International Trade in Aquatic Animals – A Risk to Aquatic Animal Health Status?

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ABSTRACT

The movement of live aquatic animals, genetic material and aquatic animal products carries an inherent risk of moving aquatic animal pathogens contained in those commodities. International trade is of particular concern because of the large volumes of live animals and products moved, the large distances covered, and the risk that entire countries hitherto free of a particular pathogen may become infected. International trade provides significant economic and other benefits to those directly involved in the trade, as well as to governments and to the public in both importing and exporting countries. It is therefore realistic to accept that such trade will always take place, and that there will always be an associated risk of spread of aquatic animal pathogens. It is also realistic to accept that once an aquatic animal pathogen has become established in a new location, it is very difficult, if not impossible, to completely eradicate it (although the effects of clinical disease can be mitigated). The old adage of "prevention is better than cure" certainly holds true. This paper suggests that the approach to managing aquatic animal disease risks associated with international movement of live aquatic animals, genetic material and aquatic animal products should be similar to a HACCP approach. Potential risk management measures can then be identified in advance for each individual step in the process of international movement of such commodities. International standards and guidelines describe such measures, both preventative (for example, certification and import risk analysis) and reactive ones (for example, contingency plans), and a range of tools are available at national, provincial, local and farm levels. All parties involved in

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international trade must recognise the need for vertical (farm, local, provincial, national, international) and horizontal (farm-to-farm, local-to-local, etc.) integration, application, and agreement regarding such measures, to ensure a continuous chain. Implementation is a responsibility that must be shared among all parties involved.

INTRODUCTION

The movement of live aquatic animals, genetic material and aquatic animal products carries an inherent risk of transferring aquatic animal pathogens. International trade is of particular concern because of the large volumes of live aquatic animals and their products moved (e.g., in 2002, about 38% – or more than 50 million tonnes live weight equivalent – of world fish production was traded internationally [FAO, 2004]), the large distances covered, and the risk that entire countries hitherto free of a particular disease may lose that status. Analysis of the disease risks associated with the translocation (including international movement) of live aquatic animals and their products has been the subject of conferences, training courses and workshops (Arthur *et al.,* 2004; Rodgers, 2001). Moreover, guidance is provided in international reference documents (OIE, 2006a, 2004a, b; Arthur *et al*., 2004; FAO/NACA, 2001, 2000).

International trade provides significant economic and other benefits to those directly involved in the trade, as well as to governments and to the public, in importing and exporting countries. It is therefore realistic to accept that such trade will continue, with associated risk of spread of aquatic animal pathogens.

More than 90% of the 50 million tonnes (live weight equivalent of world fish production) that are internationally traded is dead product (FAO, 2004). Despite this large volume, there is a paucity of scientific data on sampling strategies for product, diagnostic tests for product, or information on pathogen survival in product. Some product is internationally traded for use as feed for aquatic animals, providing a possible pathway for pathogen transfer, yet the safety of such aquatic meals for aquatic animals is not well understood or documented.

The risk of pathogen transfer is generally considered greater for movement of live aquatic animals than for movement of dead product; this paper therefore focuses on strategies to reduce the risks associated with international trade in live aquatic animals, but the authors suggest that a consistent approach should be taken for dead product.

The paper explores the options available to reduce the risk to an acceptable level of residual risk so that trade may continue relatively safely. The concepts of vertical (farm, local, provincial, national, international) and horizontal (farm-to-farm, local-to-local, etc.) integration, application, and agreement regarding such measures are explained in detail.

AQUATIC ANIMAL HEALTH RISKS IN INTERNATIONAL MOVEMENT OF LIVE AQUATIC ANIMALS

There is an inherent health risk associated with the movement of any animal (including aquatic animals), plant and human being, because any living organism harbours infectious organisms. Compared to the movement of terrestrial animals, the risk may be bigger in aquatics for the following reasons:

- Infections in aquatic animals are frequently sub-clinical, *i.e*. they would not be directly noticed before, during and immediately after the movement of that animal. This may be due to the different nature of aquatic host species in terms of, for example, unspecific defence as well as specific immune systems: host species have been able to develop despite the ubiquitous presence of infectious organisms in the aquatic environment and few means for the host animal to escape.
- The contribution of aquaculture to global supplies of fish, molluscs and crustaceans has grown from 3.9% in 1970 to 29.9% in 2002, with over 220 different farmed aquatic animal and plant species reported in 2002 (FAO, 2004). It is not surprising, then, that new pathogens continue to emerge (Bondad-Reantaso *et al.,* 2005; Murray and Peeler, 2005) and laboratory tests are not readily available, let alone standardised and validated (OIE, 2006b).
- There are multifactorial disease syndromes where several infectious agents are implicated; however, it is not known which ones are necessary *versus* which ones are sufficient to cause the disease. Examples are midcrop mortality syndrome (MCMS) of prawns in Australia (Cowley *et al*., 2005; Owens *et al.,* 2003, 1998; Spann *et al*., 1997), *Penaeus monodon* slow growth syndrome in Thailand (Chayaburakul *et al.,* 2004) and white tail disease of the giant freshwater prawn *Macrobrachium rosenbergii* in the French West Indies, China (People's Republic, PR) and India (Bonami *et al.,* 2005). To compound these problems, some viruses have been implicated in more than one disease syndrome, for example, gill-associated virus (GAV) in MCMS as well as in peripheral neuropathy and retinopathy in prawns (Callinan and Jiang, 2003; Callinan *et al.,* 2003), and some have been found at high prevalence in apparently healthy animals, for example GAV (Walker *et al.,* 2001) and Mourilyan virus (Cowley *et al.,* 2005).
- Unlike livestock, aquatic animal species are usually not domesticated, and there is comparatively little information available on their biological requirements as well as on their disease background, yet an increasing number of aquatic animal species that are native to a particular region are being developed for aquaculture (often by taking broodstock from the wild) and, when proven successful in that region, are translocated to other regions of the world as promising prospects for aquaculture (Bondad-Reantaso *et al*., 2005; Briggs *et al*., 2004).
- Disease control options are very limited (for example, there are few efficacious, commercially available vaccines, and there are very few drugs registered for use in aquatic animals).

International trade is of particular concern, because:

- The disease may spread to countries hitherto free of that disease.

- The long period of travel and associated stress can weaken the host animals' defence system and so increase both the likelihood of infection and the infectious load during transport. The traded animals may be clinically healthy before transport but may experience transport stress so that sub-clinical infection leads to disease outbreak in the entire consignment. This may only become apparent well after arrival, making tracing-back difficult.
- The traded animals may be of a species that is new to the importing country and hence immunologically naïve to resident aquatic animal pathogens. The traded animals may succumb to infection with such resident pathogens once they have been released into their new environment.
- Susceptible animals in the importing country may have never been confronted with aquatic animal pathogens carried by the imported animals, *i.e.* they are immunologically naïve and may succumb to clinical disease.
- In many cases it will not be known whether aquatic animal species in the importing country are susceptible to the pathogens that imported animals may carry, or whether the imported animals are susceptible to resident pathogens, before such un-intended "field trials" are conducted.

The disease risk inherent in the translocation (including international movement) of live aquatic animals has been well documented (Bondad-Reantaso *et al.,* 2005). Some of these movements are regarded as having caused not just localised outbreaks but even pandemics, for example, furunculosis, crayfish plague and epizootic ulcerative syndrome (Roberts, 2003). Given that the risks are well known by now, especially because of past experience and devastating socio-economic consequences (Bondad-Reantaso *et al.,* 2005), it is perhaps surprising that live aquatic animals are still being traded in a way that continues to lead to rapid international spread of disease. Examples of such spread in the Asian region in recent years are koi herpesvirus disease (KHVD) and Taura syndrome.

KHVD was first reported in Israel and United States in 1998. In the Asia-Pacific region, infection with koi herpesvirus (KHV) has been reported from China PR, Hong Kong SAR China, Indonesia, Japan, Republic of Korea, Philippines, Singapore, Taipei China and Thailand (OIE, 2005a,b; NACA/FAO, 2005a,b). KHV may have a wider than currently reported distribution because – typical of a herpesvirus – it may be present in apparently healthy fish, and the level and extent of current surveillance may be inadequate to detect such infections.

Taura syndrome was first reported in shrimp farms in Ecuador in 1991-1992 and spread throughout the Americas through shipments of infected post-larvae and broodstock, causing mass mortality of cultured shrimp. The Asia-Pacific Regional Quarterly Aquatic Animal Disease reports (until June 2005) show that Taura syndrome has been reported from Indonesia, Malaysia (suspected), Myanmar, Taipei China, Thailand and Vietnam (OIE, 2005a,c; NACA/FAO, 2005a,b). China PR reported the first occurrence in its territory of Taura syndrome in shrimp farms where a high mortality rate was observed in Hainan, Guanxi and Guangdong provinces in April, May and June 2003 (FAO/OIE/WHO, 2004).

TO TRADE OR NOT TO TRADE?

International trade in live aquatic animals (including eggs and gametes) and dead aquatic animal product creates economic and social benefits:

- Importers can obtain and sell a product that is not available, or only at a higher cost, on the domestic market. This leads to personal income for the importer as well as tax revenue for the importing country.
- Exporters make earnings from the sale of animals and products. Again, such sales create personal income for the exporter and tax revenue for the exporting country.
- The community of the importing country obtains access to a desired product.

As long as there is a financial gain to be made through international trade in aquatic animals and their products, such trade will take place (legally or illegally) and inevitably pose a risk to aquatic animal health, including to aquatic animals in the importing country. There are many possible ramifications, including:

- production losses in aquaculture
- food shortage
- unemployment
- loss of biodiversity (if wild animals are affected)
- loss of domestic consumer confidence (in the safety of seafood)
- loss of health status (loss of "free" status for a certain disease) and resultant loss of export market access
- establishment of the introduced pathogen.

The resulting question then is not "To trade or not to trade?", but what can be done to minimise the outlined risks.

It is realistic to accept that once an aquatic animal pathogen established in a new location, it is very difficult, if not impossible, to eradicate it (although the effects of clinical disease can be mitigated). The old adage of "prevention is better than cure" certainly holds true.

This paper suggests that the approach to managing aquatic animal disease risks associated with international movement of live aquatic animals, genetic material and aquatic animal products should be similar to a HACCP approach: potential risk management measures can then be identified in advance for each individual step in the process of international movement of such commodities. International standards and guidelines describe such measures, both preventative (for example, certification and import risk analysis) and reactive ones (for example, contingency plans), and a range of tools are available at national, provincial, local and farm level. All parties involved in international trade must recognise the need for vertical (farm, local, provincial, national, international) and horizontal (farm-to-farm, local-to-local, etc.) integration, application, and agreement regarding such measures, to ensure a continuous chain. Implementation is a responsibility that must be shared among all parties involved.

MANAGING AQUATIC ANIMAL HEALTH RISKS IN INTERNATIONAL TRADE

There is no magic wand that will simply remove all risk. As has been shown above, trade will happen, legally or illegally, and therefore prohibiting trade is not an option that is 100% effective. The other extreme – doing nothing at all and simply accepting all risk – may on the surface appeal because it initially does not incur any cost. However, it will in the worst case scenario lead to all diseases occurring everywhere. This, in turn, could not only lead to wide-spread and significant production (and income) losses, consequential loss on productivity because of the need for treatment of affected animals, and consumer concern and loss of consumer confidence in seafood (for example, because of residues from the treatment). It could also lead to reduction of biodiversity and loss of social amenities such as recreational fishing. In addition, "doing nothing" is rarely a politically acceptable decision.

The solution therefore lies in the middle, that is, in reducing the risk to an acceptable level of residual risk so that some trade may continue relatively safely.

MANAGING RISK – A SHARED RESPONSIBILITY

Scarfe (2003) describes biosecurity in aquaculture production as a program for protecting cultured or managed populations of aquatic organisms from harmful effects of introduced diseases, a description easily expanded to biosecurity in fisheries. He suggests that to be maximally effective, frameworks for aquatic animal biosecurity need to *inter alia* adhere to the principle of vertical (local, state, national, international) and horizontal (local to local, state to state, etc.) integration, application, and agreement (standardisation and harmonisation).

"Vertical integration, application, and agreement" includes that there needs to be a chain of sanitary measures to prevent or reduce the impact of aquatic animal disease introduction, and that this chain needs to be uninterrupted and logical in the way its elements are connected. For example, the World Trade Organization (WTO) in its Agreement on the Application of Sanitary and Phytosanitary Measures (the SPS Agreement) sets out the basic rules for food safety and animal and plant health standards, but it does not develop those standards. Rather, for animal (including aquatic animal) health and zoonoses, it recognises the standards developed by the World Organisation for Animal Health (OIE) as a reference within the SPS Agreement. The OIE, in turn, does not develop standards in isolation but through a formal process that involves Specialist Commissions, international experts, and all its Member Countries. That way, countries have the opportunity to influence the development of international animal (including aquatic animal) health standards that they are subsequently encouraged to apply when developing their national SPS measures.

The SPS Agreement encourages governments to establish national SPS measures consistent with these international standards, guidelines and recommendations. This process is often referred to as "harmonisation" (see "horizontal integration, application, and agreement" – Scarfe [2003]). The recommendations in the OIE standards make reference only to the animal (including aquatic animal) health situation in the exporting country, and assume that either the disease is not present in the importing country or is the subject of a control or eradication programme. Therefore, when determining its import measures, an importing country should do so in a way that is consistent with the principle of national treatment[1] and the other provisions of the WTO SPS Agreement.

Whilst governments carry some responsibility for ensuring market access for their industries as well as protecting them from the introduction of pests and diseases, the biosecurity "chain" will only be effective when the elements at the other end are also intact and functional. Thus, fishers and aquaculturists, too, need to act responsibly. Whether they produce fish for aquaculture, for recreational fishing, for human consumption, for ornamental purposes, or for feeding other fish, it is crucial that they learn to understand disease as a calculable business risk, not as something vague that will never happen to them. Like their governments who put national measures in place to manage the risks of introduction of aquatic animal pathogens with imports from other countries, farmers need to know how to minimise the risk of disease introduction to their enterprises. For example, rather than purchasing low-cost post-larvae, fry or fingerlings, farmers should put pressure on hatcheries and request that sanitary measures are put in place and that those hatcheries' produce is certified before purchase. Similarly, like a government that will combat disease outbreaks of national significance, farmers need to know what to do in an outbreak situation, for example, early notification of authorities and generic disease control measures.

MANAGING RISK – THE TOOLS

An important characteristic of any trans-boundary animal disease is the speed with which it can spread to other farms, villages, districts, the entire country, and even beyond that country's borders. In the aquatic world, the situation is worse: aquatic pathogens spread quickly through waterways that know no political boundaries, so that the first neighbouring farm or river system to which the disease spreads from the index case may already be located in another country, adding international spread to an already complex situation. The problem therefore needs to be tackled on all levels, *i.e.* at the farming level, the local, provincial, national and international level.

A variety of tools for aquatic animal health risk management are available. These tools are for managing risk at international, national, provincial, local and farm levels.

The SPS Agreement

The Agreement on the Application of Sanitary and Phytosanitary Measures (the "SPS Agreement") entered into force with the establishment of the WTO on 1 January 1995 (WTO, 1998). The SPS Agreement sets out the basic rules for food safety and animal

[1] A WTO Member that has a disease in a part of its territory may not impose sanitary measures that result in a higher level of protection for imports compared to the measures applied domestically to manage the disease within the country.

and plant health standards. "Sanitary and phytosanitary measures" are defined in the SPS Agreement as follows:

"… any measures applied:

(a) to protect animal or plant life or health within the territory of the Member from risks arising from the entry, establishment or spread of pests, diseases, disease-carrying organisms or disease-causing organisms;
(b) to protect human or animal life or health within the territory of the Member from risks arising from additives, contaminants, toxins or disease-causing organisms in foods, beverages or feedstuffs;
(c) to protect human life or health within the territory of the Member from risks arising from diseases carried by animals, plants or products thereof, or from the entry, establishment or spread of pests; or
(d) to prevent or limit other damage within the territory of the Member from the entry, establishment or spread of pests."

These include sanitary and phytosanitary measures taken to protect the health of fish and wild fauna, as well as of forests and wild flora.

Sanitary and phytosanitary measures, by their very nature, may result in restrictions on trade. The basic aim of the SPS Agreement is to maintain the sovereign right of any government to provide the level of health protection it deems appropriate, but to ensure that these sovereign rights are not misused for protectionist purposes and do not result in unnecessary barriers to international trade.

Members are encouraged to use international standards, guidelines and recommendations where they exist. However, Members may use measures which result in higher standards if there is scientific justification. They can also set higher standards based on appropriate assessment of risks so long as the approach is consistent, not arbitrary.

The OIE and its standards

The World Organisation for Animal Health (Office International des Epizooties, OIE) has the core mandate to improve animal health in the world. The OIE develops normative documents relating to rules that its Member Countries can use to protect themselves from diseases without setting up unjustified sanitary barriers. The main normative works produced by the OIE for aquatic animals are the *Aquatic Animal Health Code* (*Aquatic Code*) and the *Manual of Diagnostic Tests for Aquatic Animals* (*Aquatic Manual*). These aquatic standards are prepared by the Aquatic Animal Health Standards Commission (in brief, Aquatic Animals Commission), one of the OIE's four Specialist Commissions, with the assistance of internationally renowned experts. The standards are finally adopted by the OIE International Committee at the annual General Assembly of all Delegates of OIE Member Countries. The value of the OIE standards is therefore twofold:

- The measures published in the OIE standards are the result of consensus among the veterinary authorities of OIE Member Countries.
- The OIE standards constitute a reference within the SPS Agreement as international standards for animal health and zoonoses.

The OIE Aquatic Animal Health Code

The aim of the *Aquatic Code* is to assure the sanitary safety of international trade in aquatic animals (fish, molluscs and crustaceans) and their products. This is achieved through the detailing of health measures to be used by the veterinary or other competent authorities of importing and exporting countries so that the transfer of agents pathogenic for animals or humans is minimised but unjustified sanitary barriers are avoided.

The *Aquatic Code* is updated regularly, and a new edition is published each year, both in hard copy and on-line (see www.oie.int/eng/normes/en_acode.htm)

General provisions that OIE Member Countries can adopt to prevent and control aquatic animal disease

The provisions listed below are of a general nature, that is, they do not relate to specific diseases.

- Section 1.1 of Part 1 of the *Aquatic Code* provides contextual definitions of the terms or expressions used.
- Section 1.2 describes "Notification systems", commencing with the statements that "Countries shall make available to other countries, through the OIE, whatever information is necessary to minimise the spread of aquatic animal diseases and their aetiological agents and to assist in achieving better world-wide control of these diseases." This important "ground rule" is followed by detailed reporting requirements for OIE Member Countries. These rules specify the events in which immediate notification (within 24 hours) of the OIE is required and suggest that countries also provide information on the measures taken to prevent the spread of diseases, including possible quarantine measures and restrictions on the movement of aquatic animals, aquatic animal products, biological products and other miscellaneous objects that could by their nature be responsible for transmission of disease. The overall purpose of these provisions is transparency about the animal health situation worldwide. While the necessity for such transparency is particularly obvious in disease emergencies, this section of the *Aquatic Code* points out that the presence of an infectious agent, even in the absence of clinical disease, should also be reported. Section 1.2 then presents the disease listing and disease notification criteria, and the diseases listed by the OIE.
- Section 1.3 presents "Obligations and ethics in international trade", which includes information on certification procedures. The aquatic animal health situation in the exporting country, in the transit country or countries and in the importing country should be considered before determining the requirements that have to be met for trade. This Chapter then continues with "Responsibilities of the importing country", for example, that the import requirements included in the international aquatic animal health certificate should assure that commodities introduced into the importing country comply with the national level of protection, and that importing countries should restrict their requirements to those justified for such level of protection. If these are stricter than the OIE standards, guidelines and recommendations, then they should be based on an import risk analysis. There also "Responsibilities of the exporting country", notably that it is prepared to supply certain information to

importing countries on request. Responsibilities in case of an incident occurring after importation are also laid down. The second Chapter in Section 1.3 specifies certification procedures.

- Section 1.4 describes the principles of conducting risk analyses and provides detailed guidelines for each step, *i.e.* hazard analysis, risk assessment, risk management and risk communication. Two further Chapters in this section provide guidance on the evaluation of competent authorities and on zoning.
- Section 1.5 is about "Import/export procedures" and describes aquatic animal health measures applicable before departure, during transit, and on arrival. Some of these are very detailed and technical requirements; for example, disinfection of transporters, treatment of transportation water, and discharge of infected water (Chapter 1.5.1), whilst others are more general requirements to be met before and at departure (Chapter 1.5.2), for example, that each country should only authorise the exportation from its territory of live aquatic animals and aquatic animal products that are correctly identified, and inspected according to the procedures outlined in the *Aquatic Code* and *Aquatic Manual*. Chapter 1.5.5 describes aquatic animal health measures applicable on arrival, for example, that an importing country should only accept into its territory, live aquatic animals that have been subjected to examination by a member of the personnel of the Competent Authority of the exporting country or a certifying official approved by the importing country, and that are accompanied by an international aquatic animal health certificate.
- Sections 1.6 and 1.7 provide guidelines for "Contingency plans" and for "Fallowing" in aquaculture, respectively.
- Part 3 of the *Aquatic Code* contains recommendations for "Blood sampling and vaccination" and "Inactivation of pathogens". In addition, model international aquatic animal health certificates are provided in Part 4.

Recommendations applicable to specific diseases

The recommendations in each of the chapters in Part 2 of the *Aquatic Code* are designed to minimise the risk of specific diseases being introduced and established in the importing country, taking into account the nature of the commodity and the aquatic animal health status of the exporting country. This means that, correctly applied, the recommendations ensure that the intended importation can take place with an optimal level of animal health security, incorporating the latest scientific findings and available techniques.

At the General Session in 2006, the OIE International Committee adopted the ninth edition of the *Aquatic Code* including most disease chapters in a new format. There are two key aspects of this new format:

- Surveillance for declaration of freedom from disease
  Chapter 1.1.4 of the *Aquatic Manual* contains general requirements for surveillance for declaration of freedom from infection with a listed disease. These requirements differ, depending on the previous infection status and take into account, for example, historical freedom and absence of susceptible species. Where targeted surveillance is necessary, it needs to be underpinned with scientifically based, disease-specific surveys, rather than following a rigid schedule of testing 150 animals regardless

of the epidemiological situation, the disease biology and diagnostic test sensitivity and specificity. This constitutes a graded, risk-based approach. For example, where there are no susceptible species, there is no need for targeted surveillance, but basic biosecurity conditions need to be in place. These "basic biosecurity conditions" are defined in the *Aquatic Code*. They require, *inter alia*, that an "early detection system" is in place, which is also defined and which must include "veterinarians or aquatic animal health specialists trained in recognising and reporting suspicious disease occurrence".

- Commodities

  There are commodities for which, when authorising import or transit, Competent Authorities should not require any conditions relating to the disease in question, regardless of the status of the exporting country for that disease. This concept was introduced to provide better guidance to OIE Member Countries on commodities that can be traded safely and also to better reflect the realities of trade, for example the fact that more than 90% of the 50 million tonnes live weight equivalent of fisheries produce that were traded internationally in 2002 were in processed form (FAO, 2004).

  For all other commodities, a key aspect of the new disease chapters, which is consistent with the SPS Agreement, is that importing countries should not simply reject a commodity because it is deemed "too risky", but they should assess the risk and try to reduce it to an acceptable level. To aid this process, the new chapters provide guidance on disease-specific risk management measures. These depend on the status of the exporting country for that disease but also take into account the intended end-use for the traded commodity (for example, release into aquaculture, or for direct human consumption).

FAO/NACA Regional Technical Guidelines

The spread of aquatic animal pathogens has directly led to serious disease outbreaks in the Asia-Pacific region, impacting on aquaculture productivity, livelihoods, trade, and national economies. Such problems have also indirectly impacted on the trade of aquatic animal products within Asia and between Asia and major trading partners. Some of the most serious problems faced by the aquaculture sector in the Asia-Pacific region are those pathogens and diseases introduced and spread through movements of hatchery produced stocks, new species for aquaculture, and the ornamental fish trade; examples are white spot disease, Taura syndrome, and KHVD. More recent examples of economic losses due to spread of aquatic animal diseases include the following: carp mortalities in Indonesia, with estimated losses of 50 billion Indonesian rupiahs, approximately US$5.5 million (NACA/ACIAR, 2002); losses due to KHVD in Japan, estimated to be 150 million yen, approximately US$1.4 million (ISID, 2003a); and abalone mortalities in Taipei China, estimated to be 400 million Taipei China dollars, approximately US$11.4 million (ISID, 2003b).

Through cooperation of FAO, OIE and NACA and with the aid of additional regional and international expertise, guiding principles for responsible movement of aquatic animals and aquatic animal health management were established. The guiding principles in the "Asia Regional Technical Guidelines on Health Management and the Responsible Movement of Live Aquatic Animals" were adopted by 21 governments in the Asian region in 2000. Within Asia, the Technical Guidelines and their associated implementation plan, the Beijing Consensus and Implementation Strategy, provide the basic framework and guidance for national and regional efforts in reducing the risks of diseases due to trans-boundary movement of live aquatic animals and place emphasis on the concept of "phased implementation based on national needs" (FAO/NACA, 2000). There is strong endorsement by many regional, inter-governmental, and global organisations, and a shared commitment from national governments to support its implementation.

National policies and programs

One of the first countries to develop a national strategic plan for aquatic animal health was Australia. The plan was developed under the oversight of a joint industry-government committee and launched in December 1999 by the Australian Government Minister as "AQUAPLAN: Australia's National Strategic Plan for Aquatic Animal Health 1998-2003" (Commonwealth of Australia, 1999).

AQUAPLAN 1998-2003 delivered a range of tangible outputs that not only increased awareness about aquatic animal health, but also significantly enhanced Australia's capability to be prepared for, and respond to, aquatic animal disease emergencies. Standard diagnostic techniques for aquatic animal diseases, a series of emergency preparedness and response plans, training resources and disease simulation exercises were some of those outputs. *AQUAPLAN – A Five Year Review* (Commonwealth of Australia 2002) found that considerable progress had been made under *AQUAPLAN 1998-2003*, that it had delivered significant benefits to the industry and that its integrated approach was required for Australia to remain competitive. The review also noted that several priority areas within aquatic animal health remained to be addressed. The second plan – *AQUAPLAN 2005-2010* – was again jointly developed by governments and private industry sectors and launched by the Australian Government in July 2005 (Commonwealth of Australia, 2005).

Australia is not the only country that has invested into a national aquatic animal health strategy. Bondad-Reantaso *et al.,* (2005) present examples of other countries' economic investments in aquatic animal health through national strategies, disease control programmes, or research.

Import risk analyses have been conducted in several countries and are publicly available, for examples see Peeler and Thrush (2004), Peeler *et al.* (2004), Biosecurity Australia (2003), Diggles (2002), AQIS (1999a,b), EPA [United States of America] (1999), Biosecurity Authority [New Zealand] (1999) and Stone *et al.* (1997).

Farm level tools

It is well known that all cultured aquatic animal species can harbour infectious organisms that can be transferred to other regions and countries through international movement of those animals or their products. Despite the existence of the various codes, protocols, guidelines and manuals mentioned above, disease outbreaks continue to happen in new locations, as mentioned above for KHVD and Taura syndrome.

Disease outbreaks in wild aquatic populations may go unnoticed, depending on how remote the location is, *i.e.* how likely it is that there are humans to notice such an event. However, disease outbreaks (or early signs thereof) in farms would be observed fairly early, that is at a time when some intervention may be possible to mitigate the effects of the disease. The role of the farmer is therefore very important as he or she is the basic unit of the aquaculture industry and shares the responsibility for ensuring that the introduction and dispersion of pathogens is kept to a minimum. If individual farmers do not have the relevant knowledge, skills, resources or willingness, then the health of their animals (and possible that of their neighbours' animals) will be at risk.

Good farm management practices are important, and farmers need to pay special attention to biosecurity measures such as screening potential wild vectors before introducing them to the population to be cultured, and disinfecting or quarantining post-larvae, fry or fingerlings before introducing them into the aquaculture system. Complying with these rules will minimize the risk of infection. It is also crucial that farmers must notify disease outbreaks – or even suspicion of an infectious event – to other farms that may be situated on the same water supply or may have received stock from the affected farm directly or from a common supplier. The local fish or animal health authorities must also be notified. Farmers must understand the importance of providing this information, for example, so that a surveillance system can be put in place to assess and manage the risks of disease transfer associated with the trade of aquatic animals (within the country and internationally). Countries with little resources can request the assistance of international organisations.

An excellent example of an extension manual for farmers has recently been published by the Indian Marine Products Export Development Authority (MPEDA/NACA, 2003). This extension manual summarises farm level risk factors and practical management practices that can be used to reduce risks of shrimp disease outbreaks and improve farm production.

CHALLENGES AND OUTLOOK

As the above sections have shown, there are many tools available at farm, local, provincial, national and international levels to minimise the risk of international spread of aquatic animal pathogens. Why, then, do we still see international spread of aquatic animal diseases?

Of course, there is no one simple reason, but it is obvious that if we view effective biosecurity as a chain of sanitary measures to prevent or reduce the impact of aquatic animal disease introduction and spread, any missing or weak link in the chain will jeopardise the outcome, no matter at what level – farm, local, provincial, national or international – the weak member of the chain is located.

At the farm level, there can be complacency ("it won't happen to me"), or unwillingness to change traditional practices, or a genuine lack of understanding. In addition, there may be reluctance to invest resources into prevention of disease, which is often more of an insurance-like investment where returns are not obvious; buying cheaper post-larvae might have more immediate appeal.

At the local, provincial and national levels, authorities may not be sufficiently resourced to provide the required aquatic animal health services. Where regulations exist, there may be insufficient means to enforce compliance. Where governments do not compensate farmers for certain costs brought about by disease outbreaks, there is little incentive for the farmer to conscientiously report a disease outbreak to the authorities.

At an international level, there is acknowledgement that the drafting of globally applicable standards is inherently difficult, and that complicated or "over-the-top" standards have little chance of being applied. However, the need to develop such standards through a thorough, consultative process puts the onus not just on the drafting commissions but also on the countries that are subsequently expected to apply those standards.

The research community, too, is a part of the chain. There are many areas where scientific data are not available, for example, the effectiveness of inactivation of aquatic pathogens through commercial processing.

Finally, it is realistic to accept that trade will continue to occur, and despite all precautions, diseases will continue to be spread internationally. However, the risk of this happening can be reduced, and the effects can be mitigated, if all parts of the chain of trade, from producer to international organisations, accept their responsibility to cooperate in providing an unbroken chain of biosecurity.

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