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Expert Group Workshop on Transboundary Aquatic Animal Health issues in the Bay of Bengal

Report of the workshop
Jasmine Executive Suites Hotel, Bangkok, Thailand
12-13 January 2012
Prepared by the NACA Secretariat
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1. Rationale

The Bay of Bengal Large Marine Ecosystem (BOBLME) Project is a 5 year initiative involving Bangladesh, India, Indonesia, Malaysia, Maldives, Myanmar, Sri Lanka and Thailand that aims to better the lives of the coastal populations through improved regional management of the Bay of Bengal environment and its fisheries. The Project is funded principally by the Global Environment Facility (GEF), Norway, Sweden, the Food and Agriculture Organization of the United Nations (FAO), and the National Oceanic and Atmospheric Administration of the USA.

One of the two major outputs of the BOBLME Project is to produce an agreed Transboundary Diagnostic Analysis (TDA) that identifies and prioritises the major transboundary environmental and fisheries concerns in the Bay of Bengal (BOB). This is a prequisite to the other major output expected from the Project - the Strategic Action Programme (SAP) that will address and remediate these concerns and will also ensure the long-term institutional and financial sustainability of the BOBLME Programme. The TDA is a scientific and technical assessment method through which the water-related environmental issues and problems of a region are identified and quantified, their causes analysed and their impacts - environmental, social and economic - assessed.

Finalisation of the TDA falls under Component 1.1 of the BOBLME Project. The objective of this Component is to build on the BOBLME’s existing draft Framework Transboundary Diagnostic Analysis (FTDA) and complete the Project’s TDA. This is accomplished through a series of reviews and thematic workshops, as well as in-country consultations.

The implementation of this Regional Expert Group Workshop responds to some concerns related to the shrimp (and fish) aquaculture sector, a major economic use of coastal zones of several BOB countries, in particular in the area of transboundary health. To date, the TDA document has not yet considered transboundary impacts (real or perceived) of aquatic animal movements and transfers. Hence, this workshop was conducted to address these issues (aquatic animal health and transfers/movements of aquatic animals/plants) with the following expected outputs:

- Gather materials/information required for a short chapter contribution to the “Transboundary Diagnostic Analysis” document of BOBLME.
- Workshop report that summarises the findings of the Regional Expert Group including relevant issues raised as well as recommendations.

2. Participation

The workshop was held for two days from 12-13 Jan 2012 at Jasmine Executive Suites hotel, Bangkok, Thailand. It was co-organised by BOBLME, FAO-RAP and NACA, and attended by 2 participants each from 8 BOBLME member countries, 9 experts (international and regional) and the NACA secretariat (Appendix I). Country participants for this workshop were selected and nominated by their respective governments. Experts, on the other hand, were invited based on their expertise’s relevance to the different panel discussions that were planned for this workshop.

The agenda for the meeting can be found in Appendix II

BOBLME Project is an organisation that lay the foundations for a coordinated programme of action designed to improve the lives of the coastal populations through improved regional management of the Bay of Bengal environment and its fisheries. It is composed of 8 member countries surrounding the BOB which have declared their willingness to work together through the Project. FAO-RAP is one of the regional offices of FAO worldwide, with a vision for a food-secure Asia and the Pacific region. Its mission is to help member countries halve the number of undernourished people in the region by 2015 by raising agricultural productivity and alleviating poverty while protecting the region’s natural resources base. NACA is an intergovernmental organisation that promotes rural development through sustainable aquaculture. It seeks
to improve rural income, increase food production and foreign exchange earnings and to diversify farm production.

3. Opening session

The workshop was formally opened by Dr Eduardo Leaño, Coordinator of Aquatic Animal Health Programme of NACA, on behalf of the organisers. Welcome remarks were given by Dr Ambekar Eknath (Director General of NACA), Dr Simon Funge-Smith (FAO-RAPI representative) and Dr Chris O’Brien (Coordinator of BOBLME Project), highlighting the objectives and expected outcomes of the workshop. Dr Eknath also emphasised the economic importance of BOBLME, and how the transboundary issues can cause problems in sustainable development of the aquaculture industry in the region. NACA’s achievements and roles in this regard were also presented. Dr Funge-Smith mentioned the Transboundary Diagnosis Analysis (TDA) as an effective tool to resolve regional issues, and that the discussion should not be limited to shrimps, but should also include other farmed species (marine fish, molluscs). Dr Chris O’Brien appreciated the work done by NACA and FAO-RAPI in putting together an excellent team of experts and participants from BOBLME countries to participate in the workshop and contribute to its objectives. He requested the workshop to deliberate all the relevant transboundary issues and then come with a transboundary diagnostic analysis similar to the other TDAs done under the project.

4. Background and Objectives

A brief background of the expert group workshop was presented by Dr Leaño. The three main areas that have been previously identified as TDA components include: 1) overexploitation of the marine living resources; 2) degradation of critical habitats (mangroves, coral reefs and seagrass); and 3) Pollution. Major issues, transboundary nature of the major issues, root causes and recommendations for these three main areas have already been completed through a series of national consultations. However, transboundary impacts (real or perceived) of aquatic animal movements and transfers have not been considered under these three main areas, in particular, the transboundary aquatic animal health issues.

This expert group workshop was therefore undertaken with the following objectives:

1. Discuss the threats and pathways of potential pathogen transfers into the BOBLME, based on the list of key issues/questions that will be undertaken during the workshop, using a risk assessment approach and process (e.g. pathogen risk analysis) looking at pathways of introduction, release assessment, spread and persistence, potential impact, and risk management;

2. Review relevant international, regional and national instruments that deal with the issues;

3. Review relevant information (including media releases) on the nature and extent of the issues in all countries of BOBLME; and

4. Provide recommendations as to what actions BOBLME and BOBLME countries should take to address the transboundary impacts of aquatic animal movements and transfers.

5. The BOBLME Project

Dr O’Brien presented an overview of the project summarising the TDA components that have been completed, as well as some gaps that are still needed to be addressed. Traversing eight countries (Bangladesh, India, Indonesia, Maldives, Malaysia, Myanmar, Sri Lanka and Thailand) with a total area of 6.2 million km², around 450 million people are affected by the different transboundary activities around the BOBLME. There are five assessment modules used to assess sustainable development in the BOBLME: 1) Pollution and ecosystem health; 2) Fish and fisheries; 3) Governance; 4) Socio-economics; and, 5) Productivity. With the three main areas previously identified as important components of TDA, the following areas of works have been identified:
• Identifying transboundary issues and their causes, and developing a plan to address them.
• Integrated coastal management.
• Policy harmonisation.
• Fisheries resource assessment and management.
• Critical habitat management.
• Ocean dynamics, productivity and climate change.
• Marine protected areas.
• Ecosystem health indicators.
• Land-based sources of pollution.
• Training and communications.

Transboundary issue is an issue that is shared by two or more countries and is best addressed by collaborative approaches between two or more countries, or an issue that is of broader global concern that requires all regions to contribute in solving such.

The history of BOBLME TDA was also briefly presented starting from the preliminary activities from February 2003 to October 2004, to the completion of national TDA consultations in 2011. As mentioned earlier, the TDA identified three major areas of concern, but there are other transboundary issues that were not dealt with, and this include aquatic animal health issues and their potential impacts resulting from the transfer and movement of aquatic animals in the BOBLME. Recommendations on how to address or mitigate these issues should be formulated in this workshop, looking into either short term or long term solutions, taking notes on the existing initiatives that have been undertaken in the past and present, and possible funding opportunities for follow-up programmes.

The next steps after this final consultation will be to review the updated TDA, finalisation of the TDA and subsequent adoption by the Project Steering Committee, and drafting of the SAP framework and a work plan for SAP completion.

6. Process of the workshop

The workshop was divided into two major sessions: Country Presentations; and Discussion of Major Transboundary Issues. In the first session, country participants presented a comprehensive but concise country reports on major transboundary and other related issues on aquatic animal health. This was followed by a general discussion to identify the major and common transboundary issues among the member countries. Summary of the outcome during this session was used as discussion starters on the succeeding topics for the second session.

The second session (Expert Panel Discussion) tackled in detail the identified transboundary issues as follows:

• **Expert Panel Discussion I: Threats and pathways of potential pathogen transfer into BOBLME countries.** Transboundary shrimp diseases (including OIE-listed and other exotic diseases of regional importance) and movement of aquatic animals, with focus on shrimps.

• **Expert Panel Discussion II: Conservation of wild shrimp stocks.** Exploitation of wild shrimp broodstock for mass larval production: impact on natural population and risk of disease spread.

• **Expert Panel Discussion III: Environmental impacts of aquaculture.** Degradation of coastal environments including mangroves and its impact on disease outbreaks and spread.

• **Expert Panel Discussion IV: New/Reintroduced species for aquaculture.** Introduction and escape of exotic species/Reintroduction of resident species from other regions and continents: spread of diseases and genetic diversity.

General recommendations were then formulated after the series of discussions, to summarise the assessments made on each major issue that were discussed. A general discussion wrapped-up the workshop, and provision of important inputs which will be included in the final report was facilitated.
7. Country Presentations

The eight BOBLME member countries made a short country presentation highlighting some of the transboundary issues related to aquatic animal health including movement and transfer of aquatic animals. Below are summaries of the presentations; please refer to Appendix III for complete reports.

**Bangladesh (presented by Dr Masud Khan):** There are no existing strict regulations on the importation of live ornamental fishes, thus these are being introduced into the country without passing any quarantine facilities. There are also problems in quarantine implementation including lack of: skilled personnel; diagnostic and quarantine infrastructures and facilities; knowledge on indigenous shrimp/fish fauna and potential fish/shrimp pathogens; legislations; adequate enforcement by government; communication among networks of experts; and, funding. With regard to shrimp culture regulations, the government has not decided yet to import *Litopenaeus vannamei* as further studies/assessment and quarantine are still needed.

**India (presented by Dr Neeraj Sood):** National strategies on aquatic animal health management are currently being implemented in the country. However, the country still experiences huge economic losses due to diseases and has to deal with other issues including: lack of proper methodology for estimating disease-related losses; lack of emergency preparedness; use of pond-reared non-SPF broodstock of *L. vannamei*; rejection of export consignments; inadequate biosecurity measures; and, illegal and unregulated movement of aquatic animals. Important shrimp diseases (e.g. WSSD and Monodon slow growth syndrome) are significantly affecting overall shrimp production, with estimated loss of Rs10.22 billion annually. Previously, *L. vannamei* was illegally introduced into the country, but at present, strict guidelines are in place for its culture and importation as TSV and IMNV are not yet reported in the country.

**Indonesia (presented by Dr Coco Kokarkin):** Country report focused on the current status of IMNV in Indonesia. Strengthened efforts to use only SPF seeds of *L. vannamei* are now in place in the country. Preventive measures were also formulated like double screening filters (300-1000 µm) to prevent entry of crabs, barnacles, mussel, copepod, rotifers, protozoa and algae which were found to be potential carriers of the virus. Other preventive measures include water disinfection with crustacide and calcium hypochlorite, optimum pond bottom preparation, and proper eradication of dead shrimps (pre- and post-harvest. Government regulation which is now in place is the listing of IMNV as Quarantine Fish Disease (Ministerial Decree No. 17/2006) that requires all transported shrimps free of IMNV, especially postlarvae (PLs) which are suspected to be the primary cause of disease spread and infection.

**Malaysia (presented by Mr Nummeran Mohd Nordin):** The current status of coastal shrimp and fish farming as well as documented diseases was presented. With regard to national strategies for aquatic animal health, strategic plans include: strengthening of legislations especially for importation of *L. vannamei* broodstock; enhancing import/export requirements in accordance with international and regional standards; disease surveillance for cultured shrimps/fish including ornamentals; strengthening of diagnostic capacities based on the recommended OIE methods and other international standards (e.g. ISO); and improving capacity building through international, regional and national training programs on aquatic animal health management. Despite of this, there is still a need to improve biosecurity to ensure the sustainability of marine fish and shrimp production. Competent Authorities should also strengthen enforcement of these legislations and ensure that biosecurity requirement is met.

**Maldives (presented by Dr Aminath Lubna):** As the aquaculture industry in the country is still in the developing stage, there are still no serious transboundary aquatic animal health issues. Current capacity of the country in this regard is also limited due to inadequate human resource, and non-existence of proper border quarantine facilities and disease diagnostic laboratories. There is an existing plant and animal quarantine facility at present, but needs significant improvement. On the legal frameworks, existing fisheries laws do not cover aquaculture and need revision to address the current issues of a more diversified fisheries sector. Aquaculture legislations are now being developed, as well as a project on establishment of aquatic animal quarantine facility.

**Myanmar (presented by Ms May Thandar Wint):** At present, The Republic of the Union of Myanmar has around 215,000 acres devoted for shrimp culture, and 3-4 private farms are trying experimental culture of...
L. vannamei in some parts of these areas. Groupers, snapper, seabass, mullet and milkfish are also cultured in Myanmar, with groupers, snapper and seabass commanding high market prices. Regarding transboundary aquatic animal health, Myanmar DOF (Department of Fisheries) has two laboratories under Aquatic Animal Health and Disease Control Section. The Section is responsible to conduct field survey diagnostics and assign officials at the airport, seaport and border trade areas to closely check and counter check exports and imports of aquatic animals.

**Sri Lanka (presented by Mr J.A. Saminda Lakmal):** Shrimp aquaculture developed rapidly on the Western and North Western coast of the country with P. monodon as the main cultured species. Now it is expanding to the Eastern and Northern coast also. Some aquaculture companies, however, requested the government to introduce L. vannamei into the country. As such, a risk analysis was undertaken by the government on a pilot scale, but no firm decision has been made up to the present. WSSV disease is the main factor which affects the shrimp industry at present. On national strategies for aquatic animal health management, prevention of transboundary fish disease through quarantine laws and legislations and rehabilitation of the shrimp farming industry through improved health management; implementation of better management practices (BMPs), PCR screening of brood stock and PLs, zoning of shrimp farming areas and implementation of a crop calendar were also undertaken by NAQDA and other relevant government agencies and non-government organisations.

**Thailand (presented by Ms Janejit Kongkumnerd):** Current shrimp diseases reported in the country are WSD, YHD, TS and IHHN. IMNV is still not reported and the Department of Fisheries (DOF) is strengthening the import regulations, monitoring and active surveillance to prevent the spread of the disease. National strategies for aquatic animal health management include strict implementation of laws and legislations (e.g. Fisheries Act 1947 [amended in 1953 and 1985]; Animal Epidemics Act BE2499; and Import and Export Control Acts BE2522), disease diagnostic laboratories and issuance of live aquatic animal health certificate. The DOF is also responsible for the quarantine of all aquatic animals (exported and imported). Currently, importation of P. vannamei from Indonesia is banned due to IMNV outbreaks. There is no established inspection program for blood cockles which are currently being imported into the country in large numbers.

### 8. General discussion on country reports

The above country reports were mostly focused on general aquaculture production and fisheries. This is of more importance in BOBLME which should be considered when discussing the impacts of aquaculture activities and movement/transfer of live aquatic animals. Aquaculture in general contributes to pollution and habitat destruction, but to what extent? Although information are available on how important pathogens/diseases are transferred from one country to another, less or no information is available on its impacts on wild fisheries and ecosystem health.

In summary, the following points are taken:

1. Almost every country has fairly upgraded regulations for addressing imports and movements of aquatic animals, although it’s a bit late as the damage has already been done (e.g. shrimp viruses);
2. In the past, many unregulated movements (illegal; smuggling) of aquatic animals (more on shrimp PLs and broodstock) facilitated the spread of diseases in the region;
3. At present, stronger awareness against risk paved way in the establishments of quarantine services, certifications and more regulated movement of live animals;
4. Species moved live include: groupers, blood cockles, abalone, seabass, ornamental species, shrimp species, mudcrab, cobia and lobsters. These species are moved between the countries of BOB, some moved out of BOB, or imported into BOB from other regions;
5. Presentation didn’t focus very much on the downstream impacts – potential effects on wild stocks and environment, genetic effects from escapees from aquaculture to wild, issues of effluents discharge from aquaculture.
In Indonesia, epidemiology awareness programmes among the private sectors are now being implemented, with regard to the IMNV and other shrimp viruses. There are also no evidence yet on the effect of diseases (of cultured animals) to wild populations, although the possibility is high considering the continuous movement of animals within the region, escape of cultured populations into the wild, and effluent discharge from aquaculture.

Governments should also be careful on the level different regulations and legislations imposed on shrimp/fish producers. The continuous reliance on bringing-in SPF animals into the country is not a good strategy at all. Countries should be able to develop their own SPF stocks for domestic use.

Some of the recommendations raised related to transboundary movement of aquatic animals are listing of aquaculture species being moved within the BOB countries and to/from other countries, quarantine procedures need to be standardised, and more guidance on IRA tools.

9. Expert Panel Discussions

Expert Panel Discussion 1: Threats and pathways of potential pathogen transfer into BOBLME countries. Transboundary shrimp diseases (including OIE-listed and other exotic diseases of regional importance) and movement of aquatic animals, with focus on shrimps and less on finfish and molluscs. Lead Experts: Prof. Timothy Flegel, Dr Melba B. Reantaso, Dr Le Van Khoa.

The discussion was guided by a set of questions using an informal risk analysis approach briefly discussing the potential hazards, the pathways for introduction in terms of release, spread and persistence and impacts and informed by the individual country presentations. Prof Tim Flegel also made a short presentation on important transboundary aquatic animal diseases affecting shrimp including WSSV, IMNV and IHNN.

Important issues/considerations generated from Expert Panel Discussion 1 include the following and Table 1:

- Movement of live shrimp for aquaculture presents the biggest risk; if carrying pathogens, the potential for these pathogens getting into the wild and being established in endemic species is high. There is no evidence that the disease will cause significant losses to the natural fishery. However, once present, the natural carriers will constitute a perpetual threat to aquaculture in terms of intermittent losses by mortality, slow growth or increased operation costs for prevention or treatment.

- Diseases in crustaceans are quite different from diseases of finfish in the sense that once they recover from a viral pathogen they usually remain infected, often for life without gross signs of disease. These are not latent infections but active at a low level and transmissible to naïve shrimp.

- The general desire for cultured shrimp is driven by the desire to culture species that grow fast and are highly tolerant to pathogens.
Table 1. Major issues identified during Expert Panel Discussion I.

<table>
<thead>
<tr>
<th>Major Issues</th>
<th>Transboundary Nature</th>
<th>Root Cause</th>
<th>Solutions/ Recommendations¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Import or spread of important pathogens of shrimp (e.g., IMNV, WSSV) fish</td>
<td>Present high risk of spread (except for WSSV which is already prevalent in native</td>
<td>Development of new species for aquaculture; shift in species cultured; general intensification and diversification of aquaculture</td>
<td>Promote and enhance awareness and advocacy on good health management practices; prevention and protection to be used as major lines of defense. List down countries producing SPF broodstock for aquaculture use in the region.</td>
</tr>
<tr>
<td>(e.g., VNN) and molluscs; Risks associated with bringing newly developed SPF</td>
<td>fish (e.g., VNN) and molluscs; Risks associated with bringing newly developed SPF</td>
<td>Risks associated with bringing newly developed SPF stocks into the region；Transfer of newly developed SPF stocks (especially those intended for use in other regions) into the BOB may become a source of new pathogens; emerging disease concerns</td>
<td></td>
</tr>
<tr>
<td>stocks into the region</td>
<td>stocks; Transfer of newly developed SPF stocks (especially those intended for use in</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>other regions) into the BOB may become a source of new pathogens; emerging disease</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>concerns</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

¹ A comprehensive National Strategy on Aquatic Animal Health prepared within the overall framework of an Aquaculture Strategy or Aquaculture Development Plan is a useful document that will contain the government’s short, medium- and long-term actions to deal with issues pertaining to aquatic animal health, and contains important elements such as national coordination, policy and legislation, pathogen list, diagnostics, health certification and quarantine, risk analysis, surveillance and reporting, emergency preparedness and contingency planning, research, regional and international cooperation, etc.
| Continuous importation of SPF stocks; Importation of non-SPF broodstock; Illegal movement of animals; movement of infected animals | Movement of asymptomatic shrimps might still carry the pathogen which can facilitate spread of pathogen/disease among countries in the region. Continuous movement of aquatic animals (e.g. importation of SPF stocks) present a continuous low risk in the spread of unknown pathogens in both cultured and wild stocks. | Development of new species for aquaculture; shift in species cultured; general intensification and diversification of aquaculture Misconception and misunderstanding on the concept and application of SPF stocks | For safe importation of aquatic animals, follow:
- Recommendations of ICES;
- ICES Code of Practice on the introductions and transfers of marine organisms 2003;
- Guidelines for movement of exotic organisms for aquaculture or for stocking in natural waters;
- For crustaceans, additional tests are required for the presence of cryptic viral pathogens.

Countries should develop their own SPF stocks to minimise continuous importation of broodstock. [possible regional collaboration programme on SPF shrimp development including harmonisation of accreditation for SPF – NACA]

Given that the risk of introducing unknown pathogens in SPF stocks is low, governments should implement measures for development of national SPF stocks gradually and avoid highly restrictive measures to avoid illegal importation of aquatic animals during the period before the national stocks are established; maintaining balance is important.
<table>
<thead>
<tr>
<th>Event</th>
<th>Risk</th>
<th>Lack of proper regulations on movement and transfer of ornamental fish and shrimps. Volume of shipments presents a challenge in terms of systematic evaluation of health status.</th>
<th>Risk analysis should be initiated; Communication of the possible threat.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unregulated movement of ornamental shrimps/fish</td>
<td>Risk is present if the animals are used for aquaculture purposes (mass production of ornamentals); Less or no risk if they will be used solely as ornamentals in aquaria.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transfer or movement of aquaculture products/materials for reprocessing</td>
<td>Risk of pathogen transfer into wild stocks</td>
<td>Lack of proper treatment prior to discharge of wastes into the aquatic environment</td>
<td>Improve capacity on risk analysis and devise effective risk reduction measures for handling processing wastes.</td>
</tr>
<tr>
<td>Use of imported fresh/frozen aquatic animals as feeds for aquaculture broodstock</td>
<td>These might carry potential pathogens that can infect broodstock</td>
<td>Need to obtain maximum reproductive potential of broodstock</td>
<td>Develop suitable replacements such as pasteurised feeds or dry-processed feeds</td>
</tr>
<tr>
<td>Misdiagnosis of pathogens</td>
<td>Misdiagnosis will affect the health status of a country and thus present a risk to trading activities between disease free and disease affected countries. Ineffective treatment and/or management thus compromise the health status of the animal.</td>
<td>Lack of diagnostic capability and awareness</td>
<td>Improve human resource capacity and infrastructure on aquatic animal health Collaborative program on disease diagnostics, harmonisation of diagnostic techniques; proficiency testing of laboratories</td>
</tr>
</tbody>
</table>
**Human pathways of disease spread: risk coming from small-scale farmers not practicing biosecurity and/or GAPs; small scale farmers using non-SPF stocks or using SPF stocks without biosecurity support; non-implementation of IRA recommendations; weak competence of Competent Authorities. Incorporate with other issues as appropriate.**

<table>
<thead>
<tr>
<th>People and products are constantly on the move; aquaculture is a truly globalised activity</th>
<th>Lack of information and/or awareness among small scale farmers on the risk associated with transfer/movement of aquatic animals, list of notifiable diseases, etc.</th>
<th>Undertake a systematic assessment on the impacts of shrimp diseases to aquaculture to include socio-economic analysis. Ensure commitment of governments for implementation of IRA recommendations. Systematic evaluation of aquatic animal health capacity and performance as basis for identifying strengths which can be maximised and gaps which need to be addressed. Focus efforts in assisting small-scale producers to improve farming practices</th>
</tr>
</thead>
<tbody>
<tr>
<td>As signatories to these agreements and by virtue of their memberships (both obligatory and voluntary), countries are responsible for their implementation</td>
<td>Countries may be signatory to these agreements but there may be lack of understanding and/or lack of resources for implementation. In some countries, although these agreements are integrated into national laws, there is lack of effective enforcement</td>
<td>Assist countries to facilitate compliance of to these standards and agreements through national strategies</td>
</tr>
<tr>
<td>Extreme weather events, e.g. flooding which may cause spread of pathogens. No specific example for shrimp disease but may be a possibility.</td>
<td>Impacts to aquaculture</td>
<td></td>
</tr>
</tbody>
</table>

**Expert Panel Discussion II: Conservation of wild shrimp stocks. Exploitation of wild shrimp broodstock for mass larval production: impact on natural population and risk of disease spread. Lead Experts: Dr Simon Funge-Smith and Dr Matthew Briggs**

This panel discussion put focus on the possible effect of cultured stocks (mainly shrimps) that are intentionally or accidentally released into the wild to the existing wild population. Despite the reported escape of *L. vannamei* from aquaculture facilities, there is still no documentation of its capture from...
fisheries operation, except from the report from Thailand (Senanan et al. 2009) but still no evidence of establishing population in the wild. In Malaysia, the re-stocking *P. monodon* in the wild was found to have genetic narrowing effect on wild population. Intensive re-stocking of swimming crab in Indonesia might result in the long-term impact on genetic diversity of the wild population.

The movement of marine animals (e.g. *P. monodon*, *L. vannamei*, seabass, groupers, sea cucumber and seaweeds) for aquaculture purposes within and into the BOB countries shows the potential threat of exotic species on the diversity of the wild population and spread of diseases, as shown in the Figure below.

As such, the following issues (Table 2) have been identified in relation to conservation of wild stocks as well as the possible transfer of important diseases from cultured to wild stocks.

**Table 2. Major issues identified during Expert Panel Discussion II.**

<table>
<thead>
<tr>
<th>Major Issues</th>
<th>Transboundary Nature</th>
<th>Root Cause</th>
<th>Solutions/ Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fishing impacts on broodstock for shrimp and other fish species</td>
<td>May impact shared stocks. Overfishing of broodstock may affect recruitment locally and maybe regionally? Shortage of local broodstock can lead to imports from elsewhere and consequent health risks</td>
<td>Principally affects <em>P. monodon</em> as domesticated/captive broodstock not available (i.e. <em>P. monodon</em>). Not an issue for <em>L. vannamei</em> in BOBLME</td>
<td>Fishery management/ Regulatory aspects of broodstock collection (limits on numbers caught and level of sustainability of fishery) Development of domestic SPF/SPR breeding and multiplication programmes to reduce demand for local wild or imported exotic broodstock (especially <em>P. monodon</em>)</td>
</tr>
<tr>
<td>Transmission of disease to wild stocks</td>
<td>May impact shared stocks. Not much documented evidence of catastrophic impacts on wild stocks, but diseases found in wild stocks (e.g. WSSV, TSV etc) Note: The introduction of a new disease to a country threatens both wild and aquaculture stocks. This can lead to very costly/long-lasting consequences to the aquaculture sector (wild stocks may act as a reservoir)</td>
<td>Ineffective quarantine or smuggling of native and non-native stock by private sector Introduction of infected material to new area/country because no national domesticated stocks available Limited awareness of farmer Little data on health status of wild stocks – may need to monitor</td>
<td>Harmonised health certification for moving stocks Health certification/ quarantine requirements for stock movements Rules for disposal of spent broodstock Improve health laboratories and capacity for emergency response Registration/accreditation of breeding centres/hatcheries, certify and monitor hatcheries Use SPF stocks. Effective screening procedures Investigate effects of exotic diseases on wild stocks Investigate prevalence of key diseases of aquaculture in wild stocks Biosecurity/reduced exchange with open water</td>
</tr>
</tbody>
</table>
| Biodiversity impacts | Typically, little or no data available  
*L. vannamei* as yet not known to be established in wild (low threat?)  
*P. monodon* in W. Africa does form fishery now (species differences)  
Cage culture of fish i.e. India, Indonesia, Vietnam has higher possibility of escapes and impacts.  
Most of these localised – maybe not transboundary and maybe better dealt with by national legislation. | i.e. loss of stock from flooding, coastal storms) leads to release of cultured stock to the wild in large quantities  
Aquaculture stocks are bred and interbred from different geographical areas. They are different to wild stocks.  
e.g. Indonesia – National Broodstock Programme (NSPC) mates *P. monodon* from different areas and supply culture industry.  
Use of SPF stocks (from various origins) may lead to homogenisation of genetics within species | Losses which are due to natural disasters, cannot be fully managed.  
Climate proofing/disaster proofing coastal aquaculture, will limit the impact and is desirable economically since it reduces the impact of aquaculture losses.  
Implement BMPs to help prevent stock losses |
| --- | --- | --- | --- |
| Enhancement and restocking (potential impact on genetic diversity of wild stocks) | Animals can migrate across wide distances (i.e. snapper in Maldives)  
Typically highly migratory species not usually cultured  
Often enhancements are for very sessile/non migratory species | Not currently a widespread activity in the bay –although may be occurring on a local scale in several countries.  
*P. monodon* restocked in Gulf of Thailand sea in Malaysia  
Indonesia restocks swimming crabs (in Takala), shrimp and fish –mostly small scale). | Any marine enhancement activity ought to use stock with adequate genetic diversity  
Where significant enhancement is taking place - some monitoring of genetics of wild stocks would be desirable. |
| Habitat impacts (addressed in environment group) | Possible but localised | Destruction of habitat for aquaculture development  
Impacts on seabeds. | Zoning, regulation of aquaculture development |
Report on the regional workshop in transboundary aquatic animal health issues


Destruction of mangroves is thought to be the biggest environmental problem resulting from aquaculture operations (mainly shrimps). However, this is more of a national issue rather than transboundary issue, unless the mangrove areas concerned are close to national borders, and may therefore affect the coastal habitats of both countries involved. In India, mangrove destruction is cited as one of the reasons for restricting the development of aquaculture. In Sri Lanka, Indonesia and Bangladesh, significant areas of mangroves have been destroyed during the peak of shrimp aquaculture industry, but mangrove rehabilitation and transplantation programmes are now being implemented to restore some of the mangrove forests.

In connection to this, most of the aquaculture developments at present are now taking place on lands that have been used for other operations (e.g. agriculture). Modern aquaculture technology (e.g. recirculating systems) has reduced the demand for water in the aquaculture industry. Therefore the ponds can now be moved inland rather than operating in the coastal areas. This can reduce the impacts on mangrove habitat. Although some shrimp operations are now outside the mangrove areas, there are still some hotspots encroachment. According to GAA (Global Aquaculture Advocate) standard/certification, shrimp farms are not allowed to be built on mangrove lands, except those that have been cleared before 1996. Sometimes, the main driver for mangrove destruction is not aquaculture per se but the unmanaged/unregulated aquaculture practices/systems. For example, intensification of aquaculture in the mangrove areas can be disastrous. Therefore they should be moved away from the lagoons/ coast before intensification.

There is always a clash between the environmental-related and the aquaculture/ fisheries-related authorities in dealing with coastal area management, since coastal mapping is done mostly by the environment-related institutes. Therefore it is important that these two parties coordinate and collaborate for proper management of the coastal environments.

Other issues identified in this panel discussion are: fish meal requirement and use of trash fish in aquaculture leading to unsustainable fishing practices; and, eutrophication from land-based and off-shore cage aquaculture operations. These are listed in the table below.

<table>
<thead>
<tr>
<th>Demand for feeds for aquaculture</th>
<th>Driver is the aquaculture demand (typically carnivorous fish, crab aquaculture) for low value/trash fish from trawling. No known targeted fish meal stocks in the BOB at the moment (can this be verified?)</th>
<th>Move from fresh feeds to efficient compound feeds Improve dietary formulations to improve food utilisation efficiency Replace fish meal use with plant and alternative ingredients Implement BMPS to improve feeding practices to reduce FCRs</th>
</tr>
</thead>
</table>

May impact shared stocks. Impacts on juveniles of higher value species (growth overfishing) Landings between countries are occurring, and some of the catch is directed to aquaculture.
Table 3. Major issues identified during Expert Panel Discussion III.

<table>
<thead>
<tr>
<th>Major Issues</th>
<th>Transboundary Nature</th>
<th>Root Cause</th>
<th>Solutions/ Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mangrove and coastal deforestation</td>
<td>Ecosystem services (nursery for shrimp and fish); tsunami protection; erosion of coastal region</td>
<td>Intensive systems of aquaculture (Role of other causes-)</td>
<td>BOBLME in collaboration with MFF (Mangroves for the Future), IUCN, and other environment ministries to work on the following:</td>
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<tr>
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<td>• Zoning &amp; regulation</td>
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<td>• Better estimates of area &amp; change – land use estimates (coordinate Min. Env. + Agriculture)</td>
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<td>• Aquaculture planning on a geographic scale</td>
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<td>• Identify hotspots of impacts resulting from aquaculture operations</td>
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<td>• Harmonise with certification systems</td>
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<td>• Restoration programmes</td>
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<td></td>
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<td></td>
<td>• Higher productivity systems typically located outside of mangrove zones</td>
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<td></td>
<td></td>
<td></td>
<td>• Encourage mangrove-friendly aquaculture</td>
</tr>
<tr>
<td>Fish meal requirement and use of trash fish leading to unsustainable fishing practices</td>
<td>Use of transboundary stocks (future – oil sardines; Myanmar, Thai, Indonesia – demersal species); Transfer of landings to other countries</td>
<td>Culture of shrimps and carnivorous fish</td>
<td>Quantification of shared stocks/transfer of landings - used for fishmeal/trash fish for aquaculture;</td>
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<td></td>
<td>Moving from trash fish to pellet feed;</td>
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<td></td>
<td>Plant protein substitutes;</td>
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<td>Improve feeding practices to reduce FCR;</td>
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<tr>
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<td></td>
<td>Culture of fish in lower trophic level.</td>
</tr>
<tr>
<td>Eutrophication from land based and cage culture</td>
<td>Scale of impact local* (?) * impact on seagrass/MPA (needs quantification)</td>
<td>Intensification over carrying capacity</td>
<td>Bioremediation;</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>Aquaculture planning based on carrying capacity;</td>
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<td></td>
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<td></td>
<td>Discharge standards and regulations;</td>
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<td>Recirculation Aquaculture Systems (RAS);</td>
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<td></td>
<td>Address knowledge gaps –relative contribution of aquaculture on organic load; impact on seagrass/MPA; and harmful algal blooms</td>
</tr>
</tbody>
</table>

**Expert Panel Discussion IV:** New/Reintroduced species for aquaculture. Introduction and escape of exotic species/Reintroduction of resident species from other regions and continents: spread of diseases and genetic diversity. **Lead Experts: Dr A.G. Ponniah and Dr Weimin Miao**
Marine aquatic animal species that are moved/transferred within the BOBLME countries include finfishes (cobia, pompano, groupers, tilapia, seabass), shrimps (*L. vannamei, P. monodon, P. stylirostris, P. merguiensis*), mud crab, molluscs (pearl oysters, abalone, cockle, etc.), sea cucumbers, seaweeds and ornamentals. The movement of seaweeds, in particular, is quite an issue, as there are reports on spread of diseases of seaweeds through unregulated transfer of *Kappaphycus* as example. Seaweeds are not covered by conventional animal health regulations, thus some quarantine and movement regulations may easily be bypassed. The presence of epicommensals on transported seaweed and molluscs should also be considered during transfer and movement.

An interesting knowledge gap is to consider other routes of pathogen transfer beyond the fishery/aquaculture sectors:

- Monitoring around ports (including ballast waters; crustaceans, molluscs)
- International Marine Organization (IMO) – mid-ocean exchanges showed that some crustaceans/molluscs cannot be removed during water changes – this may still pose hazards as carriers of pathogens.
- In addition, ballast water coming from areas with existing aquatic animal disease/infections offers a potential route of transmission to aquaculture in other areas where the particular disease is not present.

Table 4 lists the important issues identified relating to introduction of exotic species for aquaculture purposes.
Table 4. Major issues identified during Expert Panel Discussion IV.

<table>
<thead>
<tr>
<th>Major Issues</th>
<th>Transboundary Nature</th>
<th>Root Cause</th>
<th>Solutions/ Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Alien pathogen in cultured and wild stocks</strong></td>
<td>Spread through trade, disposal of processing waste materials;</td>
<td>Expectation of higher returns &amp; new culture systems (cage);</td>
<td>Risk assessment; Quarantine; Technical capacity building;</td>
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<td></td>
<td>Spread through other pathways e.g. carry over water, live/fresh/frozen feed (fish,</td>
<td>Diversification of consumers preference;</td>
<td>Strengthen legislation, enforcement and coordination;</td>
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<tr>
<td></td>
<td>crustacean); Transmission to shared wild population (?)</td>
<td>Lack of awareness;</td>
<td>Filling knowledge gaps</td>
</tr>
<tr>
<td><strong>Escapees</strong></td>
<td>Localised or transboundary?;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• <strong>Biodiversity impacts</strong></td>
<td>Impacts on wild population shared across countries.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• <strong>Genetic homogenisation</strong>, issue for certain</td>
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<tr>
<td>species (P monodon exotic stock, SPF)</td>
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<tr>
<td>**Has the potential on wild population, however</td>
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<td>the immediate threat is limited, and need further</td>
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<tr>
<td>investigation</td>
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<td></td>
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<tr>
<td><strong>Alien fouling and pest associated with movement</strong></td>
<td>Possible problem with the movement of shellfish and seaweed stocks between countries and regions</td>
<td>Renewal of seaweed stocks or aquaculture development</td>
<td>Increase the awareness of the threat;</td>
</tr>
<tr>
<td>of mollusc and seaweed**</td>
<td></td>
<td></td>
<td>Include them in the current regulations/control protocol relevant necessary capacity needed;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Amend competent authority responsible for their movement.</td>
</tr>
<tr>
<td>Transmission of exotic pathogen through processing (waste/effluent material) and trading?</td>
<td>Not a huge transboundary issue</td>
<td>Screening/checking measure for incoming reprocessing materials for pathogen; Adequate regulation on the handling/disposal of the waste materials and effluent from reprocessing</td>
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</tr>
<tr>
<td>Transmission of exotic pathogen through ballast water (knowledge gap) For BOB to other agencies for port monitoring on ballast water</td>
<td>Potential threat to aquaculture and wild population later, though there is huge knowledge gap</td>
<td>Significant movement of shipping within the BOB and South China Sea Risk assessment on the threat of the ballast Interaction with other agencies, e.g. IMO and UNEP measure to monitor and control in the ballast water movement</td>
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</tr>
</tbody>
</table>

10. General Discussion

Transboundary aquatic animal diseases have plagued most countries in the Bay of Bengal and the rest of the Asia-Pacific region for the past 20 years. The successive waves of fish and shrimp viruses, e.g. White spot syndrome virus (WSSV), Viral nervous necrosis virus (VNNV) and more recently, Infectious myonecrosis virus (IMNV), have caused varying levels of economic impact. It is well known that the transboundary spread of infectious diseases is aided by trade in live animals and as a consequence, the pathogen broadens its host range to new species (Rodgers et al., 2011). As the aquaculture industry continues to expand and globalise coupled with increasing demand for food fish by the increasing human population, transfer and movements of aquatic animals and plants become inevitable.

From the series of expert panel discussions above, list of issues have been summarised and classified either as high risk, moderate risk and low risk, as presented in Table 5.
Table 5. List of issues identified for transboundary aquatic animal health in the Bay of Bengal Large Marine Ecosystem (BOBLME).

<table>
<thead>
<tr>
<th>Threats/issues</th>
<th>Transboundary?</th>
<th>Driver/cause</th>
<th>Solutions/ recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Import or spread of important pathogens of shrimp (e.g., IMNV, WSSV) fish (e.g., VNN) and mollusks</td>
<td>Present high risk of spread (except for WSSV which is already prevalent in native crustaceans) in BOBLME High potential of negative economic impact (e.g. IMNV) Risk of pathogen transfer into wild stocks; Transfer of newly developed SPF stocks (especially those intended for use in other regions) into the BOB may become a source of new pathogens; emerging disease concerns</td>
<td>Development of new species for aquaculture; Shift in species cultured; General intensification and diversification of aquaculture</td>
<td>Promote and enhance awareness and advocacy on good health management practices: prevention and protection to be used as major lines of defence [eg. crop rotation?] Cheap and readily available supply of SPF stock from accredited hatcheries; List down countries producing SPF broodstock for aquaculture use in the region.</td>
</tr>
<tr>
<td>Importation of non-SPF broodstock; illegal movement of animals; movement of infected animals; Risks associated with bringing newly developed SPF stocks into the region</td>
<td>High risk</td>
<td>Lack of proper treatment prior to discharge of wastes into the aquatic environment</td>
<td>Improve capacity on risk analysis and devise effective risk reduction measures for handling processing wastes. Screening/checking measure for incoming reprocessing materials for pathogen; Adequate regulation on the handling/disposal of the waste materials and effluent from reprocessing</td>
</tr>
<tr>
<td>Transmission of exotic pathogens through unregulated processing (waste/effluent material) and trading between countries and regions</td>
<td>Risk of pathogen transfer into wild and cultured stocks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Threats/issues</td>
<td>Transboundary?</td>
<td>Driver/cause</td>
<td>Solutions/ recommendations</td>
</tr>
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</tr>
<tr>
<td>Unregulated movement of ornamental shrimps/fish</td>
<td>Risk is present if the animals are used for aquaculture purposes (mass production of ornamentals); Less or no risk if they will be used solely as ornamentals in aquaria.</td>
<td>Lack of proper regulations on movement and transfer of ornamental fish and shrimps. Volume of shipments presents a challenge in terms of systematic evaluation of health status</td>
<td>Risk analysis should be initiated Communication of the possible threat</td>
</tr>
<tr>
<td><strong>Moderate risk</strong> but lack of information</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Use of imported fresh/frozen aquatic animals as feeds for broodstock and growout</td>
<td>These might carry potential pathogens that can infect broodstock; Spread through others pathways e.g. carry over water, live/fresh/frozen feed (fish, crustacean)</td>
<td>Need to obtain maximum reproductive potential of broodstock Lack of access to formulated feed</td>
<td>Develop suitable replacements such as pasteurized feeds or dry-processed feeds Promote domestic production of fresh/live feeds to reduce dependence on imports Introduce controls on the health status of fresh feeds Raise awareness of health risks associated with fresh feeds</td>
</tr>
<tr>
<td><strong>Moderate-high risk</strong> to broodstock</td>
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<tr>
<td>Lack of diagnostic capacity / misdiagnosis of pathogens; Compliance with international standards, regional agreements and trading partner requirements (e.g. WTO SPS Agreement; OIE standards; residue monitoring by EU) both</td>
<td>Misdiagnosis will affect the health status of a country and thus present a risk to trading activities between disease free and disease affected countries; Ineffective treatment and/or management thus compromise the health status of the animal; As signatories to Agreements and</td>
<td>Lack of diagnostic capability and awareness Lack of awareness of existing national and international services; Reluctance of governments to declare health status; Countries may be signatory to these Agreements but there</td>
<td>Improve human resource capacity and infrastructure on aquatic animal health; Collaborative program on disease diagnostics, harmonization of diagnostic techniques; proficiency testing of laboratories; Raise awareness of the regional resource centre mechanism; Countries develop national aquatic animal</td>
</tr>
<tr>
<td>Threats/issues</td>
<td>Transboundary?</td>
<td>Driver/cause</td>
<td>Solutions/ recommendations</td>
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</table>
| obligatory and voluntary.  
9-10 regional resources centres in place; however mechanisms for utilising them are poorly understood | by virtue of their memberships (both obligatory and voluntary), countries are responsible for implementation of regulations to comply with international standards/agreements. | may be lack of understanding and/or lack of resources for implementation.  
In some countries, although these Agreements are integrated into national laws, there is lack of effective enforcement | health strategies;  
Promote more systematic national health surveillance programmes;  
Assist countries to facilitate compliance with these standards and agreements through national strategies                                                                                           |
| Moderate risk                                                                   |                                                                                   |                                                                                                                                                                                                             |                                                                                                                                                               |
| Human pathways of disease spread: risk coming from small-scale farmers not practicing biosecurity and/or GAPs; small scale farmers using non-SPF stocks or using SPF stocks without biosecurity support; non-implementation of IRA recommendations; weak competence of Competent Authorities. | People and products are constantly on the move; aquaculture is a truly globalised activity | Lack of information and/or awareness among small scale farmers on the risk associated with transfer/movement of aquatic animals, list of notifiable diseases, etc.  
Weak competence of some Competent Authorities in general and in particular, for issuance of health certificates prior to aquatic animal movement and transfer | Undertake a systematic assessment on the impacts of shrimp diseases to aquaculture to include socio-economic analysis.  
Ensure commitment of governments for implementation of IRA activities.  
Systematic evaluation of aquatic animal health capacity and performance as basis for identifying strengths which can be maximized and gaps which need to be addressed  
Focus efforts in assisting small-scale producers to improve farming practices                                                                                       |
| Low to moderate risk                                                            |                                                                                   |                                                                                                                                                                                                             |                                                                                                                                                               |
| Transmission of disease to wild stocks; exotic pathogens in cultured and         | May impact shared stocks  
Not much documented evidence of catastrophic impacts on wild                          | Ineffective quarantine or smuggling of native and non-native stock by private | Harmonized health certification for moving stocks  
Health certification/quarantine requirements                                                                                                                                                                       |
### Threats/issues

<table>
<thead>
<tr>
<th>Wild stocks. Natural pathways</th>
<th>Presently low risk due to lack of evidence</th>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Transboundary?</th>
<th>Driver/cause</th>
<th>Solutions/recommendations</th>
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<tbody>
<tr>
<td>stocks, but diseases found in wild stocks (e.g. WSSV, TSV etc); Spread through trade, disposal of processing waste materials; Extreme weather events, e.g. flooding which may cause spread of pathogens</td>
<td></td>
<td>for stock movements</td>
</tr>
<tr>
<td>No specific example for shrimp disease but may be a possibility</td>
<td>Introduction of infected material to new area/country because no national domesticated stocks available; Limited awareness of farmer; Little data on health status of wild stocks – may need to monitor; Expectation of higher returns and new culture systems (cage); Diversification of consumers preference; Lack of awareness Lack of institutional coordination and capacity.</td>
<td>Rules for disposal of spent broodstock Improve health laboratories and capacity for emergency response Registration/accreditation of breeding centres/hatcheries, certify and monitor hatcheries Use SPF stocks. Effective screening procedures Investigate effects of exotic diseases on wild stocks Investigate prevalence of key pathogens of aquaculture in wild stocks. Biosecurity/reduced exchange with open water; Risk assessment; Quarantine and Technical capacity building; Strengthen legislation, enforcement and coordination</td>
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<tr>
<td>Threats/issues</td>
<td>Transboundary?</td>
<td>Driver/cause</td>
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<tr>
<td>Mangrove removal and coastal deforestation;</td>
<td>Ecosystem services (nursery for shrimp and fishes);</td>
<td>Extensive systems of aquaculture (Role of other causes-?)</td>
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<tr>
<td>Generally a historical issue; there may be some hotspots that require</td>
<td>tsunami protection; erosion of coastal region).</td>
<td></td>
</tr>
<tr>
<td>attention</td>
<td>Presently low risk</td>
<td></td>
</tr>
<tr>
<td><em>Alien Fouling and pest associated with movement of mollusk and seaweed</em></td>
<td>Possible problem with the movement of shellfish and seaweed stocks between</td>
<td>Renewal of seaweed stocks or aquaculture development</td>
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<tr>
<td>Presently low risk as systems are not yet widespread, possible future issue</td>
<td>countries and regions</td>
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<tr>
<td>if significant development occurs</td>
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23
<table>
<thead>
<tr>
<th>Threats/issues</th>
<th>Transboundary?</th>
<th>Driver/cause</th>
<th>Solutions/ recommendations</th>
</tr>
</thead>
</table>
| **Transmission of alien pathogen through ballast water** *(knowledge gap)*  
For BOB to other agencies for port monitoring on ballast water | Potential threat to aquaculture and wild population later, though there is huge knowledge gap | Significant movement of shipping within the BOB and South China Sea | Risk assessment on the threat of the ballast water movement  
Interaction with other agencies, e.g. IMO and UNEP measure to monitor and control in the ballast water movement |
| **Continuous importation of SPF stocks** | Movement of asymptomatic shrimps might still carry the pathogen which can facilitate spread of pathogen/disease among countries in the region. Continuous movement of aquatic animals (e.g. importation of SPF stocks) presents a continuous low risk in the spread of unknown pathogens in both cultured and wild stocks. | Misconception and misunderstanding on the concept and application of SPF stocks | For safe importation of aquatic animals, follow:  
- Recommendations of ICES;  
- ICES Code of Practice on the introductions and transfers of marine organisms 2003;  
- Guidelines for movement of exotic organisms for aquaculture or for stocking in natural waters;  
- For crustaceans, additional tests are required for the presence of cryptic viral pathogens.  
Countries should develop their own SPF stocks to minimize continuous importation of broodstock. Possible regional collaborative programme on SPF shrimp development, including harmonisation of SPF accreditation – NACA  
Given that the risk of introducing unknown pathogens in SPF stocks is low, governments should implement measures for development |
## Threats/issues

<table>
<thead>
<tr>
<th>Threats/issues</th>
<th>Transboundary?</th>
<th>Driver/cause</th>
<th>Solutions/ recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Impact of broodstock fishing for shrimp and other fish species</strong></td>
<td>May impact shared stocks</td>
<td>Principally affects <em>P. monodon</em> as domesticated/ captive broodstock not available (i.e.. <em>P. monodon</em>). Not an issue for <em>L. vannamei</em> in BOBLME</td>
<td>Fishery management/ Regulatory aspects of broodstock collection (limits on numbers caught and level of sustainability of fishery) Development of domestic SPF/SPR breeding and multiplication programmes to reduce demand for local wild or imported exotic broodstock (especially <em>P. monodon</em>)</td>
</tr>
<tr>
<td><strong>Low risk – but may be local/ national problem</strong></td>
<td>Overfishing of broodstock may affect recruitment locally and maybe regionally? Shortage of local broodstock can lead to imports from elsewhere and consequent health risk</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Genetic effects</strong></td>
<td>May impact shared stocks</td>
<td>Escapees</td>
<td>Regulations for managing/limiting discards or escapees BMP/GAP farm practice to limit discards/escapees; Regulations should cover disposal of diseased stock and related effluent;</td>
</tr>
<tr>
<td><strong>Low risk (knowledge gap)</strong></td>
<td>Interactions of domesticated stock may effect genotypic/phenotypic status of wild stocks</td>
<td>Broodstock fishing selectivity</td>
<td></td>
</tr>
<tr>
<td>Threats/Issues</td>
<td>Transboundary?</td>
<td>Driver/cause</td>
<td>Solutions/Recommendations</td>
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</tr>
<tr>
<td><strong>Biodiversity impacts</strong></td>
<td>Typically, little or no data available L. vannamei as yet not known to be</td>
<td>Genetic homogenization, issue for certain species (P. monodon exotic stock, SPF)</td>
<td>Losses which are due to</td>
</tr>
<tr>
<td>Presently low risk (knowledge</td>
<td>established in wild (low threat?)</td>
<td>Has the potential on wild population, however the immediate threat is limited, and need</td>
<td>natural disasters,</td>
</tr>
<tr>
<td>gap</td>
<td>P. monodon in W. Africa does form fishery now (species differences)</td>
<td>further investigation (i.e. loss of stock from flooding, coastal storms) leads to release</td>
<td>cannot be fully managed.</td>
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<td></td>
<td>Cage culture of fish i.e. india, Indonesia, Vietnam has higher possibility of</td>
<td>of cultured stock to the wild in large quantities</td>
<td>Climate proofing/disaster</td>
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<td></td>
<td>escapes and impacts. Most of these localized – maybe not transboundary and</td>
<td>Aquaculture stocks are bred and interbred from different geographical areas. They are</td>
<td>proofing coastal aquaculture,</td>
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<td></td>
<td>maybe better dealt with by national legislation.</td>
<td>different to wild stocks. e.g. Indonesia – National Broodstock Programme (NSPC) mates P.</td>
<td>will limit the impact and</td>
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<td></td>
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<td>monodon from different areas and supply culture industry. Use of SPF stocks (from various</td>
<td>is desirable economically</td>
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<td>origins) may led to homoginization of genetics within species</td>
<td>since it reduces the impact</td>
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<td>of aquaculture losses.</td>
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<td>Implement BMPs to help</td>
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<td>prevent stock losses</td>
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<tr>
<td><strong>Enhancement and restocking</strong></td>
<td>Animals can migrate across wide distances (i.e. snapper in Maldives)</td>
<td>Not currently a widespread activity in the bay – although may be occurring on a local</td>
<td></td>
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<tr>
<td>(potential impact on genetic)</td>
<td>Typically highly migratory species</td>
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Enhancement and restocking (potential impact on genetic)

Animals can migrate across wide distances (i.e. snapper in Maldives). Typically highly migratory species. Not currently a widespread activity in the bay – although may be occurring on a local scale. Any marine enhancement activity ought to use stock with adequate genetic diversity. Where significant enhancement is taking place, careful consideration should be given to the potential impacts on native populations.
<table>
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<tr>
<th>Threats/issues</th>
<th>Transboundary?</th>
<th>Driver/cause</th>
<th>Solutions/ recommendations</th>
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<tbody>
<tr>
<td><strong>diversity of wild stocks)</strong></td>
<td>not usually cultured</td>
<td>scale in several countries. P. monodon restocked in Gulf of Thailand sea in Malaysia, Indonesia restocks swimming crabs (in Takala), shrimp and fish – mostly small scale.</td>
<td>place - some monitoring of genetics of wild stocks would be desirable.</td>
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<td>Presently low risk as not much activity (knowledge gap)</td>
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<tr>
<td><strong>Demand for feeds for aquaculture Fish meal requirement and use of trash fish leading to unsustainable fishing practices</strong></td>
<td>May impact shared stocks. Impacts on juveniles of higher value species (growth overfishing) Landings between countries are occurring, and some of the catch is directed to aquaculture. Use of transboundary stocks (future – oil sardine/ Myanmar, Thai, Indonesia - demersal)</td>
<td>Driver is the aquaculture demand (typically carnivorous fish, crab aquaculture) for low value/trash fish from trawling. No known targeted fish meal stocks in the BOB at the moment (can this be verified?)</td>
<td>Move from fresh feeds to efficient compound feeds Improve dietary formulations to improve food utilization efficiency Replace fish meal use with plant and alternative ingredients Implement BMPS to improve feeding practices to reduce FCRs Quantification of shared stocks/ transfer of landings - used for fishmeal/ trash fish for aquaculture; Moving from trash fish to pellet feed; Plant protein substitutes; Improve feeding practices reduce FCR; Culture of fish low in tropic level</td>
</tr>
<tr>
<td>Threats/issues</td>
<td>Transboundary?</td>
<td>Driver/cause</td>
<td>Solutions/ recommendations</td>
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<tr>
<td>Habitat impacts</td>
<td>Possible but localized impacts on wild stocks</td>
<td>Destruction of habitat for aquaculture development</td>
<td>Zoning, regulation of aquaculture development</td>
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<tr>
<td>Presently low risk</td>
<td></td>
<td>Impacts on seabeds</td>
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<tr>
<td>Eutrophication from land based and cage culture</td>
<td>Scale of impact local * (?)</td>
<td>Intensification over carrying capacity (?)</td>
<td>Address knowledge gaps – relative contribution of aquaculture on organic load; impact on seagrass/MPA; harmful algal blooms [possible BOBLME / UNEP GPA collaboration]</td>
</tr>
<tr>
<td>Knowledge gap</td>
<td>Impact on seagrass/MPA/other sensitive habitats (needs quantification)</td>
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<td>Guidance on carrying capacity and loadings from different aquaculture systems</td>
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<td>Bioremediation of effluent</td>
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<td>Aquaculture planning based on carrying capacity</td>
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<td>Discharge standards &amp; Regulation</td>
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<td>Closed / low water exchange system</td>
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11. Recommendations

Based on the issues and causes identified above, the following general recommendations have been formulated:

- Promote and enhance awareness and advocacy on good health management practices with focus on prevention and protection as major lines of defence.

- Establish local high health SPF stocks and multiplication centres to reduce dependence on importation of SPF stock from overseas supplier. Criteria for accrediting SPF seed and hatchery facilities should be harmonised among BOBLME countries (ideally SPF shrimp should be free from all OIE-listed pathogens), and consequently raise awareness amongst farmers on the proper concept of using SPF stocks and the biosecurity requirements for their effective utilisation. Governments should also implement measures for development of national SPF stocks gradually and avoid highly restrictive measures to avoid illegal importation of aquatic animals during the period before the national stocks are established. Offer industry a grace period before phasing out importation of genetic material.

- For safe importation of aquatic animals, recommendations from ICES (International Council for the Exploration of the Sea) Code of Practice on the Introductions and Transfers of Marine Organisms 2003 should be followed, as well as the Guidelines for movement of exotic organisms for aquaculture or for stocking in natural waters. For crustaceans, additional tests are required for the presence of cryptic viral pathogens.

- Harmonised health certification for movement and transfer of aquatic animals to include health certification/quarantine requirements. Strengthen legislation, enforcement and coordination of such measures.

- Improve human resource capacity and aquatic animal health laboratories/diagnostic facilities, as well as capacity for emergency disease response. Collaborative programmes on disease diagnostics, harmonisation of diagnostic techniques, proficiency testing of accredited laboratories. Systematic evaluation of aquatic animal health capacity and performance.

- Promote more systematic national health surveillance programmes. Investigation/surveillance of exotic diseases and prevalence of key aquatic animal pathogens in wild stocks.

- Risk analysis on movement of ornamental fish/shrimps and seaweeds, and proper communication of the possible threat resulting to large volume shipments of these commodities.

- Adequate regulation on the handling/disposal of waste materials and effluents from reprocessing of aquatic animal products.

- Develop suitable replacement for fresh feeds (e.g. pasteurised feeds or dry-processed feeds) and domestic production of fresh/live feeds to reduce dependence on imports. Introduce controls on health status of fresh feeds and raise awareness on health risks associated with its use.

- Assist countries to facilitate compliance with national and international standards and agreements through national strategies.

- Undertake a systematic assessment on the impacts of shrimp diseases to aquaculture to include socio-economic analysis, ensure commitment of governments for implementation
of IRA activities with focus in assisting small-scale producers for improved farming practices.

- BOBLME collaboration with Mangroves for the Future, International Union for Conservation of Nature (IUCN) and other environment ministries to have better estimates of mangrove area and change, identifying hotspots of impact resulting from aquaculture development, implementing zoning and other regulations, aquaculture planning on a geographical scale, and encouraging mangrove-friendly aquaculture.

12. References


# Appendix I  List of participants

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**Report on the regional workshop in transboundary aquatic animal health issues**

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Appendix II  Agenda

Day 1 (12 January; Thursday)
08:30 – 09:00:  Registration
09:00 – 09:15:  Opening
   Welcome Remarks (Dr Amberkar E. Eknath; Director General, NACA)
09:15 – 09:30:  Overview of the Workshop: Transboundary issues of relevance, Workshop objectives, Process, and Expected Outcomes (Ed/Mohan; NACA)
09:30 – 10:00:  Transboundary diagnostic analysis – concept and approach as followed in BOBLME Project (Rudi/Chris)
10:00 – 10:15:  Coffe/Tea
10:15 – 12:30:  Country Presentations
   • Bangladesh
   • India
   • Indonesia
   • Malaysia
   • Maldives
   • Myanmar
   • Sri Lanka
   • Thailand
12:30 – 13:30:  Lunch
13:30 – 14:30:  Discussion: Common transboundary issues among member countries (based on country presentations).
14:30 – 15:30  Expert Panel Discussion I: Threats and pathways of potential pathogen transfer into BOBLME countries. Transboundary shrimp diseases (including OIE-listed and other exotic diseases of regional importance) and movement of aquatic animals, with focus on shrimps.
15:30 – 15:45:  Coffee/Tea
15:45 – 16:30:  Expert Panel Discussion I (continued)
19:00 -  Official Dinner

Day 2 (13 January; Friday)
08:30 – 10:00:  Expert Panel Discussion III: Environmental impacts of aquaculture. Degradation of coastal environments including mangroves and its impact on disease outbreaks and spread.
10:00 – 10:15:  Coffee/Tea
12:30 – 13:30:  Lunch
13:30 – 15:30:  Recommendations
15:30 – 15:45:  Coffee/Tea
15:45 – 17:00:  Final Discussion/Report Inputs
17:00 – 17:30:  Closing
Transboundary aquatic animal diseases: Bangladesh Perspective

Dr. Masud Hossain Khan
Principal Scientific Officer
&
Dr. Yahia Mahmud
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Introduction

Bangladesh is blessed with diversified water resources scattered throughout the country in the form of small ponds, beels (natural depressions), lakes, canals, small and large rivers and estuaries covering a total area of about 4.65 million ha. The culture fisheries include 0.39 million ha and coastal shrimp farms 0.25 million ha. The total inland open water resources comprising rivers and estuaries, floodplains, kaptai lakes, beels (natural depressions) and Sundarbans cover an area of 4.1 million ha (DoF, 2011). The country has a coastal area of 2.30 million ha and a coastline of 710km along the Bay of Bengal, which supports a large artisanal and coastal fisheries. In addition to this, the country has 200 miles EEZ in the Bay of Bengal. These water bodies are highly productive to produce enough fish for food, and increasing income and livelihood for the rural population.

It is evident from the analytical study of previous 10 years fish production data that during 2000-2001 financial year total fish production was 1.8 million mt., in 2009-10 the yearly production raised at 2.9 million mt. due to intervention of technology.

Coastal fisheries emerged as an important sector for earning foreign exchange is primarily characterized by shrimp culture in the tidally inundated low-lying areas in the coastal region. Some finfish are also produced along with shrimp, which happen to be present in shrimp enclosure locally known as Gher. Shrimp is primarily an export-oriented commodity. Because of international market demand for shrimp, brackish water shrimp culture area has expanded rapidly from 52,000 ha in 1982-83 to 141,000 ha in 1999-00, which is now expanded to 2,46,198ha in 2009-2010. In 2009-2010 the highest export earning of taka 2885.21 crore was earned through export of 51599 MT chilled shrimp (DoF, 2011).

Although Bangladesh is a small player in the global shrimp market, the sector plays a key role in Bangladesh economy in terms of employment, income generation and earning of foreign currency. Bangladesh has faced boom and bust in shrimp production in 1990s like Thailand, Indonesia, and the Philippines. Though the country follows extensive, improved extensive and traditional methods for shrimp aquaculture, the annual production from shrimp aquaculture continued to rise till late 1991s and it experienced a fall in production in the recent years due to outbreak of white spot diseases in the shrimp ponds.
Farming Practices

Shrimp farming areas are mainly concentrated in the southern region of Bangladesh covering Khulna, Bagerhat, Satkhira and Cox’sbazar districts. Different types of farming practice have been evolved in shrimp culture. In case of Bagda or penaid shrimp, three culture methods are practiced as follows:

a) Extensive culture system: Majority of shrimp farms fall in this category. It is the tide fed traditional system of shrimp culture having selective stocking (2-3/sqm) and feeding with local feed or without feeding.

b) Improved extensive culture system: There is a little difference between the extensive and improved extensive culture system. Stocking density remains at same level. Water supply either tide fed or pump fed and feeding with high protein diet.

c) Semi intensive culture system: The ponds belongs to this category ranges from 1-2ha. Pond dikes are higher compare to extensive type to maintain about 1m water depth. Water supplied from adjacent brakishwater rivers by pumping. Stock hatchery born PL at higher rate (10-20 PL/sqm) provided with supplementary feeding and artificial aeration by paddle wheel. Production ranges between 2-4mt/ha from a single crop. However, this culture practice is very uncommon in the country.

Prawn (Golda) farming: Freshwater prawn is a very popular locally affordable food. Prawn grows mostly along with other aquaculture, agriculture and horticulture crop. It’s demand is gradually increasing in international market. Prawn farmers find this species resistant to WSSV disease, as a result golda farming is expanding day by day.

The debate: Pro and Anti-Shrimp campaign

From the very beginning of commercial shrimp farming, two groups of people in the country have been raising their voice with different opinions those for and those against shrimp farming. The former group argues that shrimp cultivation has generated huge wealth, income and employment associated with farming practices, security of farm, ingredient business, shrimp or PL transportation, fry collection from the sea and rivers, processing plant and export, hatchery operation, fry and shrimp trading, brokering, money lending, etc. (Rahman et al., 2006).

On the contrary, anti-shrimp campaigners blame shrimp culture as a major cause of environmental degradation, reduced biodiversity, social conflict etc. in shrimp producing coastal belts. There are criticisms against shrimp farming since it has destructed coastal ecosystem, dislocated many poor and marginal people from their occupations, lives and livelihoods and generated social conflicts in the initial stage of shrimp farming in Bangladesh. Increase of soil salinity due to seepage from shrimp farms makes adjacent agricultural lands unsuitable for good yield. Recently, salinity intrusion in non saline land masses hampering the cultivation of rice, vegetables, fruits etc. Increasing soil and water salinity in canals and ponds causing scarcity of drinking water, loss of agricultural grazing
land, consequent reduction of livestock, over exploitation of wild post larvae of shrimp, reduced aquatic resources and biodiversity, destruction of trees and plants, and adverse effects on cropping pattern and diversity (Rahman et. al, 2009). One of the frequent allegations is that shrimp farmers illegally take lease of government lands and destroy cyclone resistant and environmental friendly mangrove forests. However, in spite of all the debates, majority of the general people, scientists, policy makers and politicians are in favor of shrimp farming based on judicial use of aquatic resources, environment friendly culture techniques, social integrity and justice for the greater interest of the nation.

**Marketing of shrimp**

The country is facing problems in marketing of the products due to fluctuation of price in the global market, low productivity and insufficient negotiating capacity with the global actors as well as with some issues regarding food safety. The actors are shrimp farmers, processors, traders and the government.

Major export markets of Bangladesh shrimp are Europe (40-52% of total shrimp export), USA (34-39%) for mainly cultured shrimp and Japan (5-14%) for marine caught wild shrimp (Rahman et al., 2006). All these nations are very much vigilant with issues related to food safety and quality and hence imposed some regulations upon shrimp exporting countries at all the phases of shrimp production value added chain starting from production to processing.

In this context the government is trying to help the farmers and traders to follow Good Aquaculture Practices GAP, BMP, HACCP and traceability so that the sector can grows up in a sustainable manner ensuring greater access to the global market of shrimp.

However, the Bangladesh government supports the shrimp sector with appropriate policy, new strategy, extension on promotion of biotechnology and financial support for the entrepreneurs.

**Introduction of Exotic Fishes in Bangladesh**

The inland aquatic habitats of Bangladesh are rich in faunal diversity containing at least 265 species of finfish, 63 species of prawn and shrimp, several species species of turtle, mussels, etc. It had been a common practice in most of the Asian country including Bangladesh to introduce suitable species of fish from one country to another for various purposes such as: utilizing vacant niche, increasing overall fish production, fish/shrimp seed/brood collection, sport fishing, controlling insect pest and decorating aquarium. So far total 18 food fish species/varieties are already transplanted in the country without prior information and investigation regarding the fish (Rahman, 2005). In addition to food fish, more than 25 species of ornamental fish are also imported from China, Singapore, Thailand, and India without facing any quarantine system. According to most of the farm operator, and experts the import of shrimp fry resulted in the catastrophic outbreak of white spot syndrome virus.
(WSSV) disease in Bangladesh. It is also believed that unregulated import of aquarium fish might bring disease into our ecosystem.

**Common Shrimp and fish diseases**

Asia contributes more than 90% of the world’s aquaculture production. The current trend in aquaculture development of the country is towards increased intensification and commercialization of aquatic production. As a result the likelihood of disease outbreak is increasing very fast. Thus, the aquaculture industry has been overwhelmed with its share of diseases and problems caused by viruses, bacteria, fungi, parasites and other undiagnosed and emerging pathogens. Disease is now a primary constraint to the culture of many aquatic species,impeding both economic and social development in many countries.

However, the knowledge of pathogens and parasites of aquatic animals of Bangladesh is quite limited, the common fish diseases so far reported in the country are as follows (Banu et al. 1993; Banu, et al. 2004; Barua, et al. 1989-91; Barua, et al.1994 and Chandra, 2004):

<table>
<thead>
<tr>
<th>Host</th>
<th>Types of disease</th>
<th>Pathogen/Disease</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fish</td>
<td>Parasitic</td>
<td>Ichthyobodosis, Ichthyophthiriasis,</td>
<td>Study Revealed mass infection of WSSV in 2010-11, with 70-80% mortality in the farms investigated.</td>
</tr>
<tr>
<td>disease</td>
<td>Disease</td>
<td>Chilodonellosis, Trichodiniiasis, Myxoboliasis, Dactylogryiasis, Gyrodactylosis,</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Diplozooniasis, Argulosis, Lernaeasis, Ergasilosis, Cestod infection:</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ligula, Bothriocephalus, Senga; Acanthocephala: Pallisentis, Acanthocentis;</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Leech infestation, Fish molluscs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bacterial</td>
<td>Columnaris, Aeromoad septicemia, Edwardsiella infection, Streptococcus infection,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>disease</td>
<td>Skin and fin rot, etc.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fungal</td>
<td>Saprolegniasis, brachiomyocosis and epizootic ulcerative syndrome (eus)/aphanomycosis</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nutritional</td>
<td>Lordosis/scoliosis and crack etc</td>
<td></td>
</tr>
<tr>
<td>Shrimp</td>
<td>Parasitic</td>
<td>Ectocommensal protozoan: Zoothamnium, Epistylis, Acineta, Ephelota,</td>
<td></td>
</tr>
<tr>
<td>disease</td>
<td>Viral</td>
<td>White Spot Baculo Virus (WSBV) Systemic Ectodermal And Mesodermal Baculovirus (SEMBV)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nutritional,</td>
<td>Soft shell, black spot, black gill, pink gill, hepato pancreatic necrosis,</td>
<td>Study Revealed mass infection of WSSV in 2010-11, with 70-80% mortality in the farms investigated.</td>
</tr>
<tr>
<td></td>
<td>toxic and</td>
<td>swollen and cramped tail, muscle necrosis, broken appendages etc.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>environmental</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>diseases:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prawn</td>
<td>Parasitic</td>
<td>Ectocommensal protozoan: Corthunia, Epistylis, Vorticella</td>
<td>Found (+) in the year of 2010-11 in 20-30% of the farm investigated with 3-5% mortality</td>
</tr>
<tr>
<td>disease</td>
<td>Bacterial</td>
<td>Vibrios; Aeromonas and Pseudomonas spp.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fungal</td>
<td>Fusarium sp.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Protozoan</td>
<td>The microsporidians agmasoma and</td>
<td></td>
</tr>
</tbody>
</table>
Reasons behind recent shrimp disease outbreak (2010-2011)

The recent study revealed that most of the shrimp farms are highly susceptible to WSSV infection. The viral infection WSBV/SEMBV in shrimp, which caused mass mortality since June 1994 in the semi-intensive farms at Cox's Bazar and in 1995-96, in all culture systems throughout the country because of the importation of fry from Thailand, Taiwan and Indonesia (FAO, 1998). Yet the intensity of the propagation of WSSV remains unchanged. Moreover, some limitations in culture practices also causing some environmental and nutritional disease. The following factors were found to have close association with disease outbreak during the recent outbreak:

- Most of the farms under the investigation found to be maintained by traditional method of culture system;
- High stocking density against no or partial feeding;
- Unrestricted water flow within different farms throughout the culture period;
- Accessibility of cattle and other animals within the farming area;
- Stress caused by sudden rise or fall of temperature, salinity shrimp/prawn;
- Reduced water level (less than 1 feet) due to draught during the culture period;
- Insufficient supply of Specific Pathogen Free (SPF) brood and larvae;
- Lack of awareness and proper knowledge on aquatic animal health management in farmer level.

Control measures suggested:

No treatment for viral infections has yet been developed rather ensuring preventive measures. Ensuring best management practices also reduce the risk of environmental and nutritional diseases. The following steps can be taken as control measures in reducing risks for diseases in the country:

- Fencing around farm;
- Reduce pond size to make them manageable;
- Develop reservoir, separate inlet and outlet for individual farms;
- Ensure appropriate pond preparation;
- Disinfect the farm/ farm area before start culture;
- Ensure SPF brood and larvae for culture;
- Restrict outer animal access into the farm area either by fencing or netting;
- Maintain optimum water quality and water depth (at least 1 m) throughout the culture period;
- Minimizing all sorts of stress;
- Ensure best management practices;
- Improve water quality in case of accidental infection by changing water (quality water) and liming; water exchange is normally discouraged.

**Impact of disease**

- **Impact on trade:** Diseases have certainly an adverse impact on the sustainability of the shrimp farming industry world-wide. Massive disease outbreak reduces production which in terms reduces the foreign earning. It also affects the nation’s economic condition through unemployment of the people in this sector.

- **Impact on environment:** Disease also possesses negative impacts on the environment in general. First, shrimp ponds with diseases have served as incubation areas for the spread of diseases among natural populations. Second, enhance indiscriminate use of antibiotics and chemical, due to lack of appropriate knowledge about how to deal with disease. Third, and perhaps that with the greatest long term impact on disease outbreaks, is the resulting introduction of non-endemic species around the world. Scattered disposal of waste materials into nature also increase the risk of health hazard to other aquatic and even non aquatic animals.

- **Impact on nation:** Disease definitely poses adverse impact on shrimp farming and nation’s prosperity. However repeated disease outbreaks and losses due to diseases might motivate or force a nation in developing its infrastructure, modern culture techniques, scientific manpower, research facilities etc. Bangladesh is a burning example of this event.

**Status of national strategies for aquatic animal health management**

With the intensification of aquaculture, and the consequent occurrence and spread of various diseases, aquatic animal health management has become an important issue for the sustainable development of the sub sector. The need for aquatic animal quarantine and certification has recently drawn serious regional as well as global attention, particularly after the cluttered introduction and transfer of live aquatic animals, including ornamental fish, shrimp fry and broodstock in Asian countries including Bangladesh. The recent devastating outbreaks of shrimp viral diseases and the earlier outbreaks of epizootic ulcerative syndrome (EUS) in fresh- and brackishwater fish that have occurred in most Asian countries, including Bangladesh, have caused our government to pay special attention to these issues. This has led the Government to take various steps towards finding effective solutions to prevent the
spread of aquatic animal diseases, particularly those resulting from the introduction of exotic animals.

**Capacities on disease diagnosis and surveillance**

So far a few initiatives have been taken in capacity buildup on disease diagnosis and surveillance in Bangladesh. Some leading agricultural universities namely, Bangladesh Agricultural University, Dhaka University, Khulna University, etc. along with Bangladesh Fisheries Research Institute have capable laboratory facilities on disease diagnostics and health management however, suffering in manpower shortage. Bangladesh Fisheries Research Institute (BFRI) is the only institute having the mandate to carry out need oriented research to solve the emerging problems along the line with its limited expertise whereas the universities mostly conduct their research on serving academic purposes.

However, to improve shrimp disease diagnostic capability, recently Bangladesh Government has established “Shrimp Research Station” as a new station under Bangladesh Fisheries Research Institute in Bagerhat district. The station is well equipped with 4 specialized laboratories such as Shrimp Health Management Laboratory, Quality Control Laboratory, Shrimp Feed and Nutrition Laboratory and Water and Soil Quality Management Laboratory operated by 12 scientists having field specific specialization.

**Border control protocol/Quarantine measures and facilities**

On 2 April, 1995, after the epizootics of EUS and mass mortalities of tiger shrimp, the Ministry of Fisheries and Livestock formed a nine member committee for recommending the Import of New Species of Fish or Aquatic Animals for Culture, with the Director General of FRI as the convener. The committee, in a meeting on 3 June, 1996, approved the draft of Bangladesh Fish and other Aquatic Animal Quarantine Rules, 1996 and submitted to the government for further progress.

**Implementation of quarantine: Bangladesh perspective**

On the basis of experience, scientific opinions and arguments a kind of consensus has been developed among different stakeholders for preventing trans-boundary aquatic animal disease. Although there are a few negative opinions as well regarding quarantine and sometimes termed as unnecessary burden and wastage of money. Therefore, strong commitment by national government and the cooperation of importers and exporters are considered key elements in the success of these programs.
The first and vital requirement for implementing quarantine program is the making of quarantine act for aquatic animal. Following constraints were mentioned by Arthur, 1996 for implementing quarantine.

1. Highly skilled scientific personnel: Skilled manpower in various field of disease diagnosis is quite insufficient in the country. Appropriate government policy, long term program and financial support needed to develop trained manpower in different field. However trained manpower may be recruited from research centers, universities and abroad for the time being;

2. Diagnostic and quarantine infrastructure and facilities: Infrastructure and facilities are almost absent in the country excepting the limited facilities in Bangladesh Fisheries Research Institute (BFRI) and universities. Long term program to be initiated for developing quarantine infrastructure and facilities. However preliminary trial can be started in BFRI;

3. Knowledge of indigenous fish/shrimp fauna: Appropriate knowledge on indigenous fish/shrimp species and their biology are also insufficient. Again sufficient manpower are not available at the moment;

4. Detailed knowledge of potential fish/shrimp pathogens of the country should be known and a database should be developed for reference. Without appropriate government policy, long term program and financial support it is difficult to develop trained manpower in different field;

5. Motivation- all stakeholders are to be motivated enough in order to develop quarantine system rather than thinking it unnecessary;

6. Adequate enforcement: to be provided by the government;

7. Existence of a communications network of experts: Existing communication and networking system is enough developed in the country for supporting both national and international fish health and quarantine system.

8. Sufficient funding: In recent time, the government of Bangladesh is in a position to provide minimum financial support in order to develop quarantine system in the country.

**Implement effective quarantine:**

Several attempts were made by regional and international fish health experts to identify priorities and constraints for the development of quarantine and certification programs for the region and / or to identify needs related to the general development of fish health expertise (Arthur 1996). The following list summarizes the recommendations related to legislation and the control of fish diseases made by the scientists attending the Asian Development Bank/Network of Aquaculture Centers in Asia (ADB/NACA) Regional Study and Workshop on Fish Disease and Fish Health Management held in Bangkok in 1991. These experts agreed that countries of the region should:
1. Prepare legislation to prevent the translocation of serious fish diseases both within and outside the region;
2. Develop the capability of testing exports of fish to an agreed upon regional standard;
3. Develop quarantine systems where imports of fish may be tested to regional standards;
4. Establish a standardized system of disease testing, including a common format of health certificate;
5. Compile a regional handbook of diagnostic methods;
6. Quarantine and test for disease, introductions of new species in accordance with the ICES Code of Practice;
7. Establish a working group of regional and international experts to deal with the above recommendations.

However, implementation of the above recommendations might not be convenient by respective countries due to multifarious reason discussed earlier. Therefore, a strong regional approach is very urgent to develop quarantine system in each of the member countries in order to control trans-boundary aquatic animal diseases for the greater interest of the region.

References


COUNTRY PRESENTATION
ON
THE STATUS AND ISSUES ASSOCIATED
WITH BRACKISH WATER AQUACULTURE
SYSTEMS IN INDIA

BY
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National Bureau of Fish Genetic Resources
Lucknow

and

Dr. T.V. Sankar
Head & Senior Scientist
Central Institute of Fisheries Technology
Cochin
1. Status of coastal shrimp and fish farming

The Geographic base of Indian marine fisheries has 8118 km coastline, 2.02 million sq km of Exclusive Economic Zone including 0.5 million sq km of continental shelf. The country is endowed with species diversity and plays a crucial role in the fish production in the world. The estimated area of brackish water available for aquaculture is about 1.2-1.4 million hectare (ha), of which, about 14% area has been brought under farming. Shrimp production from coastal aquaculture during 2009 stood at approximately 97010 tonnes, which is comparatively less than the production in 2006 (about 131535 t) (Fishstat Plus, 2011). The brackish water aquaculture has been confined mainly to tiger shrimp (Penaeus monodon), followed by Indian white prawn (Penaeus indicus) (Fig. 1 A,B). P. monodon production increased from 73700 t in 1999 to 130155 t in 2006 and then showed a decreasing trend and recorded a production of 118575 t in 2011. P. indicus showed a lower production level of 4870 t in 1999 and remained more or less stable up to 2004 and then decreased drastically in 2005 and 2006. By 2008, however, a marginal increase in production was noticed. The production of Litopenaeus vannamei, which has been officially permitted to be cultured, was 1730 t in 2009. During 2011, the yield of vannamei is expected to reach a level of 18247 t.

Currently about 91 percent of the shrimp farmers in India own less than 2 ha, 6 percent between 2 to 5 ha and the remaining 3 percent have an area of greater than 5 ha. Out of the total area of 0.152 million ha presently being utilised for shrimp farming in the country, Andhra Pradesh alone provides 47 percent of the area and contributes 50 percent of the total production.

Shrimp has been the mainstay of India's seafood exports as the nation ranks as one of the largest producers of the black tiger species, Penaeus monodon. Shrimp contributed
to 19 per cent by volume and 44.32 per cent by value of Indian seafood exports during 2010-11 (MPEDA, 2011). Farmed shrimp accounts for more than 60% of shrimp exported from the country.

2. Known shrimp diseases (Including OIE-listed diseases) occurring in the country

Diseases are being increasingly recognized as a significant constraint to aquaculture production particularly shrimp culture sub-sector. The following diseases have been reported from the country;

White spot Disease:
White spot disease caused by white spot syndrome virus (WSSV) is the most widely studied shrimp disease in India. For the first time, intranuclear inclusions typical of WSSV were demonstrated in shrimp samples showing signs of YHD collected from the farms located near Kandeleru creek in Gudur, Andhra Pradesh in July 1994. However, typical YHV intracytoplasmic inclusions were not observed (Mohan et al, 1998). Later on, the disease was reported from Nellore, Andhra Pradesh during same year (Shankar and Mohan, 1998). Though the disease was first reported in 1994, yet it had spread to Goa, Orissa, West Bengal, Karnataka and Gujarat in a very short span of period (Karunasagar et al., 1997; Rajenderan et al., 1998). WSD outbreaks have regularly been reported in Quarterly Aquatic Animal Disease reports from farms in Goa, Karnataka, Andhra Pradesh, Gujarat and Tamil Nadu since 2004.

Indian strains of WSSV were closely related to Thailand strains suggesting movement of a putative ancestor from Thailand to other parts of the world including India (Pradeep et al., 2008). WSSV has been detected in P. vannamei samples collected from East and West Coast (Moger et al., 2011). Recently, Reddy et al. (2011) reported that cooking shrimps at 100°C for 30 minutes was insufficient to destroy the virus and transmission risk of WSSV remains even through cooked shrimp products. It indicates that cooked shrimp products may pose a transmission risk for WSSV.

There have been a number of studies on prevalence of WSSV in brooders and postlarvae of P. monodon (Otta et al., 1999, 2002; Thakur et al., 2002; Uma et al., 2005,2007; Mishra et al., 2005; Umesh et al., 2006,2008; Rai et al., 2009; Sethi et al., 2011). The susceptibility of other crustaceans like freshwater prawn, crabs, Artemia, lobsters, to WSSV infection has been investigated (Sahul-Hameed et al., 2000,2001,2002,2003; Sarathi et al., 2008; Musthaq et al., 2006a; Vijayan et al., 2005). The immunostimulant activity of Indian herbal plants against WSSV has been screened (Citarasu et al., 2006; Balasubramanian et al., 2007,2008). There are also reports of production of polyclonal and monoclonal antibodies to WSSV or immunodominant viral protein for use in immunodot/immunocomb assay (Anil et al., 2002; Makesh et al., 2006; Musthaq et al., 2006b; Patil et al., 2008,2011). A study by Walker et al. (2011a) in Andhra Pradesh indicated a high risk of exposure to WSSV infection during grow-out and that multiple WSSV genotypes were circulating simultaneously in the farming area.
**Yellowhead disease (YHD):**

Yellow head virus (YHV), the etiological agent of YHD, is the most virulent of the shrimp pathogens, commonly causing total crop loss within several days of first signs of disease in the pond. In July 1994, first case of mass mortality of *Penaeus monodon* showing yellowing of the cephalothorax and clinical signs almost similar to YHD, was reported in shrimp in grow-out ponds in Andhra Pradesh. Interestingly, the histopathological features of the affected shrimps were atypical and intranuclear inclusions typical of white spot syndrome virus (WSSV) were present in shrimp showing signs of YHD (Shanker and Mohan, 1998). In the same year, a second epizootic occurred in Andhra Pradesh and densely stained, round intracytoplasmic inclusions typical of YHV infection were found in the lymphoid organ and haematopoietic tissue in addition to the intranuclear inclusions typical of white spot syndrome virus (WSSV), (Mohan et al., 1998). Further, Madhavi et al. (2002) reported YHV infection in *P. monodon* on the basis of presence of basophilic nuclear inclusion bodies in gills, lymphoid organs, hematopoietic and nervous tissues. However, another study on the investigation of the epizootic in Kandaleru creek area in Andhra Pradesh, since July 1994 reported that despite typical signs of YHD, the disease was designated as ‘infectious hepatopancreatic and lymphoid organ necrosis’ based on the histopathology (Vijayan et al., 1997). It was reported that haemocytes were normal and did not show any abnormal characteristics of YHD. Further, the prominent necrotic changes in the hepatopancreas and the absence of pathological changes in the gills indicated that the disease clearly differed from YHD. Hence the diagnosis of YHD in India appears to be a case of misdiagnosis as yellow head virus produces basophilic intracytoplasmic inclusion bodies, being a RNA virus. Further, since these studies did not use more sensitive molecular diagnostic tools, the reports of YHD in India become questionable.

Interestingly, the specimens from India displaying histopathology suggestive of YHV infection have given negative results in immunohistochemical tests with all 3 Mabs (against pathogenic YHV from Thailand), and also in *in situ* hybridization tests with a cDNA probe specific to the ORF1b gene of YHV (Soowannayan et al., 2003). However, the YHV viruses from samples collected from Nellore, Andhra Pradesh have been grouped in genotype 4 of yellow head complex (Wijegoonawardane et al., 2008). Gill-associated virus (genotype 2) and four other known genotypes in the yellow head complex (genotypes 3–6) are known to occur commonly in healthy *Penaeus monodon* in East Africa, Asia and Australia and are rarely or never associated with disease (OIE, 2011). Moreover, histopathology has been recommended for presumptive diagnosis and confirmatory diagnosis must be based on DNA probes, PCR and sequencing (OIE, 2011). It appears in all likelihood that YHV genotype 1, the only known agent of YHD is not present in India and the dual infections reported based on clinical signs, gross lesions and inclusion bodies earlier might have been due to involvement of genotype IV with WSSV.

Yellow head disease has also been reported in QAAD report for the period October to December 2004 and January to March 2005 from Prakasam District of Andhra Pradesh.
on basis of level I diagnosis. However, conclusive evidence needs to be provided with molecular diagnostic tools.

**Spherical Baculovirosis:**
Spherical baculovirosis is considered to be infection with Penaeus monodon-type baculovirus (MBV). The mass mortality of *P. monodon* larvae in hatcheries associated with MBV and IHHNV has been reported from India in 1983 (Felix and Devraj 1983) and this was probably first report on viral infection in shrimps from India. Subsequently, there have been number of reports on prevalence of MBV in *P. monodon* and *P. indicus* on basis of histopathology (Vijayan et al., 1995; Ramasamy et al., 1995, 2000; Manohar et al., 1996; Madhavi et al., 2002; Vaseeharan and Ramasamy 2003) and detection by PCR (Uma et al., 2005,2007; Mishra et al., 2005; Manivannan et al., 2004; Umesha et al., 2006,2008). MBV also has been detected in shrimp samples (3/72) showing signs of slow growth syndrome and post larval samples by nested PCR, (Rai et al. 2009). MBV has been reported to be widely prevalent along both coasts of India.

**Infectious hypodermal and hematopoietic necrosis:**
Infectious hypodermal and hematopoietic necrosis virus (IHHNV) causing mass mortality in a shrimp hatchery in India was first reported in 1983 (Felix and Devraj, 1983) and this report is based on histopathological examination. Severe mortality in cultured *Penaeus monodon* due to IHHNV near Chidambaram, Tamil Nadu (Sheela et al., 1998) and inclusion bodies indicative of IHHNV in subcuticular connective tissue and gills in *P. monodon* (Madhavi et al., 2002) has been reported. However, there are reports that inclusion bodies of WSSV could be easily mistaken as that of IHHNV and detection of IHHNV based of histology may not be precise (Owens et al., 1992; Flegel, 2006). Therefore, the use of molecular methods is recommended for IHHNV detection, particularly for chronic cases. Hatchery rearing of IHHNV infected *P. monodon* nauplii up to 50 days confirmed the virus to be responsible for slow growth (Rai et al. 2009) and the authors suggest that the Indian IHHNV isolate is closely related to South-East Asian isolates. Detection of IHHNV in shrimp is complicated by the fact that certain virus-related sequences are integrated into the genome of *Penaeus monodon*. IHHNV has been detected in *P. vannamei* collected from East and West Coast of India (Moger et al., 2011). The virus being reported as an etiological factor in runt-deformity syndrome (RDS) of cultured juvenile *Penaeus vannamei*, its role in Indian shrimp farming remains to be explored after the importation and culture of this Pacific white shrimp for culture in India.

**Monodon Slow Growth Syndrome (MSGS):**
It is an emerging disease in farmed black tiger shrimp in India. Laem-Singh virus (LSNV) has been detected in *P. monodon* showing the symptoms of MSGS as per case definition, by Central Institute of Brackishwater Aquaculture, Chennai (CIBA, 2011). The presence of Laem-Singh virus in cultured *P. monodon* (3/56) from southwestern and southeastern coasts of India was reported for the first time (Prakasha et al., 2007) and these 3 samples were also positive for WSSV, MBV and HPV. In the year 2007, LSNV has
been detected in *Penaeus monodon* samples from Andhra Pradesh (Sittidilokratna et al., 2009). In addition to *P. monodon*, LSNV has been detected in *Fenneropenaeus merguiensis*, *Metapenaeus dobsoni*, and *Litopenaeus vannamei*, but not in *F. indicus*, *Marsupenaeus japonicus* or *S. serrata* (Kumar et al., 2011). The authors report that LSNV was found to be more prevalent in *P. monodon* followed by *M. dobsoni*, *F. merguiensis*, and *L. vannamei*, where as the LSNV loads were highest in *P. monodon*, followed by *L. vannamei*, *M. dobsoni*, and *F. merguiensis*.

**Hepatopancreatic Disease:**
Hepatopancreatic parvovirus (HPV) infections cause considerable economic losses for shrimp farmers because of retarded growth (Flegel et al., 2004). Most HPV infected shrimps grow very slowly and stop growing at approximately 6 cm in length. Presence of HPV in *P. monodon* postlarvae in India was reported by Manivannan et al. (2002) and Umesha et al. (2003). The Indian HPV is more closely related to Thai HPV than to Korean HPV (Flegel, 2006). The prevalence of HPV in wild and farmed shrimp samples has been studied by nested PCR in India (Manjanaik et al., 2005; Umesha et al., 2006; Rai et al., 2009). HPV infections are frequently reported with other shrimp viruses like MBV, WSSV, LSNV (Prakash et al., 2007; Rai et al., 2009). There is a report that Artemia can be a possible horizontal transmission pathway for HPV (Sivakumar et al., 2009). Recently HPV has been detected in *P. vannamei* collected from East and West Coast of India (Moger et al., 2011).

**White tail disease (WTD):**
White tail disease caused by *Macrobrachium rosenbergii* nodavirus (MrNV) has been observed in larvae and post-larvae of *Macrobrachium rosenbergii* in hatcheries and nursery ponds located at Nellore, Vijayawada and Chennai, India (Sahul-Hameed et al., 2004, Shekhar et al., 2006). The occurrence of natural infection of WTD has also been reported in marine shrimp *P. indicus* and *P. monodon* postlarvae (Ravi et al., 2009). There are reports that MrNV and XSV can be detected in experimentally infected postlarval samples of *M. rosenbergii* at 3 h post infection by nested RT-PCR (Sahul-Hameed et al., 2011).

From India, Taura syndrome, Infectious myonecrosis and crayfish plague have not been reported till date.

**Bacterial Diseases:**
Bacterial diseases are reported to cause a range of problems from growth retardation and sporadic to mass mortalities. *Vibrio* spp. are the most common bacterial pathogens of shrimps and are known to cause serious production loss and mortalities in shrimp hatcheries and farms particularly in postlarvae and juvenile populations (Otta et al., 1999,2001; Karunasagar et al., 2004). The *Vibrio* spp. known to affect shrimp aquaculture include *V. harveyi*, *V. parahaemolyticus*, *V. alginolyticus*, *V. vulnificus*, *V. fluvialis*, *V. anguillarum* and *V. cholerae* (Vaseeharan and Ramasamy, 2003; Abraham and Palaniappan, 2004; Gopal et al., 2005; Haldar et al., 2007; Kannapiran et al., 2009). It has
been reported that antibiotic-resistant vibrios are widespread in the shrimp hatcheries and ponds in India (Otta et al., 2001; Vaseeharan et al., 2005). Studies have been undertaken on bacteriophage therapy, upregulation of immune response genes and immunostimulation with biofilm cells of *Vibrio* spp. (Karunasagar et al., 2007; Nayak et al., 2010; Krupesh Sharma et al., 2010, 2011).

3. Exotic Diseases: Status and Actions Taken:

White spot syndrome virus is reported to have been introduced in the country through *P. monodon* seed brought clandestinely from South East Asian countries. The virus is widely distributed in major shrimp growing regions of the country. The disease has become a major constraint to sustainability and profitability of *P. monodon* production in India. Improved health management for small holder farmers in India is being addressed through better management practice (BMP) programmes that are practical farm level interventions to address the key risk factors. The use of PCR tests to eliminate WSSV-infected seed is a key BMP recommendation. The other BMP recommendations include good pond preparation, water quality management, feed management, health monitoring, pond bottom monitoring, disease management, emergency harvest, harvest and post harvest, food safety and environmental health. Such studies have indicated a low incidence of WSD despite a high prevalence of WSSV infection in non-outbreak ponds (Walker et al., 2011b).

TSV, IMNV and crayfish plague have not been reported from India till date. It is imperative that this status is maintained by taking adequate precautionary measures. Therefore, stringent guidelines have been prepared for import of SPF broodstock and culture of *L. vannamei*. The import of SPF broodstock of *L. vannamei* has been allowed only by hatcheries which have been approved by Coastal Aquaculture Authority. These hatcheries can import broodstock from 9 suppliers shortlisted by CAA for supply of SPF broodstock. The export consignment has to be accompanied by a certificate indicating that broodstock was kept in pre-quarantine for 12 days and tested for presence of WSSV, YHV, IHHNV, IMNV, TSV, BP and NHPB. This testing must be carried out within 10 days of shipment. On arrival, the consignment is kept under quarantine for 5 days at Aquatic Quarantine Facility (AQF) at Rajiv Gandhi Centre for Aquaculture, Chennai. All the samples screened at the facility till date have been found negative for the listed pathogens. The shrimps testing negative are packed in polythene bags with oxygen and handed over to importer. In addition, only the farms approved by CAA can culture SPF *L. vannamei* and shrimp processors can only purchase *L. vannamei* from these farms.

4. Important publications/info materials on impacts of shrimp diseases

There are several positive and negative impacts of brackish water culture. It has a major role in the rural employment and economic development of coastal villages. Shrimp culture contributes a major portion of national income through high export earning. In 2010-11, frozen shrimps contributed Rs. 5718.13 crores out of the total marine product exports of 12901.47 crores. Shrimp exports during 2010-11 increased by 16.02%,
36.72% and 42.90% in quantity, rupee value and US$ value respectively over the previous year (MPEDA, 2011).

Despite the apparent economic success of shrimp farming, it has confronted many developmental problems such as large-scale mortalities due to virus infection, environmental impact, sector competition, over production, trade restrictions, and overcapitalization. Production losses during 1994-1995 due to the viral epizootics have been estimated at 10,000-12,000 tonnes, while the economic loss in 1994 alone was put at US$ 17.6 million. There are reports that farmers were losing Rs 4000-5000 million annually (Mohan and Basavrajapp 2000). In India the annual loss due to white spot disease is estimated to be around Rs. 700–800 crores (TANUVAS 2011). A survey conducted by Central Institute of Brackishwater Aquaculture revealed that the economic loss due to shrimp diseases was estimated to be Rs.1022 crores and that due to slow growth syndrome and white gut disease was Rs. 120 crores annually (CIBA, 2011).

Among the substantial environmental and social problems- including water pollution, salinization of drinking-water wells and paddy fields, destruction of fry of wild fish and crustacean species and various social conflicts related to land conversion - a critical outcome has been the conversion of mangroves to shrimp farms. Practically in all aquaculture systems, operators clearfell the mangrove forest and construct dykes, with sluice gates to retain water. The original tidal regime, which is essential for the survival of mangrove tree species, is totally disturbed. Most of the mangrove flora and fauna hardly survive in shrimp pond areas because of drastic changes caused due to drainage of farm effluents and nutrient depletion.

Shrimp culture has also adversely affected food security through the loss of rice lands due to pond conversion or salinization. Expansion of shrimp farms in Andhra Pradesh and other rice growing areas in south India has turned rice fields into fallow lands. The intensive shrimp farming practice is based on brackish water salinity of 15–25 ppt. Pumping large volumes of underground water to achieve brackish water salinity led to the lowering of groundwater levels, emptying of aquifers, and salinization of adjacent land and waterways. Salinization reduces water supplies not only for agriculture but also for drinking and other domestic needs.

To maintain the very crowded shrimp population and to attain higher production efficiency; artificial feed, chemical additives and antibiotics are used. The unscientific use of antibiotics, drugs and other pharmacologically active compounds can have adverse impact on human health and also on the environment. During January-July 2009, the EU rejected more than 50 shrimp consignments from India due to detection of an antibiotic residue, presence of bacteria, traces of heavy metals and unhygienic condition of the products (Business Standard 2009).

5. Legal/Illegal Introduction of *Litopenaeus vannamei*

In India, illegal introduction of *Litopenaeus vannamei* was reported in about 120 hactare and the original source was from Taiwan Province of China (Brigg’s et al., 2004). In 2003, two firms were given permission to import *L. vannamei* SPF broodstock by the Ministry
of Agriculture from Hawaii, for pilot scale experimentation. The quarantine was to be carried out at the farms of importer as per the detailed Guidelines issued for the purpose. A review of the process indicated that two firms had imported 1740 and 754 SPF broodstock during 2003-2006, with additional approval from Ministry. In one instance, the SPF broodstock imported had exotic pathogens and the stocks were destroyed. To address the issue of increasing demand for SPF broodstock of *L. vannamei*, the Ministry organized an Expert consultation during 2005 with stakeholders, but no consensus could be arrived during the consultation. Thereafter, the Ministry constituted a study group to carry out import risk analysis (IRA) for introduction of *L. vannamei* with Director, CIBA and Director, NBFRGR as members in January 2007.

In IRA, the status of *L. vannamei* culture in the Asian countries was reviewed. It revealed that intensive culture has been successfully carried out with both SPF and non-SPF seed. The hazard identification under the Import Risk Analysis examined the following hazards under Indian conditions –

a) Transmission of the exotic viruses- TSV, YSV, IHNV, Infectious myonecrosis virus (IMNV), Baculovirus penaei (BP) and Necrotising hepatopancreatitis bacterium (NHPB) α-Proteobacterium

b) Effects on biodiversity

c) Environmental effects

d) Socio-environmental effects

The Risk Analysis study identified five scenarios for import of SPF *L. vannamei*. Out of five scenarios, two scenarios i.e. (a) Quarantine facilities under public sector with restriction on the culture practices and (b) Establishment of SPF multiplication centre cum quarantine under public-private partnership with restricted permits for culture were considered low risk and suitable for Indian conditions. The study group suggested that culture of *L. vannamei* should not be allowed in canal or creek based farms. It could only be permitted in specific zones especially in highly biosecure, zero water exchange, sea water based farming systems. A regulatory framework for the importation of *L. vannamei* under the two recommended low-risk categories was suggested indicating the need for developing specific guidelines for the hatcheries and farms.

The Ministry approved the two low risk scenarios and constituted a subcommittee to prepare specific guidelines for large scale introductions of *L. vannamei*. The committee prepared guidelines for establishment and operation of Aquatic Quarantine facilities. These guidelines also suggested the procedures to be followed for pre-border, border and post-border quarantine. Guidelines were also formulated for granting approval to the farms for culture of *vannamei* with no zonation or restriction that culture be restricted to sea water based farming systems. The guidelines for establishing *L. vannamei* broodstock multiplication centres in the country under Public-Private partnership were also proposed.

In pursuance of the Guidelines, the Ministry of Agriculture issued two notifications i.e. Guidelines regulating the method of operation of aquatic quarantine for the import of *Litopenaeus vannamei* in India and Guidelines for regulating Hatcheries and Farms for Introduction of *L. vannamei*. As per notification, the Coastal Aquaculture Authority has
the responsibility to shortlist suppliers of SPF broodstock, approving the hatcheries for seed production and permitting the farms for culturing SPF *L. vannamei*. Nine suppliers have been short listed by Coastal Aquaculture Authority for supply of SPF broodstock of *L. vannamei* (4 from Hawaii, 3 from Thailand, 1 each from Florida and Singapore) till April 2011. Eighteen hatchery operators have been permitted to import 16100 pairs of broodstock of SPF *L. vannamei* for the year 2011-2012. A total of 360 farms with a water spread area of 2961.33 ha have been permitted to culture SPF *L. vannamei*.

An Aquatic Quarantine Facility (AQF) has been set up in Chennai, which started operation in July 2009. The AQF is funded by the National Fisheries Development Board and operates as an extension facility of the Rajiv Gandhi Centre for Aquaculture, a registered society under the Marine Products Export Development Agency. The AQF ensures the SPF status of the *L. vannamei* imported by the shrimp farmers and the hatchery operators with the approval of the Coastal Aquaculture Authority by PCR screening of the seven Office International des Epizooties (OIE)-listed pathogens. In case, any sample tests positive for any of the listed pathogens, the entire stock would be incinerated after confirmation of the results by CIBA, Chennai.

6. Status of National Strategy for Aquatic Animal Health Management:

- Ministry of Agriculture had constituted a committee under chairmanship of Dr. A.G. Ponniah, Director, NBFGR, Lucknow to formulate Strategic Plan and Guidelines on introduction of exotic species and quarantine arrangement for fish in January 2001. NBFGR had prepared 2 documents i.e. ‘National strategic plan for Aquatic Exotics and Quarantine’ which provides a framework for introduction of exotics and quarantine of aquatic organisms in the country. The execution of plan was envisaged in 2 phases i.e. Phase I was for an initial 2 years after which Phase II was supposed to start. The responsibilities of different institutes/organizations were clearly spelt out in the plan. The 2nd document ‘Aquatic Exotics and Quarantine Guidelines’ provided technical details for implementation of ‘Plan’. These documents consider and address the ecological and disease risks associated with introduction of exotic aquatic organisms. Both the documents were approved by the Ministry in November 2002. These were circulated to the Indian states for their comments and in the XI five year plan of India a provision was made for establishing a quarantine system and a national project on surveillance. However, these were not followed up. The ministry’s subsequent efforts for permitting trial introduction of tilapia and *L. vannamei* were drawn from what had been outlined in these two reports. The National Committee on Introduction of Exotic Aquatic organisms into India has the responsibility to evaluate proposals for exotic introduction as well as quarantine. This Committee has experts and Directors of ICAR Fishery Institutes and is chaired by an official of the Ministry. Based on the recommendations of the Committee, the candidate species is allowed to be imported or the proposal is rejected.

Some specific undertaken for aquatic animal health management are as follows:
• Species-specific guidelines (ornamental fish, tilapia etc.) have been formulated based on request for the import of candidate species.

• The Department of Animal Husbandry, Dairying and Fisheries (DAHDF), MOA has been coordinating the national disease reporting system due to its linkages with State Fisheries Departments and has been sending regularly information to NACA. The quarterly disease reports sent by State Fisheries Departments are collated by DAHDF in form of Quarterly Aquatic Animal Diseases report and forwarded to NACA. The personnel in State Fisheries departments need training in disease diagnosis and more coordination is required between State Fisheries Departments, Research Institutes and private laboratories. Some of the outbreaks have been reported in basis of level I diagnosis without confirmation. The report of private laboratories for shrimp pathogens is not reflected in QAAD report. Though the first paper on occurrence of white tail disease from India was published in 2004, yet it has been reflected recently in QAAD report.

• There has been vast improvement in capability to diagnose diseases of aquatic animals over last decade. A number of laboratories have established over last few years which can screen the shrimp population for a number of pathogens. Shrimp pathogens like Laem Singh virus, infectious hypodermal and hematopoietic necrosis virus as well as Macrobrachium rosenbergii nodavirus have been detected in the country recently. L. vannamei broodstock is being screened for WSSV, YHV/GAV, IHHNV, IMNV, TSV, Necrotising hepatopancreatitis bacterium and Baculovirus penaei. The first national proficiency testing in India indicate that less than 50% of the participating laboratories were able to correctly identify standard positive and negative tests (Walker and Mohan 2009). Subsequent two such ring tests conducted by CIBA and MPEDA indicated significant improvement over the first ring test.

• The country has established an Aquatic Quarantine Facility (AQF) in Chennai, which started operation in July 2009. The AQF ensures the SPF status of the L. vannamei imported by PCR screening of the seven OIE-listed pathogens. However, this facility alone is unable to cater to the ever increasing demand for import of SPF broodstock.

• The Ministry of Agriculture has issued two notifications under the Livestock Importation Act, 1898 and Coastal Aquaculture Authority Act, 2005 regarding Guidelines regulating the method of operation of aquatic quarantine for the import of Litopenaeus vannamei in India and Guidelines for regulating Hatcheries and Farms for Introduction of L. vannamei, respectively.

• The Ministry of Agriculture is presently shortlisting applications for setting up Multiplication Centers for SPF P. monodon and L. vannamei seed.

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1. INTRODUCTION

Malaysia lies within 100° and 119° East longitudes, and 7° North latitude (Figure 1). Neighboring countries are Thailand to the north and Singapore to the south. The country consists of two land masses with a total area of 330,434 square kilometers: Peninsular Malaysia is located south of Thailand, while East Malaysia, comprising the states of Sabah and Sarawak, stretches along the northern part of Borneo. The two land masses are separated by the South China Sea.

Malaysia has a total coastline of 4,675 km, with 2,068 km for the Peninsula and about 2,607 km for East Malaysia. It is on a strategic location along Straits of Malacca and southern South China Sea.

Fisheries and aquaculture play an essential role as a source of food fish supply, employment and export earnings for Malaysia. Beside food fish we also produce about 600
million pieces of ornamental fish annually. In 2010, an estimated 120 thousand people were directly engaged in primary production of fish either in capture from the wild or in aquaculture. This sector also enjoying not less than RM0.5 billion (USD 1.7 billion) surplus in trade every year.

Malaysia is taking a new shift in priority towards aquaculture and is aggressively promoting it as an important engine of growth. This is amongst the food security strategy to reduce gap between supplies against demand of food fish. Production from aquaculture can also lessen pressure on capture fisheries. Aquaculture products also generate foreign exchange earnings.

2. STATUS OF COASTAL SHRIMP AND FISH FARMING IN MALAYSIA

In 2010, fisheries sub sector showed an increase of 3.77% in production which is a total 1,777,366 tones compared to 1,710,301 tones in 2009. However at the same time it showed a decreased of 23% in value which is a total of RM 6,579 million compared to RM 8,546 million in 2009. Both captured fisheries and aquaculture contributed 1,415,211 tones and 362,155 tones respectively to the national fish production.

Coastal fisheries and deep sea fisheries contributes 79.6% of the national fish production. Landing from deep sea fisheries showed a downturn to 316,304 tones from 1,376,850 tones in 2009. However it showed a rise in production from coastal fisheries from 1,080,379 tones in 2009 to 1,098,906 tones. Deep sea fisheries showed an increased in value totaling of RM 1,271 million compared to RM 1,164 million in 2009. Coastal fisheries contributed RM 5,305 million compared to RM 4,907 million in 2009.

Aquaculture showed a rise of 7.93% in production which is a total of 362,155 tones compared to 333,450 tones in 2009. The production value itself as well increased to RM2,522 million out of RM2,295 million in 2009. Brackish water aquaculture stays as the main contributor of 205,931 tones compared to freshwater, 156,224 tones.

Under the 10th Malaysia Plan, aquaculture is identified as one of the thrust areas for fisheries development. The sector has been projected to contribute significantly towards providing food security, foreign exchange and employment in the country. Aquaculture production in the year 2015 has been targeted at 727,300 metric tons with an estimated value of RM7 billion (US$ 2.3 billion).
There were significant increase in production of freshwater and shrimp over the last decade. The local aquaculture responded rightly to the increasing demand of tilapia, catfish and shrimp in domestic and export market. Coastal shrimp and marine finfish productions trend from aquaculture showed relatively significant increase from 11,259 tons metric in 2005 to 22,521 tons metric in 2009 and from 35,104 tons metric in 2005 to 80,529 tons metric in 2009.

CURENT TRADE PRACTICE
In Malaysia, trade practice for export of fishery commodities such as marine finfish and shrimp are mostly chilled and frozen and rarely for marine finfish by live trade. For export chilled and frozen, the product from coastal fisheries or deep sea fisheries will process at registered establishment before export by cargo. For live fish export, the fish must come from registered farm and registered importer only can by the fish from registered farm before allow exporting.

3. COASTAL SHRIMP AND FISH DISEASE STATUS
With the development and intensification on aquaculture production in Malaysia and the consequence occurrence and spread of various diseases, aquatic animal health management has become an important aspect for sustainable aquaculture development. Based from Quarterly Aquatic Animal Report (Asia and Pacific Region) Year 2006- 2010, the marine finfish and marine shrimp diseases so far reported in the country are listed in the table below:
### Table 1: Status of Marine Fish Diseases in Malaysia

<table>
<thead>
<tr>
<th>#</th>
<th>FISH DISEASE</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Epizootic Ulcerative Syndrome (EUS) Last reported 1986</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>Viral Encephalopathy and Retinopathy (VER)</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Red Seabream Iridoviral Disease (RSIV)</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

### Table 2: Status of Marine Shrimp Diseases in Malaysia

<table>
<thead>
<tr>
<th>#</th>
<th>SHRIMP DISEASE</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Taura Syndrome (TSV)</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>White Spot Disease (WSSV)</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>3</td>
<td>Yellowhead Disease (YHD)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>Infectious Hypodermal and Haematopoietic Necrosis (IHHNV)</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
</tbody>
</table>

**Notes for symbols:**
- Disease reported or known to be present (+)
- No reported cases (-)
- Suspected but presence not confirmed (?)
The major threats to marine finfish and marine shrimp are:

i) Viral Encephalopathy and Retinopathy (VER), also been a major threat to the local industry and mainly affect seabass (*Lates Calcarifer*) and Grouper (*Epinephelus* sp.). Clinical signs show bloated stomach, rapid operculum movement and exophthalmia.

ii) White Spot Syndrome Virus (WSSV) also caused losses to the local farmers especially in white shrimp (*P. vannamei*).

The new emerging disease:

Malaysia has carried out a surveillance program for Infectious Myonecrosis Virus Disease (IMNV) since 2010. There are 8 marine shrimp farm involve in this program with 100 samples. To date, no positive result found.

Since early 2010, few increase mortality cases are reported in Perak and Pahang. It occurred in *P. vannamei* that caused 30 to 50% losses to the farmers. Suspected disease is the Early Mortality Stage (EMS). The cause of the EMS still not identified. Department of Fisheries Malaysia (DOF) cooperates with the industry to overcome the problem.

4. NATIONAL STRATEGIES FOR AQUATIC ANIMAL HEALTH

The Department of Fisheries (DOF) Malaysia has developed a system to prevent and control of aquatic animal diseases. Malaysia is now implementing an Aquatic Animal Health Action Plan to solve problems of transboundary pathogens or diseases transfer after European Union (EU) banned the import of coldwater ornamental fish from Malaysia such as Koi (*Cyprinus carpio*) and Gold Fish (*Carassius auratus*) since July 2008.

The strategic plans for aquatic animal health are as follows; (1) Strengthening legislation, (2) Enhancing import and export requirements, (3) Implementing disease surveillance, (4) Strengthening diagnostic capacity, (5) Improving capacity building

Malaysian Competent Authority (CA) need to put all the official controls in place to provide guarantees that is equivalent to the importing countries requirements such as European Countries and other countries.
4.1. **STRENGTHENING LEGISLATION & REGULATION**

Under legislation, Malaysia has to abide by the Fisheries Act 1985 (Act 317) Amendment 1993. For marine shrimp importation control, an Aquaculture Circular had issued in 2005 to enforce Conditions of importation of *Litopenaeus vannamei* broodstock starting 1 April 2005.

Since 2010, a new Health Certificate requirement of live fish including shrimp has been implemented for controlling transboundary movement of live fish by phase. In 2012, the Department of Fisheries Malaysia will enforce regulation on Fish Disease Control Compliance for Import and Export of Live Fish and Inland Fisheries.

4.1.1. **Current Regulations**

i) Fisheries Act 1985, Under Section 40 [Act 317] on control of live fish

ii) The Fisheries (Quality Control of Fish for Export to the European Union) Regulation 2009 (amendment 2010)

iii) The Fisheries (Prohibition of Import, etc of Fish) Regulations 1990 (amendment 2011)

4.2. **ENHANCING IMPORT AND EXPORT REQUIREMENTS**

4.2.1. **Import Requirements**

Under Section 40 on Control of Live Fish, Fisheries Act 1985 (Act 317), the Department of Fisheries (DOF) is introducing new measures to control transboundary movement of live fish. Malaysia has notified World Trade Organization (WTO) on the import condition of live fish into Malaysia on 29 June 2009 amended 2011.

The main contents of the notification are as follows:

i) Exporting country shall ensure that the fish are sourced from approved farm and under official control of the Competent Authority (CA).
ii) Health Certificate shall be issued by the Competent Authority (CA) of the exporting country.

iii) Exporting country shall ensure that the fish consignment originated from OIE listed diseases free zone. There should not be any disease outbreak for a period of two years prior to export.

**Conditions for importation of live fish into Malaysia**

The exporting country shall export to the importers who are registered with the Department of Fisheries Malaysia.

A health certificate must be presented at the entry point together with the live fish consignment. The health certificate must be issued by the competent authority of the exporting country, signed by authorized officer and contained information as follows;

i) Name and address of exporter

ii) Name and address of destination/importer

iii) Name (scientific and common name), size and number of live fish.

iv) Origin of the live fish.

v) The live fish must come from an officially recognized country, zone, farm or establishment unaffected by the OIE listed diseases. The live fish have been subjected to an aquatic animal health surveillance programme according to the procedures as described in the “Aquatic Animal Health Code” from Office International Des Epizooties (OIE).

vi) The live fish have been inspected by the competent authority of the exporting country within 72 hours of export date and showed no clinical sign of diseases.

vii) The live fish must not come from any source that had an unusual mortality during the previous six (6) months, which the cause could not be confirmed. The fish have not been subjected to any prohibitions due to unresolved increased mortality.
viii) Live fish must be quarantined for at least 14 days in approved quarantine area in the exporting country and showed no clinical sign of diseases prior to export.

ix) Exporting country shall ensure that the fish consignment originated from OIE listed diseases free country, zone, farm or establishment. There should not be any disease outbreak for a period of two years prior to export.

The imported live fish is subjected to quarantine at the registered importer’s premise within 7 to 21 days depending on the species. Registered importers shall also comply to any post import measures imposed by the Department of Fisheries.

4.2.2. Export Requirements

Department of Fisheries Malaysia has set conditions for export of live fish and inspection shall be carried out at register exporter premise to ensure:

i) The fish are sourced from registered farm under Department of Fisheries Malaysia and not associated with any significant diseases or pest within the previous 6 (six) months.

ii) The consignment was inspected by DoF 7 days prior to shipment.

iii) The live fish have been subjected to a health surveillance program according to the procedures as described in the “Diagnostic Manual for Aquatic Animal Diseases” from Office International Des Epizooties (OIE).

iv) The consignment originated from OIE listed diseases free zone. There is no any disease outbreak for a period of two years prior to export.

v) The consignment are not subject to any prohibitions due to unresolved increased mortality.

vi) The fish being held for 14 days prior to export at the exporter premises and show no clinical signs of disease.
vii) The fish are not being kept in same water with farm foodfish (fish farm for human consumption including recreational fishing) or koi carp.

viii) Adequate safeguard are in place to maintain certified fish health status until export.

4.3. IMPLEMENTING DISEASE SURVEILLANCE

Fish health surveillance and inspection programme is an official control programme implement by Department of Fisheries (DOF). The scope of surveillance and inspection of aquatic animal health covers aquaculture farms, importer and exporter premises. Disease surveillance programmes for fish and shrimp were carried out at least twice (2) a year. The status of marine shrimp diseases so far are listed in the tables below:

<table>
<thead>
<tr>
<th>NO.</th>
<th>SURVEILLANCE</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Number of farm / premise</td>
<td>-</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>Species</td>
<td>-</td>
<td>L. Calcarifer Ephinephelus sp.</td>
<td>L. Calcarifer Ephinephelus sp.</td>
</tr>
<tr>
<td>3</td>
<td>Result</td>
<td>-</td>
<td>-ve (Iridovirus, VNN)</td>
<td>-ve (Iridovirus, VNN)</td>
</tr>
</tbody>
</table>

Table 3: Status of Marine Finfish Diseases Surveillance Program

<table>
<thead>
<tr>
<th>NO.</th>
<th>SURVEILLANCE</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Number of farm</td>
<td>37</td>
<td>38</td>
<td>11</td>
</tr>
<tr>
<td>2</td>
<td>Species</td>
<td>P. vannamei P. monodon</td>
<td>P. vannamei P. monodon</td>
<td>P. vannamei P. monodon</td>
</tr>
<tr>
<td>3</td>
<td>Result</td>
<td>+ve (IHHNV) +ve (WSSV)</td>
<td>+ve (IHHNV) +ve (WSSV)</td>
<td>-ve</td>
</tr>
</tbody>
</table>

Table 4: Status of Marine Shrimp Diseases Surveillance Program
4.4. STRENGTHENING DIAGNOSTIC CAPACITY.

Malaysia is in progress to strengthen diagnostic capacity for aquatic animal health laboratories. At present, there are two (2) designated laboratories to analyze shrimp disease especially for OIE listed disease such as White Spot Syndrome Virus (WSSV), Yellow Head Disease (YHD), Infectious Hypodermal Hematopoietic Necrosis Virus (IHHNV), Taura Syndrome Virus (TSV) and Infectious Myonecrosis Virus (IMNV) which located in Northern and Southern of Peninsula Malaysia.

Both of designated laboratories are using molecular (PCR and Reverse-Transcription (RT) PCR) analysis method which is recommended by OIE. In 2012, Malaysia has target this two laboratory has award ISO 17025 accreditation.

4.5. IMPROVING CAPACITY BUILDING

Malaysia has been sent the relevant staff to attend training program at international, regional and national level regarding laboratory analysis and fish health control for improve capacity building. This program will continuously …. Among of the training program has been conduct and attend is stated below:

4.5.1. International and Regional Training
   i. Training & Testing On Aquatic Animal Health, OIE Reference Labarotory (CEFAS)
   ii. Training & Testing On Epizootic Ulcerative Syndrome, AHHRI Thailand
   iii. Training on Infectious Myonecrosis Virus Diagnostic at Fish Health Laboratory Banten, Indonesia.
   iv. Training & Testing On Epizootic Haematopoietic Necrosis, AVA Singapore

4.5.2. National Training
   i. OIE Training course for Implementation of Epidemiology & surveillance Programme
   ii. Fish Diagnostic Training Level 1, Level 2 and Level 3 for staffs
   iii. Fish Histopathology Training
5. PUBLICATIONS/INFO MATERIALS ON IMPACTS OF SHRIMP DISEASES ON TRADE


5.4. Code of Conduct (COP) for Shrimp Culture

5.5. WTO Notification - G/SPS/MYS/20 Amendment 1

5.6. WTO Notification - G/SPS/MYS/25

6. CONCLUSION

Malaysia aquaculture productions from coastal shrimp and marine finfish are showed relatively significant increase 100% and 130% within 2005 to 2009. To ensure the sustainability of finfish and shrimp production from aquaculture and capture, the biosecurity requirements need to be in place and implementing properly.

Competent Authority should develop strategic plan for aquatic animal health program with strengthening the capacity regarding legislation, capacity building, diagnostic capacity and disease surveillance to ensure all the biosecurity requirements are meet and equivalent to the international and national standard.
The growing demand for aquatic products, both for food and (ornamental trade?) aquarium industry, has resulted in lot of attention being diverted(?) toward aquaculture. While aquaculture production in the world, including the South East Asian region, increased drastically, the Maldives is still very heavily dependent on wild catch. However, the need for diversification of the fisheries sector arose from reduced catch of certain commercially important marine species, particularly tuna in recent years.

The development of an aquaculture industry is now a major focus of the Government of the Maldives, both for conservation and Livelihood purposes. The current aquaculture policy of the government is to engage the private sector in aquaculture production while the government manages aquaculture, and formulates and implements aquaculture policies. To encourage private sector involvement in aquaculture, the government provides incentives in the form of easy access to loans, subsidized rates for long term land and lagoon rent and provision of training. In addition, a project for the establishment of a national hatchery and a quarantine facility is in the pipeline to provide aquaculture development support services to the private sector.

To date, there is only one commercial aquaculture farm in the country, producing approximately 7 tones of sea cucumbers (sandfish) per year. The Marine Research Centre of the Ministry of Fisheries and Agriculture has been carrying out research into the potential aquaculture species in the country. In this regard, pilot scale projects were carried out on selected species of food fish, aquarium fish and pearl oysters, namely Brown marbled grouper, Maldives clownfish and Penguin shell, respectively.

There has been an increased interest for aquaculture development within the private sector in the recent years, especially in the production of high valued marine species, including species alien to Maldivian waters. Such species have not yet been introduced into the country; however the
introduction of exotic species into the country is a major concern of the government, considering the potential environmental and fisheries implications of such introductions.

The introduction of species such as the tiger shrimp, *Penaeus monodon*, and Asian seabass, *Lates calcarifer*, have several concerning issues. Noteworthy is the fact that Maldives, with 99% of its area covered by sea and very little available land area, will need to consider the development of sea-based aquaculture rather than those forms of land-based aquaculture that need extensive land area. The option of sea-based aquaculture development appears to be more technically and financially feasible. No risk assessment has been carried out to identify the impacts of introducing these exotic species into the marine environments. The impacts of escaped animals from mariculture facilities on the wild stock remain to be identified. Furthermore, currently the Maldives does not have the capacity to detect pathogens of importance in aquaculture. There is no aquatic health monitoring facility in the country, nor a system for certifying health status of aquatic animals; hence the introduction of exotic species that may potentially carry some harmful pathogens (for example, OIE modifiable shrimp and fish diseases), and ones that have the potential for transmission to the wild stock is of concern. For these reasons, the Maldivian government encourages investments in the aquaculture of high valued local species rather than introduced exotic species, least at the current initial stages of aquaculture development in the country.
REGIONAL EXPERT GROUP WORKSHOP
ON
TRANSBOUNDARY AQUATIC ANIMAL HEALTH
ISSUES IN THE BAY
OF BENGAL

12-13 January 2012
(Bangkok, Thailand)

May Thandar Wint
Fishery Officer
&
Yi Yi Cho
Deputy Fishery Officer
Department of Fisheries
Myanmar

18th October, 2011
A. Introduction

In the Republic of the Union of Myanmar, generally, few diseases have been detected in aquatic animals both in capture and culture fisheries. The distinct invasion is the occurrences of White Spot Syndrome Virus (WSSV) and Yellow Head Disease (YHV) in tiger shrimp culture ponds. These causatives are envisaged to be the transboundary invasion and infested in shrimp farms in Rakhine State, Yangon and Ayeyarwady Divisions. The WSSV infection was severe and caused a massive lost. The PCR diagnosis could have been applied since 2003 and some other disease are also been traced such as Infectious Hypodermal and Haematopoietic Necrosis Virus (IHNV) in larvae and Broodstock of tiger shrimps.

The transboundary movement of live aquatic animals for culture purpose is only *P. vannamei* for import and the movement (out going) of live fish and crustaceans (groupers, mud crab, lobsters, squilla, fresh water eels, and ornamental fishes) are being practiced. In the trading of live aquatic animal has been practiced inspection prior to exporting to the buyers' destination. In this regard, commodities are subject to be Healthy and Free From Any Clinical Sign of disease at the time of examination.

B. Status of coastal shrimp and fish farming

B.1 Coastal shrimp Culture

Grow-out culture of marine shrimp, *Penaeus monodon* has been initiated since early 1980 practicing traditional trap and hold system particularly in western coastal area. Natural post-larvae of *Penaeus monodon* were trapped into the pond during the high tide period through sluice gates. There were no inputs in terms of pond preparation, eradication of predators, water fertilization, feeding etc. However 30 to50 kilograms of large size of shrimp were harvested. As the ponds were usually as large as 50 to 100 hectares, the shrimp production could make more than enough money for the shrimp farmers. Having no laws concerned with aquaculture, those shrimp ponds existed as illegal ponds up to 1990. Only in 2000, the State Level Committee that was the Shrimp Aquaculture Development Committee formulated and implemented there years project plan of shrimp aquaculture development in Myanmar.

Before the project plan, existed shrimp ponds area was 67445 acre. After the project in 2003, the shrimp pond area became 199960 acre but it consisted of 5250 acre of semi-intensive or intensive shrimp ponds.
As of 2010-2011 Myanmar has three types of shrimp farming; Semi-intensive shrimp ponds 4270.41 acres, Extensive plus shrimp ponds 80200.04 acres and Extensive of traditional shrimp ponds 130332.02 acres totaling 214802.47 acres and production from those ponds were reported at 55441.31 MT.

**B.2 Coastal Marine Finfish Culture**

Myanmar has many commercial and culturable species such as grouper, snapper, seabass, mullet, milkfish etc. Among these species, grouper, snapper and sea bass are found as the most common and popular species that command the high price. There are 3-4 private farms that culture groupers in net cages. Marine net cage farming is found to be lucrative despite the constraints of quality seed and technology requirement. In the development of marine fin fish aquaculture, adequate seed supply to meet the requirement becomes main constraint. The species are grouper, red snapper and sea bass and their seeds are being collected from the wild as seed production technology is not yet developed. However, Seabass(*Lates calcarifer*) and grouper(*Epinephelus malabaricus*) seed production have been successful in 2004 and 2010 in Department of Fisheries.
C. Known shrimp diseases (including OIE-listed diseases) occurring in the country

The outbreak of disease due to Trans boundary was found on tiger shrimp, *Penaeus monodon* by White Spot Syndrome Virus (WSSV) and only a few have detected until 2011 and now have not seen in PCR Lab.

D. Status of *Penaeus vannamei* farming

Department of Fisheries as the sole competent authority of fishers sector, fully understands that *Penaeus vannamei* has the many advantageous factors for culture but it may also cause the negative impact to other shrimp aquaculture industry. DOF has been aware that *vannamei* may carry and outbreak the Taura Syndrome Virus (TSV). After a regional workshop in 2005 at Manila, that assessed the culture of *vannamei* ASEAN countries agreed to culture at reasonable documentation. At present 3-4 private farms are trying experimental culture of *vannamei*.

E. Status of national strategies for aquatic animal health management

Myanmar’s National Strategy frame work on aquatic animal health was developed during national workshop held in Yangon on 10-11 April 2002. Also, the technical mission to Myanmar was undertaken from 3rd to 9th September 2006 with the intention of supporting the development and implementation National strategies on aquatic animal health. Specifically this was a follow up activity to the first set of 2 policy workshops and one training workshop, to provide further identified country specific action plans.

Myanmar DOF has two laboratories, Main laboratory in Yangon and the other in Nyaung Done (Ayeyarwady, Region). The disease control unit has assigned mobile teams to monitor and surveillance of fish pond in strategic areas. Quarterly report on fish disease has been regularly sent to NACA, OIE since 1998 to up to date.

Myanmar DOF is highly aware of transboundary aquatic animal pathogen, DOF expand the disease control unit into new set up of organization to conduct for field survey diagnostics and assigned officials at air port and sea ports and border trade areas to closely check and counter check for every export and import. Health Certificates are issues after examined and found to be healthy and free from any clinical sign of disease at the time of examination.
F. Transboundary issues associated with shrimp farming

1) Introduction of alien aquatic species should be only made prior to consideration for safeguarding natural resources and ecosystems
2) If some species, that may not cause negative impact to conservation of fishery resources and ecosystem, are decided to be introduced, awareness on prior and reliable reporting should be conducted.
3) The culture of alien aquatic species should be facilitated through good aquaculture practice (GAP) and/or environment friendly aquaculture practices.
4) An introduced alien species should be genetically upgraded through high health management and screening method so as to sustain specific pathogen free (SPF) parent stock.
5) Collaboration among regional and global scientists should be implemented to study cause and effect on conservation of ecosystem prior to introduction of alien aquatic species.

G. Conclusion

The aquatic animal health management is the challenging factor in aquaculture development. It is most important issue for developing countries where the transboundary pathogens is common. In this regard, the collaborated implementing programs conducted in the region for counter measure is so far the best. Myanmar needs to empower and impart technical know-how and practical experiences.
Country Report- Sri Lanka
Regional Expert Group Workshop on Transboundary Aquatic Animal Health Issues in the Bay of Bengal
3-4 November 2011

J.A. Saminda Lakmal (Aquaculturist)
R.M.N.P.K. Ranathunga (Aquaculturist)

National Aquaculture Development Authority of Sri Lanka
1. Introduction

Sri Lanka is an Island situated in the Indian Ocean to the South of India, between longitudes 80° to 82° East and latitudes 6° to 10° North. The Island has an area of 65,610 km² and a coastline of 1800 km. Since the declaration of the Exclusive Economic Zone (EEZ) in 1976, Sri Lanka gained covering rights over 233,000 km² of the Ocean. Considering the topography of the country, about 75% of the land is seem to consist of a flat lowland peneplain with an average elevation of 5m above sea level, which includes the Northern half of the country and in the Southern half forms a broad strip along the East west and a narrow strip along the Southern and Western seaboard. The rest is the South Central mountain massive which goes up to an elevation of 2500m. The current population of Sri Lanka is about 20.56 million and 75% of these still live in rural areas.

1.1 Short Review of Fisheries and Aquaculture

Fisheries and aquaculture have been identified as an important sector in Sri Lankan economy in view of its contribution to food security and nutrition of the masses, employment especially in coastal belt, and foreign exchange earnings which contributes 2.4% to the total export earnings. Currently it produces about 400,000 Mt of fish annually both from marine and inland fisheries and employees about 475,000 people both directly and indirectly and their by provide livelihood to population over 2.5 million. Fish contribute 70% to the animal protein intake of the masses. The sector earns USD 200 million annually by the export of high value fishery products such as shrimps, lobsters, tuna, shark fins and ornamental fish. The current contribution of the aquaculture and fisheries to the GDP is in the range 2-3%. Present per capita fish consumption is 13.4 Kg per person and the governmental has planned to increase the fish production up to 685,700 Mt in 2013 with a view to reach the per annum per capita fish consumption up to 22 Kg. which considered as the minimum level for healthy life.
Figure 1 shows the past trends in the fisheries and aquaculture productions together with future targets.

![Fish Production and Targets](image)

**Figure 1: Fish Production and Targets**

Source: Statistics Unit of MFARD

1.2 **Water Resources for Aquaculture and Fisheries in Sri Lanka**

Sri Lanka is blessed with vast inland water resources including a well-developed irrigation systems comprising of various types of perennial and seasonal man made reservoirs. The Island possesses 3% of its land area under water which is considered as one of the highest land to water ratio in the world.

Sri Lanka has an exclusive economic zone (EEZ) of 517,000km². The continental shelf which is comparatively narrow with an average width of 22km covers an area of 30,000km² of the EEZ. It has been estimated that the EEZ could be produce about 400,000 tons of fish annually.

There are 45 major brackish water lagoons and estuaries, which spread along the coastline of the country with the total area of 158,000ha. Total of 260,00ha of fresh water bodies comprising 155,000ha perennial reservoirs, 100,000ha seasonal reservoirs about 5,000ha flood-plain lakes which are the only natural lakes exist scattered all over the country. It has been estimated that inland waters of the country have the potential to produce 100,000 tons of fish annually. The
current production from inland water is around 55,000 tons. Fish export is totally in the hands of private sector. There are 34 factories process fish and shrimp for export. All of them conform to the standards stipulated by the European Union. Around 17,568 Metric tons of fish and fishery products which valued Rupees 20,023 million were exported in 2010. The main buyers were EU (54%), non EU (23%), and Japan (13%). Major export products are food fish (Tuna), shrimps, ornamental fish, crabs, beche de mer, lobster etc. Tuna (food fish) and tuna products covers over 70 percent of the total exports.

**Table 1: Export Value of Fish and Fishery products (Rs. Mn)**

<table>
<thead>
<tr>
<th>Item</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Live fish</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td>Prawns</td>
<td>1,837</td>
<td>2,023</td>
<td>854</td>
<td>1,432</td>
<td>1,262</td>
</tr>
<tr>
<td>Lobsters</td>
<td>168</td>
<td>184</td>
<td>249</td>
<td>133</td>
<td>166</td>
</tr>
<tr>
<td>Crabs</td>
<td>568</td>
<td>1,151</td>
<td>1,283</td>
<td>2,048</td>
<td>1,848</td>
</tr>
<tr>
<td>Beche de mer</td>
<td>153</td>
<td>208</td>
<td>180</td>
<td>105</td>
<td>178</td>
</tr>
<tr>
<td>Other Moluscus</td>
<td>106</td>
<td>713</td>
<td>1,460</td>
<td>241</td>
<td>496</td>
</tr>
<tr>
<td>Shark fins</td>
<td>75</td>
<td>51</td>
<td>65</td>
<td>69</td>
<td></td>
</tr>
<tr>
<td>Fish maws</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Chank &amp; shells</td>
<td>451</td>
<td>564</td>
<td>493</td>
<td>451</td>
<td>617</td>
</tr>
<tr>
<td>Food Fish</td>
<td>14,301</td>
<td>15,473</td>
<td>15,014</td>
<td>13,857</td>
<td>13,372</td>
</tr>
<tr>
<td>Other</td>
<td>987</td>
<td>1,039</td>
<td>1,008</td>
<td>381</td>
<td>317</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>18,646</strong></td>
<td><strong>21,422</strong></td>
<td><strong>20,594</strong></td>
<td><strong>18,714</strong></td>
<td><strong>18,325</strong></td>
</tr>
</tbody>
</table>

Source: Statistics Unit of MFARD

1.3 **Status of Coastal Aquaculture**

There are no traditional practices of aquaculture in Sri Lanka. Aquaculture in Sri Lanka is a relatively new development, with interest in fish culture first appearing during the 1950’s. Shrimp culture (*Peneaus monodon*) started in the early 1980’s and the first commercial production entered the market in 1984. In addition to shrimp culture and ornamental fish culture, oyster, mussels, crabs are cultured small scale level and extensively. But lack of interest among private sector, insufficient quality seed production and undeveloped hatchery techniques are the major constraints to develop these cultures. Introduced Sea bass (*Lates calcarifer*) culture in ponds and cages could produce 150 mt during the year. Shrimp, Crabs and Oyster farming has been started in Northern and Eastern regions after the end of civil war.
1.4 Shrimp Aquaculture

In Sri Lanka brackish water shrimp farming has commenced in late 1970’s. But the farming becomes well known in early 1980’s (Jayasinghe, 1995). Large areas of land adjacent to lagoons have been utilized for shrimp culture which developed rapidly on the western and North Western coasts in the mid-1980s (Wijegoonawardena & Siriwardana, 1995).

The first commercial production enters the market in 1984 (Jayasinghe, 1995). Black tiger shrimp (*Penaeus monodon*) is the main culture species in Sri Lanka, which is completely export oriented.

According to statistics available in Ministry of Fisheries, Japan is the major market for Sri Lankan shrimp which import 1,273.2 mt from Sri Lanka in year 2009. Also it provides around 40000 direct and indirect job opportunities (Chandraratne, 2005).

Narrow coastal belt of 120 km of Puttlam district in North Western province facilitates for more than 90 % of the shrimp farming in Sri Lanka (Chandraratne, 2005). Some farms are developed in the Eastern coastal area of the country bordering to the Batticaloa lagoon (Chandraratne, 2005). Also a few farms are operated around Negombo lagoon in Gampha district. As per the records of 2005 there have been about 1434 shrimp farms with a total extent of 4539 ha in Sri Lanka (Chandraratne, 2005). According to Jayasinghe, 1996 there were 925 farms in an area of 3500 ha where annual post larvae demand was 550 millions in year 1996.

The recent study of Munasinghe et.al. (2010) shows that 90 percent of farms in the main shrimp growing region is operated under semi-intensive method in earthen ponds. 50% of farms are less than 1ha , 73% are less than 2ha, 18% are between 2 ha to 5ha and only 9% are larger than 5ha. The production cycle is between 140 and 160 days with 1.8 culture cycles completed within a year. The present stocking density used in shrimp farms is around 15 Pls m² (Munasinghe et al., 2010). The shrimp farming was done in 1,957 ponds in 667 farms and the production was 3,480 Mt in 2010. At present, 53 shrimp hatcheries are functioning and around 800 millions post-larvae are produced annually (records at Shrimp Monitoring Unit, NAQDA, 2010). At present shrimp is the top most export earning aquaculture practice in the country. The table 2 shows the shrimp production of the country over last two decades.
Table 2: Shrimp Production in Sri Lanka (Mt)

<table>
<thead>
<tr>
<th>Year</th>
<th>Shrimps</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Aquaculture</td>
<td>Wild Capture</td>
<td>Total</td>
<td></td>
</tr>
<tr>
<td>1990</td>
<td>680</td>
<td>4,470</td>
<td>5,150</td>
<td></td>
</tr>
<tr>
<td>1995</td>
<td>3,600</td>
<td>7,500</td>
<td>11,100</td>
<td></td>
</tr>
<tr>
<td>1999</td>
<td>3,820</td>
<td>7,680</td>
<td>11,500</td>
<td></td>
</tr>
<tr>
<td>2000</td>
<td>4,360</td>
<td>7,540</td>
<td>11,900</td>
<td></td>
</tr>
<tr>
<td>2001</td>
<td>3,540</td>
<td>7,360</td>
<td>10,900</td>
<td></td>
</tr>
<tr>
<td>2002</td>
<td>2,560</td>
<td>9,820</td>
<td>12,380</td>
<td></td>
</tr>
<tr>
<td>2004</td>
<td>2,390</td>
<td>10,730</td>
<td>13,120</td>
<td></td>
</tr>
<tr>
<td>2005</td>
<td>1,570</td>
<td>4,680</td>
<td>6,250</td>
<td></td>
</tr>
<tr>
<td>2006</td>
<td>2,480</td>
<td>7,840</td>
<td>10,320</td>
<td></td>
</tr>
<tr>
<td>2007</td>
<td>3,580</td>
<td>7,320</td>
<td>10,900</td>
<td></td>
</tr>
<tr>
<td>2008</td>
<td>2,230</td>
<td>9,240</td>
<td>11,470</td>
<td></td>
</tr>
<tr>
<td>2009</td>
<td>3,550</td>
<td>13,110</td>
<td>16,660</td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>3,480</td>
<td>17,640</td>
<td>21,120</td>
<td></td>
</tr>
</tbody>
</table>

Source: Statistics Unit of MFAR

2. Shrimp diseases in the country

Among the diseases of shrimp farming fungal and bacterial diseases are considered as opportunistic infections and viral diseases became the significant limiting factor on the industry since 1996. Status of occurring OIE listed aquaculture related diseases in Sri Lanka during 2011 is given in Table 3. Shrimp diseases recorded in the country are given in Table 4.
**Aquatic animal diseases in the county (2011)**

**Table 3: OIE Listed Aquaculture Related Diseases in 2011**

<table>
<thead>
<tr>
<th>Disease</th>
<th>Status in Sri Lanka in year 2010/2011</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fish diseases</strong></td>
<td></td>
</tr>
<tr>
<td>Epizootic haematopoietic necrosis</td>
<td>Not reported</td>
</tr>
<tr>
<td>Epizootic ulcerative syndrome</td>
<td>Not reported</td>
</tr>
<tr>
<td>Gyrodactylosis (<em>Gyrodactylus salaris</em>)</td>
<td>Not reported</td>
</tr>
<tr>
<td>Infectious haematopoietic necrosis</td>
<td>Not reported</td>
</tr>
<tr>
<td>Infectious salmon anaemia</td>
<td>Not reported</td>
</tr>
<tr>
<td>Koi herpesvirus disease</td>
<td>Not reported</td>
</tr>
<tr>
<td>Red sea bream iridoviral disease</td>
<td>Not reported</td>
</tr>
<tr>
<td>Spring viraemia of carp</td>
<td>Not reported</td>
</tr>
<tr>
<td>Viral haemorrhagic septicaemia</td>
<td>Not reported</td>
</tr>
<tr>
<td><strong>Mollusc diseases</strong></td>
<td></td>
</tr>
<tr>
<td>Infection with abalone herpes-like virus</td>
<td>Not reported</td>
</tr>
<tr>
<td>Infection with <em>Bonamia exitiosa</em></td>
<td>Not reported</td>
</tr>
<tr>
<td>Infection with <em>Bonamia ostreae</em></td>
<td>Not reported</td>
</tr>
<tr>
<td>Infection with <em>Marteilia refringens</em></td>
<td>Not reported</td>
</tr>
<tr>
<td>Infection with <em>Perkinsus marinus</em></td>
<td>Not reported</td>
</tr>
<tr>
<td>Infection with <em>Perkinsus olseni</em></td>
<td>Not reported</td>
</tr>
<tr>
<td>Infection with <em>Xenohaliotis californiensis</em></td>
<td>Not reported</td>
</tr>
<tr>
<td><strong>Crustacean diseases</strong></td>
<td></td>
</tr>
<tr>
<td>Crayfish plague (<em>Aphanomyces astaci</em>)</td>
<td>Not reported</td>
</tr>
<tr>
<td>Infectious hypodermal and haematopoietic necrosis</td>
<td>Not reported</td>
</tr>
<tr>
<td>Infectious myonecrosis</td>
<td>Not reported</td>
</tr>
<tr>
<td>Necrotising hepatopancreatitis</td>
<td>Not reported</td>
</tr>
<tr>
<td>Taura syndrome</td>
<td>Not reported</td>
</tr>
<tr>
<td>White spot disease</td>
<td>Reported</td>
</tr>
</tbody>
</table>
### Table 4: Shrimp diseases recorded in the country

<table>
<thead>
<tr>
<th>Disease Type</th>
<th>Disease</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viral Diseases</td>
<td>White Spot Syndrome Virus (WSSV)</td>
</tr>
<tr>
<td></td>
<td>Monodon-type Baculo Virus (MBV)</td>
</tr>
<tr>
<td>Bacterial Diseases</td>
<td>Vibrio species – mainly <em>Vibrio harveyi</em></td>
</tr>
<tr>
<td></td>
<td>White Fecal Disease</td>
</tr>
<tr>
<td>Protozoan Diseases</td>
<td>Gregarina</td>
</tr>
<tr>
<td></td>
<td>Zoothamnium</td>
</tr>
<tr>
<td></td>
<td>Epistylis</td>
</tr>
</tbody>
</table>

#### 2.1 White Spot Disease (WSSV)

Shrimp farming is characterized by boom and bust cycles as a norm. But Sri Lankan situation is the continuous bust phase. At present Sri Lankan shrimp production is low due to frequent disease out breaks, anthropogenic and socio-economic factors. Frequent out break of white spot syndrome virus (WSSV) is the major constraint at present since 1996 after the introduction of the disease to the country (Hettiarachchi and Epa, 1999; Jayasinghe, 1997).

WSSV is the major problematic disease which causes high morbidity and mortality rates in many species of Peneaid shrimp and infect other crustacean species (Hawai University, 1999). White Spot Syndrome Virus (WSSV) is the common name used to denote the out break which is characterized by white inclusion of various sizes embedded in the cuticle at the late stage of infected shrimp. The virus is rod shaped double stranded virus of Baculo type. Both juvenile and adult stages are susceptible to the infection and mode of transmission is both vertical and horizontal. Surprising feature of this virus is the wide range of potential number of hosts in the range of crustaceans. Furthermore common inhabitants of shrimp ponds also serve as asymptotic...
carriers of the disease. Clinical signs include shell spotting from abnormal deposits of calcium salts and occasional reddish discoloration due to the expansion of cuticular chromatophors. Infected shrimps become lethargic, stop feeding and swim slowly near the pond surface and eventually sink to the bottom and die (Schering-Plough Aquaculture, 2004).

White Spot Syndrome Virus emerged in East Asian region during 1992-93. Taiwan has been identified as the initial focal point for the out break in the world. Then the disease quickly spreaded with infected post larvae and brood stocks across the Asian continent to south East Asia and India. Then the disease spreaded through out the world in shrimp farming regions within another five years of time period (Hawai University, 1999).

Prior to 1996 there had been no documented occurrences of WSSV in Sri Lankan commercial facilities or in natural habitats. However in1996 the industry was severely affected by WSSV. The epizootic is believed to have entered the country with the importation of infected post larvae from India and Singapore (Jayasinghe, 2006). Almost all the farmers in the North Western Province experienced the so-called loss resulting in the closure of business (Jayasinghe, 2006). A drop in production from 5.3 to 1.9 mt/ha/cycle causing an average reduction of 64% in production and an estimated total loss of 186.62 Rs. million (US$ 4.44 million) was observed due to this disease outbreak (Jayasinghe, 1996). Total accumulated loans of the farmers exceed Rs 3 billion due to continuous crop failures and losses in foreign exchange earning has been estimated as Rs. 4000 million per year. In addition, considerable amount of job opportunities have been lost. At the same time socio-economic problems have been observed in the farming areas (Jayasinghe, 2007). According to statistics of Shrimp monitoring unit of Batuluoya NAQDA, total functioned farm area in ha, farm area of WSSV affected in ha and WSSV occurrence as a percentage of total farm area of NWP Sri Lanka in 2008 – 2010 is given in figure 2.
Today white spot virus is well established in the natural environment other than in the farm environment and lacks successful control measures for the disease. (Corea & Jayasinghe, 2009). Figure 3 shows the monthly variation of percentage WSSV infection in Brood-stock (Shrimp Monitoring Unit, NAQDA, 2011) and high level of WSSV Infection recorded in February and October.

Figure 2: Total farm area in ha, WSSV affected area in ha and WSSV occurrence percentage of farms of NWP Sri Lanka.

Source: Shrimp Monitoring Unit, NAQDA

Figure 3: Monthly variation of percentage WSSV infection in Brood-stock

Source: Shrimp Monitoring Unit, NAQDA
Financial institutions black listed the industry as a non-performing. This directly affected the investment in this sector. In spite of those obstacles Sri Lankan shrimp farming industry has a great potential for production and market expansion. As a developing country shrimp farming is ideal for Sri Lanka as a foreign exchange earner. World shrimp farming sector is struggling to overcome WSSV. But most of the shrimp farming nations in the Indo-Pacific region have reduced the risk of WSSV by implementing the appropriate set of Better Management Practices (BMP) (Waduge, 2006).

2.2 Monodon Baculo Virus (MBV)

MBV affected shrimp exhibit pale bluish gray to dark blue black coloration, sluggish and inactive swimming movements, loss of appetite and retarded growth.

During the 1988-1989 MBV affected shrimp farming industry resulted in significant loss in productivity of the industry (Edirisinghe, 2003). The importance of MBV in shrimp culture is exemplified by problems related to infection that is usually encountered in hatchery and grow-out operations. MBV should be eliminated in the culture systems because its infection can slow growth, specially in intensive culture systems thereby decreasing productivity.

According to the management systems used for shrimp hatcheries in Sri Lanka, MBV infection percentage is taken into account as an indicator of the production unit (Brood stock collecting center, hatchery). Introduction of BMPs for Brood stock collectors and hatcheries are one of the main strategy used in Sri Lanka to mitigate the % of MBV infection of the post larvae. According to past records of MBV infection percentage, comparatively higher degree of infection can be identified.
2.3 **Vibrio infections**

During the periods having higher temperature and high salinity, higher vibrio load in the grow-out ponds has been detected. In the case of hatcheries, zoea syndrome occurrence is increased due to presence of higher percentages of vibrio bacteria (*Vibrio harveyi* and *Vibrio parahaemolyticus*).

3.0 **Introduction of *Penaeus vannamei***

Some aquaculture companies have made request from Ministry of Fisheries and Aquatic Recourses to introduce *Penaeus vannamei* in to Sri Lanka. Ministry of Fisheries and Aquatic Recourses has conducted a risk analysis for introducing *P. vannamei* on a pilot scale. No firm decision has been taken upto now.
4.0 **Status of National Strategies for Aquatic Animal Health Management**

4.1 **Strategies adopted in rehabilitation of shrimp farming industry through improved health management**

Ministry of Fisheries and Aquatic Resources Development (MOFARD), National Aquaculture Development Authority of Sri Lanka (NAQDA), and Department of Animal Production and Health (DAPH) is the key Government Agencies, which have authority to regulate any health Management issues of farmed aquatic animals.

NAQDA in association with other relevant government agencies and shrimp farmers and Breeders Association introduced and implemented strategies to rehabilitate the shrimp farming Industry through improved health management. These include banning of import of shrimp post larvae to the country, implementation of Best Management Practices (BMPs), Polimerace Chain Reaction (PCR) screening of post larvae before stocking in ponds, PCR screening of brood stocks, formation of farmer organizations, Zoning of the shrimp farming area, introduction of a crop calendar, environment rehabilitation programme, farm monitoring, hatchery monitoring, create awareness etc.

4.1.1. **Banning of Import of shrimp post larvae to the country.**

Ministry of Fisheries & Aquatic Resources has banned the importation of shrimp post larvae to the country since 1996.

4.1.2 **Hatchery shut down period**

According to records of WSSV occurrences among brood stock, main high WSSV disease occurrence peaks can be identified within the year which is mid January to mid February and mid July to August. As a disease preventive strategy, hatcheries are shut down during these periods.
4.1.3 Implementation of BMP’s

Introduction of Better management(BMPs) for Shrimp Industry in Sri Lanka.

As a another step under the disease prevention Strategies, National Aquaculture Development Authority (NAQDA) to introduced the Better management practices in collaboration with shrimp farm organizations, some non-governmental Organizations like District aquaculture Development Board (DADB), Sri Lanka Aquaculture Development Alliance (SLADA), CONSORTIUM for Aquaculture, Shrimp Breeders’ Association(SBA), Technical Association for Aquaculture(TCA), University experts as well as business sector participants. Under this strategy, BMPs have been prepared for: Shrimp brood stock collector; Shrimp hatcheries; Grow out farms; Shrimp feed importers; Chemical importers;

Prior approval form

Which is filled by the monitoring officer after the monitoring of the ponds, which is confidential and one of the determining factor to decide whether a farm is allowed to stock or not.

Bill of consent of the Farmer society

SMU introduced very interactive method of implementing BMPs, by the farmers themselves for their own sake through participatory approach. This bill is issued with 3 copies (white- for farmer, Green- for NAQDA and Yellow- Society) after the careful inspection of the farms by a committee of the Farmer society. This is a novel intervention of the participatory management of the farmers through co management. And NAQDA will not issue the PL stocking permission Bill without this society recommendation. It allowed farmers themselves to interfere & control the activities of neighboring farmers which certifies the proper implementation of the recommended BMPs.

PL Bill

After considering the prior approval form and farmers society’s consent bill a PL Bill will be issued by an Aquaculturist of SMU with 4 copies (White- Farmer, Green- Hatchery, Blue- return to NAQDA after stocking and Pink- file of NAQDA).
PCR report for WSSV and PL quality report

To obtain PL bill it is necessary to provide PCR checking report for WSSV and PL quality report issued by a certified laboratory indicating overall quality of the PL Sample and percentage of MBV infection. If the PL sample is positive for WSSV farmers were not allowed to stock that PL Batch and that PL Batch will be destroyed by the NAQDA in the hatchery itself.

Any farmer who is violating the rule of having compulsory PL stocking bill and any hatchery owner, who is issuing PLs to farmer without the PL stocking bill issued by SMU will be punished under the act no 2 of 1996 issued by Ministry of Fisheries and Aquatic resources (Amendment) Act (No. 22 of 2006)

4.1.3. Zoning of the shrimp farming area and formation of farmers societies

Main shrimp farming area were decided into 5 zones based on geographical characteristics, quality of the water source and climatic characteristics. (Appendix 1). Further 5 main zones were divided into 31 sub zones (Appendix 2). Farmers’ societies in respect of these zones were established for participatory management of the shrimp farming with special emphasis on health management. Farmers’ societies are responsible for monitoring the application of BMPs and other rules and regulations of NAQDA by farmers.

4.1.4. Introduction of crop calendar

A crop calendar for shrimp farming area was introduced by NAQDA in collaboration with shrimp farmers societies in 2005. Most significant features of the crop calendar are to minimize the disease risk period, establishment of barrier zones and to ensure the continuous harvest throughout the year and to reduce the pressure on natural water bodies. Implementation of crop calendar has become a legal instrument, since this became a regulation under Act No. 2 of 1996.

4.1.5. Implementation of Environment Rehabilitation Programs.

NWP has 3 main brackish water bodies/lagoons called Chilaw lagoon, Mundel lake and Puttlam lagoon and those water bodies has been connected each others by Dutch cancel. (Appendix 3).
Under the program of Dutch canal rehabilitation, cannel was de-silted to increase the water flow and improve the water quality. In addition to that, several awareness programs and mangrove replanting programs are carried out by the support of several non-government organizations.

4.1.6. Establishment of a Shrimp Farm Monitoring Unit

NAQDA established a separate unit called shrimp Farm Monitoring Unit (SMU) to monitor and regulate shrimp farming activities. A laboratory with adequate facilities is also operated under the SMU. This SMU and the laboratory is situated within the shrimp farming area. The laboratory has facilities for PCR testing, Diagnosis of other diseases and water quality and environment monitoring.

BMPs formulated for hatcheries required screening of shrimp brood stock for WSSV. As a strategy to motivate the hatchery operators for screening all the brood stock, Government offered free PCR testing limited number of samples for each month from each hatchery.

5. Status of National Strategies for Aquatic Animal Health Management

National strategy for Aquatic Animal Health management consist of preventing trans boundary fish diseases and prevention of diseases and it’s spread through implementation of BMPs’.

5.1 Relevant Government Agencies involved.
5.1.1. Department of animal Production and health (DAPH)

DAPH is the main government Agency which is mandated to perform inspection, quarantine and certification of imports and export of animals. Legal framework for the quarantine of imported aquatic animals is the animal Diseases Act 59 of 1992, an Act to provide a legal framework for the quarantine of imported aquatic animals was established by the Animal Diseases Act, No. 59 of 1992, "An act to provide for the control and prevention of contagious diseases in animals; for the control of the import and export of animals, animal products and veterinary drugs and
veterinary biological products; and for matters connected therewith or incidental thereto."
Authority to administer the act is given to the Director of Animal Production and Health.

Facilities for testing of diseases are available at DAPH in Veterinary Investigation Center at Welisara, Veterinary Research Institute, Gannoruwa, Veterinary Investigation Centre at Gannoruwa,

Import of live fish to Sri Lanka is allowed subject to the following

(a) Submission of an International Veterinary Certificate from the Government Veterinary Authority in Exporting country along with the Consignment attesting that the aquaculture establishment from where this consignment of fish is originate is free from 6 diseases (OIE listed) for a period of two years immediately prior to export

(b) The consignment will be subjected to Quarantine surveillance at an identified isolated place for minimum period of 14(fourteen) days on its arrival to Sri Lanka and Animal Quarantine Officers will visit the Quarantine compartment, during this period.

(c) The intendant date of arrival of the consignment should be notified to the Animal Quarantine Officer, Katunayake Airport at least four days prior to arrival.

(d). Importer agree to Submit laboratory samples of fish and water at the time of Quarantine clearance for further investigation, at the port of entry and during the quarantine surveillance period.

5.1.2. Department of Fisheries & Aquatic Resources (DFAR)

Provisions for health management is provided to DFAR through Regulations framed under Aquatic Resources Act No. 2 of 1996.

5.1.3. National Aquaculture Development Authority (NAQDA)
NAQDA under it’s Act 53 No. 1998 of and regulations formed under it are empowered to regulate the aquaculture industry of which implementation of BMP’s is a key element.

5.1.4. **National Aquatic Resources Research & Development Agency (NARA)**

NARA is the research area of the Ministry of Fisheries & Aquatic Resources. NARA possess a PCR Laboratory and a bacteriology Laboratory and also have the capability to provide support services in water quality analysis.

5.1.5. **University of Peradeniya**

Facilities for Research, Training and testing service are available at the Centre for Aquatic Animal Disease Diagnosis and Research (CAADDR) at the University of Peradeniya.

5.1.6. **Department of Customs**

Inspects shipments of aquatic animals being imported or exported for necessary permits and certificates, including health certificates for aquatic organisms. Performs spot-checks for correct identity; liaises with the DAPH Quarantine Division and the Wildlife Department. Sri Lanka Customs, through the Customs Ordinance and the authority vested in the above acts, inspects shipments of aquatic animals being imported for export and import as to necessary permits and certificates, including health certificates for aquatic organisms. Customs officers perform spot-checks for correct identity; and liaise with the DAPH Quarantine Division and the Sri Lanka Wildlife Department.
Reference


Appendix 1

Main Sub Zones of Shrimp Farming in North Western Province
Appendix 2

Distribution of Shrimp Farming Sub zones in Puttalam district of Sri Lanka
Appendix 3

Geographical distribution of water bodies in the shrimp belt of Sri Lanka
Country Report of Thailand
on
Transboundary Aquatic Animal Health Issues In The Bay Of Bengal
Janejit Kongkumnerd¹ and Praphan leepayakhun²

1. Status of coastal shrimp and fish farming

Figure 1  Map showing coastline of Thailand, the figures indicating the number of provinces possessing coastline.

¹ Coastal Aquatic Animal Health Research Institute, Coastal Fisheries Research and Development Bureau, Department of Fisheries. Corresponding email: janejitkk@yahoo.com
² Fish Trade Inspection Section Office, Department of Fisheries.
The length of Thailand coastline is around 2,942.35 kilometers. It consists of 23 provinces including 6 provinces from Andaman Sea side and 17 provinces from Gulf of Thailand side. Furthermore, the longest coastline province is Prachuap Khiri Khan while the shortest one is Bangkok.

Table 1  Number and farm area of coastal aquaculture in 2009

<table>
<thead>
<tr>
<th>Zone</th>
<th>Fish</th>
<th>Shrimp</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. of farm</td>
<td>Area (rai)</td>
</tr>
<tr>
<td>Eastern Gulf</td>
<td>1,139</td>
<td>1,274</td>
</tr>
<tr>
<td>Inner Gulf</td>
<td>266</td>
<td>2,154</td>
</tr>
<tr>
<td>Western Gulf</td>
<td>3,872</td>
<td>1,465</td>
</tr>
<tr>
<td>Andaman Sea</td>
<td>6,261</td>
<td>360</td>
</tr>
</tbody>
</table>

Source: Information Technology Center, Department of Fisheries

The distribution of coastal fish and shrimp farms in Thailand is showed in Table 1. In terms of farm area, shrimp farms are mainly located in western Gulf of Thailand while major fish farms are in inner Gulf of Thailand. The intensive areas of shrimp farming are the following provinces; Surat Thani, Chachoengsao, Nakhon Si Thammarat, Prachuap Khiri Khan, Chanthaburi and Songkhla. However, high density of fish farming is operated at Samut Prakan, Samut Sakhon, Chanthaburi, Nakhon Si Thammarat, Trat and Prachuap Khiri Khan.

Only a few numbers of marine species are cultured in coastal aquaculture of Thailand. The major species of fish farming are Sea bass or barramundi (*Lates calcarifer*) and Grouper (*Epinephelus* spp.) as shown in Figure 2. In marine shrimp farming, economic species cultured in Thailand are White leg shrimp (*Penaeus vannamei*), Giant tiger prawn (*Penaeus monodon*) and Banana shrimp (*Penaeus Merguiensis*) as showed in Figure 3.
Yield of marine fish culture categorized by species (Unit: ton)

- Sea bass: 14,818
- Grouper: 2,996

Figure 2  Major fish species cultured in Thailand

Yield of marine shrimp culture categorized by species (Unit: ton)

- Banana shrimp: 571,189
- Black tiger prawn: 3,533
- White leg shrimp: 358

Figure 3  Major shrimp species cultured in Thailand

In terms of culture system, shrimp farming can be divided into three distinct types, namely extensive farming, semi-intensive farming and intensive farming. In fish farming sector, culture systems are pond and cage culture. Cage culture represents approximately 10% of total coastal area of fish farming.
From 2000, the overall yield from fish and shrimp farming in coastal aquaculture sector had been increasing continuously as shown in Table 2. In terms of production, the shrimp culture business is much larger than fish culture business representing approximately annual product value of 50,000 million baht.

Table 2 Yield of coastal aquaculture from 2000 to 2009

<table>
<thead>
<tr>
<th>Year</th>
<th>Fish Culture</th>
<th>Shrimp Culture</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>9</td>
<td>310.0</td>
</tr>
<tr>
<td>2001</td>
<td>9.4</td>
<td>280.1</td>
</tr>
<tr>
<td>2002</td>
<td>12.2</td>
<td>265.0</td>
</tr>
<tr>
<td>2003</td>
<td>14.6</td>
<td>330.8</td>
</tr>
<tr>
<td>2004</td>
<td>17.2</td>
<td>360.3</td>
</tr>
<tr>
<td>2005</td>
<td>16.8</td>
<td>401.3</td>
</tr>
<tr>
<td>2006</td>
<td>18.4</td>
<td>494.4</td>
</tr>
<tr>
<td>2007</td>
<td>15.4</td>
<td>523.4</td>
</tr>
<tr>
<td>2008</td>
<td>16.0</td>
<td>506.6</td>
</tr>
<tr>
<td>2009</td>
<td>17.8</td>
<td>575.2</td>
</tr>
</tbody>
</table>

Source: Information Technology Center, Department of Fisheries
2. Known shrimp diseases (including OIE-listed diseases) occurring in the country

Table 3  Shrimp diseases in Thailand

<table>
<thead>
<tr>
<th>Disease</th>
<th>Occurrences (no. of case reported)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2010 Jan-Dec</td>
</tr>
<tr>
<td>White spot disease (WSD)</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>(&gt;27)</td>
</tr>
<tr>
<td>Yellowhead disease (YHD)</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>(&gt;5)</td>
</tr>
<tr>
<td>Taura syndrome (TS)</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>(&gt;11)</td>
</tr>
<tr>
<td>Infectious hypodermal and haematopoietic necrosis (IHHN)</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>(&gt;7)</td>
</tr>
</tbody>
</table>


In Thailand, the White spot disease (WSD) outbreak first occurred in 1993 causing losses of over $US500 million. WSD outbreak can be found all-year-round with high risk of occurrence on January-March. However, the prevalence of the disease is decreasing which may result from better farm management.

Yellowhead disease (YHD) outbreaks occurred mostly on July-August and January-February which are rainy and cool season (winter) in Thailand, respectively. This disease has occurred in limited area, eastern Gulf of Thailand, since September 2010 with stable trend of disease prevalence.

Taura syndrome (TS) outbreaks can also be found all year round, especially on May-August and January-February. Central and eastern parts of Thailand are areas of TS occurrences. The trend of this disease prevalence has decreased which might result from better quality of seed supply and better disease management.
Infectious hypodermal and haematopoietic necrosis (IHHN) occurrences have been monitored under surveillance program since 2007. However, the disease prevalence has not decreased dramatically.

3. Exotic disease
Infectious myonecrosis (IMN) is an exotic disease for marine shrimp culture in Thailand at the present.

3.1. Status and action taken
The Department of Fisheries (DOF) is strengthening the import regulations, monitoring and active surveillance to prevent the spread of the IMN disease to Thailand. At the moment, DOF does not allow the importation of shrimp from Indonesia in order to decrease the risk of IMN disease into Thailand. Moreover, other importation of shrimp including seed and broodstocks is required the presence of health certification, quarantine inspection by Fish Quarantine Inspector and health inspection by Fish Health Inspector. In addition, Coastal Aquatic Animal Research Institute (CAAHRI) is responsible for active surveillance of IMNV in coastal aquaculture with association from Coastal Fisheries Research and Development Centers (CFRDC) which distribute in 19 provinces along coastline of Thailand. Since the beginning of the surveillance program, 1597 samples have been randomly collected from shrimp hatcheries in coastal areas by DOF officers of 19 CFRDCs. No positive result for IMNV has been found.

4. Status of *Penaeus vannamei* farming
The *Penaeus vannamei* farming in Thailand has increased the product yield since 2003, in substitution of *P. monodon* farming. The culture system of *P. vannamei* farming is intensive culture system. Generally, this farm type located in areas where ponds can be completely drained dried and prepared before each stocking. Earthen ponds are commonly found in this culture system and liners are used to reduce erosion and enhance water quality. Ponds are generally small (0.1–1.0 ha) and square. Water depth is usually >1.5 m. Stocking densities range from 60–100 PL/m² (96,000–150,000 PL/rai.) Heavy aeration is necessary for water circulation and oxygenation. Feeding with artificial diets is carried out 4–5 times per day. FCRs are 1.4–1.8:1.
5. Status of national strategies for aquatic animal health management

5.1. Law and Legislation

- Fisheries Act (1947, as amended in 1953 and 1985) provided Department of Fisheries (DOF) authority and responsibility to apply, implement and enforce the Fisheries Act and other relevant laws related to Fishery matters and to study, research and develop aquatic resources, the aquatic environment, aquaculture, fish enhancement including genetic research, and fishing gear.

- Animal Epidemics Act B.E.2499 (1956: A Royal Decree dated May 27, 2003) provided authority to Fishery officers in control all import, export and transit aquatic animals. The list of diseases including 27 diseases of aquatic animals is provided by Ministerial Notification date December 28, 2003.

- Import and Export Control Acts B.E.2522 (1979) authorized the DOF to inspect, control and certify fish and fishery product exported to other countries under the conditions specified in the Ministerial Notification of the Ministry of Commerce.
5.2. Marine Shrimp Disease monitoring and surveillance program

There are two research institutes responsible for this program. The objective of this surveillance program is to record and to communicate the status of disease outbreaks occurring in country. The details of the institutes are as follows;

- Coastal Aquatic Animal Health Research Institute (CAAHRI) – program administrator of web-based application of surveillance program
  Coastal Fisheries Research and Development Bureau
  130/2 Moo8 Pawon sub-district
  Muang district Songkhla 90100 THAILAND
- Inland Aquatic Animal Health Research Institute (AAHRI)
  Inland Fisheries Research and Development Bureau
  Department of Fisheries
  Paholyothin Rd. Jatuchak Bangkok 10900 THAILAND

5.3. Disease Diagnostic Laboratories and Issuing of Live aquatic animal Health Certificate

Under control of Coastal Fisheries Research and Development Bureau, 19 laboratories can detect shrimp virus using PCR-based method.

In addition, CAAHRI is an ISO/IEC 17025 accredited laboratory for shrimp virus detections (WSSV, TSV, YHV and IHHNV.)

In terms of health certification, all aquaculture farms must be registered with the Department of Fisheries (DOF) via Provincial Fishery Offices and are required to comply with Good Aquaculture Practice (GAP) or Code of Conduct (CoC) standard which is assessed by Competent Authority (CA). Only registered farms with GAP or CoC certification can request live aquatic animal health certificate. CAAHRI and Phuket Coastal Fisheries Research and Development Center are designated as Competent Authority (CA) for health certificate issuing concerning aquatic animal disease. The system of Live Aquatic Animal Health Certificate issuing is online web-based application and the administrator of this system is AAHRI.
5.4. Quarantine measures

The DOF is responsible for quarantine of aquatic animals. Beginning with the arrival of live aquatic animals accompanied with health certificate from exporting country, the consignments are inspected by Fish Quarantine Inspector at the port of entry (Level I diagnosis.) The animals are then transported to the facilities of importing company with quarantine standard approval. Fish Health Inspectors from CAAHRI or AAHRI take aquatic animal samples from quarantine zone to laboratory for detection of pathogens. The quarantine period is at least 15 days.

6. Transboundary issues associated with shrimp farming.

Table 4  Quantify of shrimp (Penaeus vannamei) import and export from 2010-September 2011

<table>
<thead>
<tr>
<th>Product (unit)</th>
<th>Import</th>
<th>Export</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2010</td>
<td>2010</td>
</tr>
<tr>
<td></td>
<td>January-September 2011</td>
<td>January-September 2011</td>
</tr>
<tr>
<td>Chilled or Frozen (ton)</td>
<td>367</td>
<td>362,000</td>
</tr>
<tr>
<td>Broodstock (individual)</td>
<td>1,894</td>
<td>79,670</td>
</tr>
<tr>
<td>Seed (individual)</td>
<td>58,076</td>
<td>72,828,840</td>
</tr>
</tbody>
</table>

Source: 2 Fish Trade Inspection Section Office, Department of Fisheries

Transboundary movements of aquatic animal must comply with the quarantine measures. The steps for live aquatic animal importation into Thailand summarized as follows (Kanchanakhan, 2005):

- Pre-importation: facilities of Thai aquatic animal farms or companies have to achieve the quarantine standard of the DOF before receiving an import permit.
- On arrival of aquatic animals at the port: the imported animals must be accompanied with Certificate of Origin and Health. The fish will be subjected to quarantine at the certified quarantine areas of the importing farms or companies.

- Post-importation: aquatic animals will be quarantined for at least 15 days. Fish health inspectors will examine the animals for diseases listed in the OIE and other contagious pathogens. If serious pathogens are found, the animals will be destroyed without compensation. If the fish are free from listed diseases, the importation procedures are completed.

The health certificate presented at the port of entry together with the aquatic animal shipment must be issued by competent authority, signed by veterinarian or authorized officer and contained but not least to information as follows;

1. Name and address of consignee.
2. Name and number (scientific and common name) of aquatic animals.
3. Origin of the aquatic animals exported.
4. The aquatic animals must come from a country, a zone or a farm establishment where they are submitted to health supervision set up to operate according to the procedures described in the “Diagnostic Manual for Aquatic Animal Diseases” from Office International Des Epizooties (OIE) and that this country, zone, or farm establishment is recognized officially unaffected by the OIE listed diseases. If the test methods of any diseases are not designated in most recent edition of the OIE Diagnostic Manual, test methods of the disease which having been published in international science journals shall be used and must be states in the certificate.
5. The exported animals must not come from the sources that had an un-usual mortality during the previous three months, which the causation could not be explained.
6. Before exportation, the animals must be quarantined for 7-10 days and treated with chemicals to remove all external parasites.
7. The exported animals must be certified to free from OIE-listed diseases and other relevant diseases specified in Ministerial Notification.
Thailand Country Brief Report

Status of coastal shrimp and fish farming

The coastal area is located in 25 provinces in the Southern and Central part of country. Aquaculture at the coast is composed of marine shrimp and fish farming.

Five hundred seventy-five thousand ninety-eight tons of shrimps were produced by 25,131 shrimp farms in the area of 52,811 hectares in 2009. The most produced species was *Penaeus vannamei* (571,189 of 575,098 tons = 99.32 %), while *P. monodon* and other species were produced very small amounts (only 3,533 of 575,098 tons = 0.61 % and 376 of 575,098 tons = 0.07 % respectively).

For the coastal fish farming, there are 2 major species; seabass and grouper which can be reared in the cage or the pond. In 2009, Thailand produced 14,818 tons of seabass (83.18 %) and 2,996 tons of grouper (16.82 %).

**Known shrimp diseases occurring in the country (OIE-listed diseases)**

1. Infectious hypodermal and haematopoietic necrosis
2. Taura syndrome
3. White spot disease
4. Yellowhead disease

**Exotic diseases: status and actions taken**

Infectious myonecrosis (IMN) is exotic disease for Thailand. According to the diseases surveillance program, indicating that Thailand status has still been free from Infectious myonecrosis virus (IMNV). To prevent introducing IMNV into the country, legal importation of IMNV susceptible species must be done. At the same time IMNV surveillance program is conducted within the country.

**Legal introduction of *Penaeus vannamei***

The Department of Fisheries (DoF) has established the regulation of Department of Fisheries on:

1. Importation and registration of white shrimp farm for breeding and genetic improvement B.E. 2547 (2004)
2. Importation of marine shrimp into the Kingdom of Thailand B.E. 2553 (2010)

These two regulations contain the main points as follows:

1. Pacific white shrimp (*P. Vannamei*) can be allowed to import only for breeding and genetic improvement.
2. Pacific white shrimp to be imported must be genetic selection brooders.
3. The sources of Pacific white shrimp to be imported must be improved by DoF.
4. The sources of Pacific white shrimp must be biosecurity farms that have been under the monitoring system at least 2 years and no abnormal mortality occurs during 3 months before exporting.
5. The import premises must be registered by DoF.
6. The imported Pacific white shrimp must be accompanied with health certificate to ensure that they are free from Infectious hypodermal and haematopoietic
necrosis, Taura syndrome, White spot disease, Yellowhead disease and Infectious myonecrosis.

7. The imported Pacific white shrimp must be subjected to quarantine in the registered import premises.

8. The sample of imported Pacific white shrimp must be taken to examine for Infectious hypodermal and haematopoietic necrosis virus, Taura syndrome virus, White spot syndrome virus, Yellowhead virus and Infectious myonecrosis virus if there is positive result, the shrimp will be destroyed.

**Status of national strategies for aquatic animal health management**

The Department of Fisheries had set up the national strategy for aquatic animal health (2004-2008) which aimed to support good quality aquatic animal products for national consumption and export. At present the next version of the strategy is adjusting.

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Bangladesh, India, Indonesia, Malaysia, Maldives, Myanmar, Sri Lanka and Thailand are working together through the Bay of Bengal Large Marine Ecosystem (BOBLME) Project and to lay the foundations for a coordinated programme of action designed to improve the lives of the coastal populations through improved regional management of the Bay of Bengal environment and its fisheries.

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