y Acuicultura del Istmo Centroamericano: Unidad de Pesca y Acuicultura); CENTREX-BCR (Centro de Trámites de Exportación, Banco Central de Reserva de El Salvador); DGSVA (Dirección General de Sanidad Vegetal y Animal); CAMPAC (Cámara de Pesca y Acuicultura); and FACOOPADES (Federación de Cooperativas de Pescadores Artesanales de El Salvador).

7.9.5 Conclusions and recommendations

There is no integrated national program to detect and control shrimp diseases, although there is an agreement between the government and the private sector to evaluate the shrimp culture status and there is also on-going cooperation with other countries. Trained personnel are limited, and facilities are inadequate. Diseases detected in El Salvador have affected shrimp production.

The following are recommended:
- to establish procedures to control aquatic animals pathogen trans-boundary transfer;
- to construct a diagnostic laboratory;
- to establish and share standardized methods for disease diagnosis;
- to inform shrimp farmers about biosecurity measures; and
- to unify national and international efforts to improve the shrimp farming situation

7.10 Guatemala

Presentation by Jorge Luis Morales Modenessi (UNIPESCA, Guatemala)

7.10.1 Background

The Fisheries and Aquaculture Technical Direction (Direccion Technica de Pesca y Acuicultura) was the government institution responsible for aquaculture activities until 1998, when the Fisheries and Aquaculture Special Unit (Unidad Especial de Ejecucion para la Pesca y Acuicultura) was created. However, this institution remained only one year and was replaced by the Fisheries and Aquaculture Management Office (Unidad de Manejo de la Pesca y Acuicultura) at the beginning of 1999.

Aquaculture started in Guatemala with community projects, but these were not successful. In the 1970s, freshwater shrimp culture began in different regions of the country, but yields were below those expected. Marine shrimp farming, on the other hand, began in 1982 but it was only in 1984 when significant increases in production facilities occurred. Intensification of shrimp farming started in 1991.

An updated list of freshwater culture facilities has not been prepared. However, in January, the Continental Water Office (CWO, Sección de Aguas Continentales) of UNIPESCA, elaborated an inventory of marine shrimp farming facilities in the country.

Shrimp farming in Guatemala

One-hundred percent of the shrimp production in Guatemala occurs on the Pacific coast. There are about 26 farms (total of 18 farms in operation) using 1,709 ha, where 48% (817 ha) are in active operation and 52% (891) ha are inactive. There is only one laboratory for disease diagnosis.

Shrimp farming production has not yielded as expected, due to various reasons, but mainly due to viral diseases such as Taura syndrome and climatic phenomena such as “Hurricane Mitch” in 1998. Official production records are not available, however, production was estimated to be around 3,000,000 lb per year since 1995.

7.10.2 Aquatic animal health management

The means by which shrimp pathogens have been introduced to Guatemala are unknown. Different hypotheses suggesting possible ways of pathogen introduction include via imports of food, nauplii, and frozen shrimp, and contaminated water effluent from the Fonseca Gulf. Reduction of production was significant, and survival was reduced from 95% to 10-25% since 1995. This situation has had a negative impact on rural economies, causing increased unemployment and migration to the cities, and reduced activity in shrimp processing plants. These are the main impacts of aquatic pathogen introduction in Guatemala.

In terms of the effects of pathogen transfers on biodiversity, there is no effective control system, making it very difficult to determine, in scientific terms, the impact generated by the presence of shrimp viral diseases. It is important to observe that the biomass of wild seed has not been affected.

Institutions involved in aquatic animal health management

Following the problems brought about by Taura syndrome virus (TSV) and later, by white spot syndrome virus (WSSV) in 1999, the shrimp industry, government institutions, and universities are trying to work together to develop research and to establish management measures to diagnose aquatic pathogens and prevent their spread. The institutions involved in this effort are:

1) 1) UNIPESCA – Fisheries and Aquaculture Management Office of the Ministry of Agriculture, Ranching and Food (Unidad para el Manejo de la Pesca y Acuicultura del Ministerio de Agricultura Ganadería y Alimentación)

2) AGEXPRONT - Association of exporters of non-traditional products.

3) ACRICON - Association of shrimp farmers

4) CEMA - Center for Marine and Aquaculture Research at the Universidad de San Carlos de Guatemala

5) UVG - University of the Vale, Guatemala

7.10.3 Conculusions and recommendations

The government of Guatemala, through UNIPESCA will: (a) establish import regulations for shrimp larvae; (b) look for financial support to construct an aquatic disease and water quality laboratory; and (c) help establish a Control and Surveillance Group that will look at techniques to prevent aquatic pathogen transfer, control diseases and enforce regulations. Institutions such as the University of San Carlos (Guatemala) will establish a laboratory to detect viral and bacterial diseases; this project is under revision for financial support. Members of the private sector, such as Industrias Mayasal, constructed the first hatchery laboratory to find ways to reduce risk when importing larvae. In Central America, efforts to unify criteria for the standardization and validation of diagnostic techniques for aquatic animal diseases have not been developed, and it is suggested that this is an opportune time to take such measures.

7.11 Honduras

Presentation by Hector Corrales (ANDAH/SAG, Honduras)

7.11.1 Background

There has been a steady growth in shrimp (tails and head-on) production in Honduras from 1985 to 1998, from a production of 1,150,000 lb tails and 1,769,230 lb head-on in 1985, to 20,160,000 lb tails and 31,015,380 lb head-on in 1998. Peak production was attained in 1993, with 21,200,000 lb of tails and 32,615,380 lb head-on, after which there was a decline in production between 1994-1995. Production started to pick up again from 1996 to present. In terms of production area, from 780 ha utilized in 1985, the area covered steadily grew to 15,700 ha in 1999 (see Table 1). At present, there are 229 producers, covering an area ranging between 1 to 3000 ha; over 82% of the group are in the range of 1 to 50 ha.

Table 1. Shrimp production and areas in Honduras from 1985 to 1998.

Year	Lb of Tails ('000)	Lb Head-On ('000)	Tonnes Head-On	Area (ha)
1985	1,150	1,769.23	804.19	780
1986	1,875	2,884.62	1,311.19	1,450
1987	3,437	5,287.69	2,403.49	2,100
1988	4,750	7,307.69	3,321.67	2,700
1989	5, 275	8,115.38	3,688.80	5,500
1990	7,125	10,961.54	4,982.51	6,975
1991	10,250	15,769.23	7,167.83	7,951
1992	13,125	20,192.31	9,178.32	8,622
1993	21,200	32,615.38	14,825.17	9,250
1994	17,925	27,567.92	12,534.96	11,050
1995	14,575	22,423.08	10,192.30	13, 620
1996	16,400	25,230.77	11,468.53	13,620
1997	19,387	29,826.15	13,557.34	13,870
1998	20,160	31.015.38	12,529.80	14,470
1999	-	-	-	15,700

Hatchery seed production

There are 12 operational hatcheries in the of Gulf of Fonseca area, with a production capacity of more than three billion postlarvae (PL) per year. There are also frequent imports of PL from Panama, the USA and Colombia. Figure 1 shows the percent of hatchery-produced PL used by Honduras' shrimp farms. These data, representing about 60% of the total area in production, demonstrate that hatchery-raised PL comprised only about 20% of the overall farm seed demand between 1991 and 1992. In 1994, farms stocked more hatchery-reared PL than wild, and from 1993 to 1998, the percentage of hatchery-produced animals utilized has averaged 50% of the overall seed requirement. By the end of 1999, 99% of the seed stocked by farms was hatchery raised. Figure 1 shows the proportion of hatchery seed stocked in shrimp culture in Honduras.

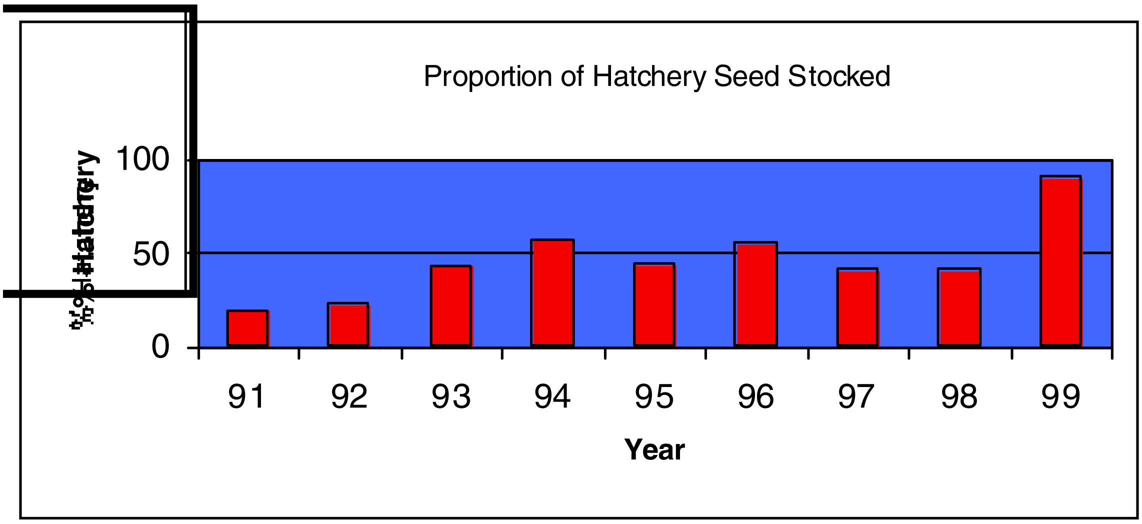


Figure 1. Proportion of hatchery seed stocked in shrimp aquaculture in Honduras from 1991 to 1999.

7.11.2 Aquatic animal health management

The presence of TSV was confirmed in Honduras during August 1994, while WSSV was found in February 1999. During 1993, the Honduran shrimp industry had unprecedented levels of productivity, with production exceeding 14,000 mt, compared to 10,000 mt in the previous year (Table 1). While there were no early suspicions of the problem, there were indications of reduced survivals during the dry season of 1994. However, these were attributed to the seasonal reduction in productivity normally encountered at this time of the year. The problem worsened considerably at the onset of the rainy season, with survival declining to 15%, and definitive confirmation identifying TSV as the causative agent. This problem continued through 1995, until the situation began to stabilize in March of 1996, when survivals and production had reached 42%. Subsequently, survivals have steadily increased to an average of around 50% prior to hurricane "Mitch" in September 1998.

TSV affected production in a similar fashion to that in other Latin countries. Gross signs first appeared in 2-6 week-old juveniles, with clinical signs being the same as those described elsewhere. While all sources of *Penaeus vannamei* were affected, it was interesting to note that certain strains outperformed others, and that *P. stylirostris* appeared to be largely immune to the effects of the virus. While the effects on production were acute and quite dramatic during the early stages of the history of this disease, the impact of TSV lessened with time, to the point that its occurrence during the low-salinity rainy period became a predictable event, which caused concern but not debilitating results.

Following hurricane "Mitch," many farms in Honduras did not immediately begin restocking ponds where inventory was lost as a result of flooding. The farms that did begin restocking primarily used hatchery -raised *P. vannamei*, However, they also stocked some wild seed, with proportions of *P. stylirostris* exceeding 10%. This was mixed with hatchery produced *P. vannamei.* During January 1999, extensive and acute mortality was encountered in *P. stylirostris* in both 100% wild-stocked ponds and laboratory *P. vannamei* mixed with seed of wild origin. What was interesting at this time was that the *P. vannamei* from laboratory and wild origins did not exhibit any signs of stress or mortality.

Impacts of viral disease on the shrimp industry in 1999-2000

There was a 93% reduction in the occurrence of viral diseases during the first quarter of 1999 due to low density stocking, as can be seen in Figure 2 on stocking vs. harvesting figures. There was also reduction in the labor force by 13%. During the second semester of 1999, employment returned to almost normal levels, and the same trend was observed for year 2000.

Comparison of performance of shrimp produced under disease conditions in 1998 and 2000

In 1998, when the industry was suffering from TSV, farmers practiced high-density stocking using smaller shrimp; although there was higher survival, there was higher risk and higher costs. In 2000, on the other hand, with TSV and WSSV, farmers used lower density and bigger shrimp, and although there was lower survival, there was lower risk and lower cost.

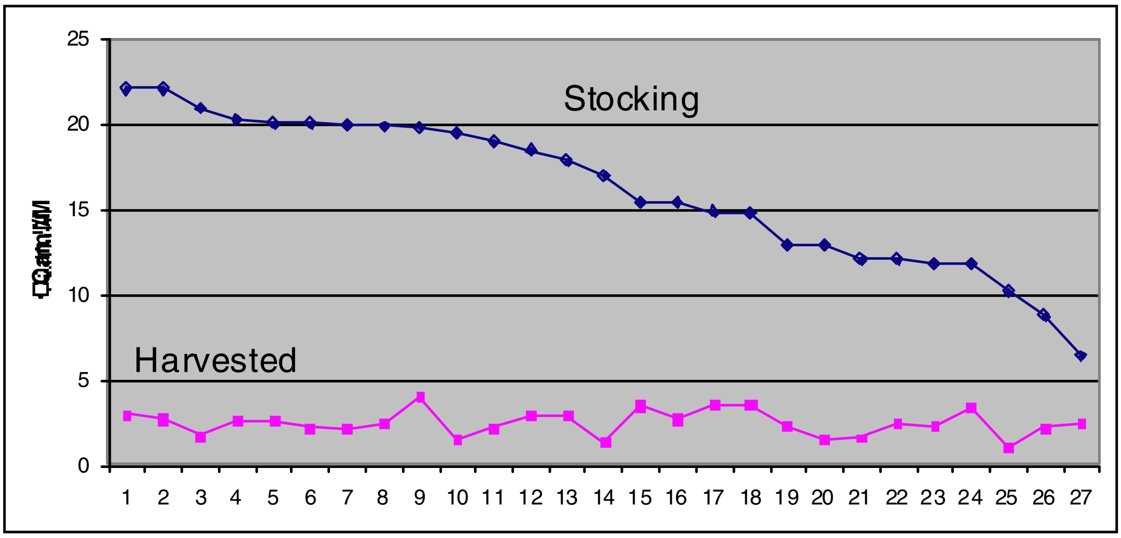


Figure 2. Stocking vs. harvesting figures.

Government regulations

A number of sanitary regulations were put in place. These are:

- New 'Reglamenta de Salud Acuicola y Pesquera' based on OIRSA Guidelines
- Joint SAG-OIRSA-ANDAH Pathology Laboratory
- Certification of International Suppliers
- Government-Producers Agreement on 'Import Ban of Vaccines'

7.11.3 Recommendations

The following are recommendations to deal with viral disease problems:

- Adherence to OIE-OIRSA guidelines (11 points)
- Conduct of Import Risk Assessment; a 100% no-risk approach could paralyze international trade and genetic improvement projects
- Development of faster and more reliable disease diagnostic tools
- Development of an operational information network at the regional level

In terms of private sector level training, the following are being undertaken/implemented:

- United Stated Department of Agriculture (USDA)-Andah-SAG Extension Program
- University of Rhode Island (URI)-Andah Development of Best Management Practice
- Global Aquaculture Alliance (GAA) Producing Guidelines

- Workshops
- Industry magazine

7.12 Panama

Presentation by Reinaldo Morales Rodriquez (Direccion National de Acuicultura, Ministerio de Desarrollo Agropecuario, Panama)

7.12.1 Background

The Nacional Directorate of Aquaculture, created in 1976, is in charge of technology generation and transfer. In 1994, there were 49 producers covering 4994 ha and production of about 6121 metric tonnes (mt).

Two laws governing incentives and dispositions about aquaculture activities are contained in Law No. 12 of January 25, 1973 and Law No. 58 of December 28, 1995. These laws are being implemented within a consultative framework between the Ministry of Agriculture and representatives of producers associations, national banks, professionals in aquaculture and other government institutions.

Other relevant laws are contained in a number of decrees as follows:

- Decree Executive No.4 of February 4, 1997
- Decree Executive No. 11 of February 5, 1997
- Law Decree No. 7 of February 10, 1998
- Law No, 41 of July 1 1998
- Decree Executive No. 58 of September 22, 1999
- Law No. 23 of June 30, 1999

Shrimp aquaculture development in Panama

Shrimp aquaculture in Panama utilizes about 988.6ha, distributed in Cocle, Herrera, Veraguas and Los Santos. Two systems are used: (a) an extensive system which produces 385 kg/ha/crop; and (b) a semi-intensive system with three production levels, namely: (1) low production (385 to 680 kg/ha/crop); (2) middle production (680 to 1135 kg/ha/crop); and (3) high production (more than 1134 kg/ha/crop). There are currently 14 processing plants, four of which are involved in aquaculture products (with production of about 45,000 mt/year) and four plants involved in feed production..

There are 15 centers of larval production, with a monthly capacity of 2658 million (M) nauplii and 454 M postlarvae (PL). In 1998, total production was 10, 076 mt (an increase of 94.4%) from 72 farms; with export earnings of about US$ 120 M.

7.12.2 Aquatic animal health management

Shrimp disease problems

In March 1999, at the Gulf of Parita, Panama, unusual mortalities with clinical signs similar to bacterial diseases caused by *Vibrio* spp. were observed. In April 1999, white spot syndrome virus (WSSV) was diagnosed in Panama. A survey and monitoring for WSSV was conducted among wild populations in 10 estuary areas and shrimp farms.

Five areas (Pablo Blanco, Rio Grande, El Salado, Chame and Sarigua) had positive light infection; while the other five areas (Los Castillos – Tonosi, El Nancito – Mariato, Anton, El Reten and La Honda) had negative infection. Fifteen percent of wild populations and 24% of farms were infected.

In 1999, there was a decrease of 77.4% in production, amounting to 16.51 M pounds; and in 1998, a reduction to 22.2%, amounting to 99 M pounds. In terms of value, reduction in production amounted to US$ 39 M (71.8 % decrease) in 1999 and US$ 99 M (54.9% decrease). Nauplii exportation also decreased to 37.9%, valued at US$ 9 M. Eighty percent of commercial activity in the Central Provinces was affected. In terms of labor force, 3000 direct and 15,000 indirect jobs were affected. In terms of over-all economic impact, there was a decrease in the total production from 5.0 mt in 1998, to 3.5 mt in 1999 and to 1.9 mt in year 2000.

Actions taken to deal with WSSV in Panama

In order to deal with the WSSV problem, the Ministerio de Desarollo Agropercuario, in April 1999, prepared a "National Emergency Plan for the Diagnosis, Prevention and Control of White Spot Disease in the Republic of Panama" (Plan Nacional de Emergencia para el Diagnostico Prevencion y Control de la Enfermedad de la 'Mancha Blanca or White Spot' in the Republic of Panama). This national plan contains actions pertaining to the diagnosis and certification for WSSV, information dissemination and sharing of experiences and research.

The knowledge and experiences regarding the behavior and effects of the disease in Panama and Latin America were disseminated; periodical meetings with technicians and professionals working in farms and laboratories to evaluate implemented measures were conducted; and visits of main scientists to countries specializing in shrimp diseases were also undertaken. In addition, 100 technicians from both private companies and the government were trained in PCR and histological diagnostic techniques.

Four different research activities were undertaken:

a) Research I: Several sub-studies on immunostimulants (betaglucans) and chemical substances for treating water; studies to determine the susceptibility and solubility of different substances (Neguvon, Sevin 80 WP) in the water; studies regarding SPF *Penaeus. stylirostris* and *L. vannamei*; and studies on domestication of *L.. vannamei*.

b) Research II: Studies on identification of viral carriers revealed that the following species are natural carriers of the virus: *P. vannamei* (white shrimp); *P. stylirostris* (blue shrimp); *Farfantepenaeus duorarum* (pink shrimp); *Alpheus* sp. (crackel shrimp); Palaemonidae (big head shrimp); *Callinectes* sp. (crab); *Uca* sp. (fiddler crab); and Gerridae/Vellidae (aquatic insects).

Research III: Sampling for WSSV in main fishing areas - 100% of the 18 samples collected from six main fishing areas (Gulf of Chiriqui, Gulf of San Miguel, Boca de Parita, La Maestra y Chiman, Pacheca) were PCR positive for WSSV.

(c) Research IV: six species of shrimp carried the virus: *P. occidentalis* (green tail white shrimp), *P. stylirostris* (blue shrimp), *Farfantepenaeus californiensis* (brown shrimp), *Xipropenaeus riveti* (Titi shrimp), *F. brevirostris* (red shrimp), and *Trachypenaeus byrdi* (Caribali shrimp).

A number of new technologies/measures were validated for semi-intensive culture (e.g., infrastructure modification for water recirculation, auxiliary aeration, reduction of stocking density from 14 to 4 PL/m^2, use of chemical substance to control vectors; and certification of PL) and intensive culture systems (e.g., aeration, stocking densities, water treatment with chemical substances such as chlorine and lime; and certification of PL). These studies (use of dolomite lime at 120 mg/L; use of immunostimulants and control of wild fauna) enabled the provision of basic guides and protocols for shrimp culture with WSSV problems.

Using the above measures lead to increased survival rates of between 5 to 50%; 150 to 2000 lb/ha with sizes ranging from 9 to 15 gm; and a total production during the first six months of 554,924 lb from 2573 ha.

Rules and regulations

There are several rules and regulations as follows:

- Law 2 of July 15, 1998, the Ministry of Agriculture, through the National Directorate of Animal Health, is the responsible entity for animal health.
- Rule under Executive Decree No.9 of February 9, 1998.

- Executive Decree No.58 of September 22, 1998 - National Directorate of Aquaculture is responsible for national aquaculture activity and also mandated to coordinate and execute the aquaculture health plan jointly with the National Directorate of Animal Health and Executive Directorate of Agriculture Quarantine.
- Ministerial Resolution No. 024-ADM-98 of May 3, 1998 pertains to mobilization of animals in the national territory, such as establishing norms and aquatic zoosanitary procedures, ensuring import policies are consistent with zoosanitary procedures , as well as the forms to register sanitary events and aquaculture areas.
- H. CIRSA - Resolution No.4 of October 4, 1998 – Approval of the guidelines for the establishment of import sanitary requirements of birds, pigs, cows and aquatic products.
- The Subcommission to revise and enforce laws regarding the registrations or import of materials and products used in aquaculture and the import of aquatic organisms (document preparation is in consultation process).

The Legislation Congress accepted the petition from the ASPAC, of a preliminary law which prohibits the introduction of live, refrigerated or frozen organisms to the country for aquaculture or industrial use coming from countries or zones with pathogens and/or diseases exotic to the country.

7.12.3 Recommendations

The recommended actions to control shrimp disease problems are as follows:

- Support shrimp producers through a subsidy of 50% of the cost related to the stocking of the first production cycle, to a maximum of US$ 600/ha.
- Strengthen research centers for the development of research projects related to the prevention and control of WSSV.
- Promote cooperation between the production and government sectors and research centers.
- Conduct research in the following areas: (a) genetic improvement in order to obtain shrimp tolerant to WSSV, (b) water treatment, (c) use of chemical substances and immunostimulants, (d) quality of the soil, and (e) aquatic pathobiology, among others.
- Validate techniques/measures developed for dealing with WSSV.
- Strengthen laboratories by providing equipment and improving the capacity of technical personnel to diagnose diseases of shrimp and other aquatic organisms.
- Supervise and monitor the implementation of established protocols for the prevention and control of WSSV at the farm level.
- Promote the participation of the private sector in a technological modernization program, particularly the use of modern equipment for better production.
- Establish quarantine measures in zones or countries that are suspected to have pathogens or diseases exotic to the region.
- Define the concept of pathogen-free zones .

7.12.4 Conclusions

At the end of the year 2000, with the implementation of recommended actions to deal with WSSV, it is expected that the shrimp culture industry will be in a more stable situation for increased production, based on newly validated and implemented technologies.

7.13 Venezuela

Presentation by Rodolfo Cadenas (Ministerio de la Produccion y el Comercio, SARPA - Servicio Autonomo de los Recursos Pesqueros y Acuicolas)

7.13 Background

The introduction of exotic species had two types of impact: ecological and economic. These are interconnected because an exotic species that causes an ecological impact also generates an economic effect. In addition, many introduced species die without causing effects on the environment. However, exotic species represent a potential risk factor that could affect the economy and the ecosystem (Colher and Courtenay 1986).

All exotic species introductions cause some change in the environment. Unfortunately, most of the observed effects are negative for native species, including changes in trophic structures and ecological relationships between native species and the environment. Trans-boundary trade in commercial exotic species is the main factor for the dissemination of high-risk diseases, for example, viral disease in the shrimp industry.

The aquaculture sector is continuously growing, based on the increasing number of farms, area used for production, and aquaculture items produced between 1983 and 1999. The number of farms registered with the Servicio Autónomo de los Recursos Pesqueros y Acuícolas (SARPA) has also increased, with a total of 2,600 ha used for production in 1999. These low-density farms have limited health problems due to the geographic conditions that allow the separation of culture areas. Shrimp farms are distributed along different regions of the coast, a factor that is important in maintaining good shrimp farming within the country (SARPA 1999).

Shrimp culture is the main aquaculture activity. Two native species, *Penaeus brasiliensis* and *P. schmitti,* have been successfully used. However, the introduction, in 1986, of *Penaeus vannamei* stimulated the industry. Venezuela is one of the few countries without viral diseases affecting shrimp farming. This is due to the cooperative measures undertaken by the private sector and government institutions, especially SARPA, which is part of the Ministry of Production and Commercial Trade. Two important factors in the success of controlling shrimp diseases are access to good information and the high technology used to produce larvae in closed systems with high standards of water quality during the grow-out period.

Health management in shrimp farming is efficiently carried out, both by the private sector and the government (SARPA), particularly with respect to domestic movement and exportation of postlarvae (PL). This includes an agreement, established in 1995, prohibiting the importation of any live crustaceans. In addition, the current regulation also limits the movement of food and imported material, such as fishmeal or any subproducts, from areas with the presence of virus.

Development of aquaculture in Venezuela during the past 10 years

Aquaculture in Venezuela began with trout culture in 1937, and was subsequently followed by culture of other imported exotic species, including common carp *(Cyprinus carpio*) and tilapia (*Oreochromis* spp.). Other exotic species used for research include sturgeon (*Acipenser sturio*), American eel (*Anguilla rostrata*) and ornamental fishes. Native species have also been used, such as cachama *(Colossoma macropomum*), morocoto (*Piaractus brachipomus*), coporo (*Prochilodus* sp.) and bagres *(Pimelodus* sp.) (SARPA 1995).

Main species used for aquaculture

The main species used for aquaculture are:

- Cachama negra *(Colossoma macropomum*)
- Cachama or cachama hybrid (C*olossoma macropomum* x *Piaractus brachipomus)*
- Coporo *(Prochilodus* sp.)
- Bocachico (*Semaprochilodus* sp.)

- Red tilapia (*Oreochromis* sp.)
- Catfish hybrid (*Pseudoplatystoma fasciatus* x *Leiarius marmoratus*)
- Rainbow trout (*Oncorhynchus mykiss*)
- Marine shrimp (*Penaeus vannamei)*

Tilapia culture

In 1959, the government imported tilapia, *Oreochromis mossambicus,* from Trinidad and Martinica. This species was stocked in different water bodies, including Lago de Valencia, Laguna de Los Patos, El Andino Dam, and other water bodies located on the coast (Ramírez 1969). The main objective was to take advantage of the high reproductive capacity of this species to provide food for carnivorous fish species. Unfortunately, the ecological effects of this high-reproductive capacity fish were not taken into account. Fortunately, the introduction of the genera *Tilapia, Sarotherodon* and *Oreochromis* by the private sector has not caused the introduction of pathogens.

The culture of tilapia was legalized in 1992, by virtue of Resolution "MARNR – MAC." This resolution allowed introduction of tilapia for aquaculture purposes, although some animals were already illegally introduced into the country.

The main tilapias cultured are red and blue tilapia, both imported in 1989. However, red tilapia is most commonly used, especially in warmwater areas (24-30 ºC). SARPA records indicate a total of 195 farms, with a total production of 2320 metric tonnes (mt) in 1999. The culture area is around 297 ha. Tilapia culture is mainly located at the Táchira, Barinas, Cojedes, Zulia and Carabobo states, and in some states in the western region (SARPA 1995).

Rainbow trout culture

The culture of rainbow trout *(Oncorhynchus mykiss*) is most important in the Andean states of Táchira, Mérida and Trujillo. SARPA records show a total of 18 trout companies, with a total area of 21 ha in 1994. The government has another three trout stations as part of the National Farming Research Funds or FONAIAP (Fondo Nacional de Investigación Agropecuaria).

Currently, trout culture has increased to 45 farms. Stocking density is very high, around 20 kg/m^2. In 1999, trout production was 678 mt, obtained from 50 ha and between 10 to 12 month/culture cycle.

Cachama culture

Cachama (*Colossoma macropomum*) culture is a tradition in Venezuela, which was one of the first countries in Latin America to use cachama. In 1994, SARPA records showed a total 38 farms with a total area of 90 ha (SARPA 1995). Currently, there are 140 farms with a total area of 195 ha, distributed along the continental areas with temperatures ranging between 24–30 ºC. Stocking density is around one pc/m^2 for semi-intensive culture and 22-30 pcs/m^3 in cages, with a production cycle running between 8 to 10 month.

Marine shrimp culture

Marine shrimp farming in Venezuela began with the native species *Penaeus schmitti* and *P. brasiliensis*. However, the exotic species *P. vannamei* was introduced for culture in 1986. This species stimulated growth of the industry, because it adapts well to intensification. Crustaceans were imported from 1986 to the beginning of 1995, when Taura syndrome virus (TSV) was already causing significant losses in Ecuador. In 1996, this virus was found in the Atlantic coast of Colombia.

Since 1989, shrimp farming has grown rapidly. Based on SARPA records, shrimp farming increased by around 215% between 1989 and 1990, with an annual growth rate of 20 %. In 1995, a total of seven farms were in operation, including Aquatec C.A. (Nueva Esparta State), Aquacam C.A. (Estado Sucre State), Desarrollos Marinos C.A. (Estado Sucre State), Aquamarina de la Costa C.A. (Anzoátegui State), Ricoa Agromarina C.A.(Falcón State), Interaqua de Venezuela C.A. (Zulia State), and Bioindustrias C.A. (Zulia State). Average production in two crops per year was 1.200 kg/ha/yr (SARPA 1995).

The prohibition to import live crustaceans lead to the improvement of local broodstock in order to provide larvae for the national industry. The Ricoa Agromarina C.A. company produced, in 1994, a variety of shrimp named "Super Shrimp." This variety offers advantages in terms of growth and meat quality. México has been using this variety. Currently, laboratory production satisfies the national demand. Excess larvae and broodstock are being exported to Ecuador, Honduras, Colombia, Brazil and Panama, and even as far as Africa.

Currently, culture areas are estimated to be around 2.000 ha distributed among 14 farms, each with 10-600 ha. These farms are all registered with SARPA. The culture systems commonly used are: (a) extensive system with densities between 5-10 animals/m^2 and (b) semi-intensive system using densities between 15–25 animals/m^2. However, some farms are using an intensive culture system with aeration, frequent water exchange, and the use of low-protein diets to diminish the impact of organic material. Farms have an average of 2.5 crops/yr, with an average production of 1500 kg/ha/yr and total production of 4500 to 5000 kg/ha/yr . Each cycle lasts for four months to obtain an average harvest weight of 200 gm. Survival rate of postlarvae (PL 5) is 60 – 70 %.

7.13.1 Aquatic animal health management

Fish and shrimp diseases

Health management is based on experiences in dealing with aquatic diseases that have not been critical for the industry. The most common cases are diseases caused by bacteria, fungi and internal trematodes, especially in cachama and tilapia cage culture. These cases have been reported during larviculture and grow-out periods.

The most important fish cultured in Venezuela are cachama and its hybrids (*Colossoma* sp) and red tilapia (*Oreochromis* sp.), because they are easy to buy, have good sales; and are useful for integrated culture systems. However, some pathogens have been detected, including columnaris disease caused by *Flexibacter columnaris*, detected in Lago de Valencia in natural populations of O. *mossambicus* (Conroy 1998). This bacterium was also detected in cachama culture, causing high larval mortality. Research with preventive vaccines for cachama and tilapia have been successful, particularly in cages and pond-culture systems. Some problems caused by internal and external parasites, such as acanthocephalans, nematodes and crustaceans, have been reported in cachama cultivated in the Guayana region, especially in cages. The most harmful fish pathogen is lymphocystis virus, with chronic infections affecting tilapia and cachama.

Based on OIE criteria, high-risk diseases, such as viral diseases, are classified as Type I. Although these high-risk viral diseases have not been reported yet in Venezuela, professionals have been reviewing information about their prevention, control and management.

Besides the prohibition to import larvae or broodstock, the private sector and SARPA have been investing in equipment and systems to prevent pathogen transfer. Laboratories use technical methods to maintain a high biosecurity level.

Shrimp food or material for food which includes fish/shrimp meals, *Artemia* or any other crustacean product originating from a country with viral diseases should have a health certificate for yellowhead virus (YHV), white spot syndrome virus (WSSV) and Taura syndrome virus (TSV).

Health management in laboratories and shrimp farming facilities

In Venezuela, aquatic health management is based mainly on preventive measures. Shrimp farmers try to avoid contact with countries known to have viral diseases by avoiding importation of fish/shrimp meals, *Artemia*, and even frozen shrimp for human consumption. The use of antibiotics or drugs for larval production is limited. It is very common to use disinfectants, such as sodium hyphochlorite or similar products. Inorganic iodine is especially used at the entrance of laboratories in footbaths.

Health management procedures during the grow-out period are implemented using progressive steps to maintain facilities for production. In general, water for ponds is taken directly from the sea. Water from rivers is also used to maintain salinity.

In some farms, an initial grow-out period is conducted in round tanks made of concrete material 6 m in diameter. These tanks are filled with water previously filtered by a sedimentation system and larvae (PL 5) are stocked and harvested as PL 30. Feed is gradually increased. The tanks have aeration and a water exchange rate of 100% per day. Drugs are not used.

The grow-out phase begins with the preparation of ponds, with sizes ranging between 10 to 15 ha. However, ponds with 60 to 90 ha are used for extensive culture. After harvest, sediments remaining in the ponds are removed and then lime ($CaCO_3$) is applied at 1000 kg/ha. Ponds are left to dry by the sun from 8 to 10 d. Solid particles in the pond bottom are removed using a tractor and, after 20-30 d, fertilizers are applied and finally, ponds are filled with water. The initial stocking density is 15 - 25 PL (30 pcs/m^2); survival rate at this stage is around 85%, with a cycle lasting approximately 125 d; and with an average harvest size of 20 gm.

In the laboratory, formalin is commonly used as quick baths during maturation to control bacterial and fungal infections. Water quality is maintained via a filtration process using sand, diamoton, UV and ozone filters. The personnel are required to use boots, gloves and uniforms in their daily work. Each tank or section has its own separate set of equipment.

SARPA has been developing a control program since 1999. Efforts are concentrated in the areas of Lago de Maracaibo and the western coast of the Facón states, where large shrimp farms exist.

The southern part of the Lago de Maracaibo basin has large plain areas used for aquaculture and suitable for shrimp ponds. This basin receives fresh water from several rivers, including Catatumbo River from Colombia, Chama River (Mèrida State) and small rivers from Trujillo State. These rivers maintain salinity around 5 to 6 ppt. This area has low water exchange, high oil exploitation and agricultural activities. For this reason, SARPA, the Autoridad Unica del Ambiente (ARA) and the Ministry of Environment (MARN - Ministerio del Ambiente y los Recursos Naturales) are taking actions to effectively process the permits required to develop shrimp farming operation in the Lago de Maracaibo.

An important part of this program is the distance needed between farms to diminish water effluent discharge contamination among farms. This consideration is important in limiting the number of facilities in zones with special environmental characteristics.

Diagnostic methods

Because shrimp importation has been prohibited during the last five years, diagnostic methods for high-risk diseases are not commonly used. However, conferences and workshops about diagnostic methods for viral, bacterial and fungal diseases are frequently provided to private laboratories and government inspectors.

Experts, including Dr Donald Lightner, Dr Rolland Laramore, Dr Beatriz Polanco, Dr David Conroy and Dr Antonia Clavijo, have given training to shrimp farmers in Venezuela on preventive methods.

There is a project to import broodstock to improve original stocks, which are already 14 to 25 generations old. For this reason, PCR techniques are going to be used. Only the large companies already have the equipment needed to detect pathogens. However, the Instituto de Ciencias Aplicadas del Mar de la Universidad de Oriente, Nueva Esparta, is developing a project to construct a biosecurity laboratory to conduct PCR tests.

Common methodologies

The Ministry of Production and Commerce (Ministerio de la Producción y el Comercio), through SARPA, has protocols to regulate shrimp (*Penaeus* spp.) importation which include the following measures:

- Quarantine: Current regulation is to establish a quarantine period of 30 days on facilities selected by SARPA. This process is opened, supervised and closed by a SARPA inspector. If this process is not followed, animals are eliminated immediately. Each quarantine station should have its own equipment. Materials cannot been taken in or out during quarantine. If, during the quarantine, any diseases or infection processes (Type A) are observed, eradication and disinfection procedures will be conducted. Inorganic iodine or ammonium may be used to disinfect quarantine installations.

- Virology Techniques: Animals with signs of viral infection are used for analysis. Methods include examination of fresh material, histopathology, electron microscopy (EM) and other techniques that allow detection of viral inclusions or viral particles.

Substances used at different phases of shrimp farming for Penaeus vannamei

Different substances are currently used:

- Maturation phase: substances with inorganic iodine in footbaths, located at entrances of facilities, are used.
- Larviculture phase: equipment is disinfected with substances such as sodium hypochlorite, formalin and some low-spectrum antibiotic or ammonium-based solutions; water filtration is done using UV or ozone filters.
- Grow-out phase: compounds rich in nitrogen, phosphorus and urea are used to stimulate photosynthesis.
- Harvest phase: bisulfite or metabisulfite is used for melanosis.

Organization and distribution of laboratories and diagnostic centers

The majority of shrimp farmers are registered at the National Aquaculture Chamber (CAN - Cámara Nacional de Acuicultura). Shrimp farmers at the Lago de Maracaibo created the Asociación de Camaroneros de la Cuenca del Lago de Maracaibo (APROCLAM), which supports the special program for this area, as mentioned above.

Shrimp farming is developed on large and small farms. Large farms have their own laboratories, which export any excess production of larvae. Small farms receive larvae from the larger ones or from private laboratories. Only large farms have equipment for diagnostic techniques. Farms have trained personnel to maintain healthy shrimp populations. There are also many experts on shrimp farming, some of them from the Asociación Americana de Soya (ASB), who provide technical assistance and trained personnel. Currently, SARPA is proposing to the FAO Representative in Venezuela a Technical Cooperation Program entitled "Technical assistance to prevent and manage viral problems in shrimp farming in the Americas" (Asistencia técnica de la FAO para prevenir y manejar problemas de virus en las camaroniculturas de las Américas)**.** This program was initially proposed by Ecuador and later extended to Latin-America. General management procedures being followed are based on recommendations presented at the "Códigos de Prácticas para el Cultivo Responsable del Camarón," published by the Global Aquaculture Alliance.

Because shrimp production is exported to USA (75%) and to the European Union (25%), shrimp farmers have to fulfill international regulations, such as HACCP and the "Course of action for the presentation and evaluation of plans for residue" (Lineamientos para la presentacion y evaluacion de los planes de residuos – Directiva del Consejo 96/23/EC), which regulate substances and their residues.

Health experts certified by SARPA-MPC

The following provides a list of health experts certified by SARPA-MPC, including their profession and location:

- Alexia Calderon, Biologist, SARPA-Sucre
- Fatima Ferrer, Biologist, SARPA-Zulia
- Evelin Bravo de Trompiz, Biologist, SARPA-Falcon
- Maribel Matute, Marine Biologist, SARPA- Carabobo
- Jorge Sayegh, Marine Biologist, SARPA- Anzoategui
- David Conroy, Biologist, Faculty of Veterinary Science, UCV

Legal framework

Current regulations for the control and prevention of the introduction of diseases agents (Type I) include:

- Decree 2.223 of 23/04/92, entitled "Normas para Regular la Introducción de la Flora y Fauna Silvestres y Acuáticas".
- Resolution No. 179 of 08/03/ 2000, which limits importation. Based on the facts that:
  -shrimp farming is an important economic activity,
  -neighboring countries have detected pathogens, and
  -the government has the responsibility to protect national aquatic production.

The following presents relevant excerpts from the above resolution:

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President of the Republic following "e" Article 20 of the Fisheries Law and ordinal 8º of the Central Administration Law:

DECIDE

Article 1.- the objective is to establish preventive measures to avoid introduction of viral diseases such as Taura Syndrome (TSV), White Spot Syndrome Virus (WSSV) and Yellow Head Virus (YHV).

Article 2.- The importation of live marine shrimp of the genus: *Penaeus*, *Litopenaeus* and *Farfantepenaeus* at any life stage and for any purposes are restricted to facilities that have the following characteristics:
Located in countries free of viral diseases (TVS, WSSV, YHV)
Use broodstock or nauplii from Venezuelan laboratories.
Do not use wild animals
Country of origin should have similar regulations about importation
Country of origin should certify that the product is free of viral pathogens based on pathology test following OIE standard.
Should have health certificate from the Ministry.

Article 3.- Importation of *Artemia* sp., worms, dry food with shrimp meal and other materials elaborated with crustacean products is restricted to countries with Health Certificate to guarantee that these products are free of pathogens.

Article 4.- Importation of dead aquatic crustaceans, its products or sub-products, except canning products for human consumption, should have a Health Certificate.

Article 5.- Any person or company that is planning to develop shrimp culture with *Penaeus, Litopenaeus or Farfantepenaeus*, but do not consider to have its own laboratory, should sign an agreement with a certified local laboratory.

Article 6.- Any infringement will be penalized according with current laws .

Article 7.- Resolution MAC-DM/Nº 495, published in the Gaceta Oficial Nº 36.797, of 29-09-99.

7.13.2 References

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7.14 Asia-Pacific regional summary

Presentation by Dr Melba Bondad Reantaso (NACA, Bangkok, Thailand), Dr Rohana Subasinghe (FAO, Rome, Italy) and Dr Michael Phillips (NACA, Bangkok, Thailand)

Aquatic animal disease have caused major impacts on aquaculture in the Asian region. Governments and the private sector have been giving increasing attention towards the development of effective aquatic animal disease control measures.

The presentation introduced the recently adopted Asia Regional Technical Guidelines on "Health Management for the Responsible Movement of Live Aquatic Animals" and the Beijing Consensus and Implementation Strategy [12] The Asia Regional Technical Guidelines on Health Management for the Responsible Movement of Live Aquatic Animals (hereafter referred to as the "Technical Guidelines") and their associated implementation plan, the Beijing Consensus and Implementation Strategy (BCIS), were developed by representatives from 21 Asian governments[13], scientists and experts on aquatic animal health, as well as by representatives from several national, regional and international agencies and organizations.

The *Technical Guidelines* provide valuable guidance for national and regional efforts in reducing the risks of disease due to trans-boundary movement of live aquatic animals. Their implementation will contribute to securing and increasing income of aquaculturists in Asia by minimizing the disease risks associated with trans-boundary movement of aquatic animal pathogens. In many countries in Asia, aquaculture and capture fisheries provide a mainstay of rural food security and livelihoods, and implementation of the *Technical Guidelines* will contribute to regional efforts to improve rural livelihoods, within the broader framework of responsible management, environmental sustainability and protection of aquatic biodiversity.

The *Technical Guidelines* were developed based on a set of Guiding Principles which were reached by consensus among the 21 participating countries. They are:

1. Movement of living aquatic animals within and across national boundaries is a necessity for economic, social and development purposes.

2. Such movements may lead to the introduction of new and emerging pathogens and to disease establishment and, therefore, may pose risks to the importing country's animal, plant and human health status.

3. The role of health management is to reduce the risks arising from the entry, establishment or spread of pathogens to a manageable level with the view to protecting animal, plant and human life. Health management should also protect living aquatic resources, the natural aquatic environment and aquatic biodiversity, as well as support the movement of aquatic animals and protect trade.

4. The health management process is defined, in the broad sense, as aquatic animal health management encompassing pre-border (exporter), border and post-border (importer) activities, as well as relevant national and regional capacity-building requirements (infrastructure and specialized expertise) for addressing health management activities, and development and implementation of effective national and regional policies and regulatory frameworks required to reduce the risk of disease spread through movement (intra- and international) of live aquatic animals.

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[12] FAO/NACA. 2000. Asia Regional Technical Guidelines on Health Management for the Responsible Movement of Live Aquatic Animals and the Beijing Consensus and Implementation Strategy. FAO Fisheries Technical Paper. No. 402. Rome, FAO. 53 p.

[13] For the purpose of these *Technical Guidelines*, the term "country" covers an entity which may be a nation, a region of a country or a government.

5. Health management measures should be practical, cost-effective and easy to implement by utilizing readily available facilities. Individual countries may need to adopt, modify or vary these *Technical Guidelines* to suit their own particular situations and resources.

6. The varying capacity of developing countries to implement programs on health management should be acknowledged by relevant international organizations and financial institutions. These organizations should give full recognition to the special circumstances and requirements of many developing countries.

7. Health management measures shall be based on an assessment of the risk to animal, plant and human life or health. In assessing the risk, prevalence of specific pathogens in both the region of origin and the region of destination shall be a crucial issue. The likelihood of new or emerging pathogens becoming established in the region of destination is a major consideration.

8. All movements of aquatic animals should be conducted within the provisions given in existing relevant international agreements and instruments. Health management measures should not be applied in a manner which would constitute a disguised restriction on trade. Health management measures should be applied only to the extent necessary to protect animal, plant or human life or health, and must be based on scientific principles and not be maintained without sufficient scientific evidence.

9. In determining the appropriate level (stringency) of health management measures to be applied, relevant economic and ecological factors have to be taken into account. These are, *inter alia*: potential damage due to loss of production or value, and the cost of control or eradication. A conservative approach should be adopted in cases where insufficient knowledge exists in relation to disease risks posed by a particular import; a higher stringency of health management procedures should be adopted where inadequate knowledge exists.

10. The first movement (introduction) of a new species into a new area will require special health management considerations in light of the need to evaluate scientific evidence regarding the risk of introducing pathogens to new areas.

11. Different regions should attempt to harmonize health management procedures to facilitate safe movement of aquatic animals within and between regions.

12. Considering the free movement of aquatic species in trans-boundary waterways, division of regions into manageable sub-regional units based on factors such as geography, hydrography, ecosystems, epizootiological surveillance and effectiveness of control is necessary for the effective implementation of health management procedures. The basis for the establishment of such units should be uniform, clear and unambiguous.

13. Honest, conscientious and transparent reporting is essential for health management to be effective.

14. Technical co-operation among regional experts is essential to promote exchange of information and expertise.

15. Collaboration among the governments, public institutions, and the private sector, including all stakeholders, is important to achieve the full purpose of implementing effective health management. Opportunities for sharing the benefits of health management among all stakeholders should be explored.

Based on the guiding principles the Technical Guidelines were prepared and adopted by Asian governments to provide detailed guidance on the implementation of these principles. The Technical Guidelines cover the various issues to be considered in the responsible movement of live aquatic animals. The following points are covered in the Technical Guidelines:

- Identification of pathogens of concern, including the development of an agreed Asia regional list of pathogens of concern to the Asia region.
- Disease diagnosis, and means of harmonization of diagnostic measures
- Health certification and quarantine measures.
- Disease zoning
- Disease surveillance and reporting
- Contingency planning for serious disease outbreaks, including regional, national and farm level planning.
- Import risk analysis
- The development of national strategies, legislation and policy frameworks to support responsible movement of live aquatic animals
- Regional capacity building.
- Support to implementation of the guidelines.

The Technical Guidelines emphasize a broad approach to identification and management of risk associated with the movement of live aquatic animals. Following the adoption of the Technical Guidelines, the governments of the Asian region adopted a plan to support implementation. The focus of the current Asia regional program plan is now shifting to implementation.

8 Consultant report: A review of trans-boundary aquatic animal pathogen introductions and transfers

D. Fegan, J.R. Arthur, R.P. Subasinghe, M.B. Reantaso, V. Alday de Graindorge and M.J. Phillips

8.1 Abstract

A review is presented of current problems associated with trans-boundary (introduced and transferred) aquatic animal diseases, with emphasis on diseases of penaeid shrimp and the situation in the Asian Region and Latin America. Included is a brief summary of currently important diseases and their socio-economic impacts on developing countries. An analysis of government and private sector responses to recent epizootic disease outbreaks in Asia and Latin America indicates that governments and aquaculturists have generally been caught unprepared and that their immediate responses have been, for the most part, ineffective in preventing or reducing losses. In some countries in both Latin America and Asia, the private sector has made considerable progress towards preventing on-farm disease problems in penaeid shrimp culture through such measures as improved farm management strategies (reduced water flow, prevention of carrier entry, etc.), development of SPF and SPR stocks and closure of the life cycle, and the formation of farmer organizations for sharing of information and coordinated action. Although national governments, particularly in Asia, have made laudable progress in developing expertise, infrastructure and capacity for aquatic animal health management, aquaculture and capture fisheries in most developed and developing countries remain highly vulnerable to further incursions by trans-boundary diseases.

8.2 Introduction

8.2.1 International movement of aquatic animals

The use of exotic aquatic species to increase food production and income has been an established practice since the middle of the 19th Century. However, the practice dates back much further, to the ancient Romans and medieval European monks, who transported common carp, *Cyprinus carpio*, and redfin perch, *Perca fluviatilis*, around Europe and the Roman Empire; and to the Greeks, who transplanted oysters around the Greek Islands during the Golden Age of Greece. Advances in controlling the spawning of salmonids, primarily rainbow trout, *Oncorhynchus mykiss*, in the mid-1800s led to increased exportation of these fish to other areas (Welcomme 1988). Recent advances in trade and transport have made large-scale movements of many different species over great distances possible.

Controversy over the use of exotic species stems from the many highly publicized and spectacular successes and failures. For example, Chile has become the world's second leading producer of farmed salmon because of the introduction of coho salmon (*O. kisutch*), Atlantic salmon (*Salmo salar*) and rainbow trout. The Chilean salmonid culture industry provides foreign exchange and employment for thousands of people in areas where there are few other opportunities for development. In contrast, the introduction of the golden apple snail (*Ampullaria canaliculata*) to the Philippines, to increase farmers' income and generate export earnings (which were not attained, anyway), led to the infestation of 15% of the Philippine rice fields with losses in some areas as high as 75%. Perhaps the most famous controversy is the introduction the Nile perch (*Lates niloticus*) into Lake Victoria. As a result of this introduction, a primarily artisanal fishery turned into a multi-million dollar industrial fishery and processing operation. Tremendous income was generated, but the socio-economic system of the community surrounding the lake changed, and there have been estimates that perhaps hundreds of enzootic species of fish have been lost to predation by the Nile perch.

FAO statistics on the introduction of inland aquatic species (see Table 1) show that aquaculture development has been the primary reason cited for most introductions, accounting for almost 40% of all cases. Other important reasons cited for the introduction of exotic species include development of capture and sport fisheries, accidental introductions (escapes), ornamental fish culture, research, control programs for insects and aquatic plants, use as bait, etc.

Table 1. Reasons for the Introduction of Exotic Species.[1]

Reason	**%**
Aquaculture	38.7
Fisheries	8.7
Angling/Sport	7.9
Accidental	7.5
Ornamental	7.3
Unknown	15.4
Other (research, control, bait, etc.)	14.5

[1]*Source: FAO's Database of Introduced Aquatic Species (DIAS) (www.fao.org/fi/statist/fisoft/dias/mainpage.htm).*

Welcomme (1988) listed 1,354 international movements of 237 species of inland fishes. Of the 237 species, the three most widely introduced were common carp, Nile tilapia (*Oreochromis niloticus*), and rainbow trout. These three and others, such as black bass (*Micropterus* spp.), mosquitofish (*Gambusia affinis*), and grass carp (*Ctenopharyngodon idella*), now occur on every continent except Antarctica as the result of human-assisted movement (see Table 2).

Table 2. Most often introduced fishes.[1]

Species	No. Records
Common carp	124
Rainbow trout	99
Mozambique tilapia	92
Grass carp	91
Nile tilapia	80
Silver carp	79
Mosquitofish	67
Largemouth black bass	64
Bighead carp	55
Goldfish	54

[1]*Source: FAO's Database of Introduced Aquatic Species (DIAS) (www.fao.org/fi/statist/fisoft/dias/mainpage.htm).*

FAO statistics also show that there has been an exponential increase in the number of introductions since 1940 (Table 3), and that this trend has continued during the past 20 years. This increasing trend towards the international movement of live aquatic animals has been made possible by advances in transportation which allow rapid shipment of live fish and shellfish throughout the world, and to a large extent, is directly related to the global development of the aquaculture industry and the concomitant demand in many countries for new species for culture.

Table 3. Statistics by Year of Introduction.[1]

Year	% Total Records
Before 1800	1.5
1800-1899	4.3
1900-1939	10.0
1940-1979	35.5
1980-date	19.2
Unknown	26.6

[1]*Source: FAO's Database of Introduced Aquatic Species (DIAS) (www.fao.org/fi/statist/fisoft/dias/mainpage.htm).*

8.3 Trans-boundary aquatic animal diseases (TAADs) – the problem of pathogen movement with introductions and transfers of finfish, shellfish and mollusc

It has become increasingly clear that many of the human-assisted movements of aquatic animals into new areas have also been responsible for the introduction, establishment and spread of pathogens and parasites into new geographic areas. Hoffman (1970) and Bauer and Hoffman (1976) summarized the state of knowledge on the transfers of fish parasites along with host movements through human activities. Although Hoffman (1970) was able to document movement and establishment on new continents of at least 48 species of parasite (5 Protozoa, 31 Monogenea, 3 Nematoda, 5 Digenea, 1 Acanthocephala and 3 Copepoda), it is clear, given the number of host species that have been moved, that the actual number must be much higher. For example, Arthur (1995) noted that 50% (9 of 18) of the parasites known from Nile tilapia in the Philippines were probably introduced into the country along with the introduction of this fish for aquaculture and stocking in natural waters. Given that the number of transfers and introductions has increased significantly with the increased ease of air travel and the recent explosive growth of the aquaculture industry, and that movements of other types of pathogens (e.g., viruses, bacteria, fungi) have not been well considered, the number of pathogens and parasites that have been moved and are now established in new localities must number in the thousands. In general, fisheries managers must be faulted for not giving pathogens adequate consideration when contemplating introductions and transfers of aquatic animals. In many cases this has led to serious pathogens becoming established in new areas and hosts. Once established in natural waters, such pathogens are usually impossible to eradicate. With proper planning, the introduction of many these pathogens could have been avoided.

There are a number of international codes of practice and guidelines which, if followed by fisheries management, would do much to reduce the risk of introducing pathogens into new areas along with the movements of their hosts. The Office International des Épizooties (OIE), has developed recommendations and protocols for the prevention of the international spread of diseases of aquatic organisms as part of its *International Aquatic Animal Health Code* (OIE 1997a), which deals with the health surveillance of aquatic animals for domestic and international trade. Recommendations for policies dealing with the introduction of aquatic species and guidelines for their implementation, including methods to minimize the possibility of disease transfers, have also been developed by the International Council for the Exploration of the Sea (ICES) for marine introductions (ICES 1995). More regionally oriented guidelines are provided by the Great Lakes Fish Disease Control Committee of the Great Lakes Fishery Commission (Meyer *et al.* 1983) and the North American Commission of the North Atlantic Salmon Conservation Organization (Porter 1992), among others. Regionally, there have been a number of initiatives (see Arthur 1996), the most recent being the FAO/NACA Regional Technical Cooperation Program (TCP/RAS 6714 (A) and 9605 (A)) "Assistance for the Responsible Movement of Live Aquatic Animals," which developed the Asia Technical Guidelines on Health Management for the Responsible Movement of Live Aquatic Animals (see FAO/NACA/OIE 1998).

Despite these various codes, protocols, and guidelines, fish and shellfish continue to be introduced into new areas with little consideration of potential disease consequences. There exists an enormous number of documented cases where parasites and diseases have been spread to new regions due to human activity (for examples, see the summaries by Hoffman 1970, Bauer and Hoffman 1976, Bauer 1991, Williams and Sindermann 1992, Humphrey 1995, and Arthur 1995). Most well documented cases involve international movements - diseases introduced along with exotic fishes, and the subsequent spread of these exotic species and their pathogens within national borders. Because transfers (movements of aquatic animals to areas within their areas of historical distributions) are generally less controversial, they appear to be less often documented, and the possible concurrent movement of pathogens and parasites less well investigated. Nevertheless, there are equally valid concerns regarding transfers of aquatic animals; an additional concern is the potential for introducing new diseases and/or new strains of established pathogens which may be specific to the host species being transferred. Because of this specificity, these pathogens or strains may increase the chance of a disease incursion which will severely impact existing wild and cultured populations of the species.

8.4 Major trans-boundary disease problems in finfish, shellfish and mollusc

The precise origin of an epizootic disease is not often clearly determined. In some instances, disease occurrence can be clearly linked to a particular human activity, such as the introduction of sturgeon mentioned below. However, in many cases, diseases are presumed to be of exotic origin based on circumstantial evidence, such as previous absence of reports of the disease in the newly affected country, the occurrence of recent disease outbreaks in neighboring countries or trading partners, and a known history of importation (legal or illegal) of living susceptible species or their products (in which pathogen is known to remain viable) from a country(ies) known to harbor the disease, to the country where the disease is presumed to have been absent.

Major aquatic animal diseases considered to be of concern in the international trade of finfish, shellfish and molluscs are listed in the disease lists of the Office International des Épizooties (OIE), and for the Asia-Pacific Region, in the Network of Aquaculture Centres in Asia-Pacific/Food and Agriculture Organization of the United Nations (NACA/FAO) disease list (see OIE 1997a; NACA/FAO 1999). Information on these diseases, along with several others not listed by the OIE or NACA/FAO is presented in Table 4.

It should be noted that the OIE and NACA/FAO disease lists generally focus on diseases which affect commercial aquaculture, and which are of real or potential importance to more than one country. The listed diseases are, for the most part, also those that mainly affect aquaculture production in developed countries, historically, those of North America and Europe, with more recent addition of diseases important to Australia and Japan. As such, there are many other pathogens that have been transmitted across international borders. A number of these unlisted pathogens have become established in new areas and have caused serious losses to aquaculture and capture fisheries, although often on a more restricted geographic or financial scale, when compared to the most important diseases listed by OIE and NACA/FAO (those appearing on the OIE "list of notifiable diseases"). A few of these non-OIE-listed diseases causing current problems (e.g., whirling disease, anguillicolosis, neobenedeniosis) are listed in Table 4. Many other examples, both historical and current, can be found in the literature (see, for example, Hoffman 1970, Bauer and Hoffman 1976, Bauer 1991, Williams and Sindermann 1992, Humphrey 1995, Arthur 1995, Arthur and Ogawa 1996).

8.5 Some examples of the impacts of trans-boundary aquatic animal diseases

Introductions and transfers of aquatic animals have often occurred with little apparent repercussions due to exotic disease introduction (although, this may be due, to a large extent, to lack of any detailed pre- and post-introduction studies). However, there are many examples where ill-considered introductions of fish and shellfish have resulted in the spread of exotic pathogens which have caused unexpected and far ranging adverse impacts on host populations and commercial and sport fisheries, with accompanying severe socio-economic impacts on human populations. The following section presents three examples involving finfish, one of historical interest, and two of recent occurrence which continue to have major effects on inland capture and sport fisheries. More specific examples related to diseases of penaeid shrimp are found elsewhere in this review, while some estimates of the financial costs of trans-boundary diseases of fish, shellfish and molluscs in Asia and Latin America are given in Table 5.

***Nitzschia sturionis* - a monogenean destroys a valuable commercial fishery**

The first scientifically documented case of the devastating effects exotic pathogens can have on a previously unexposed fish population was apparently reported by Dogiel and Lutta (1937). In an investigation into mass mortalities of spiny sturgeon (*Acipenser nudiventris*) in the Aral Sea, these authors found that the gills this extremely valuable fish were severely infected by a large, blood-feeding parasite, the monogenean *Nitzschia sturionis*. This monogenean was unknown in the Aral Sea prior to 1936; however, in 1934 spawners of the Caspian stellate sturgeon (*A. stellatus*) were transferred by fisheries managers from the Caspian Sea into the Aral Sea without inspection by fish disease specialists. As all Caspian sturgeon are known to be suitable hosts for *N. sturionis*, it was clear that these mortalities were due to the introduction of this parasite into a new water body where it was able to infect and severely damage populations of a previously unexposed host species.

Table 1. Important trans-boundary aquatic animal diseases[14].

Disease	Pathogen	Susceptible Hosts	Geographic Distribution[15]	OIE Status[16]	Remarks
Molluscan Diseases					
Bonamiosis	(1) *Bonamia ostrea* (2) *Bonamia* sp.	(1) *Ostrea edulis*, *O. conchaphila*, *O. puelchana*, *O. angasi* & *Tiostrea chilensis* (2) *O. angasi, O. denselammellosa* & *T. chilensis*	(1 France, Ireland, Italy, Netherlands, New Zealand, Spain, United Kingdom (not Scotland), USA (California, Maine, Washington State) (2) Australia, New Zealand	1	All species of *Ostrea* & *Tiostreas* and other ostreids are considered susceptible. Bonamiosis is also listed as having been reported from Greece & Kuwait.
Haplosporidiosis	(1) *Haplosporidium costale* (2) *H. nelsoni*	(1) *Crassostrea virginica* (2) *C. virginica, C. gigas*	(1) Long Island Sound, New York to Cape Charles, Virginia, USA. (2) north Florida to Massachusetts and Maine, USA.	1	Other species of the genus infect *C. gigas, O. edulis, O. angasi, & Ruditapes decussatus.* Haplosporidiosis is also listed as having been reported from Australia, France, Japan, R.O. Korea, Kuwait, Martinique & the Netherlands.
Marteiliosis	(1) *Marteilia refringens*, (2) *M. sydneyi*	(1) *Crassostrea gigas, Ostrea conchaphila*; experimentally in *C. virginica, O. edulis*. (2) *Saccostrea commercialis*, possibly also *S. echinata*	(1) Greece, France, Italy, Morocco, Portugal, Spain (2) Australia (New South Wales, Queensland & Western Australia)	1	Other *Marteilia* spp. have been reported from a number of other bivalves.
Mikrocytosis	(1) *Mikrocytos mackini*, (2) *M. roughleyi*	(1) *C. gigas, O. edulis,& O. conchaphila;* experimentally in *C. virginica* (2) *S. commercialis*	(1) Canada (west coast) (2) Australia (NSW and Western Australia)	1	Unconfirmed Mikrocytosis is also listed as reported from *C. gigas* in Kuwait & the Pacific USA.
Perkinsosis	(1) *Perkinsus marinus* (2) *P. olseni*	(1) *C. virginica;* also experimentally in *C. gigas* (2) *Haliotis ruber, H. cyclobates, H. scalaris* & *H. laevigata*	(1) East coast of the USA from Massachusetts to Florida, along the Gulf coast to Venezuela; Puerto Rico, Cuba ,Brazil, Hawaii. (introduced) (2) South Australia	1	Some 50 species of molluscs, including *Pinctada maxima*, are infected by *Perkinsis* spp. without apparent pathogenicity. This disease is also listed as reported from France, Italy, Japan, R.O. Korea, Kuwait, Netherlands, Portugal, Spain. & Vanuata. In the USA, the range of perkinsosis has recently extended into Delaware Bay, New Jersey, Cape Cod and Maine.
Iridovirosis (Oyster velar disease)	Iridoviruses	*Crassostrea angulata, C. gigas*	France, Portugal, Spain, USA (Washington State)	3	Listed as one of the “other significant diseases” by OIE (1997a) & by FAO/NACA, but not included in more recent OIE listings.

[14] Information on OIE-listed diseases was extracted from the OIE *International Aquatic Animal Health Code* (OIE 1997a), the OIE *Diagnostic Manual for Aquatic Animal Diseases* (OIE 1997b), the OIE website (www.oie.org), and the Centre for Environment, Fisheries and Aquaculture Science (CEFAS) OIE *International Database on Aquatic Animal Diseases* (www.cefasdb.co.uk).

[15] Historical or suspect distributional records contained in the OIE *International Database on Aquatic Animal Diseases* are not included.

[16] 1 = notifiable to the OIE, 2 = other significant disease, 3 = not listed by the OIE.

Disease	Pathogen	Susceptible Hosts	Geographic Distribution[15]	OIE Status[16]	Remarks
Crustacean Diseases					
Taura Syndrome (TS)	Taura syndrome virus (TSV)	*Penaeus vannamei;* also infects *P. stylirostris*, *P. setiferus*, & *P. schmitti;* experimentally in *P. aztecus, P. duorarum, P. chinensis, P. monodon* & *P. japonicus*	Pacific coast of the Americas from Peru to Mexico (enzootic in cultured shrimp & occasionally found in wild *P. vannamei;* Atlantic, Caribbean & Gulf of Mexico coasts of the Americas (cultured shrimp, but not reported in wild stocks); Taipei	1	An important disease of cultured penaeid shrimp in the Americas. Recently reported from *P. vannamei* imported from Central America to Taipei.
White spot disease (WSD)	White spot syndrome virus (WSSV)	Penaeus spp.	Widespread in Asia & the Americas	1	Has recently been introduced from Asia to the Americas, where it is now the most important problem in shrimp culture in several Latin American countries.
Yellowhead disease (YHD)	Yellowhead virus (YHV)	*Penaeus* spp.	Southeast Asia, Latin America	1	Recently introduced from Asia to Latin America.
Baculoviral midgut gland necrosis (BMN)	Baculoviral midgut gland necrosis virus (BMNV)	*Penaeus japonicus, P. monodon*	Japan, Korea; Australia, Indonesia, Philippines	2	Type C baculovirus (considered identical to BMNV) has been reported from *P. monodon* in Australia, Indonesia & the Philippines. BMN has been experimentally transmitted *to P. monodon, P. chinensis* and *P. semisulcatus*. Also listed as having been reported from Malaysia.
Nuclear polyhedrosis baculoviroses	(1*) Baculovirus penaei* (BP) (2) *Penaeus monodon*-type baculovirus (MBV)	(1) *Penaeus* spp., *Metapenaeus ensis* (2) *Penaeus* spp.	(1) Widespread in the Americas on both the Atlantic & Pacific coasts (2) Australia, East Africa, the Middle East, many Indo-Pacific countries, & South & East Asia; also in cultured shrimp in the Mediterranean & West Africa. In introduced *P. monodon* in the Western Hemisphere (Tahiti, Hawaii, & a number of shrimp-farming sites in North & South America & the Caribbean.)	2	MBV is particularly pathogenic to larval *P. monodon.* BP is known to be pathogenic to larval *P. vannamei*, *P. aztecus*, *P. duorarum* & *P. marginatus*.
Infectious hypodermal and haematopoietic necrosis	Infectious hypodermal and haematopoietic necrosis virus (IHHNV)	*Penaeus* spp.	World wide in cultured &/or wild shrimp (reported from cultured, but not wild shrimp in the Atlantic side of the Americas)	2	Causes acute epizootics & mass mortality only in *P. stylirostris; a*lso causes disease in *P. vannamei* and *P. monodon*. Infections in other penaeid species have been observed without disease occurrence.

Crayfish plague	*Aphanomyces astaci*	Cambaridae (crayfish)	Widespread in Europe & North America	2	Pathogenic to all freshwater crayfish of non-North American origin. Highly susceptible species - *Astacus astacus, A. leptodactylus, Austropotamobius pallipe, A.. torrentium,* Chinese mitten crab (*Eriocheir sinensis*) have been experimentally infected. North American species (*Pacifastacus leniusculus* & *Procambarus clarki* act as carriers but are affected only under adverse conditions.
Spawner-isolated mortality syndrome	Spawner-isolated mortality virus (SMV)	*Penaeus monodon*	Australia, Philippines	2	
Gill associated virus	Gill associated virus (GAV)	*Penaeus monodon*	Australia	3	Listed in the OIE and FAO/NACA regional disease lists for the Asia-Pacific. Comparison of DNA sequences suggests GAV & YHV are closely related strains or species
Necrotising hepatopancreatitis	NHP bacterium	*Penaeus aztecus, , P. californiensis, P. setiferus, P. stylirostris, P. vannamei*	Brazil, Costa Rica, Ecuador, Panama, USA (Texas), Venezuela	3	Cited on the NACA/FAO & OIE regional disease reporting form for the Asia and Pacific as an example of “Any other diseases of importance.” Information from Lightner (1996)
Finfish Diseases					
Epizootic haematopoietic necrosis (EHN)	(1) epizootic haematopoietic necrosis virus (EHNV) (2) European sheatfish virus (ESV) (3) European catfish virus (ECV)	(1) *Perca fluviatilis, Oncorhynchus mykiss* (2) *Silurus glanis* (3) *Ictalurus melas*	(1) Australia (mainland) (2,3) Europe	1	As ESV &ECV share at least one antigen with EHNV, the OIE recently included these two viruses as causative agents of EHN. EHNV is generally lethal to redfin perch; rainbow trout are generally resistant. Other species that have been infected experimentally include *Macquaria australasica*, *Gambusa affinis*, *Bidyanus bidyanus* & *Galaxias olidus* EHN has also been reported from Kuwait, Pakistan, Peru & Vanuatu.
Infectious haematopoietic necrosis (IHN)	Infectious haematopoietic necrosis virus (IHNV)	*Oncorhynchus mykiss, O. tshawytscha, O. nerka, O. keta, O. masou, O. rhodurus, O. kisutch,. Salmo salar*	North America, Europe, the Far East	1	IHN was originally restricted to western North America, but has spread to Europe & the Far East with the human-mediated movements of salmonids. Various non-salmonid fishes have been experimentally infected. Also reported from Bolivia, Kuwait & Pakistan.
Oncorhynchus masou virus disease (OMVD)	*Oncorhynchus masou* virus (OMV)	*Oncorhynchus masou, O. nerka, O. keta, O. kisutch, O. mykiss*	Japan	1	Also reported from Kuwait & UK/Northern Ireland.

Spring viraemia of carp (SVC)	Spring viraemia of carp virus (SVCV)	Cyprinidae, *Silurus glanis*	Continental Europe (countries having low water temperatures during winter)	1	Overt infections occur in *Cyprinus carpio* (most susceptible & principal host), *Ctenopharyngodon idella, Hypophthalmichthys molitrix*, *Aristichthys nobilis*, *Carassius carassius, C. auratus*, *Tinca tinca* & *Silurus glanis*. Young fish of various species have been experimentally infected. Also reported from Great Britain, Bolivia & Kuwait, and as suspected, in Laos & Vanuatu.
Viral haemorrhagic septicaemia (VHS)	Viral haemorrhagic septicaemia virus (VHSV)	*Oncorhynchus mykiss*, *Salmo trutta*, *Thymallus thymallus*, *Coregonus* sp., *Esox lucius, Gadus morhua*, *Dicentrarchus labrax*, *Melanogrammus aeglefinus*, *Rhinonemus cimbrius*, (*Sprattus sprattus*, *Clupea harengus*, *Trisopterus esmarkii*, *Micromesistius poutassou*, *Merlangius merlangius Argentina sphyraena, Scophthalmus maximus*	Continental Europe, the Atlantic Ocean & Baltic Sea.	1	Important due to consequences for rainbow trout farming. VHSV-like viruses have also isolated from *Oncorhynchus* spp., *Gadus macrocephalus* & *Clupea pallasi* in the Northeastern Pacific Ocean. However, VHS continues to be considered a European-based disease, until the phylogenetic identities of the VHSV-like viruses which do not cause pathology in rainbow trout can be clearly established. Also reported from Brazil, Kuwait, Malaysia & Pakistan.
Channel catfish virus disease (CCVD)	Channel catfish virus (CCV)	*Ictalurus punctatus* Also in *I. catus* (experimental) and *I. furcatus* (natural)	USA	2	Important due to consequences to channel catfish farming. Exceptional occurrences reported for Honduras & the Russian Federation.
Enteric septicaemia of catfish (ESC)	*Edwardsiella ictaluri*	*Ictalurus punctatus.* Also in *Ameiurus catus*, *A. natalis*, *A. melas, I. nebulosis, Clarias batrachus*, & several ornamental species. Experimental in other species, including salmonids.	USA, Thailand	2	Important due to consequences to channel catfish farming in the USA.

Viral encephalopathy and retinopathy (VER)	Nodaviridae (striped jack nervous necrosis virus, (SJNNV) and others)	Marine fishes belonging to at least 22 species from 11 families; most affected species include *Lates calcarifer, Dicentrarchus labrax*, *Epinephelus akaara, E. fuscoguttatus, E. malabaricus, E. moara, E. septemfasciatus, E. tauvina*, *Pseudocaranx dentex, Seriola dumerili*, *Oplegnathus fasciatus*, *Takifugu rubripes, Verasper moseri, Hippoglossus hippoglossus, Paralichthys olivaceus,& Scopthalmus maximus*	Mediterranean, Pacific & Australia (almost worldwide except for the Americas & Africa)	2	Causes losses of larval and juvenile cultured marine fishes.

Infectious pancreatic necrosis (IPN)	Infectious pancreatic necrosis virus (IPNV)	Salmonidae (*Oncorhynchus* spp., *Salvelinus fontinalis, Salmo trutta)*	Most if not all major salmonid farming countries of North & South America, Europe & Asia; South Africa	2	IPNV or serologically related viruses have been detected in a wide variety of marine, anadromous & freshwater fishes.
Infectious salmon anaemia (ISA)	Infectious salmon anaemia virus (ISAV)	*Salmo salar;* carriers *include S. trutta*, *Oncorhynchus mykiss & Clupea harengus*	Canada (Atlantic coast), Faroe Islands, Norway, United Kingdom	2	Important disease of cultured Atlantic salmon.
Epizootic ulcerative syndrome (EUS)	*Aphanomyces invadans*	Over 50 fresh- & brackishwater fishes belonging to various families & genera	South, Southeast & West Asia, Japan, Australia	2	Although there is still some debate as to the primary cause of EUS, the OIE case definition requires the presence of *Aphanomyces* (see OIE 1997b). Outbreaks of ulcerative disease in *Brevoortia tyrannus in* the USA are very similar to EUS in Asia.
Bacterial kidney disease (BKD)	*Renibacterium salmoninarum*	Salmonidae	North America, Japan, western Europe, Chile	2	Also reported from Turkey. Several marine &freshwater non-salmonids have been shown to be carriers or infected experimentally.
Piscirickettsiosis	*Piscirickettsia salmonis*	*Oncorhynchus gorbuscha, O. kisutch, O. masou, O. mykiss , O. tshawytscha, Salmo salar*	Canada, Chile, Ireland, Norway, USA	2	An important disease of cultured salmonids.
Gyrodactylosis of Atlantic salmon	*Gyrodactylus salaris*	*Salmo salar*. Also. susceptible are *Oncorhynchus mykiss*, *Salvelinus alpinus*, *S. fontinalis*, *S. namaycush, Thymallus thymallus & Salmo trutta*.	Europe	2	Important due to it's high pathogenicity to young wild & farmed Atlantic salmon.
Red sea bream iridoviral disease (RSIVD)	Red sea bream iridovirus (RSIV)	*Pagrus major*, *Seriola quinqueradiata*, *Lateolabrax* sp., *Oplegnathus fasciatus*	Japan	2	An important disease of red seabream and other cultured marine fishes in Japan. A serologically and genetically related iridovirus was isolated from *Epinephelus malabaricus* from Thailand. A similar disease seriously damaged stocks of 20 species of cultured marine fish (Perciformes, Pleuronectiformes & Tetradontiformes) in south-western Japan
White sturgeon iridoviral disease (SIV)	White sturgeon iridovirus (WSIV)	*Acipenser transmontanus*, *A. gueldenstaedii, A. baeri;* also experimental in *A. fluvescens*	Europe, North America	2	Causes significant mortalities of farm-raised juvenile white sturgeon in North America and Russian sturgeon in Europe.
Angullicoliosis	*Anguillicola crassus*	*Anguilla anguilla, A. japonica, A. rostrata*	East Asia, Egypt, Europe, USA	3	An important pathogen of cultured & wild European eels.

Neobenedeniosis	*Neobenedenia girellae*	various marine fishes	China, Japan, Indonesia, USA (Pacific)	3	Introduced from Hainan and Hong Kong China to Japan due to importation of amberjack fry. Never reported among Japanese marine fishes prior to 1991. Currently 14 marine finfishes are known to be susceptible. Now affecting cultured groupers in the Asian Region.
Whirling disease	*Myxobolus cerebralis*	*Oncorhynchus mykiss*; also infects other salmonids including *Oncorhynchus* spp., *Salvelinus* spp., *Thymallus thymallus, Hucho hucho*	Europe, New Zealand, South Africa, USA	3	Currently a serious pathogen of wild rainbow trout in the western USA.

Whirling disease – an introduced parasite impacts a trophy sport fishery

The spread of *Myxobolus cerebralis*, the causative agent of whirling disease in rainbow (*Oncorhynchus mykiss)* and cutthroat trout (*O. clarki*), into the rivers of the western United States provides evidence of the serious unanticipated impacts exotic diseases can have on natural fisheries. *Myxobolus cerebralis* is a myxozoan parasite first found in North America in 1956 in Pennsylvania (Bergersen and Anderson 1997), and is believed to have been imported into the United States along with shipments of infected European trout (see Hoffman 1963). The parasite infects, but causes no apparent disease, in European brown trout (*Salmo trutta*), however, rainbow trout, a species native to western North America, are highly susceptible (Hoffman 1970). Small trout are severely affected, the pathogen infecting and eroding cartilage and weakening the skeletal structure. By destroying the auditory capsule, equilibrium is affected, producing the characteristic clinical sign of whirling.

Myxobolus cerebralis has gradually spread westward across the United States, and was first detected west of the Mississippi River in 1965 in both California and Nevada (Bergersen and Anderson 1997). It is now distributed in 21 states having self-sustaining trout populations. Until the 1990s whirling disease was considered a manageable problem affecting rainbow trout in hatcheries. However, it has recently become established in natural waters of the Rocky Mountain states (Colorado, Wyoming, Utah, Montana, Idaho, New Mexico) where it is causing heavy mortalities in several trophy sportfishing rivers.

Epizootic ulcerative syndrome causes mass mortalities throughout Asia

The history of epizootic ulcerative syndrome (EUS) in South and South Asia is well known to all fish health workers in the region, as this condition has been the major cause of losses of freshwater fishes for more than two decades (see Lilley *et al*. 1992, Roberts *et al*. 1994, Das 1997).

Among the diseases affecting freshwater aquaculture and capture fisheries in developing countries of Asia, EUS has had by far the most serious socio-economic impacts. These include direct economic losses to small-scale fishermen and aquaculturists due to high mortalities of wild and cultured fish, and indirect losses due to collapsed markets for fish, resulting in loss of employment opportunities to fish sellers, transporters, processors and those involved in selling supplies and equipment used by all these sectors.

Examples of the effects of this disease on local economies, and its severe impacts on rural fishing communities are provided for Bangladesh by Barua (1994) and for India by Das (1994). EUS was first confirmed in Bangladesh in 1988, before which such large-scale fish mortalities had never been seen in the country. The disease first appeared in irrigation canals in the Chandpur District, about 200 km from the Myanmar border, and may have occurred in water bodies in districts bordering Myanmar the previous year. The disease then spread in all directions, affecting the entire eastern and central parts of the country within nine months, then spreading northward during the flooding of September 1988. The first outbreak, which lasted 13 months, was followed annually by less severe outbreaks during October to March. EUS caused severe socio-economic impacts, including a sharp drop in the price of fish, as consumers avoided eating fish. As in other countries, this was based on unfounded fears that consuming EUS-affected fish would affect human health. The nature of the disease was irresponsibly reported by some sectors of the media, resulting in fear and confusion among the rural population. The result was a drop in demand and supply of fish by some 64.5%, with prices falling 50-75% in badly affected districts. Total economic losses due to EUS were estimated at $US 3.38 million during the first outbreak and some $2.24 million during the second occurrence.

By May 1988, the disease had spread into the northeastern states of India (Das 1994), and by 1990 outbreaks had occurred throughout much of the country. As in Bangladesh, sectors dependent upon capture and culture of fish were severely affected. A study conducted in five districts of Kerala showed that EUS had completely disrupted the inland fish market. The economic situation of small-scale fishermen and fish vendors, many of them women, was particularly affected, farther marginalizing this segment of the rural poor and forcing many to seek employment in the most impoverished sectors such as agricultural laborers, head-load and quarry workers, etc. with little success. The disease also affected small-scale aquaculturists. In five districts of West Bengal, for example, 73% of aquaculture operations were adversely affected. Aquaculturists suffered direct losses due to mortalities in the ponds. Some 42% suffered losses of 31-40% of their stock, while another 25% had losses of between 21 and 30%. Additional indirect losses were also felt due to severely affected markets.

Similar scenarios have been played out in many of the developing countries in South and South East Asia (see Lilley *et al.* 1992; Roberts *et al*. 1994). Total losses due to EUS in the region are impossible to calculate with any degree of accuracy, however, Chinabut (1994) has suggested that losses due to EUS in Thailand alone may exceed $US 100 million (for estimates of EUS losses, see Table 5).

8.6 Social and economic impacts of trans-boundary diseases

There are few rigorous analyses of the costs of disease on aquaculture systems and capture fisheries. Most estimates are based on the estimated value of production which was presumed to be lost due to disease by comparison of national production figures for years pre-and post-disease outbreak. Some idea of the enormous losses caused by disease is reflected in estimates provided by ABD/NACA for the Asian Region, which indicate that total losses caused by diseases in aquaculture in Asia in 1990 was on the order of $US1.36 billion (ADB/NACA 1991), and that total losses to disease and environmental problems may exceed $US billion annually (ADB/NACA 1996). Some estimates of financial losses for finfish, shellfish and molluscs that are known or believed to have been caused by trans-boundary aquatic animal diseases are presented in Table 5 and discussed below.

8.6.1 Finfish diseases

Diseases, many of them TAADs, affect both cultured finfishes and small-scale rural capture fisheries, both through direct mortalities, and through reduced growth and lowered production. Available figures indicate that combined losses from epizootic ulcerative syndrome (EUS) in several Asian countries before 1990 were more than US$ 10 million; losses in Thailand alone from 1983-1993 were estimated at some US$ 100 million. Marine finfish disease losses have also been recorded in Japan amounting to US$ 114.4 million in 1992; and in Thailand in 1989, losses from cage-cultured seabass and grouper diseases were estimated at US$ 1.9 million. In Western Europe, annual losses due to viral hemorrhagic septicemia (VHS) are estimated to be US$ 60 million. These, and other loss estimates are given in Table 5.

8.6.2 Viral diseases of penaeid shrimp

Reports of catastrophic losses due to viral diseases of shrimp (primarily WSSV) are in the range of more than US$ 400 million in China (1993), US$ 17.6 million in India (1994), over US$ 500 million in Thailand (1996), and US$ 280 million in Ecuador (1999) (see Table 5), to a global estimate of US$ 3000 million/year.

8.6.3 Molluscan diseases

Most of the knowledge of bivalve mollusc diseases in the Asia-Pacific Region is derived from studies from Australia and New Zealand. These studies have reported the presence of several serious pathogens of bivalves, including four of the 10 OIE-listed disease agents of molluscs (i.e., *Marteilia sydneyi*, *Bonamia* sp., *Mikrocytos roughleyi*, *Perkinsus olseni*). Another seven organisms, closely related to the OIE-listed pathogens, are known to occur in the region (*Marteilia lengehi*, *Marteilia* sp., *Marteilioides branchialis*, *M. chungmuensis*, *Haplosporidium* sp. and *Perkinsus* sp.) in pearl oysters (*Pinctada maxima*), (*M. lengehi, M. branchialis*, *M. chungmuensis*, *Haplosporidium* sp.) and blacklip rock oysters (*Saccostrea cucullata*) (*Haplosporidium* sp.) around Australia.

The four OIE-listed diseases have had an economic impact on farming and wild harvesting of molluscs in Australasia. *Marteilia sydneyi* causes greater than 90% mortalities among farmed Sydney rock oysters (*Saccostrea commercialis*), with losses of about 40% of total production, in eastern Australia. *Bonamia* sp. destroyed 90% of the wild stocks of flat oysters (*Tiostrea chilensis*) around New Zealand between 1986 and 1992, resulting in closure of the fishery and loss of work for some 1,000 people. In New Zealand and Australia, the presence of the parasite has prevented the development of flat oyster (*T. chilensis, Ostrea angasi*) farming. Winter mortality, caused by *Mikrocytos roughleyi*, originally caused significant losses among Sydney rock oyster farmers in New South Wales. However, understanding of the biology of this protozoan parasite has allowed farmers to manage around the problem. *Perkinsus olseni* caused mass mortalities among abalone (*Haliotis ruber, H. laevigata* and *H. cyclobates*) around South Australia in 1972, and continues to have an economic impact due to the yellow pustules it causes in the meat, making many abalone unmarketable.

It is likely that serious diseases also occur in bivalves of Southeast Asia, as there are reports for a number of pathogens closely related to those discussed above. For example, *Perkinsus atlanticus* was recently described in Korea, while another OIE-listed pathogen, *Haplosporidium nelsoni,* may occur in Pacific oysters in Japan and Korea. Two other protozoans, not listed by the OIE, may also have a significant impact on bivalve culture in Asia. *Marteilioides chungmuensis* infects the ova of oysters (*Saccostrea echinata, Crassostrea gigas*) in Australia, Korea and Japan. Infection can so reduce fecundity that there are spawning failures. Another ovarian parasite, *Steinhausia mytilovum,* infects the eggs of mussels (*Mytilus* spp.) in Korea and Japan, and again affects the fecundity of the host.

Apart from the significant and potentially significant diseases listed by OIE and those described above, some countries of the Asian region are faced with increasing molluscan epizootics during the last few years. These include bay scallop mortalities in China and pearl oyster mortalities in Japan, Indonesia and the Philippines, to mention a few.

8.6.4 Effects on the small-scale farming sector and rural poor

The impacts of such diseases extend beyond direct mortalities and production losses and affect all levels of aquaculture activity. They are profoundly felt by small-scale farmers, who represent the backbone of many rural communities in industrialized as well as non-industrialized countries, and whose livelihoods are threatened through reduction in food availability, loss of income and employment, social upheaval and increased vulnerability. In the case of large-scale aquaculture businesses, the financial impacts and effect on investor confidence are considerable, and there is also significant further impact on employment and income in rural communities, where such operations tend to be located.

Exotic aquatic animal diseases have been responsible for severe economic losses experienced by small farming communities, a sector of society where the success or failure of a harvest will determine the raising of families above or below the UN poverty threshold. In southern Vietnam, for example, annual losses due to shrimp diseases amounting to more than US$ 300,000 have been experienced by some 1,200 families dependant on rice-shrimp culture. Between 1995-1997, the ‘red spot disease’ of grass carp affected 4000 of 5000 cages in operation, with losses estimated at US$ 0.5 million. The socio-economic impacts felt by small-scale farmers come not only through direct losses, but also include reduction in food availability, loss of employment, social upheaval and increased vulnerability. The devastating effects of EUS on rural populations in the developing countries of Asia have been highlighted previously.

Table 5. Some Estimates of Economic Losses Due to Trans-Boundary Diseases of Aquatic Animals in Asia and Latin America.

Country	Species Affected	Disease	Period	Estimated Losses (monetary value or % loss of total production)	Other Impacts	Source
LATIN AMERICA						
Ecuador	*Penaeus stylirostris*	WSSV	April-Aug. 1999 by October 1999	US$280.5 M (63,000 tonnes) US$ 250 M	26,000 direct jobs lost (13% of labor force) 42% of available farm production capacity not achieved 74% of hatchery capacity idle by Aug. 1999 68% reduction in sales & production for feed mills & packing plants 64% layoffs at feed mills 150,000 jobs lost in sector	Alday de Graindorge and Griffith 2000
Honduras	*L. stylirostris*	TSV WSSV	1994 1995 1996 Jan-March 1999	18% 31% 25% not quantified	13% reduction in labor force (disease impact combined with Hurricane Mitch in Jan 1999)	Corrales *et al.* 2000
Mexico	primarily *P. stylirostris*	IHHNV viral disease similar to TS	late 1980s, early 1990s 1995	US$ 25 M (4000 tonnes)		SEMARNAP 2000
Nicaragua	*Penaeus*	TSV WSSV	since 1995 since January 1999	no estimate no estimate	also affected by El Nino also affected by Hurricane Mitch	Drazba 2000
Panama	*Penaeus*	TSV WSSV	1996 early 1999 (continuing to present)	30% (285 tonnes) $US 40 M (exports) (4400 tonnes; 40%)	45% reduction in nauplius production 1500 direct and 3500 indirect jobs lost	Morales *et al.* 2000

Country	Species Affected	Disease	Period	Estimated Losses (monetary value or % loss of total production)	Other Impacts	Source
Peru	*P. stylirostris*	NHP TSV	summer 1993 1993	up to US$ 20 M US$ 2.5 M	production affected by La Nina in 1998	Talavera and Vargas 2000

Regional Loss Estimates						
Asia Region	**all cultured species**	**all diseases**	**1990**	**at least US$1.36 billion**		**ADB/NACA 1991**
	all cultured species	all diseases & environmental problems	annually	may exceed US$3 billion/year		ADB/NACA 1996
Estimates for Losses in Penaeid Shrimp Culture						
Australia	*P. monodon*	MCMS	1994-1998	US$ 32.5 M (based on an assumed AGR of 20%)		Walker 2000
Bangladesh	*P. monodon*	WSSV	1996 1995 1994	intensive farming: Tk 800 M (3400 tonnes) extensive farming: US $10 M (Tk 468 M; 13000 tonnes based on $7700/tonnes) semi-intensive farms: US$10 M	500 direct jobs lost; Disease almost caused abandonment of semi-intensive farming DOF estimate Massive unemployment (unquantified) note: probably same data as cited for 1995	Rahman 2000 Mazid and Hasna Banu 2000
India	*P. monodon*	WSSV and YHV	1994-1995 1994-current	US$ 17.6 million (10,000-12,000 tonnes) Rs 4000-5000 million annual loss to farmers		Mohan and Basavarajappa 2000

Regional Loss Estimates						
Asia Region	**all cultured species**	**all diseases**	**1990**	**at least US$1.36 billion**		**ADB/NACA 1991**
Indonesia	*P. monodon*	*Vibrio harveyi* luminescent vibriosis "crop failures due to disease" (WSSV and YHV)	annual 1991 not specific [since 1992?]	Rp 140 billion annually (hatcheries) US$ 100 M/yr (hatcheries) US$ 300 M		Rukyani 2000
Malaysia	*P. monodon*	WSSV	1995-current	US$ 25 M annually		Yang *et al.* 2000
Philippines	*P. monodon*	"disease & environmental deterioration		no estimates given; production drop in W. Visayas from 1,000 tonnes/month to 100 tonnes/month		Albaladejo 2000
PR China	*P. chinensis, P. japonicus, P. monodon*	WSSV	1993 1993	over US$ 250 M (120,000tonnes) US$450,000	disease impacted the lives of 1 million people outbreaks have continued every year to present (estimate for same loss)	Jiang 2000 Wei 2000
Sri Lanka	*P. monodon*	MBV WSSV WSSV/YHV	1988 1996 1998-present	Rs 186.62 M (64%) Rs. 1 billion no estimate	 90% of farms put out of production production area reduced to 9.5%; export value reduced by 70%	Siriwardena 2000

Regional Loss Estimates						
Asia Region	**all cultured species**	**all diseases**	**1990**	**at least US$1.36 billion**		**ADB/NACA 1991**
Thailand	*P. monodon*	YHV	1992, 1993	US$ 30 – 40 M		Chanratchakool *et al.* 2000
		YHV	1992	US$ 30.6 M		
		“all shrimp disease outbreaks”	1994	US$ 650 M		
		WSSV	1996	US$ 210 – 250 M (70,000 tonnes; around 40%)		
		WSSV/YHV	1994/1995	US$ 240 M		
		WSSV/YHV	1997	US$ 600 M (30%)		
Vietnam	*Penaeus* spp.	viral diseases (MBV, YHV,WSSV)	1993	US$ 100 M		Khoa *et al.* 2000

Estimates for Losses of Finfish in Aquaculture and Artisanal Fisheries						
Bangladesh	freshwater fishes (wild)	EUS	1988-89	US$3.4 M (Tk. 118.3 M)		Mazid and Hasna Banu 2000
Indonesia	freshwater fishes	EUS	1980s	Rp 50 billion		Rukyani *et al.* 1996, cited by Directorate of Fishery Resources Management 2000
Sri Lanka	freshwater fishes	EUS	1987-1993 (mainly 1987-1989)	US$0.4-0.8		Balasuriya 1994
Thailand	freshwater fishes	EUS	1982-83	US$8.7M		Tonguthai 1985
	freshwater fishes	EUS	1882-1993	may be > $US100 M		Chinabut 1994

8.7 State sector responses to trans-boundary aquatic animal diseases: legislative, policy and institutional initiatives

While making international trade as easy as possible, the role of the State with respect to trans-boundary aquatic animal diseases, is to minimize the risk to national aquatic resources, including aquatic biodiversity and existing capture fisheries and aquaculture, posed by trade in living aquatic animals and their products. The State thus has a primary role and responsibility in preventing exotic aquatic animal diseases from establishing in national waters, and in implementing measures to treat, and where possible, contain and eradicate diseases which may cause serious economic, sociologic or ecological impacts. This section reviews briefly some of the responses and initiatives taken by the state sector in Asia and Latin America in response to recent epizootic disease outbreaks in aquaculture and capture fisheries.

8.7.1 Immediate direct governmental actions when faced with an epizootic outbreak of disease

It is only within the past 20 years, with the appearance of several epizootic diseases that have affected capture and culture fisheries in Asia (EUS) and penaeid shrimp culture in both Latin America and Asia (WSSV, yellowhead virus (YHV), Taura syndrome virus (TSV)], that national governments of most countries have begun to recognize the serious threat posed by trans-boundary aquatic animal diseases to their economies and societies.

In both Asia and Latin America, epizootic disease outbreaks have generally caught governments unprepared, even though in many cases, the events that occurred within national contexts were foreshadowed by similar events that occurred in neighboring countries, and the eventual arrival of the most destructive pathogens could often have been foreseen several years in advance. For example, although it is now been shown that WSSV has been present in Ecuador since 1996, a lack of local diagnostic expertise meant that the pathogen's presence remained undetected until disease outbreak occurred in 1999. If the pathogen had been recognized earlier, its impact could have been greatly reduced. Given the history of extensive and often ill-considered movements of aquatic species that has taken place world-wide, aquaculturists and governments in the Americas could have anticipated that WSSV and YHV would eventually appear in their region, as Asian aquaculturists might have predicted that TSV would eventually appear in Asia. Through foresight, risk assessment and good contingency planning, governments might be able to limit the impacts of such diseases.

Upon the first appearance of mass mortalities of aquatic animals, national governments in Asia typically reacted by:

- Mobilizing local expertise in an attempt to identify pathogens and devise treatment and prevention strategies
- Passing emergency legislation or orders to ban the import of all penaeid postlarvae and/or broodstock
- Undertaking public relations campaigns in an attempt to assure industry and the general public that government was taking action
- Disseminating information to assure the public that aquatic animal disease did not constitute a threat to human health

In Latin America, however, it was typically the private sector which undertook these initial actions.

Effectiveness

Because of the generally poor state of preparedness of most governments in Latin America and Asia, the initial measures taken were mainly ineffective. Technical responses were often slow to initiate, poorly designed, and poorly coordinated. This was due mainly to an absence of essential expertise, capacity, and infrastructure, and a failure of governments to have in place workable contingency plans.

In some countries (e.g., India, the Philippines) government information campaigns may have helped to assure the public, and in particular, the rural poor, that fish suffering from the ulcerous lesions of EUS posed no threat to human health, and that not all fish (including marine species) were affected by the disease. The latter was particularly important, as in many countries, people stopped eating fish entirely, affecting both freshwater and marine capture fisheries and aquaculture.

Implementation of bans on importation of penaeid shrimp after the appearance of WSSV-caused epizootics has been unproductive. In Bangladesh, for example, the pathogen was already well established and apparently wide-spread in the country at the time a ban was instituted and, because of the porous national borders with Myanmar and India, and the fact that national supplies of PLs and locally caught broodstock were insufficient, aquaculturists had both the motive and the mechanisms to circumvent enforcement of the legislation. In Latin America, similar events occurred in Mexico, Ecuador, Peru and Colombia.

In the end, it must be admitted that the national governments of countries in Asia and Latin America have not be able to prevent the entry of highly pathogenic organisms such as WSSV, YHV, TSV and EUS. Most countries, particularly the LIFDCs (low-income food-deficit countries) and the more developed countries in Asia and Latin America, remain highly vulnerable to serious outbreaks caused by new aquatic animal pathogens. While many countries can be lauded for having made great advances in developing national expertise, capacity and ability to manage existing disease problems, they remain largely unable to prevent the entry of new exotic diseases, or to contain or eradicate them once they have gained a foothold, due to the extremely complicated nature of this problem. The state role in aquatic animal health has not been very effective in most countries; even where there is legislation in place, there is little effective enforcement.

Even the most developed countries, such as the United States and Australia, remain highly susceptible to disease incursions through mechanisms such as pathogen transfer in ship's ballast waters and the ornamental fish trade.

Since diseases such as WSSV, YHD, TSV and EUS have not been contained, there has not been any serious attempt at disease eradication at the national level in either Asia or Latin America. However, it is interesting to note that TSV was apparently accidentally eradicated from Hawaii by switching from culture of *P. vannamei* to *P. stylirostris.* Upon return to culture of *P. vannamei* two years later, no pathogen was encountered.

8.7.2 Medium to long-term government reactions to aquatic animal disease outbreaks

Recent outbreaks of epizootic trans-boundary diseases, their serious impacts on aquaculture and capture fisheries, and the trade implications of the World Trade Organization (WTO) and the Sanitary and Phytosanitary Agreement (SPS Agreement) have made governments around the world view aquatic animal pathogens in a much more serious vein. As a result, many states have begun to develop national strategies for aquatic animal health management. There is also concern that use of scientifically unsupported disease concerns may be a disguised restriction on trade, an action clearly in contravention of the spirit of the WTO and the SPS Agreement.

Longer-term actions taken by governments to prevent the entry of exotic aquatic animal diseases, and to manage, contain, or eradicate enzootic and exotic diseases, form part of national strategies or action plans for aquatic animal health management, although such national strategies have not always been clearly articulated, fully or coherently developed, or presented as such by state governments. Medium to long-term actions to deal with trans-boundary aquatic animal diseases are included within these national strategies. At least two countries (Australia and Panama) have well-developed national strategies in place.

Government actions for development of capacity in aquatic animal health often have overriding concerns that are much broader than the concerns of a single industry, sector or segment of society. These include aquatic animal health management for fish, shellfish and molluscs; and protection of aquaculture, capture fisheries, and non-exploited species and their habitats (biodiversity) for the benefit of all citizens.

An example of a fully formulated national strategy for aquatic animal health management is AQUAPLAN, developed and implemented by the Government of Australia (AFFA 1999, Bernoth 2000).

AQUAPLAN is comprised of eight programs, with appropriate program activities, forming a comprehensive integrated national approach to aquatic animal health. The programs and activities are as follows:

PROGRAM 1 – INTERNATIONAL LINKAGES
- *Development of regional technical guidelines for aquatic animal quarantine and health certification (FAO/NACA/OIE Regional Program)*
- *Aquatic Animal Pathogen and Quarantine Information System (AAPQIS)*
- *OIE's aquatic animal disease categorization, and disease lists*
- *International and regional disease status reports*

PROGRAM 2 – QUARANTINE
- *Import risk analysis (IRA)*
- *Review and regulation of post-arrival quarantine procedures for live fish*
- *Training of quarantine officers in aquatic animal quarantine*
- *Random sampling of imported fish and fish products*
- *Dissemination of quarantine information on fish and fish products*
- *Health certification*

PROGRAM 3 – SURVEILLANCE, MONITORING AND REPORTING
- *Surveillance and monitoring strategies*
- *Diagnostic capability*
- *Standard Diagnostics Techniques and Standard Operating Procedures*
- *Reporting and disease status*
- *Zoning programs for aquatic animal diseases*

PROGRAM 4 – PREPARDNESS AND RESPONSE
- *Institutional arrangements for aquatic animal disease emergency management*
- *Disease simulation exercises*

PROGRAM 5 – AWARENESS
- *Australian Aquatic Animal Disease Identification Field Guide*
- *Inclusion of aquatic animal health in veterinary curricula and other tertiary education*

PROGRAM 6 – RESEARCH AND DEVELOPMENT
- *Inventory of aquatic animal health research projects in Australia*
- *Strategic prioritization of research projects*

PROGRAM 7 – LEGISLATION, POLICIES AND JURISDICTION
- *Identify and work towards necessary legislative and jurisdictional outcomes*
- *Control of exotic/emerging disease on Commonwealth land an in Commonwealth places*

PROGRAM 8 – RESOURCES AND FUNDING

It is important to note that AQUAPLAN is strongly linked to, and fully compatible with, the OIE's International Aquatic Animal Health Code and Diagnostic Manual (OIE 1997a, 1997b), and the provisions of membership in the World Trade Organization and the SPS Agreement.

Legislative and Policy Interventions

Many countries in Asia and Latin American have developed, or are currently developing legislation and policy to minimize the risk of introducing exotic aquatic animal diseases.

A core activity in minimizing the threat of TAADs, is the use if Import Risk Analyses (IRA). IRAs involve (i) Hazard Identification, (ii) Risk Assessment, (iii) Risk Management, and (iv) Risk Communication. However, because few countries have experience or expertise with IRA, these activities have generally been done in a less structured and *ad hoc* fashion, without conscious adherence to a formal IRA procedure. This process leads to legislative and policy decisions, such as:

- Restrictions on species that can be imported
- Species specific restrictions on life cycle stages (broodstock, larvae, fertilized ova, gametes)
- Requirements for mitigative measures (e.g., quarantine and health certification (by lot, facility or region (zone))

Effectiveness

Legislation designed to minimize the risk of trans-boundary aquatic animal diseases associated with the importation of live aquatic animals and their products is often difficult to implement or ineffective due to requirements for:

- Well thought-out legislation
- High technical capability (diagnostics, research, infrastructure)
- Effective enforcement mechanisms (prevention of illegal introductions)
- Limited possibilities for natural transmission (fish, birds, mammals, currents, etc.)
- Closure of other routes of entry (e.g., ship's ballast water)
- Aware and responsible industry and public

Bans on importation's put in place while WSSV was still exotic have had mixed results. In the Philippines, WSSV was recently detected despite a Fisheries Administrative Order banning importation of penaeid shrimp having been in place for several years. Pathogen entry was most likely due to inability of the government to effectively enforce this legislation, and the irresponsible actions of a small segment of the aquaculture industry.

There have been some successful cases where legislation, with the cooperation of industry, has prevented the introduction of pathogens. Venezuela, for example, has had very comprehensive legislation in place since 1989 and has avoided major disease outbreaks in aquatic animals. Another example of success is Colombia, which has two internal zones (Atlantic and Pacific) with different sanitary status with regards to WSSV. The restriction of movement of penaeid shrimp within the country has been successful, as until now there have been no reports of WSSV disease on the Atlantic Coast. Australia believes its restriction on the importation of live penaeid shrimp has prevented the entry of WSSV. However, despite attempts to prevent disease entry by restricting trade in live shrimp, outbreaks of viral disease have still occurred in the majority of shrimp-producing countries.

8.7.3 International responsibilities/interventions

Most countries are members of the World Trade Organization (WTO), and thus have rights and responsibilities related to trade in living aquatic animals and their products as spelled out in the STP Agreement. Among others, this calls for free trade in living aquatic animals, requiring that any restrictions on importation's must be based on sound scientific evidence. Most states are also members of the Office International des Epizooties (OIE), an international veterinary organization. Both organizations require member states to behave ethically with regard to disease issues as they affect trade in live aquatic animals. States are also morally bound by membership in international and regional organizations (e.g., FAO, NACA, ASEAN, SARC, APEC, OIRSA, etc.) and as signatories to international and regional treaties.

Effectiveness

The potential contribution of international agreements and cooperation has not yet been realized except, perhaps in the European Community (EU) where effective disease zoning is in place.

8.7.4 Financial policy interventions

Governments have assisted the aquaculture and fisheries sectors to recover from the effects of epizootic diseases by:

- increased availability of capital (loans, favorable investment terms)
- favorable bank interest rates to sector
- reduced taxation
- reduced tariffs and duties on imports (equipment, feed, etc.)
- favorable rates for electricity, water, etc.
- restructuring of debts (forgiveness or capitalization of interest
- full or partial bailouts
- seeking/mobilizing international funding (e.g., FAO emergency funding, bilateral aid)

Effectiveness

These efforts have been effective in promoting industry development an expansion in some countries and in assisting industry to weather financial losses. However, they have had little or no direct impact on disease management.

8.7.5 Planning and coordination interventions

Planning and coordination activities undertaken by government include the development of long-range "visionary" planning for the aquaculture sector, the setting up of multidisciplinary committees and taskforces (which may involve experts from government, industry, academe, and NGOs), to address specific problems.

Some governments have developed coastal zone management plans, including development of regulations and standards related to farms (e.g., farm siting, farm density, farm design, effluents, etc.).

Some governments have also initiated, or assisted industry in the development of guidelines for sustainable development and management of aquaculture. These efforts to encourage industry maturation include:

- Organization/support to Industry Groups
- Encouragement of Responsible Industry and Self-Regulation
- Codes of Practice
- Best Management Practices - communication, etc.

Some governments have initiated emergency planning and actions to deal with future disease outbreaks. These include programs for:

- Surveillance and Monitoring
- Disease Reporting
- National and regional/international disease lists
- Contingency Planning
- Regional communication and linkages

Development of National Strategies, such as Australia's AQUAPLAN, is one of the areas where national government leadership is required. Such long-term strategic plans for aquatic animal health encompass all the activities discussed in this section. As part of the FAO/NACA Regional Program, National Strategies of aquatic animal health management have been developed for 21 governments in the Asia Region (see FAO/NACA 2000).

Effectiveness

In most cases, planning and coordination interventions have not been fully developed nor tested. However, they have good potential to put industry on a sustainable basis and to protect national aquatic resources, if fully implemented.

8.7.6 Technical support interventions

In Asia, governments have provided substantial technical support for disease research, diagnostics and extension to the shrimp culture industry, while in the Americas, except for Mexico and the USA, most technical interventions have been undertaken by the private sector. These include:

- Diagnostics services (expert services and routine diagnostics, including establishing PRC labs).
- Hatchery operation and fry distribution (some cases).
- Genetics and closed broodstock development programs (however, many of these initiatives are now in difficulties, as the animals in their programs are infected with WSSV).
- SPF/SPR development (Colombia and Panama for TSV, Hawaii for IHHNV, and Panama for WSSV).
- Disease investigations (for example, CENAIM conducts research on health management protocols, evolution of outbreaks of WSSV in the pond, and monitoring).
- PCR screening (now widespread in both the Americas and Asia).
- Technology assessment, development and transfer via extension services (demonstration farms, health monitoring, water quality checks, etc.).
- Training (seminars, workshops short-term training awareness building, etc.)
- Applied research via government laboratories, support/direction to university laboratories, and cooperation with industry.
- Communication activities (via various media).

Effectiveness

These activities have been highly effective in increasing capability at the farm level for disease prevention and management.

8.8 Private sector responses to exotic disease of penaeid shrimp

The private sector has borne the brunt of the three major shrimp diseases that have occurred in the past 10 years. Taura syndrome virus (TSV) in the Americas and both yellowhead (YHV) and white spot syndrome (WSSV) viruses in Asia caused billions of US dollars of losses to all sectors of the industry, from hatcheries and farms to suppliers, processors and exporters. The real risk of trans-boundary movement of these diseases is highlighted by the appearance of TSV in Asia and YHV and TSV in the Americas. Unfortunately, little epidemiological evidence is available to determine how these diseases have spread, although it is likely that TSV appeared in Asia as a result of the importation of the western Pacific species *P. vannamei* and *P. stylirostris* into the region. The source of WSSV in the Americas has been the subject of considerable debate, since it was detected in shrimp farms in the USA. Infectivity experiments carried out on frozen shrimp displaying the gross signs of WSSV purchased in the US demonstrated the potential for such shrimp to transmit the disease to *P. vannamei* (Lightner, et al. 1997). This prompted some speculation that the outbreaks in the US may have originated from processing plant waste landfill via some vector such as migratory birds (Lightner 1996). Although this hypothesis has gained some credence, it remains the subject of debate. Other potential routes of infection are import of live animals, spread through carrier or vector populations in the wild, unsafe disposal of processing plant waste directly into open water systems, and through live carriers or vectors in ballast water discharge (Nakano *et al.* 1994, Takahashi *et al.* 1994, JSA 1997).

The impact of the diseases, and the measures that can be taken to mitigate them, are highly dependent on the type of production system in use. The production systems can vary within a particular region from small, stand-alone, family-run operations to large, vertically integrated corporate structures, and production operations in Asia and Latin America show a completely different structure. Small-scale producers dominate the Asian shrimp industry. Pond and farm sizes are small with ponds between 0.5 and 2 ha each and farm sizes generally less than 10 ha total farm area. In Thailand, for example, it has estimated that around 70% of producers have farms of less than 2 ha size. In many Asian countries, the dominant form of production is semi-intensive, averaging approximately 3-5 tonnes/ha/crop, although in some countries, extensive production is more common. Postlarval supply for farms, especially in the major producing countries such as Thailand, Indonesia and China, comes largely from hatcheries, although these are almost completely dependent on wild broodstock supply.

The semi-intensive systems typical of many Asian farms also demand a relatively higher level of pond management. The higher stocking densities employed, the smaller pond and farm size, and the higher investment mean that much more time is devoted to pond management on a daily basis. Also, the higher predominance of owner-operated farms increases the direct stake held in the farm and its success by those working on it.

The Latin American shrimp industry has a predominance of large-scale producers and more vertically integrated operations. Farm and pond sizes are much larger than in Asia, with farms of several hundred hectares being fairly common. Pond sizes generally vary between 5 - 20 ha each. This probably reflects both the availability of relatively cheap land and a greater concentration of land holdings by individuals. Production levels are lower than in Asia, with yields averaging around 0.5-2 tonnes/ha/crop. Both wild and hatchery-reared postlarvae are used, but despite the fact that hatchery technology is better developed in the Americas than in Asia, there is still a marked preference for wild postlarvae. Despite this, progress in domestication of the principal species cultured in Latin America (*P. stylirostris* and *P. vannamei*) is more advanced than in *P. monodon* or any of the other Asian species. This has led to a greater availability of domesticated stocks and stocks of postlarvae and broodstock which are specific-pathogen free (SPF) for the major viral pathogens and, in the case of some strains of *P. stylirostris*, specific-pathogen resistant (SPR) for infectious hypodermal and haematopoietic necrosis virus (IHHNV).

These differences in production systems and the structure of the industry have major consequences for the development of strategies to deal with disease problems, not least in the economic and logistic limitations. Another important factor is the availability and extent of government support and infrastructure to assist the industry in identifying the causes of problems and potential means of prevention or treatment.

In addition to the severe losses due to catastrophic disease outbreaks, the impact of non-catastrophic, chronic disease losses may be higher. Unfortunately, the extent of such losses is difficult to assess, but some indication may be obtained from average survival rate. Survival rates in commercial shrimp farms are highly variable, but generally average between 40 and 60%, low compared to terrestrial agriculture values. A significant portion of this mortality is disease-related, although the losses are sufficiently small and cumulative that most farmers take them for granted. The cost of such an inefficient production is, however, likely to be considerable. The impact of IHHNV-related “runting” on crop value of *P. vannamei,* for example (Table 6) gives some indication of the potential economic cost of non-lethal disease impact (Wyban *et al*. 1992). Removal of IHHNV from an intensive system in Hawaii increased crop value by 162% over infected stock.

Table 6. Summary of U.S. commercial grow-out production performance of high health vs. non-high health shrimp in 1991 (from Wyban *et al*. 1992)

Region	System	Variable	High Health	Non-High Health
Hawaii	0.4 ha, earthen ponds	kg/ha/crop	857	395
Hawaii	0.2 ha intensive pond	kg/ha	9685	7120
		crop value	$20,326	$12,507
South Carolina	2 ha earthen ponds	survival	75 %	48 %
Texas	5 ha earthen ponds	size distribution	uniform	spread
		size	44 % 31/35 size 44 % 36/40 size	9 size classes

8.8.1 Farm/private sector management strategies

Private sector management strategies for disease have largely developed on an *ad hoc* basis as a reaction to a disease event. The effective strategies generally evolve in tandem with developments in research into the specific disease of concern. For Taura virus and yellowhead virus, for example, strategies to cope with the disease were already developing even before the pathogen responsible had been identified. It should also be noted that, with time, some of the risks associated with disease may be reduced, either through increased knowledge of the relative risk, or through changes in the pathogenicity and virulence of the causative agent. This can result in a reduction of concern and consequently adoption of less stringent disease control measures. In Thailand, for example, many farmers have become less concerned about the risk of white spot disease, resulting in the development of a market for postlarvae of unknown disease status. The following brief overview covers some of the major strategies adopted to deal with disease outbreaks in Asia and Latin America.

To date, much of the effort in disease control and management has taken place with little, if any, attention paid to the epidemiological patterns of disease spread. Most of the research into shrimp disease has focussed on the identification of the pathogen, diagnosis of clinical signs of disease and work on the transmission and pathogenicity of the disease. There are very few studies, most of them recent, on the epidemiology of some of the major diseases. Further epidemiological studies are necessary to better elucidate the mechanisms of disease occurrence and risk factors for outbreaks in populations of shrimp in ponds and farms, and within and between countries. They will also allow, through risk assessments and evaluations of relative risks, the development of appropriate and more effective strategies for disease control and health management.

One major problem in the conduct of epidemiological studies of earlier outbreaks is the lack of a clear confirmation of a particular virus as the principal cause of losses. The lack of a clear case definition in most cases has resulted in much of the information on outbreaks and spread being anecdotal rather than fact-based. This is particularly problematic due to the tendency to ascribe any unusual loss or mortality to the prevailing pathogen of concern without confirmatory diagnosis. This is further exacerbated by the frequent lack of clear, unambiguous clinical signs. In the case of YHV and WSSV in particular, this makes *a posteriori* epidemiological analysis based on the clinical signs of yellow heads or white spots impossible due to the fact that many cases of both diseases do not conform to the named clinical signs. Most recent cases of YHV loss have been diagnosed through histology in the absence of the gross signs of yellowing of the head and diagnosis of WSV is further complicated by the existence of other conditions resulting in similar white spots in the absence of the virus. Species differences also occur, with infected *P. vannamei* being less likely to display white spots than *P. monodon*.

Problems have been encountered in disease diagnostics where these are used to assist decision-making at the farm level. There has been much confusion as to some of the methods used and their interpretation in the field. Any diagnostic test suffers from limitations, particularly in terms of the rate of false positive and false negative results. Issues of sampling error and lack of standardization have also become important, particularly since the private sector has been faced with the economic and risk consequences of diagnostic test limitations. The use of polymerase chain reaction (PCR) testing for WSV, for example, suffered from some of the following constraints:

- Lack of appreciation of sampling and statistics by diagnosticians
- Inconsistent results between laboratories
- Lack of information to the usefulness of the technique for decision-making
- Lack of standardized and validated methods
- Unreasonably high expectations on the part of the farmer

This clearly shows that it is important that diagnostic efforts to assist the industry take account of more than the results of the test, but that they address issues of test reliability, sampling and interpretation of the results to assist improved decision making at the farm.

Dealing with disease and developing strategies for its control requires a more proactive approach to disease rather than the reactive approach that has been prevalent. This requires a greater level of control and understanding of the mechanisms of health management. This will require considerable effort focusing on education and awareness building at all levels of the industry. This is particularly true for the small-scale farming systems and the generally lower level of educational attainment of Asian farmers.

The development of industry-wide approaches to deal with disease will require far greater co-operation at all levels. Co-operation between the various sectors of the industry to develop a common strategy to deal with disease is important. In some cases, for example, efforts to deal with disease may be most appropriate at one level although the benefits accumulate in another level. . For example, efforts to control WSSV may require considerable efforts in the hatchery sector to prevent vertical transmission although the benefits may only be seen in the farm. This requires a common approach and objectives and may need some thought as to means of compensating the hatchery sector for the efforts taken.

Co-operation is also necessary between the private and public sectors at the national and international levels. Regulations and measures designed to control the spread of disease will be more effective with the participation and understanding of the private sector and will vastly reduce the risk of non-compliance. At the same time, implementation of research and development strategies designed to assist the private sector should be developed in close consultation with the private sector so that they meet the needs and objectives of the sector. There are several cases where private sector input into research and planning efforts have borne good results. In Thailand, the establishment of specific task forces to deal with disease outbreaks has involved the public and private sectors, with funding coming from both. Several Latin American countries such as Ecuador, Honduras and Colombia, also have joint efforts and funding of research and planning activities.

Hatchery management strategies

The hatchery is the first line of defense in cases where a disease can be passed down from the spawners or parent stocks. Hatchery practices are widely different between Asia, where small, artisanal hatcheries using nauplii or spawners predominate, and Latin America, where hatcheries are generally larger and there is more experience in the use of broodstock matured and spawned in the hatchery. The management of disease problems at the hatchery level is also highly dependent on the level of vertical integration and co-operation within the industry. In many Asian countries, for example, the lack of vertical integration and farmers reluctance to pay extra for good quality or uninfected PL has frequently resulted in a “buyer beware” attitude, as hatcheries have little incentive to take the necessary precautions.

Quarantine of broodstock and spawners

Holding broodstock or spawners in quarantine to establish their disease status before bringing them into maturation is not practiced in small-scale hatcheries in Asia. The predominant use of wild-caught spawners rather than maturation in Asia imposes a time constraint on establishing disease status and quarantine is not practical. At the same time the lack of market demand for disease screening on nauplius and spawner suppliers by hatcheries reduces the incentive to determine disease status.

Some quarantine efforts to limit the entry of known pathogens into the hatchery have already been made. Several hatcheries in Latin America routinely hold broodstock in isolation until the results of a screening for particular pathogens of concern have been completed. Only when the broodstock have passed this screening are they allowed into the maturation facility. This does not provide a guarantee of freedom from the disease, but will reduce that risk.

Broodstock screening

The screening of broodstock by PCR has also been demonstrated to be effective in eliminating positive brooders. Figure 1 summarizes data obtained by Hsu et al. (1999). Repeated testing of the same individual before and after spawning gave dramatically different results that strongly suggest that broodstock screening is more reliable after spawning.

Before spawning, there is poor repeatability of the 2-step PCR test used, with only 60% (38% positive and 22% negative) of the samples showing complete agreement in all five repetitions, calling into question results obtained on only a single sample. After spawning, however, the repeatability is complete, with samples being either positive in all repetitions or negative.

Tests have also shown that the virus can be detected in the spermatophore of male shrimp, suggesting that PCR-negative females could produce positive offspring through contamination from spermatophore tissue (Lo *et al.* 1997). Therefore, further precautions should be taken and checks should be made on later stages.

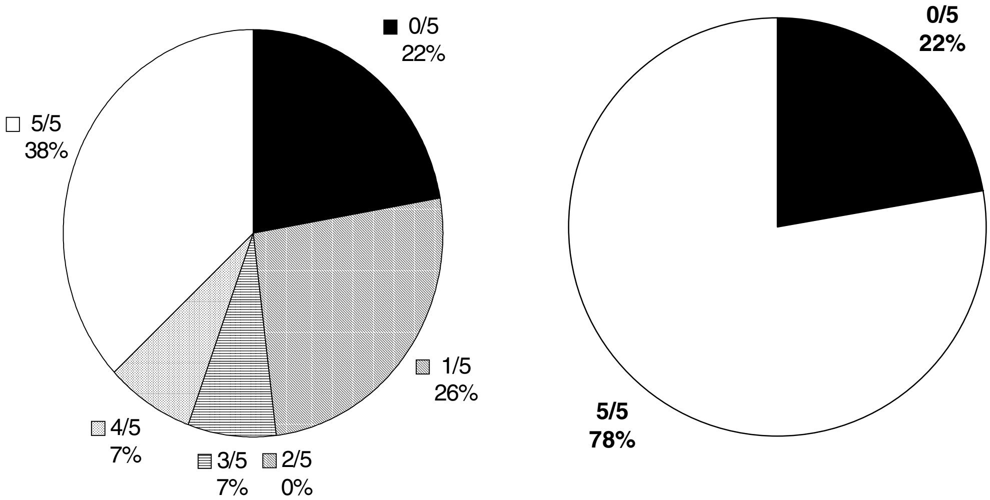

Figure 1: Results of 5 replicated PCR tests on spawners before (L) and after (R) spawning (data from Hsu *et al.* in press)

The cost of mass screening of broodstock by PCR can be considerable, especially in Latin American hatcheries where thousands of animals may be introduced into a maturation facility on a weekly basis. In such cases, stratified screening using cheaper methods such as rapid staining histology or dot-blot may be used to eliminate infected individuals without the need for PCR, which would be subsequently carried out only on those animals which pass the initial screening. Given the numbers involved, it is likely that sampling would also have to be done on a sub-sample of a batch or lot of shrimp. In such cases the lots would be kept separate until the results were available and acceptance/rejection of the lot based on the sample test results.

Broodstock selection

The elimination and/or exclusion of obviously diseased or unhealthy individuals from the broodstock facility should be a routine component of best management practice (BMP). Disinfection of broodstock with formalin or other disinfectants before moving into the quarantine, maturation or spawning facility has also been used as an effective, simple and cheap means of reducing the risk of disease associated with external pathogens and parasites. Although data on efficacy is lacking, its adoption as a routine precautionary measure should be considered a part of best management practice (BMP).

PCR screening of postlarvae

Screening of postlarvae has been shown to reduce disease risk through the elimination of batches of shrimp that are positive for the disease. Tables 7 and 8 show the relative risk associated with stocking of PCR-positive PL based on a 2-step PCR test with a sample of only 30 postlarvae from data by Withyachumnarnkul (1999). Although this sampling level is relatively insensitive (giving a 95% chance of detection of 10% prevalence) the data clearly demonstrate the risk of crop failure associated with the stocking of PCR-positive PL. In Table 7, the relative risk of failure of using PCR-positive PL is almost 50 times greater than the use of shrimp which never test positive during the crop. This decreases significantly if PCR-positive shrimp are detected during the crop, possibly as a result of either a low initial prevalence which was undetected due to the small sample size used or infection post-stocking by some other route. Even if the subsequent positive ponds are combined with the negative group (5) there is still a three-fold increase in risk when using PCR-positive postlarvae.

Table 7. Comparative risk of failure and proportion of failure in 6 pond groups defined according to WSV-PCR status of samples before and after stocking (from Withyachumnarnkul 1999).

Pond Group	Number Ponds	Number Failed	Proportion Failed	Relative Failure Risk*
Group 0 (PCR^+ PL)	43	41	0.953	49.6
Group 1 (1^{st} Mo. PCR^+)	23	12	0.522	27.1
Group 2 (2^{nd} Mo. PCR^+)	40	19	0.475	24.7
Group 3 (3^{rd} Mo. PCR^+)	24	9	0.375	19.5
Group 4 (4^{th} Mo. PCR^+)	6	4	0.667	34.7
Group 5 (Never PCR^+)	52	1	0.019	NA
Total	188	86	0.457	NA

**Compared to Group 5; NA = not applicable; Total # ponds studied = 188; Total # ponds failing = 86 (46%)*

Table 8. Comparative risk of failure and proportion of failure in ponds stocked with WSSV-PCR positive and negative PL batches (from Withyachumnarnkul 1999).

Pond Group	Number Ponds	Number Failed	Proportion Failed	Relative Failure Risk*
Group 0 (PCR^+ PL)	43	41	0.953	3.1
Groups 1-5	145	45	0.310	NA
Total	188	86	0.457	NA

**Compared to combined Groups 1-5 = all pond groups stocked with WSSV-PCR negative PL; NA = not applicable.*

Spawning

The use of individual spawning in tanks can reduce the risk of transmission of pathogens from a single or small number of shrimp to an entire batch. The nauplii and, if practical, the larvae would be kept in individual lots at least until the test results on the spawner were available. Hatcheries in Latin America have practiced individual spawning for many years. In Asia, however, the use of mass spawning in common tanks has been the norm. This has been shown to carry a high risk of cross-contamination of the offspring. In recent years, however, there has been a switch towards individual spawning in smaller tanks to reduce this risk.

Use of SPF stocks

Specific Pathogen-Free (SPF) shrimp stocks are stocks which have been domesticated and reared under a SPF program, as described by Lotz (1992, 1997) and Wyban (1992), in systems in which specific pathogens have been excluded. This does not imply that they are resistant to the specific pathogen nor that they are free of other pathogens.

Few specific pathogen-free stocks of species other than *P. vannamei* are available for commercial use, although SPF populations of other species are currently being developed (Withyachumnarnkul *et al.* 1998). Their use will eliminate the vertical transmission of the particular SPF pathogen excluded, but do not give any guarantees of success if subsequently exposed to the same, or other, pathogens. Domesticated Mexican strain IHHNV-SPF *P. vannamei* from Hawaii stocked in Latin America, for example, suffered greater losses to Taura syndrome virus than wild postlarvae due to an apparently higher susceptibility to the disease (Brock *et al.* 1995). This demonstrates that SPF shrimp, when grown in environments where they are exposed to pathogens, may not have any inherent advantage unless other sources of infection are removed (Lotz 1997). There has been relatively little work done on developing standard protocols for the commercial cultivation of SPF and high health shrimp. This would be necessary if this approach were to be more widely applied.

Use of SPR stocks

Specific Pathogen-Resistant (SPR) shrimp refers to shrimp which have been developed from domesticated stocks selected for their ability to survive infection by a specific pathogen. In type 1 SPR, the shrimp are infected by a specific pathogen in a latent state (i.e., are “carriers” of the pathogen). The pathogen remains infective and can be transmitted to, and cause disease in, naïve stocks. These should be distinguished from stocks of shrimp which are genetically selected for their ability to resist disease upon exposure to the pathogen and which are uninfected at the time of selection (Type 2 SPR). Type 2 SPR shrimp would be SPF and SPR for the pathogen.

The long-term implications of use of Type 1 SPR stocks relates to dependence on infected animals and the need to develop stocks which are resistant to multiple pathogens. This is likely to be untenable both technically and due to concerns about the international spread of pathogens. Type 2 SPR stocks, therefore, represent a more sustainable future for development. However, some virus populations, especially RNA viruses such as TSV and YHV, can have a high rate of mutation which can result in reductions in the effectiveness of the pathogen resistance.

Stocks of *P. stylirostris* that had been introduced and grown in captivity in Tahiti were subsequently found to have acquired resistance to IHHNV. This had been one of the main reasons behind the lack of interest in *P. stylirostris* for culture in Latin America, as IHHNV infection caused massive losses. When TSV was causing high mortalities in *P. vannamei*, *P. stylirostris* was re-imported from Tahiti to several Latin American countries as an alternative.

At around the same time, it was noted by many farmers that nauplii and postlarvae from Panama appeared to be more resistant to TSV. This led to some speculation that the Panamanian stocks may have been exposed to the virus for a longer time and developed some resistance. A large demand developed for Panamanian shrimp, which were subsequently exported to many other countries in Latin America. In general this proved to be advantageous. However, in the absence of effective health controls, this does represent an increased risk of pathogen transfer. With the outbreak of WSSV and its reported presence in Panama, this led to widespread suspicion that these exports may have been responsible for transmission of the disease.

8.8.2 Farm management strategies

Individual farm management strategies have depended heavily on the circumstances of individual farms or farming systems. As previously mentioned, the differences in farming systems between Asia and Latin America and the relative experience in both areas have resulted in some differences in the management approaches adopted in both regions. This section will review some of the broader strategies that have shown some benefits in disease management.

Postlarval selection

PCR screening for viruses has been dealt with previously in the section on Hatchery Management Strategies. Other means of postlarval quality assessment have also been used including microscopic examination of postlarval condition, stress tests and treatments to eliminate weak, possibly infected, PL (Bauman and Jamandre 1990, Clifford 1992, Fegan 1992, Fegan *et al.* 1993). In most cases these are not specific to a particular disease, but provide some additional level of confidence that the postlarvae to be stocked are relatively healthy and capable of withstanding the stress of stocking.

The use of formalin to eliminate weak and potentially infected postlarvae prior to stocking has been used in Thailand and some other countries (Chanratchakool and Limsuwan 1998). There is a limited amount of data directly demonstrating differences in infection rates in treated and untreated batches but what there is does tend to support the concept. The elimination of weak and potentially infected individuals, and the effect of the formalin treatment on external parasites and fouling organisms, does have advantages. This, together with the low cost and simplicity of the method, and the fact that it can have benefits without necessarily knowing the disease status of the PL, make it an appropriate method for routine use in a "best management practice."

Wild PLs

Experience with TSV in Ecuador and other Latin American countries indicated that wild postlarvae may be more capable of withstanding a disease outbreak than those raised in hatcheries (Stern 1995). However, the use of wild PL is inherently more risky than the use of hatchery PL due to the unknown disease status of wild postlarval stocks. This, and the longer-term need to develop domesticated stocks selected for desirable characteristics, make it increasingly important to reduce dependence on wild stocks. However, switching from dependence on wild PL to hatchery PL has implications for sustaining rural livelihoods and employment of wild fry collectors which must be considered.

Use of domesticated stocks

The greater experience of hatchery operators in the Americas in captive maturation and in domestication of *P. vannamei* and *P. stylirostris* means that development of domesticated, genetically selected stocks of shrimp is more advanced in these species than in *P. monodon* and other Asian stocks, despite a long history of attempts (Primavera 1978, Aquacop 1983, Srimukda 1987, Menasveta *et al.* 1993; Withyachumnarnkul *et al*. 1998). Several private-sector groups in the Americas are involved in the development of breeding programs and SPF/high health stocks in the USA, Mexico, Colombia and other countries. Results to date have been reasonably promising, and it is likely that the adoption of domesticated stocks at a commercial level will continue.

The situation in Asia is much different. Although the production cycle of *P. monodon* has been closed since the late 1970s, there has been little effort to develop domesticated stocks until relatively recently. The continued availability of wild spawners and a relatively low efficiency of postlarval production from domesticated broodstock reduced the level of interest in breeding programs, especially among hatchery operators. Some private-sector projects were discontinued when the results failed to meet expectations and project costs exceeded planned budgets. In recent years, however, there has been renewed interest in domestication, and several projects have started with more planned for some of the other Asian countries. The future success of these projects will depend on continued investment and research to increase the efficiency of production of postlarvae.

Carrier exclusion

The large number of carriers, vectors and alternate hosts for some of the viruses mean that external sources of the virus in the farm environment can carry a significant risk of introducing infection (Flegel 1997). From farm observations in both Asia and Latin America, it appears that the large size of farms in Latin America may expose them to a greater risk from this source than is the case in Asia. The large size of Latin American farms also makes it far more difficult to introduce measures for control of carriers that have been developed for the smaller farm systems in Asia.

Chemical treatments have been used in several cases for the elimination or exclusion of carriers in commercial farm systems. Chlorine compounds have been used to eradicate carriers in Asia since its introduction as a measure to reduce the risk of infection with yellowhead virus. In Ecuador, the potential for aquatic insect larvae to transmit TSV to postlarvae was reduced through the use of a thin layer of diesel on the surface of nursery ponds (Griffith pers. comm.). This blocked the passage of air to the larvae, killing them without adversely affecting the shrimp. Insecticides have also been used to selectively eliminate crustacean carriers. The insecticide Sevin was used in Latin America to remove "ghost shrimp" in ponds at dry-out (Clifford 1992). This practice was initially used to prevent predation of postlarvae, but the use of Sevin has recently been aimed at killing carriers of WSV. In Asia, the insecticide Trichlorfon has been used to kill crustaceans and insect larvae prior to stocking ponds.

The large size of Latin American farms makes it very difficult and costly to implement some of the chemical treatments used in Asia. Also, the health and environmental implications of large-scale use of chlorine compounds and insecticides make these a less attractive and practical means of carrier control.

Filtration of incoming sea water through the use of fine-mesh filter bags has also been used to prevent the entry of carrier species into the system. Some work carried out by John Wigglesworth (pers. comm.) in Honduras suggests that a mesh size of 300 µm is sufficient to exclude the larvae of potential carriers. This would be a more practical option for large farm systems, through the use of selective screens at the entrance to the farm or individual ponds.

Small fences to prevent the movement of crabs between ponds and canals were widely used in Asia in the early stages of the YHV and WSSV epidemics. Although crabs have been shown to be capable of transmitting the disease to shrimp, experience in the past few years has indicated that this may not be a significant source of disease in Asia, and the use of crab fences has largely been discontinued. Although Latin American farms may be at more risk of carrier-mediated disease, the cost and logistics of using crab fences over hundreds or thousands of kilometers of pond levees make this an impractical proposal.

Water use strategies

The impact of viral diseases in Asia and the risk associated with high water exchange have led to a major change in water use strategies in shrimp farms. Prior to the outbreak of YHV, farmers were used to changing up to 30% of the pond water on a daily basis, with water exchange being used as one of the main strategies to ameliorate poor environmental conditions and their impact on shrimp health. Subsequent to the YHV outbreak the perceived risks associated with water exchange led to a marked reduction in exchange rates. This was further reinforced by the observation that heavy water exchange appeared to be a factor in provoking increased losses due to WSV. Farms started to reduce water exchange rates as much as possible, requiring greater attention to management of water quality parameters than was previously the case. Farms were re-engineered to include reservoirs for water storage and, in some cases, treatment and a few farms went so far as to adopt full water re-cycling (Fast and Menasveta 1998).

The cost of re-engineering to convert an existing farm, and the reduction in overall income due to the loss of productive farm area, make this option quite costly. Once again the larger size of shrimp farms in the Americas makes it extremely difficult to re-engineer existing farms, but some smaller farms have tried this and one new farm in Belize has been constructed to use only stored water during the crop (McIntosh 1999).

In Asia, water exchange or addition during the first two months after stocking was perceived as having a high risk of infecting the postlarvae. This was countered by avoiding water exchange for the first two months of culture. This led to some confusion initially, as farmers frequently misunderstood the intent and did not exchange water even when it was necessary due to deterioration of the pond water quality, particularly following crashes of the algal bloom or benthic algal mats. Losses then followed due to water quality problems rather than white spot disease. A similar confusion also occurred when the same strategy was introduced to Latin America.

There have been claims that cultivation in lower salinities carries a reduced risk of losses due to white spot virus. However, Chang et al. (1998) showed that salinity alone had no effect on the virulence or pathogenicity of the virus itself, suggesting that any impact is indirect. It is possible that acclimatization to lower salinities may reduce the stress associated with salinity reduction following heavy rainfall. The widespread belief that low-salinity ponds were less likely to be affected by WSV led to the development of brackishwater farming in low saline areas of Thailand. This resulted in considerable pressure from environmentalists, eventually forcing the government to pass a law banning the culture of shrimp in fresh water in many Thai provinces.

It is not clear exactly how successful these measures have been in preventing disease outbreaks or reducing their impact but there are other benefits that accrue from their use that make these useful as a component of a best management practice.

Cultivation strategies

Changes in stocking strategy have been widely implemented as a response to viral and other disease outbreaks. In the initial stages of a disease outbreak, it is quite common for farmers to increase stocking densities on the assumption that survival rates will remain constant and thus yields will be maintained. This has worked successfully for some diseases such as Taura syndrome, where production levels were maintained following TSV-associated losses in the early months of cultivation. It is important to consider the time of the expected mortality since, if it occurs continuously or later in the cycle, feed and other costs may not be covered. For many diseases, however, this type of strategy does not confer any advantage, and farmers will often reduce stocking densities to reduce their economic exposure in the event of losses.

Economic considerations also lead many farms to close, either temporarily or permanently. Temporary closure of farms as a “crop holiday” was advocated in India during the early stages of the WSSV epidemic. This response was largely initiated by the Marine Products Export Development Agency (MPEDA,) who recommended the “crop holiday”, or moratorium on stocking, in an attempt to let the virus die out through a lack of available hosts. Although some success was claimed for this approach, it is unlikely to have had much direct impact given the wide range of wild crustaceans capable of carrying or harboring the disease and the likelihood of subsequent re-infection through infected postlarvae. Despite this, Mohan and Basavarajappa (2000) claim the approach failed to prevent further outbreaks as a result of farmers failing to comply with the voluntary moratorium.

The strong seasonality in losses caused by the major viruses in Asia have also resulted in changes in the overall cultivation strategies employed by farmers. Cultivation during the rainy season carries a much higher risk of crop loss than dry-season culture. The reasons for this are not well understood, but appear to be associated with rapid changes in water quality following heavy downpours. Farmers have changed their cultivation strategy to avoid the rainy season, either by closing down for an extended period, or avoiding stocking in the high-risk months. There has also been a tendency to decrease the time for the culture cycle, harvesting smaller-size shrimp. This has had an impact on international trade in shrimp, with a change in the size availability *of P. monodon* from farms as farmers harvest smaller shrimp.

Others

Treatments for viral diseases

The value of a shrimp crop and the extent of losses due to a viral disease has led to a massive increase in commercial products sold to farmers to prevent or ameliorate the impact of the viruses. Among the types of products available are:

- immune stimulants
- "vaccines" or "tolerines"
- nutritional supplements
- vitamin mixes
- fruit/vegetable extracts

To date, little clear evidence exists on their effectiveness against disease, either in the laboratory or field situation, although there is a high market acceptance of such products. Field information is often confusing and difficult to interpret due to the lack of sufficiently rigorous trials and the difficulty of obtaining sufficient replicates to establish statistical significance. Despite this, farmers are willing to pay for such products given the potential cost-benefits should they reduce disease losses. As an example, at the time of the yellowhead outbreak, Thai farmers were asked how much they would be willing to spend to try out a product that offered the potential to improve their yield but without any guarantee of success. The average amount per pond per crop was approximately US$750. Extrapolating this to the whole country, this would represent an annual market of close to US$100 million to try out potential solutions.

Recently, some compounds have been identified that do appear to have a direct impact on the virus and its pathogenicity, at least in the laboratory. One such compound is fucoidan, an extract from Japanese brown algae which has been shown to be able to inactivate fish and shrimp viruses (Takahashi *et al.* 1998). The cost of fucoidan, however, is still too high for treatment to be a commercially viable option, although some companies in Latin America are using it in field trials. Itami *et al.* (1998) also showed in laboratory trials that oral administration of peptidoglycan from *Bifidobacterium thremophilum* as an immune stimulant was effective in preventing white spot disease in *P. japonicus.*

There has also been some indication that some plant or algal extracts from may be effective against virus, although the quantities required are impractical for use in the field (Direkbusarakom *et al*. 1995, 1997). In these cases, further work is needed to identify the active compound(s) and try to produce these more cheaply.

8.8.3 Outbreak strategies

Slaughter

Slaughter of stocks to eliminate disease is a drastic step. It is an expensive decision and is only taken when absolutely necessary. A policy of slaughter is justified when the speed and consequences of a virulent disease spreading are high. The slaughter of shrimp in the first ponds showing mortality due to yellowhead virus in some farms in Thailand was one of the strategies use in its containment. This use was justified due to apparently rapid spread of the virus between ponds, and there were some indications that it was partially successful in restricting the spread of the disease. In order to reduce the potential for error in taking such a drastic decision, it was necessary to develop some rapid diagnostic tests to confirm the mortality was due to YHV. The high cost of a slaughter strategy, and problems with its implementation, however, restricted its usefulness and, given current knowledge of the disease, it may not be economically justifiable.

Emergency harvest

Where shrimp stocks in a pond have a market value and the potential for rapid mortality is high, the best course of action may to reduce the losses by harvesting as quickly as possible. Some problems are so serious that additional delays in attempting treatment simply waste time and result in higher losses. Rapid diagnosis and decision making are essential to keep financial, if not stock losses to a minimum. Treatments that slow down mortality rates should not be considered as solving the problem, but as simply buying time to allow the farmer to find a buyer for his stocks. Emergency harvest is a commonly used strategy in dealing with virus disease losses.

8.8.4 Treatments

Development of eradication protocols

Dixon and Dorado (1997) describe a program designed to manage Taura syndrome virus in a shrimp farm in Belize. This incorporated two elements, an eradication program and a prevention program. The eradication program was implemented after harvesting all infected ponds and consisted of pond dry-out and disinfection, farm disinfection and insecticide spraying. Pond dry-out and tilling of topsoil allows oxidization of the soil and exposes any virus on the soil surface to UV rays in the sunlight. The ponds were disinfected using a strong chlorine solution (to provide a minimum free chlorine residual of 10 ppm, Bell and Lightner 1992), followed by liming and application of insecticides to kill any insects and crustaceans.

Farm disinfection consisted of treating all production areas, reservoirs and water canals with rotenone and chlorine to eradicate all potential carriers of disease. The ancillary facilities (processing plant, office building, maintenance and feed storage buildings were also disinfected based on recommendations from Bell and Lightner (1992). This involved a total clean up of the farm facilities and the use of various disinfecting regimes to disinfect all surfaces, including vehicles. This was followed by the development of a comprehensive health management program to be followed during subsequent crops.

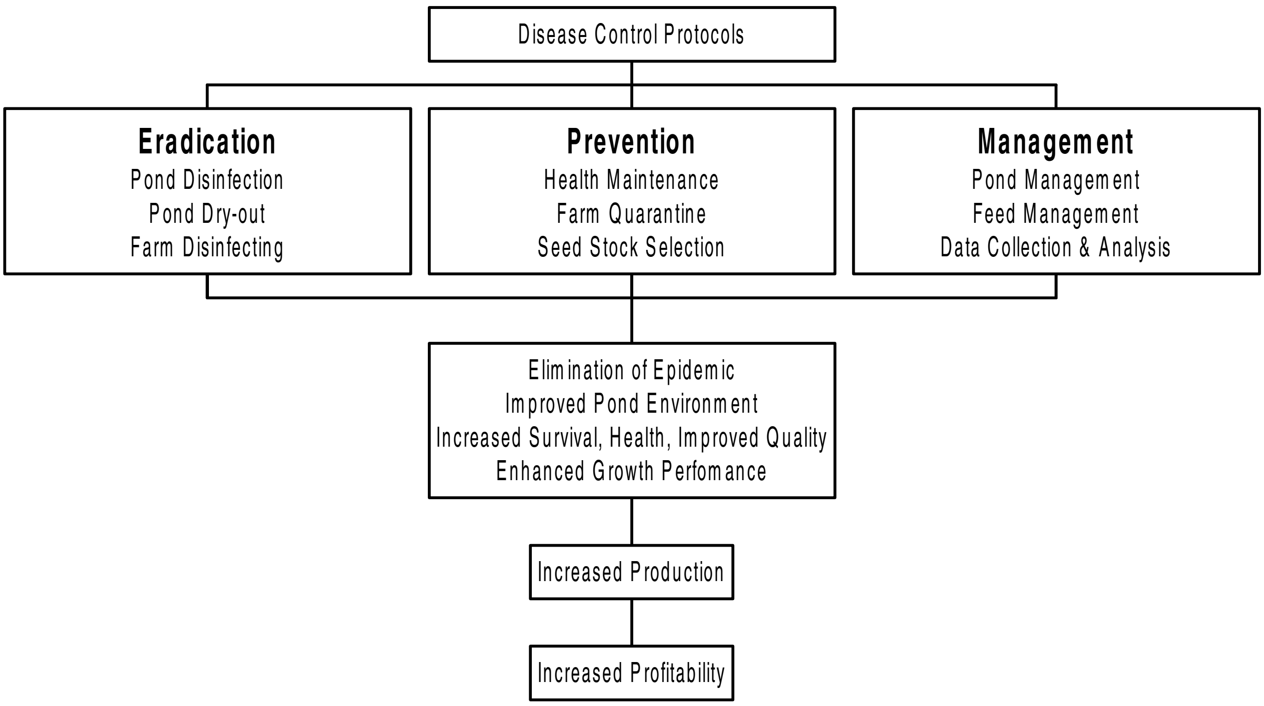

Figure 1: Integrated components of successful disease control protocols (based on Dixon and Dorado 1997)

8.8.5 Constraints

Lack of information to provide a realistic evaluation of relative risk

Risk assessments are a key component of any epidemiological investigation of a disease outbreak and development of appropriate management strategies. Unfortunately, the application of epidemiological principles, common in veterinary practice and livestock health management, is in its infancy in aquaculture. This stems from aquaculture's development as a fishery, rather than an agricultural, discipline in which veterinary science and epidemiology are not commonly considered. It is only since we adopted a greater involvement of epidemiological expertise and principles, however, that we have been able to develop a better understanding of how the disease spreads through the farms rather than how it affects the individual shrimp. This uses a common-sense approach that allows for a better understanding of the risks associated with a particular source of infection or combination of circumstances than is possible with traditional, laboratory-based disease investigations.

Lack of specific contingency plans to deal with exotic disease

The appearance and rapid spread of white spot syndrome virus in the Americas emphasizes the importance of keeping abreast of developments in all areas of the world, taking appropriate precautions and developing contingency plans in the event of an outbreak. In the case of WSSV for example, it appears that the threat from the virus in Latin America was not considered significant, despite the fact that it had been in the Americas since 1995 and that the possibility of its spread through wild populations could not be discounted. The detection of the virus in Panama in early 1999 came too late to prevent possible transfer of virus through live shrimp shipments. However, the fact that it could be detected in wild populations of shrimp indicates that it had been in the wild population for some time, a hypothesis which is supported by its detection in wild crustacean populations over a wide area of the continent within a few months of its initial detection. A contingency plan based on experience from Asia at that time might have limited the spread of the disease in the Americas. The more recent outbreak of Taura syndrome virus in Chinese Taipei in stocks of imported *P. vannamei* and the lack of a specific plan for its prevention and control provides clear evidence that the same is also true of Asian farmers. Thus, it is important to emphasize the need for greater communication between farmers and researchers in both regions to avoid or reduce the impact of future diseases which may spread between the continents.

8.9 Recommendations

The following recommendations related to legislation, policy and planning were made at the regional workshop held in Cebu, Philippines, and are presented for further discussion by the Working Group and possible elaboration of means for implementation:

Recommendations arising from Latin America

- For some countries, formulate laws designed to allow the industry to import PL and nauplii in a manner that will reduce risk of disease spread.
- Achieve better co-ordination between government and the private sector in the implementation of action plans.
- For some countries, establish "micro-regions" for effective application of control methods.
- Emphasize the use of HACCP in farms.
- Define protocols for actions which are obligatory.
- Apply biosecurity principles widely.

Recommendations Arising from Asia

- Increase interaction between planners, policy makers and industry to discuss strategies and options for practical approaches to sustainable shrimp farming.
- For some countries, formulate national policies recognizing the role of shrimp farming as a contributor to economic development.
- For some countries, formulate plans for sustainable development of coastal aquaculture, focussing on comprehensive health management strategies for shrimp farming.
- Establish policies that are relevant to the development of environmentally friendly shrimp farming.
- For some countries, provide financial assistance to help farmers recover from catastrophic losses to speed up the recovery of the farming sector.
- Develop disease control programs based on "holistic," systems-wide approaches that incorporate innovations to correct problems in the environment, animal and pathogen.

- Review accepted and tested basic principles of shrimp culture to formulate effective disease prevention strategies that take full advantage of the benefits accorded by existing disease prevention strategies and those offered by new technologies.
- Develop national contingency plans for aquatic animal disease outbreaks.
- Develop codes of "best practices" for industry self-management, based on the FAO *Code of Conduct for Responsible Fisheries* and similar guidelines on aquaculture development.
- For some countries, enforce coastal area management regulations that are relevant to shrimp culture, including increased monitoring and law enforcement to maintain environmental quality, developing law authority capacity, extensive dissemination of information on laws and regulations to local communities; increased effectiveness, co-ordination and integration of law enforcement; improving and completing regulations, and encouraging community capability and awareness in implementing regulations.
- Develop improved legal frameworks, monitoring systems and enforcement capabilities for effective regulation to control expansion of shrimp farming, observe proper siting and prevent environmental impacts and self-pollution.
- For some countries, examine critically the current approval process for shrimp farms.

Recommendations arising from the Working Groups

- Develop national strategies (master plans) for animal health in harmony with regional guidelines and policies. Government, industry and other stakeholders should be linked. Where regional guidelines do not exist, they should be developed using appropriate existing guidelines, which may need to be adapted to local/national situations, as models.
- Develop and promote codes of practice/conduct, as appropriate.
- Develop government infrastructure and industry liaison, as required, to manage, share experience, develop policy, promote awareness and identify expertise in relation to control, prevention and eradication of diseases.

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9 Summary of main findings and recommendations from the Cebu workshop

An expert workshop to prepare a "Thematic Review on Management Strategies for Major Diseases in Shrimp Aquaculture" was held in Cebu, Philippines from 28 – 30 November 1999. The Expert Workshop is one component of the WB/NACA/WWF/FAO Program on Shrimp Farming and the Environment, which seeks to promote sustainable shrimp culture thorough implementation of the FAO's *Code of Conduct for Responsible Fisheries* (CCFR). To set the tone for the workshop, four broad thematic reviews were presented dealing with aspects of introductions and transfers of aquatic animals. These included (i) a presentation on the issues surrounding trans-boundary pathogen spread with the movements of fish and shellfish; (ii) a paper dealing with industry perspectives with regard disease outbreaks; (iii) a review of knowledge and experience in trans-boundary movement of aquatic animal pathogens: the roots, impacts and implications for aquaculture and aquatic biodiversity, and options and interventions available for mitigation; and (iv) a presentation on species introductions, international conventions and biodiversity impacts, and the associated prospects and challenges.

During the workshop, participants from 15 countries (5 from Latin America and 10 from Asia) presented reviews on the history and current national status of major shrimp diseases, including their socio-economic impacts and an evaluation of the successes and failures of state and private sector interventions intended to solve them. The countries represented included Equador, Honduras, Nicaragua, Panama, and Peru; and Australia, Bangladesh, India, Indonesia, Malaysia, Philippines, P.R. China, Sri Lanka, Thailand and Vietnam. The report gives major recommendations arising from the Expert Workshop, laying groundwork for the Puerta Vallarta workshop. The detailed report of the workshop was provided to the participants in Puerto Vallarta, and is being published separately.

The following summarizes the main recommendations and general needs identified in the Summaries provided by (a) participants from the Latin American Region, and (b) from the Asian Region, and (c) the recommendations of regional significance given in the reports of the four workshop discussion groups.

A. Recommendations for the Latin American Region:

I. Infrastructure, Capacity Building and Training

- Promote education to increase farmer's awareness of disease and its prevention.
- Implement routine surveillance for current and emerging diseases.
- Increase the number of trained epidemiologists working on shrimp diseases.
- Increase the capacity of animal health and aquaculture staff in aquatic health.
- Fund and encourage industry to develop diagnostic capability, backed up by technology transfer, extension services, and increased research.
- Increase financial support to national governments to support the industry at the research and technical levels.
- Develop service and support organizations to co-ordinate extension services for industry.

II. Research and Development

- Develop effective treatments to deal with disease problems.
- For some countries, adjust management techniques, if not the entire production paradigm.
- For areas such as Central America, where climatological conditions are extremely variable, find new ways to insure minimum conditions in the water column.
- For some countries, develop monitoring programs for physico-chemical and biological characteristics to establish levels of contamination in the main estuaries used for shrimp culture.
- Define the main routes of viral transmission in the wild.
- Continue studies with local broodstock to close the reproductive cycle, reducing disease threats by replacing wild-caught spawners with domesticated (ideally, high health) stock through successful breeding programs.
- Establish programs for shrimp gene banks.
- Establish quarantine units for broodstock and PL.

III. Legislation, Policy and Planning

- For some countries, formulate laws designed to allow the industry to import PL and nauplii in a manner that will reduce risk of disease spread.
- Achieve better co-ordination between government and the private sector in the implementation of action plans.
- For some countries, establish "micro-regions" for effective application of control methods.
- Emphasize the use of HACCP in farms.
- Define protocols for actions which are obligatory.
- Apply biosecurity principles widely.

IV. Regional and International Co-operation

- Establish regional programs for disease surveillance and contingency planning.
- Establish a regional network of reference diagnostic laboratories to support health certification, within a standardized protocol.
- Establish R&D stations and local laboratories for disease diagnosis for countries lacking such facilities.
- Improve communication within the shrimp farming community so that vital management information can be rapidly disseminated.
- Establish an inter-regional newsletter, magazine or other communication system.
- Continue to build public awareness through workshops and lectures.
- Provide training and grants for personnel to attend courses.
- Sponsor expert interchange between countries.
- Establish a regional task force to determine the aetiology, epidemiology and treatment of new diseases, to develop strategies to control disease outbreaks and to improve farm biosecurity.
- Undertake co-operative research projects, such as the development of sustainable broodstock supplies for hatchery seed production and research on life histories and broodstock maturation in captivity.

B. Recommendations for the Asian Region

I. Infrastructure, Capacity Building and Training

- Establish laboratories in national lead centers for disease identification, and shrimp health laboratories in shrimp culture areas with modern equipment and trained manpower.
- For some countries, develop shrimp hatcheries to supply healthy PLs to farmers.
- Allocate necessary supplies, equipment, and travel required to assess shrimp health management status.
- For some countries, provide overseas and local training in shrimp health management and disease diagnostics.
- Provide training for extension specialists, farmers and hatchery operators.
- Enhance technical research and speed up extension of aquaculture disease prevention technology.
- For some countries, establish or strengthen quarantine systems to control the import and export of aquatic animals.
- For some countries, set up central databanks on all shrimp farms based on high resolution GIS system for effective regulation, industry self-assessment, monitoring and law enforcement.
- Organize shrimp farmer's associations to act as lobbying groups, articulating industry needs and providing a range of services to members.
- Improve information dissemination and increase pubic awareness through more effective use of newsletters and bulletins.

II. Research and Development

- Fund more intensive R&D programs to find ways to combat disease threats. Encourage increased public/private sector co-operation.
- Establish closed-cycle breeding programs to produce PL that are certified free of specified viruses (i.e., SPF) to improve disease security.

- Identify all potential viral pathogens and develop sensitive and specific tools for their detection.
- Conduct research leading towards farming systems which are most appropriate to national situations, whether intensive semi-closed farming systems using high quality SPF, domesticated and genetically selected stock (e.g., Australia) or extensive traditional systems (e.g., India).
- Establish programs to monitor aquatic environments in and around shrimp farming areas
- For some countries, evaluate the economic viability of alternative shrimp farming systems (e.g., low-salinity and freshwater culture systems).
- Expand technology obtained from current pilot projects.
- Assess shrimp culture production, including both small- and large-scale hatcheries, grow-out ponds, and production systems for hatchery, grow-out and pre-harvest.
- Identify shrimp health management programs, including aspects related to pond construction and irrigation systems, water quality management, feed and nutrition, disease and mortalities, disease control and health management, drugs and chemical treatment, and genetics.
- For some countries, assess national shrimp health management capabilities, including facilities at individual farms and hatcheries.
- Develop new rapid diagnostic methods for use by farmers and small laboratories.
- For some countries, conduct case studies on shrimp farming to analyze serious disease outbreaks and their socio-economic and environmental impacts.

III. Legislation, Policy and Planning

- Increase interaction between planners, policy makers and industry to discuss strategies and options for practical approaches to sustainable shrimp farming.
- For some countries, formulate national policies recognizing the role of shrimp farming as a contributor to economic development.
- For some countries, formulate plans for sustainable development of coastal aquaculture, focussing on comprehensive health management strategies for shrimp farming.
- Establish policies that are relevant to the development of environmentally friendly shrimp farming.
- For some countries, provide financial assistance to help farmers recover from catastrophic losses to speed up the recovery of the farming sector.
- Develop disease control programs based on "holistic," systems-wide approaches that incorporate innovations to correct problems in the environment, animal and pathogen.
- Review accepted and tested basic principles of shrimp culture to formulate effective disease prevention strategies that take full advantage of the benefits accorded by existing disease prevention strategies and those offered by new technologies.
- Develop national contingency plans for aquatic animal disease outbreaks.
- Develop codes of "best practices" for industry self-management, based on the FAO *Code of Conduct for Responsible Fisheries* and similar guidelines on aquaculture development.
- For some countries, enforce coastal area management regulations that are relevant to shrimp culture, including increased monitoring and law enforcement to maintain environmental quality, developing law authority capacity, extensive dissemination of information on laws and regulations to local communities; increased effectiveness, co-ordination and integration of law enforcement; improving and completing regulations, and encouraging community capability and awareness in implementing regulations.
- Develop improved legal frameworks, monitoring systems and enforcement capabilities for effective regulation to control expansion of shrimp farming, observe proper siting and prevent environmental impacts and self-pollution.
- For some countries, examine critically the current approval process for shrimp farms.

IV. Regional and International Co-operation

- Support information systems for research and training via a regional Shrimp Health Management unit in NACA.
- Link national diagnostics and disease control systems with other countries' networks.
- Establish a website for recent shrimp disease diagnostics and control measures, so that countries can immediately access needed information.
- Set up a regional disease information network and a timely disease reporting system.

- Strengthen co-operation among Asian countries on information exchange, policy and quarantine.
- Organize regional annual meetings and workshops on shrimp health management.
- Conduct collaborative projects among regional countries on various aspects of disease diagnosis and control.

C. Working Group Recommendations

The following section summarizes the major recommendations arising from the Working Group Discussions. More specific recommendations of a technical or highly specific nature can be found in the reports from individual working groups.

I. Recommendations to be Addressed by the APEC Meeting

- A comprehensive review of the data contained in the individual country reports presented at the Cebu Workshop should be undertaken to provide a more in-depth evaluation of country documents to support development and implementation of policy, legislation and regulatory frameworks at the up-coming regional meeting in Mexico.
- A comprehensive review of methods and strategies employed by the industry to combat disease outbreaks and reduce disease risks at the farm level should be prepared for the Mexico meeting.
- Given that some codes (e.g., the ICES/EIFAC code) call for the establishment of advisory bodies, the Mexico consultation may wish to examine the need to establish such a body.
- Sources of funding and technical assistance necessary to support quarantine activities and other environmental protection activities will become available provided a "responsible approach" is taken (e.g., via FAO, WB, GEF/CBD, etc.). Technical training in various areas will be required. The Mexico meeting should address ways to expedite this process.
- With regard to the small-scale sector, the APEC agenda should include an emphasis on:
  - The role and potential of small-scale shrimp aquaculture within a rural development perspective.
  - Addressing the implications of transboundary movements and health management issues for the small-scale sector.
  - Proposing an action plan that will give special attention to initiatives which support the small-scale sector, e.g., regional co-operation on information exchange, capacity building and other ways to reduce risk and improve delivery of health management programs to small-scale shrimp farmers.

II. Other Recommendations of Regional/International Significance

(i) Infrastructure, Capacity Building and Training

- Provide support for effective quarantine services.
- Provide support for laboratory capabilities, disease diagnosis and health certification. These activities should be consistent with regional quality control guidelines, i.e., standardization, nomenclature, technology transfer and monitoring/surveillance programs.
- Develop mechanisms for R&D support, including partnerships between government and industry.
- Increase capacity by providing support for training, technology transfer and support, and the institutions that offer them. This may include support from industry and other donors, such as international organizations.
- Promote training in the epidemiology of major shrimp diseases to improve awareness and develop practical health management schemes at the farm, national and regional levels.
- Emphasize education and awareness-building at all levels of the production chain. In particular, dissemination of information and training in hatchery production methods, the use of simple diagnostic methods for field use (e.g., rapid staining or dot blot methods), and basic methods of PL quality assessment are needed.
- Provide farmer and diagnostician training in the use and interpretation of diagnostic test results to avoid confusion, particularly for the more sensitive DNA-based methods.

(ii) Research and Development

There are many areas in which research is needed to support sustainable shrimp culture. The following areas were highlighted by the Working Groups:

- Develop treatment methods for live feeds to eliminate major pathogens without adversely affecting feed acceptability by broodstock.
- Develop epidemiological approaches to disease management.
- Develop simpler, faster, low-cost, pond-side diagnostics for real-time decision making.
- Evaluate the specificity of existing diagnostic tests to ensure accuracy of diagnostic interpretations, improve reliability and ensure appropriate coverage of all potentially pathogenic strains.
- Evaluate current methods of water treatment for their worth and effectiveness in reducing disease risk.
- Develop simple and cost-effective means of reducing exposure to land-based carriers of disease.
- Develop more information on the relative risk associated with farm practices, such as the use of equipment in several ponds.
- Evaluate the effectiveness of "green water" culture strategies to reduce the impact of disease outbreaks.
- Develop appropriate polyculture strategies to reduce disease transmission within the pond.
- Standardize and cross-validate tests between laboratories, as recommended by the expert consultation on DNA-based diagnostics.

(iii) Legislation, Policy and Planning

- Develop national strategies (master plans) for animal health in harmony with regional guidelines and policies. Government, industry and other stakeholders should be linked. Where regional guidelines do not exist, they should be developed using appropriate existing guidelines, which may need to be adapted to local/national situations, as models.
- Develop and promote codes of practice/conduct, as appropriate.
- Develop government infrastructure and industry liaison, as required, to manage, share experience, develop policy, promote awareness and identify expertise in relation to control, prevention and eradication of diseases.

Inter-regional Co-operation

- Give priority to collaboration between the Latin American and Asian regions.
- Support continued development of AAPQIS-Asia and initiate development of a similar information system, AAPQIS-Latina (Mexico, Central and South America).
- Recognize that some codes of practice and similar initiatives are mechanisms for interregional collaboration and development. Codes of practice requiring acquisition of broodstock from low prevalence or disease-free regions or zones are needed.
- Examine the applicability of the FAO/NACA guidelines to Central and South America.
- Develop plans for controlling important diseases on a regional basis
- Develop accreditation schemes for laboratories and promote participation in quality assurance programs to achieve uniform testing capabilities and standards.
- Exchange information on opportunities for small-scale livelihood focussed development among countries. Successful experiences and priorities to support the small-scale sector should be discussed both regionally and inter-regionally.

III. Recommendations for the Control of Trans-boundary Moment of Shrimp Pathogens

The following are specific recommendations made by the Working Group for the Control of Trans-boundary Movement of Shrimp Pathogens:

- Quality assurance programs (HACCP) are considered the best strategies for immediate incorporation into the procedures manuals for hatcheries, farms and processors. The greatest impact is at the hatchery level and therefore, the greatest emphasis should be placed on implementation of programs aimed at quality assurance with regards to broodstock, nauplii and PL.
- A Quality Assurance Program for diagnostic labs is needed to insure that they are useful tools in the control of disease transmission. Standardization of techniques and training of personnel in molecular biology are the most immediate needs, however, training in all areas of pathology and a general standardization of techniques are recommended.

- There should be a continuous process of development of Codes of Conduct and Codes of Practice based on the FAO *Code of Conduct for Responsible Fisheries*, Chapter IX Aquaculture. The most logical sequence would be the low cost development and implementation of Codes of Conduct which serve to raise levels of awareness. Further development would lead to the design and implementation of Codes of Practice beginning with self-evaluation but leading eventually to externally audited codes. The latter would potentially have greater impact but would require more time and money to implement.
- National reference pathology labs should be established to assure the quality of the local private labs in any country. These national reference labs would work with regional reference labs, if available, and with the existing OIE reference laboratories.
- Import Risk Analysis (IRA) appears to be an important tool in the control of disease transmission, but it is expensive and more difficult to implement than several of the other measures. Work should be initiated to define criteria, trade issues and regional or inter-regional issues related to IRAs now in order to permit their harmonization across countries and regions and their implementation at the earliest possible opportunity. Workshops should be held to train officials in the concepts of the IRA process, monitoring and contingency planning.
- Environmental Impact Assessments (EIA) are good tools for the prevention of disease. EIAs should directly address disease transmission issues, especially when considering the source of broodstock, nauplii and postlarval shrimp. Countries that do not currently require EIAs for hatcheries or shrimp grow-out installations should require them.

10 Annexes

10.1 Annex 1: Workshop program

DATE	TIME	ACTIVITY
24 July	0830 - 0900	**Workshop registration**
	0900 – 0930	**Session I** – Opening ceremony Lic Francisco Mayorga, Secretario de Desarrollo Agropecuario del Gobierno del Estado de Jalisco. Lic Carlos Camacho Gaos, Subsecretario de Pesca, SEMARNAP Mr Stetson Tinkham, APEC Fisheries Working Group Dr Rohana Subasinghe, FAO Mr Hassanai Kongkeo, NACA Coordinator Dr Porfirio Alvarez Torres, Director General de Investigacion en Acuacultura, INP SEMARNAP Biol. Carlos Ramirez Martinez, Director General de Acuacultura, SEMARNAP Master of Ceremonies: Gabriel Martinez
	0930 – 1000	Coffee
	1000 - 1230	**Session II** – Overview and objectives Chairperson: Dr Rohana Subasinghe. Rapporteur: Dr Christina Chavez Sanchez
	1000 – 1020	Objectives and expected outcomes from the Expert Consultation - FWG 03/2000 Project Overseer **– Dr Ana Montero**
	1020 – 1050	An overview of FAO/NACA activities and regional, inter-regional, and international co-operation in trans-boundary aquatic animal disease control – **Dr Rohana Subasinghe (FAO) and Dr Melba Reantaso (NACA)**
	1050 – 1120	Review of existing knowledge on the social, economic and biological impacts of trans-boundary aquatic animal pathogen movement and their establishment - **Dr J. Richard Arthur (Project consultant, Canada)**
	1120 – 1220	Trans-boundary aquatic animal movement: compliance to international treaties and conventions (part 1): Two 30 minute presentations OIE – **Dr Barry Hill (CEFAS, UK)** CBD – **Dr Devin Bartley (FAO)**
	1120 – 1250	Cebu workshop on Shrimp Health Management Strategies: the main conclusions and recommendations – **Dr Michael Phillips (NACA) and Dr Rohana Subasinghe (FAO)**
	1250 – 1400	Lunch
	1400 - 1730	**Session III** – Twenty-minute presentation by APEC economies and countries in Americas and Asia (see Annex II for instructions to presenters) Chairperson: Dr Porfirio Alvarez Torres. Rapporteur: Victoria Alday de Graindorge
	1400 - 1600	Belize, Colombia, Costa Rica, Cuba, El-Salvador, Peru
	1600- 1630	Coffee
	1630 – 1830	Ecuador, Guatemala , Honduras, Mexico, Panama, Venezuela

25 July	0830 – 0930	**Session III** – Continues
	0830 - 0930	United States of America
	0930 - 1030	Presentation of experts from Asian economies – Thailand, Asia Regional Technical Guidelines on Health Management for Responsible Movement of Live Aquatic Animals – **Dr Rohana Subasinghe and Dr Melba Reantaso**
	1030 - 1100	Coffee
	1100 - 1300	**Session IV** – Potential national, regional, inter-regional interventions, strategies, and co-operation Chairperson: Stetson Tinkham. Rapporteur: Melba Reantaso
	1100 - 1145	Private sector management and technological requirements for shrimp disease control (covering both the 'industrial' and small-scale livelihood sector) – **Mr Daniel Fegan (Project consultant, Thailand)**
	1145 - 1230	Policy, legal and institutional requirements for trans-boundary aquatic animal disease control and management – **Dr Richard Arthur (Project consultant, Canada), Dr Rohana Subasinghe (FAO) and Dr Melba Reantaso (NACA)**
	1230 –1300	Discussion
	1300 - 1430	Lunch
	1430 - 1500	Trans-boundary aquatic animal movement: compliance to international treaties and conventions (part 2): WTO – **Dr Alejandro Thiermann (USDA/APHIS, USA)**
	1500 – 1530	An overview of shrimp viral diseases, their distribution and impacts, with an emphasis on the current situation in the Americas – **Dr Victoria Alday de Graindorge (Ecuador)**
	1530 –1600	Regional and international activities and future requirements for standardization/harmonization of diagnostic techniques for aquatic animal diseases identification and control – **Dr Peter Walker (CSIRO, Australia)**
	1600 - 1630	Trans-boundary movement of aquatic animals: applying risk assessment for reducing transfer of pathogens– **Dr Alejandro Thiermann (USDA/APHIS, USA)**
	1630 – 1700	Regional and inter-regional cooperation requirements for aquatic animal disease control, with emphasis on opportunities for inter-regional co-operation in the Americas and APEC/Asia-Pacific region – **Dr Michael Phillips (NACA) and Dr Rohana Subasinghe (FAO)**
	1700 – 1730	Discussion
	1730 - 1745	Introduction and presentation of guidelines for Working Groups
26 July	0830 – 1730	**Session V** – Working group discussions
27 July	0830 - 1000	**Session V** – Continues
	1000 - 1030	Coffee
	1030 – 1245	**Session V** – Continues
	1245 – 1400	Lunch
	1400 – 1530	**Session VI** – Presentation of working group draft findings Chairperson: Dr Michael Phillips. Rapporteur: Dr Rohana Subasinghe
		Working Group I plenary presentation and 15 minute discussion
		Working Group II plenary presentation and 15 minute discussion
		Working Group III plenary presentation and 15 minute discussion
	1530 – 1600	Coffee
	1600 - 1730	**Session VI** – Plenary discussions continued

28 July	0800 - 1530	Field trip (and preparation of workshop report by Secretariat)
	1530 - 1600	Coffee
	1600 - 1645	**Session VII** – Presentation and adoption of the workshop report in plenary Chairperson: Dr Carlos Ramirez Martinez. Rapporteur: Dr Melba Reantaso
	1645 – 1730	Discussion
	1730 – 1800	**Session VIII** – Closing ceremony
	2000 – 2300	Dinner

10.2 Annex 2: Workshop participants

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10.3 Annex 3: Revised APEC Fisheries Working Group mandate

FISHERIES WORKING GROUP (FWG)'s Goal:

To optimise the economic benefits from, and the sustainability of, all aquatic organisms for the common benefit of all APEC members.

10.3.1 Terms of Reference

1. **To promote conservation, management and sustainable utilisation of fisheries resources.**
   This work will involve:
   - technical workshops to facilitate information exchange, analysis and technological advice, policy development and formulation of recommendations
   - working more closely with the Marine Resource Conservation Working Group
   - implementing on a regional basis broader global initiatives and selected voluntary commitments such as those arising from the work of the FAO.

2. **To assist APEC in enabling economies to reap the benefits of trade and investment liberalisation.**
   This work will involve:
   - being active in the implementation of the APEC Early Voluntary Sectoral Liberalisation (EVSL) proposal for the fish sector
   - undertake and promote sector specific work relating to trade and investment liberalisation and facilitation.

3. **To assist APEC in broadening its outreach to the business community and increase the involvement of business in APEC's development activities**
   This work will involve:
   - utilising existing business and regulatory bodies to deliver change to the APEC process
   - increasing industry involvement in all APEC and FWG activities
   - taking a leading role in collaborating with other regional organisations and agencies within the Asia-Pacific region to progress the FWG work program and broader APEC policy outcomes.

4. **To assist APEC's Economic and Technical Cooperation (ECOTECH) goals through activities relating to aquaculture, food safety and environment;**
   This work will involve:
   - promoting the sustainable and responsible management of both fisheries resources and aquaculture
   - enhancing food safety and quality of fish and fisheries products
   - to continue to run the APEC Aquaculture Forum and technical workshops in areas such as fisheries management, environmental issues and trade,
   - develop a longer term aquaculture agenda
   - promote the role of FWG in regional fisheries management activities
   - continuing to implement food safety and HACCP training
   - promote research and technology for development of fisheries and aquaculture.

10.4 Annex 4: Terms of Reference for Working Groups

10.4.1 Objectives of the workshop

1. To ***review existing knowledge on impacts*** of trans-boundary aquatic animal pathogen movement and their establishment. Different pathways of pathogen transfer and the impact on aquaculture, rural livelihood, trade, aquatic biodiversity, and other potential sectors were evaluated.

2. To review ***management strategies*** to control impacts of aquatic animal diseases, with an emphasis on measures taken at ***government level*** and among the ***private sector***, including farmers, hatcheries, feed manufacturers and others, Special reference was given to the White Spot Syndrome Virus (WSSV) and Taura Syndrome Virus (TSV) problems as such diseases have contributed to significant economic losses within aquaculture industries in Asia and the Americas.

3. To identify and ***evaluate current and potential future management interventions*** at national, regional and international levels, with special reference to ongoing Asia-Pacific and international programs and potential cooperative mechanisms.

4. To review the existing knowledge on the ***standardization, validation and harmonization of diagnostic techniques*** for fish and shellfish diseases (with special reference to shrimp viral diseases), and making compatible, national and international standards and regulations.

To develop a ***program of action*** in order to make compatible the different standards for aquaculture health management, in particular shrimp.

10.4.2 Expected outputs of the workshop

The workshop is expected to compile the current technical knowledge on the subject, the prospects, challenges, considerations, and recommendations to reduce impacts of trans-boundary transfers of aquatic animal pathogens. The specific outcomes include:

- peer-reviewed technical document containing the technical papers presented to the workshop;
- consensus on short-, medium-, and long-term interventions and activities to minimize negative impacts on trans-boundary pathogen transfer;
- an action agenda incorporating the recommendations of the workshop, based on the knowledge gained during the workshop, to address the future regional and inter-regional needs and activities on aquatic animal health management;
- opportunities for managing identified risks in aquatic animal health through co-operation, between relevant APEC economies, other relevant countries in Asia and Americas, and appropriate national, regional and international agencies and organizations, through international and inter-regional co-operation;
- a platform for developing harmonized standards on aquatic animal health; and
- an ***Action Plan*** for achieving the above at national and regional levels.

10.4.3 Terms of reference for the Working Groups

Three working groups will be convened to develop an ***Action Plan*** on improving the regional standards and capacity on aquatic animal health management, including summaries and recommendations on specific subject areas. The working groups should examine the proposed FAO Regional Technical Co-operation Project concept and identify potential areas and activities to be considered within the project (see project concept paper). The working groups should take the advantage of recommendations and activities identified during Cebu Workshop in November 1999 and Bangkok DNA Workshop in February 1999 (reports available), The three working groups should address the following subjects.

Working Group 1:
Disease diagnostics, pathogen screening and certification procedures and protocols

Chairperson : Peter Walker, CSIRO, Australia
Rapporteurs : Victoria Alday de Graindorge, CENAIM, Ecuador
: Cristina Chavez Sanchez, CIAD, Mexico

- Examine the methodologies, protocols, and procedures currently used for detection of pathogens, diagnosis of diseases, screening and certification for pathogens.

- Evaluate the validity and effectiveness of such procedures and protocols. Where possible identify 'success' stories/good examples where effective procedures have been developed/followed.

- Analyze the information provided by the countries represented at the workshop and the information and recommendation from previous workshops (Cebu and Bangkok 1999) on the diagnostic procedures, etc.

- Using the expert knowledge and experience of the members of the Working Group 1, identify and develop basic principles of a national/regional diagnostic programme.

- Identify the areas requiring improvement, in terms of infrastructure needs, research, capacity building, training, etc., and make recommendations for incorporation in the ***Action Plan*** on possible activities, interventions and strategies for improving procedures and protocols (short-, medium-, and long-term) for detection, diagnosis, and screening of pathogens and certification for health, with an emphasis on eventual harmonization of procedures. The action plan recommendations should be directed towards:

    - Short, medium and long-term actions required at national, regional and inter-regional levels,
    - Recommendations to APEC, inter-regional co-operation
    - Recommendations for regional co-operation within Americas.
    - General recommendations on potential follow up actions to be implemented by the states, FAO, NACA, and OIE.

Working Group 2: Policies, legislation and regulatory frameworks relevant to movement of aquatic animals and animal pathogens.

Chairperson : Barry Hill , CEFAS/OIE, United Kingdom
Rapporteurs : Richard Arthur, Canada
: Luis Contreras, SEMARNAP, Mexico

- Evaluate the current situation from a national and regional perspective and identify possible model intervention strategies for reducing the risk of disease introduction and spread in shrimp aquaculture (current and future problems). This might include such issues as:
    - National policy decisions on transfers of post-larvae and broodstock.
    - Effectiveness of enforcement of restricted movement of post larvae and broodstock
    - Need for new rules, regulation, and legislation at he national and regional level.
    - Quarantine, health certification, zoning, risk analysis, contingency planning, genetic improvements, etc., etc. (development of National Strategies)
    - Training and capacity building within farmers, private sector and state sector personnel.
    - Institutional arrangements for supporting the private sector dealing with shrimp health problems.

- Evaluate the validity and effectiveness of various national policy decisions taken so far in the region to reduce the risk of disease transfer in shrimp aquaculture Where possible identify 'success' stories/good examples where effective procedures have been developed/followed.

- Analyze the information provided by the countries represented at the workshop and the information and recommendation from previous workshops (Cebu and Bangkok 1999) on the policy and regulatory issues.

- Using the expert knowledge and experience of the members of Working Group 2, identify and develop basic principles of an effective national/regional policy and regulatory framework.

- Identify the areas requiring improvement, in terms of infrastructure needs, research, capacity building, training, etc., and make recommendations for incorporation in the ***Action Plan*** on possible activities, interventions and strategies for improving national/regional policies and regulatory frameworks on trans-boundary aquatic animal pathogen movement. The action plan recommendations should be directed towards:

  - Short, medium and long-term actions required at national, regional and inter-regional levels,
  - Recommendations to APEC on inter-regional co-operation
  - Recommendations for regional co-operation within Americas.
  - General recommendations on potential follow up actions to be implemented by the states, FAO, NACA, and OIE.

Working Group 3: State- and Private-Sector participation in reducing the risk of trans-boundary movement of aquatic animal pathogens

Chairperson : Hector Corrales, ANDAH, Honduras
Rapporteurs : Daniel Fegan, Thailand
: Devin Bartley, FAO

- Identify the components of an effective state/private sector management framework, covering hatcheries, farms, giving consideration to
  - Risk analysis programmes and their role in disease control and health management
  - Quality assurance schemes
  - Codes of Conduct
  - Codes of Practice
  - ISO and HACCP approaches
  - Producer associations and organizations

- Review the current status, and evaluate the validity and effectiveness of various private sector decisions and co-operation attempts between the state- and the private-sector. Where possible identify 'success' stories/good examples where effective procedures have been developed/followed.

- Evaluate the issues needing attention to develop and effective co-operate mechanism.

- Analyze the information provided by the countries represented at the workshop and the information and recommendation from previous workshops (Cebu and Bangkok 1999) on private-sector participation, co-operation between the state and private-sector, etc., on reducing the risk of trans-boundary aquatic animal diseases.

- Identify the areas requiring improvement for developing effective state- and private-sector co-operate programme for reducing trans-boundary aquatic animal diseases, and make recommendations for incorporation in the ***Action Plan*** on possible activities, interventions and strategies. The action plan recommendations should be directed towards:

  - Short, medium and long-term actions required at national, regional and inter-regional levels,

- Recommendations to APEC, inter-regional co-operation
- Recommendations for regional co-operation within Americas.
- General recommendations on potential follow up actions to be implemented by the states, FAO, NACA, and OIE.

Working Group composition

WG I = Disease diagnosis and pathogen screening – **Room Cuvevos**
WG II = Policy, legislation and regulatory frameworks – **Room Anguino**
WG III= State/Private sector collaboration – **Room O'Gorman**

NO	NAME	COUNTRY	WG I CUEVOS	WG II ANGUINO	WG III O'GORMAN
1	**Peter Walker (Chairperson)**	Australia	**X**		
2	Beverly Wade	Belize		X	
3	Richard Arthur	Canada		X	
4	Consuelo Vazquez Diaz	Colombia		X	
5	Ricardo Gutierrez Vargas	Costa Rica		X	
6	Adela Prieto	Cuba	X		
7	Victoria Alday de Graindorge	Ecuador	X		
8	Franklin Ormaza Gonzalez	Ecuador		X	
9	Leonardo S. Maridueña	Ecuador			X
10	Maria Vargas De Marino	El Salvador		X	
11	Jorge Luis Morales	Guatemala			X
12	**Hector Corrales (Chairperson)**	Honduras			**X**
13	Lorenzo M. Juarez	Honduras			X
14	Luciano Grobet	Mexico	X		
15	Gaudencio Ortiz Navarro	Mexico		X	
16	Gabriel Martinez Gonzalez	Mexico			X
17	Maria Cristina Chavez Sanchez	Mexico	X		
18	Ana Roque	Mexico			X
19	Porfirio Alvarez Torres	Mexico			X
20	Margarita Hernandez Martinez	Mexico		X	
21	Victor Manuel Arriaga Haro	Mexico	X		
22	Leobardo Montoya Rodriguez	Mexico	X		
23	Marco Linne Unzueta Bustamante	Mexico	X		
24	Valente Velazquez Ordoñez	Mexico		X	
25	Cesar Ortega Santana	Mexico	X		
26	Leon Armando Alvidrez	Mexico	X		
27	Pablo Del Monte Luna	Mexico			X
28	Josefina Audelo Del Valle	Mexico			X
29	Ana Bertha Montero Rocha	Mexico			X
30	Luis Contreras Flores	Mexico		X	
31	Reynaldo Morales Rodriguez	Panama		X	
32	Victor Nishio	Peru		X	
34	Jorge Llanos Urbina	Peru	X		
33	Daniel F. Fegan	Thailand			X
36	Pornlerd Chanratchakool	Thailand			X
34	Hassanai Kongkeo	Thailand			X
35	Michael Phillipas	Thailand	X	X	X
36	Melba B. Reantaso	Thailand	X	X	X
37	**Barry Hill (Chairperson)**	UK		**X**	
38	Stetson Tinkham	USA		X	
39	Jeffrey M.Lotz	USA	X		
40	Alex Thiermann	USA		X	
41	Rodolfo Cadenas	Venezuela			X
42	Devin Bartley	FAO			X
43	Rohana P. Subasinghe	FAO	X	X	X

10.5 Annex 5: List of acronyms and abbreviations

AAHRI	Aquatic Animal Health Research Institute (DOF, Thailand)
AAPQIS	Aquatic Animal Pathogen and Quarantine Information System
ACIAR	Australian Centre for International Agricultural Research
ADB	Asian Development Bank
ACRICON	Association of shrimp farmers (Guatemala)
AFFA	Agriculture, Fisheries and Forestry of Australia
ALAQUA	Associacion Latinoamerifcano de Aquacultura
ANDAH	Association Nacional de Acuicultores de Honduras
APEC	Asia-Pacific Economic Cooperation
APHIS	Animal and Plant Health Inspection Service
AQIS	Australian Quarantine Inspection Service
AusAID	Australian Agency for International Development
BIOTEC	Thai National Center for Genetic Engineering and Biotechnology
BKD	Bacterial kidney disease
BMN	Baculoviral midgut gland necrosis
BMNV	Baculoviral midgut gland necrosis virus
BP	Baculovirus penaei
CAMPAC	Camara de Pesca y Acuicultura
CBC	Convention on Biological Diversity
CCRF	Code of Conduct for Responsible Fisheries of FAO
CCV	Channel catfish virus
CCVD	Channel catfish virus disease
CEFAS	The Center for Environment, Fisheries and Aquaculture Science of UK
CENAIM	Centro Nacional de Investigaciones Marinos
CENDEPESCA	Centro de Desarollo Pesquero of El Salvador
CENTREX-BCR	Centro de Tramites de Exportacion, Banco Central de Reserva de El Salvador
CIAD- Mazatlan	
CIESA	Centro de Investigacion y Estudios Avanzados en Salud Animal of Mexico
COFI	Committee of Fisheries of FAO
CSIRO	Commonwealth Scientific International Research Organization
DIAS	FAO's Database of Introduced Aquatic Species
DFID	Department for International Development of the United Kingdom
DGSVA	Dirreccion General de Sanidad Vegetal y Animal of El Salvador
DOF	Department of Fisheries of Thailand
EAFP	European Association of Fish Pathologists
ECOTECH	APEC's Economic and Technical Cooperation
ECV	European catfish virus
EHN	Epizootic haematopoietic necrosis
EHNV	Epizootic haematopoietic necrosis virus
ESC	Enteric septicaemia of catfish
ESV	European sheatfish virus
EUS	Epizootic ulcerative syndrome
FAO	Food and Agriculture Organization of the United Nations
FAO/RLAC	FAO Regional Office for Latin America and the Carribean
FACOOPADES	Federacion de Cooperativas de Pescadores Artesanales de El Salvador
FHS/AFS	Fish Health Section of the Asian Fisheries Society
FHS/AFS	Fish Health Section of the American Fisheries Society

FIRBA	Fundacion de Investigacion de Recursos Bio Aquaticos
FWG	Fisheries Working Group of APEC
GAV	Gill associated virus
GMPs	Good Management Practices
HACCP	Hazard Analysis Critical Control Point
IICA	Inter-American Institute for Co-operation in Agriculture
ICES	International Council for Exploration of the Sea
IHHN	Infectious hypodermal and haematopoeitic necrosis
IHHNV	Infectious hypodermal and haematopoeitic necrosis virus
IICA	Inter-American Institute for Cooperation in Agriculture
INCOPESCA	Instituto Costarricense de Pesca y Acuacultura of Costa Rica
INPA	Instituto Nacional de Pesca y Acuicultura – National Institute of Fisheries and Aquaculture of Colombia
IMARPE	Peruvian Marine Research Institute
IPN	Infectious pancreatic necrosis
IPNV	Infectious pancreatic necrosis virus
IRA	Import Risk Analysis
ISA	Infectious salmon anaemia
ISAV	Infectious salmon anaemia virus
ITS	Instituto Technologico Pesquero del Peru
ITSON	Instituto Technologico de Sonora of Mexico
JSFP	Japanese Society of Fish Pathology
LAP	Laboratory for Aquaculture Pathology of Colombia
LOV	Lymphoid organ virus
MAGA	Ministerio de Agricultura Ganadenaria y Alimentacion of Guatemala
MBV	*Penaeus monodon*-type baculovirus
MSRDC	Marine Shrimp Research and Development Center of Thailand
MSRDI	Marine Shrimp Research and Development Institute of Thailand
NACA	Network of Aquaculture Centres in Asia-Pacific
NAHRL	National Aquatic Animal Health Reference Laboratory of Cuba
NIWA	National Institute of Water and Atmospheric Research of New Zealand
NHP	Necrotising hepatopancreatitis
NSTDA	National Science and Technology Development Agency of Thailand
OIE	Office International des Epizooties
OIRSA	Organismo International Regional de Sanidad Agropecuaria of
OMV	*Oncorhynchus masou* virus
PCR	Polymerase chain reaction
RSIVD	Red sea bream iridoviral disease
RSIV	Red sea bream iridovirus
SARPA	Servicio Autonomo de los Recursos Pesqueros y Acuicola of Venezuela
SCRD	Shrimp Culture Research and Development Company
SEAFDEC-AQD	Southeast Asian Fisheries Development Center – Aquaculture Department
SEMARNAP	Secretario de Medio Ambiente Recursos Naturales y Pesca of Mexico
SEMBV	Systemic ectodermal and mesodermal baculovirus
SJNNV	Striped jack nervous necrosis virus
SICA-OSPESCA	Secretaria de Integracion Centroamericana- Oficina Sectorial de Pesca y Acuicultura of Cuba
SIV	White sturgeon iridoviral disease
SMV	Spawner-isolated mortality virus
SPS Agreement	Agreement of Sanitary and Phytosanitary Measures
SVCV	Spring viremia of carp virus
TAADs	Trans-boundary Aquatic Animal Diseases

TSV	Taura Syndrome Virus
USAID	United States Agency for International Development
VHS	Viral haemorrhagic septicaemia
VHSV	Viral haemorrhagic septicaemia virus
WB	World Bank
WSD	White Spot Disease
WSIV	White sturgeon iridovirus
WSSV	White Spot Syndrome Virus
WTO	World Trade Organization
WWF	World Wide Fund for Nature
YHV	Yellow Head Virus

TRANS-BOUNDARY AQUATIC ANIMAL PATHOGEN TRANSFER AND THE DEVELOPMENT OF HARMONIZED STANDARDS ON AQUACULTURE HEALTH MANAGEMENT (FWG 03/2000)

REPORT OF THE JOINT APEC/FAO/NACA/SEMARNAP WORKSHOP

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