

Quarantine Procedures and Their Implementation¹

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Abstract

Diseases have become one of the most significant constraints to aquaculture development and management worldwide. It is clear that most disease incursions and outbreaks stem from unregulated movement of aquatic animals, with little or no risk assessment and quarantine. The way to reduce the introduction of pathogens and occurrence of disease outbreaks is to apply appropriate international norms, recommendations, and standards that govern safe trans-boundary movement of aquatic animals and animal products. This paper discusses the various international conventions and agreements dealing with safe trans-boundary movement and the requirements for better quarantine as part of the process.

Introduction

Quarantine measures are outlined in most codes on introduced fish. Policies dealing with the introduction of aquatic species, including methods to minimize disease transfers, have also been developed by the International Council for the Exploration of the Sea (ICES) for marine introductions (ICES 1995). The World Organisation for Animal Health (OIE) has also developed recommendations and protocols for the international prevention and spread of specific diseases of aquatic organisms, as described in the Aquatic Animal Health Code and Manual (OIE 2003a; OIE 2003b). This also includes protocols for health surveillance of animals for domestic and international trade. Major international codes and guidelines for aquatic animal health and movement of aquatic animals include:

- The World Animal Health Organisation (OIE) Aquatic Animal Health Code and Manual (OIE 2003a; OIE 2003b);
- Asia Regional Technical Guidelines on Health Management for the Responsible Movement of Live Aquatic Animals (FAO 2000);
- The ICES Code of Practice on the Introductions and Transfers of Marine Organisms - 1994 (ICES 1995);
- The International Council for the Exploration of the Sea (ICES) and the European Inland Fisheries Advisory Commission (EIFAC)

Codes of Practice and Manual of Procedures for Consideration of Introductions and Transfers of Marine and Freshwater Organisms (Turner 1988);

- The ICES Guidelines for the Implementation of the ICES Code of Practice concerning Introductions and Transfers of Marine Species (ICES 1984); and
- The ICES Overview of Current Molluscan Disease Control Measures (ICES 1991).

There is an enormous number of cases where parasites and diseases have been spread to new regions by human activity. Most well-documented cases involve international movements and diseases introduced with exotic species to the receiving waters. Despite these examples and the codes and protocols described above, fish and shellfish continue to be introduced into new areas, with little consideration of the potential disease consequences. Additionally, transfers (movements of aquatic animals to areas within their areas of historical distribution) are commonly regarded as less risky, and thus are poorly documented, which complicates investigation of concurrent movements of pathogens and parasites. It should be noted, however, that there are equally significant health risks associated with transfers of aquatic animals within their geographic range. A population that is adapted to a specific pathogen can carry it with no sign of infection. There is a

¹This paper is drawn from the material and information provided in two recent publications dealing with aquatic animal health management strategies for the responsible movement of live aquatic animals in the Asia-Pacific region. The information provided in these documents is highly relevant to the other regions of the world, including Africa. The documents referred to are: (i) FAO/NACA. 2000. Asia Regional Technical Guidelines on Health Management for the Responsible Movement of Live Aquatic Animals and the Beijing Consensus and Implementation Strategy. FAO Fisheries Technical Paper No. 402. FAO, Rome, 53 p.; and (ii) FAO/NACA. 2001. Manual of Procedures for the Implementation of the Asia Regional Technical Guidelines on Health Management for the Responsible Movement of Live Aquatic Animals. FAO Fisheries Technical Paper No. 402. Suppl. 1. FAO, Rome. 106 p.

high risk of disease outbreak if that pathogen is introduced to a naive (non-adapted) population of the same host species.

International Conventions and Codes of Practice

Policies, legislation, practices and guidelines concerning aquatic animal health and the movement of live aquatic animals are in a state of constant change. Frequent revisions and modifications are necessitated by: (i) rapid worldwide developments in aquaculture and culture-based fisheries; (ii) increasing knowledge on diseases of aquatic animals; (iii) improved or new diagnostic tools; and (iv) improved pathogen detection procedures. In addition, changing trade patterns that reflect changes in the political, social, industrial, and economic environments of individual countries and regions also contribute to the dynamics of risk assessment sensitivity. As an adjunct to national legislation, policies, guidelines, and codes of practice have been developed by international agencies or working groups with responsibility for aquatic animal disease control. These have been developed to provide a degree of international standardization for the prevention of pathogen transfer with movements of live aquatic animals. Box 1 shows some of the major international initiatives. There are also relevant items within the Code of Conduct for Responsible Fisheries (CCRF), the Convention on Biological Diversity (CBD), and the World Trade Organization's (WTO) Sanitary and Phytosanitary Agreement.

FAO Code of Conduct for Responsible Fisheries (CCRF)

"States should, in order to minimise risks of disease transfer and other adverse effects on wild and cultured stocks, encourage adoption of appropriate practices in the genetic improvement of broodstocks, the introduction of non-native species, and in the production, sale and transport of eggs, larvae or fry, broodstock or other live materials. States should facilitate the preparation and implementation of appropriate national codes of practice and procedures to this effect."

Government representatives at the FAO Conference adopted this voluntary code in October 1995, with the objective of providing a framework to ensure national and international exploitation of aquatic living resources in sustainable harmony with the environment. Article 9 of the code refers

Box 1. Major international codes and guidelines for aquatic animal health and movement of aquatic animals.

- The World Animal Health Organisation (OIE) *Aquatic Animal Health Code* (OIE 2003a).
- The ICES *Code of Practice on the Introductions and Transfers of Marine Organisms - 1994* (ICES 1995).
- The International Council for Exploration of the Sea (ICES) and the European Inland Fisheries Advisory Commission (EIFAC) *Codes of Practice and Manual of Procedures for Consideration of Marine and Freshwater Organisms* (Turner 1988).
- The ICES *Guidelines for the Implementation of the ICES Code of Practice Concerning Introducing and Transfers of Marine Species* (ICES 1984).
- The ICES *Overview of Current Molluscan Disease Control Measures* (ICES 1991).

specifically to aquaculture and provides several principles relating to aquatic animal disease control. Article 9.3.3 is particularly relevant. The CCRF also emphasizes:

- The importance of cooperation with neighboring states in the introduction of species in trans-boundary aquatic ecosystems (Article 9.2);
- The need to establish databases and information networks to collect, share and disseminate aquaculture data, at national, regional and global levels (Article 9.2.4); and
- The need for cooperation in the elaboration, adoption and implementation of international codes of practice and procedures for introductions and transfers of aquatic organisms (Article 9.3.2).

Significantly, Article 9.4 also identifies the importance of producers (such as farmers, fishery stakeholders, etc.) in the development and implementation of practices for the responsible development of aquaculture, including aquatic animal health management and disease control.

Convention on Biological Diversity

The Convention on Biological Diversity (CBD) was opened for signature on 5 June 1992 at the United Nations Conference on Environment and Development (the Rio "Earth Summit"). The Convention, which came into force on 29 December 1993, emphasizes the conservation and management of aquatic animal biodiversity. This includes clear recognition of the importance of protocols to minimize the negative impact on aquatic biodiversity due to the movement of exotic species and uncontrolled spread of aquatic animal pathogens. The parties to the CBD agreed on a program of action for implementing the CBD

with respect to marine and coastal biodiversity at their second conference, held in Jakarta in 1995. This program, termed the “Jakarta Mandate on Marine and Coastal Biodiversity”, contains five “Action Items”. Two are directly relevant to the development of these regional guidelines: Action Item 4: “Ensure that mariculture operations are sustainable”, and Action Item 5: “Prevent introduction of, and control or eradicate, harmful alien species”. The latter identified introductions of pests and diseases with alien species as important risks that should be assessed and managed (de Fontaubert et al. 1996).

The Jakarta mandate also recommended the implementation of the articles of the Code of Conduct for Responsible Fisheries (FAO 1995) and of international guidelines. Also recommended was the development of databases to share information on important pathogens to assist risk assessments.

The Aquatic Animal Health Code

The World Animal Health Organisation (OIE), an international veterinary organization with 165 member countries, has recently revised recommendations and protocols for the prevention of the international spread of diseases of fish, mollusks, and crustaceans in its Aquatic Animal Health Code (OIE 2003a). The principal policy of the OIE is to facilitate international trade in animals and animal products, including aquatic animals and their products, on the basis of health control and preventative measures. The OIE also recognizes public health issues connected to the consumption of animal products, for example drug residues, radioactive pollution, and related health risk analyses. The OIE Code was first published in 1995 and is regularly revised with the last version published in 2003.

ICES/EIFAC Code of Practice

Recommendations for policies dealing with the introduction of aquatic species and guidelines for their implementation, including methods to minimize the possibility of disease transfers, have also been developed by the International Council for the Exploration of the Sea (ICES) and the European Inland Fisheries Advisory Commission of the FAO (EIFAC) (Anon. 1984; Turner 1988; Carlton 1993). These documents detail codes of practice for the transfer of live aquatic organisms,

including inspection, certification, quarantine, pathology, and environmental impact.

Additional ICES Codes and Guidelines

The Revised 1990 ICES Code of Practice to Reduce the Risks of Adverse Effects arising from the Introduction and Transfers of Marine Species was developed by the ICES Working Group on Introductions and Transfers of Marine Organisms (Carlton 1993). This Code of Practice is divided into five major parts: (i) a recommended procedure for assessment of all new species for introductions; (ii) actions regarding introductions; (iii) use of strict quarantine measures²; (iv) species involved in current commercial practice; and (v) different approaches toward the selection of the place of inspection and control of the consignment.

The ICES (1991) Overview of Current Molluscan Disease Control Measures recognized the rapidly expanding aquaculture industries based on mollusks, difficulties in the treatment and control of disease outbreaks in mollusks in open waters, and demands for transfers and introductions of indigenous and non-indigenous molluscan species. It noted considerable diversity among countries in disease control and quarantine legislation, and concluded that certification practices and procedures were of questionable value and required better definition regarding sampling regimes, numbers, and methods for disease detection.

Guiding Principles

When FAO developed the Asia Regional Technical Guidelines, they were based on a set of Guiding Principles. They are:

1. Movement of living aquatic animals within and across national boundaries is a necessity for economic, social, and development purposes.
2. Such movements may lead to the introduction of new and emerging pathogens and to disease establishment and, therefore may pose risks to the importing country's animal, plant, and human health status.
3. The role of health management is to reduce the risks arising from the entry, establishment or spread of pathogens

² Strict quarantine facilities differ from quarantine holding facilities used for low risk or routinely transferred aquatic animal species.

to a manageable level with the view to protecting animal, plant, and human life. Health management should also protect living aquatic resources, the natural aquatic environment and aquatic biodiversity, as well as support the movement of aquatic animals and protect trade.

4. The health management process is defined, in the broad sense, as aquatic animal health management encompassing pre-border (exporter), border, and post-border (importer) activities, as well as relevant national and regional capacity-building requirements (infrastructure and specialized expertise) for addressing health management activities, and development and implementation of effective national and regional policies and regulatory frameworks to reduce the risk of disease spread through movements (intra and international) of live aquatic animals.
5. Health management measures should be practical, cost-effective and easy to implement by utilizing readily available facilities. Individual countries may need to adopt, modify or vary these Technical Guidelines to suit their own particular situations and resources.
6. The varying capacity of developing countries to implement programs on health management should be acknowledged by relevant international organizations and financial institutions. These organizations should give full recognition to the special circumstances and requirements of many developing countries.
7. Health management measures will be based on an assessment of the risk to animal, plant, and human life or health. In assessing the risk, the prevalence of specific pathogens in both the region of origin and the region of destination are crucial issues. The likelihood of new or emerging pathogens becoming established in the region of destination is a major consideration.
8. All movements of aquatic animals should be conducted within the provisions given in existing relevant international agreements and instruments. Health management measures should not be applied in a manner that would constitute a disguised restriction on trade. Health management measures should be applied only to the extent necessary to protect animal, plant or human life or health, and must be based on scientific principles and not be maintained without sufficient scientific evidence.
9. In determining the appropriate level (stringency) of health management measures to be applied, relevant economic and ecological factors have to be taken into account. These are, *inter alia*: potential damage due to loss of production or value, and the cost of control or eradication. A conservative approach should be adopted in cases where insufficient knowledge exists in relation to disease risks posed by a particular import; a higher stringency of health management procedures should be adopted where in adequate knowledge exists.
10. The first movement (introduction) of a new species into a different area will require special health management considerations in light of the need to evaluate scientific evidence regarding the risk of introducing pathogens to new areas.
11. Different regions should attempt to harmonize health management procedures to facilitate safe movements of aquatic animals within and between regions.
12. Considering the free movement of aquatic species in trans-boundary waterways, it is necessary to divide regions into manageable sub-regional units based on factors such as geography, hydrography, ecosystems, epizootiological surveillance and effectiveness of control for the effective implementation of health management procedures. The basis for the establishment of such units should be uniform, clear, and unambiguous.
13. Honest, conscientious and transparent reporting is essential for health management to be effective.
14. Technical cooperation among regional experts is essential to promote the exchange of information and expertise.
15. Collaboration among the governments, public institutions, and the private sector, including all stakeholders, is important to

achieve the full purpose of implementing effective health management. Opportunities for sharing the benefits of health management among all stakeholders should be explored.

Health Certification and Quarantine Measures

In view of the current freedom from many serious diseases, documented disease introductions elsewhere, and the economic importance of fisheries and aquaculture industries, a compelling case exists for health certification and the quarantine of aquatic animals for the African region. Health certification and quarantine should facilitate the movement of healthy aquatic animals, be practical, readily implemented, by using available facilities (where possible), and be cost efficient. It should not pose unjustifiable or excessive restrictions on trade.

Development of quarantine measures for a first-time introduction requires a detailed knowledge of the disease status of aquatic animals within the region, as well as the nature and range of specific exotic diseases that may affect, or be carried by, the candidate species. A national or regional database, which can be continuously updated as new information becomes available, will greatly assist in this process. Freedom from disease concerns, in this case, is best assessed by holding and observing animals in quarantine facilities, whereby testing for infectious agents can be undertaken at the same time as protecting surrounding water and aquatic animals from exposure to the potential introduced species or any living effluent from its holding facility (various mechanisms exist to ensure that effluent from quarantine facilities is sterile or directed away from surrounding waters for land-based disposal). Access to more specialized laboratories and resources may be necessary to diagnose certain diseases.

A minimum standard of health certification and quarantine should be applied to all movements, with increasing levels of stringency, as the risk of introducing disease increases. Classification into lower risk and higher risk categories is, therefore, essential.

Health certification and quarantine measures should be implemented on a case-by-case basis, taking into account all circumstances and factors relating to the proposed movement. A full disease

history of the candidate species, including a detailed review of specific pathogens and their status in the country or region of origin, should be compiled.

Quarantine and health certification protocols should be developed in collaboration with fisheries scientists, veterinarians, quarantine authorities, and industry stakeholders. An advisory authority on quarantine and health certification, including such expertise, should be formed to report to the government and act as a forum for all issues relating to trans-boundary movement of live aquatic animals.

Since the development of quarantine and health certification protocols requires detailed knowledge of the disease status of aquatic animals within the region, national and regional databases should be developed and updated as new information becomes available. While such databases are under development, the disease status can be assessed by holding shipments of aquatic animals in quarantine and, where appropriate, treating them. Access to specialized laboratories and resources may be necessary to diagnose certain diseases.

Quarantine and health certification considerations should be treated separately from ecological and environmental or genetic concerns, since the latter do not, normally, fall within the capability of aquatic animal health specialists.

Health Certification Process

Health certification provides documented assurance that a stock of live aquatic animals to be moved from one area to another (usually trans-boundary) is free of disease agents of concern to the importing country. Such certification also provides documentation for the shipper, in the case of a subsequent disease outbreak. Both aspects of certification assist effective tracing of the source of infection and the control or prevention of repeat infections.

Certification, by definition, means that the signing authority takes responsibility for the accuracy of the statements made on the certificate. This is especially important when the certificate is a condition for issue of a transfer license under an established legal framework. This means that the signing authority has a legal, as well as moral, obligation to ensure that the statements included in the certificate are accurate to the best of his/her

knowledge. Thus, the signing authority must have direct experience or authority over employees who provide the scientific advice upon which the authority decides whether or not to sign a health certificate. This requires:

- training in aquatic animal diseases of concern to importers;
- accurate knowledge of the health status of the source of the exports being certified; and
- accurate knowledge of the health status of the same and related species in the receiving waters.

Certificates signed by personnel with inadequate training and experiences provide little assurance against disease transfer. Such certificates are a liability to both the importer and exporter. It should also be noted that border checks for gross signs of disease, which currently form the basis for the issue of health certificates in many countries, are of little value in detecting most aquatic animal pathogens.

In many countries, current infrastructure may not permit immediate improvement of health certification and quarantine procedures. In addition, many living aquatic animals pose logistical complications for effective post-border quarantine processing. For such cases, an accurate pre-border risk assessment is the pivotal factor for deciding what level of quarantine is necessary. Alternative procedures, such as accreditation of hatcheries, grow out facilities, holding establishments, etc., should also be considered as mechanisms to reduce the risk of trans-boundary introduction of aquatic animal pathogens.

Quarantine Process

Minimum quarantine requirements

Minimum quarantine requirements are those applied to all transfers or introductions assessed as having a minimal risk of disease transportation. Additional measures will be required for cases with a higher risk of disease transfer. Minimum quarantine requirements include, but are not necessarily limited to:

- some mechanism of assurance (for example pre-border health certification) that the source is free of diseases of concern;
- border level examination for gross signs of disease and ill-health; and
- shipment rejection, or border containment, of any shipments showing signs of disease and

ill-health that are not likely to be attributable to shipping stress or damage.

Levels of risk can be minimized through biological awareness, as well as physical infrastructure. Eggs, embryonic or juvenile life stages should be selected for transfer, where possible, since these generally carry fewer primary or sub-clinical infections than do adult aquatic animals, and they are generally easier than adults to maintain under quarantine conditions.

Candidate stocks should be transferred on a batch-by-batch basis, where a batch is defined as a group of animals of the same age, from the identical population, and maintained as a discrete group. Mixing of animals, water or equipment between batches means that, for disease-screening purposes, those batches must be considered as a single batch.

Duration of quarantine

It is not possible to stipulate the duration of quarantine evaluation or containment, since this will vary depending on the candidate species and the risks associated with its movement. Most protocols for international introductions recommend spawning under quarantine containment conditions, with the release of the F1 generation after the broodstock has passed health surveillance and diagnostic screening (for example see ICES 1995). This is applied mainly to first-time introductions or high-risk introductions. Introductions from sources that have passed a quarantine containment process may receive "approval" status if conditions do not change at the export site, reducing further quarantine requirements and/or duration.

Pre-transfer quarantine

Animals destined for transfer should be placed in a quarantine facility for health examination, certification, and disease testing, as required. Any therapeutant used must be reported to the Competent Authority (CA) of the importing country. Health examinations should include sub-sampling for pathogens at least once prior to transfer. The cause of any disease detected should be determined or the transfer aborted.

Post-transfer quarantine

Animals should enter quarantine in the importing country for health examination and

disease testing. Depending on the risk assessment of the source, sub-samples may be taken for examination for specific infectious agents of concern. Any animal that shows signs of disease should be examined, and the cause of the disease determined. If the cause cannot be determined, or if pathogens or parasites of concern are found, the transfer should be aborted and transport materials disinfected or disposed of in a sterile manner. Closed circulation quarantine containment facilities, used for higher risk transfers, should be thoroughly disinfected following detection of disease.

Quarantine inspection procedures

To ensure compliance with all import conditions, an official appointed by the importing authority should inspect each consignment of animals on entry. The CA may have additional responsibilities to inspect for requirements other than health (such as contamination by other organisms, human health requirements, etc.).

Pathogen containment facilities

A pre-transfer facility should ensure minimal exposure to infection risks at the export site. Post-transfer facilities should ensure prevention of escape of any animals or their disease agents into waters of the importing country prior to health screening.

Physical security

Quarantine containment facilities used for introductions of high or unknown risk should be capable of preventing:

- entry by unauthorized people;
- loss or release of quarantined animals; and
- loss of contaminated water or equipment.

The facility should be located within, or close to, existing fisheries or animal health facilities and, preferably, should have 24-hour supervision. The facility should be lockable and access restricted to designated personnel.

Containment facility location

Tanks, ponds, pools or other containers of an appropriate size and volume for the aquatic animal species in transit should be isolated from aquaculture facilities, as well as municipal and open waters. Construction and siting should be

such that, in the event of an accidental spill or discharge, no water, animals or equipment will gain access to surrounding waters.

Intake water

Intake water should be obtained from a clean, unpolluted source to prevent physiological stress or masking of infectious agents by opportunistic infections. Incoming water should be filtered, wherever possible, for pre-transfer quarantine, to prevent exposure to infectious agents during the pre-transfer. This is not required for the post-transfer facility, however filtered influent water is recommended for containment of high or unknown health risk animals. This helps in identifying the source of any disease outbreak that may occur during the quarantine containment period.

Discharge water

All water leaving a post-transfer quarantine facility should be regarded as potentially infected. Thus, effluent from high-risk aquatic animals should not be discharged directly into surrounding waterways. Effluent containment in a sump, reservoir or pond that permits chemical disinfection, or discharge into a land-based pit or pond, is recommended for such cases. Any chemically disinfected (for example chlorinated) water should be neutralized prior to release into the environment.

Containment facility equipment

All equipment used for high disease-risk transfers and introductions (such as nets, containers, pipes, hoses, pumps) should remain within the containment facility and not be removed or used for any other purpose unless disinfected.

Containment facility laboratory area

An enclosed area, which can be used as a laboratory, is necessary to prepare samples and, where possible, undertake microscopic examinations, during quarantine evaluation of high-risk transfers and introductions. Containers and reagents should be available to permit sample dispatch to diagnostic laboratories for examination, if necessary. Samples leaving a high-risk quarantine containment facility should be delivered by approved quarantine personnel or be preserved and secured for handling by non-

quarantine personnel (such as clear handling and delivery instructions, sealed waterproof containers, documentation, etc.).

Disease Diagnosis and Health Examinations

Gross examination for evidence of disease is a minimum requirement for quarantine measures. Personnel can readily undertake microscopic examination for surface parasites as long as they have basic training in fish health and access to dissecting equipment and compound microscopes. Such training should include recognition of the broad taxonomic groups of protistan and metazoan parasites of fish and aquatic invertebrates, as a basis for treatment.

All animals that die or appear unhealthy should be examined. Access to specialized laboratory facilities, and/or personnel with experience in fish and shellfish diseases, is necessary if disease problems cannot be resolved within the quarantine facility.

Examination of healthy animals may be required in order to screen for sub-clinical infections. This is the case for introductions or transfers that have been assessed as being of high or unknown health risk. One such examination should be conducted pre-transfer and at least one other examination made post-transfer. The number of animals sampled should be in accordance with standard sampling procedures. This typically requires the use of specific diagnostic procedures and tests, and the use of quarantine containment laboratory facilities.

Freedom from specific diseases

A checklist of diseases and parasites known to affect the candidate species should be used as the basis for health certification of freedom from such diseases.

Treatment

Many diseases, especially the common diseases caused by external parasites, can be treated with readily available treatments (for example salt baths, fresh water, formalin). Other registered treatments may be available, but might require veterinary prescription or administration. Many organisms, especially internal agents, cannot readily be treated. It should be noted that the misuse of chemical treatment may cause

additional health complications, such as the development of antibiotic-resistant strains of bacteria. Chemical therapy should, therefore, be used with due caution and expert advice. Wild stocks are particularly susceptible to outbreaks of external parasites. This can be prevented by an initial treatment of animals entering a quarantine facility or by careful monitoring and husbandry modification (for example temperature reduction, decreased feeding regime or holding density).

Institutional Development and Capacity Building Requirements Legislative Frameworks

There are varying degrees of aquatic animal quarantine or health-related regulations to be found in the African region, ranging from the total absence to strict regulation, based on precise legislation. In general terms, a legal framework concerning the health management procedure is essential to the implementation of an effective program to reduce the risk of trans-boundary movement of aquatic animal pathogens.

In all cases, legislation for the import and export of live aquatic animals tends to be more comprehensive than that for the within-country movement of aquatic animals. Equally, more precise legislation dealing with the importation of live aquatic animals was reported in comparison to that dealing with their exportation. In terms of health, export regulations are governed predominantly by importing country requirements.

Resources

The resources that are needed for aquatic animal disease control take many forms, and will require access to institutional, laboratory, and human resources.

Institutional Resources

Institutional resources comprise both those organizations responsible for policy development, and those applying and enforcing regulations. The country strategies indicate a range of existing governmental infrastructure in terms of aquatic animal trade and production. Institutions, other than those holding direct legislative responsibility for aquatic animal health and live animal movement involved in this area, include government and semi-government research organizations, universities, international research

institutes, extension services, and private sector companies with diagnostic capability.

Laboratory Resources

The diagnostic laboratory resources range from those whose primary purpose is non-diagnostic (for example general bacteriology or water quality laboratories) through general veterinary facilities to laboratories specializing in aquatic animal disease diagnosis for fisheries and/or aquaculture. Diagnostic capability in many of the participating countries was reported to be deficient, from Level I to Level III capacity. Enhancement of laboratory facilities and increased training are frequently identified within national strategies as areas for improvement.

Human Resources

The level of human resources involved in aquatic animal disease control, measured both as the number of staff and as the level of expertise and formal qualifications held by individuals, vary greatly among countries. Human resources development at all levels from the farmer to the level of the policy-maker will be essential to support the implementation of disease control programs. The range of expert disciplines includes veterinary science, virology, bacteriology and mycology, parasitology, water and soil chemistry and specific aquatic animal health and pathology expertise. The qualifications of staff include: doctoral (Ph.D.), master's (M.Sc.), and bachelor's (B.Sc.) degrees in biological sciences; veterinary science degrees (D.V.M.), and other technical qualifications. Many countries in Africa lack aquatic animal health expertise and call for greater support in training. Training at all levels must take account of the educational level and language skills of the participants. The quality of training should be monitored to ensure effectiveness. This is particularly critical at the extension and farm levels, where many people must be trained and the educational levels may be lower. This is also the first and most important level of reporting and information gathering. In general terms, considerable capacity building in terms of knowledge and skills is required at this level the pond level among farmers and local (government and non-government) institutions involved in working directly with farmers.

Training at the satellite, national and regional laboratory levels must ensure accuracy and

standardization if it is to fulfill both the needs of farmers and of an internationally recognized reporting system. Standardization of approaches will benefit from better national and regional cooperation in human resources development. In researchers, the capacity to carry out problem-solving research must be available. This research must be demand-led and serve the end user. Research products must be delivered in a timely manner, and in a form that serves both the research and farming communities. In this way, both national and regional needs will be served. Technical and other support staff must be trained in order to relieve researchers and diagnosticians of the burden of routine work and to ensure that this work is handled rapidly.

Training and infrastructure development should be clearly matched against requirements (for example potential pathogen risks, economic importance). Many of the least costly activities are ultimately the most important and are likely to generate the greatest benefits, as disease awareness and reporting begins at the pond side. Analysis of cost-benefits from investments in infrastructure and training should be considered at an early stage in the development of national strategies.

There are considerable opportunities for regional-level training, particularly in those areas where advanced skills are scarce or not yet available. This may include training in such fields as epidemiology, histopathological diagnosis, immunology and molecular biology, virology, extension methodology in aquatic animal health, mycology, research methodology and design, and risk analysis and management.

Training should be matched against the health management procedures. Examples of knowledge and skills required for selected health management procedures are provided in Table 1. A rational approach to staff development requires national institutions to develop a policy that identifies their requirements and focuses on areas of need, identifying appropriate staff, and providing them with the training and resources needed to develop facilities and services.

Financial Resources

There are significant differences among African countries in the budgetary allocation to aquatic animal health control. Some governments have injected considerable funds into aquatic animal

Table 1. Examples of knowledge and skills required for selected health management procedures.

Level	Site	Activity	Requirement
I	Field	Observation of animal and the environment Clinical examination	Investment in training, access to information – little or no equipment required. (Site access may require boat or negotiation of cooperation with culture-site managers and employees). Investment in training and basic equipment; access to information required.
II	Lab	Parasitology Bacteriology Mycology Histopathology	Significant investment in training, equipment and running costs. Access to current information required.
III	Lab	Virology Electron microscopy Molecular biology Immunology	Considerable investment in training and equipment and considerable running costs. Access to current information required.

health in response to the devastating impact of disease on aquaculture and fisheries in the region. Others have no specific funding earmarked for aquatic animal health-related activities, although some work is performed using general budgetary allocations for agriculture and fisheries activities.

- Jurisdictional clarity;
- Consistency with international standards and obligations; and
- Greater participation of the private sector in policy making and providing financial resources.

Harmonization with International Standards

International harmonization of aquatic animal health measures is becoming increasingly important, and all member countries should tailor development of aquatic animal health strategies to be consistent with their international trade and other obligations, such as the WTO's Agreement on the Application of Sanitary and Phytosanitary Measures.

Consistency between terrestrial and aquatic animal systems will provide increased efficiency and a larger workforce of trained staff at times of peak demand, as well as facilitate meeting international obligations.

Conclusion

The advent of serious disease incidents in both aquaculture and fisheries in the Asian and Latin American regions over the past decade has resulted in a greater emphasis on aquatic animal health all over the world. In response, there has been the development of improved legislative frameworks, diagnostic facilities and expertise, and an increased commitment to the goals of sustainability and minimizing ecological impacts. However, it is clear that much remains to be done. Greater resources coupled with increased cooperation among countries, and a degree of harmonization of aquatic animal disease control policies and measures will facilitate meeting this goal.

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The following are three specific areas that countries in the African region should consider when developing aquatic animal health strategies:

- FAO/NACA. 2001. Manual of Procedures for the Implementation of the Asia Regional Technical Guidelines on Health Management for the Responsible Movement of Live Aquatic Animals. FAO Fisheries Technical Paper No.402.Suppl. 1. FAO, Rome. 106 p.
- ICES. 1984. Guidelines for the Implementation of the ICES Code of Practice Concerning Introductions and Transfers of Marine Species. ICES Co-operative Research Report No. 130, 20 p.
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