

Aquatic animal health: history, present and future

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Summary

Aquaculture stands as the fastest-growing food fish sector, expected to satisfy global demand for aquatic products. However, its expansion has led to disease emergence, adversely affecting both production and biodiversity. In response, since the mid-1990s the World Organisation for Animal Health (WOAH) has developed initiatives, notably the *Aquatic Animal Health Code* and the *Manual of Diagnostic Tests for Aquatic Animals*, aimed at harmonising health standards for international trade in aquatic animals.

With advances in aquaculture came the global spread of pathogens, resulting in significant disease outbreaks and economic losses. Efforts to curb these events led to the establishment of emergency programmes and conferences emphasising surveillance, preparedness and response and fostering increased collaboration among stakeholders. As aquatic animals grow in importance for global nutrition and food security, the emergence of new pathogens poses a threat. Understanding disease mechanisms and main drivers becomes pivotal for disease prevention. Collaboration across sectors, including government, industry, science and stakeholders, is vital for implementation of effective biosecurity measures to mitigate disease risks.

The Aquatic Animal Health Strategy, introduced by WOAHA in 2021, reflects the recognition of the growing significance of aquatic animal health and its relevance in food security and outlines a strategic approach to management of aquatic animal health worldwide. Emphasising standards, capacity building, resilience and leadership, this Strategy aims to address critical challenges in aquatic animal health and welfare.

Looking forward, the One Health approach will become imperative in confronting global health risks. In this holistic approach for ensuring sustainable aquaculture, it is important to recognise the great value of the people working in aquaculture and their contribution to global food security.

Keywords

Aquaculture – Aquatic Animal Health Strategy – Biosecurity – Food security – International standards – One Health – Sustainability.

Introduction

Aquaculture is the fastest-growing food producing sector in the world and is expected to produce significant quantities of aquatic protein in the coming years to meet the growing global demand for aquatic animal products [1]. Since 1970, aquaculture has grown at a rate of between 5% and 10% per year through expansion into new areas, farming of new (often non-native) species and intensified production [1,2]. These features of aquaculture, combined with large-scale movements of animals, have driven disease emergence, with negative consequences for both production and biodiversity [2,3,4].

It has been almost 30 years since the World Organisation for Animal Health (WOAH) published 'Preventing the spread of aquatic animal diseases' in the *Scientific and Technical Review* in June 1996 [1], and more than 20 years after, in August 2019, another issue was published on 'The role of aquatic animal health in food security' [5]. Both issues of the *Review* address these challenges, but since their publication, there have been significant developments in aquatic animal disease prevention and control.

The beginning: *Aquatic Animal Health Code and Manual of Diagnostic Tests for Aquatic Animals* of the World Organisation for Animal Health

In 1995, the World Trade Organization was established, and with it the Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement) [6]. The aim of the SPS Agreement was to minimise the negative effects of animal health restrictions on international trade [7]. To achieve this aim, measures established by countries to ensure the protection of human and animal life and health were to be based on international standards, guidelines and recommendations, primarily those developed by WOAH [8].

The WOAH *Aquatic Animal Health Code (Aquatic Code)* was first published in 1995, based on the principles set out in the corresponding *International Animal Health Code for Terrestrial Animals*. The WOAH *Manual of Diagnostic Tests for Aquatic Animals (Aquatic Manual)* was also first published in 1995 to provide general information on sampling methods and good laboratory practices, as well as detailed information on

diagnostic tests for laboratory technicians [6,7]. The principal aims of the *Aquatic Code* and *Aquatic Manual* were to harmonise health guarantees for international trade in aquatic animals (fish, molluscs, crustaceans) and aquatic animal products and to guide state Veterinary Services and other competent authorities in the preparation of appropriate health certificates [9]. The *Aquatic Code* and *Aquatic Manual* provided detailed information on disease definitions, notifications in connection with certification procedures, import risk analysis and import/export procedures [6,10,11]. By these means, the preparation of international health certificates could be based on a uniform approach to health control in aquatic animal populations, using the standardised methods described in the *Aquatic Manual* [11]. In general, health certification under the *Aquatic Code* was required only for diseases notifiable to WOA (five and six diseases for fish and molluscs, respectively). In addition to such notifiable diseases, however, the *Aquatic Code* established a list of other significant diseases (for fish, bivalve molluscs and crustaceans) that needed consideration [12]. The listed diseases were recognised as serious transmissible diseases of socio-economic and/or public health importance, in relation to which the international trade of aquatic animals and their products posed a significant risk of transfer between countries [3].

Advances in aquaculture in the years that followed included the use of exotic aquatic species and large-scale movements of many different species over great distances [4]. These practices led to the rapid development of aquaculture production but also contributed to the spread of pathogens between countries and regions [13]. The technology, experience or extent of surveillance was insufficient to assess the situation, resulting in serious epizootics incurring heavy losses worldwide. Efforts to overcome these problems were met with only partial success [13,14].

Advances in aquatic animal health: successful aquatic animal disease emergency programmes

Over the following decades, marine penaeid shrimp were affected by approximately 20 viruses. A decline in production was registered in some countries in Asia and Latin America beginning in the early 1990s, due to mass mortality caused by outbreaks of white spot syndrome virus and Taura syndrome virus [15]. In feral and farmed fish populations, infections like viral haemorrhagic septicaemia, infectious haematopoietic necrosis, infectious salmon anaemia and infectious pancreatic necrosis were diagnosed in areas of the world where they had previously been absent [16,17]. These infectious diseases created large problems in the fish farming industry and thus were the subject

of aquatic animal disease emergency programmes in several countries, resulting in successful eradication or control of certain diseases of aquatic animals [7,18].

In order to reduce the risks of transboundary aquatic animal disease epizootics, effective prevention and control measures should be complemented with improved diagnostic and extension services, educational programmes and other capacity building activities for farmers and other seafood producers [19]. Challenges for aquatic animal health were related to national and international legislation, including the development of standard approaches for control, the creation of appropriate infrastructures and a better understanding of the epidemiology of aquatic animal diseases. It was important to ensure that operational capability at the national level was in place to respond effectively to disease emergencies [20]. The Fish Diseases Commission, known since 2003 as the Aquatic Animal Health Standards Commission (AAHSC), played an important role by defining the basic principles for such procedures.

In October 2006, WOAHA held the first Global Conference on Aquatic Animal Health in Norway. The conference was arranged as a result of growing awareness of the constraints on managing aquatic animal diseases, due to both knowledge gaps and fragmented governmental responsibilities in many countries. Main issues raised at the conference concerned clarifying roles and responsibilities, building disease surveillance systems and preparing an emergency response, and identifying knowledge gaps and educational needs [21]. It was determined that the control of aquatic animal disease emergencies should be strategic, with full acceptance of all policy decisions from all stakeholders. WOAHA Members were requested to increase their capability to manage and report aquatic animal diseases through the establishment of national Focal Points. WOAHA intended to increase support for its members in aquatic animal health management through a future revision of the Performance of Veterinary Services Tool to include an evaluation of capacity to deal with aquatic animal health governance [21].

In the years that followed, WOAHA developed rules for its Members. For aquatic animal diseases, the *Aquatic Code* and *Aquatic Manual* were prepared by the AAHSC, with the assistance of internationally renowned experts and the other WOAHA Specialist Commissions, and in consultation with WOAHA Members. WOAHA Reference Laboratories and Collaborating Centres for aquatic animal diseases emerged as a network of expertise in aquatic animal health, playing a key role in aquatic animal disease prevention and control by providing diagnostic services and expert advice that are particularly useful in emergency situations [10,11,22].

Changing trends in managing aquatic animal disease emergencies

During this time, the rapid increase in aquaculture production and trade, and increased attention to the negative effects of diseases, were becoming stimuli for developing national biosecurity strategies for aquaculture. Technical and operational plans were increasingly common at individual enterprise level, with disease being recognised as a business risk [12,15,23].

Science underpinned these developments with novel vaccines and diagnostics, models assisted in the prevention and control of aquatic animal disease emergencies, and new concepts such as compartmentalisation provided managerial options to better deal with disease emergencies [18]. On the other hand, aquatic animal welfare and the possible development of antimicrobial resistance in aquaculture presented new challenges for mounting an effective disease response [24,25].

To improve health management programmes in aquatic animals and animal products moving around the world rapidly, it was necessary to develop appropriate guidelines for establishing national regulatory frameworks to improve responsibility in transboundary movement of live aquatic animals at national and regional levels [26,27,28]. In Australia, cooperation between industry and government led to the development of Australia's National Strategic Plan for Aquatic Animal Health, known as AQUAPLAN [20]. In 2000, the Food and Agriculture Organization of the United Nations, in collaboration with the Network of Aquaculture Centres in Asia-Pacific and in partnership with 21 Asian countries, developed the Asia Regional Technical Guidelines on Health Management for the Responsible Movement of Live Aquatic Animals and led their implementation at national level [19].

The role of aquatic animal health in food security

Aquatic animals have never been as important to human nutrition and food security as they are now. Aquaculture makes an important contribution to many of the United Nations Sustainable Development Goals, such as eliminating poverty and hunger and improving human health and well-being [29,30,31].

As aquaculture and trade in aquatic animals continue to grow, new pathogens will emerge, spread and add to current disease challenges [32]. If the opportunities presented by aquaculture are to be realised (and food security protected), it is clear that

global performance in preventing the spread of aquatic animal diseases and mitigating their impacts must be strengthened [5,33].

The rate of disease emergence can be reduced by understanding the underpinning mechanisms and developing mitigating measures. The three principal mechanisms of disease emergence, namely host switching, decreased host immunocompetence and increased pathogen virulence, have many drivers, such as an increasing international trade in live aquatic animals and their products, intensive aquaculture operations and climate change [34].

Improved aquatic animal health management must be a key component of aquaculture's future. At the national level, public–private partnerships are vital to achieving objectives of common benefit. Implementing biosecurity measures on a risk basis through the aquaculture value chain at regional, national or farm level is critical in the prevention and control of listed and emerging diseases and can be achieved only through government, industry, science and stakeholder collaboration [35,36,37].

Aquatic Animal Health Strategy

The fourth WOAHA Global Conference on Aquatic Animal Health, held in Chile in April 2019, concluded with a commitment to develop the Aquatic Animal Health Strategy to enable Veterinary Services or Aquatic Animal Health Services to meet both the opportunities and the challenges of this growth in aquaculture. The development of the Strategy was led by WOAHA with the support of the AAHSC. The resulting Aquatic Animal Health Strategy 2021–2025 recognises the growing importance of aquatic animal health and the need for a strategic approach to its management worldwide. It supports WOAHA's 7th Strategic Plan (2021–2025) and is aligned with its mandate.

The Aquatic Animal Health Strategy is a call to action to address the greatest challenges in managing aquatic animal health and welfare. It seeks to identify and coordinate actions that address the highest-priority common needs and to focus resources on activities that will provide enduring impacts. The Strategy has been designed to guide actions to strengthen four areas of the aquatic animal health system: standards, capacity building, resilience and leadership [38].

Conclusions and the way forward

From the publication of the 'Preventing the spread of aquatic animal diseases' issue of the *Review* in 1996 through to the establishment of the Aquatic Animal Health Strategy,

the path toward improved aquatic animal health has been a process involving numerous challenges, self-learning, collective efforts, inter-country collaboration and resilience building.

Recently, the Covid-19 pandemic dramatically emphasised the importance of the One Health concept in understanding and confronting global health risks. In addition to coordinating multisectoral efforts for prevention, preparedness and response to zoonotic diseases, other elements need to be addressed, such as antimicrobial resistance, food safety and climate change impacts [39]. These require a multisectoral and multidisciplinary approach that is truly One Health. Managing these major global health risks requires the full cooperation of the animal, human, plant and environmental health sectors in close collaboration with government, industry and science.

In this holistic approach, the greatest value lies within the individuals who work day in and day out for sustainable aquaculture. Recognition is owed to all of them for their contribution to global food security.

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